VIRGINIA ELECTRIC AND POWER COMPANY

RICHMOND, VIRGINIA 23261

December 10, 1996

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

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MPW/ETS R1
Docket Nos. 50-338, 339
License Nos. NPF-4, 7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
SERVICE WATER GROUNDWATER SPECIAL REPORT

A Special Report is being submitted in accordance with the North Anna Technical Specifications Section 6.9.2. The report is required because the groundwater levels specified for the service water reservoir have exceeded the current maximum water level in the Technical Specifications. An engineering evaluation has been performed to determine the cause of the high ground water and the influence on the stability of the service water reservoir dike. The results of this study are provided in Attachment 1.

The increase in groundwater level observed by piezometers is slight and not due to any single identifiable condition. Furthermore, the increased water level does not indicate a significant reduction in the stability of the service water reservoir dike. However, the piezometers along the southeast portion of the dike will be monitored on an increased frequency (quarterly basis) for a year to better determine any trend in the water levels. Additional standpipe piezometers will be installed at the toe of the slope of the dike along the southeast section to provide further information relative to groundwater conditions in the area of the two existing piezometers (P-21 and P-22).

This Special Report has been reviewed by the Station Nuclear Safety and Operating Committee. Should you have any questions regarding this report, please contact us.

Very truly yours,

James P. O'Hanlon

James P. O'Hanlon
Senior Vice President - Nuclear

1/1
A065

Attachment

cc: U. S. Nuclear Regulatory Commission
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Mr. R. D. McWhorter
NRC Senior Resident Inspector
North Anna Power Station

ATTACHMENT 1

SERVICE WATER GROUNDWATER
LEVEL EVALUATION

90 DAY REPORT

SERVICE WATER RESERVOIR GROUNDWATER LEVEL EVALUATION

NORTH ANNA POWER STATION

NP-3141

Prepared By

CIVIL ENGINEERING

DESIGN ENGINEERING & SUPPORT
NUCLEAR ENGINEERING SERVICES
VIRGINIA POWER

ᶠ ecember 1996

QA CATEGORY: SAFETY RELATED

1.0 INTRODUCTION

North Anna Technical Specification 3/4.7.13, "Groundwater Level - Service Water Reservoir," (Ref. 1) requires that a special report be submitted to the NRC within 90 days from the time the groundwater levels exceed the levels contained in Table 3.7-6 of the Technical Specification. If the water levels exceed the allowable levels, "an engineering evaluation shall be performed by a Licensed Civil Engineer to determine the cause of the high groundwater and the influence on the stability of the service water reservoir and pumphouse." (Ref. 1) The current version of Technical Specification 3/4.7.13 is contained in Appendix A.

The water level at piezometer P-22 exceeded the allowable limit on September 13, 1996 as determined during performance of the surveillance for Technical Specification 4.7.13.1 implemented by procedure 0-PT-75.7, "Service Water Reservoir - Groundwater Level", (Ref. 2). This PT is presently being performed on a monthly frequency rather than the six month frequency required by the Technical Specification due to a recommendation contained in an engineering report dated March, 1996 (Ref. 3). The recommendation for more frequent readings resulted from an apparent increased water level in piezometers over the past several years as indicated by previous periodic tests.

2.0 BACKGROUND INFORMATION

2.1 Piezometers

Pneumatic piezometers P-1 through P-9 were installed in trenches during construction of the Service Water Reservoir (SWR) embankment in 1972. By late 1977, it was apparent that expected high groundwater levels were below the piezometer tips, therefore reading of the piezometers was not possible and was discontinued (Ref. 4). Pneumatic piezometers P-10 through P-18 were then installed in boreholes after construction of the dike was completed. Piezometers

P-13 and P-14 were installed near the Service Water Pump House (SWPH) specifically to monitor the water levels during well pump tests which were conducted in August 1976 to provide design parameters for groundwater control beneath the SWPH. Monitoring of some of these pneumatic piezometers began as early as 1975. As expected with this type of device, monitoring continued for a number of years until most became inoperative. The location of all the piezometers in the SWR, operative and inoperative, are shown on Figure 1.

