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Church Rock Site
Gallup, New Mexico

Prepared for:

UNC Mining and Milling
A Division of United Nuclear Corporation
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Part I of II

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1989 GROUND WATER CORRECTIVE ACTION ANNUAL REVIEW
UNITED NUCLEAR CORPORATION'S
CHURCH ROCK MILL AND TAILINGS SITE
GALLUP, NEW MEXICO

1.0 INTRODUCTION AND SUMMARY

Canonie Environmental Services Corp. (Canonie) has prepared this report of the annual review of the performance of the ground water corrective action systems installed and operating at United Nuclear Corporation's (United Nuclear) Church Rock Mill and tailings site in Gallup, New Mexico. This report consists of two parts with Part I containing the text, tables, figures, and appendices and Part II containing the water level and water quality data collected for the performance monitoring program. This report represents the first in a series that will be prepared during implementation of corrective action.

The corrective action systems for tailings seepage remediation were installed and began operating during the summer of 1989. This report describes of the construction and operation of the systems, results of the evaluation of the performance monitoring data, responses of the affected aquifers to operation of the remediation systems, and predictions of future operational adjustments.

This report was prepared in accordance with Nuclear Regulatory Commission (NRC) requirements set forth in Condition 30 of United Nuclear's Source Materials License SUA-1475 (License) and with Environmental Protection Agency (EPA) requirements set forth in an Administrative Order (AO) issued by the EPA on July 3, 1989, Docket 6-11-89, to United Nuclear pursuant to Section 106(a) of the Comprehensive Environmental Response, Compensation and Liability Act of 1989 (EPA 1989).

1.1 Background

In April 1989, United Nuclear submitted the Remedial Design (RD) report (Canonie, 1989a), which presented the technical basis and design of seepage remedial action to be implemented at the Church Rock site pursuant to Amendment I (Canonie, 1988a) and Amendment II (Canonie, 1989b) to the Reclamation Plan (Canonie, 1987a). As described in the RD, the remedial action was to be implemented for the three geologic formations of concern

identified as Zone 3 and Zone 1 of the Upper Gallup Sandstone and the Southwest Alluvium. These formations are described in the Geohydrologic Report (GHR) (Canonie, 1987b), the EPA's Feasibility Study (EPA, 1988a), and the EPA's Remedial Investigation (EPA, 1988b).

The corrective action at the Church Rock site described in the RD consists of extraction of tailings seepage from Zone 3 and the Southwest Alluvium. Limited seepage extraction from Zone 1 was to continue until dewatering of Borrow Pit No. 2, which is the source of tailings seepage in Zone 1, is completed. Figure 1-1 is a site orientation map that provides an overview of current site conditions and the target areas where corrective action is being implemented. The remedial action target areas were delineated in the RD (Canonie, 1989). For Zone 3 and Zone 1, acidic pH and calculations of travel distance were used to determine the extent of the target area. For the Southwest Alluvium, chloride concentrations greater than 100 milligrams per liter (mg/l) and calculations of travel distance were used to determine the extent of the target area. A summary of the remedial actions completed in 1989 is presented below.

1.2 Remedial Activities

1.2.1 Zone 3 Remedial Action

Remedial action in Zone 3 consists of pumping the existing northeast pumpback and new extraction wells located in or adjacent to the target area located northeast of the North Cell of the tailings impoundment. The existing northeast system consists of six wells pumping at an average combined rate of approximately 8 gallons per minute (gpm). Figure 1-1 shows the location of the system. The wells were installed in 1983 as required by the New Mexico Environmental Improvement Division to control migration of tailings seepage. The wells have been pumping continuously since that time and have extracted a portion of the seepage migrating from the North Cell of the tailings impoundment.

The purpose of the new extraction well system is to create a hydraulic barrier to further migration of the plume and to dewater the remedial

action target area shown on Figure 1-1. The extractable volume of the target area in Zone 3 is estimated to be 200 million gallons or less. The system of wells is designed to remove this volume in 6 1/2 years of operation. However, monitoring of hydrogeologic conditions during remediation will determine the duration and magnitude of pumping actually required.

Figure 1-1 shows the locations of the new extraction wells. As shown, a total of 12 new wells, numbered 701 through 713, were installed in 1989. These wells comprise Stage I of the Zone 3 system described in the RD. The remaining Stage II wells are scheduled to be installed in 1991 with the number and location to be determined based on the performance of the Stage I wells.

Originally, a total of 13 wells was proposed for the first stage of well installation . However, the results of the aquifer test conducted in the first five wells installed (708 through 712) indicated that Well 704 would have a low yield and, by interfering with adjacent extraction wells, could cause a net loss of system capacity by reducing the productivity of surrounding wells. United Nuclear sought and received approval from the NRC and EPA for exclusion of the well from the program in June 1989.

The new Zone 3 extraction wells began pumping on August 7 and 8, after installation of the distribution lines was completed. The wells have pumped continuously since that time with a combined average flow rate of approximately 43 gpm. This rate is less than the rate of 60 gpm assumed during the system design because the hydraulic properties of the formation limit the productivity of the wells. The extraction wells are monitored daily for water level, instantaneous pumping rate, and cumulative volume pumped so that adjustments to system operation can be made as needed. Evaluation of the performance of the system is based on the data collected since the third quarter sampling event in July 1989.

1.2.2 Zone 1 Remedial Action

Tailings seepage in Zone 1 originated from its subcrop in Borrow Pit No. 2 and migrated to the east of the Central Cell of the tailings impoundment.

Figure 1-1 shows the location of Borrow Pit No. 2 in relation to the plume in Zone 1. The remedial action for Zone 1 consists of dewatering Borrow Pit No. 2 and continuation of pumping from the existing north cross dike and east pump-back wells until the pit is dewatered. Additional pumping in Zone 1 has been determined to be infeasible due to the low transmissivity of the formation within the target area (Canonie, 1987b; EPA, 1988a).

In accordance with the schedule presented in the RD, Borrow Pit No. 2 was dewatered in 1989. In fact, dewatering was completed at the end of April 1989, which was approximately 6 months earlier than anticipated at the time the RD was submitted. Since Borrow Pit No. 2 is dry, remedial activities for Zone 1 consist of monitoring water levels and water quality in 10 wells located east and northeast of the pit. Although Borrow Pit No. 2 is dry, the existing pump-back wells continue to operate as required by the NRC License and the EPA in the AO (EPA, 1989). Evaluation of the performance of the Zone 1 remediation is based on the data collected since the second quarter sampling event in April 1989, when Borrow Pit No. 2 was dewatered.

1.2.3 Southwest Alluvium Remedial Action

Remedial action for the Southwest Alluvium consists of pumping three extraction wells comprising a barrier/collection system in the target area shown on Figure 1-1. The system is located downgradient of the southern edge of the South Cell of the tailings impoundment and upgradient of the Points of Compliance (POC) wells designated by the NRC for the Southwest Alluvium. The location, spacing, and pumping rates for the wells were designed to establish a hydraulic barrier to further migration of seepage through the alluvium while the source is being remediated.

Figure 1-1 shows the location of the three extraction wells (801 through 803) and four monitoring wells (804 through 807) that were installed in the Southwest Alluvium. The wells were installed in August 1989 and began pumping on October 16, 1989. The wells have pumped continuously since that time with a combined average flow rate of approximately 20 gpm. This rate is higher than the rate of 17 gpm assumed for development of the system design. As with the Zone 3 system, the extraction wells are monitored

daily for water level, instantaneous pumping rate, and cumulative volume pumped so that adjustments to system performance can be made as needed. Evaluation of the performance of the system is based on the data collected since the fourth quarter sampling event in October 1989.

1.2.4 Evaporation Disposal System

Seepage collected by the extraction wells is being disposed of by evaporation. The evaporation disposal system is designed to dispose of the extracted tailings seepage by the end of 1996. As shown on Figure 1-1 the system consists of two, five-acre lined evaporation ponds equipped with an evaporation mist system and a separate mist or spray evaporation system installed on the surface of the tailings. The evaporation disposal system has been installed and is operating entirely within the tailings disposal area. Details of the design and construction of the system are presented in Amendment I of the Reclamation Plan (Canonie, 1988a), the Technical Specifications (Canonie, 1988b) and the As-Built Report (Canonie, 1989c).

The lined ponds were constructed in October 1988 through January 1989 and began operation on January 3, 1989. The misters were installed in spring 1988 and have been used during the summer months to help control windblown tailings and dispose of the water from the extraction wells and Borrow Pit No. 2.

Between January and April 1989, water discharged to the ponds consisted of water pumped from the existing northeast, north cross dike, and east pump-back well systems and from Borrow Pit No. 2. Since Borrow Pit No. 2 was dewatered in April 1989, only water from the existing and new extraction wells has been discharged to the system.

1.2.5 Source Control - Surface Reclamation

Another component of the remedial action is the surface reclamation of tailings. Surface reclamation activities related to source control began in May 1989 and will continue until October 1997, when reclamation is

scheduled to be completed. Beneficial effects from the reclamation activities are to be realized by placement of a cover over the tailings impoundment to prevent infiltration of precipitation. A description of, and technical specifications for, the surface reclamation activities are presented in the Reclamation Plan (Canonie, 1987a).

As shown on Figure 1-1, the reclamation activities completed in 1989 included regrading and placement of the interim soil cover in the North Cell. Regrading of the North Cell is an important step for source control for Zone 3 because the seepage present in this unit originated from tailings liquids in direct contact with the sandstone exposed in the northeast corner of the North Cell [GHR (Canonie, 1987b)]. The regrading and recontouring of the tailings materials, shown on Figure 1-2, eliminates ponded water and minimizes infiltration. In addition, placement of the compacted soil cover provides a low permeability layer that also minimizes infiltration. Permeability testing of the interim cover material provided values of 1.4×10^{-6} centimeters per second (cm/sec), 3.9×10^{-8} cm/sec, and 3.5×10^{-8} cm/sec. These values confirm that the compacted soil cover serves a barrier to infiltration. As a result, further seepage recharge to Zone 3 is minimized.

1.3 Performance Monitoring

A program of performance monitoring was established to evaluate the success of the remedial action in meeting the design expectations. Performance monitoring may indicate that the objectives have been met and the remedy is complete. The results of the monitoring may also indicate that achievement of all cleanup levels in a reasonable time period is technically impractical and that establishment of Alternate Concentration Limits (ACLs) or a waiver to meeting certain contaminant-specific Applicable or Relevant and Appropriate Requirements (ARARs) is necessary. A detailed description of the monitoring program is presented in the RD (Canonie, 1989a). Figure 1-2 presents the locations of the wells included in the performance monitoring program.

The objective of the monitoring program is to provide statistically valid data that can be used to evaluate the performance of the extraction system in meeting regulatory criteria. Water chemistry analysis for the monitoring program has been and will continue to be conducted for the chemical constituents displayed in Table 1.1. The list includes the constituents for which the NRC has established ground water protection standards and/or the EPA has established ARARs for the site. Water chemistry data will be used to:

1. Monitor compliance with License Condition 30, Part B criteria at POC wells;

2. Monitor and assess trends in water quality that may develop in response to pumping;

3. Evaluate the effectiveness of cleanup within the target areas;

4. Provide an adequate database for development of ACLs (NRC) and waivers to ARARs (EPA), where necessary; and

5. Supplement the existing database.

Water level data will be used to determine the effects of the remediation systems on geohydrological conditions, including creation and performance of the hydraulic barriers, and to monitor the decreases in saturation that will occur as pre-mining natural conditions are reestablished. The monitoring program is also designed to further aid in establishing background water quality conditions. Background water quality plays a very important role in setting both the NRC's ground water protection standards and the EPA's ARARs.

1.3.1 Quality Assurance/Quality Control Plan

A Quality Assurance/Quality Control (QA/QC) Plan for the performance monitoring program was developed and described in the Remedial Action Plan (RAP) (United Nuclear, 1989) submitted to the EPA in April 1989. The

purpose of the plan is to assure that data generated from the performance monitoring program is accurate, representative, comparable, and complete so that performance evaluations and decisions can be made on an informed and logical basis.

Implementation of the QA/QC procedures for ground water sampling were verified by Canonie personnel during collection of the fourth quarter 1989 water samples. Observation of the procedures used by United Nuclear personnel to collect, treat, and ship samples conform with the procedures outlined in the RAP (United Nuclear, 1989). The procedures used ensure that samples are representative of site conditions and that variability in water quality caused by sample collection and handling procedures is minimized.

In addition to the QA/QC procedures implemented for sample collection and analysis, the water quality data are also subject to review, including statistical trend analyses, to identify analytical or reporting errors. This review is conducted as the data are received from the laboratory.

1.3.2 Performance Monitoring Evaluation

Evaluation of the results of the performance monitoring was conducted for the data collected since the remedial actions were implemented in Zone 3, Zone 1, and the Southwest Alluvium. Because of the limited time period over which data were collected, particularly in the Southwest Alluvium, the results of the evaluation provide only a preliminary assessment of the performance of the remedial actions. The following is a summary of the evaluation conducted for the three formations.

Zone 3 - Performance Monitoring Evaluation

The Zone 3 performance monitoring evaluation utilized the water level and water quality data collected during the third and fourth quarters 1989 sampling events. The third quarter data represent initial conditions since

they were collected in mid-July, immediately prior to startup of the system. The fourth quarter data represent conditions after three months of pumping (August through October).

The results of the evaluation indicate that the extraction wells are performing as designed and are successful in:

1. Capturing and extracting seepage in the remedial action target area; and

2. Creating a hydraulic barrier to further migration of tailings seepage.

For example, the saturated thickness of the formation has been reduced by more than 20 feet in the center of the well system. The area where drawdown caused by the wells equals or exceeds 10 feet is approximately 52 acres. This area of intense dewatering incorporates 90 percent of the Zone 3 target area.

Additional confirmation of the performance of the well system is provided by a comparison of actual field conditions and conditions predicted by the computer simulation. The location and configuration of the contours of saturated thickness based on the fourth quarter water level data are similar to those generated by the computer simulation. The similarity of the contour plots indicates the system is operating as predicted in the RD (Canonie, 1989a).

The preliminary pH data provide confirmation that the wells are extracting seepage. Comparison of the data from the third quarter and the fourth quarter sampling events indicates that the areal extent of tailings seepage represented by acidic pH was reduced by half, from approximately 72 acres to 34 acres, during the first three months of system operation.

Zone 1 - Performance Monitoring Evaluation

The Zone 1 performance monitoring evaluation utilized data collected during the second, third, and fourth quarter 1989 sampling events. The second quarter data represent initial conditions since they were collected at the end of April, immediately prior to dewatering of Borrow Pit No. 2.

The results of the Zone 1 performance monitoring evaluation indicate that water level and pH measurements remained stable for the period between second quarter 1989 (when Borrow Pit No. 2 was dewatered) and fourth quarter 1989. The plume, represented by acidic pH, has migrated approximately 150 feet downgradient from that delineated by the remedial action target area in the RD (Canonie, 1989a). Since the target area was established based on data collected in 1986, this distance is approximately one-third less than would be expected using the velocity of 115 feet per year to 148 feet per year calculated in the RD (Canonie, 1989a). Given the low permeability of Zone 1, dissipation of the mound will be a long-term process and identifiable changes or trends in water level and pH will occur in small increments.

Southwest Alluvium Performance Monitoring Evaluation

The Southwest Alluvium performance monitoring evaluation utilized data collected during the fourth quarter sampling event in October 1989 and water level readings obtained in December 1989 specifically for this report. The fourth quarter data represent initial conditions since they were collected immediately prior to startup of the extraction wells.

The results indicate that the extraction wells are performing as designed. Because the wells did not start operating until mid-October, the monitoring data provide only a preliminary indication of the effects of the extraction wells. However, review of the water level data indicates that the extraction wells are beginning to cause a reversal of the water level gradient and creating a hydraulic barrier to flow.

1.4 Recommendations for Continued Operation

Currently the remediation systems in all three zones are functioning as designed and, therefore, changes to operation are considered unnecessary at this time. However, discontinuation of operation of the east and north cross dike Zone 1 pump-back wells is being considered for the following reasons:

1. Pumping rates in the wells are so low that continued pumping is impracticable;

2. As a result of the low pumping rates, the wells have little or no effect in terms of accelerating dewatering of the mound and controlling migration of tailings seepage in Zone 1; and

3. The cost of operating the wells far outweighs the benefits achieved.

The performance monitoring data confirm the predictions made in Amendment I (Canonie, 1988a), the RD (Canonie, 1989a), and the EPA's Record of Decision (EPA, 1988c) that pumping and extraction of seepage is not a viable remediation option in Zone 1. Continued monitoring of the system for an additional year is recommended to verify that operation of the pump-back wells is unwarranted. Based on the results of the additional year of monitoring, United Nuclear may then request permission to discontinue operation of these wells.

2.0 SEEPAGE REMEDIAL ACTIONS

The following sections provide a detailed description of the seepage remedial actions for Zone 3 and Zone 1 of the upper Gallup Sandstone and the Southwest Alluvium that were completed in 1989. These activities included well drilling, aquifer testing, and operation of extraction wells for Zone 3 and the Southwest Alluvium; dewatering of Borrow Pit No. 2 and continued operation of the existing pump-back wells for Zone 1; and performance monitoring of the effects of remedial actions in each zone.

2.1 Zone 3 Remedial Action

Remedial action for Zone 3 consisted of continued operation of the northeast pump-back wells and installation and operation of the new Stage I wells. Figure 2-1 presents the locations of these wells. As of November 17, 1989 the northeast pump-back wells were pumping at a combined rate of 8.2 gpm. As described in Amendment I (Canonie, 1988a) and the RD (Canonie, 1989a), the existing wells are scheduled to operate through 1993, when the pumping rates of the wells are expected to decline to less than 1 gpm each. At that time, United Nuclear will request approval from the NRC and the EPA to discontinue operation of the wells.

The Stage I wells for the Zone 3 remediation system were installed in May and June 1989. As described in the RD (Canonie, 1989a), the wells were installed in sequence with the first five (708 through 712) completed in the first phase and the remaining seven (701 through 703, 705 through 707, and 713) completed in the second phase after aquifer testing was completed. The first five wells were tested to verify the performance of the system as designed and to determine the total number and locations of new wells needed for this stage. The remaining wells were then installed.

Well 704 was eliminated from the system based on the results of the aquifer test evaluation. The need to modify the Zone 3 remedial action was discussed with Gary Konwinski of the NRC and William Rowe of the EPA in June 1989. Both gentlemen gave verbal approval to eliminate Well 704 from the program. Documentation of the approval is contained in company files.

2.1.1 Well Installation

The wells were installed in accordance with the specifications presented in the RD (Canonie, 1989a). Details of the well installation and completion procedures are presented in Appendix A. A summary of the well completion details is presented in Table 2.1.

Initially, a pilot hole was drilled to the top of Zone 2 of the Gallup Sandstone, and geophysical logs were run to select the screened intervals. The hole was then reamed to a minimum diameter of 10 inches and conditioned for well completion. As shown in Table 2.1 the wells were completed with 6-inch-diameter casing with 20 to 30 feet of screen located at the bottom of the well. After installation was completed, the wells were developed using jetting, air-lifting, swabbing, and overpumping. Five of the wells (708 through 712) were then tested using the step-drawdown method to establish the specific yield and efficiency. The results of the step-drawdown tests are included with the well completion details presented in Appendix A.

2.1.2 Aquifer Testing

The first five wells installed in Zone 3 (708 through 712) were tested for individual capacity and interference to allow verification of the design pumping rates and refine the well spacing. Appendix B presents a detailed description of the aquifer test procedures and the data collected.

The first test utilized a single pumping well and was conducted to verify the validity of the hydraulic parameters used in the design. The test consisted of Pumping Well 709 at a constant rate of 5.0 gpm for 51 hours. Nine observation wells were monitored during the test, and responses were observed in four of the wells (EPA-15, EPA-15A, EPA-15C, and EPA-15D).

The second test utilized multiple pumping wells and was conducted to simulate operation performance. Wells 708 through 712 were pumped simultaneously for a period of 91 hours, and water level changes were observed at wells located between the pumping wells.

Evaluation of the test results provided the following information about the hydraulic properties of Zone 3 and revisions to the location and number of additional wells to be installed:

1. The average transmissivity is 1,000 gallons per day per foot. The average storativity is 2 percent. These values are similar to those estimated from previous aquifer tests in the vicinity and reported in the GHR (Canonie, 1987b) and were also used for the design of the remediation system.

2. The well spacings and locations in the design are adequate with the exception of Well 704, which should be removed from the system. Well 704 would produce very little water and, by interference, would further reduce the productivity of surrounding wells with a probable net loss of system capacity.

3. The wells should be equipped with automatic controls and pumped in cycles to reduce incrustation. Although the wells could sustain a steady pumping rate, the specific capacities of the wells indicated that water levels during pumping will drop to the level of the screens during the first year of operation. Past experience with the existing Zone 3 wells has shown that when water levels are within the screened interval, severe incrustation and plugging occurs. Pumping the existing wells in cycles successfully reduced the incrustation.

2.1.3 Well Operation

The new Zone 3 wells began pumping on August 7 and 8, 1989. Table 2.2 provides a summary of the pumping rates for the individual wells. As shown, initial pumping rates for the wells ranged from 1.0 gpm for Well 705 to 5 gpm for Wells 706 and 709. Adjustments to these rates were made in order to maximize pumping rates while maintaining a minimum water level equivalent to 15 to 20 feet of saturation in each well, which allows maintenance of long-term operation. The low-yield wells, including Wells 702, 712, and 713, have been equipped with controls to automatically turn off

the pumps for a preset time period when the water level in the well declines to the level of the pump intake. Additional wells may be equipped with the automatic controls as water levels continue to decline in response to pumping. As of November 17, 1989 the combined average pumping rate from the Stage I wells was 43 gpm with a total of 5.6 million gallons extracted.

2.1.4 Performance Monitoring Evaluation

Performance monitoring in Zone 3 consists of measurements of water level for those wells not equipped with automatic controls, instantaneous pumping rate, and total volume pumped in the extraction wells on a weekly basis plus water level and water quality monitoring in the compliance monitoring wells four times a year. Delineation of the performance monitoring program was presented in the RD (Canonie, 1989a). Table 2.3 and Figure 2-2 display the wells included in the performance monitoring program. This evaluation utilized the data collected during the third quarter and the fourth quarter 1989 sampling events. The data are presented in Sections 1.0 (Water Level Data) and 2.0 (Water Quality Data) of Part II to this report.

Review of the monitoring data indicates that the extraction wells are performing as designed and are successful in:

1. Capturing and extracting seepage in the target area; and

2. Creating a hydraulic barrier to further migration of tailings seepage.

Water level and pH were used to evaluate the effect of the pumping wells on the aquifer. The water level data included water level measurements from the NRC compliance monitoring wells and the Zone 3 - Stage I extraction wells. For the extraction wells equipped with automatic controllers, the pump-intake elevation was used as the water level elevation because water levels in these wells will decline to this elevation before the controller turns off the well. The pH data included laboratory measurements of pH from the compliance monitoring wells and field pH measurements from the extraction wells.

The evaluation of the performance monitoring chemical constituents listed in Table 1.1 is limited in this review because of the limited data generated from the water quality data collected in 1989. Preliminary review of the water quality data indicates that changes in water quality in response to pumping are not yet visible based on the two data sets (third and fourth quarters) available. However, the data is consistent with the historical data generated at the site to date.

Water Level Data

The evaluation of the water level data first presents a historical perspective to show how the dewatering by the Zone 3 - Stage I wells fits in with other activities that have affected the hydrogeologic regime in Zone 3. The remainder of the evaluation then focuses on the effects of the new extraction wells during the first three months of operation, represented by the third and fourth quarter 1989 monitoring data.

Figure 2-3 presents historical trends in water levels in selected Zone 3 wells reported for the period between 1981 and fourth quarter 1989. The figure illustrates the response of Zone 3 to the various activities described in the GHR (Canonie, 1987b) and the RD (Canonie, 1989a), including recharge from mine water discharged to Pipeline Arroyo; operation of the northeast pump-back wells; cessation of mine water discharge to the arroyo; and operation of the Zone 3 - Stage I wells that have created the ground water regime at the site.

Review of the figure shows that during the period between 1981 and 1983, recharge to Zone 3 from the mine water discharged to Pipeline Arroyo caused an increase in water levels. In 1983, the northeast pump-back wells were turned on, causing a decrease and then stabilization of water levels in the vicinity of the pumping wells. Wells located outside the influence of the pump-back wells, such as Wells 420, 501B, and 502B, continued to show an increase in water levels in response to the recharge from the arroyo. Water levels began to decline in 1986 after the source of recharge--ie, the mine water discharged to the arroyo--was eliminated. This decline

continued through 1989. As the figure shows, more recently the Zone 3 - Stage I wells caused a sharp decline in water levels when they were turned on in August 1989.

Figure 2-4 presents the change in saturated thickness caused by the new extraction wells during the first three months of operation from August to October 1989. As shown, the saturated thickness of the aquifer has been reduced by more than 20 feet in the center of the well system. The area of the aquifer that is being dewatered by the extraction wells, using the contour representing 10 feet of reduction in saturated thickness, is approximately 52 acres. This area incorporates approximately 90 percent of the remedial action target area. Therefore, not only are the wells capturing and extracting seepage, but they have also created a barrier to further migration of tailings seepage.

Further confirmation of the performance of the Zone 3 system wells s provided by a comparison of actual field conditions and conditions predicted by the computer simulation after three months of operation. Figure 2-5 presents contours of saturated thickness based on the fourth quarter 1989 water level data and a computer simulation of the aquifer response to pumping after three months of operation. The computer simulation utilized the model described in the RD (Canonie, 1989a) that was developed for refinement of the design of the system.

Review of Figure 2-5 shows that the location and configuration of the contours based on the actual and simulated conditions is similar. The 20-foot, 40-foot, and 60-foot contours for both actual and simulated conditions almost directly overlay each other. The similarity of the contour plots indicates that the system is operating as predicted in the RD (Canonie 1989a).

pH Data

The initial change in the pH provides a further indication that the wells are extracting seepage. Figures 2-6 and 2-7 present the isoconcentrations of pH for initial conditions (third quarter 1989) and after pumping for

three months (fourth quarter 1989). Comparison of the figures indicates that the extraction wells are removing tailings seepage and causing clean water from the north and west to flush the remediation target area. The area of tailings seepage represented by acidic pH is reduced by 34 acres, ie, by more than one-half on Figure 2-7 as compared with Figure 2-6.

Figure 2-8 presents graphs of pH data for Wells EPA-3 and EPA-18 for the period from April 1988 through October 1989. These graphs further illustrate the initial effects of the extraction wells in capturing acidic seepage. The wells are located in the area to the south and east of the extraction wells where the extent of the remedial action target area has been reduced.

Review of Figure 2-8 shows that pH values in EPA-3 have been on a declining trend for the past two years. Pumping from the extraction wells appears to be reversing this trend, as evidenced by the increase in pH between the third quarter and the fourth quarter 1989 sampling events. Figure 2-8 shows that pH of water from Well EPA-18 also increased in response to pumping from the extraction wells. During 1988 and early 1989, pH values were approximately stable or declining. A sharp increase in pH is evident after the extraction wells began pumping. Future data will help confirm this initial observation.

Water Quality

Table 1.1 provides a list of the constituents analyzed for the ground water monitoring program as described in Amendment II (Canonie, 1989b) and the RD (Canonie, 1989a). The list includes those constituents for which the NRC has set ground water protection standards and the EPA has set ARARs. Evaluation of the water quality data indicates that as of fourth quarter 1989 all but five of the constituents analyzed exceed the NRC and/or EPA standards in one or more of the Zone 3 POC wells.

Table 2.4 lists the constituent concentrations reported for water samples collected from the POC wells during the third and fourth quarter 1989 sampling events. As shown, concentrations of cyanide and napthalene were

below the NRC's ground water protection standards, and concentrations of chloride, aluminum, and molybdenum were below the EPA's ARARs in all the POC wells.

Water quality data were also reviewed for EPA wells located outside the target area and identified in the ROD (EPA, 1988c) as having exceedances of ARARs. The data for these wells are included in Section 2.0 of Part II to this report. The review indicates that the water quality in these wells has remained stable or shows improvement. For example, concentrations of molybdenum in Well EPA-11 have remained in the range of 50 to 60 mg/l since 1985. In contrast, concentrations of Radium-228 have declined from 14.6 picoCuries per liter (pCi/l) reported in the ROD (EPA, 1988c) to a range of 2 to 4 pCi/l.

The use of the water quality data to evaluate the effect of the extraction wells is limited because only one sampling event has occurred (ie, fourth quarter 1989) since the wells began operation. As a result, a change or a lack of change in water quality in response to the pumping may be identified, but verification of these changes in terms of statistically valid trends cannot be made until additional data are available.

2.2 Zone 1 Remedial Action

The remedial action for Zone 1 consists of dewatering Borrow Pit No. 2 in conjunction with continued extraction of seepage from the existing east and north cross dike pump-back wells. Figure 2-9 shows the location of Borrow Pit No. 2 and the pump-back wells that are currently operating. Dewatering of Borrow Pit No. 2 serves two purposes. First, the source of seepage, the tailings liquid, is removed. Second, the hydraulic head (ie, height of the water in the pit above the Zone 1 subcrop), which is driving the seepage into Zone 1, is removed. As a result, the tailings seepage mound will decline, and the plume will dissipate naturally as the flow system in Zone 1 returns to the unsaturated conditions existing prior to mining and milling operations.

2.2.1 Status of Borrow Pit No. 2

Borrow Pit No. 2 was dewatered at the end of April 1989, approximately 6 months prior to the time predicted in the RD. The time required to dewater was accelerated mainly because the actual volume of water remaining in the pit was much less than predicted. Increased evaporation in 1989 as a result of dryer than usual climatological conditions was also a contributing factor.

Additional inflow to the pit from the surrounding formations will not occur because the water level measured in wells located adjacent to the pit on the west and north sides appears to be at or near the original bottom of the pit. For example, Well B-3 and B-4, located on the west side of Borrow Pit No. 2 (Figure 2-9), have been dry since third quarter 1989. The bottom elevation of these wells is 6934.4 feet, which is approximately at the bottom elevation of the pit.

Since Borrow Pit No. 2 has been dewatered and the formations surrounding the pit appear to be unsaturated, continued recharge to the Zone 1 plume will be minimal.

2.2.2 Operation of Existing Pump-back Wells

Figure 2-9 shows the locations of the existing east and north cross-dike pump-back wells. Operation of the wells is required by both the NRC in the License and the EPA in the AO (EPA, 1989). The east pump-back wells are the most important from the standpoint of evaluating plume migration. As shown on Figure 2-9, these wells are located adjacent to Borrow Pit No. 2 and are intended to intercept some of the seepage migrating into the Zone 1 remedial action target area. Therefore, pH data collected while these wells are operating will be included in the evaluation of the performance of the Zone 1 remedial action.

As discussed in the RD (Canonie, 1989a) pumping rates for the east pump-back wells are low and, therefore, the effect of the wells in intercepting seepage is limited. The average pumping rates for the wells, measured in

October 1989 at the time of the fourth quarter sampling event, ranged from 0.16 gpm to 2.3 gpm with a combined average flow rate of 4.1 gpm.

2.2.3 Performance Monitoring Evaluation

The performance monitoring program for Zone 1 focuses primarily on water level monitoring in the wells located to the east of Borrow Pit No. 2. The objective of the program is to monitor and evaluate the effect of dewatering the borrow pit. Table 2.5 and Figure 2-9 display the wells included in the Zone 1 monitoring program. For this report, monitoring data evaluated include those collected during the second, third, and fourth quarter 1989 sampling events. The second quarter data approximate initial conditions since Borrow Pit No. 2 was dewatered at the end of April, shortly after the second quarter monitoring data was collected. The performance monitoring data are presented in Sections 3.0 (Water Level Data) and 4.0 (Water Quality Data) of Part II to this report.

The evaluation consisted of review of the water level and pH data to determine whether changes in the values are related to dewatering of Borrow Pit No. 2. Tables 2.6 and 2.7 provide the water level elevations and pH measurements, respectively, that were used for the evaluation. Because of the low permeability of Zone 1, changes water levels and pH values were not anticipated during the six-month period since the borrow pit was dewatered and none of major significance occurred.

Water Level Data

The evaluation of the water level data first presents a historical perspective to illustrate the effect of Borrow Pit No. 2 in creating the hydrogeologic regime in Zone 1. The remainder of the evaluation then focuses on the response of Zone 1 to dewatering the borrow pit.

Figure 2-10 presents historical trends in water levels in selected Zone 1 wells for the period between 1981 and fourth quarter 1989. The figure illustrates the response of Zone 1 to recharge from the water stored in

Borrow Pit No. 2, operation of the east pump-back wells, and dewatering of Borrow Pit No. 2 in April 1989.

Review of the figure shows that between 1981 and 1984 recharge to Zone 1 from the water in Borrow Pit No. 2 is indicated by the increase in water levels measured in Wells 515A and 516A. In 1984, the east pump-back wells were turned on, causing a decrease and then stabilization of water levels. Water levels remained stable through the end of 1986 and then began increasing. During the period between the end of 1986 and 1988, water levels in the wells increased as Borrow Pit No. 2 was filled indicating that the borrow pit was recharging Zone 1. By 1988, water levels again stabilized with little or no change evident through 1989. After Borrow Pit No. 2 was dewatered in April 1989, water levels in the wells located adjacent to Borrow Pit No. 2 (ie, 515A, 516A, 604, and 614) remained stable or declined slightly. Water levels in the wells located downgradient from the borrow pit, particularly EPA-2 and EPA-8, continued to increase after the borrow pit was dewatered, indicating that the mound of water originating from Borrow Pit No. 2 is continuing to migrate through Zone 1.

Review of the water level data collected since Borrow Pit No. 2 was dewatered confirms the predictions made in the RD (Canonie, 1989a) and the GHR (Canonie, 1987b) that dissipation of the mound will occur very slowly, that the effects of dewatering may not be apparent during the initial phases of the remedial action, and that operation of the existing pump-back wells will have no remedial effect. Table 2.6 lists the water levels measured in the monitoring wells during the second, third, and fourth quarter 1989 sampling events. As shown, only Wells EPA-2 and EPA-8 exhibited changes in water level equal to or greater than 1 foot. These changes represent less than 4 percent of the saturated thickness of Zone 1 in this area. The changes in the remaining wells represent less than 1 percent of the saturated thickness.

pH Data

Review of the pH measurements listed in Table 2.7 confirms the conclusion that the mound in Zone 1 was unaffected for the six months following dewatering of Borrow Pit No. 2. The data listed show that values of pH have remained stable with only minor changes that are probably related to sampling or analytical variability.

Figure 2-11 presents the isoconcentrations of pH for fourth quarter 1989. The plume, represented by acidic pH, has migrated approximately 150 feet downgradient from the extent of the remedial action target area depicted in the RD (Canonie, 1989a). Since the extent of the remedial action target area was based on pH data collected in 1986, this travel distance is approximately three times shorter than expected based on the Zone 1 flow velocity of 115 feet per year to 148 feet per year calculated in the RD (Canonie, 1989a). The pH values reported in 1989 are similar to those reported in 1986 as would be expected given the fact that the mound has remained stable during this three-year period. The small change in pH is expected considering the low transmissivity of the formation and the resulting low flow rates in the formation.

The stable water level and pH conditions in Zone 1 that are evident since Borrow Pit No. 2 was dewatered indicate that operation of the pump-back wells is ineffective in accelerating dewatering of the mound. Because the wells are only capable of pumping at very low rates, the effect on the mound is limited to the immediate vicinity of each well. Therefore, continued operation of the wells is considered impracticable, and decommissioning of the wells is recommended.

Water Quality

The evaluation of the water quality data for the performance monitoring constituents listed in Table 1.1 indicates that, as of fourth quarter 1989, all but seven of the constituents analyzed exceed the NRC and/or EPA standards in one or more of the Zone 1 POC wells. Table 2.8 lists the constituent concentrations reported for water samples collected from the POC

wells during the second, third, and fourth quarter 1989 sampling events. As shown, arsenic, beryllium, cadmium, naphthalene, molybdenum, vanadium, and uranium were reported in concentrations at or below the detection limit in all the wells. In addition, lead, selenium, and cyanide were reported in only a few wells for one sampling event.

Water quality in the EPA wells located outside the target area and identified in the ROD (EPA, 1988c) as having exceedances of ARARs was also reviewed. The data are presented in Section 4.0 of Part II of this report. The review indicated that the water quality has remained stable or is improving. For example, concentrations of manganese in water from Well EPA-4 are in the range of 2 to 3 mg/l, which is similar to the value of 2.7 mg/l reported in the ROD (EPA, 1988c). In contrast, concentrations of gross alpha in Wells EPA-2, EPA-8, and EPA-5 have declined to 1 to 2 pCi/l, which is well below the ARAR concentration of 15.0 pCi/l established for this site. Also, cadmium concentrations in water from Well EPA-5 have declined from the value of 0.11 mg/l reported in the ROD (EPA, 1988c) to less than the detection limit of 0.01 mg/l.

2.3 Southwest Alluvium Remedial Action

The three extraction wells (801 through 803) and four monitoring wells (804 through 807) for the Southwest Alluvium remedial system were installed in August 1989. Figure 2-12 presents the locations of these wells.

2.3.1 Well Installation

Installation of the wells was conducted in accordance with the specifications presented in the RD (Canonie, 1989a). Modifications to the drilling procedures were made to account for field conditions that could not be anticipated in the design. Details of the well installation and completion procedures are presented in Appendix C. A summary of the well completion details is presented in Table 2.9.

The wells were drilled through the alluvium to the top of the Mancos Shale to ensure full penetration of the saturated thickness of alluvium. Initially, the drilling method used was hollow-stem auger as recommended in the RD (Canonie, 1989a). However, unconsolidated sands and greater than expected depth to the Mancos Shale contact prevented successful completion of the wells using this method. United Nuclear sought and received approval from the NRC to change the revised drilling procedures. NRC personnel also conducted a field inspection of the revised drilling procedures in August 1989.

The drilling method was changed to rotary using clean water from the mill site water supply well as the drilling fluid. The hollow-stem auger continued to be used to drill exploration holes for each well to collect samples for identification of the lithology. The rotary rig was then used to install the borehole for each well adjacent to the exploration hole. Samples were collected during drilling to provide information on the lithology of the alluvium and to identify the alluvium-Mancos contact. As shown in Table 2.9, the wells were completed with 4 1/2-inch-diameter casing and 20 feet to 60 feet of screen located at the bottom of the well. The observation wells were completed with 2-inch-diameter casing and 40 feet to 80 feet of screen located at the bottom of the well.

After completion, the wells were developed by washing sections of the screen using a specially designed packer, then surging, airlifting, and finally overpumping. The extraction wells (801 through 803) were then tested using the step-drawdown method to establish the specific yield and efficiency. The results of the step-drawdown tests are included with the well completion details presented in Appendix C.

2.3.2 Aquifer Testing

The extraction wells were tested for individual capacity and interference to allow verification of the design pumping rates and determination of the permeability of the alluvium. Appendix D presents a detailed description of the aquifer test procedure and the data collected. The test consisted of pumping Well 802 at a constant rate of 15 gpm and monitoring the

water levels in Wells 801, 803, 804, 805, 806, 807, 632, GW-1, GW-2, 30D, and 514AD.

The results of the testing showed that aquifer permeability is approximately 2×10^{-2} cm/sec. This value is an order of magnitude higher than the value of 2.6×10^{-3} cm/sec used to predict pumping rates for design of the barrier well system. Normally, the higher permeability would mean that higher pumping rates would be required to create the same drawdown as would be achieved at the lower permeability. However, a no-flow boundary was identified along the southeast edge of the alluvial valley. A boundary of this type appears in the observation well data as water level declines, which are larger than those predicted by theory. The boundary is expected to counteract the effect of the higher permeability by causing an increase in the water level declines in response to pumping and enhancing the effectiveness of the hydraulic barrier.

2.3.3 Well Operation

The Southwest Alluvium extraction wells began pumping on October 16, 1989. Table 2.10 provides a summary of the pumping rates of the individual wells. As shown, initial pumping rates for the wells ranged from 20 gpm for Well 802 to 2.6 gpm for Well 801. Adjustments to these rates were made in order to maximize the effect of the barrier, while maintaining a minimum saturation in each well which allows maintenance of long-term operation. In particular, the pumping rate for Well 802 was reduced to approximately 11 gpm. As of November 17, 1989 the combined average pumping rate for Southwest Alluvium wells was 19.7 gpm with a total of 0.8 million gallons extracted.

2.3.4 Performance Monitoring Evaluation

Performance monitoring in the Southwest Alluvium relies on measurements of water level, instantaneous pumping rate, and total volume pumped in the extraction wells on a weekly basis, plus water level and water quality monitoring in the compliance monitoring wells four times a year. Delineation of the performance monitoring program is presented in the RD

(Canonie, 1989a). Table 2.11 and Figure 2-12 show the wells included in the performance monitoring program. This evaluation utilizes the data collected during the fourth quarter 1989 sampling event and through December 4, 1989. The data are presented in Sections 5.0 (Water Level Data) and 6.0 (Water Quality Data) of Part II to this report.

Review of the water level data indicate that the system is operating as designed and is beginning to create a hydraulic barrier to flow. Figures 2-13 and 2-14 present the potentiometric surface of the alluvium for initial conditions (fourth quarter 1989) and after pumping for 1.5 months (October 16 through December 4, 1989), respectively. Comparison of the figures shows that the extraction wells are causing a reversal in the slope of the water table in the vicinity of the system wells.

Currently, most of the flow through the target area is captured by the extraction wells. Continued monitoring of water levels should begin to show the effects of the boundary identified during the aquifer test. An increase in the decline of water levels will be evident when the boundary begins to affect the operation of the wells. Verification of the location and extent of the hydraulic barrier will be possible after pumping rates and the decline in water level, caused by the boundary, stabilize.

Chemical data reflecting conditions after pumping started in the Southwest Alluvium will not be collected until first quarter 1989. Therefore, only initial conditions are presented at this time. Figure 2-15 presents chloride concentrations reported for fourth quarter 1989, collected prior to operation of the wells. As shown, the extent of the chloride plume, represented by concentrations of 100 mg/l, is the same as the extent of the remedial action target area shown on Figure 2-12.

Table 2.12 lists the constituents analyzed and the results of initial water quality sampling in the Southwest Alluvium. As shown, more than half the constituents were reported at concentrations close to or below the detection limit in all but one of the Southwest Alluvium POC wells. Also, almost all the metals that were detected were reported in concentrations below the NRC and EPA standards established for the site. Lead, lead-210,

thorium-230, TDS, nitrate, and sulfate were the only constituents with concentrations exceeding the NRC or EPA standards established for the site.

Water quality data were also reviewed for the EPA wells identified in the ROD (EPA, 1988c) as having exceedances of ARARs. The data for these wells are included in Section 6.0 of Part II of this report. The review indicates that the water quality has improved. For example, cadmium, selenium, and gross alpha are reported in concentrations at or below the detection limit, and all are below the ARAR concentrations established for the site. In contrast, concentrations of nitrate have remained stable at levels exceeding the ARARs.

2.4 Evaporation Disposal System

The evaporation disposal system began operation on January 5, 1989. Between January and April water from the extraction wells and Borrow Pit No. 2 was discharged to the ponds for temporary storage. Beginning in April, the stored water was discharged through the mist evaporation system for disposal. Evaporation from the surface of the ponds also disposed of some of the water.

During 1989, almost all extracted water was discharged to the North Evaporation Pond. Only one pond was utilized because the reduced volume of water in Borrow Pit No. 2 and lower pumping rates from the new Zone 3 extraction wells reduced the total volume of water discharged. Also, the high evaporation rate experienced in 1989 allowed for more evaporative disposal than anticipated.

Borrow Pit No. 2 was expected to contain up to 12 million gallons of water but only 5.4 million gallons were actually removed during 1989. This difference was due to the larger than expected accumulation of solids in the bottom of the pit. As a result, inflows to the evaporation disposal system were reduced from the predicted volume by 7 million gallons.

Also, the average total pumping rate for the new Zone 3 extraction wells is 43 gpm, rather than the 60 gpm that was used in the RD (Canonie, 1989a) for the design of the system.

Finally, the net evaporation rate for 1989 was higher than expected because 1989 was an exceptionally dry year. The net pan evaporation rate for 1989 was approximately 90 inches. In contrast, the rate used for the design was 54 inches, which was based on 30 years of data from the weather station in Gallup, New Mexico.

Some repairs to the South Evaporation Pond embankment and the synthetic liners in the evaporation ponds were conducted in 1989. Continued settlement of a portion of the south embankment of the South Pond was observed during the spring and summer of 1989. This settlement prompted modification to the embankment including installation of a drainage system to control and direct seepage through the embankment should the liner unexpectedly leak.

The drain system consists of a trench installed along the center line of the embankment with three perpendicular drainways positioned in the location of the highest stress concentration. Tailings sand was used as the drainage material and excess soil from the trench excavation was used to cap the trench and to fill the downstream slope of the embankment where a depression had formed as a result of the settlement. Controlling potential seepage through the embankment in this manner will improve the embankment's stability should seepage occur. Settlement of the south embankment will continue to be monitored during the weekly inspections.

During routine inspection, blistering of portions of the synthetic liner within the South Evaporation Pond and on the embankment of the North Evaporation Pond was noted. The manufacturer was notified and repairs were initiated in November and will be completed in January 1990, weather permitting. The condition of the repaired liners will also be monitored during the weekly inspections.

