Attachment 2 to
AECM-85/0035

HIGH GROUND-WATER LEVEL STUDY

GRAND GULF UNIT 1

Prepared for

MISSISSIPPI POWER AND LIGHT CO.

By

BECHTEL POWER CORPORATION

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GRAND GULF UNIT 1

1.0 INTRODUCTION

This report presents the results of a study performed for Mississippi Power and Light Company (MP&L) at the Grand Gulf Nuclear Station to determine the possible causes for exceeding the design ground-water level (elevation 109 feet) in Dewatering Well 8 (DW-8) from January to July, 1983. The well is a construction dewatering well located between the Unit 1 intake and discharge lines of the circulating water system in the Southeast corner of the power block (Figure 1). Water level measurements in DW-8 are taken by MP&L on a monthly basis.

The purpose of this study was to determine if the rise in water level in DW-8 above elevation 109 feet was due to naturally occurring causes such as; increased rainfall, infiltration, and ground-water inflow or to leakage from the circulating water pipes and the cooling tower basin. A secondary purpose of this study was to provide information for use in determining licensing impact. The scope of the study included a review of existing hydrogeologic and pertinent construction data, a site investigation to inspect and test DW-8 and the development of findings as to the cause of the water level rise.

2.0 BACKGROUND

The power block area and Stand-by Service Water (SSW) basins for Grand Gulf Units 1 and 2 were constructed within an open excavation that extends from yard grade at elevation 132.5 feet to the Catahoula Formation at about elevation 87 feet. The excavated area for the power block structures is supported by a soldier pile or tieback wall as shown on Figure 1.

Seepage of ground water into the excavation from the Terrace deposits overlying the Catahoula Formation and inflow of precipitation falling on the excavation was initially controlled by pumping from sumps. However, as construction proceeded, pumping from sumps became impractical due to construction interference. A construction dewatering system was installed in 1979 and 1980 in order to continue the removal of seepage from the excavation.

The construction dewatering system at Grand Gulf consists of eight 10-inch diameter wells located around the power block of Units 1 and 2. Four wells are located in the Unit 2 power block area, three wells in the Unit 1 power block area and one adjacent to the SSW basin which is common to both areas. The wells are located within the previously excavated area between the tieback wall and the structures as shown on Figure 1. The Unit 1 wells (DW-6, DW-7 and DW-8) and SSW basin well (DW-5) have not been operated since the completion and turnover of Unit 1 to MP&L in April, 1982. The Unit 2 wells are still operating. The wells remove ground water which migrates to the Unit 2 excavation area from flow through the Terrace deposits and permeable backfill. They provide a dry excavation for the placement of granular backfill in the Unit 2 area and remove water added to the backfill during placement (Reference 1).

Seven monitoring wells (MW-1 through MW-7) were installed around the power block in 1976 to replace the 11 construction observation wells destroyed during the start of construction in 1975. The monitoring wells are 6-inch diameter PVC pipe installed within the backfill (Figure 1).

Water levels in either construction observation wells, monitoring wells or construction dewatering wells in the power block area, except DW-2, have been measured at least monthly since 1973 with the exception of the periods from April 4, 1982 to September 24, 1982 and November 19, 1982 to January 28, 1983. During these periods only the Unit 2 wells were measured. DW-2 was not monitored due to its inaccessability in the open excavation for Unit 2. MW-1 and MW-2 are located near DW-2 and provide representative values of ground-water elevation in the area.

Historically, since the start of the power block excavation in 1974, the only water-level measurements which exceeded elevation 109 feet were recorded for MW-4 in September 1978 and January 1979. The cause of the high ground-water level was recharge to the sand backfill from ponded surface water at the monitoring well. As documented in the FSAR (Reference 1), upon correction of the drainage and repair of the well, the water level returned to elevations below 109 feet.

Since it was installed in July, 1980, water levels in DW-8 have typically been higher than those recorded in other dewatering and monitoring wells in the power block area.

Upon the completion of backfilling, to minimize infiltration and recharge, a two foot thick clay surface seal has been placed in the area between the tieback wall and the structures. The clay seal extends at least 8 feet out from the tieback wall except where interrupted by permanent roads, parking areas, and railroad tracks. The extent of installation of the clay seal is shown on Figure 2. Backfilling around Unit 2 has not been completed, therefore, the clay seal has not been placed in this area.

3.0 HYDROGEOLOGIC CONDITIONS

Construction dewatering well DW-8 is located in the southeast corner of the area previously excavated for the plant structures (Figure 1). The screened interval is within the granular backfill which was placed between the Radwaste Building and the east tieback wall. Water levels in DW-8 have fluctuated between elevation 103.75 and 110.21 feet MSL during the period from the initial reading in July, 1980 to present. The lowest reading reflects the effects of pumping (prior to the spring of 1982) while the well was operational. During the period September, 1982 through October, 1983 the water level has fluctuated between elevation 106.51 feet to 110.21 feet MSL (Reference 2).

The following are the permeabilities of the various materials in the power block area. Permeabilities ranging from 10^{-7} to 10^{-9} cm/sec were obtained from falling head tests in the Catahoula Formation (Reference 1 and 3). The compacted granular backfill has a calculated range of permeability from 10^{-1} to 10^{-3} cm/sec. The Terrace deposits have widely varying permeabilities depending on their silt and clay content. Permeability test results range from 2.8×10^{-1} to 1.0×10^{-4} cm/sec (Reference 1). The clay seal has a permeability of less than 10^{-5} cm/sec.