The anticipated piezometric elevations for piezometers P-1 through P-18 prior to installation of the horizontal drains were contained in the Geotechnical Instrumentation Manual dated April, 1977 (Ref. 5). An excerpt from this manual entitled "Table 5, Piezometers Around Service Water Reservoir" is included in Appendix B. The allowable groundwater levels given in the Technical Specifications differ from those contained in Table 5 of the Geotechnical Instrumentation Manual (Manual). The Manual shows the anticipated groundwater levels along the southeastern section of the dike to be significantly higher than those listed in the Technical Specifications. P-22, which replaced P-17, is located in the southeast section of the SWR dike (see Figure 1). The anticipated levels shown in Table 5 of the Manual for the piezometers located in the crest of the southeast section of the dike are 26 ft. higher (at el. 306 ft.) than the allowable levels listed in the Technical Specifications. For piezometers located near the Service Water Pumphouse (SWPH), the anticipated groundwater levels specified in the Manual and allowable groundwater level specified by the Technical Specification are very close. The basis for the Technical Specification note that the "Groundwater threshold levels have been established based on historical groundwater data available in 1977." Apparently little consideration was given to a possible future rise in the groundwater table due to long-term seepage from the reservoir and a general progressive rise in the local groundwater level due to the presence of the lake.

At the request of the NRC, six horizontal drains were installed beneath the Service Water Pumphouse (SWPH) in July through August of 1977 to lower the water level to el. 275 ft. under the pumphouse. As stated in the UFSAR,"The purpose of this system as outlined by the NRC, was to minimize or avoid additional settlement and/or loss of stability that might be caused by increases in groundwater levels due to seepage from the reservoir"(Ref. 6). Pneumatic piezometer P-14 which operated from 1976 to 1993, was installed on a slant so that the tip was directly under the Service Water Pumphouse (SWPH) and it could monitor the effects of the horizontal drains on lowering of the groundwater level. The effect of the drains on the water level beneath the SWPH can be seen on a graph of the water level obtained from monitoring piezometer P-14 which is contained in Appendix C.

Presently only pneumatic piezometers P-10 and P-11 of the original P-10 through P-18, are currently monitored as per 0-PT-75.7 (Ref. 2). P-11 reads zero due to the water table being below the tip, but is still monitored since observing water levels above the tip could be an indicator of an increased groundwater level. Four open standpipe piezometers, P-19, P-20, P-21 and P-22, were installed in late 1990 to replace the original pneumatic piezometers which had become inoperable and to provide coverage for the SWR. In 1993, two additional open standpipe piezometers, P-14 (new) and P-18 (new), were installed to provide redundancy to two areas of the dike and to replace the original pneumatic piezometers which were failing (see Figure 1).

Technical Specification 3/4.7.13 was also changed in 1992 to reflect the addition of the new piezometers. The Technical Specification requires that the groundwater level within the dike be monitored in each of the three zones to verify that the groundwater level does not exceed values established in Table 3.7-6 of the Technical Specification. The allowable water levels listed in Table 3.7-6 for the new piezometers were the same as those for the pneumatic piezometers

they replaced. This version of the Technical Specification is contained in Appendix A.

2.2 Groundwater Information

Original plant boring B-46, drilled in what is now the center of the SWR and boring B-44 which was drilled southeast of the SE segment of the SWR dike and P-10, showed water levels at el. 291 ft. and el. 263 ft. respectively. Boring B-48 which was drilled approximately 100 ft. north of the current location of P-22 encountered water at el. 278 ft. (Ref. 7). These borings were drilled in September 1968, prior to construction or filling of the SWR or Lake Anna. The location of the original 1968 borings are shown on Figure 1. The recorded water level at the time the borings were made are shown beside the boring symbol. Rock was encountered at elevations 240 ft. (B-46) and 200 ft. (B-44) and 219 ft. (B-48) respectively. Test boring D-2, drilled in April of 1994 and located approximately 1200 ft. (1/4 mile ±) west of the SWR encountered groundwater at elevation 306 ft. and rock at el. 255 ft. (Ref. 8). The groundwater level generally mirrors the rock contours. The rock contours and groundwater gradient in the vicinity for the SWR slope to the east-southeast towards the discharge canal.

A statement contained in Appendix 3E of UFSAR states, "When the phreatic surface (at the SWR) is fully developed under operation conditions, the water surface is expected to be approximately at el. 287-290 under the dike at both sections [the southeast section and a section near the SWPH]..., an increase of less than 10 ft." (Ref. 9). These water levels are significantly higher than the maximum allowable water levels of el. 280 ft. contained in the Technical Specification for the southeast section of the dike.

