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WASTE PITS 3 AND 5 AND CLEARWELL DIKES STABILITY ANALYSIS REPORT JANUARY 1992

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Waste Pits 3 and 5 and Clearwell Dikes Stability Analysis Report

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio

DOE Contract No. DE-AC05-90OR21951
January 1992
Revision No. 0

Operable Unit 1, Project Order 11

PARSONS

Fairfield Executive Center
6120 South Gilmore Road
Fairfield, Ohio 45014

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CONTENTS

Executive Summary v

SECTION

1.0 **Introduction** 1-1

2.0 **Technical Approach** 2-1
- 2.1 Field Investigation 2-1
- 2.2 Geotechnical Laboratory Testing 2-1
- 2.3 Slope Stability Analysis 2-2

3.0 **Results** 3-1
- 3.1 Field Investigation 3-1
- 3.2 Geotechnical Laboratory Testing 3-5
- 3.3 Slope Stability Analysis 3-7

4.0 **Conclusions** 4-1
- 4.1 Probability of Failure 4-1
- 4.2 Methods to Reduce the Probability of Failure 4-3

5.0 **Recommendations** 5-1

6.0 **References** 6-1

APPENDICES

A Boring Logs
B Geotechnical Laboratory Testing Results
C Slope Stability Analysis Results Cases 1-3
D Slope Stability Analysis Results: Flatter Exterior Slope (2.5H:1V) Case

3

TABLES

3-1 Soil Index Properties Summary
3-2 Soil Design Parameters
3-3 Summary of Stability Analysis Results
4-1 Effect of Flatter Waste Pit 3 Exterior Slope

LIST OF FIGURES

2-1 Waste Pit 5 Dike, Target Monument, Borehole, and Piezometer Locations

2-2 Waste Pit 3 and Clearwell Dike Target Monument and Borehole Locations

3-1 Typical Waste Pit 3 Cross Section

3-2 Typical Waste Pit 5 Cross Section

3-3 Typical Clearwell Cross Section

3-4 Typical Dike Stability Analysis Results

4-1 Potential for Failure Occurrence

LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
COE	U.S. Army Corps of Engineers
DOE	U.S. Department of Energy
EM	Engineer Manual
FEMP	Fernald Environmental Management Project
g	acceleration due to gravity (9.82 m/sec^2)
H	Horizontal
LL	Liquid Limit
NAVFAC	Naval Facilities Engineering Command
PCF	Pounds per cubic foot
PI	Plasticity Index
PL	Plastic Limit
PSF	Pounds per square foot
PZ	piezometer designation
SAIC	Science Applications International, Inc.
STABL	slope stability computer code designation
T	target monument designation
UBC	Uniform Building Code
UCRL	University of California Research Laboratory
USCS	Unified Soil Classification System
V	Vertical
XSTABL	slope stability computer code designation

Executive Summary

PARSONS was tasked to evaluate the structural integrity of the Waste Storage Area dikes (Waste Pits 3 and 5 and the Clearwell). To accomplish this evaluation, three activities were performed. The first activity consisted of a field investigation of the subsurface soil and groundwater conditions in and around the dikes. The second activity consisted of geotechnical laboratory testing of soil samples obtained during the field investigation. In the final activity, the slope stability analysis, the data from the field investigation, and laboratory testing were utilized in a computer model to evaluate the potential for slope failure. The results of the structural evaluation are documented in this report.

The stability analyses determined that all three perimeter dikes are structurally stable based on existing dike geometry, soil strength, and groundwater conditions encountered during a recent subsurface investigation of the area. The analyses evaluated eight cross sections at various locations along the dikes and calculated a Factor of Safety for each section. The Factors of Safety of the eight cross sections analyzed ranged from 1.42 to 2.31. These values are greater than the minimum value (1.25) recommended by the Naval Facilities Engineering Command (NAVFAC). The section of dike with the lowest Factor of Safety was that of Waste Pit 3. Based on the these Factors of Safety, NAVFAC recommended Factors of Safety, and documented studies of slope failures, the potential for structural slope failure occurring was determined to be very low.

The stability analyses considered two other conditions that could potentially lead to structural instability of the dikes. One condition was that of high groundwater elevations caused by the low probability event of a high intensity, long duration torrential rainstorm (100-year storm). The Factors of Safety for the eight cross sections under these conditions ranged from 1.22 to 1.88. All cross sections analyzed except one at Waste Pit 3 had Factors of Safety greater than the NAVFAC recommended minimum value of 1.25. Based on these Factors of Safety, NAVFAC recommended Factors of Safety, and documented studies of slope failures, the potential for failure of these sections during high groundwater conditions was determined to be very low. The cross section at Waste Pit 3 with a Factor of Safety of 1.22 was also determined to have a low probability for failure during high groundwater conditions based on existing groundwater conditions and low infiltration rates in clay soils.