Figure 3 is a generalized cross-section showing the distribution of undisturbed and backfill materials around the Radwaste Building foundation, circulating water pipelines and the tieback wall. As shown, a portion of the tieback wall was removed and the excavation extended to the east for the installation of the outlet pipelines for Unit 1. Natural materials (Loess, Terrace deposits, and Catahoula Formation) exist outside and beneath the excavation area. The top of the Terrace deposits is at about elevation 110 feet and the lower contact with the Catahoula Formation is at about elevation 97 feet. Mapping of the tieback wall face, performed by Bechtel in 1974, indicated that the Terrace deposits in this area consist primarily of fine to medium grained sand overlain by hard, light gray clay and brown, silty clay. The exposure of the Catahoula Formation consists of hard, gray, weathered clay about 1-2 feet thick overlying green, silty clay.

A granular backfill compacted to 95 percent Modified Proctor was placed on top of the Terrace deposits, Catahoula Formation, and the circulating water pipelines between the east wall of the Radwaste Building and the eastern portion of the excavation. Various mechanical piping and a blowdown pipeline exist in the backfill on the eastern edge of the excavation.

4.0 PROGRAM DESCRIPTION

The determination of the cause for the water-level rise in the vicinity of DW-8 involved several steps:

1. The reference point elevation on the existing riser casing of DW-8 was verified. The reference point is the location on the top of the riser casing from which water level measurements are made.

2. A response test was performed on DW-8 to verify that the well screen was still open and that ground water could move freely into the well.

3. Monthly site rainfall data from the years 1981 and 1982 and daily rainfall measurements from November, 1982 through October, 1983 were obtained and reviewed to determine if a correlation with the water-level rise was apparent.

4. Dewatering and monitoring well hydrographs were reviewed to determine if similar changes in water level within the power block have occurred in the past.

5. Construction records of the clay seal installation were reviewed to determine the extent of the seal and the time of its placement.

6. Excavation drawings in the vicinity of the tieback wall and the circulating water pipelines were inspected to determine the depth and areal extent of the excavation.

7. Survey data obtained after site grading was completed in the yard area southeast of the power block were reviewed to see if low areas exist which could retain surface water.

8. Assuming a ground water rise, an analysis of the liquefaction potential of the backfill in the power block area was performed to determine the seismic margin available against liquefaction.

5.0 RESULTS OF INVESTIGATIONS

The DW-8 reference point elevation which is used to calculate water-level elevation was checked by MP&L and found to be accurate. The verified elevation is 134.31 feet.

A falling head response test was run in well DW-8 on October 14, 1983. About 35 gallons of water were poured into the well over a period of 3 minutes. A decline in water level of 0.79 feet was recorded in 23 minutes. Four minutes following the addition of the water to the well the water level was only 0.95 feet above the initial static level, indicating the injected water moved into the backfill. Thus, the well is open to the backfill and ground water can move freely through the screen.

The precipitation records for Grand Gulf Nuclear Station for the period November, 1982 through October, 1983 were compared with the long-term mean precipitation at Jackson, Mississippi. This period includes the seven months (January through July, 1983) in which the ground water level exceeded elevation 109 feet MSL. The comparison was made to establish the departure of the precipitation record at the site from the long-term mean (1909-1981) at Jackson, Mississippi. The comparison is shown on Table 1.

As indicated on the table, the precipitation for November, 1982 through October 24, 1983 at the site was above average by about 27 inches or slightly greater than 150 percent of the total long term average at Jackson. The precipitation for the seven month period (December 1982 to June 1983) was 69.81 inches as compared to the long term mean for that period of 34.52 inches, i.e., about 36 inches more than the mean. This above average precipitation increased the amount of water available for infiltration to the water table for the seven month period.

A review of the water level records for the plant site and vicinity reflect the increase in rainfall and resulting infiltration. An increase of four to five feet in water levels measured in wells on the Unit 1 side of the power block was common from January through June, 1983 (Figure 5). With two exceptions the rise is not reflected in Unit 2 observation wells. Levels in the Unit 2 area were controlled by operations of the dewatering wells in response to rising water levels. The exceptions are DW-1 and MW-7 which are located on the east side of the Unit 2 excavation. Due to operational problems with the pump in DW-1 it was pumped only on an intermittant basis from February through June, 1983. The water level elevation in DW-1 averaged about 88 feet prior to February 10, 1983. From February through the end of June, 1983, recorded levels reached as high as 104.8 feet, an increase of almost 17 feet. Since July, 1983, after modification of the pumping system, water levels in DW-1 have averaged between 97 and 98 feet. Hydrographs for several of the dewatering wells and monitoring wells are presented on Figure 5.

Based on the review of water levels obtained in the dewatering and monitoring wells, the ground-water gradient across the power block is from south to north in response to continued operation of the Unit 2 dewatering system. The wells in the Unit 2 power block form a hydrologic sink for subsurface flow. It is possible that ground water in the backfill forms a mound due to constriction between the structures and the tieback wall during periods of higher than normal recharge such as may occur from heavy precipitation.

The water level rise of four feet in Unit 1 wells MW-6 and DW-7 during the same period as the rise in DW-8 is probably due to response to the abnormally high precipitation experienced during the seven month period. Recharge of the backfill in this area is from infiltration through the more permeable lenses in the Terrace deposits.