2.3 Results of Current Piezometer Monitoring

Currently piezometers P-10, P-11, P-14, P-18, P-19, P-20, P-21, and P-22 are being monitored. A graphic plot of the results of monitoring of these and various other piezometers with time are contained in Appendix C. Standpipe piezometer P-22, has only been in service since 1991. P-22 is located near and was designed to replace P-17, a pneumatic piezometer, which operated from 1976 to 1985. A plot of water levels obtained from P-17 and later P-22 are presented on a combined graph also contained in Appendix C.

Table 1 provides the Technical Specification allowable groundwater elevation, and the maximum recorded elevation and date. As shown in Table 1 and graphs contained in Appendix C, all operative piezometers except P-11 are near or at historical highs.

TABLE 1

Piezometer No.	Allowable Groundwater El. (Ft.)	Max Recorded Groundwater El. (Date)
P-10	277[1]	276.56 (9-96)
P-11	280	282.0 (Original 10/75 Reading)[2]
P-14 (New)[3]	280	274.36 (9-96)
P-18 (New)[3]	295	291.6 (10/96)
P-19	295	290.58 (10/96)
P-20	280	277.36 (10/96)
P-21	280	263.51 (10/96)
P-22	280	280.31 (9/96)

Notes: 1. P-10 is located at the toe of the slope, approximately 40 ft. below the crest of the dike whether all of the other piezometers listed are located.

2. Groundwater levels lowered due to proximity of horizontal drains. Groundwater level lowered below the piezometer tip (el. 275.4 ft.) in 1977.

3. Installed in 1993.

The recent water level in P-22 (280.3 ft.) which has exceeded the Technical Specification level of 280 ft., is 16.6 ft. higher than the level in P-21 (263.7 ft.) which is 400 feet northeast of P-22 (see Figure 1). They are both located along the southeast quadrant of the dike, which is the highest section of the dike. Although the elevation at the toe of the slope near P-22 and P-21 are approximately the same, the area just west of the toe at P-22 is relatively high whereas the area south of the toe at P-21 drops off sharply. This may explain the difference in the water levels between P-22 and P-21.

3.0 DISCUSSION

Several separate conditions are occurring in concert to cause the water in most piezometers to rise to or near historical highs. First, it is reasonable to expect groundwater levels to fluctuate with the seasons, and extended periods of wet and dry weather. With a given rainfall, groundwater levels may be higher in the winter and early spring due to lack of vegetation and reduced drying due to shorter days, and colder temperatures. Evapotranspiration is lower under these conditions. Usually in the summer little recharge occurs. Other conditions which could influence groundwater levels are discussed in the sections below

3.1 Rainfall

An attempt was made to correlate rainfall quantity and groundwater levels in the piezometers. The rainfall data was obtained daily or monthly and the piezometric levels represent a "snapshot" of the water levels once a month or twice yearly depending on monitoring frequency. It is difficult to identify discernable correlations between rainfall and a rise or lowering of water levels in the piezometers. However, there has been an above average rainfall so far in 1996 which may have contributed to a general overall increase in piezometer levels. Through September of this year the total rainfall at North Anna has been 34.9

