MAC 54

November 12, 1982

Docket No. 50-206
LS05-82-11-044

Mr. R. Dietch, Vice President
Nuclear Engineering and Operations
Southern California Edison Company
2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770

Dear Mr. Dietch:

SUBJECT: SEP TOPIC II-4.D, STABILITY OF SLOPES
SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1

Enclosed is a copy of our evaluation of Systematic Evaluation Program Topic II-4.D, "Stability of Slopes." This assessment compares your site condition, as described in the Docket and references, with the criteria currently used by the regulatory staff for licensing new facilities. Please inform us if your site condition differs from the licensing basis assumed in our assessment.

Our review of this topic is complete and this evaluation will be a basic input to the integrated safety assessment for your facility unless you identify changes needed to reflect the existing site condition at your facility. This topic assessment may be revised in the future if your facility design is changed or if NRC criteria relating to this topic is modified before the integrated assessment is completed.

Sincerely,

Walt Paulson, Project Manager
Operating Reactors Branch #5
Division of Licensing

Enclosure:
As stated

cc w/enclosure:
See next page

SEO4
DSU USE EX(08)
Add: T. Cheng

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SYSTEMATIC EVALUATION PROGRAM
TOPIC II-4.D

SAN ONOFRE

TOPIC: II-4.D, STABILITY OF SLOPES

I. INTRODUCTION

This topic pertains to the Geotechnical Engineering Review of the stability of all earth and rock slopes, both natural and man-made (cuts, fills, embankments, dams, etc.), whose failure, under any of the conditions to which they could be exposed during the life of the plant, could adversely affect the safety of the plant. The scope of the review embraces the following subjects which are evaluated using data developed by the applicant and information available from all sources: (1) slope characteristics; (2) design criteria and analyses; (3) results of field and laboratory tests; (4) excavation, backfill, and earthwork in slopes; (5) liquefaction potential affecting slopes; and (6) proposed instrumentation and performance monitoring.

II. REVIEW CRITERIA

The applicable rules and basic acceptance criteria pertinent to the review of this topic are:

1. 10 CFR Part 50, Appendix A
   (a) General Design Criterion 1 - "Quality Standards and Records." This criterion requires that structures, systems and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. It also requires that appropriate records of the design, fabrication, erection, and testing of structures, systems and components important to safety shall be maintained by or under the control of the nuclear power plant licensee throughout the life of the plant.

   (b) General Design Criterion 2 - "Design Bases for Protection Against Natural Phenomena." This criterion requires that safety-related portions of the system shall be designed to withstand the effects

of earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

(c) General Design Criterion 44 - "Cooling Water." This criterion requires that a systems shall be provided with the safety function of transferring the combined heat load from structures, systems and components important to safety to an ultimate heat sink under normal operating and accidental conditions.

2. 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants"
These criteria describe the nature of the investigation required to obtain the geologic and seismic data necessary to determine site suitability and identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants.

III. RELATED SAFETY TOPICS AND INTERFACES

Geotechnical engineering aspects of Settlement of Structure and Buried Equipment are reviewed under Topic II-4.F. Other interface topics include:

II-3.B, "Flooding Potential and Protection Requirements;"
II-3.C, "Safety-Related Water Supply (Ultimate Heat Sink);"
II-4.E, "Dam Integrity;"
III-3.A, "Effects of High Water Level on Structures;"
III-3.C, "In-service Inspection of Water Control Structures;"
III-6, "Seismic Design Considerations;"
IX-3, "Station Service and Cooling Water Systems;" and
XVI, "Technical Specifications."

IV. REVIEW GUIDELINES

In general, the review process was conducted in accordance with the procedures described in Standard Review Plan (NUREG-0800) Section 2.5.5, (Reference 1). The geotechnical engineering aspects of the design and as-

constructed conditions of slopes were reviewed and compared to current criteria, and the safety significance of any differences was evaluated.