The review of construction records indicated that the clay seal was placed around the Unit 1 power block area and the essential service water basins. Installation was completed in April, 1982. The present extent of the clay seal is shown on Figure 2. The purpose of the clay seal is to prevent the in filtration of runoff into the highly permeable backfill between the structures and the tieback wall. This feature, along with the structures, extensive paved areas, and a grading plan which directs runoff away from the structures, is expected to provide a reduction in infiltration upon completion of the plant. The clay is to be covered with six inches of topsoil and sod to prevent dessication of the clay (Reference 1).

The yard area south and east of DW-8 has no permanent structures or clay seal. The area includes the excavation for the four 10 foot diameter circulating water pipelines between the Unit 1 pump house and the Unit 1 cooling tower. The excavation for the inlet and discharge lines extends about 70 feet eastward of the tieback wall. Backfill for the circulating water pipeline consists of a clean granular material compacted to 90 percent Modified Proctor. The clay seal only covers the portion of the excavation within the tieback wall (Figure 3). The excavation south of the Radwaste Building is about 500 feet long and 155 feet wide (Figure 4). Depth of the excavation is 22 feet below present grade or at elevation 110.5 feet (Figure 3).

The area east of the Radwaste Building and DW-8 is presently a laydown area with a gravel surface. The remainder of the area south of the Radwaste Building is sodded except where crossed by roadways. These areas south and east of the main power block excavation allow for the infiltration of precipitation and are the likely source of recharge to the granular backfill.

Based on site elevation surveys performed in 1982, two areas south of the Radwaste Building and east of the Low Volume Waste Water Basin are lower than the surrounding roads, thus they are capable of surface water retention. One low area is located about 100 feet eastward from the Low Volume Waste Water Basin to the north-south road from the cooling tower to the power block and the other is east of that road about 110 feet. The crown of the roadway is elevated above the surrounding area and the Low Volume Waste Water Basin forms an obstruction to natural overland flow of surface runoff to the southwest away from the power block. Both areas are terminated on the north by an east-west elevated road and on the south by grading around the Low Volume Waste Water Basin.

Excavation through the clay seal has been required at various times for repair of facilities or the addition or modification of some plant systems. At least two such areas were identified by MP&L in the vicinity of DW-7. Each of these excavations are potential zones for infiltration.

In summary, the high ground-water level experienced in DW-8 can probably be attributed to excessive precipitation at the site and subsequent infiltration and migration of ground water through the granular backfill around the circulating water pipeline in areas not covered by the clay seal. Local ponding of water due to the presence of buildings, roadways, railroad lines and the Low Level Waste Water basin also contributes to the total infiltration.

6.0 LICENSING IMPLICATIONS

Prior to the start of construction, a ground-water elevation as high as 113 feet was recorded in the power block area. The design maximum ground water level was selected early in the design stage based on the assumption that, following plant completion, ground-water levels in the perched water zone would not return to pre-construction levels due to the presence of structures, the clay seal, extensive paved areas and site grading. However, the design maximum ground-water level was exceeded in the power block area in DW-8 during the period January through July, 1983.

While water levels are not expected to return to pre-construction levels following plant completion, at the present time both units of the plant are not completed. Unit 1 is complete and the clay seal installed. Unit 2 is still under construction and the excavation is open and being dewatered, therefore normal ground-water gradients are disrupted. For licensing purposes, while Unit 1 may be completed, from a ground-water standpoint the site is not complete.

The frequency of the extreme precipitation recorded for the period December to June (seven months) was analyzed for Jackson, Mississippi for the period 1943 to 1981 to establish the frequency of the site precipitation (69.81 inches). Based on this analysis the seven months precipitation of 1982-1983 has a frequency of about 1 in 200 years.

Control of the surface water flow south of the power block and extension of the clay seal over the circulating water lines will reduce the area available for infiltration of precipitation into the backfill. This will result in lower ground-water levels.

An estimate of post-construction ground-water levels and gradient around the power block may be determined by stopping the pumping of the Unit 2 wells and allowing water levels to reach equilibrium. It is estimated that at least one week would be required to establish an equilibrium condition around the power block. To perform this test, all penetrations in the Unit 2 side of the power block below elevation 115 feet would have to be sealed.

An alternate method to satisfy licensing concerns about exceeding the design ground water elevation involves checking the stresses on the building walls if ground water rises to a higher elevation than 109 feet.

As an initial step in performing this analysis, the seismic margin available against liquefaction of the backfill under higher ground-water conditions was analyzed. The Category I structural backfill was determined to be stable and have an adequate factor of safety to at least elevation 117 feet.

7.0 CONCLUSIONS

1. A resurvey of the casing elevation and response tests performed in DW-8 indicates that water levels recorded in the well are accurate.

2. Rainfall in the plant area for the seven month period (December, 1982 through June, 1983) was over 200 percent of normal.

3. The power block excavation for Units 1 and 2 forms a collection basin for migrating ground water. The anticipated post-construction reduction in ground-water inflow has not been realized due to the open excavation around Unit 2, incomplete site grading, the use of yard areas for laydown and temporary facilities, and the ponding of surface flow due to obstructions.

4. A clay seal has been installed around the Unit 1 power block and stand-by service water basins.

5. A source of ground-water flow to DW-8 is from infiltration through the backfill in the circulating water line excavation which extends from the Unit 1 cooling tower to the pump house. The area outside of the boundaries of the tieback wall is not capped with a clay seal.