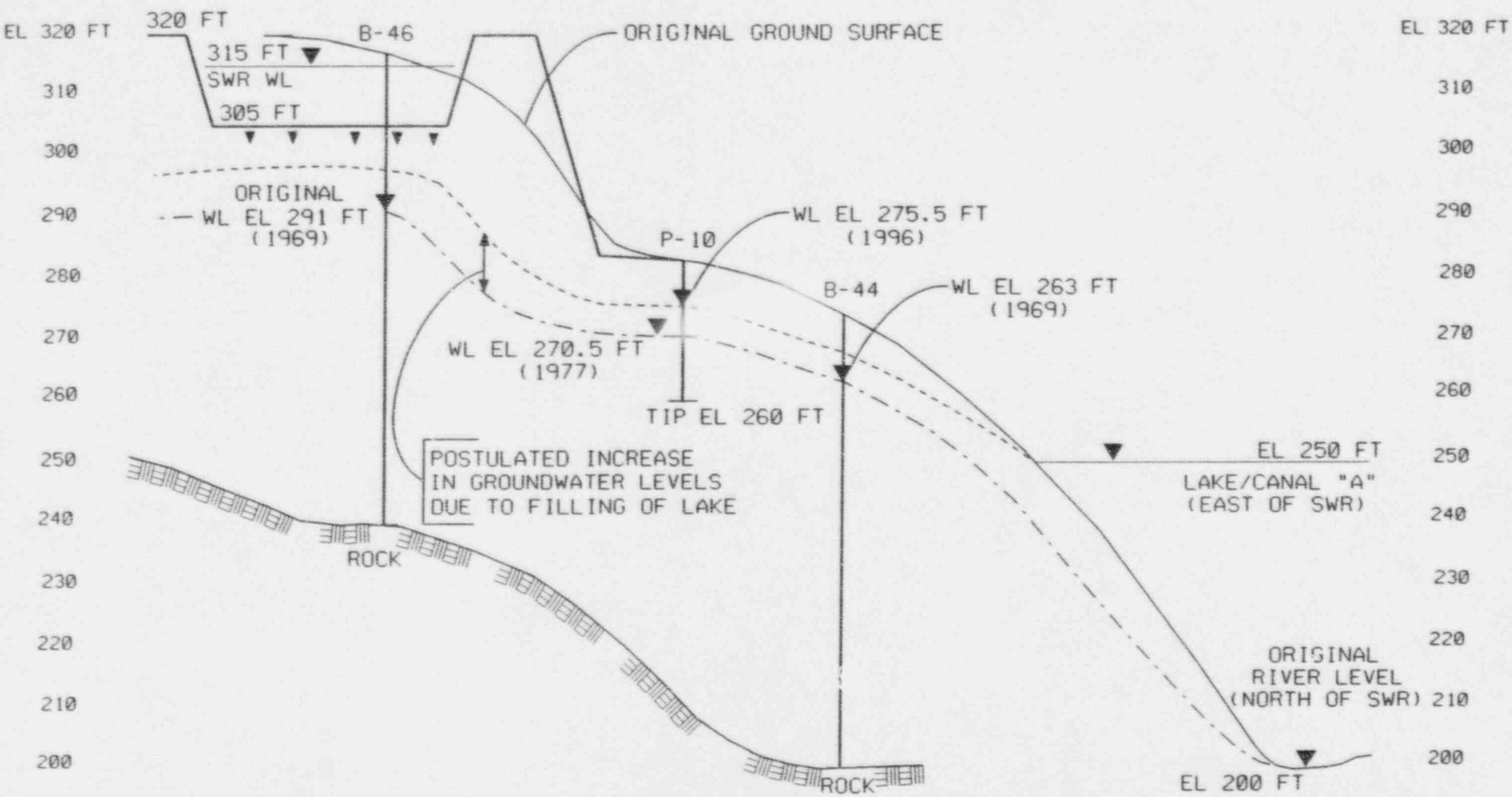
inches, which is 11.3 inches more than the corresponding average from 1978 to 1996 (19 years). The rainfall through September this year is the highest for the first nine months of any year since 1978; 48% higher than the 19 year average. Table 2 provides the average rainfall for July, August and September for 1978 through 1996, recorded rainfall for each of those months in 1996, and the departure from the average. The unusually high rainfall may have contributed to a general increase in groundwater levels although it is probably a minor contributor.

TABLE 2

Month	Monthly Rainfall (Inches)		
	19 Year Average	1996	Departure From Avg.
July	3.6	8.4	+4.8
August	2.9	3.0	+0.1
September	2.3	6.6	+ 4.3

3.2 Increase in Local Groundwater Levels

The groundwater level over the entire area adjacent to the lake is higher than it was prior to filling the lake. Prior to filling of the lake, the North Anna River was the main body of water in the area and the groundwater drained to the river level which was approximately el. 200 ft. The lake is currently maintained at el. 250 ft. thereby gradually increasing the groundwater table in the immediate vicinity of the lake approximately 50 ft. over time. This increase is shown schematically in Sketch 1 which utilizes information from the original borings and current water levels to illustrate the condition. The original water level as depicted in Sketch 1 could exit on the slope as with a spring or dip to the river level. A reduction in the gradient, or the difference in head of water over length, to the discharge canal



SKETCH 1

SECTION OF SERVICE WATER RESERVOIR
AND LAKE WATER LEVEL - SCHEMATIC
NOT TO SCALE

would result in less water being discharged from the area near the SWR towards the lake and more water build-up under the SWR. The location of the discharge canal which is a part of the lake and the SWR are shown on Figure 2.