3.0 CONCLUSION

The results of this first annual review show that the remedial actions implemented and operating to date are meeting the design objectives outlined in the RD (Canonie, 1989a). Specifically, the extraction wells are meeting the NRC objective outlined in the License to implement a corrective action program to return concentrations of contaminants to the ground water protection standards set forth in the License. The remedial actions are also meeting the objective stated by the EPA in Appendix A to the ROD (EPA, 1988c) to capture seepage, which has migrated from the tailings impoundment, and abate future migration of seepage.

The effect of the remedial actions to date are summarized as follows:

Zone 3 - The Zone 3 - Stage I extraction wells are successfully capturing and extracting seepage in the remedial action target area and creating a hydraulic barrier to further seepage migration. The wells have reduced the saturated thickness by 10 to 20 feet over an area of 52 acres. The area of dewatering includes 90 percent of the target area. At the same time the areal extent of the acidic pH plume has been reduced by more than half.

Water quality data for this year's evaluation is limited because only one sampling event (ie, fourth quarter) occurred after the wells began operation. Review of the data indicates that all the constituents, except cyanide, naphthalene, chloride, aluminum, and molybdenum, were detected in concentrations exceeding the NRC ground water protection standards or the EPA ARARs established for this site.

Zone 1 - Dewatering of Borrow Pit No. 2 was completed in April 1989. The east and north cross dike pump-back wells continue to operate in accordance with EPA requirements set forth in the ROD (EPA, 1988c). Monitoring data indicate that dissipation of the mound is occurring at a very slow rate.

Water quality data for this year's evaluation are limited because only two sampling events (ie, third and fourth quarter) occurred after the pit was dewatered. Review of the data indicates that all constituents, except

arsenic, beryllium, cadmium, naphthalene, molybdenum, vanadium, and uranium were detected in concentrations exceeding the NRC or EPA standards established for the site.

Southwest Alluvium - The Southwest Alluvium extraction wells are successfully creating a hydraulic barrier to flow while the source is being remediated. Because the wells did not start operating until mid-October, the monitoring data provide only a preliminary indication of the effects of the extraction wells. However, review of the water level data indicates that the extraction wells are beginning to cause a reversal of the water level gradient and creating a hydraulic barrier to flow.

Water quality data for this year's evaluation are limited because only one data point (ie, fourth quarter) was generated. In addition, operation of the extraction wells began after the fourth quarter samples were collected so that the data presented herein represent initial, preoperational conditions. Review of the data indicates that more than half of the constituents were reported in concentrations close to or below the detection limit in all but one of the POC wells. Also, almost all metals that were detected were reported in concentrations below the NRC and EPA standards.

The seepage remedial action program implemented in 1989 has operated for a limited time period. The data collected to date indicate that the effects anticipated by the RD (Canonie, 1989a) are taking place. The Zone 3 wells are, in fact, dewatering the area of concern. The alluvial wells are creating a hydraulic barrier to further migration of seepage, and monitoring of Zone 1 is indicating that the formation is too impermeable to pump effectively. Additional data are necessary to confirm these preliminary results. Therefore, it is recommended that the systems continue to be operated as designed and constructed to provide the data for future recommendations.

If on review of this report you need additional information, please contact Suzie du Pont, Project Scientist; Marek Wilczewski, Project Scientist; or me.

Respectfully submitted,

Roman S. Popielak
Project Manager

RSP/jb

REFERENCES

REFERENCES

Canonie Environmental Services Corp., April 1987a, "Reclamation Plan," Church Rock Site, Gallup, New Mexico.

Canonie Environmental Services Corp., May 1987b, "Report, Reclamation Engineering Services, Geohydrologic Report," Church Rock Site, Gallup, New Mexico.

Canonie Environmental Services Corp., July 1988a, "Amendment I, Reclamation Plan, License No. SUA-1475," Church Rock Site, Gallup, New Mexico.

Canonie Environmental Services Corp., July 1988b, "Technical Specifications, Ground Water Remediation System," Church Rock Mill and Tailings Disposal Area, Gallup, New Mexico.

Canonie Environmental Services Corp., April 1989a, "Remedial Design Report," Church Rock Site, Gallup, New Mexico.

Canonie Environmental Services Corp., April 1989b, "Amendment II, Reclamation Plan, License No. SUA-1475," Church Rock Site, Gallup, New Mexico.

Canonie Environmental Services Corp., March 1989c, "As-Built Report, Evaporation Pond Construction," Church Rock Site, Gallup, New Mexico.

Environmental Protection Agency, August 1988a, "United Nuclear Corporation, Church Rock Site, Operable Unit Feasibility Study, Gallup, New Mexico."

Environmental Protection Agency, January 1988b, "Remedial Investigation, United Nuclear Corporation, Church Rock Site," EPA No. 124-6L15.

Environmental Protection Agency, September 1988c, "Record of Decision, United Nuclear Corporation, Ground Water Operable Unit," McKinley County, New Mexico, U.S. Environmental Protection Agency, Region VI, Dallas, Texas.

Environmental Protection Agency, June 1989, "Administrative Order Docket Number CERCLA 6-11-89," Regarding the United Nuclear Corporation Site, Church Rock, New Mexico.

Freeze, R. Allan and John A. Cherry, 1979, Groundwater, Prentice-Hall, New Jersey.

United Nuclear Corporation, April 1989, "Remedial Action Plan, Church Rock Uranium Mill Tailings Facility."

TABLES

TABLE 1.1

PERFORMANCE MONITORING ANALYTES[a]

Arsenic
Aluminum
Cadmium
Chloride
Cobalt
Nitrate
Sulfate
Ammonia
Manganese
Molybdenum
Calcium
Magnesium
Sodium
Bicarbonate
Potassium
TDS
Beryllium
Chloroform
Cyanide
Lead
Lead 210
Naphthalene
Nickel
Combined Radium-226, Radium-228
Selenium
Thorium-230
Uranium
Gross Alpha
Vanadium

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[a] Field pH and water levels will be measured when samples are collected.

TABLE 2.1

SUMMARY OF WELL COMPLETION DATA
ZONE 3 - STAGE I WELLS

Well Number	Date Completed	Ground Surface Elevation (feet)	Northing	Easting	Total Depth [a] (feet)	Casing Diameter (inches)	Screen Interval		Zone 3	
							From [a] (feet)	To [a] (feet)	From [a] (feet)	To [a] (feet)
701	14-Jun-89	6,958.99	75,699.94	60,699.84	104	6	78	98	34	98
702	29-Jun-89	6,971.99	75,294.75	60,839.53	96	6	69	89	8	89
703	28-Jun-89	6,976.78	75,489.83	61,100.32	114	6	77	107	15	107
705	23-Jun-89	7,003.04	75,909.61	61,152.17	157	6	120	150	75	150
706	26-Jun-89	6,969.69	76,119.06	61,091.46	134	6	108	128	50	128
707	21-Jun-89	7,002.11	76,349.32	61,340.18	173	6	148	168	80	168
708	24-May-89	7,010.38	76,032.30	61,500.17	172	6	137	167	82	167
709	17-May-89	7,001.01	76,469.30	61,520.85	173	6	138	168	91	168
710	22-May-89	7,014.18	76,299.53	61,699.35	180	6	143	173	92	173
711	09-May-89	7,040.00	76,100.38	61,899.37	206	6	168	198	113	198
712	15-May-89	7,019.72	76,498.98	61,900.60	185	6	149	179	93	179
713	19-Jun-89	7,021.28	76,300.00	62,100.03	178	6	143	173	100	173

[a] Depth in feet below ground surface.

TABLE 2.2

SUMMARY OF OPERATIONAL DATA
ZONE 3 - STAGE I WELLS

Well Number	Automatic Control[a] (yes/no)	Initial Pumping Rate (gpm)	Current Pumping Rate[b] (gpm)	Average Pumping Rate[c] (gpm)	Design Pumping Rate[d] (gpm)
701	No	4.2	6.3	5.4	5
702	Yes	1.3	0.4	-1.0	5
703	No	3.7	2.0	3.0	5
705	No	1.0	1.4	1.7	5
706	No	5.0	8.0	8.2	5
707	No	4.0	3.8	4.3	5
708	No	2.5	4.0	4.7	2.5
709	No	5.0	2.4	2.8	5
710	No	2.0	0.8	1.1	5
711	No	3.8	5.3	5.0	2.5
712	Yes	4.3	2.1	-2.7	5
713	Yes	3.0	2.6	3.0	5
			Total	43	55

Total Volume Pumped = 5.6 million gallons[c]

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[a] Wells equipped with the automatic control pump in cycles. If the well is not pumping at the time of inspection, then the pumping rate cannot be recorded. The well meters record the cumulative flow and the flow rate is calculated based on these readings and the time elapsed between readings.

[b] Average pumping rate reported for the week of November 10 through November 17, 1989.

[c] Pumping rate and total volume pumped estimated for the period between August 7 through November 17, 1989.

[d] The total design pumping rate presented in the RD (Canonie, 1989a) was 60 gpm. This rate included 5 gpm for Well 704, which has been excluded from the system.

TABLE 2.3

ZONE 3 PERFORMANCE MONITORING WELLS

Wells Specified In License Condition 30 Parts A and B[a]	Extraction System Wells[b]
106D	701
9D	702
517	703
518	705
504-B	706
502-B	707
501-B	708
420	709
411	710
EPA-18	711
EPA-17	712
EPA-15	713
EPA-14	
EPA-13	
EPA-12	
EPA-11	
EPA-9	
EPA-3	
EPA-1	

[a] Wells in this column will be sampled quarterly for water level and constituents specified in Table 1.1.

[b] Wells in this column will be monitored for water level only. Wells that are equipped with automatic controllers (ie, 702, 712, and 713) are not measured for water level. For these wells, the water level is assumed to be equivalent to the elevation of the pump in-take since this is the elevation to which the water level will drop before the well turns off.

TABLE 2.4

ZONE 3 WATER QUALITY SUMMARY
THIRD AND FOURTH QUARTERS 1989

		Constituent Concentrations														
Well Number	Date	As (mg/l)	Be (mg/l)	Cd (mg/l)	Ni (mg/l)	Pb (mg/l)	Se (mg/l)	V (mg/l)	CN (mg/l)	Chloroform (mg/l)	Napthalene (mg/l)	U (mg/l)	Gross Alpha (pCi/l)	Combined Ra-226 Ra-228 (pCi/l)	Pb-210 (pCi/l)	Th-230 (pCi/l)
NRC Standard		0.05	0.05	0.01	0.05	0.05	0.01	0.1	0.005	0.001	0.001	0.3	15.0	5.0	1.0	5.0
EPA Standard		0.05	0.017	0.01	0.20	0.05	0.01	0.7	NA	NA	NA	5.0	15.0	5.0	NA	15.0
501 B	07/20/89	0.244	0.13	-0.01	1.80	0.08	-0.001	-0.1	-0.005	-0.001	-0.001	0.6100	96.3	33.1	-1.0	5.4
501 B	10/08/89	0.046	0.09	-0.01	1.20	0.07	-0.001	-0.1	-0.005	-0.001	-0.001	0.4690	34.7	22.4	-1.0	15.0
517	07/23/89	-0.001	-0.05	-0.01	-0.05	-0.05	0.001	-0.1	-0.005	0.0011	-0.001	0.2520	44.1	21.4	2.1	-0.2
517	10/11/89	-0.001	-0.05	-0.01	-0.05	0.06	0.013	-0.1	-0.005	-0.001	-0.001	0.1960	4.7	8.5	2.8	-0.2
518	07/23/89	0.001	0.16	-0.01	1.90	0.11	0.001	-0.1	-0.005	0.043	-0.001	0.8420	120.0	41.0	4.1	17.9
518	10/11/89	-0.001	0.19	0.03	2.10	0.19	0.006	1.0	-0.005	0.042	-0.001	1.0800	70.1	22.7	5.0	55.8
EPA 3	07/26/89	0.003	-0.05	-0.01	-0.05	0.07	-0.001	-0.1	-0.005	-0.001	-0.001	0.0103	4.3	1.5	-1.0	2.3
EPA 3	10/05/89	0.017	-0.05	-0.01	-0.05	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0160	-1.0	1.5	-1.0	-0.2
EPA 18	07/25/89	0.008	-0.05	-0.01	0.23	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0310	8.0	12.6	-1.0	6.1
EPA 18	10/04/89	0.006	-0.05	-0.01	0.27	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0370	6.2	12.5	2.1	0.3

Well Number	Date	Lab TDS (mg/l)	Ca (mg/l)	Cl (mg/l)	K (mg/l)	Mg (mg/l)	Na (mg/l)	HCO3 (mg/l)	NH4 (mg/l)	NO3 (mg/l)	SO4 (mg/l)	Al (mg/l)	Co (mg/l)	Mn (mg/l)	Mo (mg/l)
NRC Standard		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA Standard		3,170	NA	250.0	NA	NA	NA	NA	NA	30	2,160	5.0	0.05	2.60	1.00
501 B	07/20/89	5,722	443	24.2	17.5	492	106	0	1.36	0.21	4,074	100.0	1.10	12.00	0.11
501 B	10/08/89	5,594	454	36.2	20.2	540	110	0	1.06	0.20	3,758	70.0	0.83	11.00	0.03
517	07/23/89	3,617	543	20.9	4.5	291	111	303	0.53	39.00	2,079	-0.1	-0.01	0.58	0.14
517	10/11/89	3,738	507	21.8	6.8	290	117	298	0.31	43.00	2,199	-0.1	0.01	0.64	0.18
518	07/23/89	9,675	443	64.6	35.8	764	236	0	123.00	22.00	6,727	420.0	1.70	41.00	-0.10
518	10/11/89	10,260	417	133.0	46.8	770	223	0	77.20	29.00	6,908	500.0	1.80	44.00	-0.01
EPA 3	07/26/89	4,839	587	25.1	10.5	465	118	168	0.31	0.02	3,358	-0.1	0.03	5.60	-0.10
EPA 3	10/05/89	4,742	507	24.6	13.9	438	115	159	0.27	0.09	3,131	-0.1	0.02	4.80	0.05
EPA 18	07/25/89	5,818	543	27.1	11.6	608	132	44	0.46	0.08	3,974	-0.1	0.19	6.70	0.05
EPA 18	10/04/89	5,742	513	27.5	12.6	604	113	49	0.43	0.01	3,746	-0.1	0.21	7.00	-0.01

Notes:

1. NRC standard as listed in License Condition 30, Part B.
2. EPA standard as listed in Table 2, "Contaminant-specific Groundwater ARARs" of the ROD (EPA 1988c).
3. NA - Not applicable.
4. "-" Minus sign: not detected at the level shown in the table.
5. All values that exceed the NRC and/or EPA standards are shaded.
6. Gross alpha value excludes contribution from radon and uranium.

TABLE 2.5

ZONE 1 PERFORMANCE MONITORING WELLS

515A
516A
604
614
619
EPA-2
EPA-4
EPA-5
EPA-7
EPA-8
141
142
143

Note: All wells listed are included in the monitoring program required by NRC under License Condition 30, Parts A and B.

TABLE 2.6

ZONE 1 WATER LEVEL DATA
SECOND, THIRD, AND FOURTH QUARTERS 1989

Well Number	Second Quarter Water Level Elevation (feet)	Third Quarter Water Level Elevation (feet)	Change In Elevation (feet)	Fourth Quarter Water Level Elevation (feet)	Change In Elevation (feet)	Total Change in Elevation (feet)
0515 A	6,920.2	6,920.5	+ 0.3	6,920.8	+ 0.3	+ 0.6
0516 A	6,919.1	6,918.7	- 0.4	6,918.5	- 0.2	- 0.6
0604	6,919.3	6,919.2	- 0.1	6,919.1	- 0.1	- 0.2
0614	6,930.2	6,929.3	- 0.9	6,929.0	- 0.3	- 1.2
0619	6,887.9	6,888.1	+ 0.2	6,888.2	+ 0.1	+ 0.3
EPA 02	6,843.3	6,843.9	+ 0.6	6,844.3	+ 0.4	+ 1.0
EPA 04	6,868.4	6,868.8	+ 0.4	6,869.1	+ 0.3	+ 0.7
EPA 05	6,895.2	6,895.2	0	6,895.4	+ 0.2	+ 0.2
EPA 07	6,907.8	6,907.8	0	6,908.0	+ 0.2	+ 0.2
EPA 08	6,856.8	6,857.4	+ 0.6	6,858.0	+ 0.6	+ 1.2

TABLE 2.7

ZONE 1 pH MEASUREMENTS
SECOND, THIRD, AND FOURTH QUARTERS 1989

Well Number	Second Quarter pH	Third Quarter pH	Change in pH	Fourth Quarter ph	Change in pH	Total Change in pH
515 A	3.9	4.6	+ 0.7	4.6	0	+ 0.7
516 A	4.2	4.1	- 0.1	4.2	+ 0.1	0
604	4.4	4.0	- 0.4	4.1	+ 0.1	- 0.3
614	7.0	6.8	- 0.2	7.0	+ 0.2	0
619	7.8	6.5	- 1.3	7.3	+ 0.8	- 0.5
EPA-2	6.9	6.8	- 0.1	7.0	+ 0.2	+ 0.1
EPA-4	7.1	6.0	- 1.1	6.9	+ 0.9	- 0.2
EPA-5	7.3	6.2	- 1.1	6.9	+ 0.7	- 0.4
EPA-7	4.3	4.0	- 0.3	4.3	+ 0.3	0
EPA-8	6.3	5.9	- 0.4	7.0	+ 1.1	+ 0.7

TABLE 2.8

ZONE 1 WATER QUALITY SUMMARY
SECOND, THIRD, AND FOURTH QUARTERS 1989

		Constituent Concentrations														
Well Number	Date	As (mg/l)	Be (mg/l)	Cd (mg/l)	Ni (mg/l)	Pb (mg/l)	Se (mg/l)	V (mg/l)	CN (mg/l)	Chloroform (mg/l)	Napthalene (mg/l)	U (mg/l)	Alpha (pCi/l)	Combined Ra-226 Ra-228 (pCi/l)	Pb-210 (pCi/l)	Th-230 (pCi/l)
NRC Standard		0.05	0.050	0.01	0.05	0.05	0.010	0.1	0.005	0.001	0.001	0.3	15.0	5.0	1.0	5.0
EPA Standard		0.05	0.017	0.01	0.20	0.05	0.010	0.7	NA	NA	NA	5	15.0	5.0	NA	15.0
516 A	04/03/89	-0.001	-0.05	-0.01	0.47	-0.05	-0.001	0.1	0.051	-0.001	-0.001	0.0	26.0	11.0	-1.0	-0.2
516 A	07/23/89	-0.001	-0.05	-0.01	0.05	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0	53.8	21.9	2.9	-0.2
516 A	10/12/89	-0.001	-0.05	-0.01	0.41	0.12	0.010	-0.1	-0.005	-0.001	-0.001	0.0	2.5	21.4	1.8	-0.2
604	04/03/89	-0.001	-0.05	-0.01	0.38	-0.05	0.004	-0.1	-0.005	-0.001	-0.001	0.0018	50.4	25.6	-1.0	41.0
604	07/23/89	-0.001	-0.05	-0.01	0.39	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0040	60.2	30.9	1.7	3.5
604	10/12/89	-0.001	-0.05	0.01	0.34	-0.05	0.006	-0.1	-0.005	-0.001	-0.001	0.0060	41.7	15.5	-1.0	33.9
614	04/03/89	-0.001	-0.05	-0.01	-0.05	-0.05	0.003	-0.1	0.031	0.011	-0.001	0.0668	3.0	1.2	-1.0	-0.2
614	07/23/89	-0.001	-0.05	-0.01	-0.05	-0.05	0.003	-0.1	-0.005	0.082	-0.001	0.0624	8.9	6.3	-1.0	0.6
614	10/12/89	-0.001	-0.05	-0.01	-0.05	-0.05	0.020	-0.1	-0.005	0.059	-0.001	0.0640	1.5	5.5	2.1	-0.2
EPA 4	04/17/89	-0.001	-0.05	-0.01	-0.05	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0004	1.2	3.1	-1.0	-0.2
EPA 4	07/26/89	-0.001	-0.05	-0.01	-0.05	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0040	3.0	3.3	-1.0	0.9
EPA 4	10/05/89	-0.001	-0.05	-0.01	-0.05	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0030	3.0	3.9	2.2	0.3
EPA 7	04/17/89	-0.001	-0.05	-0.01	0.25	-0.05	-0.001	-0.1	0.022	-0.001	-0.001	0.0072	3.1	9.0	-1.0	-0.2
EPA 7	07/26/89	-0.001	-0.05	-0.01	0.27	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0080	9.0	6.1	-1.0	6.0
EPA 7	10/05/89	-0.001	-0.05	-0.01	0.29	0.09	0.002	-0.1	-0.005	-0.001	-0.001	0.0120	2.5	5.3	-1.0	0.8

Well Number	Date	Lab TDS (mg/l)	Ca (mg/l)	Cl (mg/l)	K (mg/l)	Mg (mg/l)	Na (mg/l)	HCO3 (mg/l)	NH4 (mg/l)	NO3 (mg/l)	SO4 (mg/l)	Al (mg/l)	Co (mg/l)	Mn (mg/l)	Mo (mg/l)
NRC Standard		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA Standard		3,170	NA	250.0	NA	NA	NA	NA	NA	30.00	2,160	5.0	0.05	2.60	1.00
516 A	04/03/89	12,312	459	253.0	8.80	1,568	377	0	24.0	147.00	8,360	---	---	33.00	---
516 A	07/23/89	12,629	454	207.0	9.29	1,519	399	0	30.5	146.00	8,605	240.0	0.45	37.00	-0.10
516 A	10/12/89	11,560	449	264.0	13.60	1,343	358	0	39.8	188.00	6,992	150.0	0.40	29.00	-0.01
604	04/03/89	6,418	470	68.3	10.7	650	217	0	8.9	18.40	4,736	---	---	26.00	---
604	07/23/89	6,697	454	21.4	11.6	707	251	0	6.4	31.00	3,891	60.0	0.31	22.00	-0.10
604	10/12/89	6,728	428	33.7	14.6	644	235	0	6.1	39.00	4,407	66.0	0.31	22.00	-0.10
614	04/03/89	6,306	724	370.0	6.80	643	406	1,763	33.3	112.00	2,896	---	---	0.07	---
614	07/23/89	6,868	697	381.0	9.80	672	491	1,501	51.0	99.00	3,485	-0.1	-0.01	0.13	-0.10
614	10/12/89	6,734	624	377.0	11.60	612	479	1,540	38.6	126.00	3,002	0.2	-0.01	0.08	-0.01
EPA 4	04/17/89	4,506	529	36.5	8.50	350	217	184	0.8	-0.01	2,962	---	---	2.80	---
EPA 4	07/26/89	4,433	559	37.1	9.10	373	242	183	0.9	0.03	3,039	-0.1	-0.01	3.40	-0.10
EPA 4	10/05/89	4,760	560	38.9	12.30	371	244	182	1.0	0.10	3,043	-0.1	-0.01	3.10	-0.01
EPA 7	04/17/89	7,750	482	166.0	9.30	850	190	0	3.2	88.00	5,263	---	---	25.00	---
EPA 7	07/26/89	7,774	526	134.0	9.10	871	212	0	3.5	94.00	5,092	94.0	0.25	24.00	-0.10
EPA 7	10/05/89	8,076	497	192.0	12.00	877	221	0	3.4	69.00	5,272	99.0	0.26	25.00	-0.01

Notes:
1. NRC standard as listed in License Condition 30, Part B.
2. EPA standard as listed in Table 2, "Contaminant-specific Groundwater ARARs" of the ROD (EPA 1988c).
3. NA - Not applicable.
4. "-" Minus sign: not detected at the level shown in the table.
5. All values that exceed the NRC and/or EPA standards are shaded.
6. Gross alpha value excludes contribution from radon and uranium.

TABLE 2.9

SUMMARY OF WELL COMPLETION DATA
SOUTHWEST ALLUVIUM WELLS

Well Number	Date Completed	Ground Surface Elevation (feet)	Northing	Easting	Total Depth (feet)[a]	Casing Diameter (inches)	Screen Interval		Alluvium	
							From (feet)[a]	To (feet)[a]	From (feet)[a]	To (feet)[a]
801	24-Aug-89	6,900.85	71,630.35	56,273.79	61.5	4.5	39	59	0	60.5
802	25-Aug-89	6,904.02	71,854.39	56,215.05	82	4.5	51.5	81.5	0	81.5
803	23-Aug-89	6,921.49	72,280.56	56,369.62	123	4.5	58	118	0	118
804	04-Aug-89	6,902.56	71,770.85	56,302.73	71	2	25.5	65.5	0	65.5
805	28-Aug-89	6,910.05	72,154.29	56,339.06	121	2	39	119	0	120
806	29-Aug-89	6,910.44	72,182.05	56,371.40	98	2	30	90	0	95
807	30-Aug-89	6,919.14	72,490.25	56,492.38	105	2	25	100	0	100

[a] Depth in feet below ground surface.

TABLE 2.10

SUMMARY OF OPERATIONAL DATA
SOUTHWEST ALLUVIUM EXTRACTION WELLS

Well Number	Initial Pumping Rate[a] (gpm)	Current Pumping Rate[b] (gpm)	Average Pumping Rate[c] (gpm)	Design Pumping Rate (gpm)
801	2.6	2.0	2.0	2.0
802	20.0	11.6	14.9	5.0
803	3.4	2.2	2.8	10.0
		Total	19.7	17

Total Volume Pumped = 810,031[c]

---

a Measured on October 16, 1989.

b Average pumping rate reported for the week of November 10 through November 17, 1989.

c Average pumping rate and total volume pumped estimated for the period between October 16 and November 17, 1989.

TABLE 2.11

SOUTHWEST ALLUVIUM PERFORMANCE MONITORING WELLS

Current Monitoring Wells in Alluvium (License Condition 30, Parts A & B Criteria)	System Wells	Alluvial Wells
GW-1	801	624
GW-2	802	627
GW-3	803	639
GW-4	804[b]	642
EPA-22A	805[b]	644
EPA-23	806[b]	645
EPA-25	807[b]	
EPA-27[a]		
EPA-28		
509D		
632		
29A[a]		

[a] Data from these wells may not be representative of ground water conditions in the alluvium because of problematic completion.

[b] Wells monitored for water level only.

TABLE 2.12

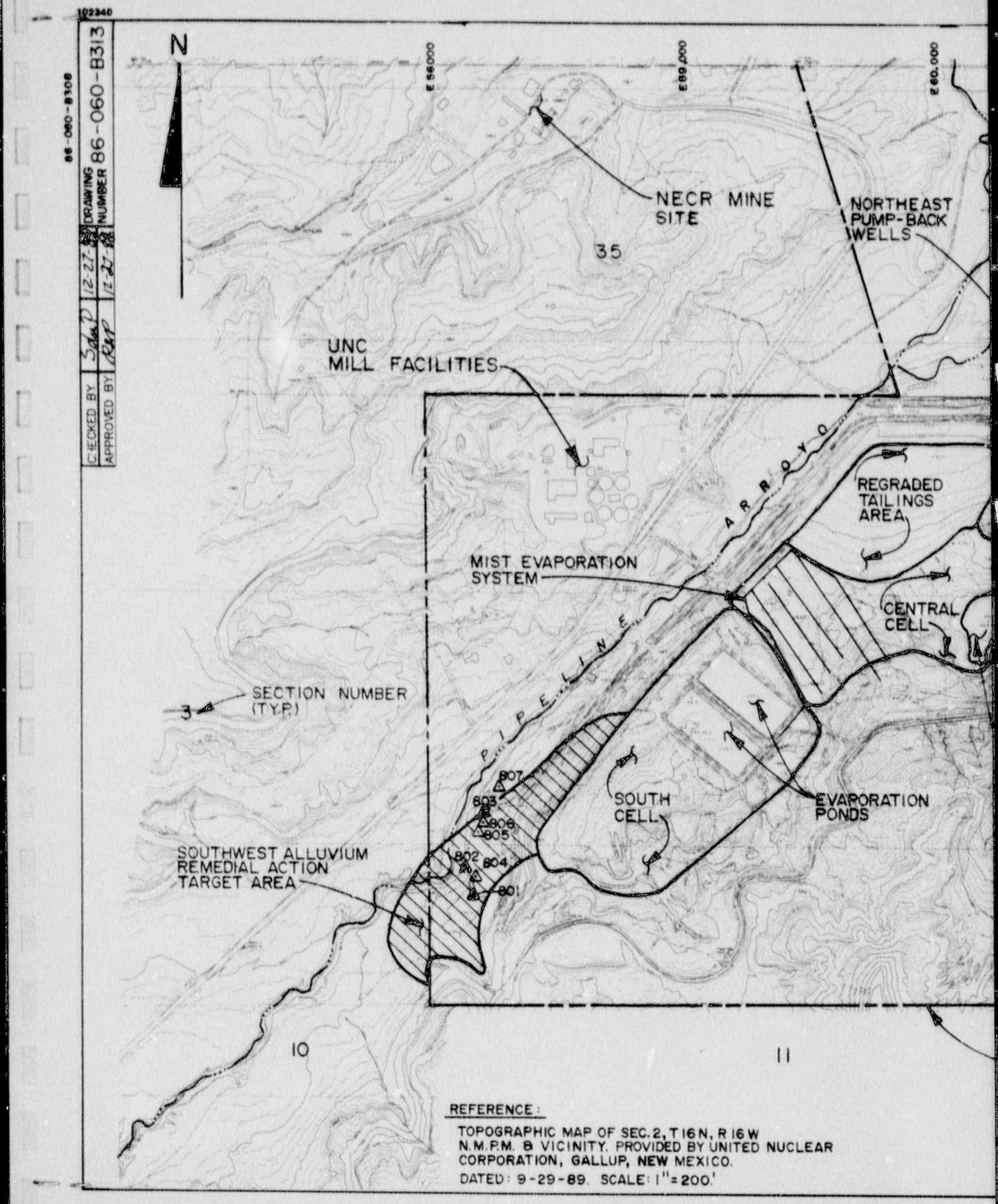
SOUTHWEST ALLUVIUM WATER QUALITY SUMMARY
FOURTH QUARTER, 1989

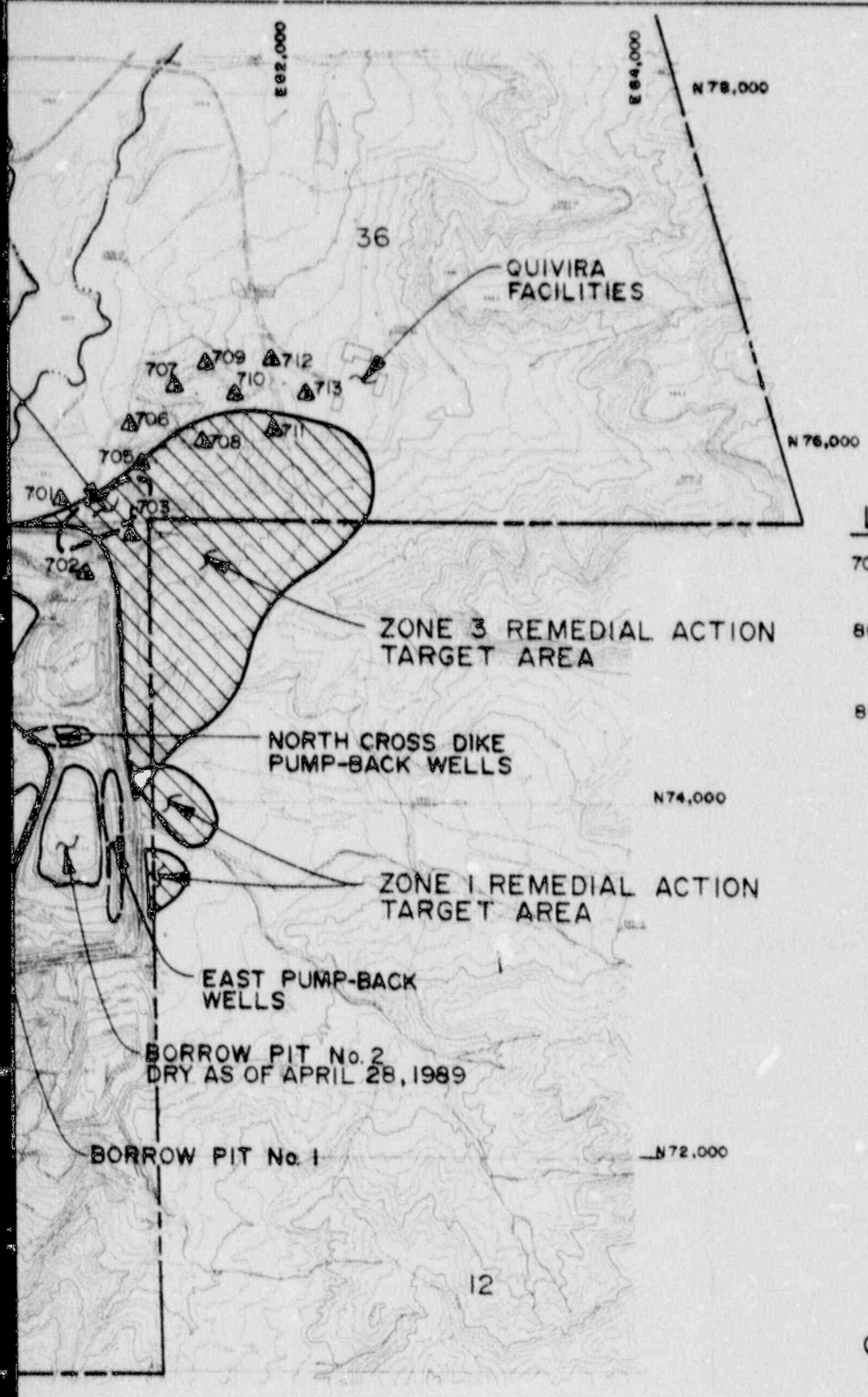
Well Number	Date	Constituent Concentrations														
		As (mg/l)	Be (mg/l)	Cd (mg/l)	Ni (mg/l)	Pb (mg/l)	Se (mg/l)	V (mg/l)	CN (mg/l)	Chloroform (ug/l)	Napthalene (ug/l)	U (mg/l)	Gross Alpha (pCi/l)	Combined Ra-226 Ra-228 (pCi/l)	Pb-210 (pCi/l)	Th-230 (pCi/l)
NRC Standard		0.05	0.05	0.01	0.05	0.05	0.01	0.1	0.005	0.001	0.001	0.3	15.0	5.0	1.0	5.0
EPA Standard		0.05	0.017	0.01	0.20	0.05	0.01	0.7	NA	NA	NA	5.0	15.0	5.0	NA	15.0
509 D	10/12/89	0.001	-0.05	-0.01	-0.05	0.07	0.001	-0.1	-0.005	-0.001	-0.001	0.1050	1.2	0.8	2.3	-0.2
632	10/16/89	-0.001	-0.05	-0.01	-0.05	-0.05	0.003	-0.1	-0.005	-0.001	-0.001	0.1110	-1.0	2.9	-1.0	-0.2
EPA 22A	10/08/89	-0.001	-0.05	-0.01	-0.05	-0.05	-0.001	-0.1	-0.005	-0.001	-0.001	0.0290	7.8	0.9	4.1	5.9
EPA 23	10/08/89	-0.001	-0.05	-0.01	-0.05	-0.05	0.001	-0.1	-0.005	-0.001	-0.001	0.0400	10.2	0.2	-1.0	9.8
EPA 28	10/04/89	-0.001	-0.05	-0.01	-0.05	-0.05	0.002	-0.1	-0.005	-0.001	-0.001	0.0410	8.4	2.7	-1.0	4.6
GW 1	10/16/89	-0.001	-0.05	-0.01	-0.05	-0.05	0.001	-0.1	-0.005	-0.001	-0.001	0.0979	3.7	0.4	1.5	4.0
GW 2	10/16/89	-0.001	-0.05	-0.01	-0.05	-0.05	0.001	-0.1	-0.005	-0.001	-0.001	0.1960	15.0	3.8	1.5	11.0

Well Number	Date	Lab TDS (mg/l)	Ca (mg/l)	Cl (mg/l)	K (mg/l)	Mg (mg/l)	Na (mg/l)	HCO3 (mg/l)	NH4 (mg/l)	NO3 (mg/l)	SO4 (mg/l)	Al (mg/l)	Co (mg/l)	Mn (mg/l)	Mo (mg/l)
NRC Standard		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA Standard		3,170	NA	250.0	NA	NA	NA	NA	NA	30.00	2,160	5.0	0.05	2.00	1.00
509 D	10/12/89	6,860	854	197.0	13.5	332.0	201.0	1,703	0.13	58.00	2,053	0.12	-0.01	0.39	-0.1
632	10/16/89	6,466	781	246.0	10.7	671.0	408.0	2,257	0.47	95.00	2,578	-0.10	-0.01	0.12	-0.1
EPA 22A	10/08/89	1,310	269	11.4	4.3	55.4	88.2	521	0.06	0.26	605	-0.10	-0.01	0.08	-0.1
EPA 23	10/08/89	4,930	682	91.0	14.1	397.0	173.0	1,086	0.53	91.00	2,339	-0.10	-0.01	1.90	-0.1
EPA 28	10/04/89	4,989	565	107.0	14.1	475.0	216.0	738	-0.05	113.00	2,720	-0.10	-0.01	0.19	-0.1
GW 1	10/16/89	5,376	856	236.0	3.8	431.0	331.0	2,030	0.13	110.00	1,931	-0.10	-0.01	0.08	-0.1
GW 2	10/16/89	5,564	789	181.0	11.7	479.0	266.0	1,818	0.10	76.00	2,314	-0.10	-0.01	0.31	-0.1

1. NRC standard as listed in License Condition 30, Part B.
2. EPA standard as listed in Table 2, "Contaminant-specific Groundwater ARARs" of the ROD (EPA 1988c).
3. NA - Not applicable.
4. "-" Minus sign: not detected at the level shown in the table.
5. All values that exceed the NRC and/or EPA standards are shaded.
6. Gross alpha value excludes contribution from radon and uranium.

FIGURES


102340
86-060-B308
DRAWING NUMBER 86-060-B313
CHECKED BY
APPROVED BY
12-27-89
12-27-89
N
E 56000
E 59,000
E 60,000
NECR MINE SITE
NORTHEAST PUMP-BACK WELLS
35
UNC MILL FACILITIES
ARROYO
REGRADED TAILINGS AREA
MIST EVAPORATION SYSTEM
CENTRAL CELL
PIPELINE
3 SECTION NUMBER (TYP.)
807
803
806
805
802
804
801
SOUTH CELL
EVAPORATION PONDS
SOUTHWEST ALLUVIUM REMEDIAL ACTION TARGET AREA
10
11
REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T 16 N, R 16 W N.M.P.M. & VICINITY. PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, NEW MEXICO.
DATED: 9-29-89. SCALE: 1" = 200'



LEGEND:

706 ▲ ZONE 3 - STAGE 1 EXTRACTION WELL LOCATION AND NUMBER

801 ▲ SOUTHWEST ALLUVIUM EXTRACTION WELL LOCATION AND NUMBER

807 △ SOUTHWEST ALLUVIUM OBSERVATION WELL LOCATION AND NUMBER

SCALE
400 0 400 800 FEET

CURRENT SITE CONDITIONS

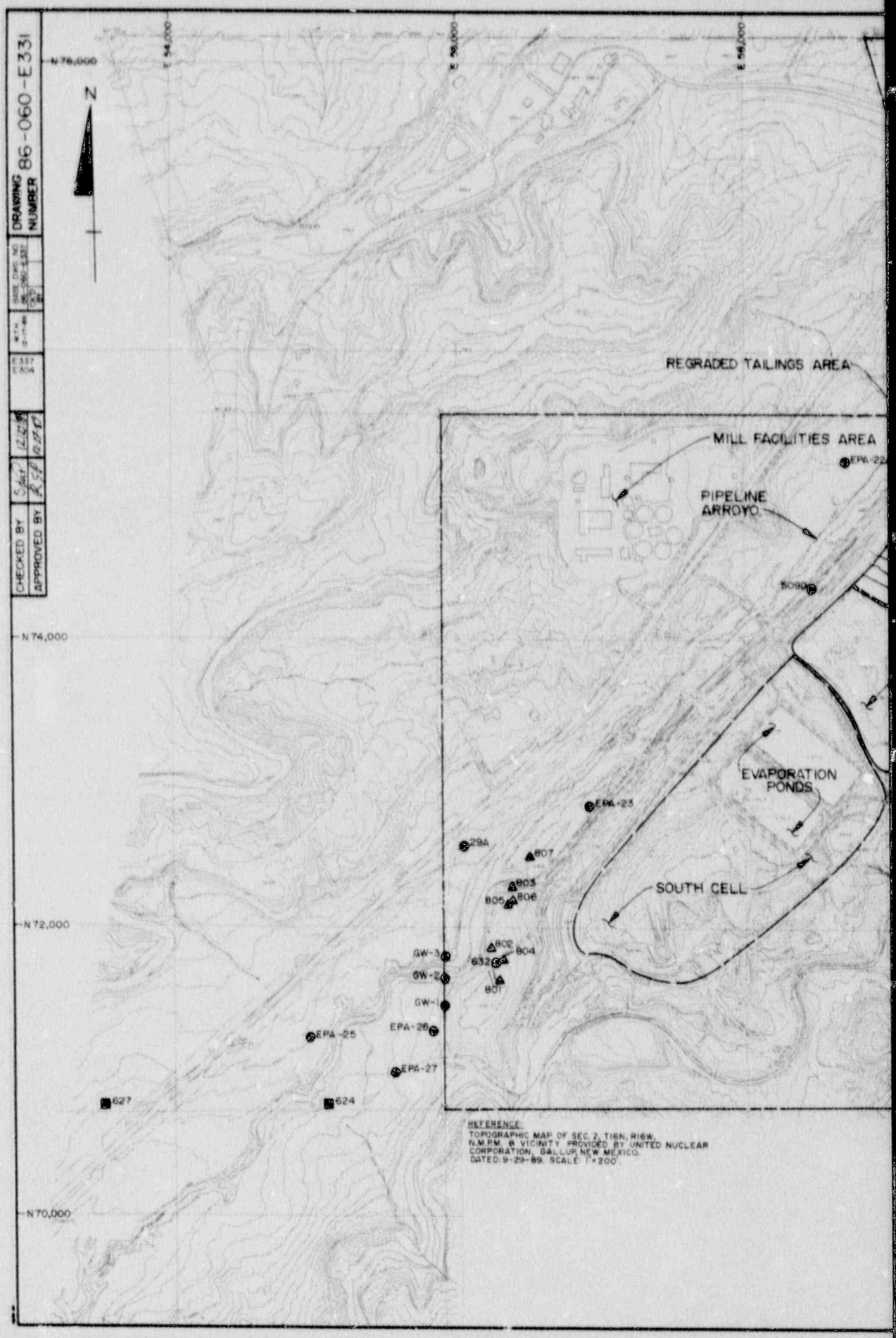
PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 11-27-89	FIGURE 1-1	DRAWING NUMBER
SCALE: AS SHOWN		86-060-B313

86-060-B308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APPROVED BY
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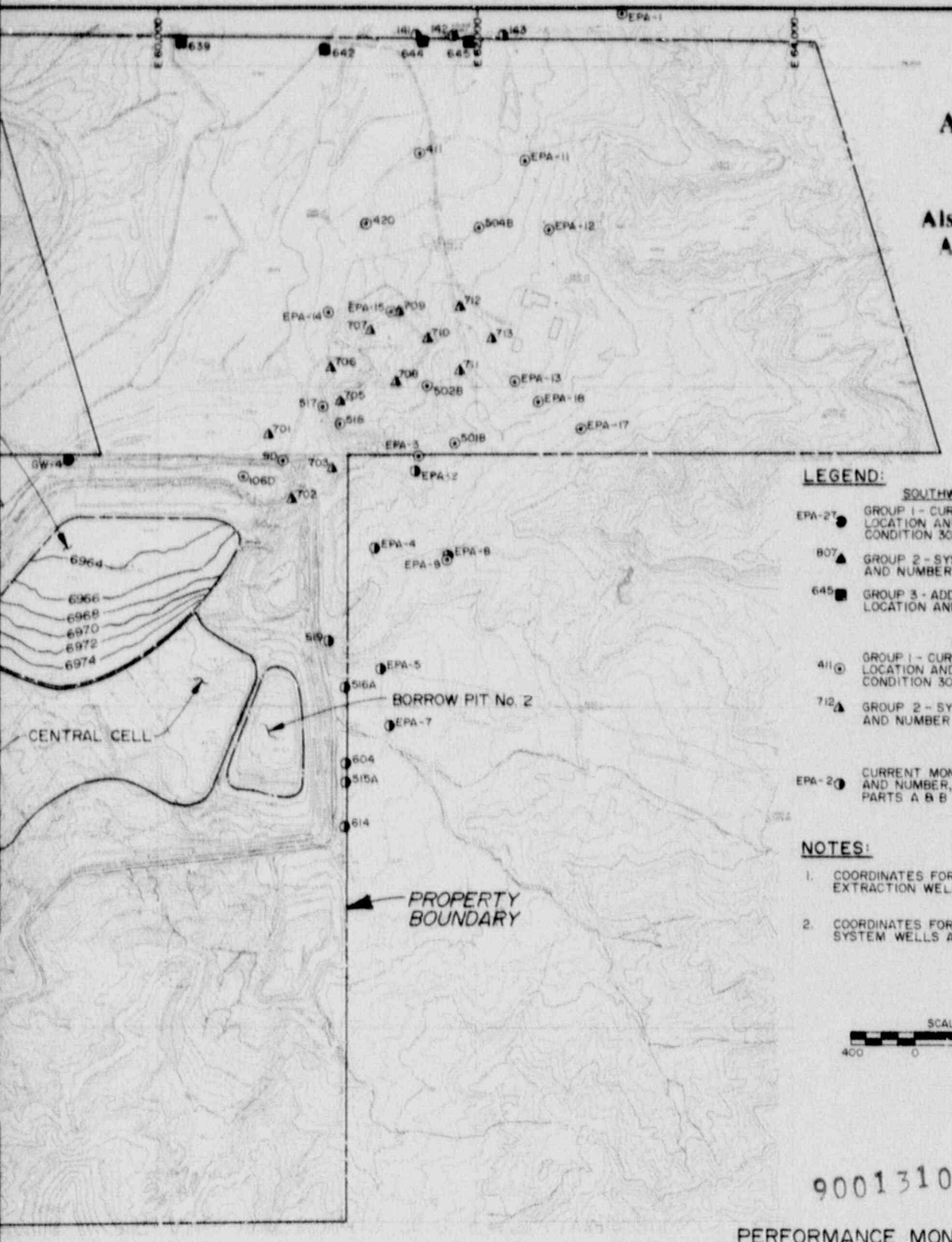
N 74,000
N 72,000
N 70,000
E 54,000
E 56,000
E 58,000
N
REGRADED TAILINGS AREA
MILL FACILITIES AREA
EPA-22
PIPELINE ARROYO
5090
EVAPORATION PONDS
EPA-23
SOUTH CELL
29A
807
803
805
806
802
804
632
801
GW-3
GW-2
GW-1
EPA-26
EPA-25
EPA-27
627
624
REFERENCE
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, NEW MEXICO. DATED: 9-29-89. SCALE 1"=200'.