6. Water levels in adjacent dewatering and monitoring wells in the Unit 1 area increased four to five feet during the same period that the design ground-water level was exceeded in DW-8. This indicates that

the probable cause of higher than normal ground-water levels in DW-8 is increased infiltration from natural causes as opposed to seepage from buried pipelines or water impoundment facilities.

7. An analysis was performed to determine the liquefaction potential within the backfill under a rising ground-water condition. The backfill was determined to have an adequate factor of safety for a ground water rise to at least elevation 117 feet.

8.0 REFERENCES

1. Mississippi Power and Light, Grand Gulf Nuclear Station Units 1 and 2 Final Safety Analysis Report, Vol. 2.

2. Water level records for site wells, years 1982 and 1983.

3. Bechtel Power Corporation, 1974, "Site Hydrogeologic Conditions Report, Grand Gulf Nuclear Station."

TABLE 1

PRECIPITATION MEASUREMENT

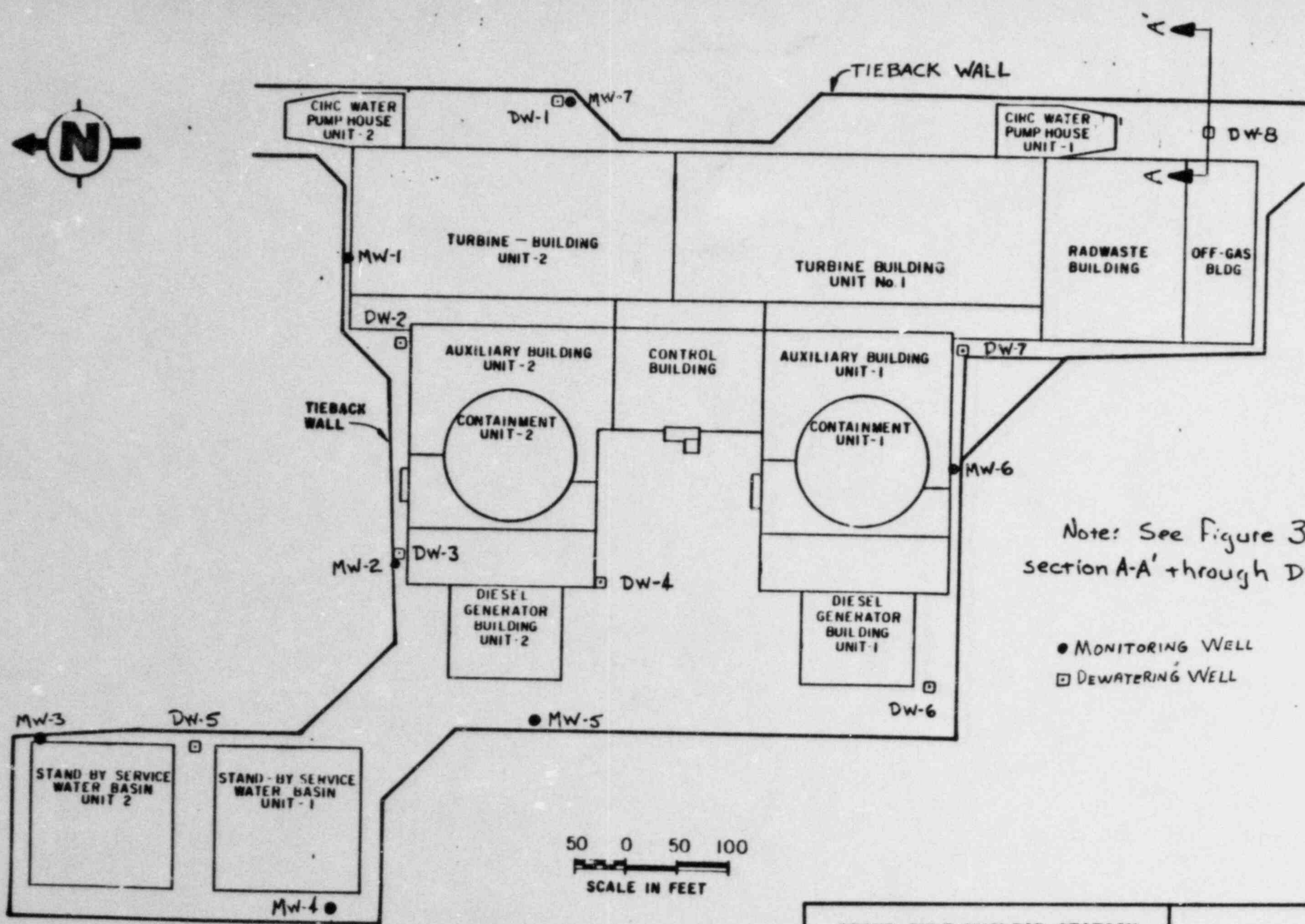
GRAND GULF AND JACKSON, MISSISSIPPI

PERIOD	OBSERVED AT SITE YEAR 1982-1983(1) INCHES	LONG-TERM MEAN(2) INCHES
November	2.77	3.80
December	16.21	5.47
January	1.51	4.97
February	6.58	4.69
March	6.56	5.67
April	14.36	5.39
May	14.31	4.59
June	10.28	3.74
July	2.10	4.59
August	2.17	3.59
September	1.29	2.87
October	0.71*	2.33
TOTAL	78.85	51.70