3.3 Recharge from SWR

The SWR also acts as a recharge basin. The reservoir was constructed in a relatively high area above the plant on partially saturated residual soil having a low permeability. The reservoir is lined by two feet of a practically impermeable soil liner. There is a slow seepage of water out of the SWR which percolates down through the partially saturated residual soil to the groundwater table. The original groundwater table was 15 to 25 ft. below the bottom of the SWR (See Sketch 1 and Borings 46 and 48). The SWR recharges the natural groundwater in the area through seepage, although this recharge is very slow due to the low permeability of the soils and the relative low volume of the seepage from the SWR. If the recharge is occurring at a faster rate than the horizontal groundwater movement away from the reservoir, "a mound" in the groundwater table the SWR is created. Estimates of recharge vs. horizontal flow indicate the recharge rate to be greater than the rate of horizontal groundwater movement. A schematic of this phenomena as presented in Sketch 2.

It is also reasonable to expect that the mound or saturation will increase toward the southeast in future years. This could cause water levels in the piezometers along the southeast segment of the dike to show a greater increase in water levels than piezometers on the northeast or up gradient side as is apparently the case.

3.4 Additive Conditions

If these conditions exist and are additive, it explains the gradual increase in monitored water levels especially along the southeast segment of the dike.

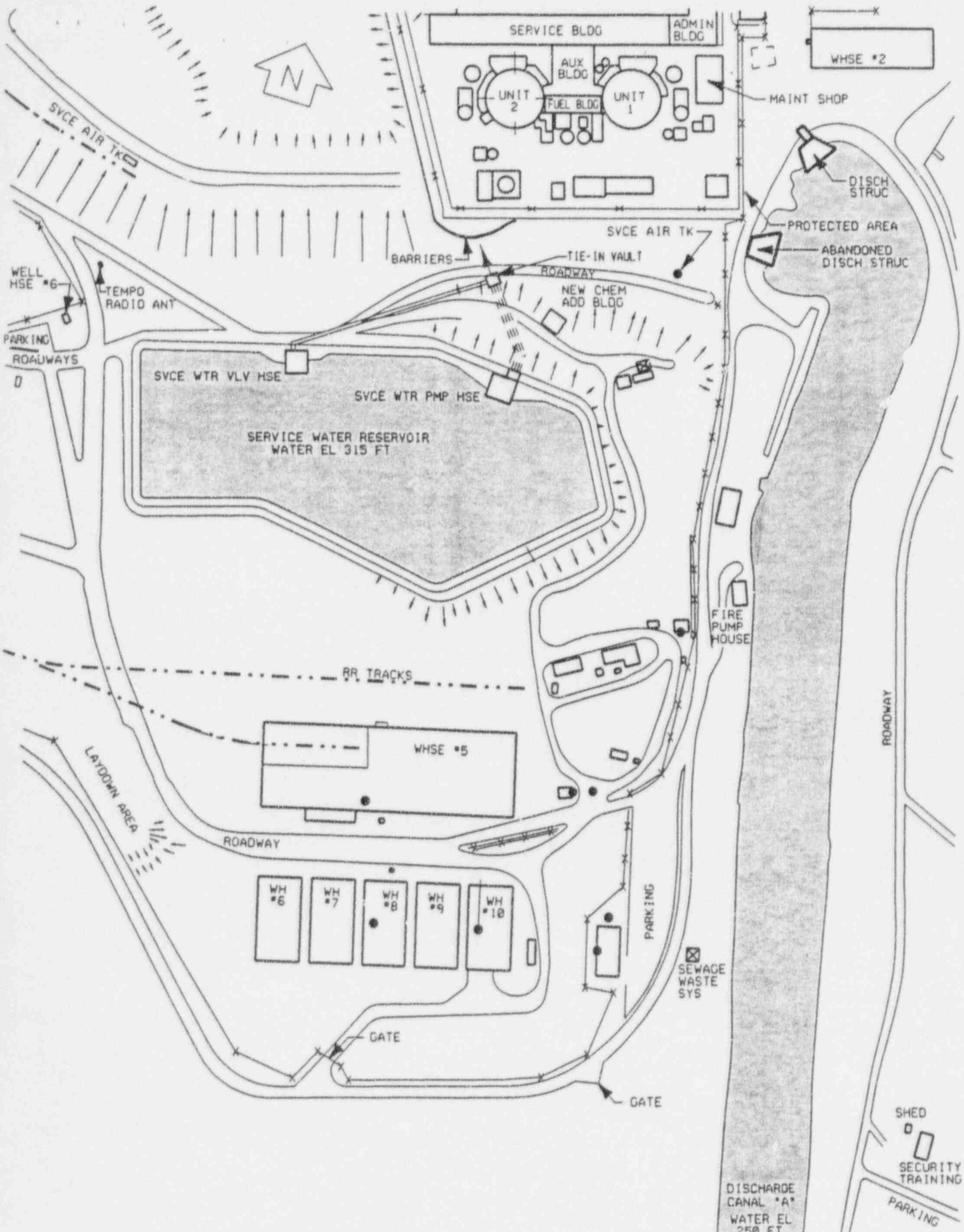
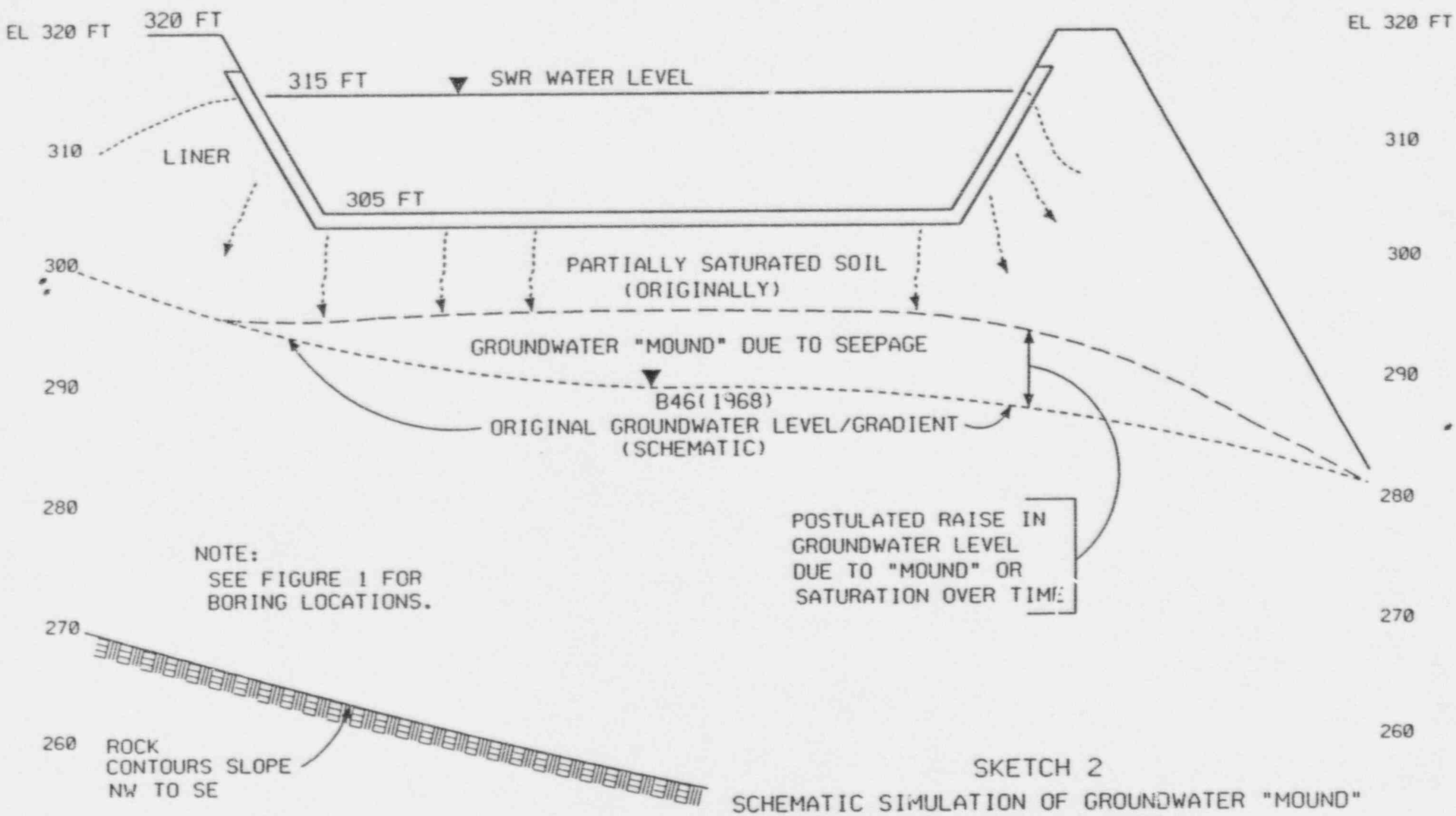