LEGEND:

SOUTHWEST ALLUVIUM

EPA-27 ● GROUP 1 - CURRENT MONITORING WELL LOCATION AND NUMBER, LICENSE CONDITION 30, PARTS A & B CRITERIA

807 ▲ GROUP 2 - SYSTEM WELL LOCATION AND NUMBER

645 ■ GROUP 3 - ADDITIONAL ALLUVIAL WELL LOCATION AND NUMBER

ZONE 3

411 ⊙ GROUP 1 - CURRENT MONITORING WELL LOCATION AND NUMBER, LICENSE CONDITION 30, PARTS A & B CRITERIA

712 ▲ GROUP 2 - SYSTEM WELL LOCATION AND NUMBER

ZONE 1

EPA-2 ◑ CURRENT MONITORING WELL LOCATION AND NUMBER, LICENSE CONDITION 30, PARTS A & B CRITERIA

NOTES:

1. COORDINATES FOR ZONE 3 - STAGE 1 EXTRACTION WELLS ARE LISTED IN TABLE 2.1.
2. COORDINATES FOR SOUTHWEST ALLUVIUM SYSTEM WELLS ARE LISTED IN TABLE 2.9.

SCALE
400 0 400 800 FEET

PERFORMANCE MONITORING WELLS

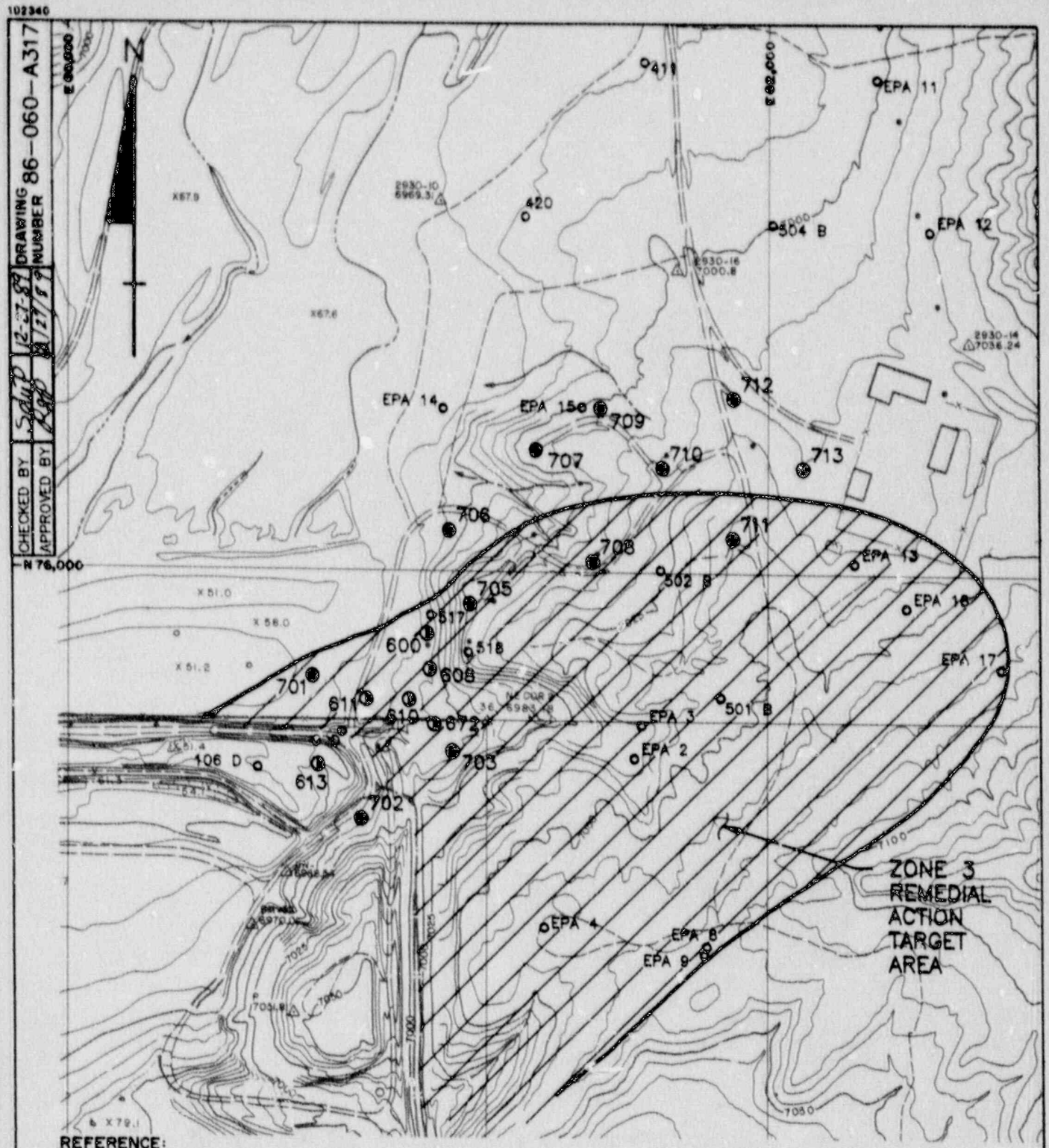
PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

12-17-89 86-060-E337	DATE: 12-8-89	FIGURE 1-2	DRAWING NUMBER 86-060-E331	REV.
	SCALE: AS SHOWN			

86-060-E304



REFERENCE:

TOPOGRAPHIC MAP OF SEC.2, T16N, R16W N.M.P.M. & VICINITY, PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, NEW MEXICO. DATED: 9-29-89. SCALE 1"=200'.

LEGEND:

- ● 708 ZONE 3- STAGE I EXTRACTION WELLS
- ◐ 672 NORTHEAST PUMP-BACK WELLS

SCALE

400 0 400 FEET

ZONE 3 WELL LOCATIONS

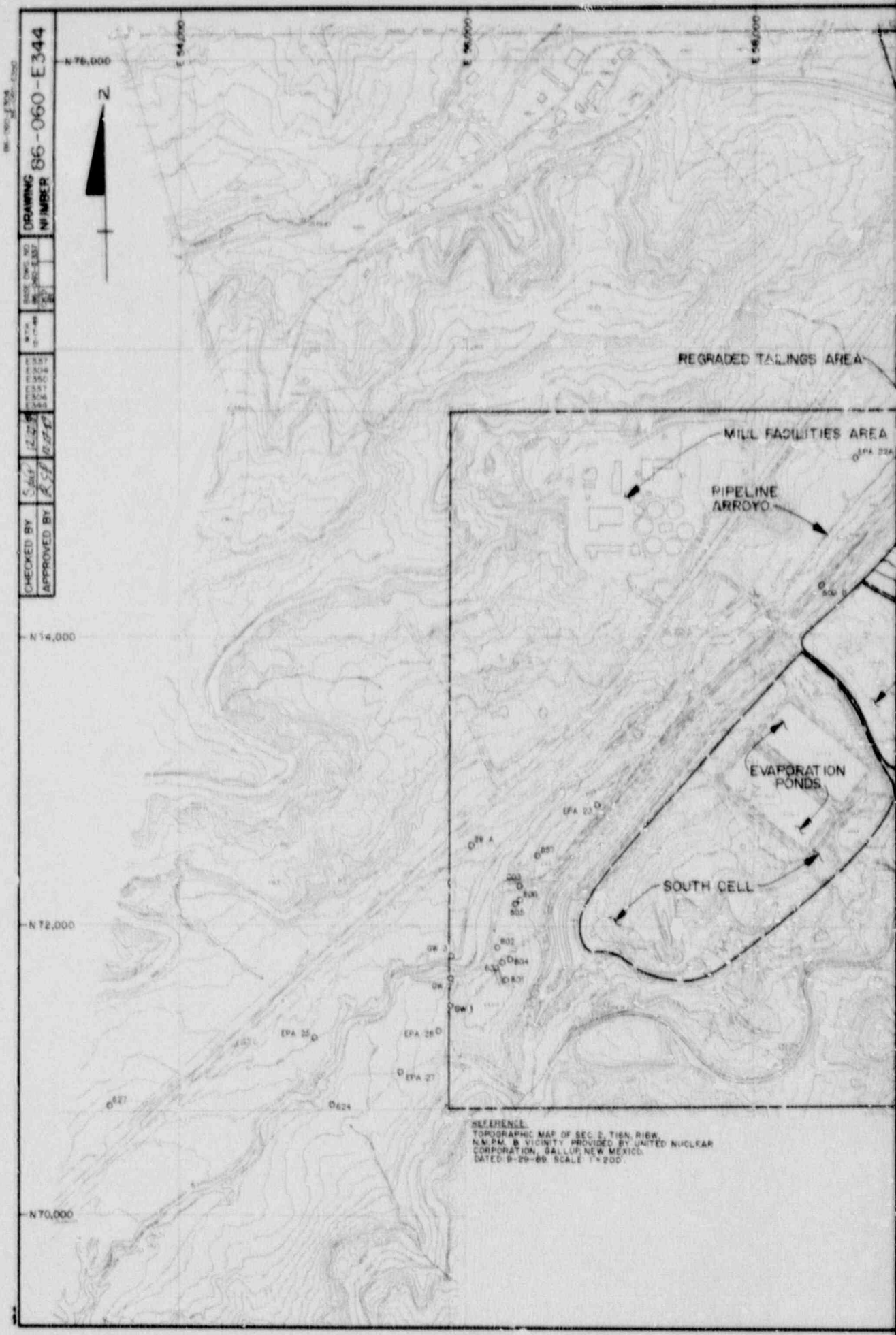
PREPARED FOR

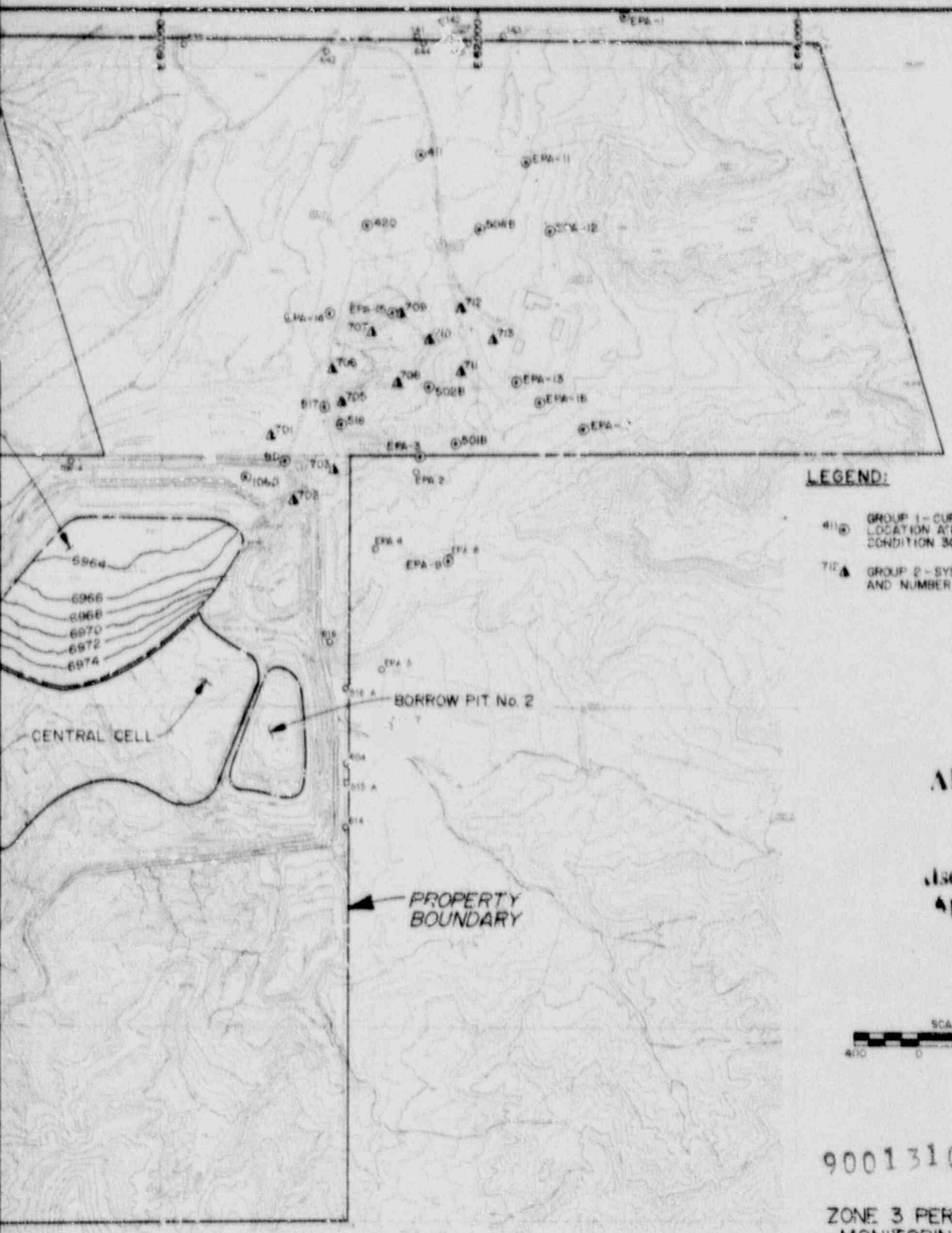
UNC MINING AND MILLING
GALLUP, NEW MEXICO

CanonieEnvironmental

DATE: 11-29-89	FIGURE 2-1	DRAWING NUMBER 86-060-A317
SCALE: AS SHOWN		

86-060-A309


DRAWING NUMBER 86-060-E344
CHECKED BY
APPROVED BY
N 76,000
N 74,000
N 72,000
N 70,000
E 54,000
E 56,000
E 58,000
N
REGRADED TAILINGS AREA
MILL FACILITIES AREA
PIPELINE ARROYO
EVAPORATION PONDS
SOUTH CELL
EPA 23
EPA 25
EPA 26
EPA 27
REFERENCE:
TOPOGRAPHIC MAP OF SEC 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, NEW MEXICO.
DATED 9-29-89 SCALE 1"=200'



LEGEND:

ZONE 3

411 ◉ GROUP 1 - CURRENT MONITORING WELL LOCATION AND NUMBER, LICENSE CONDITION 30, PARTS A & B CRITERIA

712 ▲ GROUP 2 - SYSTEM WELL LOCATION AND NUMBER

SCALE
400 0 400 800 FEET

9001310108-03

ZONE 3 PERFORMANCE MONITORING WELLS

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

12-17-89
86-060-E337

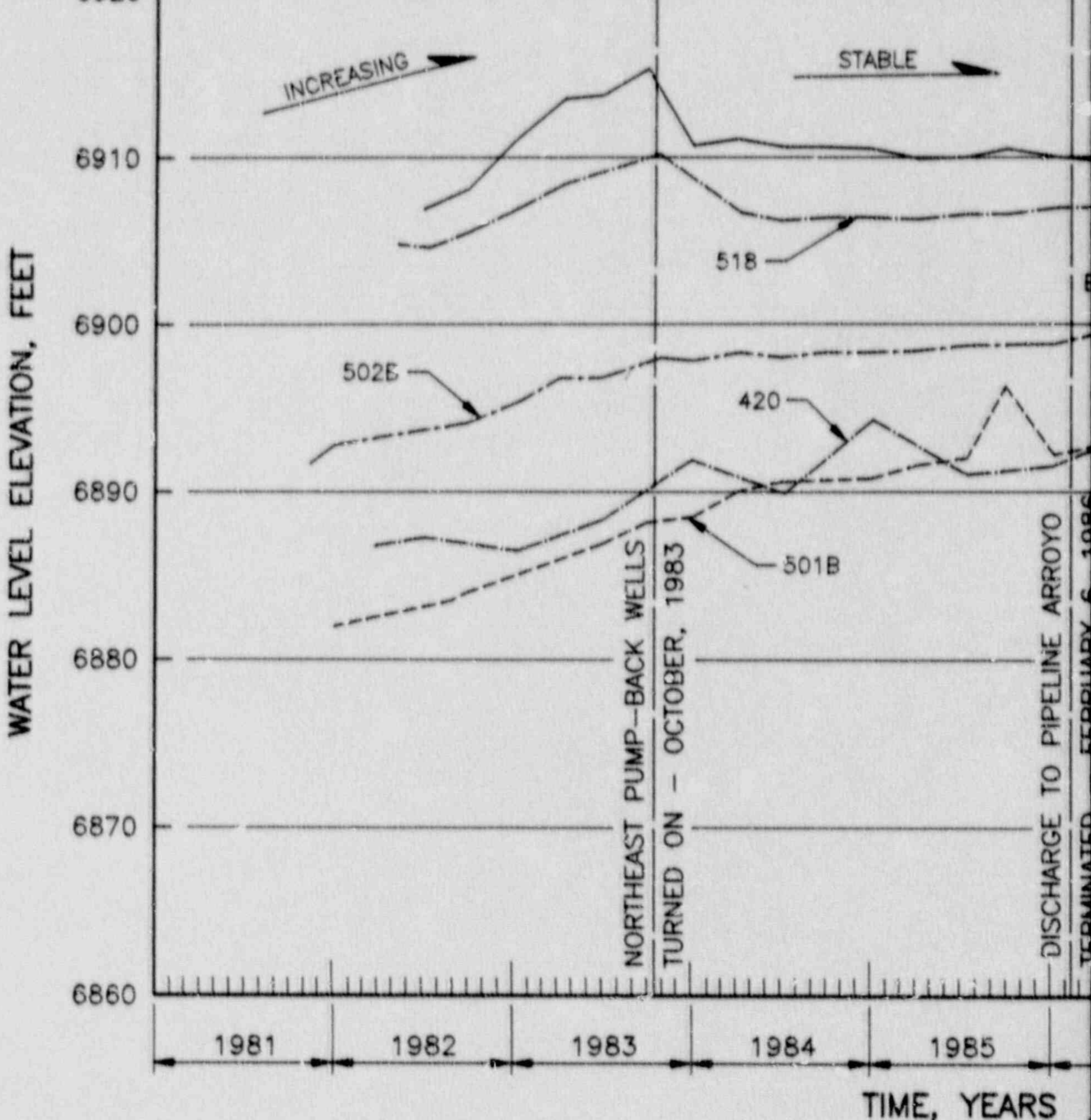
DATE: 12-22-89	FIGURE 2-2	DRAWING NUMBER 86-060-E344	REV.
SCALE: AS SHOWN			

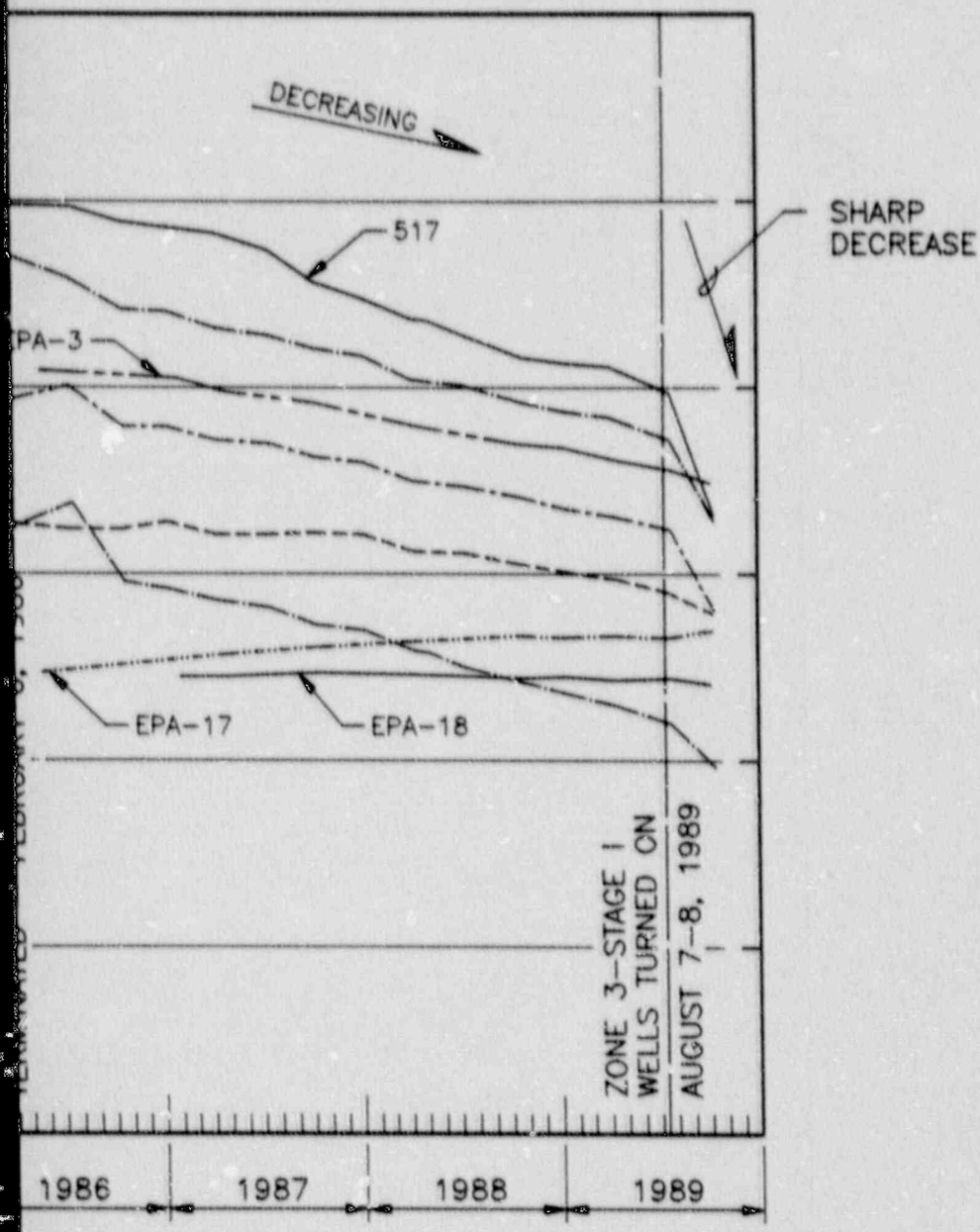
86-060-E309
86-060-E310

DRAWING NUMBER 86-060-B340

CHECKED BY [signature] 12-22-89

APPROVED BY [signature] 12/27/89





9001310108 - 04

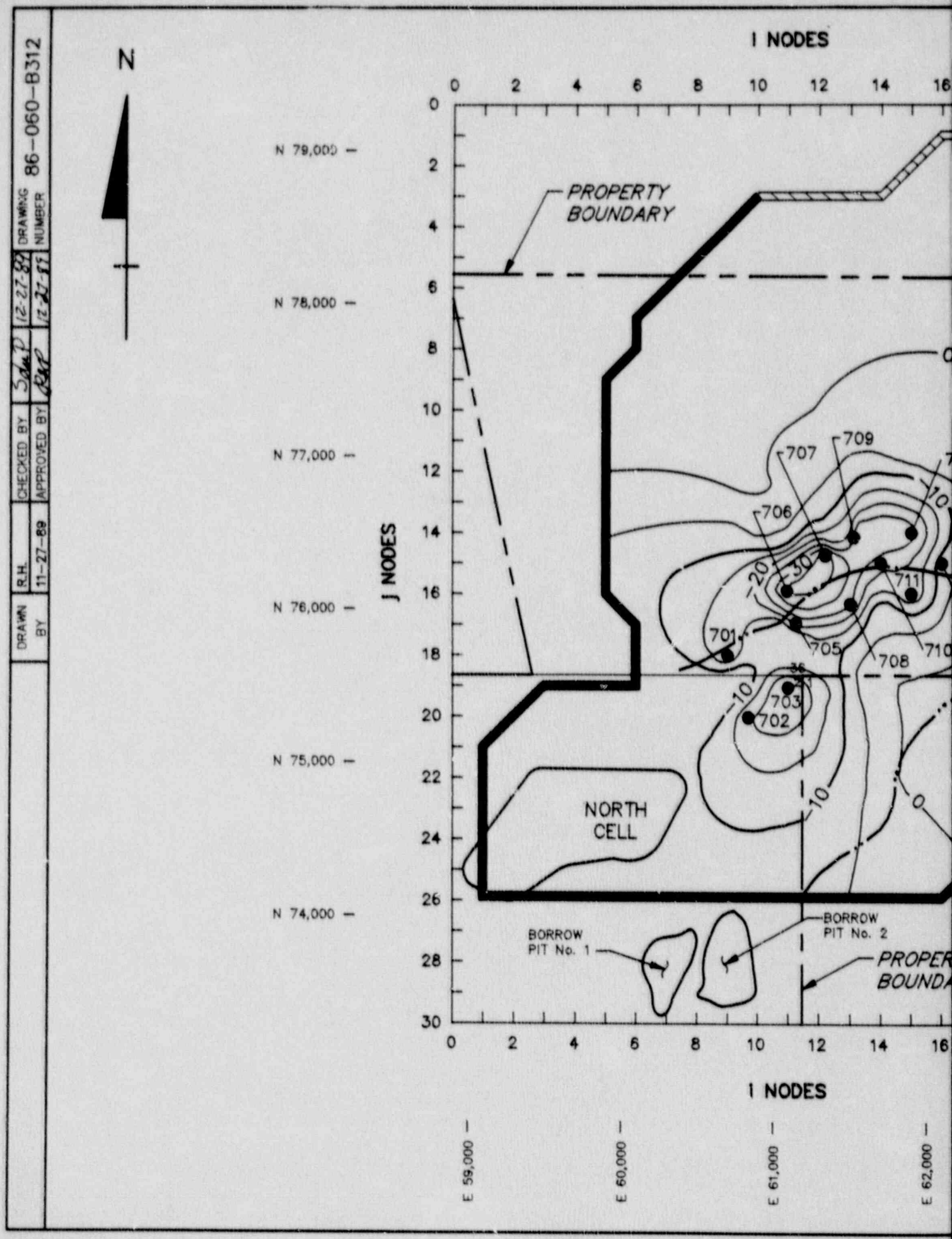
ZONE 3
WATER LEVEL TRENDS

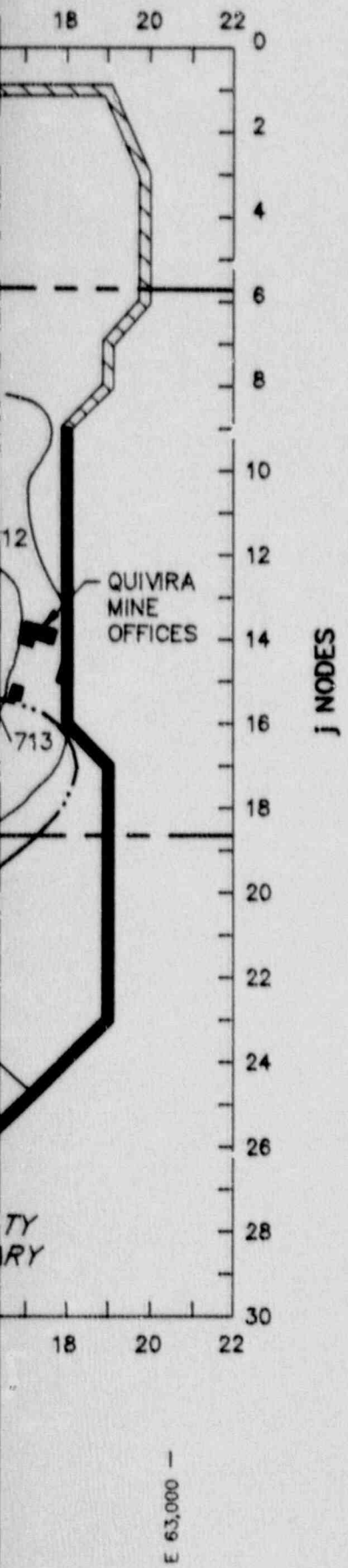
PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

CanonieEnvironmental

DATE: 12-18-89 SCALE: AS SHOWN	FIGURE 2-3	DRAWING NUMBER 86-060-B340


DRAWN BY
R.H.
11-27-89
CHECKED BY
APPROVED BY
12-27-89
12-27-89
DRAWING NUMBER 86-060-B312
N
I NODES
J NODES
PROPERTY BOUNDARY
NORTH CELL
BORROW PIT No. 1
BORROW PIT No. 2
N 79,000
N 78,000
N 77,000
N 76,000
N 75,000
N 74,000
E 59,000
E 60,000
E 61,000
E 62,000
701
702
703
705
706
707
708
709
710
711



SI APERTURE CARD

Also Available On Aperture Card

NOTES:

1. MEASURED CHANGES IN SATURATED THICKNESS ARE PRESENTED WITHIN THE FRAMEWORK OF THE COMPUTER SIMULATION USED TO REFINE THE DESIGN OF THE SYSTEM. FOR A DESCRIPTION OF THE COMPUTER SIMULATION REFER TO THE RD (CANONIE 1989a). THE CONTOURS PRESENTED ARE BASED ON FIELD DATA AND ARE NOT PREDICTED BY THE MODEL.

2. CONTOUR INTERVAL IS 5 FEET.

LEGEND:

- MODEL BOUNDARY: CONSTANT HEAD
- MODEL BOUNDARY: NO FLOW
- 707 — STAGE 1 EXTRACTION WELL LOCATION AND NUMBER
- -30- — DECREASE IN SATURATED THICKNESS OF ZONE 3 BASED ON 3rd AND 4th QUARTER 1989 DATA, FEET
- BOUNDARY OF REMEDIAL ACTION TARGET AREA
- 36 / 2 | 1 — SECTION CORNER AND NUMBERS

SCALE

800 0 800 FEET

9001310108 - 05

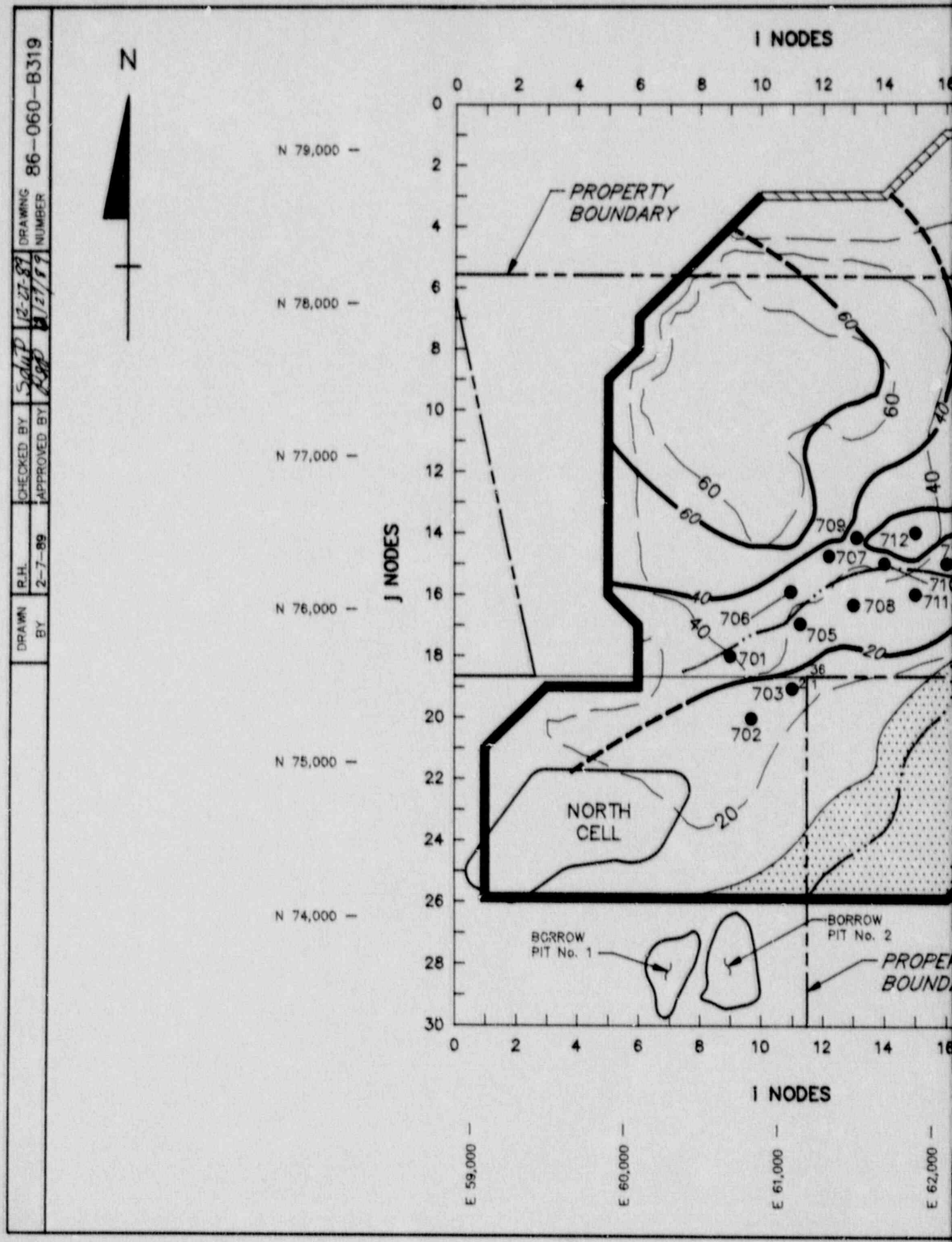
CHANGE IN ZONE 3
SATURATED THICKNESS
BETWEEN 3rd AND 4th QUARTERS, 1989

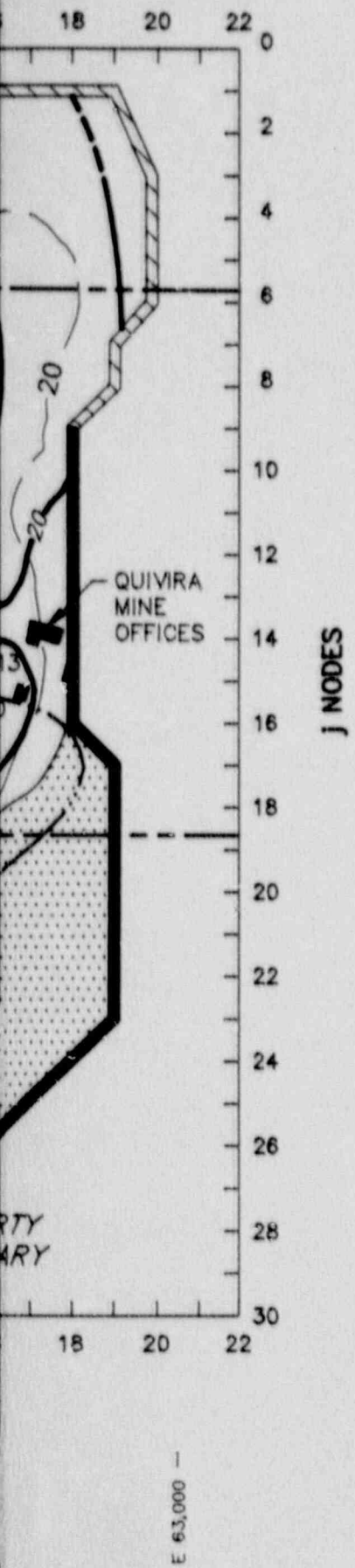
PREPARED FOR

UNC MINING AND MILLING
CHURCH ROCK, NEW MEXICO

Canonie Environmental

DATE: 11-27-89 SCALE: AS SHOWN	FIGURE 2-4	DRAWING NUMBER 86-060-B312


DRAWN BY
R.H.
2-7-89
CHECKED BY
APPROVED BY
2-27-89
DRAWING NUMBER
86-060-B319
N
I NODES
J NODES
N 79,000
N 78,000
N 77,000
N 76,000
N 75,000
N 74,000
PROPERTY BOUNDARY
60
40
20
709
712
707
708
706
705
701
703
702
NORTH CELL
BORROW PIT No. 1
BORROW PIT No. 2
E 59,000
E 60,000
E 61,000
E 62,000



NOTES:

1. NODAL SPACING EQUAL TO 200 FEET.
2. MODEL USED FOR SIMULATION IS PRICKETTE LONNQUIST FINITE DIFFERENCE MODEL.
3. CONTOUR INTERVAL IS 20 FEET.

LEGEND:

- MODEL BOUNDARY: CONSTANT HEAD
- MODEL BOUNDARY: NO FLOW
- ●707 — STAGE I EXTRACTION WELL LOCATION AND NUMBER
- 60 — MODELED CONTOUR OF SATURATED THICKNESS AFTER 3 MONTHS OF PUMPING, FEET
- 40 — CONTOUR OF SATURATED THICKNESS, 4TH QUARTER 1989, FEET (DASHED WHERE INFERRED)
- AREA WHERE ZONE 3 SATURATED THICKNESS WAS LESS THAN 10 FEET PRIOR TO EXTRACTION
- BOUNDARY OF REMEDIAL ACTION TARGET AREA
- 36 / 2 1 — SECTION CORNER

SCALE

800 0 800 FEET

9001310108 - 06

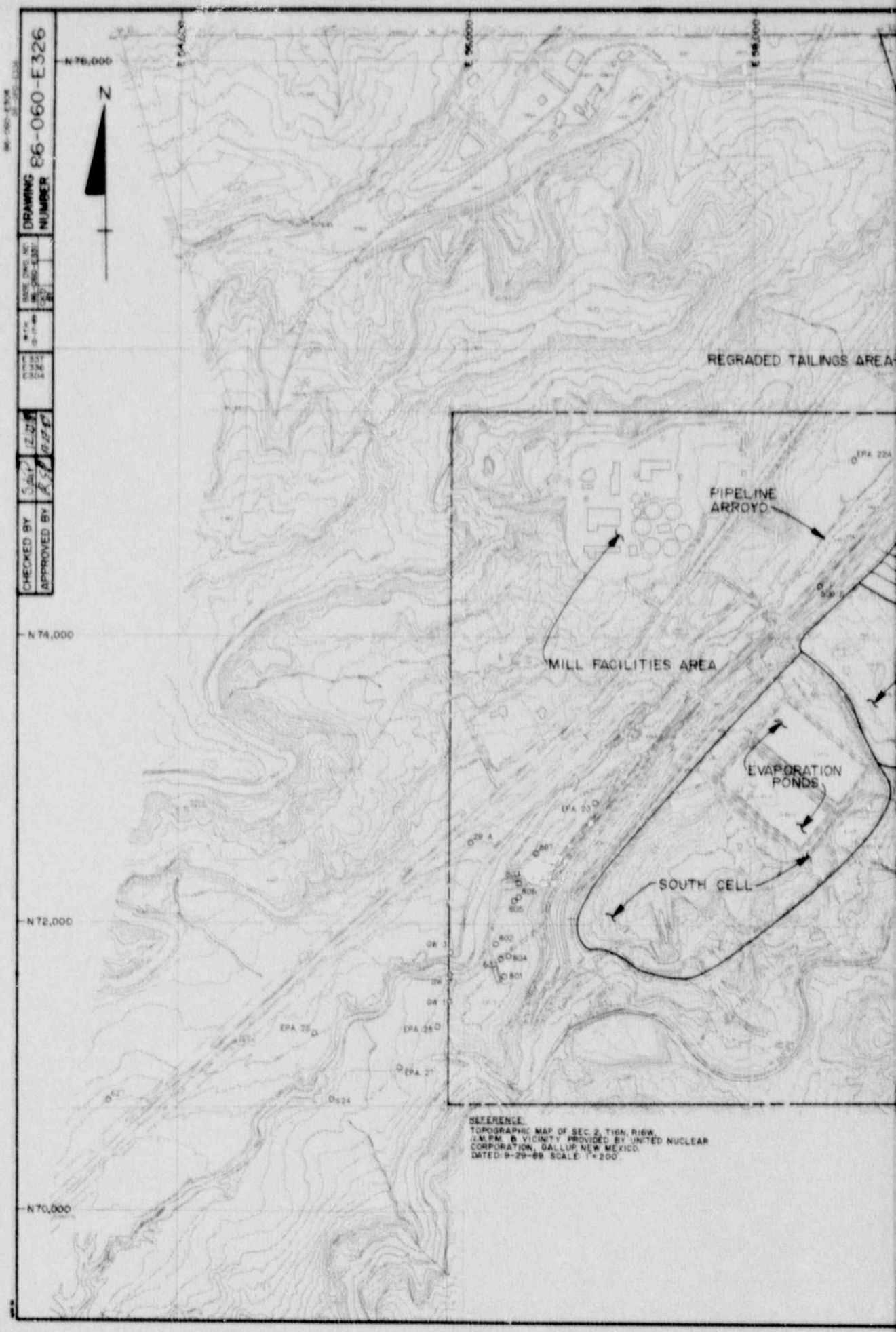
COMPARISON OF ACTUAL VS. PREDICTED SATURATED THICKNESS AFTER 3 MONTHS OF PUMPING (3rd AND 4th QUARTERS, 1989)

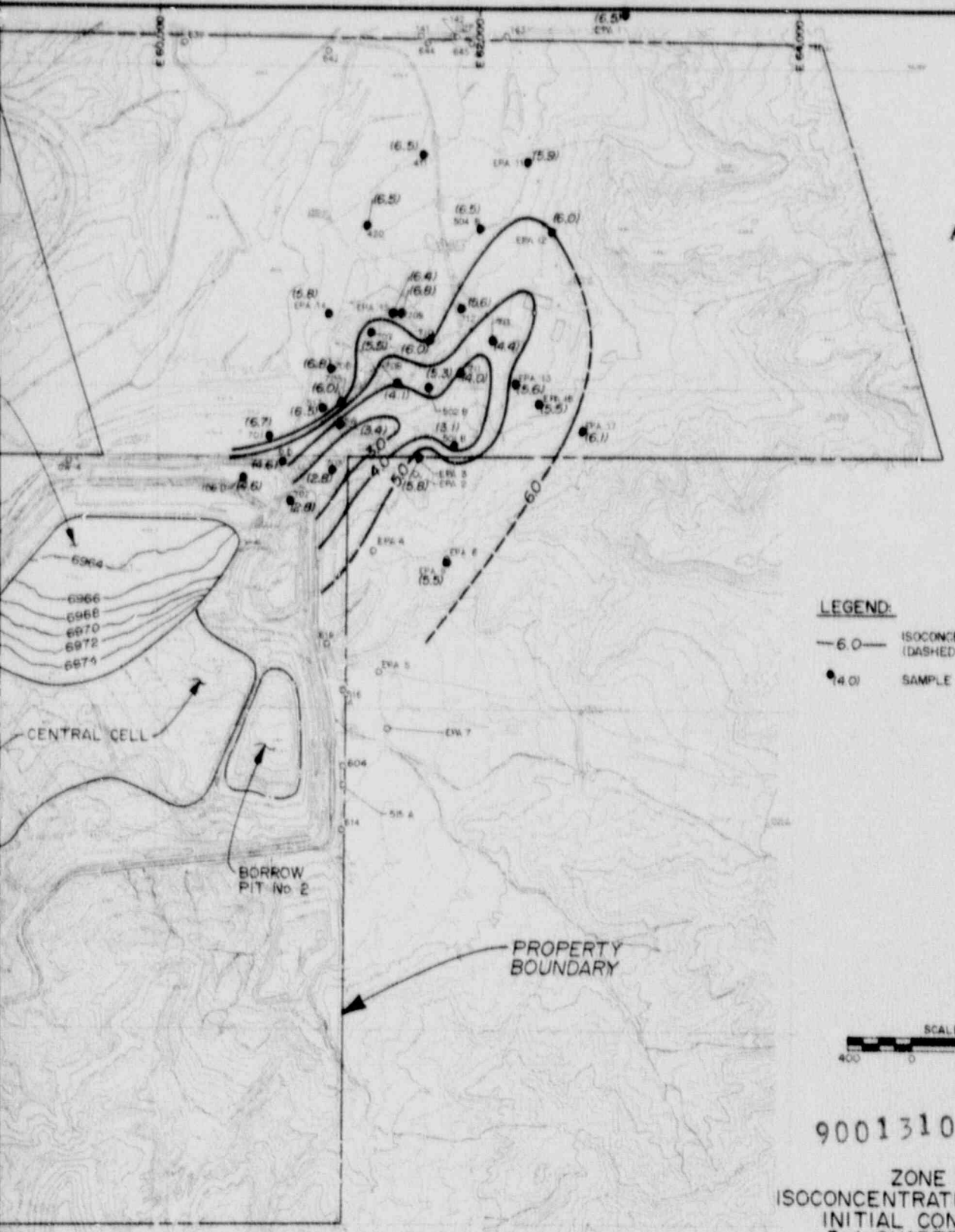
PREPARED FOR

UNC MINING AND MILLING
CHURCH ROCK, NEW MEXICO

CanonieEnvironmental

DATE: 2-7-89	FIGURE 2-5	DRAWING NUMBER
SCALE: AS SHOWN		86-060-B319


DRAWING NUMBER 86-060-E326
CHECKED BY
APPROVED BY
N 76,000
N 74,000
N 72,000
N 70,000
E 54,000
E 56,000
E 58,000
N
REGRADED TAILINGS AREA
PIPELINE ARROYO
MILL FACILITIES AREA
EVAPORATION PONDS
SOUTH CELL
EPA 22A
EPA 23
EPA 25
EPA 26
EPA 27
REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, NEW MEXICO.
DATED: 9-29-89 SCALE: 1"=200'