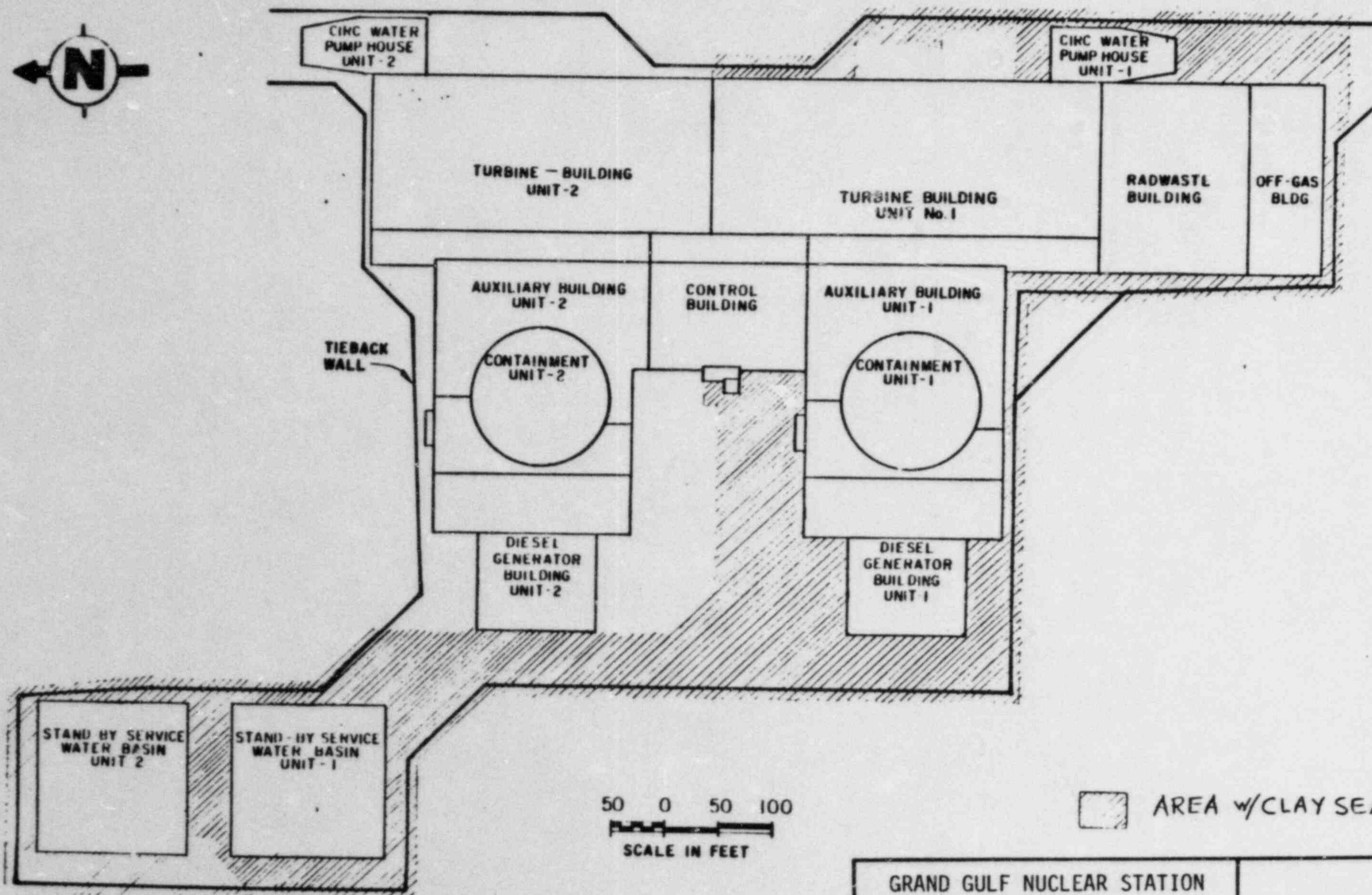
* Up to October 24, 1983.

(1) Rainfall measurements from Met Tower at Grand Gulf.