FIGURE 2
LOCATION OF SERVICE WATER RESERVOIR
RELATIVE TO DISCHARGE CANAL
NOT TO SCALE



SKETCH 2

SCHEMATIC SIMULATION OF GROUNDWATER "MOUND"
SECTION THRU B-46 LOOKING NORTH

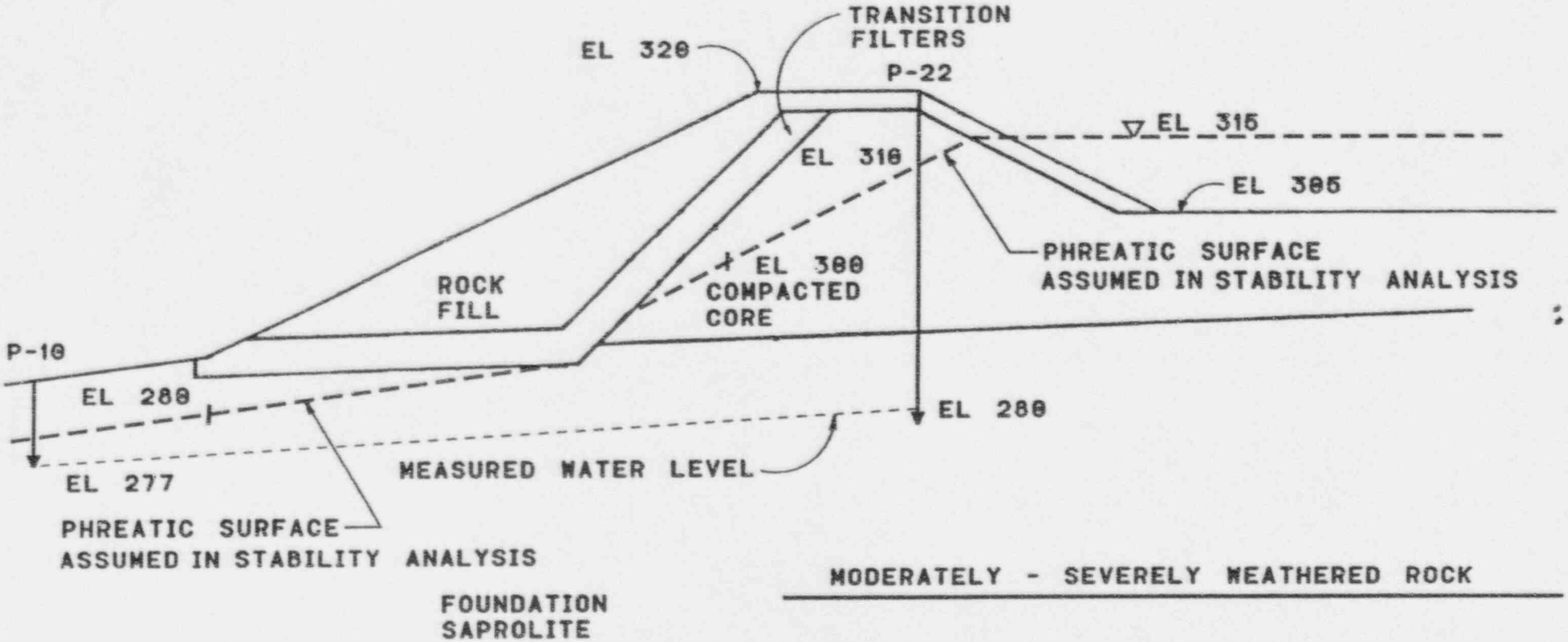
NOT TO SCALE
HORIZONTAL SCALE GREATLY EXAGGERATED

3.5 Effect on Seepage

The slight increases in piezometric levels do not, in our opinion, indicate a material increase in seepage from the SWR, only an increase in groundwater levels around the SWR due to the factors mentioned above. The calculated seepage from the SWR is relatively small, 16.2 gpm (Ref. 10). The maximum allowable SWR inventory loss was evaluated at 200 gpm, more than 12 times the estimated seepage (Ref. 11).