SI APERTURE CARD

Also Available On Aperture Card

LEGEND:

—6.0— ISOCONCENTRATION LINES OF pH (DASHED WHERE INFERRED)

(4.0) SAMPLE POINT AND pH VALUE

SCALE
400 0 400 800 FEET

9001310108-07

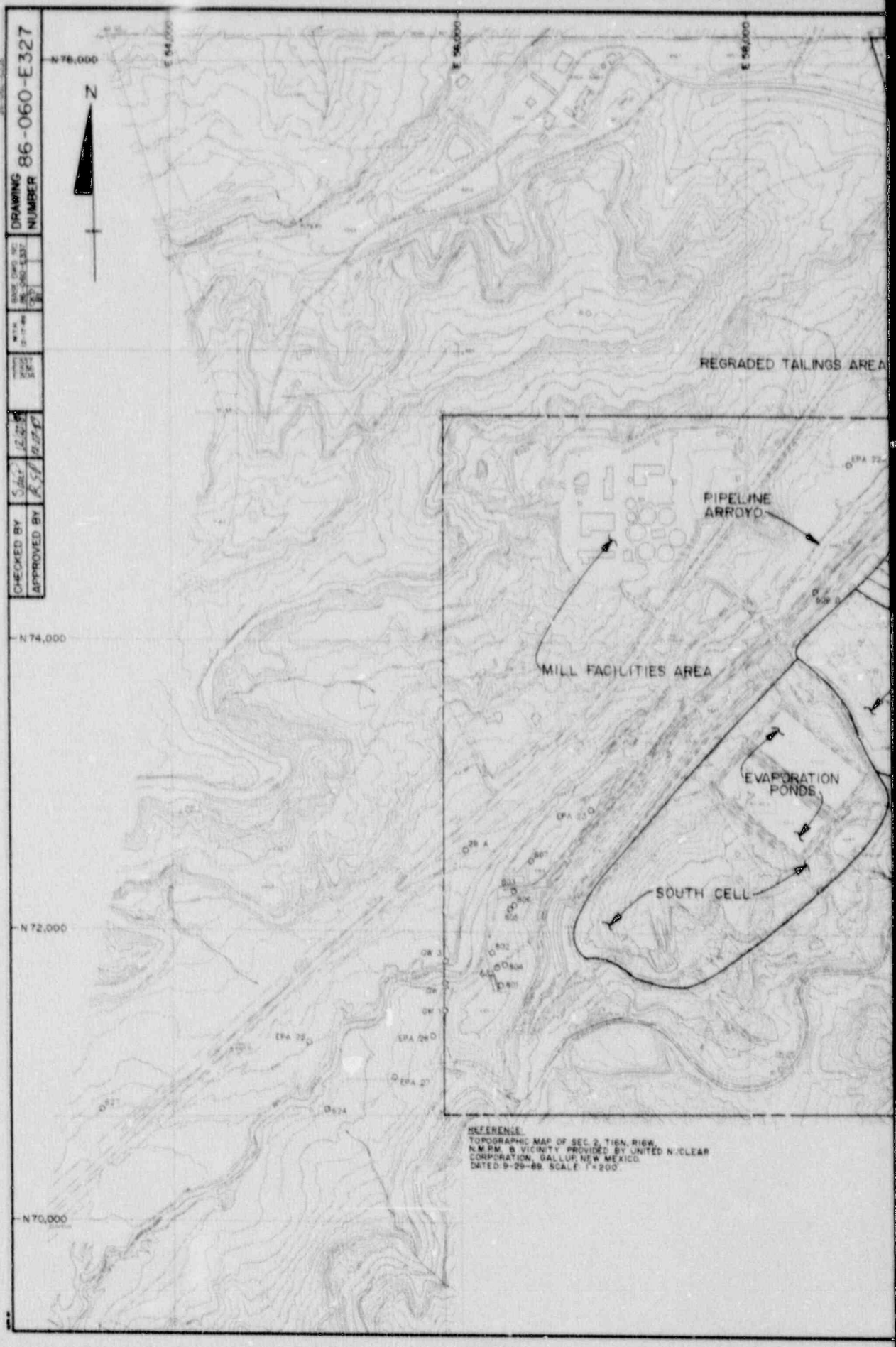
ZONE 3
ISOCONCENTRATIONS OF pH
INITIAL CONDITIONS
3rd QUARTER, 1989

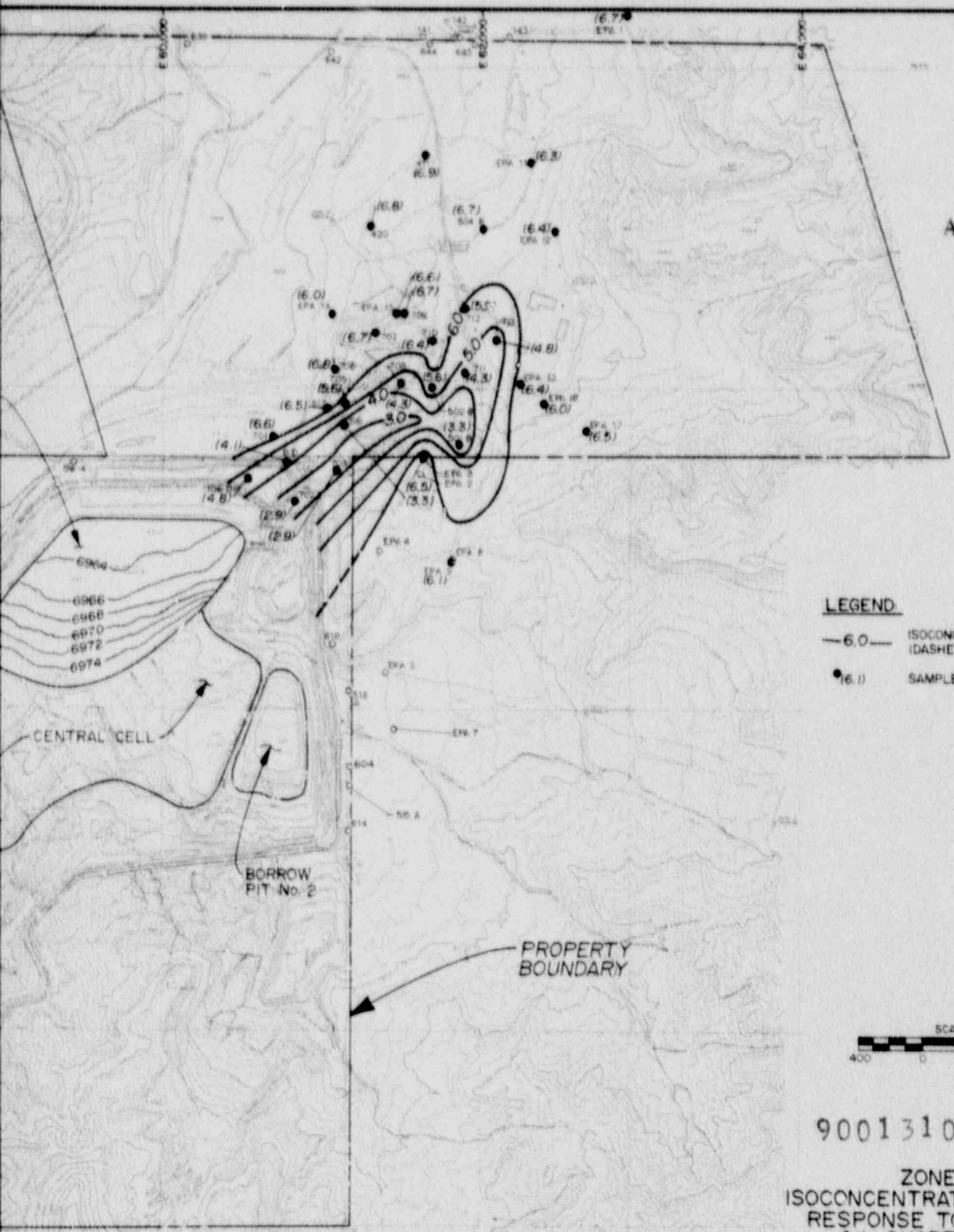
PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

12-17-89 86-060-E337	DATE: 12-7-89 SCALE: AS SHOWN	FIGURE 2-6	DRAWING NUMBER 86-060-E326	REV. 1


DRAWING NUMBER 86-060-E327
CHECKED BY
APPROVED BY
N 78,000
N 74,000
N 72,000
N 70,000
E 54,000
E 56,000
E 58,000
N
REGRADED TAILINGS AREA
PIPELINE ARROYO
MILL FACILITIES AREA
EVAPORATION PONDS
SOUTH CELL
REFERENCE
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY, PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, NEW MEXICO.
DATED: 9-29-69. SCALE: 1"=200'.



SI APERTURE CARD

Also Available On Aperture Card

LEGEND

—6.0— ISOCONCENTRATION LINES OF pH (DASHED WHERE INFERRED)

•(6.1) SAMPLE POINT AND pH VALUE

SCALE
400 0 400 800 FEET

9001310108 - 02

ZONE 3
ISOCONCENTRATIONS OF pH
RESPONSE TO PUMPING
4th QUARTER, 1989

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

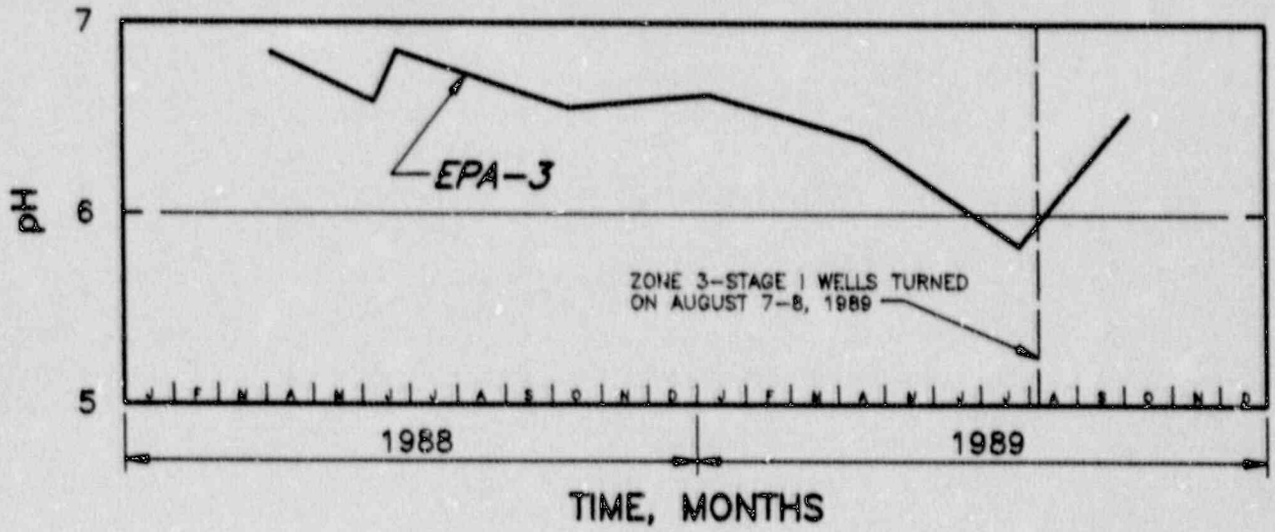
Canonie Environmental

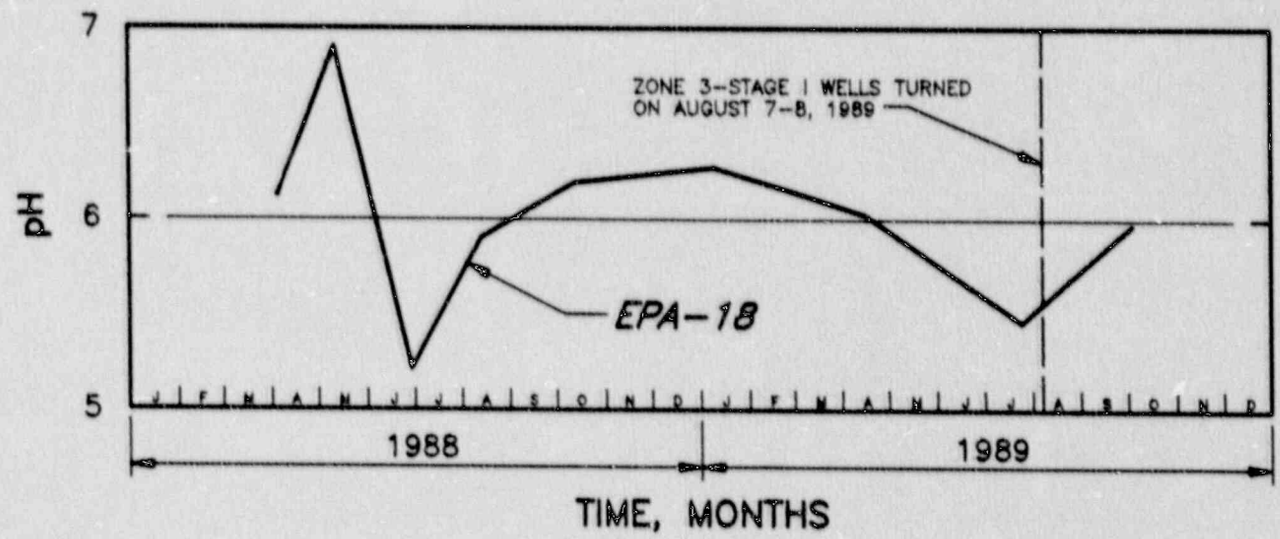
12-17-89
86-060-E337

DATE: 12-7-89	FIGURE 2-7	DRAWING NUMBER 86-060-E327	REV. △
SCALE: AS SHOWN			

CHECKED BY	SAW	12-21-89
APPROVED BY	RAP	12/21/89

DRAWING NUMBER 86-060-A341





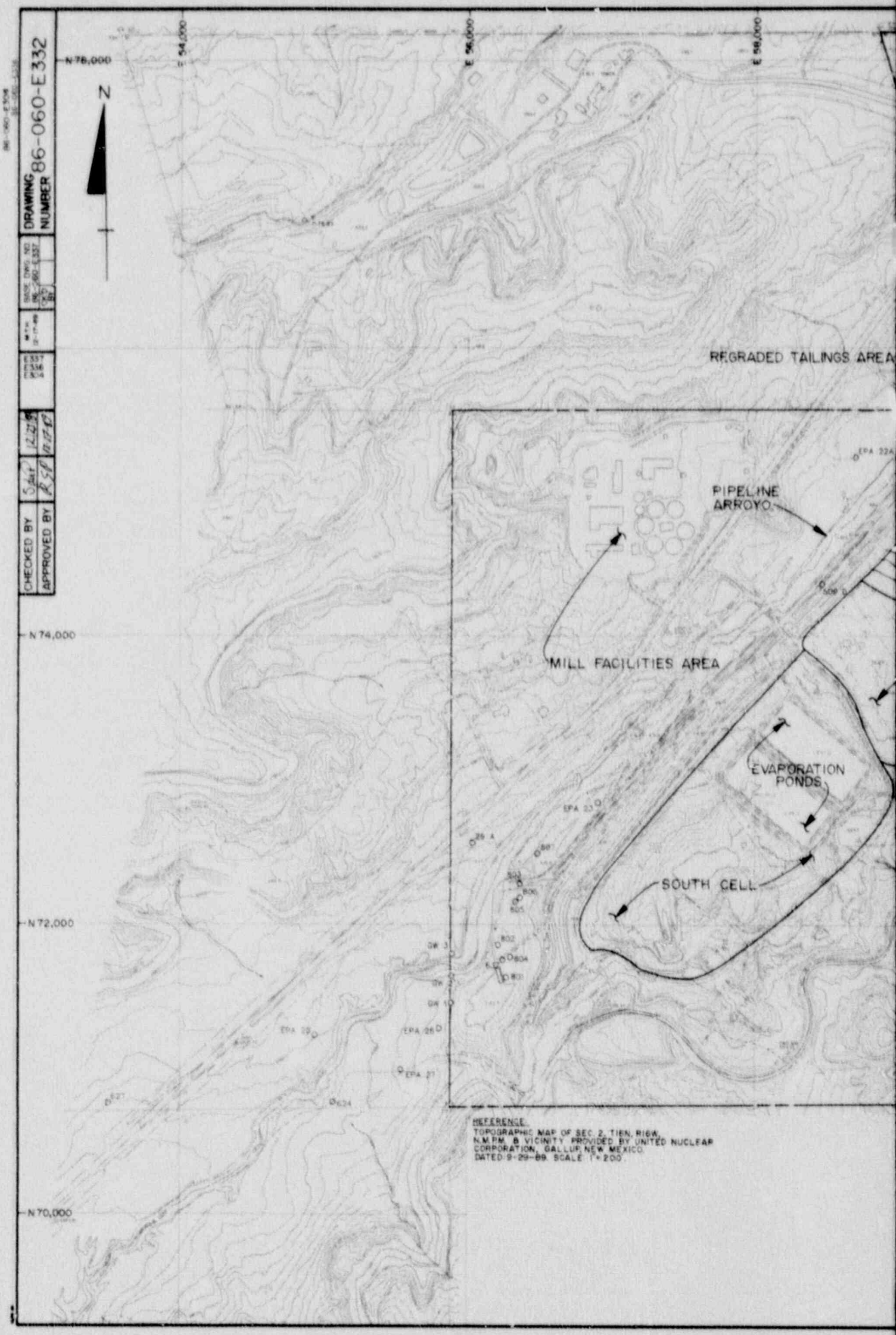
pH VERSUS TIME
RESPONSE TO PUMPING

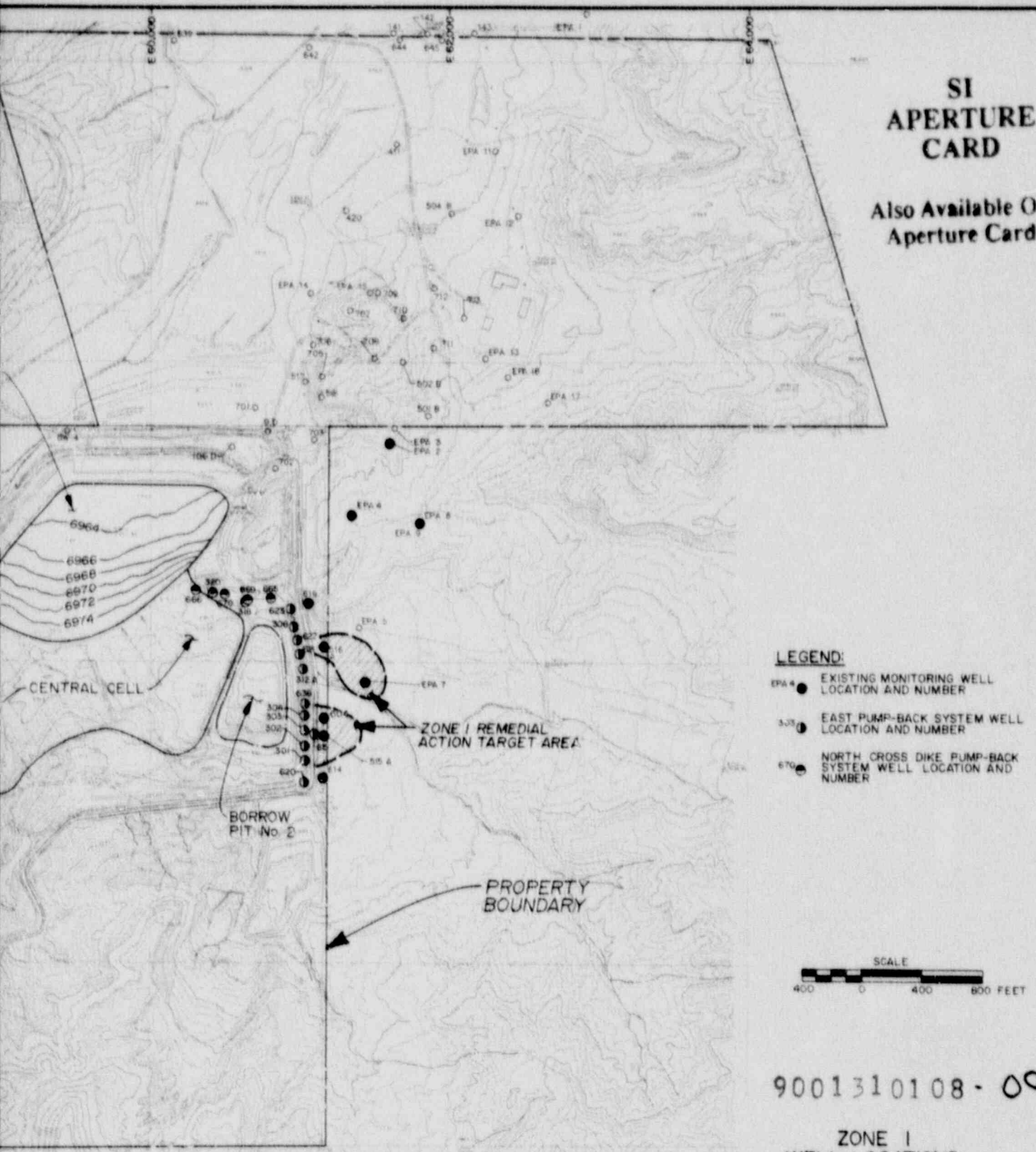
PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 12-20-89	FIGURE 2-8	DRAWING NUMBER 86-060-A341
SCALE: AS SHOWN		


DRAWING NUMBER 86-060-E332
CHECKED BY
APPROVED BY
N 78,000
N 74,000
N 72,000
N 70,000
E 54,000
E 56,000
E 58,000
N
REGRADED TAILINGS AREA
PIPELINE ARROYO
MILL FACILITIES AREA
EVAPORATION PONDS
SOUTH CELL
EPA 22A
EPA 23
EPA 25
EPA 26
EPA 27
REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, NEW MEXICO.
DATED: 9-29-89. SCALE 1"=200'.



SI APERTURE CARD

Also Available On Aperture Card

9001310108 - 09

ZONE I
WELL LOCATIONS

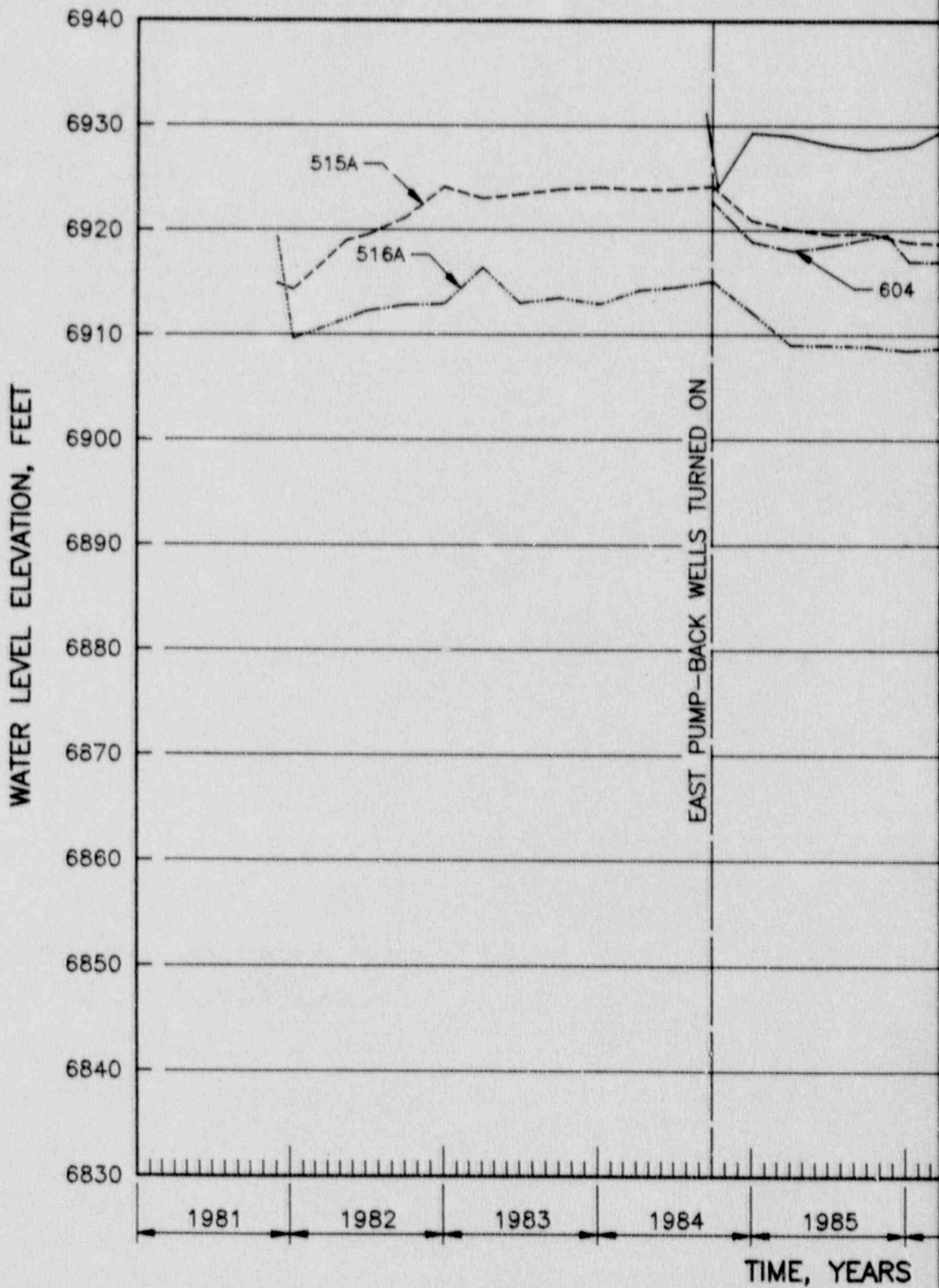
PREPARED FOR

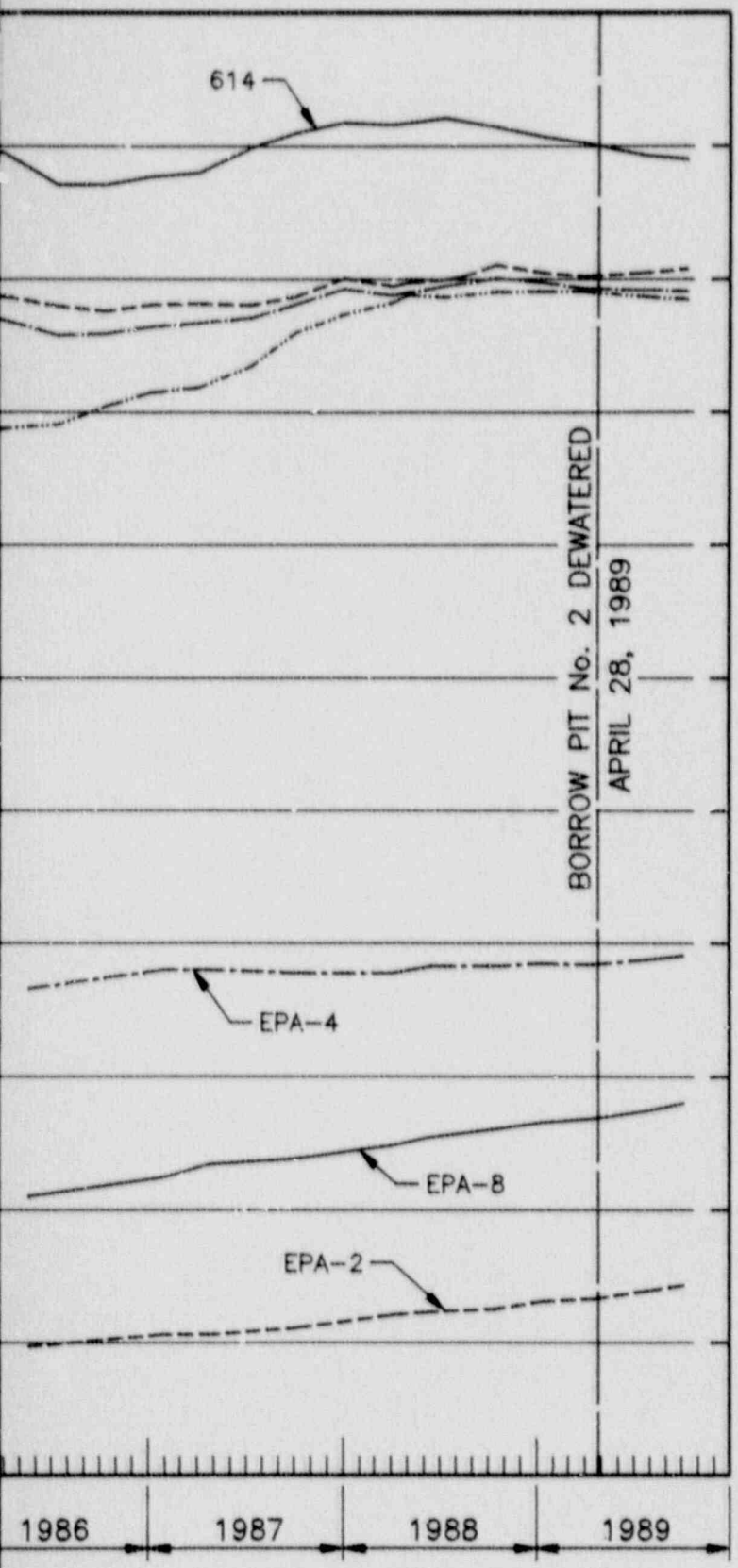
UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

12-17-89 86-060-E337	DATE: 12-9-89 SCALE: AS SHOWN	FIGURE 2-9	DRAWING NUMBER 86-060-E332	REV.

CHECKED BY	Schuff	12-27-87	DRAWING NUMBER 86-060-B339
APPROVED BY	Rogo	12/27/87	





WELLS LOCATED ADJACENT TO BORROW PIT No. 2

WELLS LOCATED DOWNGRADIENT FROM BORROW PIT No. 2

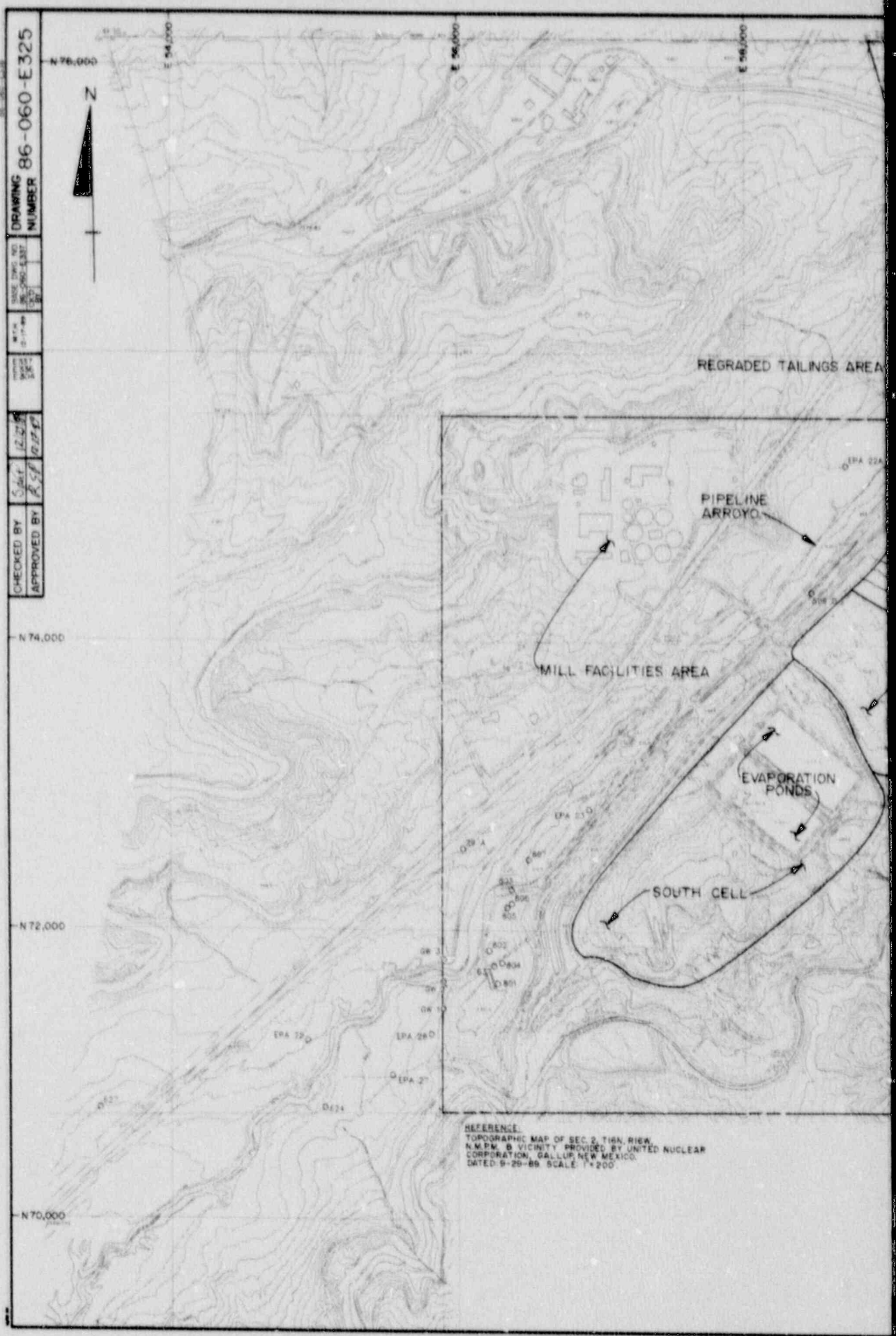
ZONE 1
WATER LEVEL TRENDS

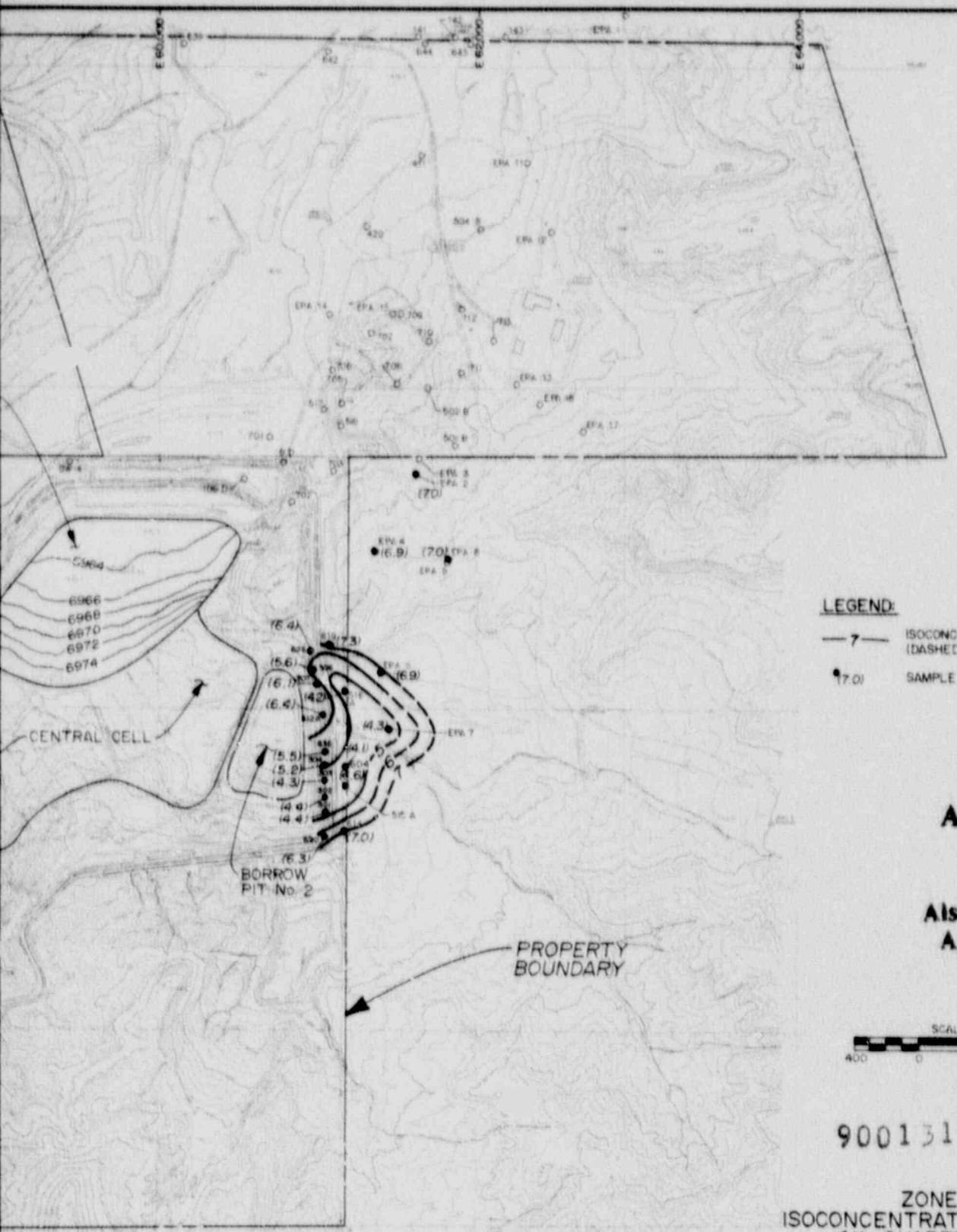
PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 12-18-89	FIGURE 2-10	DRAWING NUMBER 86-060-B339
SCALE: AS SHOWN		


DRAWING NUMBER 86-060-E325
CHECKED BY
APPROVED BY
N 76,000
N 74,000
N 72,000
N 70,000
E 54,000
E 56,000
E 58,000
N
REGRADED TAILINGS AREA
PIPELINE ARROYO
MILL FACILITIES AREA
EVAPORATION PONDS
SOUTH CELL
EPA 22A
EPA 23
EPA 29
EPA 28
EPA 27
EPA 26
EPA 2
REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, NEW MEXICO.
DATED 9-29-89 SCALE 1"=200'



LEGEND:

—7— ISOCONCENTRATION LINES OF pH (DASHED WHERE INFERRED)

•(7.0) SAMPLE POINT AND pH VALUE

SI APERTURE CARD

Also Available On Aperture Card

SCALE
400 0 400 800 FEET

9001310108-11

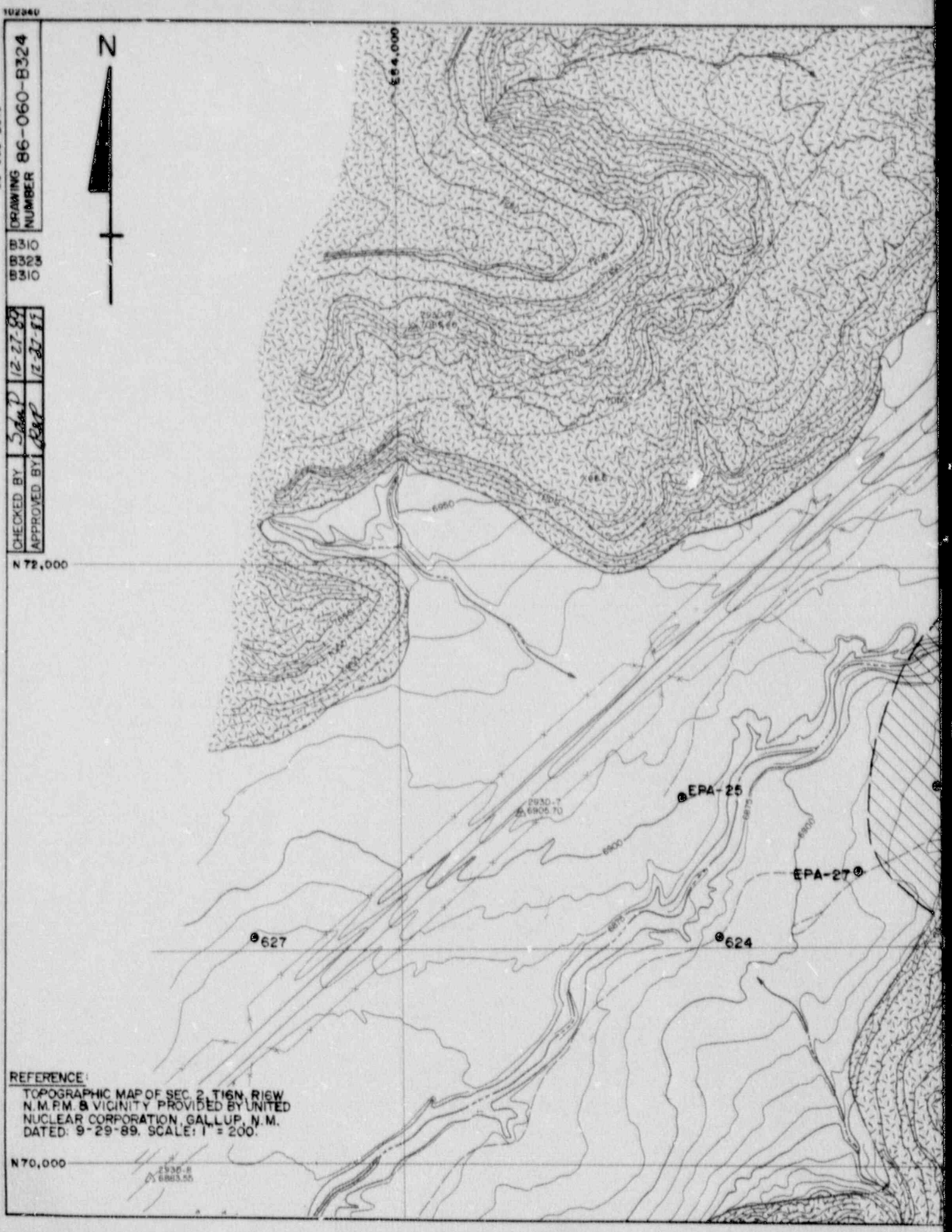
ZONE I
ISOCONCENTRATIONS OF pH
4th QUARTER, 1989

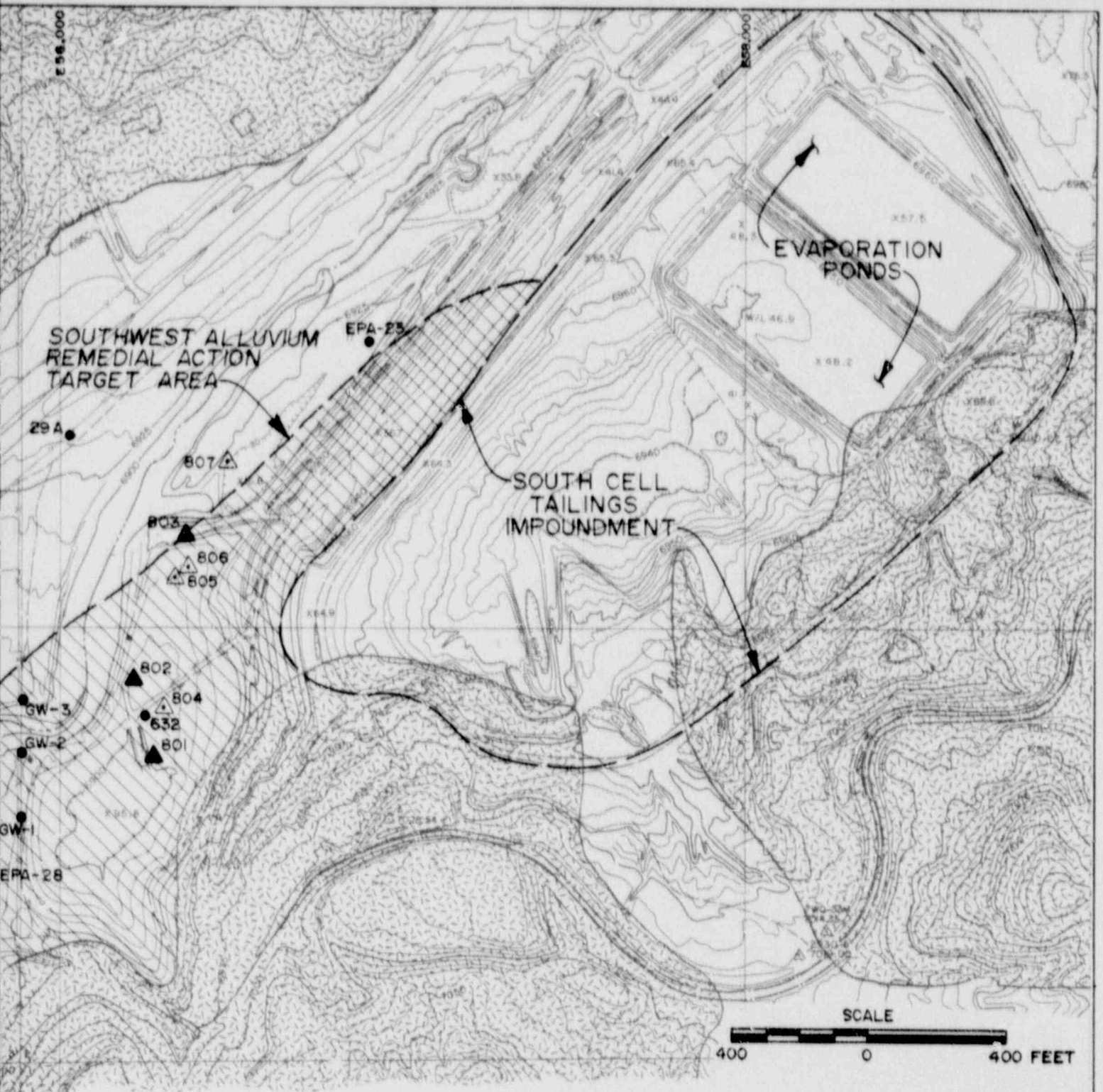
PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

12-17-89 86-060-E337	DATE: 12-7-89 SCALE: AS SHOWN	FIGURE 2-11	DRAWING NUMBER 86-060-E325	REV. 1


102360
86-060-B323
86-060-B310
DRAWING NUMBER 86-060-B324
B310
B323
B310
CHECKED BY
APPROVED BY
12-27-89
12-27-89
N
E64,000
N72,000
N70,000
EPA-25
EPA-27
627
624
REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, N.M. DATED: 9-29-89. SCALE: 1" = 200'.