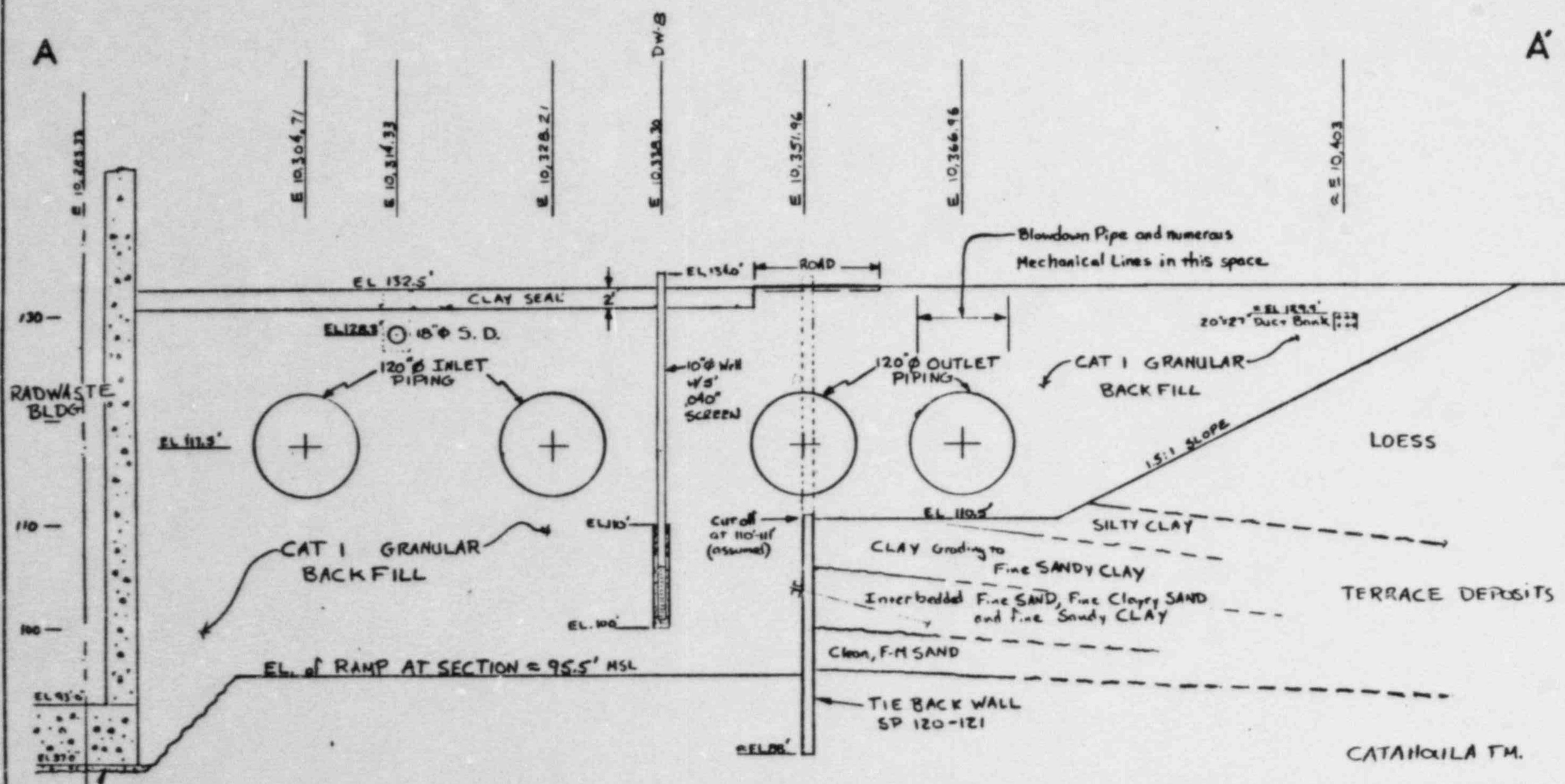
(2) U.S. Weather Bureau Station Jackson, Mississippi for 1909-1981.