The following Regulatory Guides provide information, recommendations, and guidance and in general describe a basis acceptable to the staff that may be used to implement the requirements of the above described criteria.

(1) Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants." - This guide describes programs of site investigations related to geotechnical engineering aspects that would normally meet the needs for evaluating the safety of the site from the standpoint of the performance of foundation and earthworks under anticipated loading conditions including earthquakes in complying with 10 CFR, Part 100, Appendix A. It provides general guidance and recommendations for developing site-specific investigation programs as well as specific guidance for conducting subsurface investigations, the spacing and depth of borings, and sampling.

(2) Regulatory Guide 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants." - This guide describes laboratory investigations and testing practices acceptable for determining soil and rock properties and characteristics needed for engineering analysis and design for foundations and earthwork for nuclear power plants in complying with 10 CFR, Part 100 and 10 CFR, Part 100, Appendix A.

V. TOPIC EVALUATION

1. Site Description

The San Onofre Unit 1 site is located on the Camp Pendleton Marine Corps Reservation on the coast of California in San Diego County about 51 miles northwest of San Diego and about 62 miles southeast of Los Angeles. The topographic features of the immediate coastal area include a narrow band of beach sand terminating at seacliffs which reach a height of 60 to 80 feet in the vicinity of the site. A gentle coastal plain extends inland to the

western foothills of the Santa Margarita Mountain Range approximately 1-1/2 miles to the east. The plant site is on the shoreline. Prior to construction of the plant, the original plant site elevation at the tope of the seacliff bluff ranged from 80 to +115 feet MLLW. The finished plant grade elevation is +20 feet MLLW.

The subsurface structure exposed in the excavation for the plant facilities include Quarternary terrace deposits which overlie a Pliocene age sand material named the San Mateo Formation. The terrace deposits consist of tan, buff and light brown, silty or clayey, fine to coarse sand with some cobbles. The deposits are crudely stratified with thickness up to 55 feet. The San Mateo Formation is a cemented, massive, well graded, yellow-brown, fine to coarse sand with gravel and occasional lenses of thin bedded gray shale or siltstone and is approximately 1,000 feet thick at the site. At grade, the San Mateo Formation is a poorly cemented but very dense sand.

To accommodate the plant, the seacliff bluff was cut back using a "Bench Design" approach. Cut slope profiles consist of a 15 foot bench at the horizontal interface of the terrace deposit and the San Mateo Formation. The San Mateo Formation comprises the lower 25 feet of the cut slope. Above and below the bench, the cuts were excavated to a slope of one horizontal to two vertical. (Ref. 2)

2. Properties of Subsurface Materials

The initial soil investigations at the San Onofre Unit 1 site were performed in September and October, 1962. Foundation exploratory drilling was accomplished in May 1963. A total of 14 test holes were drilled at the site. The licensee has presented boring logs depicting the soil conditions encountered in these investigations (Ref. 3). Field investigation efforts included standard penetration tests (SPT) and soil sampling using a Pitcher rotary core barrel. Surface seismic refraction surveys were also made at the plant site using dynamite blasts as the energy source. Laboratory testing of soil samples was accomplished to determine significant engineering characteristics and physical properties. Testing included specific gravity determinations, natural moisture content and unit weight determinations, particle size analysis, minimum and

maximum relative density determinations, and consolidation and direct shear testing (Ref. 3). Considerable additional field exploratory sampling, and laboratory testing, including cyclic triaxial testing, was performed in 1972 to 1974 during geotechnical investigation associates with the San Onofre Units 2 and 3 project (Ref. 4). Table 1 presents soil strength parameters which were developed by the licensee from the results of the site subsurface and laboratory investigation and used in the site slope stability analyses.

Based on a review of the information presented by the licensee, the staff concludes that the scope of field and laboratory testing was adequate to define conservative strength parameters of the subsurface soils.