3.6 Effect on Stability of SWR

A slight increase in piezometric head in the dike and at the toe does not significantly lower the stability of the dike. Calculations 11715-141-"SWR Stability Analysis," Ref. 12, assumes a much higher phreatic surface for the stability analyses than the Technical Specification allowable limits. The calculation assumes a phreatic surface at an approximate elevation 311 ft. at the inboard edge of the slope crest where P-22 is located, elevation 280 ft. at the toe, and elevation 276 ft. at the approximate location of P-10. Figure 3 is a sketch taken from the UFSAR which shows the idealized water levels used in the seismic and static stability analysis. The water levels used in both analyses are the same. The maximum allowable water level as required by the Technical Specifications at P-10 and P-22 are 277 ft. and 280 ft. respectively are superimposed on Figure 3. The minimum factors of safety obtained in the seismic and static stability analysis utilizing the higher water levels shown in Figure 3 were 1.2 and 1.5 respectively (Ref. 13). Current recorded water levels at P-22 are approximately 31 ft. below that assumed in the stability calculation. The calculated factor of safety against failure of the dike would be significantly increased if the actual water levels were used in the stability calculations. Therefore, the stability of the dike is not decreased by the small increase in water levels indicated in P-10 and



SECTION THROUGH SWR DIKE
AT P-22 & P-10 LOOKING WEST
PHREATIC SURFACE - ASSUMED & MEASURED
NORTH ANNA POWER STATION

FIGURE 3

P-22, and a significant margin remains to the safety factor against a stability failure.

There is no reduction in the stability of the SWR dike or SWPH on the northeast side of the SWR as the water levels remain below the Technical Specification limits.

4.0 CONCLUSIONS

The slight increases in water levels in piezometers, including P-22, have resulted from a combination of conditions. The total increase does not indicate a significant increase in seepage or reduction of the stability of the SWR dike or SWPH.

The current levels in the Technical Specification were set because of concerns over seepage, settlement, and stability of the SWR along the northeast segment of the dike at and near the SWPH. The groundwater levels along the southeastern segment where P-21, P-22 and P-10 are located, were not an issue at the time the Technical Specifications were formulated, and therefore, approximately the same limiting groundwater levels were selected as were selected at the northeast section.

5.0 RECOMMENDATIONS

5.1 The piezometers along the southeast portion of the dike (P-10, 21, and 22) be monitored on a quarterly frequency for approximately one additional year and the results be evaluated at that time.

5.2 Since P-10 and P-11 are the last operative pneumatic piezometers, additional standpipe piezometers should be installed at the toe of the slope along the SE section near P-21 and near P-22. P-10 is presently located at the toe of the slope approximately midway between the two piezometers.

6.0 REFERENCES

1. Technical Specification 3/4.7.13, "Groundwater Level - Service Water Reservoir" (current version).

2. Procedure 0-PT-75.7, Rev. 2, "Inservice Water Reservoir Groundwater Levels."

3. NP-2846, Type 1 Report, "Inservice Inspection of Service Water Reservoir, North Anna Power Station", July 1994.

4. "Report of Initial Inservice Inspection of Service Water Reservoir, North Anna Power Station," performed by Stone & Webster Engineering Corporation (SWEC), September, 1982.

5. "Geotechnical Instrumentation Manual for North Anna Power Station", Stone & Webster Engineering Corp., April, 1977.

6. UFSAR, Section 3.8.4.6.

7. "Report Site Environmental Studies, Proposed North Anna Nuclear Power Station, Louisa County, Virginia," Dames & Moore, January, 1969.

8. Safety Analysis Report, North Anna Power Station, Independent Spent Fuel Storage Installation, submitted to the NRC on May 9, 1995.

9. UFSAR, Appendix 3E, Geotechnical Investigation and Soil Sample Testing for the Service Water Reservoir.

10. UFSAR, Section 9.2.1.2.2, Service Water Reservoir Design.

11. Calculation ME-0200, Evaluation of Leakage Effects on Service Water System, 11-4-88.

12. Calculation 11715-141, "S.W.R. Stability Analysis," SWEC, April, 1974.

13. UFSAR Section 3.8.4.4 and Table 3.8-14.