LEGEND:

- ●624 EXISTING MONITORING WELL
- ▲801 SOUTHWEST ALLUVIUM EXTRACTION WELL
- △804 SOUTHWEST ALLUVIUM OBSERVATION WELL

SOUTHWEST ALLUVIUM WELL LOCATIONS

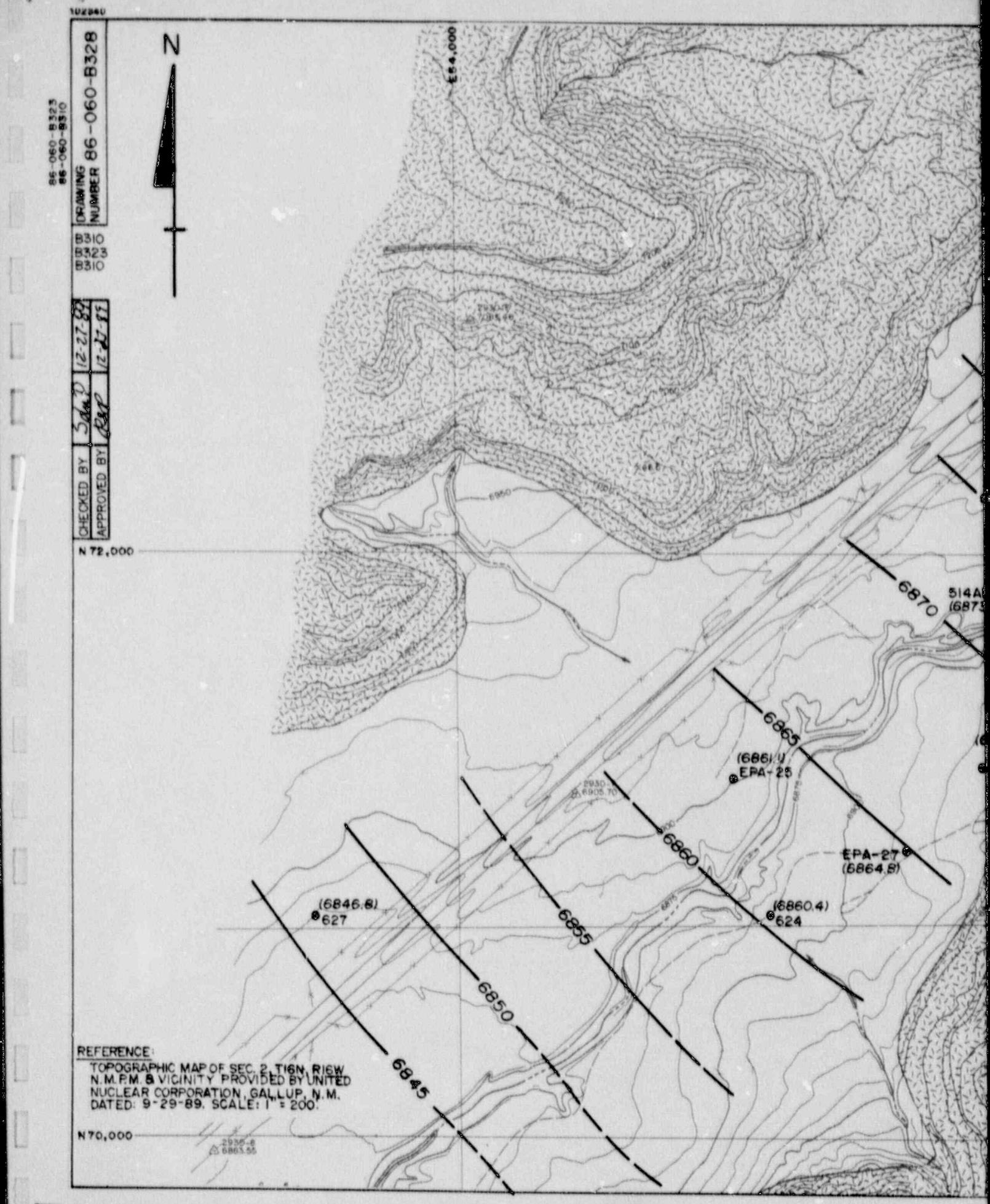
PREPARED FOR

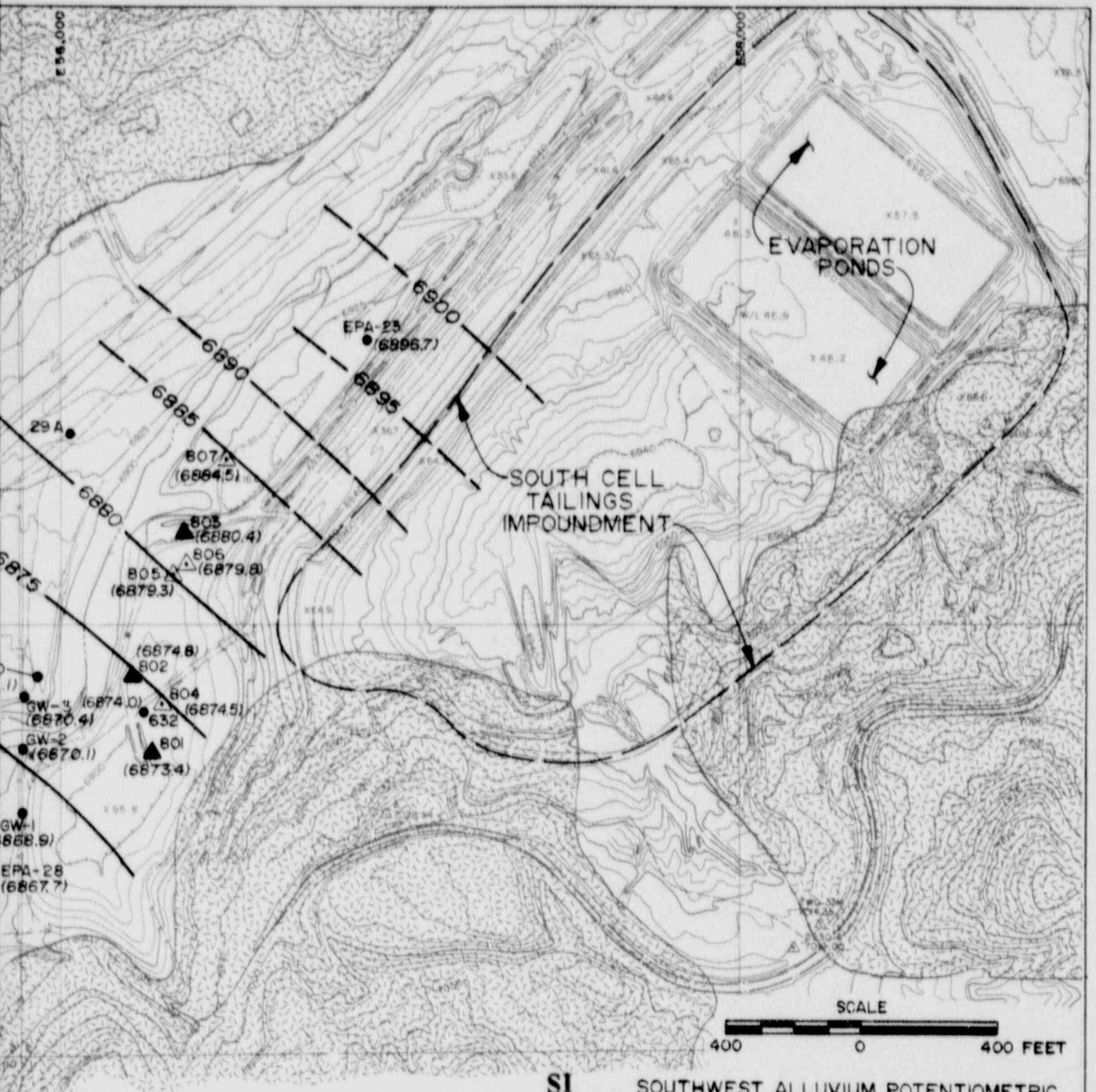
UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 12-6-89	FIGURE 2-12	DRAWING NUMBER 86-060-B324
SCALE: AS SHOWN		

86-060-B310
86-060-B323


102840
86-060-B323
86-060-B310
DRAWING NUMBER 86-060-B328
B310
B323
B310
CHECKED BY
APPROVED BY
12-27-89
12-22-89
N
E54,000
N 72,000
N 70,000
6870
6865
6860
6855
6850
6845
(6861.1)
EPA-25
EPA-27
(6864.8)
(6846.8)
627
(6860.4)
624
REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, N.M. DATED: 9-29-89. SCALE: 1" = 200'.



LEGEND:

- ●624 EXISTING MONITORING WELL
- ▲801 SOUTHWEST ALLUVIUM EXTRACTION WELL
- △804 SOUTHWEST ALLUVIUM OBSERVATION WELL
- —6860— WATER LEVEL ELEVATION CONTOURS, FEET (DASHED WHERE INFERRED)
- (6860.4) WATER LEVEL ELEVATION, FEET

SOUTHWEST ALLUVIUM POTENTIOMETRIC SURFACE, INITIAL CONDITIONS
OCTOBER 16, 1989

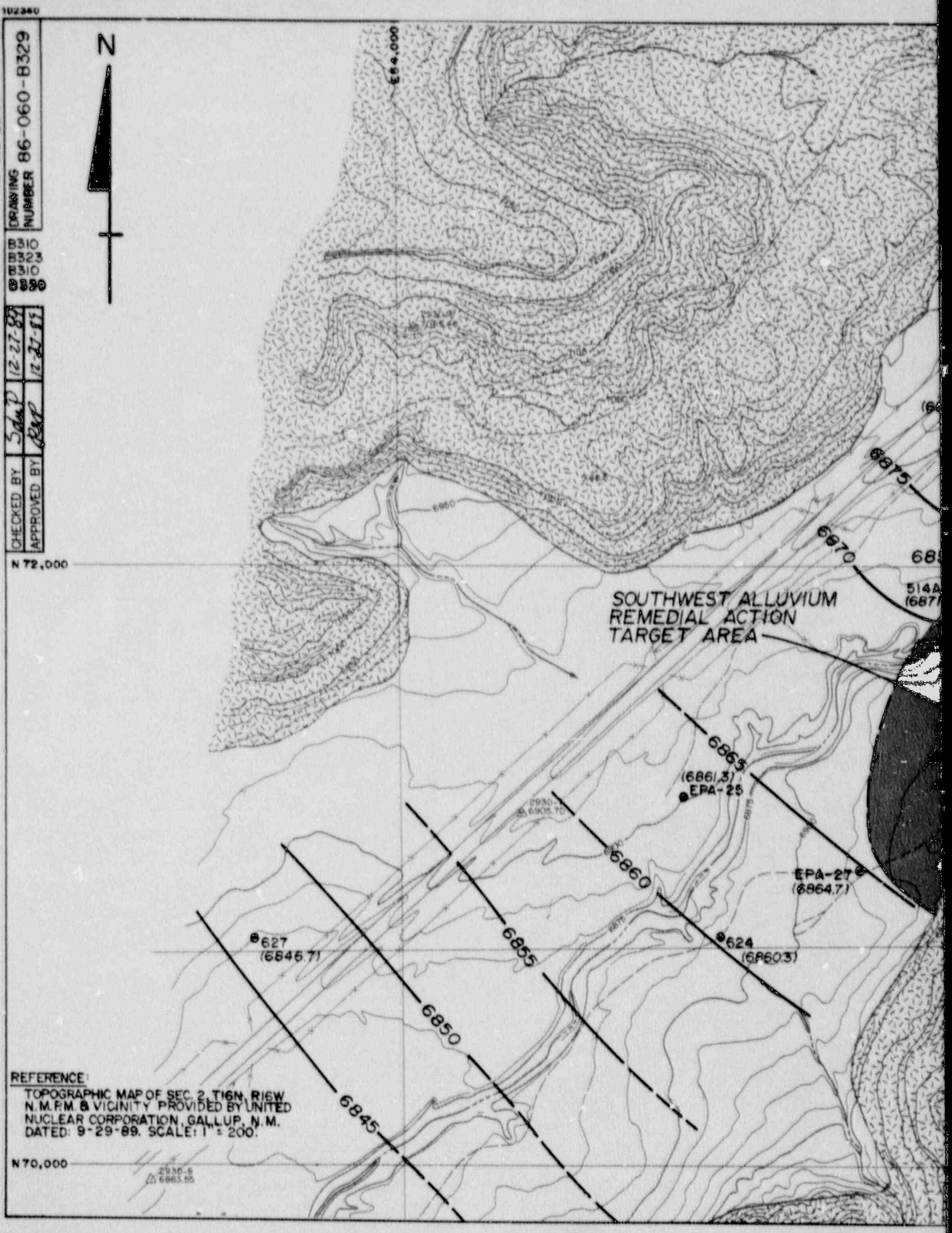
PREPARED FOR

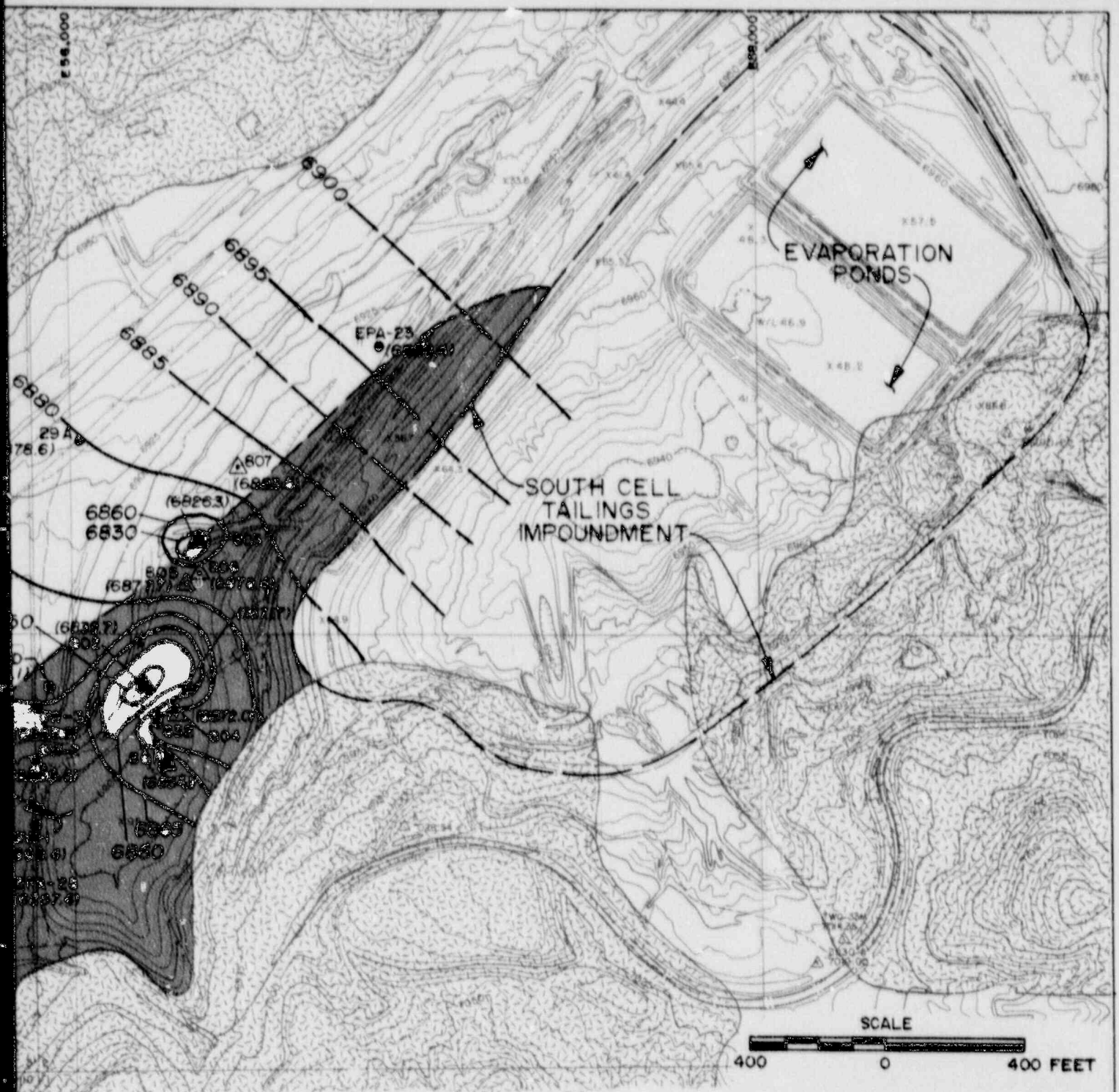
UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 12-7-89	FIGURE 2-13	DRAWING NUMBER
SCALE: AS SHOWN		86-060-B328

86-060-B310
86-060-B323


102340
86-060-B339
86-060-B323
86-060-B310
DRAWING NUMBER 86-060-B329
B310
B323
B310
CHECKED BY
APPROVED BY
12-27-89
12-27-89
N
E84,000
N 72,000
N 70,000
6875
6870
6865
6860
6855
6850
6845
SOUTHWEST ALLUVIUM
REMEDIAL ACTION
TARGET AREA
(6861.3)
EPA-25
EPA-27
(6864.7)
627
(6845.71)
624
(6860.31)
REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, N.M. DATED: 9-29-89. SCALE: 1" = 200'.



LEGEND:

- ●624 EXISTING MONITORING WELL
- ▲801 SOUTHWEST ALLUVIUM EXTRACTION WELL
- △804 SOUTHWEST ALLUVIUM OBSERVATION WELL
- —6860— WATER LEVEL ELEVATION CONTOURS, FEET (DASHED WHERE INFERRED)
- (6860.4) WATER LEVEL ELEVATION, FEET

SI APERTURE CARD

Also Available On Aperture Card

SOUTHWEST ALLUVIUM POTENTIOMETRIC SURFACE, DECEMBER 4, 1989

9001310108 - 14

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 12-7-89	FIGURE 2-14	DRAWING NUMBER
SCALE: AS SHOWN		86-060-B329

86-060-B310
86-060-B323
86-060-B338

102340

86-060-B323
86-060-B310

DRAWING NUMBER	86-060-B330
	B310
	B323
	B310
CHECKED BY	[illegible] 12-22-89
APPROVED BY	[illegible] 12-22-89

N

E 69,000

N 72,000

N 70,000

(31.7)
EPA-25

(107)

EPA-27
(74.5)

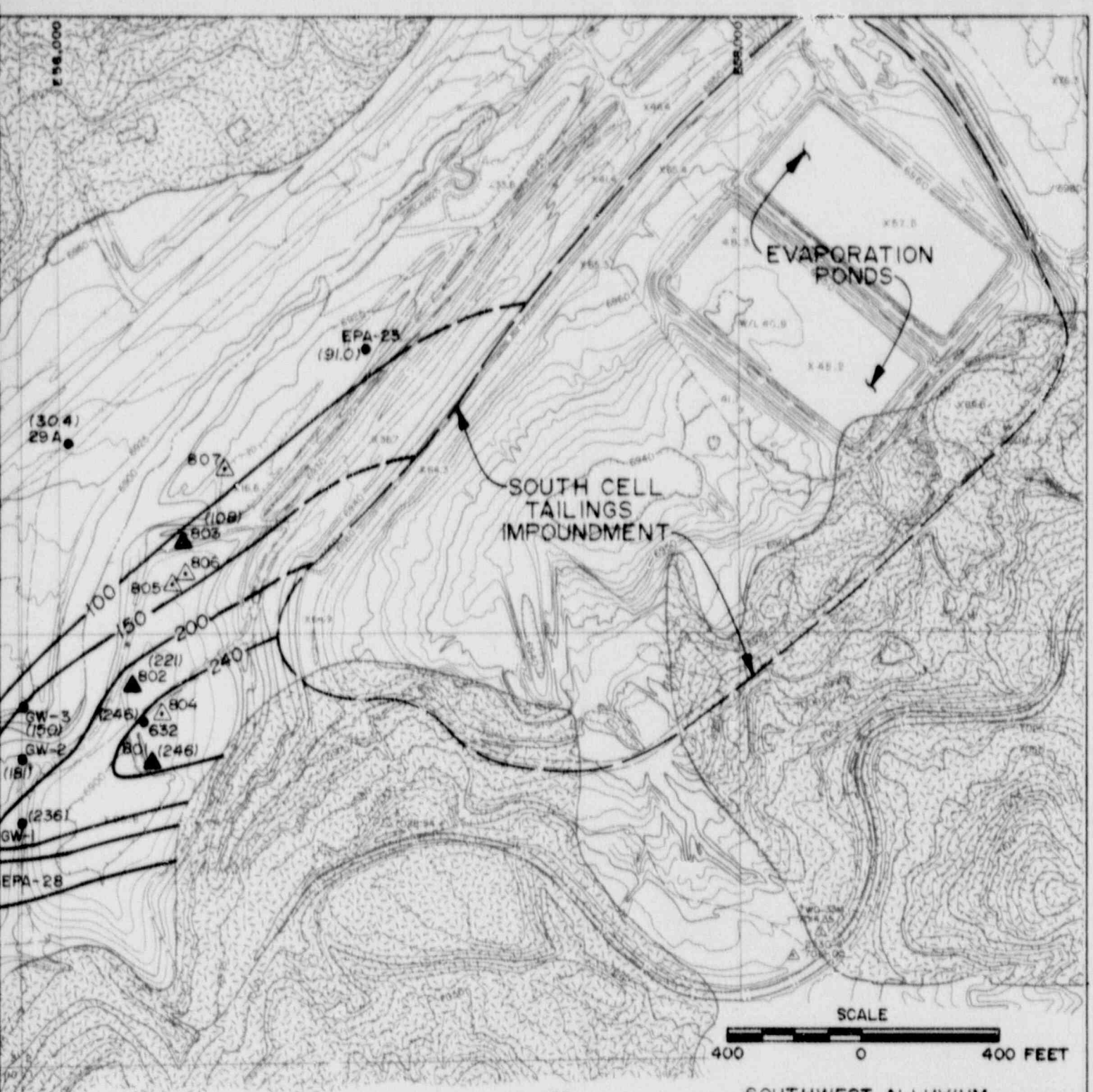
627
(36.6)

624
(110)

2930-7
6905.70

2930-8
6883.55

REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, N.M. DATED: 9-29-89. SCALE: 1" = 200'.



LEGEND:

- ●624 EXISTING MONITORING WELL
- ▲801 SOUTHWEST ALLUVIUM EXTRACTION WELL
- △804 SOUTHWEST ALLUVIUM OBSERVATION WELL
- —100— ISOCONCENTRATION LINES OF CHLORIDE, mg/l (DASHED WHERE INFERRED)
- (31.7) CHLORIDE VALUE, mg/l

SI APERTURE CARD

Also Available On Aperture Card

SOUTHWEST ALLUVIUM
CHLORIDE CONCENTRATION
4th QUARTER, 1989

9001310108 - 15

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 12-7-89	FIGURE 2-15	DRAWING NUMBER
SCALE: AS SHOWN		86-060-B330

86-060-B310
86-060-B323

APPENDIX A

FIELD INSTALLATION REPORT
ZONE 3 - STAGE I EXTRACTION WELLS

APPENDIX A

FIELD INSTALLATION REPORT
ZONE 3 - STAGE I EXTRACTION WELLS

1.0 INTRODUCTION

This report presents as-built installation data for the Zone 3 - Stage I extraction wells (701 through 713, excluding 704). Figure A-1 shows the locations of those wells.

All drilling, installation, and development were performed by United Nuclear Corporation's (United Nuclear) subcontractor, Rocky Mountain Drilling, from May 3, 1989 to June 29, 1989. Geophysical logging in the Zone 3 wells was performed by Western Wireline Corporation. The field work was supervised by United Nuclear's designated geologist with consultation by Canonie Environmental Services Corp.'s (Canonie) field hydrogeologist.

The work was performed in accordance with the specifications and procedures presented in the Remedial Design report prepared by Canonie in April 1989.

2.0 DESCRIPTION OF WORK COMPLETED

The drilling and installation program consisted of the following items and activities:

1. Drilling of 5 5/8-inch-diameter pilot hole;
2. Geophysical logging;
3. Reaming of the pilot hole to 10 5/8-inch diameter;
4. Well installation;
5. Development of the well;
6. Testing of the designated wells; and
7. Surveying of final well locations, ground surface, and top of casing elevations.

2.1 Drilling

A total of 12 boreholes were drilled at the site for installation of the Zone 3 extraction wells (701 through 713, excluding 704). The first five wells were tested to verify the performance of the system as designed and to determine the total number and locations of new wells needed for this stage. Well No. 704 was eliminated from the system based on the results of the testing.

The pilot holes were advanced by mud rotary techniques. The first boring (No. 711) was drilled using a bentonite-based mud. Mud losses of approximately 5 to 10 gallon per minute were observed during drilling of that hole. Subsequent drilling was performed using clean water with rotary technique to avoid clogging of the aquifer by bentonite and to prevent time-consuming, extensive development.

The pilot holes were drilled to the top of Zone 2 of the Upper Gallup Sandstone. Samples of drill cuttings were obtained at 5-foot intervals or when a change in lithology was noted. Samples were visually classified and logged. The lithologic description of the cuttings is presented on the Well Completion Logs, pages A-10 through A-29.

The downhole drilling equipment was cleaned and decontaminated prior to use in each of the boreholes. A high-pressure, hot-water, steam-cleaning unit was used to accomplish this task.

2.2 Geophysical Logging

Borehole geophysics were used in all Zone 3 wells to assist in the delineation of subsurface lithology, water-bearing zones, and selection of screened intervals. The geophysical logging was designed to supplement the interpretations from the lithologic logging performed during drilling by the field geologist.

Three borehole geophysical techniques were used during drilling of the Zone 3 wells:

1. Resistivity;

2. Spontaneous potential; and

3. Natural gamma.

A primary focus of the geophysical logging was to aid in selection of screened intervals prior to well completion. Therefore, interpretation of the geophysical logs was completed in the field. The geophysical logs obtained during this task are presented on the Well Completion Logs, pages A-10 through A-29.

Prior to running the geophysical logs, the boreholes were filled with a bentonite-based mud with a viscosity of 32 seconds to increase the contrast between the borehole fluids and formation fluids. The bentonite-based mud

was displaced with fresh water immediately after completion of the logging run.

In addition to the above-described logs, a caliper log was run in each well after reaming to the final diameter. The caliper logs were run to aid in the calculations of the volumes of the sand pack, seal material, and grout.

2.3 Reaming

The boreholes were reamed to a final diameter of 10 5/8 inch after the geophysical logging was completed. The first four borings (Nos. 709 through 712) were reamed using an air-foam rotary technique. However, use of the foam resulted in only partial recovery of cuttings, made removal of the cuttings and conditioning of the borehole difficult, and prolonged the time required for borehole conditioning. Therefore, the drilling fluid was changed to clean water. All subsequent reaming was performed using fresh water and rotary technique.

2.4 Well Installation

Well construction details are presented on the Well Completion Logs, pages A-10 through A-29. A summary of well completion details is included in Table A.1.

The wells were completed with 6-inch-diameter polyvinyl chloride (PVC) casing and with the same diameter PVC wire-wound (Johnson-type) screen. All the casing joints were flush threaded and equipped with O-ring seals. The slot size of the well screen was 0.050 inch. The screened intervals were selected in the field based on the lithologic logs, water level, and borehole geophysical data. All wells were screened from the Zone 2 contact upward 20 or 30 feet. Well Nos. 701, 702, 706, and 707 were equipped with 20 feet of the screen. The remaining eight wells were constructed with 30 feet of the screen due to the finer, shalely material encountered at the base of the Zone 3 at these locations. All well screens were equipped with a bottom cap.

A sand pack of 8 - 12 sieve size was placed by gravity flow, typically to a height of 5 feet above the well screen. Ten feet of bentonite pellets were placed above the sand pack as a seal. An additional seal, consisting of bentonite mud at a viscosity of at least 80 seconds, was placed above the bentonite pellets for a minimum of 12 feet. The remaining part of the annular space was filled to the ground level with cement grout. The grout material used was Type I Portland Cement with 4 percent bentonite to reduce shrinkage.

Stainless steel casing centralizers were installed in all wells. Three centralizers were placed in each well, one at the bottom and one at the top of screened interval, and the third typically in the seal interval.

A cement pedestal, 3 feet by 3 feet by 1 foot, was erected around each wellhead to protect the well from washing by surface water and to reinforce the casing above ground level. The cement pedestal is bound to the grout, filling up the annular space inside the borehole.

2.5 Development

Following well installation, the wells were developed in two stages. The first stage consisted of washing the well screen by high-velocity jetting with fresh water (typically 5,000 to 10,000 gallons was used); then, the well was swabbed and finally air-lifted. Air-lifting continued until the pumped water was clean and free of solids.

In the second stage of development, a submersible pump was installed in the well. Development consisted of surging and overpumping. Pumping was continued until the pumped water was completely clean and free of solids. Typical total development time for the individual wells was between four and six hours.

2.6 Testing

A step-drawdown pumping test was performed in each of the first five Zone 3 wells after completion. The objective of the testing program was to assess

well efficiency, specific capacity of the well, dynamic performance of the pump, and the optimum pump setting depth. The above parameters were necessary for designing the multi-well extraction system test. The step-drawdown pumping test was performed in five wells, Nos. 708 through 712. Table A.2 presents the results of the pumping test.

2.7 Surveying

The elevations of the tops of all casing and ground levels as well as coordinates for each well were surveyed after completion. The survey was performed by United Nuclear field staff. Table A.1 presents the elevations and coordinates for each well.

TABLE A.1

SUMMARY OF WELL COMPLETION DATA
ZONE 3 - STAGE I WELLS

Well Number	Date Completed	Ground Surface Elevation (feet)	Top of Casing Elevation (feet)	Northing	Easting	Total Depth [a] (feet)	Casing Diameter (inches)	Screen Interval		Zone 3	
								From [a] (feet)	To [a] (feet)	From [a] (feet)	To [a] (feet)
0701	14-Jun-89	6,958.99	6,961.28	75,699.94	60,699.84	104	6	78	98	34	98
0702	29-Jun-89	6,971.99	6,974.25	75,294.75	60,839.53	96	6	69	89	8	89
0703	28-Jun-89	6,976.70	6,078.92	75,489.83	61,100.32	114	6	77	107	15	107
0705	23-Jun-89	7,003.04	7,006.85	75,909.61	61,152.17	157	6	120	150	75	150
0706	26-Jun-89	6,969.69	6,972.47	76,119.06	61,091.46	134	6	108	128	50	128
0707	21-Jun-89	7,002.11	7,005.21	76,349.32	61,340.18	173	6	148	168	80	168
0708	24-May-89	7,010.38	7,011.98	76,032.30	61,500.17	172	6	137	167	82	167
0709	17-May-89	7,001.01	7,003.54	76,469.30	61,520.85	173	6	138	168	91	168
0710	22-May-89	7,014.18	7,016.52	76,299.53	61,699.35	180	6	143	173	92	173
0711	09-May-89	7,040.00	7,042.60	76,100.38	61,899.37	206	6	168	198	113	198
0712	15-May-89	7,019.72	7,022.17	76,498.98	61,900.60	185	6	149	179	93	179
0713	19-Jun-89	7,021.28	7,024.48	76,300.00	62,100.03	178	6	143	173	100	173

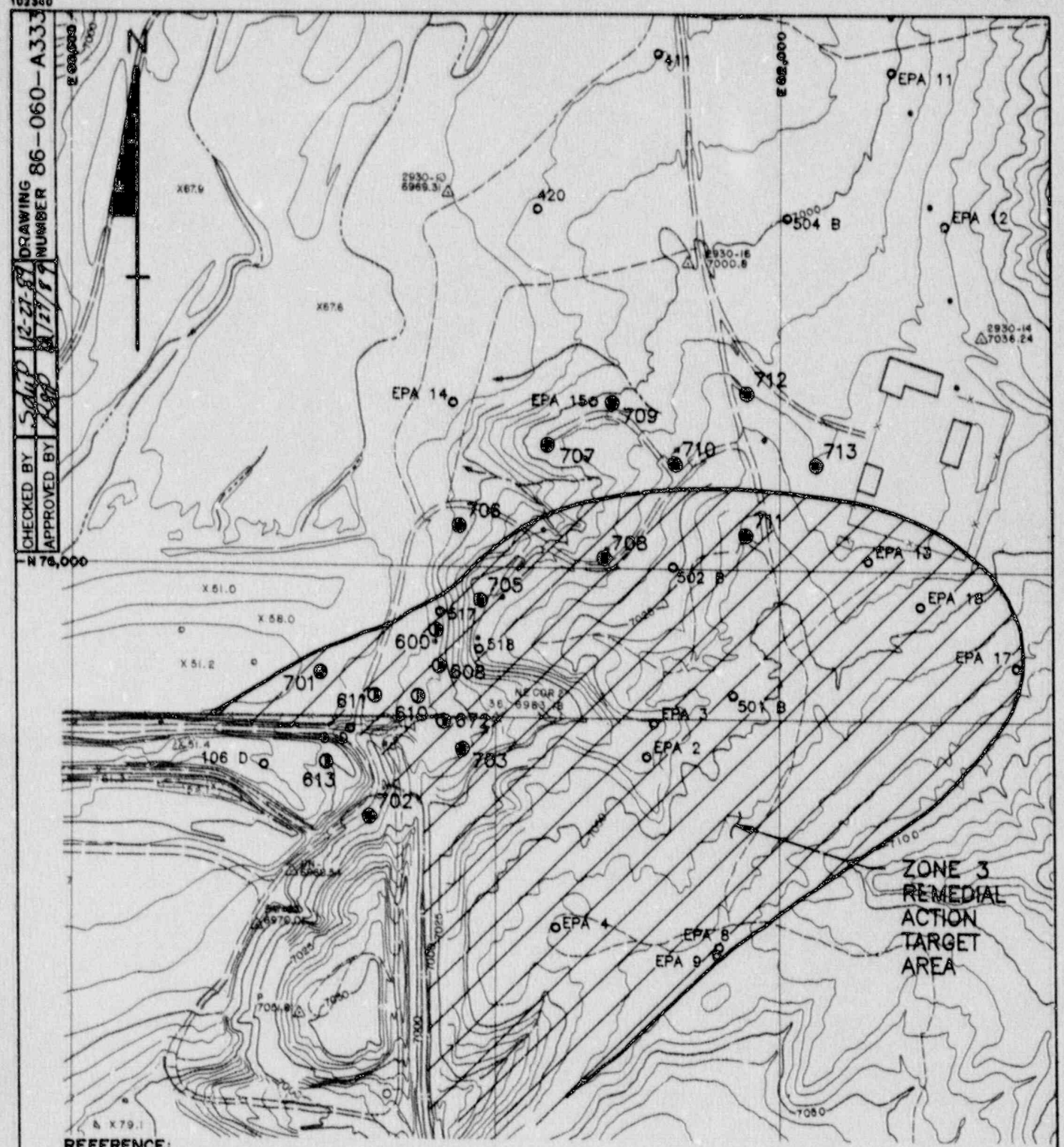
[a] Depth in feet below ground surface.

TABLE A.2

RESULTS OF STEP DRAWDOWN TESTS
ZONE 3 - STAGE I EXTRACTION WELLS

Well Number	Maximum Discharge (gpm)	Maximum Drawdown (feet)	Specific Capacity (gpm/feet)	Well[a] Efficiency (percent)
708	12.0	21.6	0.56	59.5
709	8.6	26.9	0.32	65.3
710	4.0	26.4	0.15	49.9
711	9.0	12.3	0.73	55.6
712	9.0	19.0	0.47	34.0

[a]Average well efficiency measured during step-drawdown test.



REFERENCE:

TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W N.M.P.M. & VICINITY, PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, NEW MEXICO. DATED: 9-29-89. SCALE 1" = 200'.

LEGEND:

- ● 708 ZONE 3– STAGE I EXTRACTION WELLS
- ◑ 672 NORTHEAST PUMP–BACK WELLS

SCALE

400 0 400 FEET

ZONE 3 WELL LOCATIONS

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 11-29-89	FIGURE A–1	DRAWING NUMBER 86-060-A333
SCALE: AS SHOWN		

86-060-A309

DRAWING NUMBER 86-060-8349

CHECKED BY

APPROVED BY

Don Rodrigues 12-26-89

DRAWN BY

Symbols used for designation of subsurface materials on boring logs and

OVERBURDEN

- Glacial till
- Gravel
- Sand
- Silt
- Clay
- Organic Material

SEDIMENTARY ROCKS

- Limestone
- Siltstone
- Sandstone
- Massive Mudstone or Claystone
- Shale
- Coal
- Dolomite
- Conglomerate
- Breccia
- Crystalline Limestone
- Bedded Chert
- Marble
- Chalk
- Gypsum
- Salt
- Anhydrite
- Limestone Containing Nodules Of Chert Or Flint

METAMORPHIC

IGNEOUS ROCKS

- Schistose Or Gneissoid Gran
- Granite
- Gneiss
- Quartzite
- Schist
- Basic Lava F
- Bedded Tuff

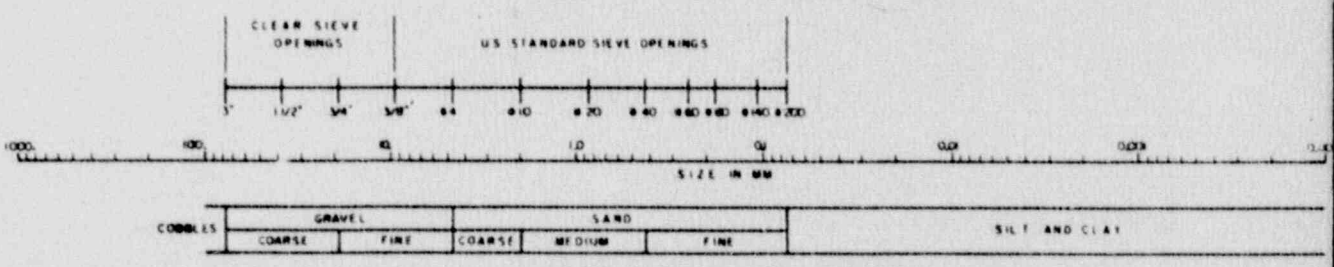
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH TONS PER SQUARE FOOT
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DESIGNATION	BLOWS PER FOOT
VERY LOOSE	0-4
LOOSE	5-10
MEDIUM DENSE	11-30
DENSE	31-50
VERY DENSE	OVER 50

STANDARD PENETRATION RESI
BLOWS REQUIRED TO DRIVE A
SAMPLER 12 INCHES USING A
FREELY THROUGH 30 INCHES
18 INCHES AND THE NUMBER O
EACH 6 INCH INTERVAL THE R
IS INDICATED ON THE DRAWIN



USCS CLASSIFICATION FOR SOILS

BOULDER	COBBLE	PEBBLE						SILT	CLAY
BOULDER CONGLOMERATE	COBBLE CONGLOMERATE	PEBBLE CONGLOMERATE						SILTSTONE	CLAYSTONE AND SHALE

WENTWORTH SCALE FOR ROCK

TERMS USED TO DESCRIBE THE RELATIVE DEGREES OF ROCK CORE HARDNESS

DESCRIPTIVE TERMS	DEFINING CHARACTERISTICS
VERY SOFT	CRUSHES UNDER PRESSURE OF FINGERS AND/OR THUMB
SOFT	CRUSHES UNDER PRESSURE OF PRESSED HAMMER
MEDIUM HARD	BREAKS EASILY UNDER SINGLE HAMMER BLOW BUT WITH CRUMBLY EDGES
HARD	BREAKS UNDER ONE OR TWO STRONG HAMMER BLOWS BUT WITH RESISTANT SHARP EDGES
VERY HARD	BREAKS UNDER SEVERAL STRONG HAMMER BLOWS BUT WITH VERY RESISTANT SHARP EDGES AND MAY SPALL LEAVING CONCHOIDAL FRACTURES

THE SPACING OF THE DISCON
IN THE ROCK MAY BE DES
BY ONE OF THE FOLLOWING

DESCRIPTIVE TERMS	SPA
VERY BROKEN	LESS
BROKEN	1 IN
SLIGHTLY BROKEN	3 IN
MASSIVE	6 IN AN

subsurface sections

MISCELLANEOUS


Slag

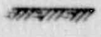

Fill


Concrete


Void (Indicate Size of Void)


Water


Approximate Existing Ground Surface


Approximate Top Of Rock

P INDICATES PITCHER BARREL SAMPLER


2" O D SPLIT BARREL SAMPLE NUMBER

75/0 5" PENETRATION REFUSAL RESISTANCE AND FRACTIONAL INCREMENT DRIVEN IN FEET

12-10-75 GROUND WATER LEVEL AND DATE

U S C S UNIFIED SOIL CLASSIFICATION SYSTEM (CAPITAL LETTERS INDICATE LAB TEST CLASSIFICATION, LOWER CASE LETTERS INDICATE VISUAL FIELD CLASSIFICATION)

ROD (ROCK QUALITY DESIGNATION - PERCENT) (LENGTH OF NUMBER OF PIECES GREATER THAN 4 INCHES DIVIDED BY THE LENGTH OF THE CORE RUN)

INDICATES PERCENT OF CORE RECOVERED (LENGTH OF CORE RECOVERED DIVIDED BY LENGTH OF CORE RUN)

DRILLING FLUID LOSS ____ %

DRILLING FLUID REGAINED ___ %

SI APERTURE CARD

Also Available On Aperture Card

STANCE IS THE NUMBER OF
2 INCH O D SPLIT BARREL
40 POUND HAMMER FALLING
HE SAMPLER WAS DRIVEN
F BLOWS RECORDED FOR
SISTANCE TO PENETRATION
S AS BLOWS PER FOOT

TRACE INDICATES PRESENCE OF LESS THAN 5% OF SUBJECT MATERIAL BY WEIGHT.

SOME INDICATES PRESENCE OF 5 TO 30% OF SUBJECT MATERIAL BY WEIGHT.

AND INDICATES PRESENCE OF 30 TO 50% OF SUBJECT MATERIAL BY WEIGHT.