3. Slope Stability

Review of available onsite and offsite topographic data indicates there are no offsite slopes whose failure could cause radiological consequences adversely affecting the public health and safety (Ref. 5). One onsite slope, the north plant site slope, was identified by the licensee and evaluated for safety in conjunction with this topic (see Fig. 1). A generalized, typical section for this slope was developed from subsurface data and is presented in Figure 2.

The staff has performed a stability analysis of this slope using conservative soil strength parameters developed from the results of the site subsurface investigation reported by the licensee as presented in Table 1. The staff used the computer program "Slope" currently commercially available for processing at McDonnel Douglas Automation Company (MCAUTO). Slope stability was assessed under both static and pseudostatic (earthquake loading) conditions.

Results of this analysis indicate the factor of safety against failure under static loading conditions is greater than 2.0. Based upon the criteria contained in Reference 6, the staff concludes that an adequate margin of safety exists under static loading conditions.

The staff evaluated the effect of potential slope failure under dynamic loading condition using the computer program "Slope" and Newmark's procedures (Ref. 7) for estimating permanent slope displacements due to seismic loadings. The results indicate that the maximum slope displacement for unsymetrical sliding due to an SSE event of 0.67 g is estimated to be less than 4 inches. Considering the fact that the distance separating the toe of the north plant site slope from the nearest Seismic Category I structure is approximately 105 feet, and also considering the existence of a gunite blanket overlying the slope to prevent surface erosion (Ref. 8), the staff concludes that the expected slope displacement resulting from slope instability due to a 0.67 g SSE event would not adversely impact the safety of the plant.

Table 1 Subsurface soil strength parameters

Material properties	Subsurface materials		
	Terrace clay	Terrace sand	Formation San Mateo sand
Average depth (ft.-MLLW)	Surface to +65	+65 to +48	below +48
Unit weight (lb/CF)	130	120	130
Friction, ϕ (degrees)	17	38	41.5
Cohesion (K/SF)	2.6	0.2	0.75