GRAND GULF NUCLEAR STATION	
LOCATION OF MONITORING AND DEWATERING WELLS	FIGURE 1



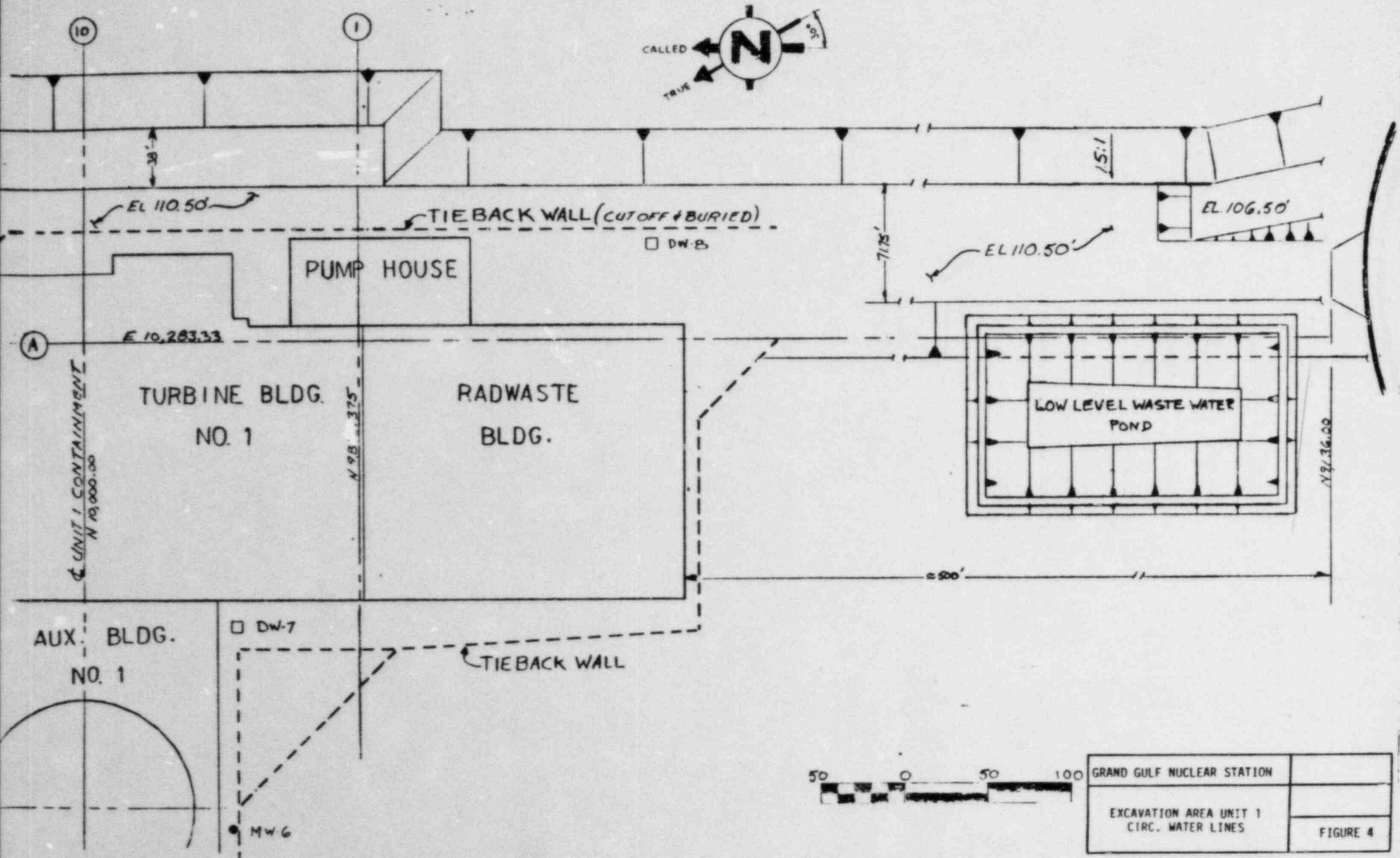
GRAND GULF NUCLEAR STATION	
AREA COVERED BY CLAY SEAL	FIGURE 2

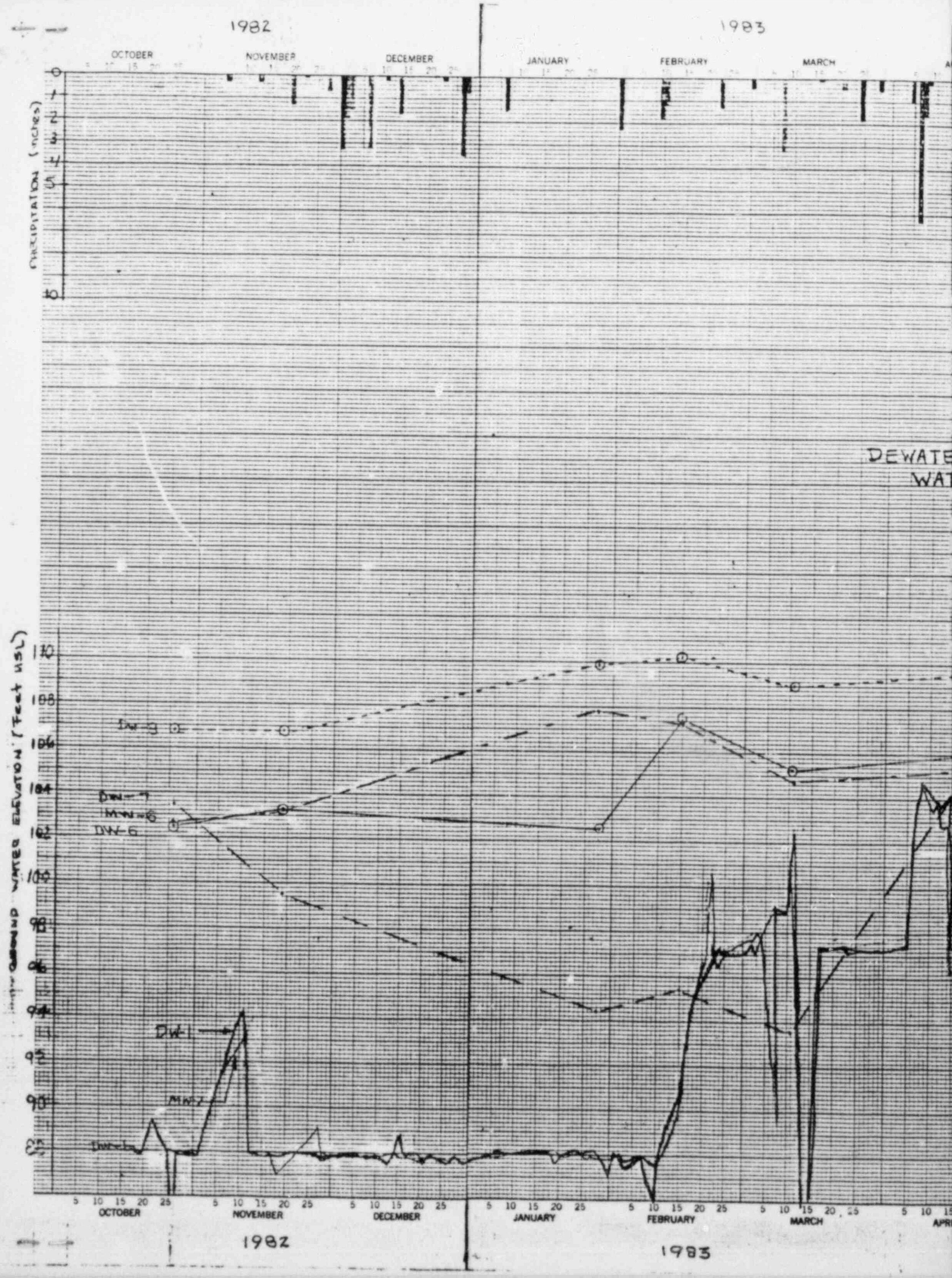


SECTION A-A' THROUGH DW-8
(looking North)