INDIVIDUAL PARTICLES

CEMENTED/CRYSTALLIZED ROCK

INUITIES
RIBED
TERMS

CING
HAN 1 IN
O 3 IN
O 6 IN
D GREATER

THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS

SUBSURFACE DESCRIPTIONS SHOWN IN PARENTHESES ( ) INDICATE CLASSIFICATION FROM WASH SOIL RETAINED ON DRILL TOOLS OR ACTION OF DRILL TOOLS DURING ADVANCEMENT OF BORING

9001310108 - 16

GENERAL LEGEND

PREPARED FOR

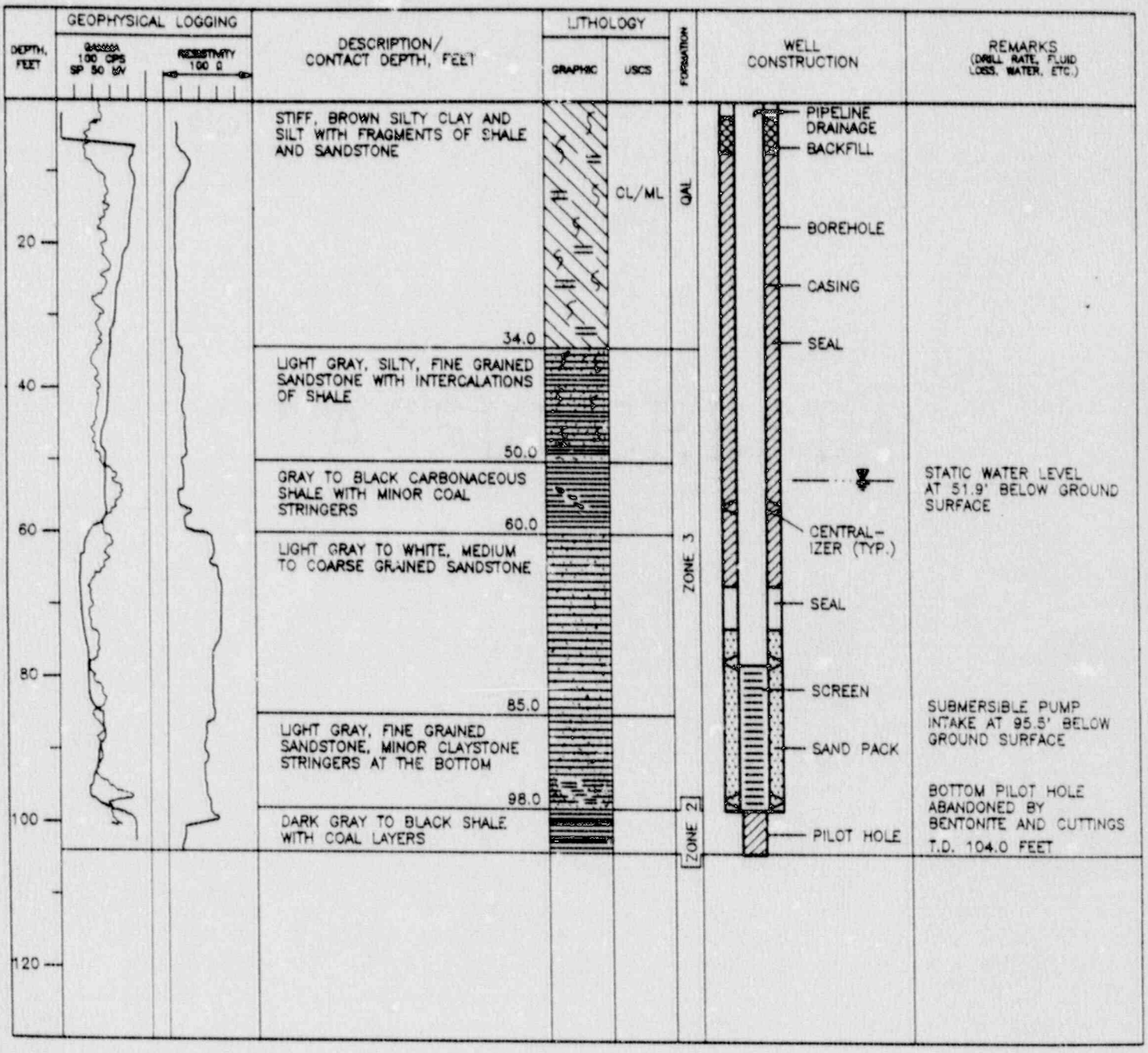
UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 12-26-89		DWG. NO.
SCALE: N.T.S.		86-060-B349

WELL/PIEZOMETER COMPLETION LOG

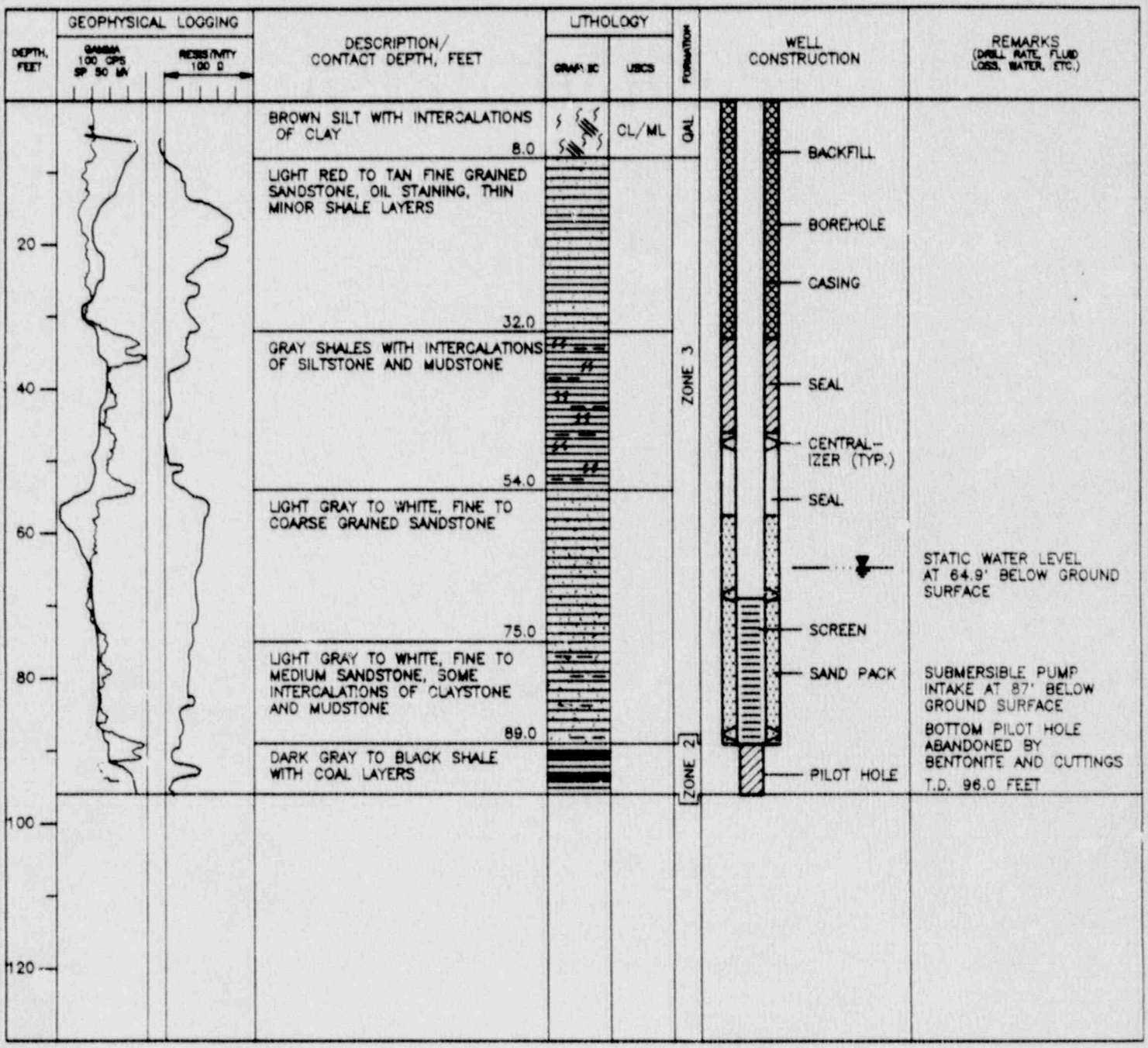
PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-080-18
BORING NUMBER: 701
BORING LOCATION: NORTH 75899.944' EAST 60699.844'
SURFACE ELEVATION, FEET: 6958.99
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: L. RAMIREZ - ROCKY MTN. DRILLING
DATE: START 6-13-89 FINISH 6-14-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 104
TOP OF CASING ELEVATION, FEET: 6961.28
DRILLING FLUID: WATER BIT SIZE, INCHES: 5-5/8, 10-5/8
NO. OF SAMPLES: DIST. 21 UNDIST. N/A
CASING TYPE AND SIZE: 6" Ø SCH. 80 & 40 PVC FROM 2.3 FT. ABOVE GROUND SURFACE TO 78 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" Ø SCH. 40 PVC, WIRE WOUND FROM 78 TO 98 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11" AT 56, 77.5, 97 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE FROM 73 TO 98 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 67 TO 73 TYPE 80 SEC. BENT. MUD FROM 7 TO 67 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT FROM 2 TO 7 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING: N/A AFTER COMPLETION: 6907.08 FT.



Canonie Environmental

WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 702
BORING LOCATION: NORTH 75294.754' EAST 60839.532'
SURFACE ELEVATION, FEET: 6971.99
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 6-28-89 FINISH 6-29-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 96
TOP OF CASING ELEVATION, FEET: 6974.23
DRILLING FLUID: WATER BIT SIZE, INCHES: 5-5/8, 10-5/8
NO. OF SAMPLES: DIST. 19 UNDIST. N/A
CASING TYPE AND SIZE: 6" ø PVC SCH. 80 & 40 FROM 2.3 FT. ABOVE GROUND SURFACE TO 69 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" ø PVC SCH. 40, WIRE-WOUND FROM 69 TO 89 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11" AT 47.5, 68.5, 88 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE FROM 57.5 TO 89 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 46 TO 57.5 TYPE 80 SEC. BENT. MUD FROM 33 TO 46 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT FROM 0 TO 33 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING N/A AFTER COMPLETION 6907.05 FT.

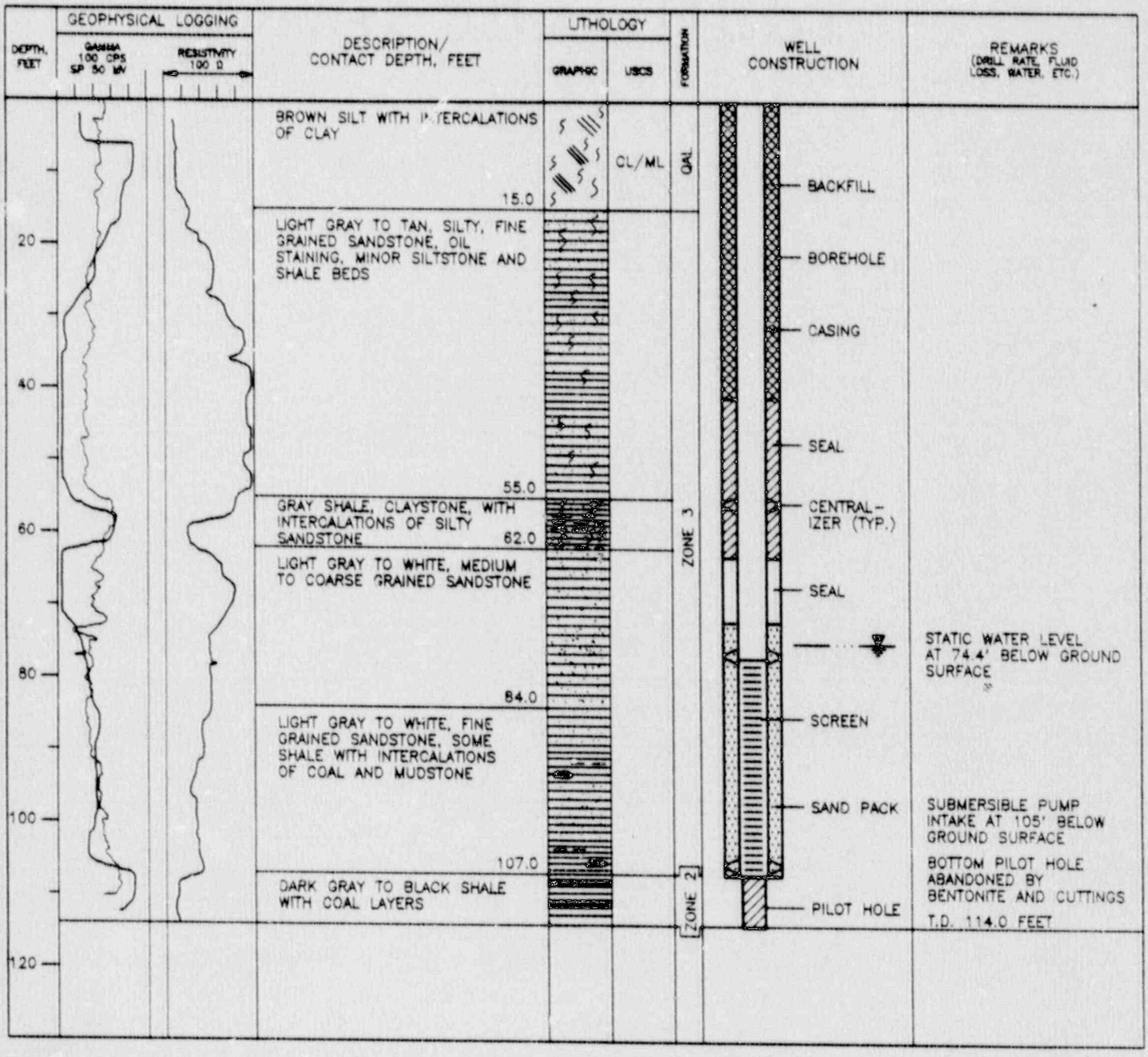


Canonie Environmental

A-12 PAGE 1 of 1

WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 703
BORING LOCATION: NORTH 75489.826 EAST 61100.317
SURFACE ELEVATION, FEET: 6976.70
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 6-26-89 FINISH 6-28-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 114
TOP OF CASING ELEVATION, FEET: 6978.92
DRILLING FLUID: WATER BIT SIZE, INCHES: 5-5/8, 10-5/8
NO. OF SAMPLES: DIST. 23 UNDIST. N/A
CASING TYPE AND SIZE: 6" ø PVC SCH. 80 & 40 FROM 2.2 FT. ABOVE GROUND SURFACE TO 77 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" ø PVC SCH. 40, WIRE-WOUND FROM 77 TO 107 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11" AT 55.8, 76.5, 106 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE FROM 72 TO 107 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 63 TO 72 TYPE 80 SEC. BENT. MUD FROM 41 TO 63 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT FROM 0 TO 41 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING N/A AFTER COMPLETION 6907.05 FT.



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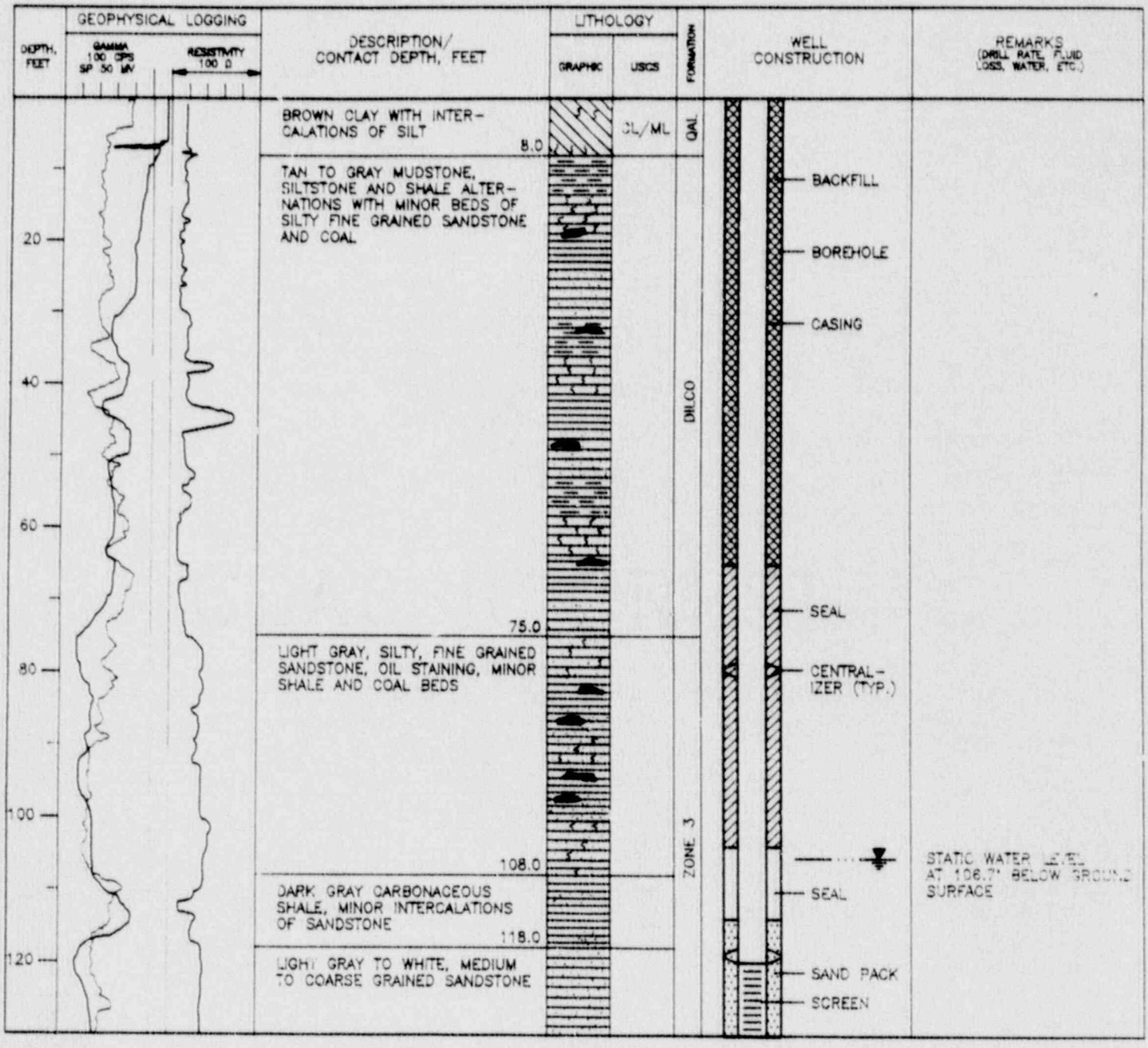
WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18 BORING NUMBER: 705
BORING LOCATION: NORTH 75909.609' EAST 61152.166'
SURFACE ELEVATION, FEET: 7003.04
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 6-21-89 FINISH 6-23-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 157 TOP OF CASING ELEVATION, FEET: 7006.85
DRILLING FLUID: WATER BIT SIZE, INCHES: 5-5/8, 10-5/8
NO. OF SAMPLES: DIST. 31 UNDIST. N/A
CASING TYPE AND SIZE: 6" ø PVC SCH. 80 & 40 FROM 3.81 FT. ABOVE GROUND SURFACE TO 120 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" ø PVC SCH. 40, WIRE-WOUND FROM 120 TO 150 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11" AT 79.3, 119, 149 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE FROM 114 TO 150 FT. BELOW GROUND SURFACE
SEAL TYPE: BENTONITE PELLETS FROM 104 TO 114 TYPE: 80 SEC. BENT. MUD FROM 65 TO 104 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT FROM 0 TO 65 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING: N/A AFTER COMPLETION: 6896.39 FT.



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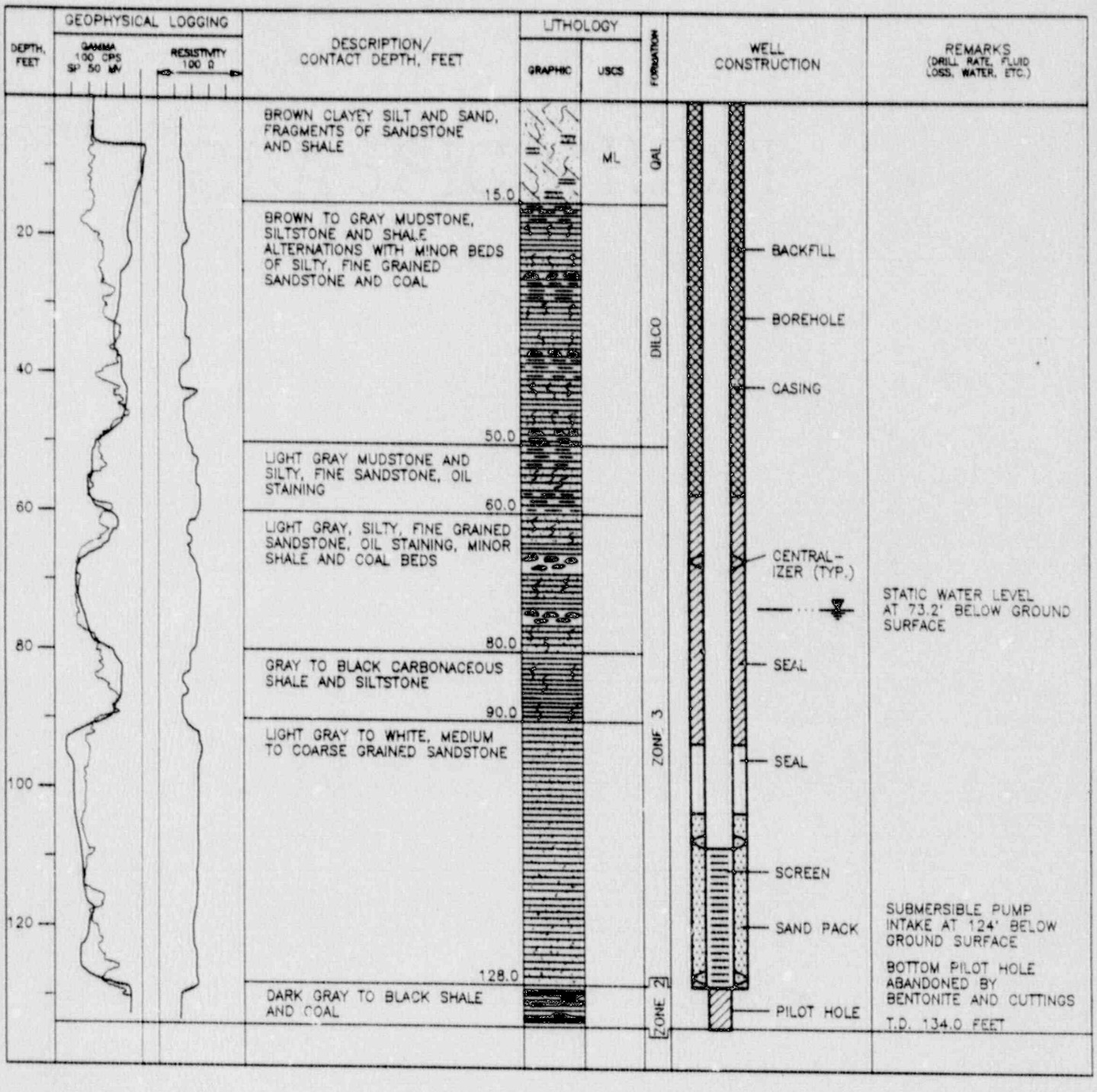
WELL/PIEZOMETER COMPLETION LOG--CONT'D

PROJECT NAME UNC - REMEDIAL ACTION PROJECT NUMBER 86-060-18 BORING NUMBER 705

DEPTH, FEET	GEOPHYSICAL LOGGING: GAMMA 100 CPS SP 50 MV	GEOPHYSICAL LOGGING: RESISTIVITY 100 Ω	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY: GRAPHIC	LITHOLOGY: USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
140			LIGHT GRAY TO WHITE, FINE TO MEDIUM GRAINED SANDSTONE, SOME SHALE, INTERCALATIONS OF MUDSTONE AND COAL			ZONE 3	SCREEN; SAND PACK	SUBMERSIBLE PUMP INTAKE AT 148' BELOW GROUND SURFACE
			150.0					BOTTOM PILOT HOLE ABANDONED BY BENTONITE AND CUTTINGS
			DARK GRAY TO BLACK SHALE AND COAL			ZONE 2	PILOT HOLE	T.D. 157.0 FEET
			157.0					
160								
180								
200								
220								
240								
260								
280								

WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 706
BORING LOCATION: NORTH 76119.055' EAST 61091.463'
SURFACE ELEVATION, FEET: 6969.69
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 6-23-89 FINISH 6-26-89
DRILLING METHOD: ROTARY
DRILLING FLUID: WATER BIT SIZE, INCHES 5-5/8, 10/5/8
TOTAL DEPTH, FEET: 134
TOP OF CASING ELEVATION, FEET: 6972.47
NO. OF SAMPLES: DIST. 27 UNDIST. N/A
CASING TYPE AND SIZE: 6" Ø SCH. 80 & 40 PVC
FROM 2.8 FT. ABOVE GROUND SURFACE TO 108 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" Ø SCH. 40 PVC, WIRE-WOUND
FROM 108 TO 128 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11"
AT 66.5, 107, 127 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE
FROM 103 TO 128 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 93 TO 103 TYPE 80 SEC. BENT. MUD FROM 57 TO 93 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT
FROM 0 TO 57 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING N/A
AFTER COMPLETION 6896.47 FT.



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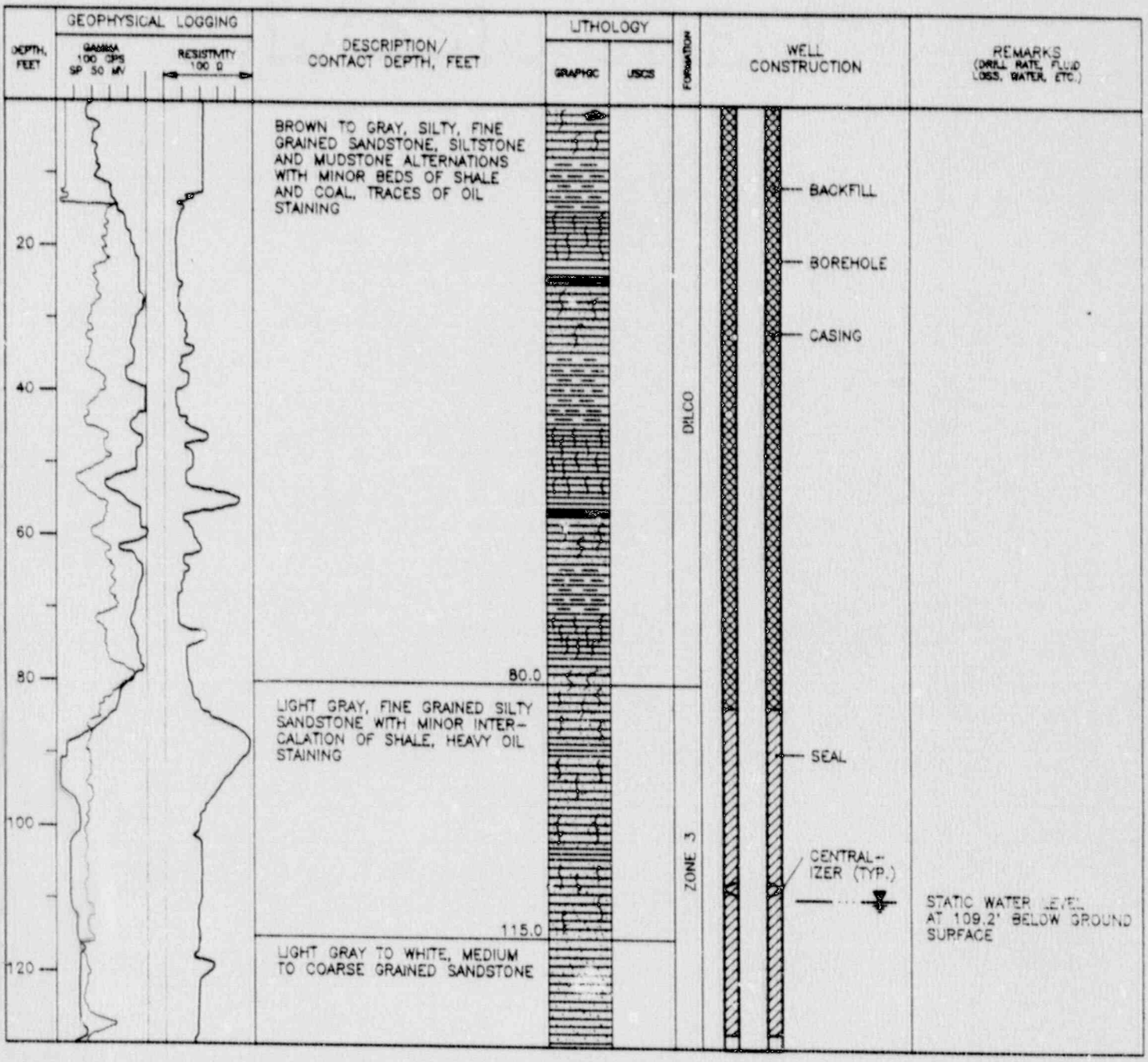
WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 707
BORING LOCATION: NORTH 76349.323' EAST 61340.182'
SURFACE ELEVATION, FEET: 7002.11
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 6-19-89 FINISH 6-21-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 173
TOP OF CASING ELEVATION, FEET: 7005.21
DRILLING FLUID: WATER BIT SIZE, INCHES: 5-5/8, 10-5/8
NO. OF SAMPLES: DIST. 35 UNDIST. N/A
CASING TYPE AND SIZE: 6" Ø SCH. 80 & 40 PVC
FROM 3.1 FT. ABOVE GROUND SURFACE TO 148 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" Ø SCH. 40 PVC, WIRE WOUND
FROM 148 TO 168 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11"
AT 108, 148, 167 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE
FROM 139 TO 168 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 128 TO 139 TYPE 80 SEC. BENT. MUD FROM 83 TO 128 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT
FROM 0 TO 83 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING N/A
AFTER COMPLETION 6892.91 FT.



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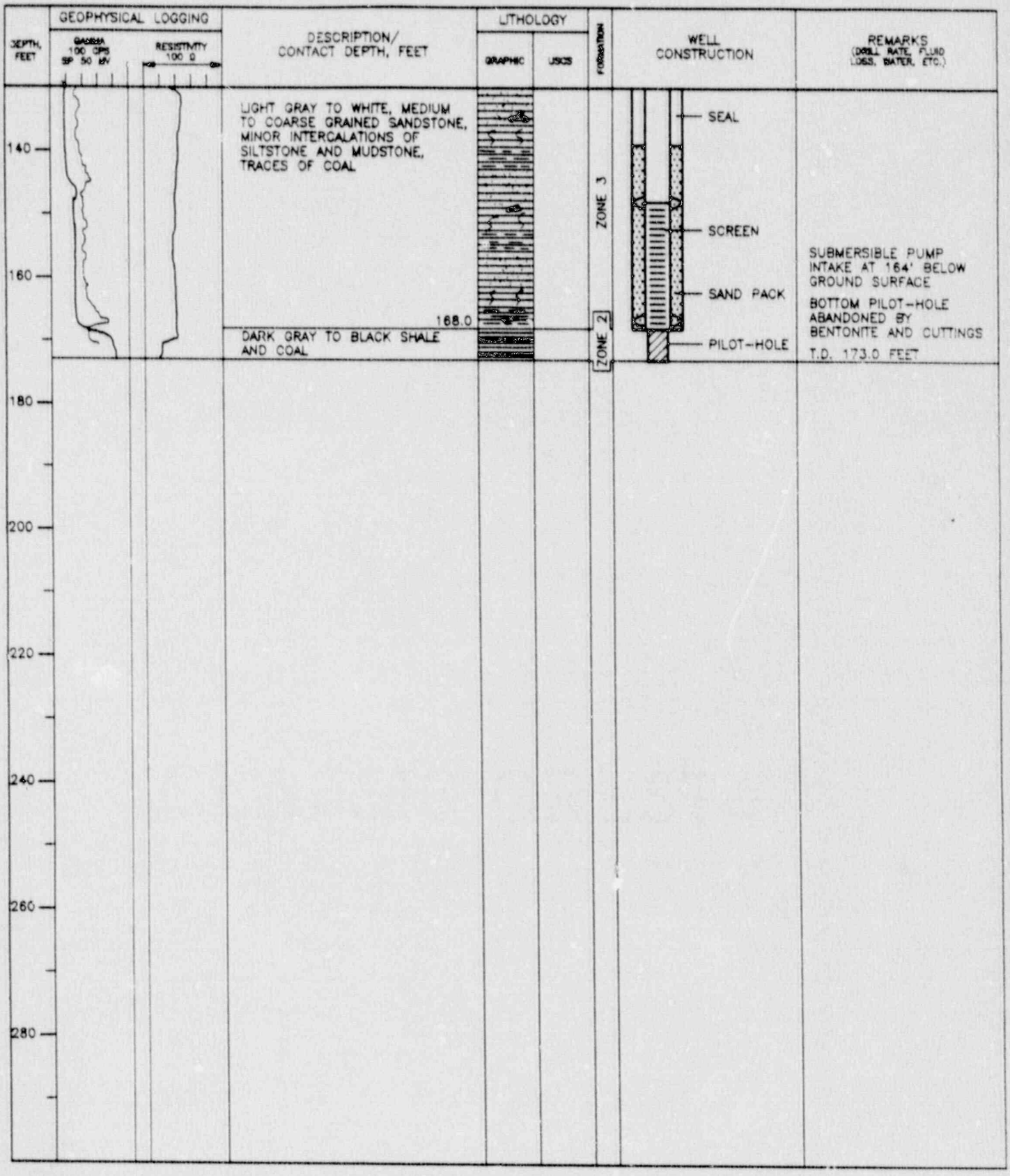
WELL/PIEZOMETER COMPLETION LOG-CONT'D

PROJECT NAME: UNC - REMEDIAL ACTION PROJECT NUMBER: 86-060-18 BORING NUMBER: 707



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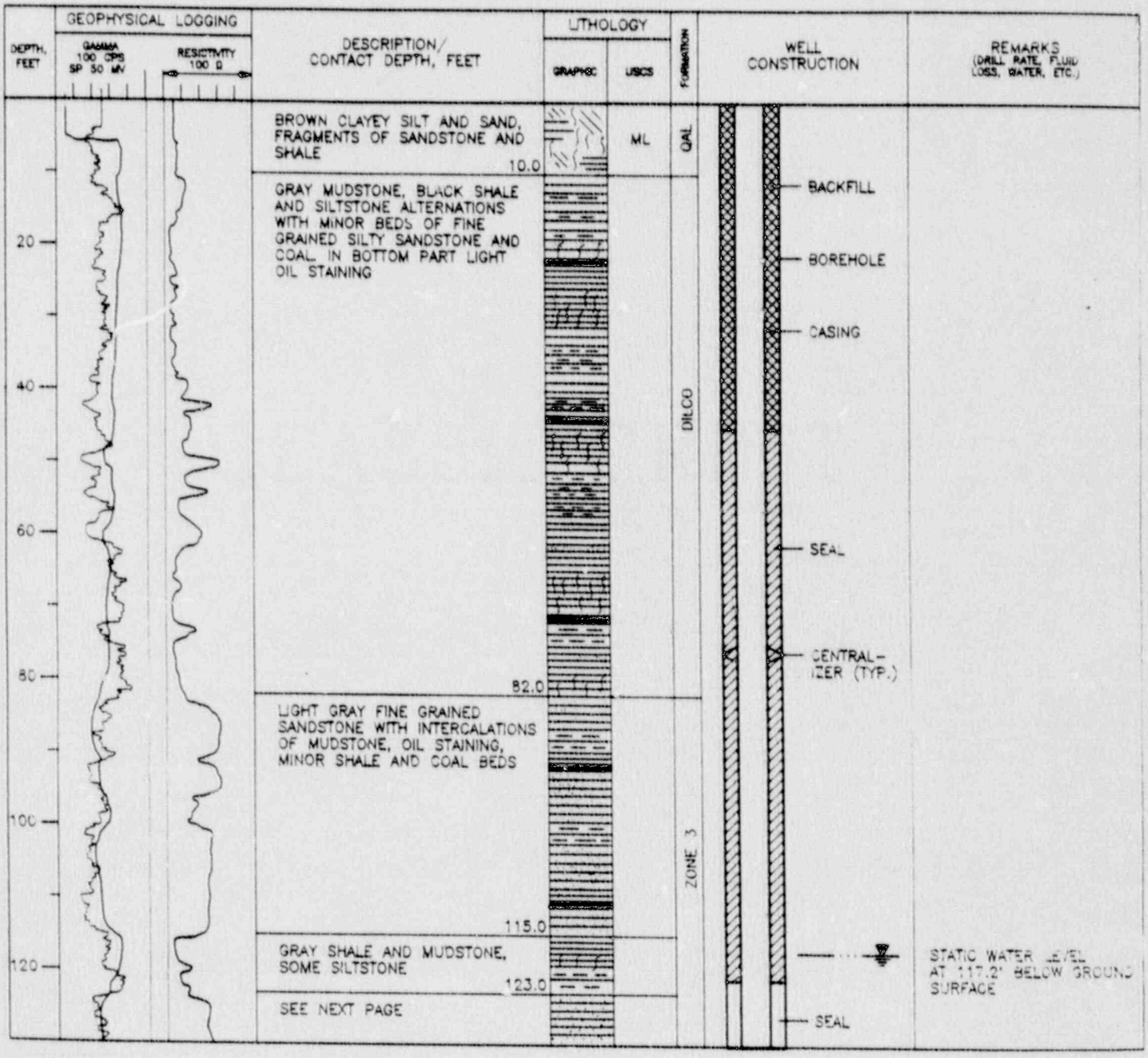
WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 708
BORING LOCATION: NORTH 76032.295' EAST 61500.167'
SURFACE ELEVATION, FEET: 7010.38
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: F. RAMIREZ - ROCKY MTN. DRILLING
DATE: START 5-22-89 FINISH 5-25-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 172
TOP OF CASING ELEVATION, FEET: 7011.78
DRILLING FLUID: WATER BIT SIZE, INCHES: 5-5/8, 10-5/8
NO. OF SAMPLES: DIST. 35 UNDIST. N/A
CASING TYPE AND SIZE: 6" Ø SCH. 80 & 40 PVC FROM 1.6 FT. ABOVE GROUND SURFACE TO 137 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" Ø SCH. 40 PVC, WIRE WOUND FROM 137 TO 167 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11" AT 76, 136.5, 166 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE FROM 131 TO 167 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 121 TO 131 TYPE 80 SEC. BENT. MUD FROM 45 TO 121 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT FROM 0 TO 45 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING N/A AFTER COMPLETION 6893.18 FT.



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WELL/PIEZOMETER COMPLETION LOG–CONT'D

PROJECT NAME UNC – REMEDIAL ACTION PROJECT NUMBER 86-060-18 BORING NUMBER 708

DEPTH, FEET	GEOPHYSICAL LOGGING: GAMMA 100 CPS SP 50 MV / RESISTIVITY 100 Ω	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY: GRAPHIC	LITHOLOGY: USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
140		LIGHT GRAY TO WHITE, MEDIUM TO COARSE GRAINED SANDSTONE			ZONE 3		
		147.0					
160		LIGHT GRAY TO WHITE MEDIUM TO COARSE SANDSTONE WITH INTERCALATIONS OF MUDSTONE AND MINOR COAL				SCREEN; SAND PACK	SUBMERSIBLE PUMP INTAKE AT 160.0' BELOW GROUND SURFACE
		167.0			ZONE 2		BOTTOM PILOT HOLE ABANDONED BY BENTONITE AND CUTTINGS
		DARK GRAY TO BLACK SHALE AND COAL				PILOT HOLE	T.D. 172.0 FEET
180							
200							
220							
240							
260							
280							

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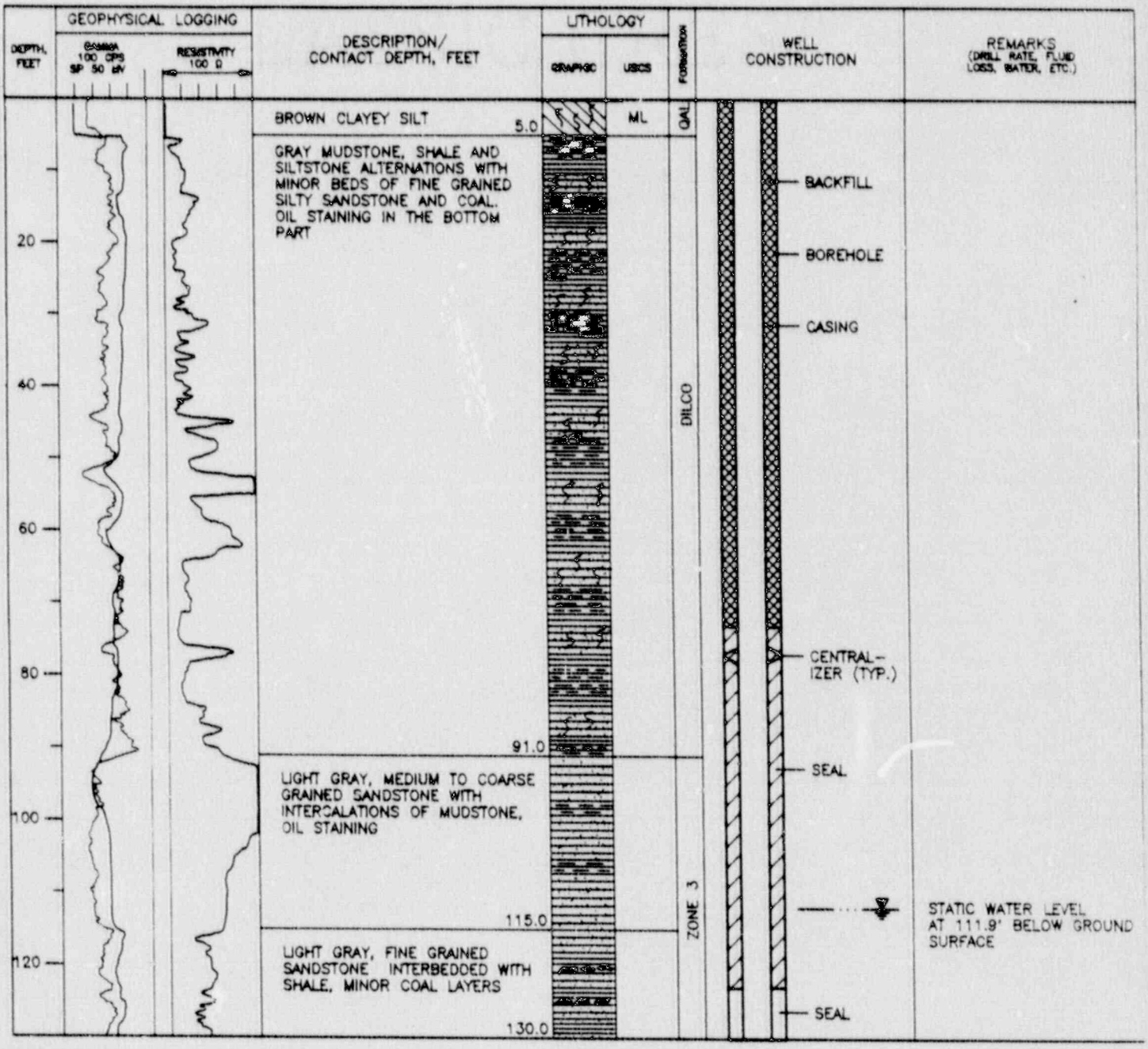
WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-080-18 BORING NUMBER: 709
BORING LOCATION: NORTH 78469.296' EAST 61520.850' SURFACE ELEVATION, FEET: 7001.01
LOGGED BY: L. BUSH - UNC CHECKED BY: M. WILCZEWSKI
DRILLER: F. RAMIREZ - ROCKY MTN. DRILLING DATE: START 5-15-89 FINISH 5-17-89
DRILLING METHOD: ROTARY TOTAL DEPTH, FEET: 173 TOP OF CASING ELEVATION, FEET: 7003.54
DRILLING FLUID: WATER AND FOAM BIT SIZE, INCHES: 5-5/8, 10-5/8 NO. OF SAMPLES: DIST. 35 UNDIST. N/A
CASING TYPE AND SIZE: 6" ø PVC SCH. 80 & 40 FROM 2.5 FT. ABOVE GROUND SURFACE TO 138 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" ø PVC SCH. 40, WIRE-WOUND FROM 138 TO 168 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11" AT 77, 137.5, 167 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE FROM 133 TO 168 FT. BELOW GROUND SURFACE
SEAL TYPE: BENTONITE PELLETS FROM 123 TO 133 TYPE: 80 SEC. BENT. MUD FROM 73 TO 123 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT FROM 0 TO 73 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING N/A AFTER COMPLETION 6889.14 FT.