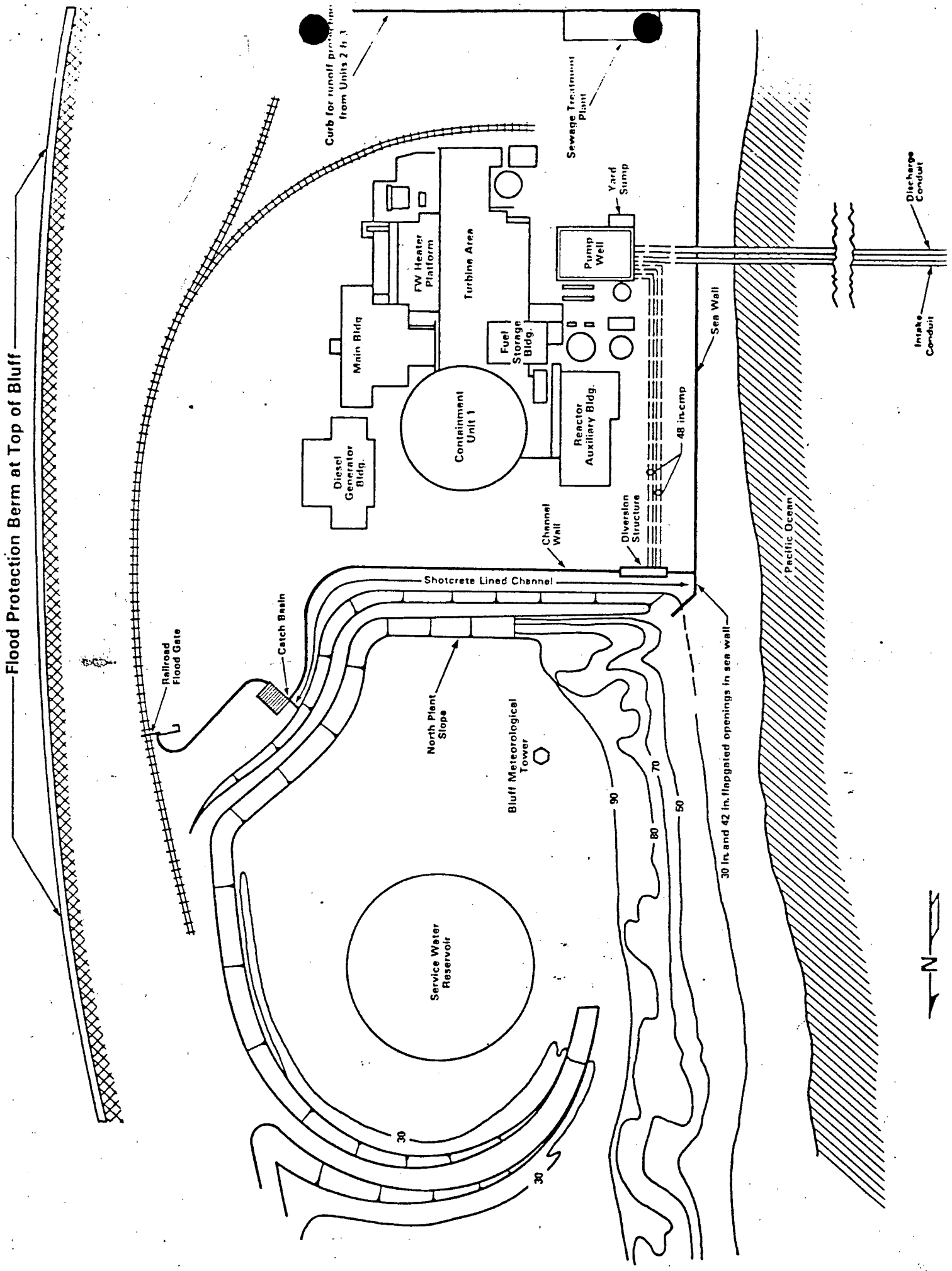

Figure 1 - San Onofre - General Site Plan

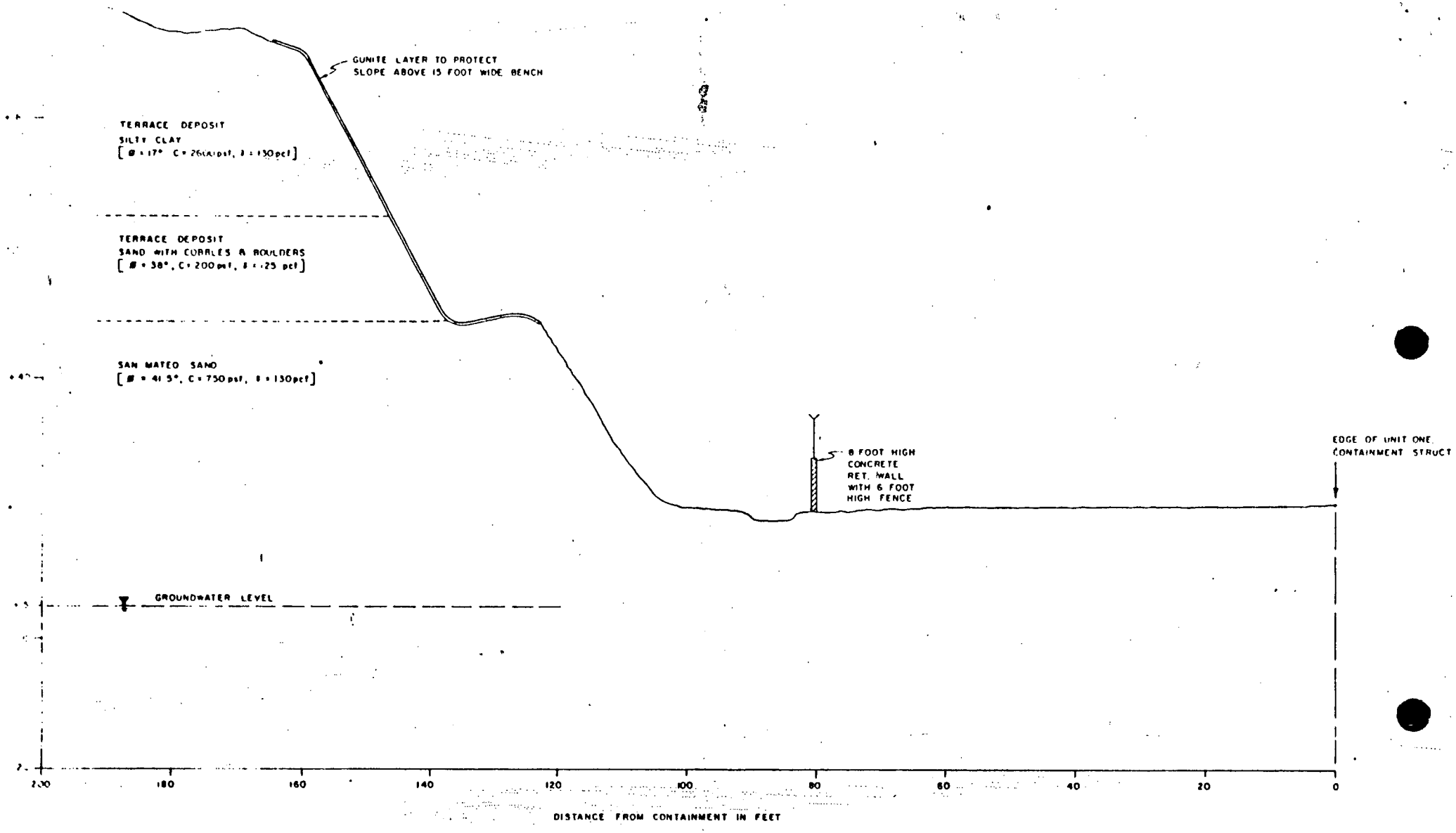

Figure 2 - North Plant Slope Generalized Typical Section

VI CONCLUSIONS

Based on the review of available site data and on information obtained during a staff visit to the site, the staff concurs with the licensee's conclusion (Ref. 8) that the stability or movement of slopes associated with the San Onofre Nuclear Generating Station Unit 1 site does not pose a safety concern for this plant.

VII. REFERENCES

Documents marked with an asterisk are available for inspection and copying for a fee in the NRC Public Document Room, 1717 H Street, N.W., Washington, D.C. 20555 (PDR). They are also available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and from the National Technical Information Service, Springfield, Virginia 22161.

*1. "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants - LWR Edition," NUREG-0800, July 1981.

*2. "Final Safety Analysis Report, San Onofre Nuclear Generating Station, Unit 1," Docket No. 50-206.

*3. Southern California Edison Company Letter, Krieger to Crutchfield, February 1, 1982. Subject: SEP Topics II-4.D and II-4.F, San Onofre Nuclear Generating Station Unit 1, Docket No. 50-206.

*4. "Final Safety Analysis Report, San Onofre Nuclear Generating Station, Units 2 and 3," Docket No. 50-361/362.

*5. Southern California Edison Company - "Topographic Map of San Onofre Nuclear Generating Station Site," 8-29-76, 81067-7 (8202080412) Docket No. 50-206.

6. U.S. Army Corps of Engineers Manual - "Engineering and Design Stability of Earth and Rock Fill Dams" - EMN 1110-2-1902 April 1, 1970.

7. N. M. Newmark - "Effects of Earthquake on Dams and Embankments." Geotechnique, Vol XV, No. 2, The Institution of Civil Engineers, London, England, pp. 139-160, 1965.

*8. Southern California Edison Company Letter, Moody to Crutchfield, November 2, 1981. Subject: SEP Topic II-4.D and II-4.F, San Onofre Nuclear Generating Station Unit 1. Docket No. 50-206.