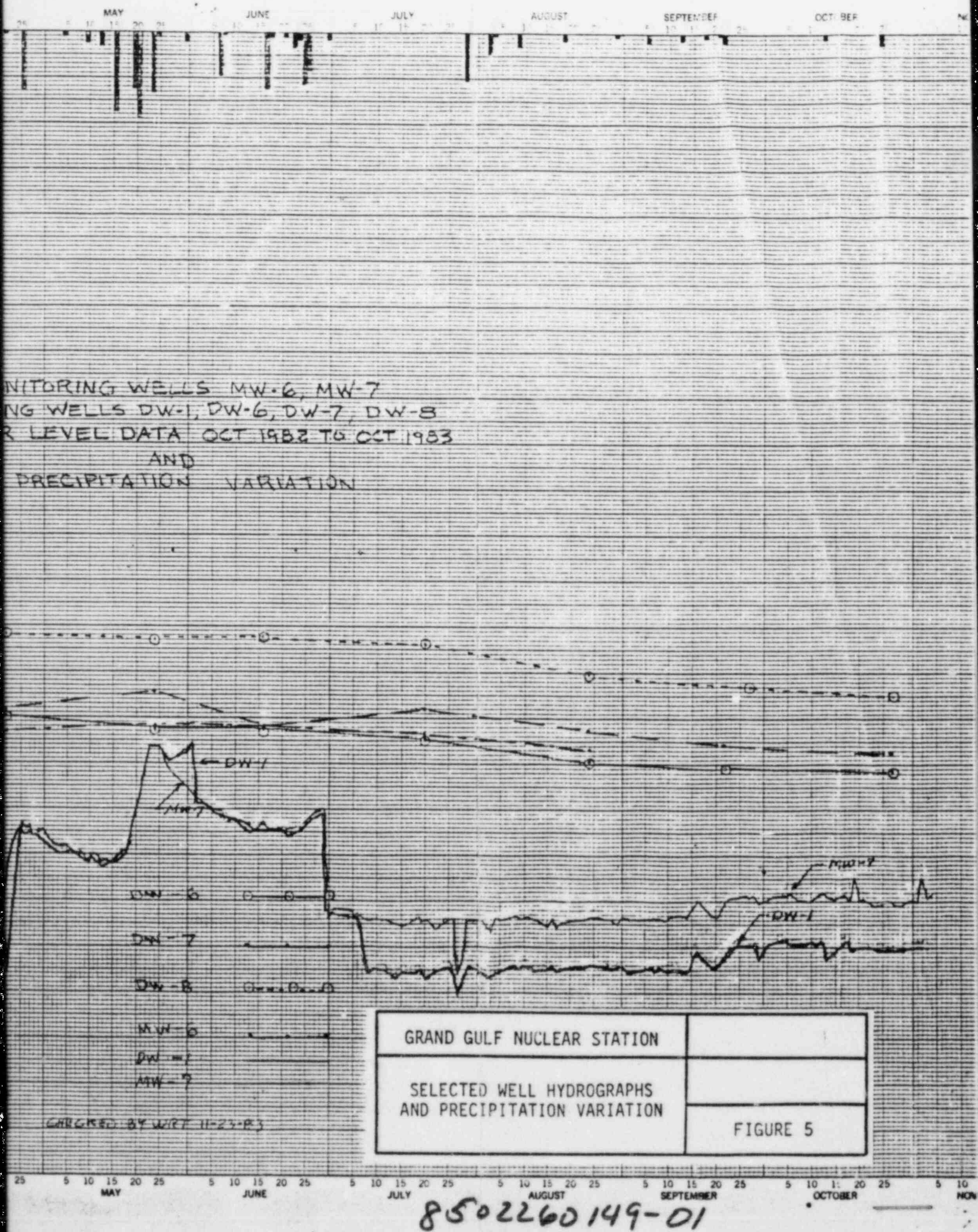
Note: For location of section see Figure 1.

GRAND GULF NUCLEAR STATION	
SECTION A-A' THROUGH DW-8	FIGURE 3


10
1
CALLED
TRUE
N
30°
38'
15:1
EL 110.50'
TIEBACK WALL (CUT OFF & BURIED)
EL 106.50'
DW-8
PUMP HOUSE
71.75'
EL 110.50'
A
E 10,283.33
TURBINE BLDG.
NO. 1
RADWASTE
BLDG.
LOW LEVEL WASTE WATER
POND
℄ UNIT 1 CONTAINMENT
N 10,000.00
N 98...375
N 9,136.00
≈500'
AUX. BLDG.
NO. 1
DW-7
TIEBACK WALL
MW-6
50
0
50
100
GRAND GULF NUCLEAR STATION
EXCAVATION AREA UNIT 1
CIRC. WATER LINES
FIGURE 4



1982
1983
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
PRECIPITATION (inches)
DEWATE
WAT
GROUND WATER ELEVATION (Feet MSL)
DW-3
DW-7
MW-6
DW-6
DW-1
MW-7



GRAND GULF NUCLEAR STATION

SELECTED WELL HYDROGRAPHS AND PRECIPITATION VARIATION

FIGURE 5

8502260149-01