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WELL/PIEZOMETER COMPLETION LOG-CONT'D

PROJECT NAME: UNC - REMEDIAL ACTION PROJECT NUMBER: 86-060-18 BORING NUMBER: 709

DEPTH, FEET	GEOPHYSICAL LOGGING: GAMMA 100 CPS / SP 50 MV; RESISTIVITY 100 Ω	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY: GRAPHIC	LITHOLOGY: USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
140		LIGHT GRAY TO WHITE, MEDIUM TO COARSE GRAINED SANDSTONE, WITH MINOR , THIN BEDS OF GRAY SHALE			ZONE 3		
160						SCREEN; SAND PACK	SUBMERSIBLE PUMP INTAKE AT 160.5' BELOW GROUND SURFACE
		168.0					BOTTOM PILOT HOLE ABANDONED BY BENTONITE AND CUTTINGS
		DARK GRAY TO BLACK SHALE AND COAL			ZONE 2	PILOT HOLE	T.D. 173.0 FEET
180							
200							
220							
240							
260							
280							

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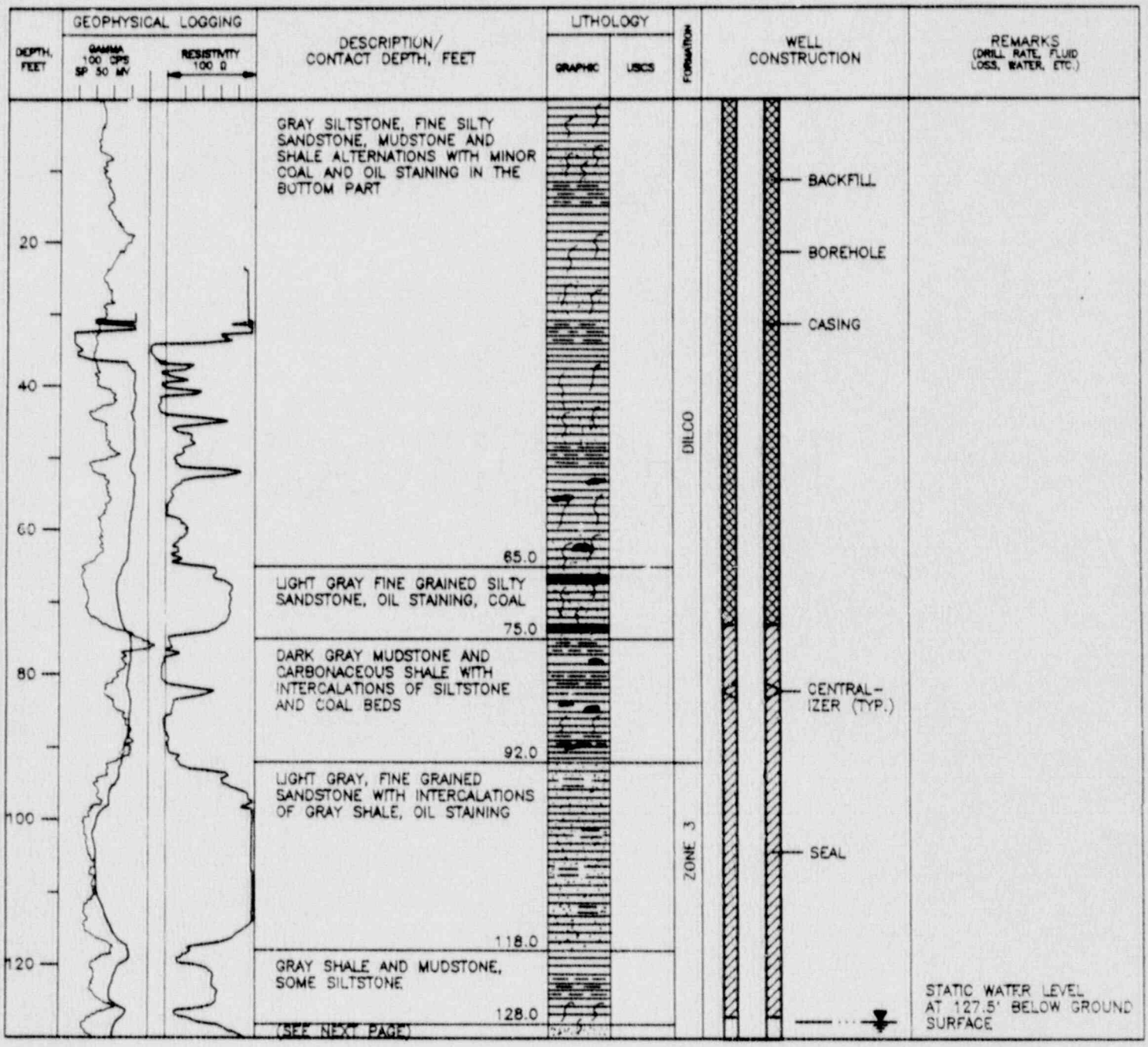
WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 710
BORING LOCATION: NORTH 76299.530' EAST 61699.349'
SURFACE ELEVATION, FEET: 7014.18
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: F. RAMIREZ - ROCKY MTN. DRILLING
DATE: START 5-18-89 FINISH 5-22-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 180
TOP OF CASING ELEVATION, FEET: 7016.52
DRILLING FLUID: WATER AND FOAM
BIT SIZE, INCHES: 5-5/8, 10-5/8
NO. OF SAMPLES: DIST. 36 UNDIST. N/A
CASING TYPE AND SIZE: 6" ø SCH. 80 & 40 PVC
FROM 2.3 FT. ABOVE GROUND SURFACE TO 143 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" ø SCH. 40 PVC, WIRE WOUND
FROM 143 TO 173 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11"
AT 82, 142.5, 172 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE
FROM 137 TO 173 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 127 TO 137 TYPE 80 SEC. BENT. MUD FROM 73 TO 127 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT
FROM 0 TO 73 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING N/A
AFTER COMPLETION 6886.72 FT.



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WELL/PIEZOMETER COMPLETION LOG-CONT'D

PROJECT NAME UNC - REMEDIAL ACTION PROJECT NUMBER 86-060-18 BORING NUMBER 710

DEPTH, FEET	GEOPHYSICAL LOGGING: GAMMA 100 CPS SP 50 MV / RESISTIVITY 100 Ω	DESCRIPTION / CONTACT DEPTH, FEET	LITHOLOGY: GRAPHIC	LITHOLOGY: USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
140		LIGHT GRAY TO WHITE, FINE TO MEDIUM SANDSTONE INTERBEDDED WITH MINOR SHALE AND COAL. HEAVY TAR AT 130'.			ZONE 3	SEAL	
160		160.0 LIGHT GRAY TO WHITE, MEDIUM TO COARSE SANDSTONE, MINOR INTERCALATIONS OF SHALE				SCREEN / SAND PACK	SUBMERSIBLE PUMP INTAKE AT 164' BELOW GROUND SURFACE
180		173.0 DARK GRAY TO BLACK SHALE AND COAL			ZONE 2	PILOT HOLE	BOTTOM PILOT HOLE ABANDONED BY BENTONITE AND CUTTINGS. T.D. 180.0 FEET
200							
220							
240							
260							
280							

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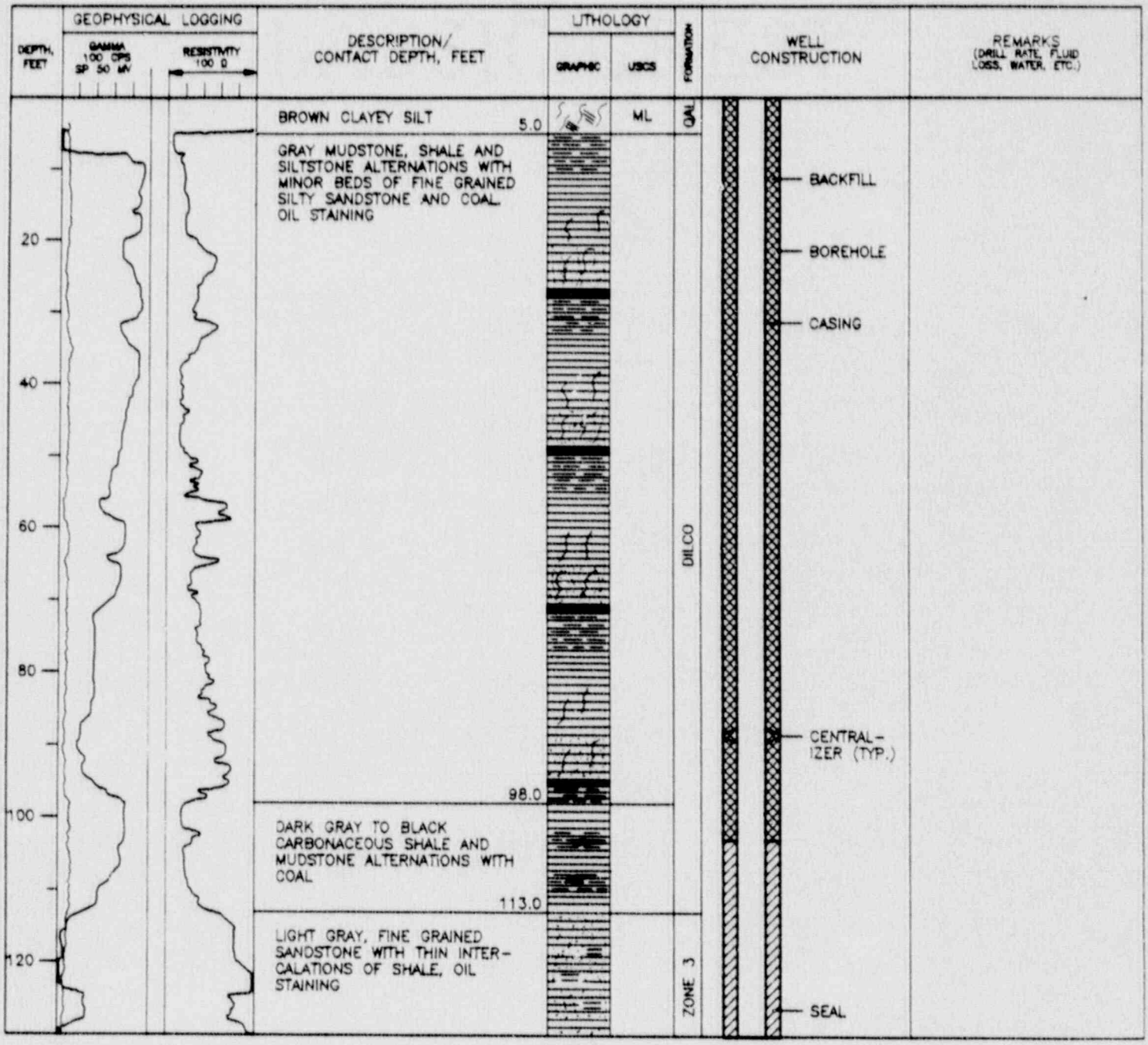
WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 711
BORING LOCATION: NORTH 76100.378' EAST 61899.367'
SURFACE ELEVATION, FEET: 7040.00
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: F. RAMIREZ - ROCKY MTN. DRILLING
DATE: START 5-5-89 FINISH 5-9-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 206
TOP OF CASING ELEVATION, FEET: 7042.60
DRILLING FLUID: WATER AND FOAM BIT SIZE, INCHES: 5-5/8, 10-5/8
NO. OF SAMPLES: DIST. 41 UNDIST. N/A
CASING TYPE AND SIZE: 6" ø SCH. 80 & 40 PVC FROM 2.6 FT. ABOVE GROUND SURFACE TO 168 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" ø SCH. 40 PVC, WIRE WOUND FROM 168 TO 198 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11" AT 88.5, 167.5, 197 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE FROM 158 TO 198 FT. BELOW GROUND SURFACE
SEAL TYPE: BENTONITE PELLETS FROM 149 TO 158 TYPE: 80 SEC. BENT. MUD FROM 113 TO 149 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT FROM 0 TO 113 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING: N/A AFTER COMPLETION: 6885.7 FT.



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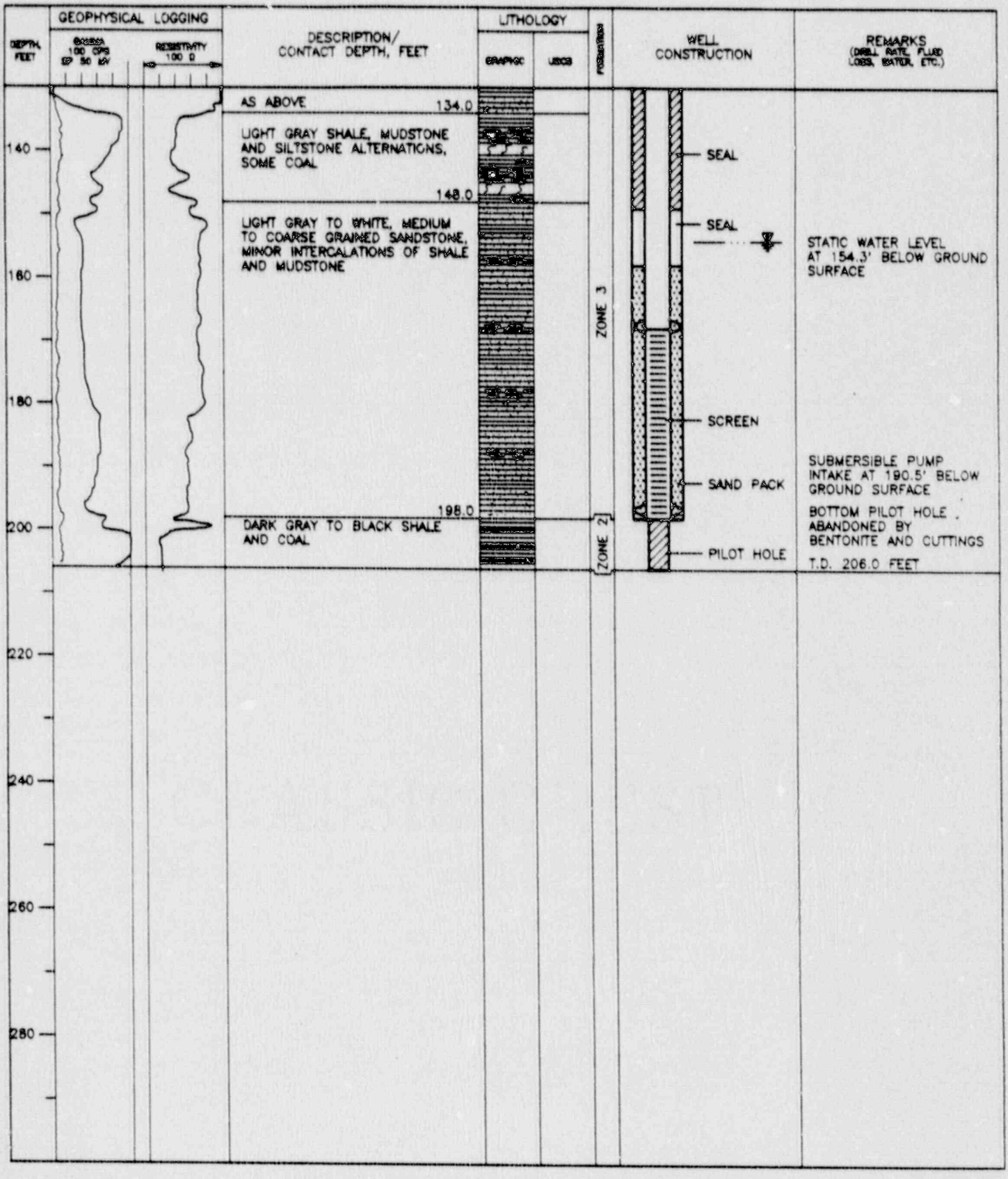
WELL/PIEZOMETER COMPLETION LOG--CONT'D

PROJECT NAME UNC - REMEDIAL ACTION PROJECT NUMBER 86-030-18 BORING NUMBER 711



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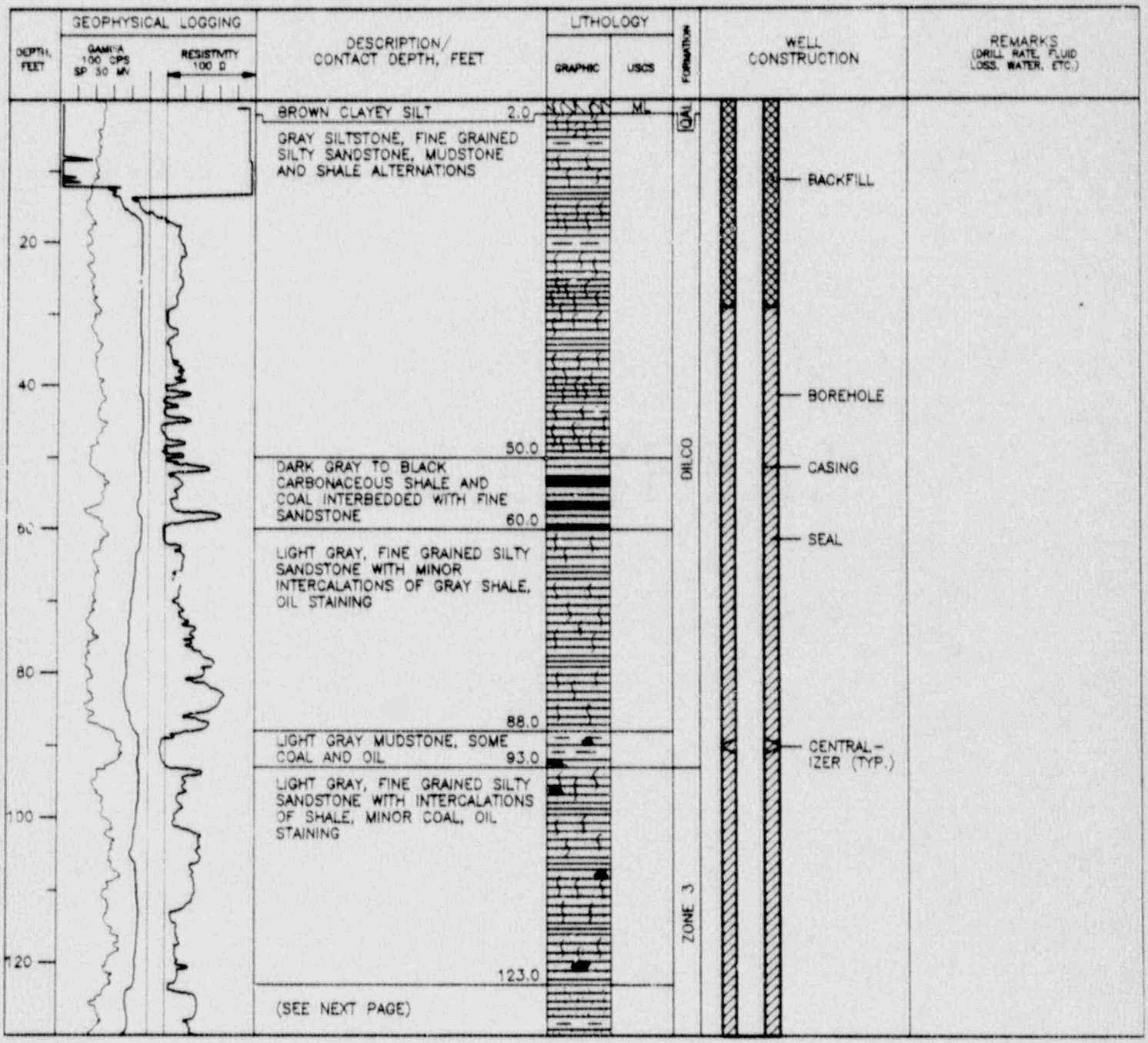
WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: E8-060-18
BORING NUMBER: 712
BORING LOCATION: NORTH 76498.981' EAST 61900.597'
SURFACE ELEVATION, FEET: 7019.72
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: F. RAMIREZ - ROCKY MTN. DRILLING
DATE: START 5-11-89 FINISH 5-15-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 185
TOP OF CASING ELEVATION, FEET: 7022.17
DRILLING FLUID: WATER AND FOAM BIT SIZE, INCHES: 5-5/8, 10-5/8
NO. OF SAMPLES: DIST. 37 UNDIST. N/A
CASING TYPE AND SIZE: 6" ø SCH. 80 & 40 PVC
FROM 2.45 FT. ABOVE GROUND SURFACE TO 149 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" ø SCH. 40 PVC, WIRE-WOUND
FROM 149 TO 179 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11"
AT 90, 148, 178 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE
FROM 144 TO 179 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 134 TO 144 TYPE 80 SEC. BENT. MUD FROM 29 TO 134 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT
FROM 0 TO 29 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING N/A AFTER COMPLETION 6879.87 FT.



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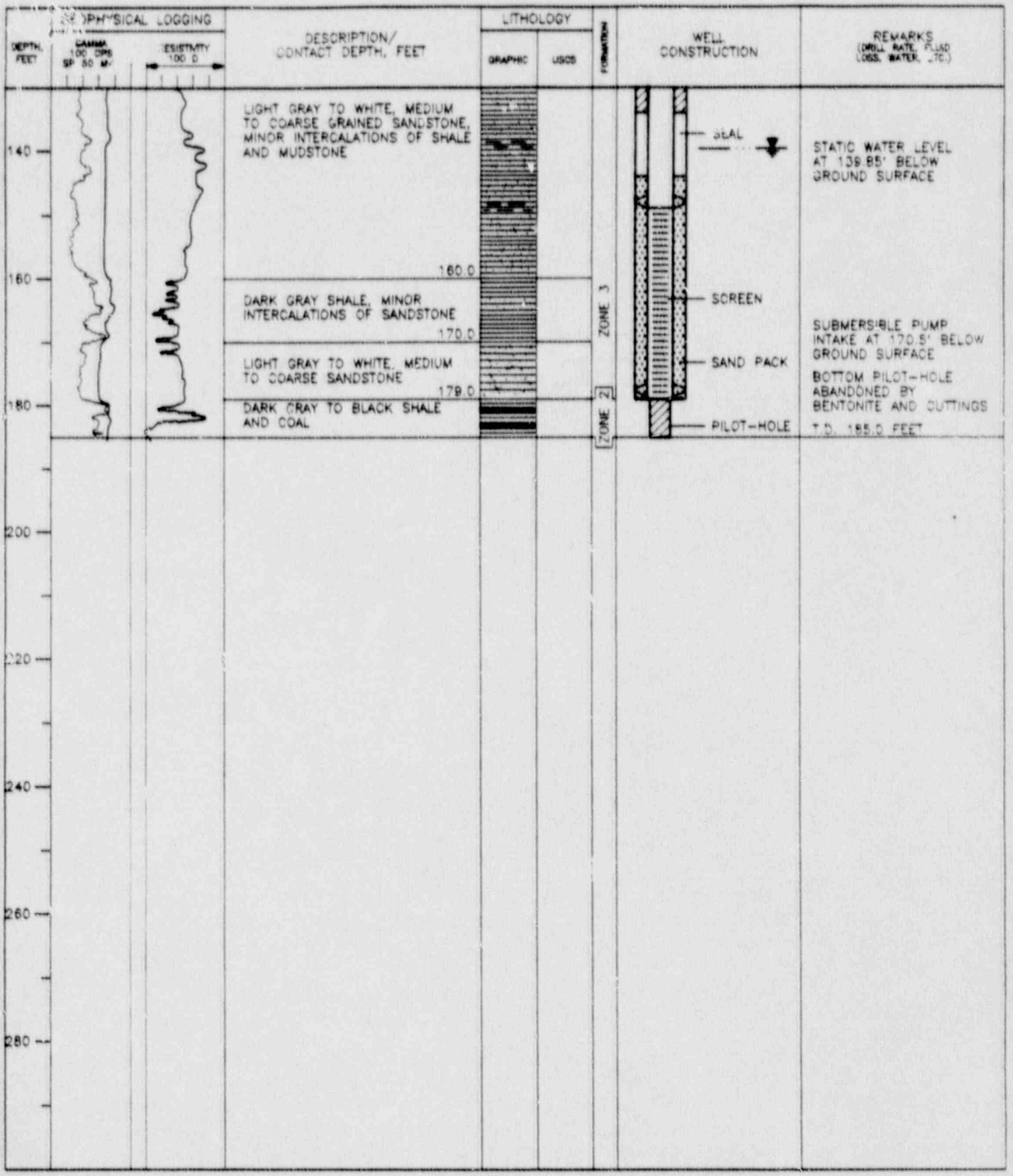
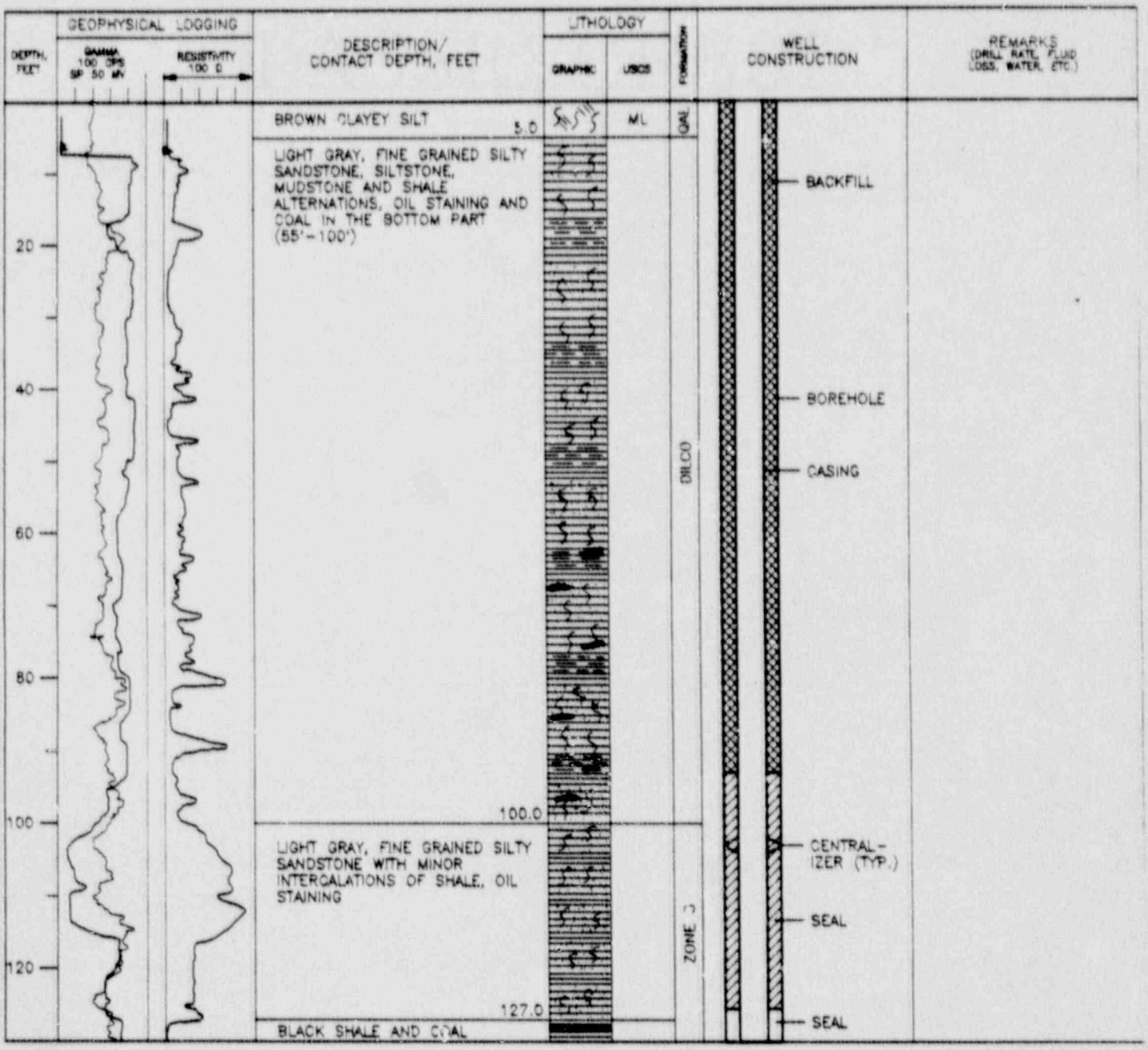
WELL/PIEZOMETER COMPLETION LOG--CONT'D

PROJECT NAME UNC - REMEDIAL ACTION PROJECT NUMBER 86-060-18 BORING NUMBER 712



WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 713
BORING LOCATION: NORTH 76300.001' EAST 62100.030
SURFACE ELEVATION, FEET: 7021.28
LOGGED BY: L. BUSH - UNC
CHECKED BY: M. WILCZEWSKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 6-15-89 FINISH 6-19-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 178
TOP OF CASING ELEVATION, FEET: 7024.48
DRILLING FLUID: WATER
BIT SIZE, INCHES: 5-5/8, 10-7/8
NO. OF SAMPLES: DIST. 36 UNDIST. N/A
CASING TYPE AND SIZE: 6" Ø SCH. 80 & 40 PVC
FROM 3.2 FT. ABOVE GROUND SURFACE TO 143 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 6" Ø SCH. 40 PVC, WIRE-WOUND
FROM 143 TO 173 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 6" x 11"
AT 103, 142.5, 172 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 8-12 SIEVE
FROM 135.5 TO 173 FT. BELOW GROUND SURFACE
SEAL TYPE: BENTONITE PELLETS FROM 125.5 TO 135.5 TYPE 80 SEC. BENT. MUD FROM 93 TO 125.5 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT
FROM 0 TO 93 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION DURING DRILLING: N/A
AFTER COMPLETION: 6882.48 FT.



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WELL/PIEZOMETER COMPLETION LOG–CONT'D

PROJECT NAME UNC – REMEDIAL ACTION PROJECT NUMBER 86-060-18 BORING NUMBER 713

DEPTH, FEET	GEOPHYSICAL LOGGING: GAMMA 100 CPS, SP 50 MV	GEOPHYSICAL LOGGING: RESISTIVITY 100 Ω	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY: GRAPHIC	LITHOLOGY: USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
140			(AS ABOVE) 132.0 LIGHT GRAY TO WHITE, MEDIUM TO COARSE GRAINED SANDSTONE, MINOR THIN SHALE BEDS			ZONE 3	SEAL SAND PACK	STATIC WATER LEVEL AT 138.8' BELOW GROUND SURFACE
160			155.0 LIGHT GRAY SHALE AND MUDSTONE 162.0 LIGHT GRAY TO WHITE, MEDIUM TO COARSE SANDSTONE, SOME SHALE 173.0				SCREEN	SUBMERSIBLE PUMP INTAKE AT 167.0' BELOW GROUND SURFACE
180			DARK GRAY TO BLACK SHALE AND COAL			ZONE 2	PILOT-HOLE	BOTTOM PILOT-HOLE ABANDONED BY BENTONITE AND CUTTINGS T.D. 178.0 FEET
200								
220								
240								
260								
280								

APPENDIX B

ZONE 3 - STAGE I AQUIFER TEST RESULTS

APPENDIX B

ZONE 3 - STAGE I AQUIFER TEST RESULTS

An aquifer test was conducted in the Zone 3 - Stage I wells during the period from May 31, 1989 through June 9, 1989 by Canonie Environmental Services Corp. (Canonie) personnel. The objective of the testing, as stated in the Remedial Design (RD) (Canonie, 1989a), was twofold. First, a single-well pumping test was conducted to verify the validity of the hydraulic parameters used in the design. Second, a multi-well test was conducted by pumping five system wells simultaneously to simulate operation performance. Adjustment to the system design and recommendations for its operation are presented below, based on the test results.

In summary, the well spacing and locations were found to be adequate with the exception of Well 704, which should be removed from the system. Additionally, it is recommended that the wells be pumped in cycles rather than at a steady rate in order to avoid problems with incrustation resulting from drawdown into the well screens.

Single-Well Test

A single-well, constant rate-pumping test was conducted for 51 hours, from May 31, 1989 to June 2, 1989, using Well 709 as the pumping well. Nine observation wells were monitored during the test, and a hydraulic response was observed in four of the wells (EPA-15, EPA-15A, EPA-15C, and EPA-15D). The drawdown data from the four responding wells was analyzed using the Theis equation and yielded an average transmissivity of 115 square feet per day (1,000 gallons per day per foot) and an average storativity of 2 percent.

Multiple-Well Test

A multiple-well test was conducted by pumping the System Wells 708, 709, 710, 711, and 712 simultaneously for 91 hours from June 5, 1989 through June 9, 1989. The purpose of the test was to verify the hydraulic performance of the system, based on the cumulative impact of pumping wells in producing interference drawdown. This was accomplished by observing water levels at wells located between the pumping wells.

Observation wells at the intermediate locations should show combined drawdown effects from the several pumping locations, which can be predicted by the hydraulic parameters from the single-well test. In fact, one Observation Well (502B) showed the predicted interference effect; other Observation Wells (EPA-15, EPA-15C, and TWQ-127) showed drawdowns predicted by higher storativity values. This result indicates that a range of storativity from 2 to 10 percent describes the system. The lower 2 percent value describes behavior on a local, single-well scale. The higher 5 to 10 percent value used in the design describes the behavior on the larger scale of the system. These results, combined with the absence of strong directional responses (abnormally large drawdown, which is not predicted by the Theis equation), substantiate the design assumption that Zone 3 is a single, transversely isotropic, granular, saturated material.

Operational and Design Modifications

The results of the two tests indicate two points of importance to the design and operation of the Zone 3 extraction system:

1. The well spacing and locations were found to be adequate; however, Well 704 should be deleted from the system's construction. The tests indicate that storativity on the local scale is 3 to 8 percent lower than that assumed in the design. The lower storativity may cause a 10 to 20 percent increase in drawdown in the pumping wells over time. Although this will have minor operational impacts on the system as a whole, two Wells, 710 and 704, will experience greater effects due to their location at the center of well clusters. For these two wells, the drawdown will be 40 to 50 percent greater than predicted.

   Well 704, which has not been drilled, should not be included in the system. Well 704 may produce very little water and, by interference, will further reduce the productivity of surrounding wells with a probable net loss of system capacity. This conclusion was substantiated by use of the existing computer model, using the lower storativity value. Operational pumping rate for Well 710

(already installed) will be evaluated at the time of system startup.

2. The specific capacities of the existing wells, summarized in the attached Table 1, indicate that the pumping water levels will drop into the screens of the wells during the course of the first year. In the past, Zone 3 wells, which pumped at levels below the screen, experienced severe incrustation and plugging. To reduce incrustation problems, the new wells should be equipped with automatic controls and pumped in cycles, even though the wells could sustain a steady pumping rate. United Nuclear's experience with the existing northeast pump-back wells has shown that pumping the wells in cycles successfully reduces incrustation.

   Due to the cyclical pumping that is being recommended, the monitoring of water levels in the Zone 3 extraction wells will not provide meaningful data. Therefore, the monitoring of water levels to assess system performance should be conducted in the 19 nonpumping wells listed in Table 2.3 of the RDR, rather than in the system wells. If collection of static/nonpumping water level data from the system wells becomes necessary in the future, the system can be temporarily shut off for 24 to 48 hours, after which time the measurements can be taken.

Additionally, the testing demonstrated that the existing wells will capture acidic seepage. At the end of the multi-well test, the wells were pumping water of the following pH:

Well	pH
708	4.2
709	6.5
710	5.9
711	4.0
712	5.9

In summary, the testing has demonstrated the adequacy of the design, with the necessity of one minor modification. As extraction continues, the necessity for operational modifications will be addressed as they become evident.

TABLE B.1

SPECIFIC CAPACITY OF TEST WELLS AND PREDICTED OPERATIONAL DRAWDOWN

Well	Multi-well Test		Specific Capacity (gpm/feet)	Well Efficiency[a] (percent)	Operational Discharge (gpm)	Predicted Operational Drawdown[b] (feet)	Drawdown To Top Of Screen (feet)
	Discharge (gpm)	Drawdown (feet)					
708	10	26	.38	59.8	5	16.6	19.3
709	5	30	.17	65.3	5	33.2	24.3
710	2	35	.06	49.9	2	35.4	14.0
711	5	11	.45	55.6	5	21.6	11.3
712	5	15	.33	34.0	5	18.8	7.0

[a] Average well efficiency measured during step drawdown test.

[b] Total drawdown for the well, including interference effects, calculated for the first year. Actual drawdown may be 10 - 20 percent greater due to loss of saturated thickness.

APPENDIX C

FIELD INSTALLATION REPORT
SOUTHWEST ALLUVIUM EXTRACTION AND OBSERVATION WELLS

APPENDIX C

FIELD INSTALLATION REPORT
SOUTHWEST ALLUVIUM EXTRACTION AND OBSERVATION WELLS

1.0 INTRODUCTION

This report presents as-built installation data for the Southwest Alluvium extraction wells (801 through 803) and observation wells (804 through 807). Figure C-1 shows the locations of these wells.

All drilling, installation, and development were performed by United Nuclear Corporation's (United Nuclear) subcontractors, Professional Services Industries, Inc. and Rocky Mountain Drilling, from August 3, 1989 to August 30, 1989. The field work was supervised by United Nuclear's designated geologist with consultation by Canonie Environmental Services Corp.'s (Canonie) field hydrogeologist.

The work was performed in accordance with the specifications and procedures presented in the Remedial Design report prepared by Canonie in April 1989.

2.0 DESCRIPTION OF WORK COMPLETED

The drilling and installation program consisted of the following items and activities:

1. Drilling of 6 5/8-inch-diameter pilot hole for extraction wells and 6 3/4-inch-diameter pilot hole for observation wells;

2. Reaming of the pilot hole to 9 7/8-inch diameter, for extraction wells only;

3. Well installation;

4. Development of the well;

5. Testing of the extraction wells; and

6. Surveying of final well locations, ground surface, and top of casing elevations.

2.1 Drilling

A total of 7 boreholes were drilled at the site for installation of three extraction wells (801 through 803) and four observation wells (804 through 807) in the Southwest Alluvium. The first three wells were tested to verify the performance of the system as designed.

Initially, a hollow-stem auger rig was employed for drilling and well installation. However, the rig was not able to complete the wells due to heaving sands encountered in the drilling area and the greater than expected depth to the Mancos Shale contact. Several attempts at well installation ended by locking the casing/screen column inside the auger flight. Finally, the decision was made that the hollow-stem auger rig would continue drilling the exploratory borings to collect split-spoon samples for determination of the lithology of the formation. Then, a rotary rig using fresh water from the mill site water supply well was

employed to drill a new boring adjacent to (within 3 to 10 feet of) the auger holes. The auger holes were then abandoned by filling them with cuttings topped by bentonite pellets.

The boreholes were advanced by rotary techniques with the use of clean water as the drilling fluid. The boreholes were drilled to the top of the Mancos Formation. Samples of drill cuttings were obtained at 5-foot intervals or when a change in lithology was noted to confirm the lithology obtained by auger drilling. Samples were visually classified and logged. The lithologic description of the cuttings is presented on the Well Completion Logs, pages C-9 through C-15.

The downhole drilling equipment was cleaned and decontaminated prior to use in each of the boreholes. A high-pressure, hot-water, steam-cleaning unit was used to accomplish this task.

2.2 Reaming

The three boreholes for installation of the extraction wells were reamed to a final diameter of 9 7/8 inches. All reaming was performed using fresh water and rotary technique.

2.3 Well Installation

Well construction details are presented on the Well Completion Logs, pages C-9 through C-15. A summary of well completion details is included in Table C.1.

The extraction wells were completed with 4 1/2-inch-diameter polyvinyl chloride (PVC) casing and with the same diameter PVC slotted screen. All the joints were flush threaded and equipped with O-ring seals. The slot size of the well screen was 0.020 inch. The screened intervals were selected in the field based on the lithologic logs and water level. All extraction wells were screened from the Mancos Shale contact upward from 20 to 60 feet. Well No. 801 was equipped with 20 feet of the screen, Well No. 802 was constructed with 30 feet of the screen, and Well No. 803 was

constructed with 60 feet of the screen. All well screens were equipped with a bottom cap.

The observation wells were completed with 2-inch-diameter PVC casing and with the same diameter PVC slotted screen. The slot size of the well screen was 0.020 inch. All the joints were flush threaded and equipped with O-ring seals. All observation wells were screened from the Mancos Shale contact upward from 40 to 80 feet. All well screens were equipped with a bottom cap.

A sand pack of 16 - 30 sieve size for the extraction wells and 20 - 40 sieve size for observation wells were placed typically to a height of 5 feet above the well screen. Five feet of bentonite pellets were placed above the sand pack as a seal. The remaining part of the annular space was filled to the ground level with cement grout. The grout material used was Type I Portland Cement with 4 percent bentonite to reduce shrinkage.

Stainless steel casing centralizers were installed in all wells. Three centralizers were placed in each well, one at the bottom and one at the top of screened interval, and the third typically in the seal interval.

A cement pedestal, 3 feet by 3 feet by 1 foot, was erected around each wellhead to protect the well from washing by surface water and to reinforce the casing above ground level. The cement pedestal is bound to the grout, filling up the annular space inside the borehole.

2.4 Development

Following well installation, the wells were developed in two stages. The first stage consisted of washing the well screen with fresh water (typically 3,000 to 5,000 gallons was used), using a specially designed packer, then swabbing and finally air-lifting. Air-lifting continued until the pumped water was clean and free of solids.

In the second stage of development, a submersible pump was installed in the well. Development consisted of surging and overpumping. Pumping was

continued until the pumped water was completely clean and free of solids. Typical total development time for the individual wells was between four and six hours.

2.5 Testing

A step-drawdown pumping test was performed in each of the three extraction wells (801 through 803). The objective of the testing program was to assess well efficiency, specific capacity of the well, dynamic performance of the pump, and the optimum pump setting depth. The above parameters were necessary for designing the operational discharge rate. Table C.2 presents the results of the pumping test.

2.6 Surveying

The elevations of the tops of all casing and ground levels as well as coordinates for each well were surveyed after completion. The survey was performed by United Nuclear field staff. Table C.1 presents the elevations and coordinates for each well.

TABLE C.1

SUMMARY OF WELL COMPLETION DATA
SOUTHWEST ALLUVIUM WELLS

Well Number	Date Completed	Ground Surface Elevation (feet)	Top of Casing Elevation (feet)	Northing	Easting	Total Depth (feet)[a]	Casing Diameter (inches)	Screen Interval From (feet)[a]	Screen Interval To (feet)[a]	Alluvium From (feet)[a]	Alluvium To (feet)[a]
801	24-Aug-89	6,900.85	6,904.32	71,630.35	56,273.79	61.5	4.5	39	59	0	60.5
802	25-Aug-89	6,904.02	6,905.84	71,854.39	56,215.05	82	4.5	51.5	81.5	0	81.5
803	23-Aug-89	6,921.49	6,922.58	72,280.56	56,369.62	123	4.5	58	118	0	118
804	04-Aug-89	6,902.56	6,906.76	71,770.85	56,302.73	71	2	25.5	65.5	0	65.5
805	28-Aug-89	6,910.05	6,915.65	72,154.29	56,339.06	121	2	39	119	0	120
806	29-Aug-89	6,910.44	6,916.04	72,182.05	56,371.40	98	2	30	90	0	95
807	30-Aug-89	6,919.14	6,923.39	72,490.25	56,492.38	105	2	25	100	0	100

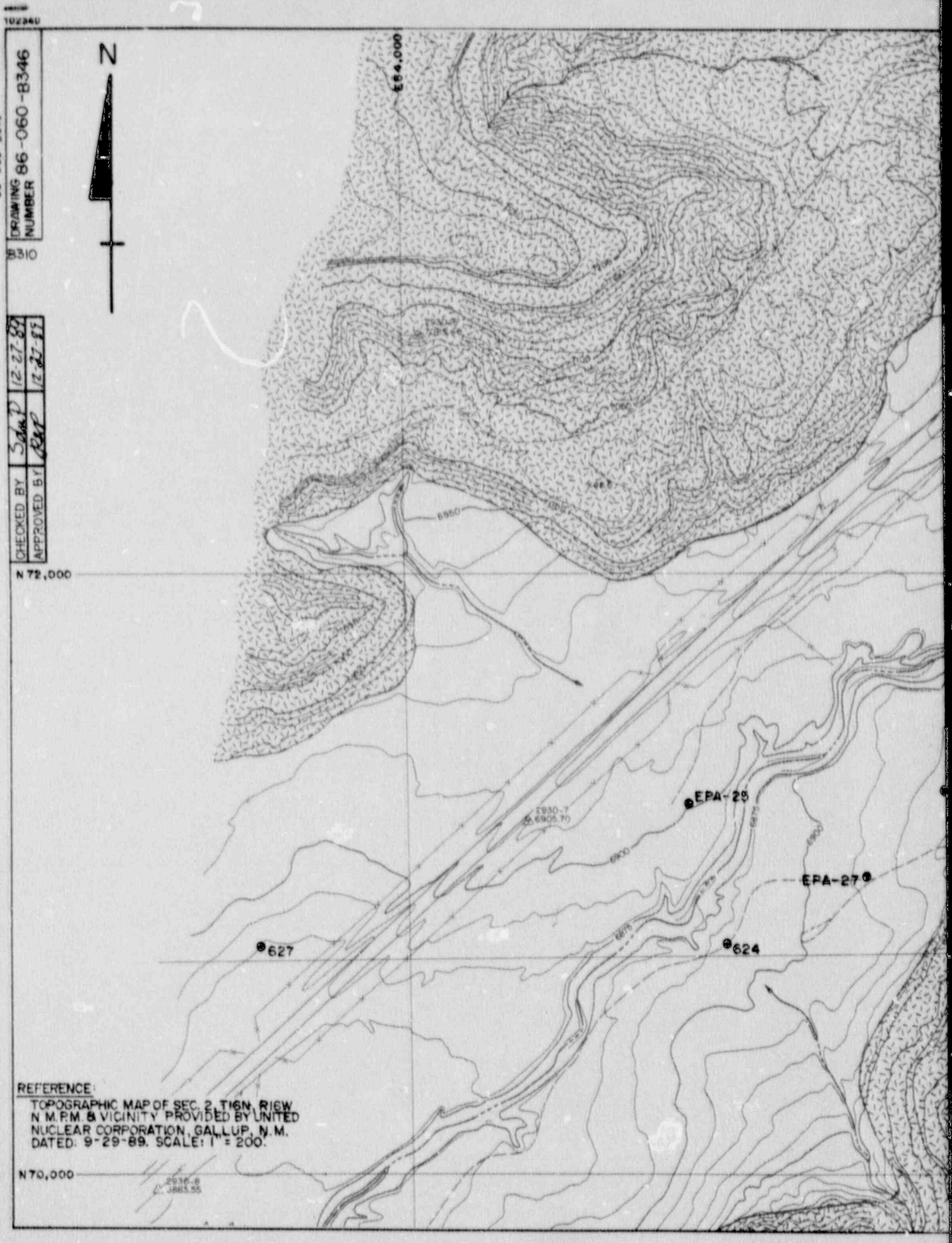
[a] Depth in feet below ground surface.

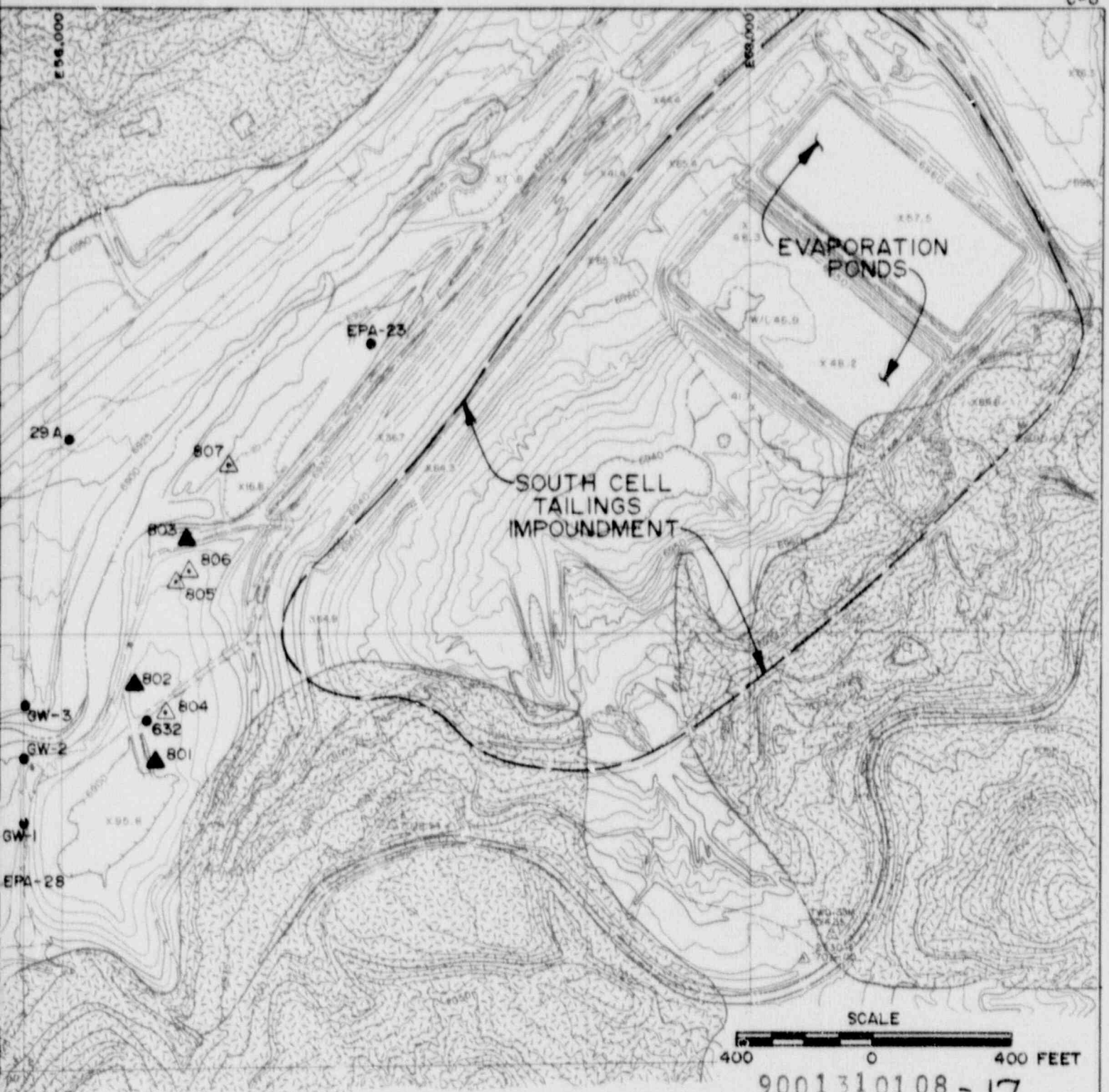
TABLE C.2

RESULTS OF STEP-DRAWDOWN TESTS
SOUTHWEST ALLUVIUM EXTRACTION WELLS

Well Number	Maximum Discharge (gpm)	Maximum Drawdown (feet)	Specific Capacity (gpm/feet)	Well[a] Efficiency (percent)
801	13.5	18.3	0.74	43.2
802	37.5	36.4	1.03	66.3
803	7.3	49.6	0.15	54.0

[a]Average well efficiency measured during step-drawdown test.


102340
86-060-8310
DRAWING NUMBER 86-060-8346
8310
CHECKED BY
APPROVED BY
12-27-89
12-27-89
N
E64,000
N 72,000
N 70,000
EPA-28
EPA-27
627
624
REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, N.M. DATED: 9-29-89. SCALE: 1" = 200'.



LEGEND:

- ●624 EXISTING MONITORING WELL
- ▲801 SOUTHWEST ALLUVIUM EXTRACTION WELL
- △804 SOUTHWEST ALLUVIUM OBSERVATION WELL

SOUTHWEST ALLUVIUM WELL LOCATIONS

PREPARED FOR

NL MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 12-21-89	FIGURE C-1	DRAWING NUMBER 86-060-B346
SCALE: AS SHOWN		

86-060-B310

DRAWING NUMBER	86-060-B349
CHECKED BY	
APPROVED BY	
DATE	12-26-89
DRAWN BY	

Symbols used for designation of subsurface materials on boring logs and

OVERBURDEN

- Glacial till
- Gravel
- Sand
- Silt
- Clay
- Organic Material

SEDIMENTARY ROCKS

- Limestone
- Siltstone
- Sandstone
- Massive Mudstone or Claystone
- Shale
- Coal
- Dolomite
- Conglomerate
- Breccia
- Crystalline Limestone
- Bedded Chert
- Marble
- Chalk
- Gypsum
- Salt
- Anhydrite
- Limestone Containing Nodules Of Chert Or Flint

METAMORPHIC

IGNEOUS ROCK

- Schistose Or Gneissoid Gra
- Granite
- Gneiss
- Quartzite
- Schist
- Basic Lava F
- Bedded Tuff

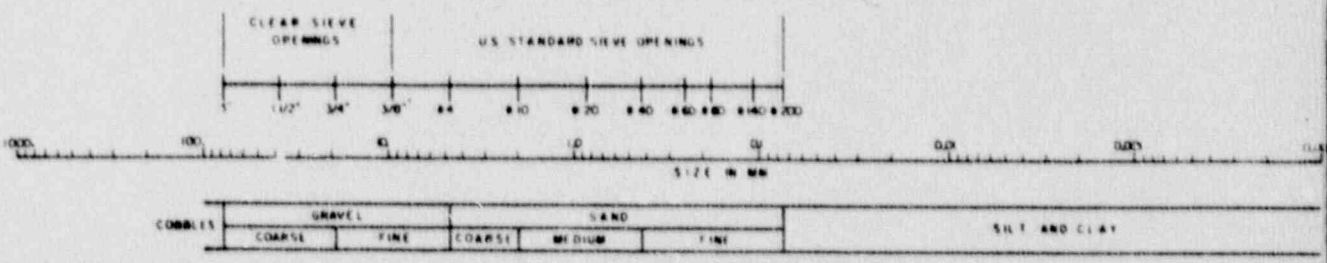
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH TONS PER SQUARE FOOT
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DESIGNATION	BLOWS PER FOOT
VERY LOOSE	[illegible]4
LOOSE	[illegible]10
MEDIUM DENSE	11-30
DENSE	31-50
VERY DENSE	OVER 50

STANDARD PENETRATION RESI
BLOWS REQUIRED TO DRIVE A
SAMPLER 12 INCHES USING A
FREELY THROUGH 30 INCHES
18 INCHES AND THE NUMBER
EACH 6 INCH INTERVAL THE R
IS INDICATED ON THE DRAWIN



USCS CLASSIFICATION FOR SOILS

BOULDER	COBBLE	PEBBLE							SILT	CLAY
BOULDER CONGLOMERATE	COBBLE CONGLOMERATE	PEBBLE CONGLOMERATE							SILTSTONE	CLAYSTONE AND SHALE

WENTWORTH SCALE FOR ROCK

TERMS USED TO DESCRIBE THE RELATIVE DEGREES OF ROCK CORE HARDNESS

DESCRIPTIVE TERMS	DEFINING CHARACTERISTICS
VERY SOFT	CRUSHES UNDER PRESSURE OF FINGERS AND/OR THUMB
SOFT	CRUSHES UNDER PRESSURE OF PRESSED HAMMER
MEDIUM HARD	BREAKS EASILY UNDER SINGLE HAMMER BLOW BUT WITH CRUMBLY EDGES
HARD	BREAKS UNDER ONE OR TWO STRONG HAMMER BLOWS BUT WITH RESISTANT SHARP EDGES
VERY HARD	BREAKS UNDER SEVERAL STRONG HAMMER BLOWS BUT WITH VERY RESISTANT SHARP EDGES AND MAY SPALL LEAVING CONCHOIDAL FRACTURES

THE SPACING OF THE DISCON
IN THE ROCK MAY BE DES
BY ONE OF THE FOLLOWING

DESCRIPTIVE TERMS	SP
VERY BROKEN	LESS
BROKEN	1 IN
SLIGHTLY BROKEN	3 IN
MASSIVE	6 IN AN

subsurface sections

MISCELLANEOUS

- Slag
- Fill
- Concrete
- Void (Indicate Size of Void)
- Water
- Approximate Existing Ground Surface
- Approximate Top Of Rock

P INDICATES PITCHER BARREL SAMPLER

2" O D SPLIT BARREL SAMPLE NUMBER

75/0 5 PENETRATION REFUSAL RESISTANCE AND FRACTIONAL INCREMENT DRIVEN IN FEET

12-10-75 GROUND WATER LEVEL AND DATE

U S C S UNIFIED SOIL CLASSIFICATION SYSTEM (CAPITAL LETTERS INDICATE LAB TEST CLASSIFICATION, LOWER CASE LETTERS INDICATE VISUAL FIELD CLASSIFICATION)

SAMPLE NUMBER
3" UNDISTURBED SAMPLE (SHELBY TUBE)
RECOVERY INCHES

PLASTIC LIMIT (PL)
ATTERBERG LIMITS
LIQUID LIMIT (LL)

ROD (ROCK QUALITY DESIGNATION PERCENT)
(LENGTH OF NUMBER OF PIECES GREATER THAN 4 INCHES DIVIDED BY THE LENGTH OF THE CORE RUN)
(60)
90
INDICATES PERCENT OF CORE RECOVERED (LENGTH OF CORE RECOVERED DIVIDED BY LENGTH OF CORE RUN)

DRILLING FLUID LOSS ____ %

DRILLING FLUID REGAINED ___ %

SI APERTURE CARD

Also Available On Aperture Card

STANCE IS THE NUMBER OF
2 INCH O D SPLIT BARREL
40 POUND HAMMER FALLING
HE SAMPLER WAS DRIVEN
F BLOWS RECORDED FOR
SISTANCE TO PENETRATION
AS BLOWS PER FOOT

TRACE - INDICATES PRESENCE OF LESS THAN 5% OF SUBJECT MATERIAL BY WEIGHT.

SOME - INDICATES PRESENCE OF 5 TO 30% OF SUBJECT MATERIAL BY WEIGHT.

AND - INDICATES PRESENCE OF 30 TO 50% OF SUBJECT MATERIAL BY WEIGHT.

INDIVIDUAL PARTICLES
CONSOLIDATED ROCK

INORTICS
RIBED
TERMS

CING
AN 1 IN
0 3 IN
0 6 IN
GREATER

THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS

SUBSURFACE DESCRIPTIONS SHOWN IN PARENTHESES ( ) INDICATE CLASSIFICATION FROM WASH SOIL RETAINED ON DRILL TOOLS OR ACTION OF DRILL TOOLS DURING ADVANCEMENT OF BORING

9001310108 - 18

GENERAL LEGEND

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

DATE: 12-26-89		DWG. NO.
SCALE N.T.S.		86-060-B349

WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 801
BORING LOCATION: NORTH 71630.3511' EAST 56273.7885'
SURFACE ELEVATION, FEET: 6900.85
LOGGED BY: M. WILCZEWSKI
CHECKED BY: E. BIELECKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 8-24-89 FINISH 8-24-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 61.5
TOP OF CASING ELEVATION, FEET: 6904.34
DRILLING FLUID: WATER BIT SIZE, INCHES: 6-5/8, 9-7/8
NO. OF SAMPLES: DIST. N/A UNDIST. 13 (SPLIT SPOON)
CASING TYPE AND SIZE: 4-1/2" ø SCH. 40 PVC FROM 3.5 FT. ABOVE GROUND SURFACE TO 39 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 4-1/2" ø SCH. 40 SLOTTED PVC FROM 39 TO 59 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 4-1/2" x 10' AT 15, 38.5, 58.5 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 16-30 SIEVE FROM 33 TO 59 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 28 TO 33 TYPE N/A FROM N/A TO N/A FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT FROM 3 TO 28 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING 6870.0 AFTER COMPLETION 6873.4 FT.

DEPTH, FEET	GEOPHYSICAL LOGGING: GAMMA 100 CPS / SP 50 MV	GEOPHYSICAL LOGGING: RESISTIVITY 100 Ω	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY: GRAPHIC	LITHOLOGY: USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
20	GEOPHYSICAL LOGGING NOT PERFORMED	GEOPHYSICAL LOGGING NOT PERFORMED	STIFF TO VERY STIFF BROWN SILTY CLAY, FRAGMENTS OF SANDSTONE AND SHALE, MINOR LAYERS OF YELLOW FINE SAND, DRY		CL/SM	QAL	PIPELINE DRAINAGE; BACKFILL; BOREHOLE; CASING	
			LOOSE TO MEDIUM DENSE CLAYEY AND SILTY SAND, WET		SC/SM		SEAL	STATIC WATER LEVEL AT 27.4' BELOW GROUND SURFACE
40			VERY STIFF, BROWN CLAY, MOIST		CL		CENTRALIZER (TYP.)	
			MEDIUM DENSE TO DENSE, MEDIUM TO COARSE SAND WITH PEBBLES OF SANDSTONE, MINOR CLAY LAYERS		SW/CL		SCREEN; SAND PACK	SUBMERSIBLE PUMP INTAKE AT 57.0' BELOW GROUND SURFACE
			55.5					
60			HARD BROWN CLAY 60.5		CL	MANCOS	PILOT HOLE	T.D. 61.5 FEET
			HARD, GRAY, LAMINATED SHALE, MOIST					
80								
100								
120								

Canonie Environmental

WELL/PIEZOMETER COMPLETION LOG

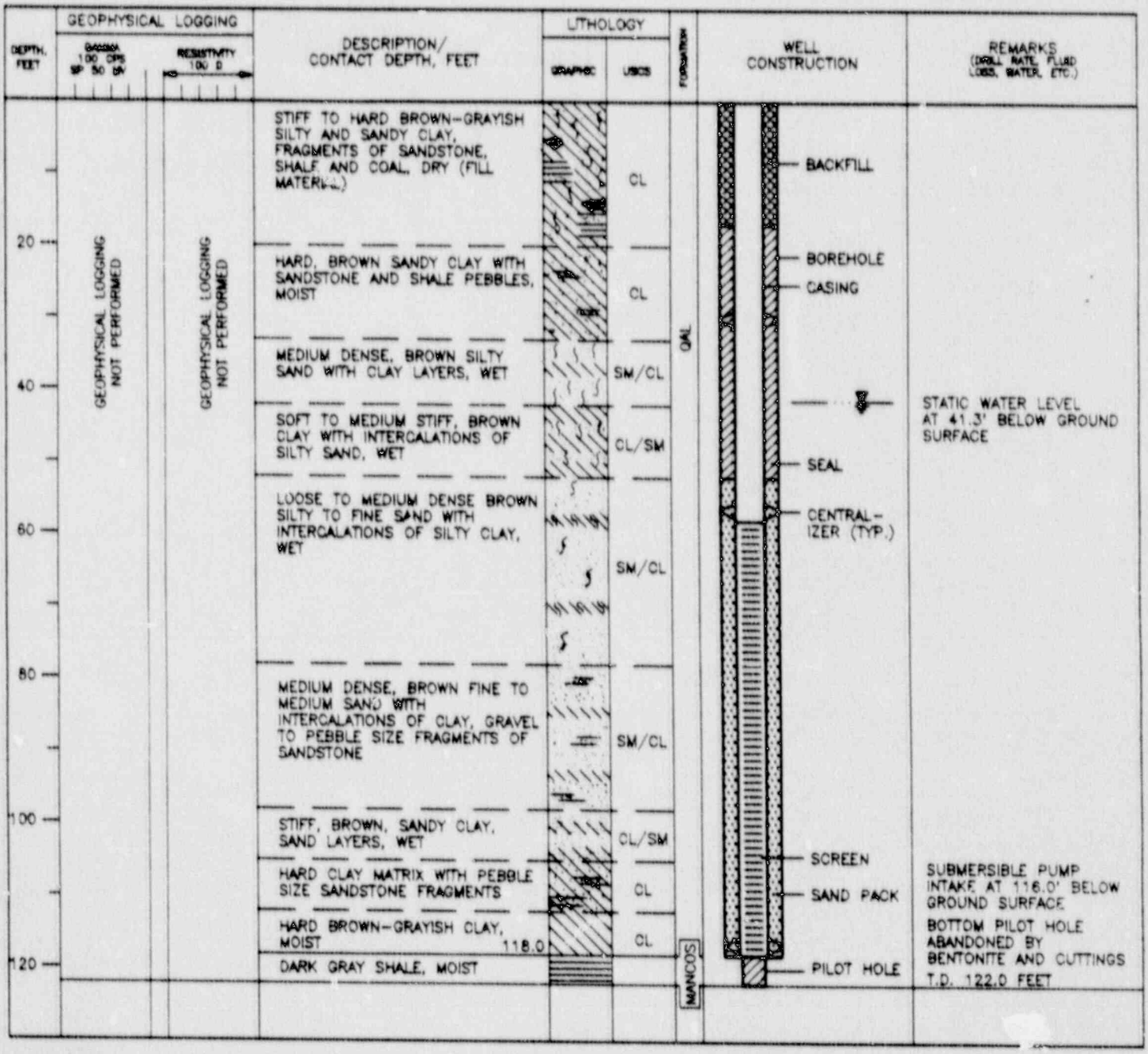
PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 802
BORING LOCATION: NORTH 71854.3905' EAST 56215.0508'
SURFACE ELEVATION, FEET: 6904.02
LOGGED BY: M. WILCZEWSKI
CHECKED BY: E. BIELECKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 8-25-89 FINISH 8-25-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 82.0
TOP OF CASING ELEVATION, FEET: 6905.8371
DRILLING FLUID: WATER
BIT SIZE, INCHES: 6-5/8, 9-7/8
NO. OF SAMPLES: DIST. N/A UNDIST. 16 (SPLIT SPOON)
CASING TYPE AND SIZE: 4-1/2" ø SCH. 40 PVC
FROM 1.8 FT. ABOVE GROUND SURFACE TO 51.5 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 4-1/2" ø SCH. 40 SLOTTED PVC
FROM 51.5 TO 81.5 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 4-1/2" x 10"
AT 20, 51, 81 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 16-30 SIEVE
FROM 40 TO 81.5 FT. BELOW GROUND SURFACE
SEAL TYPE: BENTONITE PELLETS FROM 34 TO 40 TYPE N/A FROM N/A TO N/A FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT
FROM 0 TO 34 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING 6864.0
AFTER COMPLETION 6874.6 FT.

DEPTH, FEET	GEOPHYSICAL LOGGING	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY GRAPHIC	LITHOLOGY USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
20	GEOPHYSICAL LOGGING NOT PERFORMED	STIFF, BROWN-GRAYISH, SILTY AND SANDY CLAY, FRAGMENTS OF SANDSTONE, SHALE AND COAL, MOIST. IN BOTTOM PART, THIN LAYERS OF CLAYEY SAND		CL/SC	QAL	BACKFILL; BOREHOLE; CASING	
		30.5					STATIC WATER LEVEL AT 29.4' BELOW GROUND SURFACE
40		MEDIUM DENSE, SILTY AND CLAYEY, FINE TO MEDIUM SAND WITH THIN LAYERS OF SILTY CLAY, WET		SC/CL		SEAL	
60		MEDIUM DENSE, MEDIUM SAND, SOME PEBBLES OF SANDSTONE, WET		SW		CENTRAL-IZER (TYP.); SCREEN; SAND PACK	
		81.0					SUBMERSIBLE PUMP INTAKE AT 78.0' BELOW GROUND SURFACE
80		STIFF, BROWN CLAY, MOIST 81.5		CL	MANCOS	PILOT HOLE	T.D. 82.0 FEET
		HARD, GRAY SHALE, MOIST					
100							
120							

Canonie Environmental

WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-080-18
BORING NUMBER: 803
BORING LOCATION: NORTH 72280.5592' EAST 56369.6209'
SURFACE ELEVATION, FEET: 6921.49
LOGGED BY: M. WILCZEWSKI
CHECKED BY: E. BIELECKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 8-23-89 FINISH 8-23-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 123
TOP OF CASING ELEVATION, FEET: 6922.5823
DRILLING FLUID: WATER BIT SIZE, INCHES: 6-5/8, 9-7/8
NO. OF SAMPLES: DIST. N/A INTERVAL: 23 (SPLIT SPOON)
CASING TYPE AND SIZE: 4-1/2" ø SCH. 40 PVC — FROM 1.1 FT. ABOVE GROUND SURFACE TO 58 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 4-1/2" ø SCH. 40 SLOTTED PVC — FROM 58 TO 118 FT. BELOW GROUND SURFACE
CENTRALIZERS: TYPE SST 4-1/2" x 10" — AT 30, 57.5, 117.5 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 16-30 SIEVE — FROM 52 TO 118 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM 17 TO 52 — TYPE N/A FROM N/A TO N/A FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT — FROM 0 TO 17 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING 6889.5 — AFTER COMPLETION 6880.2 FT.



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WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 88-080-18
BORING NUMBER: 804
BORING LOCATION: NORTH 71770.8453' EAST 56302.7258'
SURFACE ELEVATION, FEET: 6902.56
LOGGED BY: M. WILCZEWSKI
CHECKED BY: E. BIELECKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 8-4-89 FINISH 8-4-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 71
TOP OF CASING ELEVATION, FEET: 6906.7581
DRILLING FLUID: WATER
BIT SIZE, INCHES: 6-3/4
NO. OF SAMPLES: DIST. N/A
U/DISTT. 14 (SPLIT SPOON)
CASING TYPE AND SIZE: 2" ϕ SCH. 40 PVC
FROM 4.2 FT. ABOVE GROUND SURFACE TO 25.5 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 2" ϕ SCH. 40 SLOTTED PVC
FROM 25.5 TO 65.5 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 2" x 6-5/8"
AT 25, 65 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 20-40 SIEVE
FROM 19.5 TO 65.5 FT. BELOW GROUND SURFACE
SEAL TYPE: BENTONITE PELLETS FROM 11.5 TO 19.5 TYPE N/A FROM N/A TO N/A FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT
FROM 0 TO 11.5 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING 6865.6
AFTER COMPLETION 6874.3 FT.

DEPTH, FEET	GEOPHYSICAL LOGGING	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY		FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
			GRAPHIC	USCS			
	GEOPHYSICAL LOGGING NOT PERFORMED	DENSE, YELLOW-BROWNISH SILTY SAND, DRY		SM	QAL	BACKFILL	
		VERY STIFF, BROWN SILTY CLAY, MOIST		CL		SEAL	
		MEDIUM DENSE, BROWN CLAYEY SAND AND SILT, MOIST		ML		BOREHOLE	
20		STIFF, BROWN SILTY CLAY, WET		CL		CASING	
	GEOPHYSICAL LOGGING NOT PERFORMED	MEDIUM DENSE, REDDISH CLAYEY SAND, THIN LAYERS OF CLAY		SC/CL		STATIC WATER LEVEL AT 28.2' BELOW GROUND SURFACE	
40						SCREEN	
		STIFF TO VERY STIFF BROWN CLAY AND SILTY CLAY, MOIST. LAYER OF WET CLAYEY SAND AT 47'		CL/SC		SAND PACK	
60		VERY DENSE, BROWN CLAYEY SILT, WET 65.5		ML		CENTRALIZER (TYP.)	BOTTOM PILOT HOLE ABANDONED BY BENTONITE AND CUTTINGS
		GRAY, LAMINATED SHALE, MOIST			MANCOS	PILOT HOLE	T.D. 71.0 FEET
80							
100							
120							

Canonie Environmental

WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18
BORING NUMBER: 805
BORING LOCATION: NORTH 72154.2914 EAST 56339.0612
SURFACE ELEVATION, FEET: 6910.05
LOGGED BY: M. WILCZEWSKI
CHECKED BY: E. BIELECKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE: START 8-28-89 FINISH 8-28-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 121 TOP OF CASING ELEVATION, FEET: 6915.6516
DRILLING FLUID: WATER BIT SIZE, INCHES: 6-3/4 NO. OF SAMPLES: SPT: N/A UNDIST: 22 (SPLIT SPOON)
CASING TYPE AND SIZE: 2" ø SCH. 40 PVC FROM: 5.6 FT. ABOVE GROUND SURFACE TO: 39 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 2" ø SCH. 40 SLOTTED PVC FROM: 39 TO: 119 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 2" x 6-5/8" AT: 30, 69, AND 118.5 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 20-60 SIEVE FROM: 34 TO: 119 FT. BELOW GROUND SURFACE
SEAL TYPE: BENTONITE PELLETS FROM: 29 TO: 34 TYPE: N/A FROM: N/A TO: N/A FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT FROM: 0 TO: 29 FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING: 6872.0 AFTER COMPLETION: 6878.8 FT.

DEPTH, FEET	GEOPHYSICAL LOGGING: GAMMA 100 CPS / SP 50 mV	GEOPHYSICAL LOGGING: RESISTIVITY 100 Ω	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY: GRAPHIC	LITHOLOGY: USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
20	GEOPHYSICAL LOGGING NOT PERFORMED	GEOPHYSICAL LOGGING NOT PERFORMED	STIFF, BROWN, SILTY AND SANDY CLAY WITH FRAGMENTS OF SANDSTONE, COAL, AND SHALE, MOIST		CL		BACKFILL	
			LOOSE TO MEDIUM DENSE CLAYEY SAND, WET		SC		SEAL	STATIC WATER LEVEL AT 31.2' BELOW GROUND SURFACE
40			MEDIUM STIFF, BROWN, SILTY AND SANDY CLAY WITH INTERCALATIONS OF CLAYEY SAND, WET		CL/SC		SCREEN	
			MEDIUM DENSE, BROWN, FINE TO MEDIUM SAND, SOME THIN LAYERS OF CLAY, WET		SW/CL		BOREHOLE	
60						QAL	CASING	
			SOFT TO MEDIUM STIFF, BROWN SANDY CLAY, WET		CL		CENTRALIZER (TYP.)	
80			MEDIUM DENSE, BROWN, FINE TO MEDIUM SAND, SOME THIN LAYERS OF CLAY, WET				SAND PACK	
100					SW/CL			
			105' TO 108' HARD CLAY MATRIX WITH GRAVEL TO PEBBLE SIZE SANDSTONE FRAGMENTS. BELOW SAND/CLAY ALTERNATIONS 120.0'		CL/SC			BOTTOM PILOT HOLE ABANDONED BY BENTONITE AND CUTTINGS
120			DARK GRAY SHALE ALTERNATIONS WITH GRAY, FINE SAND AND SANDSTONE LAYERS			MANCOS	PILOT HOLE	T.D. 121.0'

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WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 86-060-18 BORING NUMBER: 806
BORING LOCATION NORTH: 72182.0535' EAST: 56371.3953' SURFACE ELEVATION, FEET: 6910.44
LOGGED BY: M. WILCZEWSKI ENGINEER BY: E. BIELECKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING DATE START: 8-29-89 FINISH: 8-29-89
DRILLING METHOD: ROTARY
DRILLING FLUID: WATER BIT SIZE, INCHES: 6-3/4 TOTAL DEPTH, FEET: 98 TOP OF CASING ELEVATION, FEET: 6916.0449
CASING TYPE AND SIZE: 2" Ø SCH. 40 PVC NO. OF SAMPLES TAKEN: 2 LENGTH: 18 (SPLIT SPOON)
SCREEN TYPE AND SIZE: 2" Ø SCH. 40 SLOTTED PVC FROM: 5.6 FT. ABOVE GROUND SURFACE TO: 30 FT. BELOW GROUND SURFACE
CENTRALIZERS TYPE: SST 2" x 6-1/2" FROM: 30 TO: 90 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 20-40 SIEVE AT: 19, 49, 89 FT. BELOW GROUND SURFACE
SEAL TYPE: BENTONITE PELLETS FROM: 20 TO: 28 FROM: 26 TO: 90 FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: CEMENT/BENTONITE GROUT TYPE: N/A FROM: N/A TO: N/A FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING: 6860.0 FROM: 0 TO: 20 FT. BELOW GROUND SURFACE
AFTER COMPLETION: 6879.5 FT.

DEPTH, FEET	GEOPHYSICAL LOGGING: GAMMA 100 CPS SP 50 MV	GEOPHYSICAL LOGGING: RESISTIVITY 100 Ω	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY: GRAPHIC	LITHOLOGY: USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
	GEOPHYSICAL LOGGING NOT PERFORMED	GEOPHYSICAL LOGGING NOT PERFORMED	STIFF, BROWN SILTY AND SANDY CLAY, FRAGMENTS OF SANDSTONE, COAL AND SHALE, MOIST		CL	QAL	BACKFILL	
20			LOOSE TO MEDIUM DENSE, BROWN CLAYEY SAND, MOIST		SC		SEAL	
			STIFF, BROWN-GRAYISH CLAY WITH THIN LAYERS OF FINE SAND, MOIST		CL/SW		STATIC WATER LEVEL	STATIC WATER LEVEL AT 30.9' BELOW GROUND SURFACE
40							BOREHOLE	
							CASING	
			MEDIUM DENSE, BROWN, FINE TO MEDIUM SAND WITH THIN LAYERS OF CLAY, WET		SW/CL			
60							SCREEN	
			STIFF, BROWN SANDY CLAY, WET		CL		SAND PACK	
80			92.0					
			HARD, CLAY MATRIX WITH PEBBLES OF SANDSTONE 95.0		CL	MANCOS	CENTRALIZER (TYP.)	BOTTOM PILOT HOLE ABANDONED BY BENTONITE AND CUTTINGS
			DARK GRAY SHALE, MOIST				PILOT HOLE	T.D. 98.0 FEET
100								
120								

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WELL/PIEZOMETER COMPLETION LOG

PROJECT NAME: UNC - REMEDIAL ACTION
PROJECT NUMBER: 88-080-18
BORING NUMBER: 807
BORING LOCATION: NORTH 72490.2501' EAST 56492.3751'
SURFACE ELEVATION, FEET: 6919.14
LOGGED BY: M. WILCZEWSKI
CHECKED BY: E. BIELECKI
DRILLER: L. GARCIA - ROCKY MTN. DRILLING
DATE START: 8-30-89 FINISH: 8-30-89
DRILLING METHOD: ROTARY
TOTAL DEPTH, FEET: 105
TOP OF CASING ELEVATION, FEET: 6923.3926
DRILLING FLUID: WATER BIT SIZE, INCHES: 6-3/4
NO. OF SAMPLES: DIST. 3 UNDIST. 18 (SPLIT SPOON)
CASING TYPE AND SIZE: 2" ϕ SCH. 40 PVC
FROM: 4.3 FT. ABOVE GROUND SURFACE TO 25 FT. BELOW GROUND SURFACE
SCREEN TYPE AND SIZE: 2" ϕ SCH. 40 SLOTTED PVC
FROM: 25 TO 100 FT. BELOW GROUND SURFACE
CENTRALIZERS: TYPE SST 2" x 6-5/8'
AT: 24, 49, 99 FT. BELOW GROUND SURFACE
PACK TYPE AND SIZE: SAND 20-40 SIEVE
FROM: 20 TO 100 FT. BELOW GROUND SURFACE
SEAL: TYPE BENTONITE PELLETS FROM: TO 20 TYPE N/A FROM N/A TO N/A FT. BELOW GROUND SURFACE
ANNULAR BACKFILL TYPE: N/A
FROM: N/A TO N/A FT. BELOW GROUND SURFACE
WATER LEVEL ELEVATION: DURING DRILLING 6887.0 AFTER COMPLETION 6884.2 FT.

DEPTH, FEET	GEOPHYSICAL LOGGING: GAMMA 100 CPS SP 50 CM	GEOPHYSICAL LOGGING: RESISTIVITY 100 Ω	DESCRIPTION/ CONTACT DEPTH, FEET	LITHOLOGY: GRAPHIC	LITHOLOGY: USCS	FORMATION	WELL CONSTRUCTION	REMARKS (DRILL RATE, FLUID LOSS, WATER, ETC.)
20	GEOPHYSICAL LOGGING NOT PERFORMED	GEOPHYSICAL LOGGING NOT PERFORMED	LOOSE TO MEDIUM DENSE, BROWN SILTY SAND AND SILT, WITH FRAGMENTS OF SANDSTONE, DRY, MINOR, THIN LAYERS OF CLAY AT BOTTOM		SM/CL	QAL	SEAL	
40			HARD TO STIFF, BROWN, SILTY CLAY, MOIST, MINOR THIN LAYERS OF SILTY SAND AND TRACES OF COAL		CL/CM		CENTRAL-IZER (TYP.)	STATIC WATER LEVEL AT 34.9' BELOW GROUND SURFACE
60			MEDIUM DENSE, BROWN, FINE TO MEDIUM SAND WITH MINOR, THIN LAYERS OF STIFF, BROWN CLAY, WET				BOREHOLE	
80					SW/CL		CASING	
100			STIFF, BROWN SANDY CLAY AND CLAYEY SAND, WET 100.0		CL/SC		SCREEN	
			DARK GRAY SHALE, MOIST			MANCOS	SAND PACK	BOTTOM PILOT HOLE ABANDONED BY BENTONITE AND CUTTINGS
120							PILOT HOLE	T.D. 105.0 FEET

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APPENDIX D

SOUTHWEST ALLUVIUM AQUIFER TEST RESULTS

APPENDIX D

SOUTHWEST ALLUVIUM AQUIFER TEST RESULTS

An aquifer test was conducted in the Southwest Alluvium by Canonie Environmental Services Corp. (Canonie) personnel from October 2, 1989 to October 6, 1989. The purpose of the test was to determine the operational parameters of the 800 series well system, based on the aquifer response to pumping. The results of the test show that the alluvium has a hydraulic conductivity of 2×10^{-2} centimeters per second (cm/sec), which is approximately one order of magnitude higher than the value used for the design, and that the walls of the alluvial valley behave as hydraulic boundaries.

The test results indicate that the system will need to be pumped at an initial rate of 27 gallon per minute (gpm), which is somewhat higher than the previously anticipated rate of 17 gpm. The higher rate is necessary due to the fact that the permeability measured in the recent test is higher than that which was used to design initial pumping rates. The boundary conditions that were encountered during the test also indicate that water level declines through time will be larger than predicted by theory; as a result it is anticipated that pumping rates will be reduced after several months.

Aquifer Parameters

The test consisted of pumping Well 802 for 48 hours at a constant rate of 15 gpm. Water level declines were observed at Wells 801, 803, 804, 805, 806, 807, 632, GW-1, GW-2, 30D, and 514AD shown on Figure D-1. The water level declines observed at Wells 632 and 804 were used to calculate aquifer properties. Table D.1 summarizes the calculated parameters.

The hydraulic conductivity values obtained from this test, shown on Table D.1, are reasonable for a clean sand (Freeze and Cherry, 1979), but are an order of magnitude higher than the value of 2.6×10^{-3} cm/sec used to predict pumping rates for design of the barrier well system. This result means that the barrier wells will need to be pumped at a rate that is higher than the design rate for an initial period of time to achieve

hydraulic barrier to flow. As discussed further below, the boundary effects of the valley walls will improve the barrier efficiency of the wells with time, counteracting the effects of the higher permeability.

Boundary Effects

The data collected from the test indicate the presence of a negative boundary (a wall, or physical limit, to the areal extent of the aquifer) in the vicinity of the test wells. A boundary of this type appears in the observation well data as water level declines, which are larger than those predicted by theory. Calculations of the boundary distance, based on the drawdown data, indicate that the southeast canyon wall is the boundary identified by the test.

Figure D-1 displays the boundary identified in the test. The strong hydraulic effects of this boundary will increase the water level declines, which will occur in response to pumping the barrier system, and enhance the effectiveness of the hydraulic barrier. The northwest canyon wall is also expected to produce boundary effects over the long-term operational period of the system. However, a boundary at the northwest wall was not identified during this test.

System Operation

The test results indicate that the system's operation must be adjusted to account for two hydraulic characteristics of the natural system. First, the higher permeability (2×10^{-2} cm/sec) will necessitate higher pumping rates to establish a barrier. Second, with time the boundary effects will compensate for the higher permeability, thereby limiting the length of time for which the higher rates will be necessary.

An analysis of well capture zones was conducted, utilizing the higher permeability and the anticipated boundary effects. Boundary effects were quantified by extrapolating the test data over a two-month period. This process indicates that drawdowns in the area of the system will be approximately 250 percent greater than predicted by theory.

The revised capture zones and their corresponding pumping rates are displayed on Figure D-1. As shown on this figure, the recommended initial pumping rates are as follows:

1. Well 801 - 2 gpm (as originally predicted);

2. Well 802 - 20 gpm (4 x originally predicted); and

3. Well 803 - 5 gpm (maximum pumpable rate).

As system operation continues the boundary conditions will become more pronounced, drawdown and radius of influence of each well will increase, and the effectiveness of the hydraulic barrier will increase. Therefore, after several months of operation, pumping rates can be reduced without resulting in the loss of the effect of the barrier.

Weekly water level measurements are recommended to be taken from Wells GW-1, GW-2, 514-AD, 632, 804, 805, 806, and 807 during the initial weeks of system operation. These data will verify the creation of the hydraulic barrier and allow prudent reductions in pumping rates.

TABLE D.1

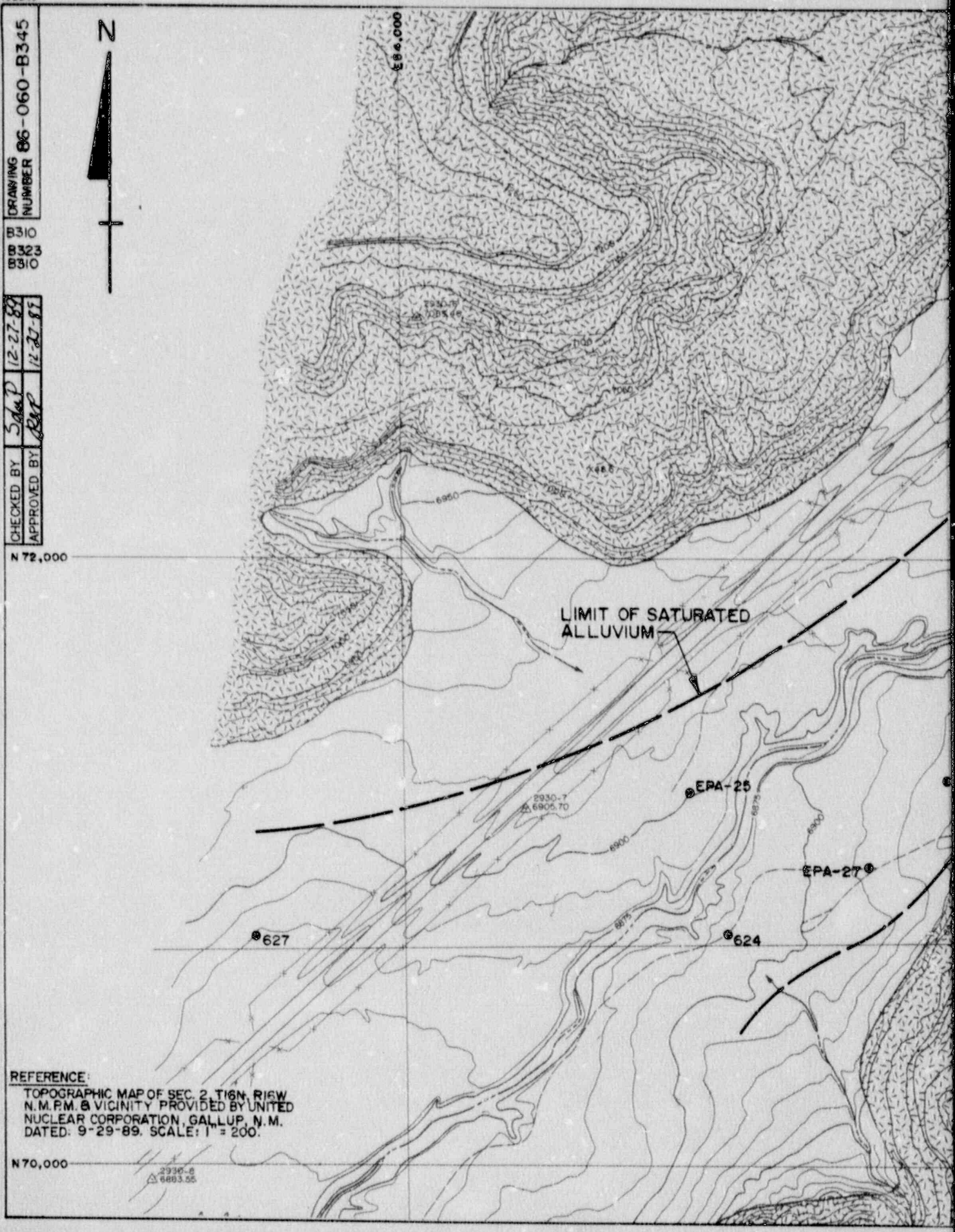
AQUIFER PARAMETERS CALCULATED FROM PUMPING TEST OF WELL 802

	Observed From Well 632	Observed From Well 804
Transmissivity	2,500 ft^2/day	4,300 ft^2/day
Hydraulic Conductivity (Horizontal)	1.8×10^{-2} cm/sec	2.9×10^{-2} cm/sec
Hydraulic Conductivity (Vertical)	1.0×10^{-2}	
Storativity		4.8×10^{-3}
Specific Yield	0.017	

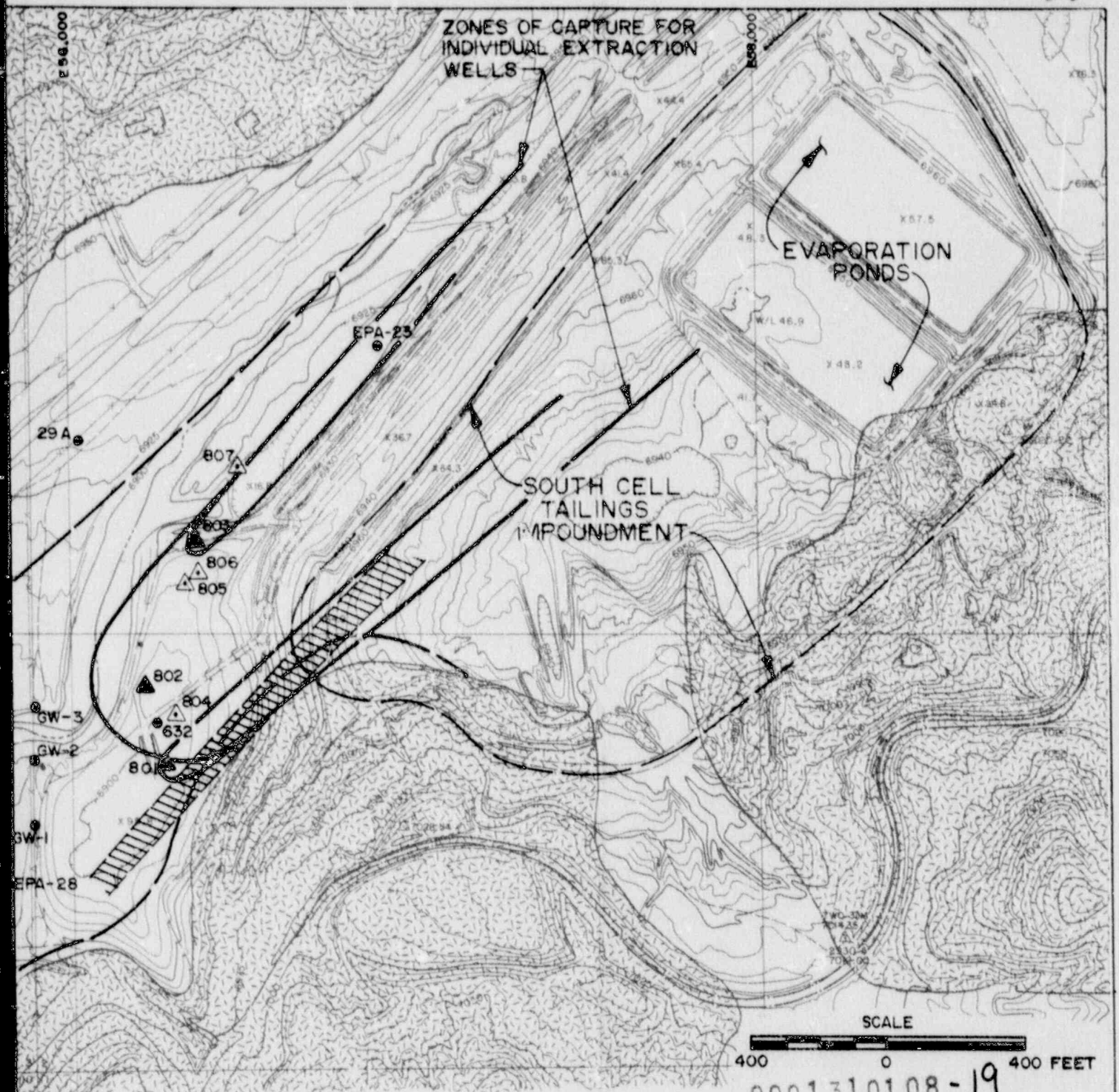
102340

86-060-B323
86-060-B310

DRAWING NUMBER 86-060-B345		
B310		
B323		
B310		
CHECKED BY	SAP	12-27-89
APPROVED BY	RKP	12-27-89



REFERENCE:
TOPOGRAPHIC MAP OF SEC. 2, T16N, R16W, N.M.P.M. & VICINITY PROVIDED BY UNITED NUCLEAR CORPORATION, GALLUP, N.M. DATED: 9-29-89. SCALE: 1" = 200'.



LEGEND:

- ●624 EXISTING MONITORING WELL
- ▲801 SOUTHWEST ALLUVIUM EXTRACTION WELL
- △804 SOUTHWEST ALLUVIUM OBSERVATION WELL
- BOUNDARY LOCATION IDENTIFIED IN TEST
- BEDROCK OUTCROP

WELL CAPTURE ZONES AND BOUNDARY LOCATIONS

PREPARED FOR

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DATE: 12-21-89	FIGURE D-1	DRAWING NUMBER 86-060-B345
SCALE: AS SHOWN		

86-060-B310
86-060-B323