The other condition considered in the stability analyses was earthquake loading. To determine the dikes' stability during an earthquake, the forces associated with a horizontal acceleration of 0.1g were factored into the analyses. This value is consistent with the provisions of the Uniform Building Code (UBC) and the recommendations and evaluation guidance developed for the Fernald Environmental Management Project (FEMP) by the Lawrence Livermore National Laboratory. An earthquake producing these accelerations has a return period of 500 years. The Factors of Safety under static and dynamic loading for cross sections except those of Waste Pit 3 ranged from 1.36 to 1.83. These values are greater than the minimum Factor of Safety of 1.15 recommended by NAVFAC for earthquake loading conditions.

Therefore, these cross sections have a low potential for failure during a 500-year earthquake. The Waste Pit 3 dike cross sections showed Factors of Safety of approximately 1.10 during a 500-year earthquake. This value is less than the NAVFAC recommended value of 1.15. Therefore, the Waste Pit 3 dike has the potential for failure under the magnitude of forces anticipated during a 500-year earthquake. Further stability analyses estimated that a 0.14g horizontal acceleration would be required to place the Waste Pit 3 Dike at a condition of impending failure. An earthquake producing horizontal accelerations of this magnitude are estimated to have a return period of approximately 1,000 years.

These overall results of the evaluation indicate that there is no immediate need to remove the contents of Waste Pits 3 and 5 and the Clearwell based on the structural integrity of the earthen dikes. Periodic visual inspections and semi-annual verification surveys of the dikes are recommended as measures to monitor structural integrity .

SECTION 1

INTRODUCTION

This report documents the results of the structural stability analyses of the earthen dikes bordering Waste Pits 3 and 5 and the Clearwell located at the Waste Storage Area, Fernald Environmental Management Project (FEMP) near Fernald, Ohio. These analyses evaluate the potential for slope failure of the three dikes in question. This report was the basis for development of the *Waste Pits 3 and 5 and Clearwell Dikes Removal Site Evaluation* (PARSONS 1992).

The *Project Plan for Project Order Number 11* (PARSONS 1990) describes the requirement for an evaluation of the structural integrity of the Waste Storage Area dikes. To accomplish this evaluation, three activities were performed. The first activity consisted of a field investigation of the subsurface soil and groundwater conditions in and around the dikes. The second activity consisted of geotechnical laboratory testing of soil samples obtained during the field investigation. In the final activity, the slope stability analysis, the data from the field investigation and laboratory testing were used in a computer model of the dike to evaluate the potential for failure due to instability. Details of these activities are described in Section 2.

SECTION 2

TECHNICAL APPROACH

2.1 Field Investigation

The field investigation involved soil sampling and piezometer installation. Details and specifications for field activities are contained in *Soil Investigation Plan for Dike Stability Analysis of Waste Pits 3 and 5 and the Clearwell* (PARSONS 1991) and are summarized below.

2.1.1 Soil Sampling

The soil sampling generally consisted of advancing soil test borings to obtain subsurface soil samples of the earthen materials beneath, within, and near the Waste Storage Area dikes. Soil samples were recovered in the undisturbed material below the bottom of the augers using the Standard Method for Penetration Resistance and Split-Barrel Sampling (ASTM D 1586). These soil samples were obtained for visual classification and laboratory index property testing. Additionally, relatively undisturbed Shelby tube samples (ASTM 1587) were obtained for laboratory testing of physical properties. All drilling was performed to elevations which avoided penetration of the underlying aquifer. During drilling, a geologist was on site to visually classify the soil samples and log the borings. These boring logs were used to establish the subsurface stratigraphy in the vicinity of the dikes.

2.1.2 Piezometer Installation

Temporary piezometers were installed in borings where groundwater was encountered during the field investigation. The purpose of these piezometers was to measure the groundwater (phreatic surface) elevation within the dike. After installation, the piezometer water levels were monitored and logged by site personnel.

2.2 Geotechnical Laboratory Testing

The geotechnical laboratory testing program was directed toward determining the classifications of the in situ soils and their engineering properties. Details and specifications for laboratory testing activities are contained in *Soil Investigation Plan for Dike Stability Analysis of Waste Pits 3 and 5 and the Clearwell* (PARSONS 1991) and are summarized below.

2.2.1 Index Properties Testing

The laboratory index tests were performed on split-barrel and Shelby tube soil samples. Index/classification tests performed included natural moisture contents (ASTM D 2216), Atterberg Limits (ASTM D 4318) and grain size tests (ASTM D 422).

Classification of the soils utilizing these tests provided a systematic method for categorizing the dikes' soils according to their probable engineering behavior. This classification allowed for correlation of physical properties from a test at a location in a soil stratum to other locations having a similar classification. This also allowed access to accumulated engineering experience with similarly classified soils. Additionally, grain size analyses provide a means to evaluate zones of potential seepage.

2.2.2 Physical Properties Testing

The laboratory physical property tests were performed on relatively undisturbed Shelby tube samples collected from the subsurface soils. Physical property tests included consolidated-undrained (with pore pressure measurements) triaxial compression tests (ASTM D 4767), consolidation tests (ASTM D 2435), and triaxial permeability tests (COE-EM-1110-2-1906).

Results of triaxial compression tests were used to determine the shear strength of consolidated dike soil samples during saturated, confined, undrained compression. The measurement of the samples pore pressure during the test allows for evaluation of the soil strength under drained conditions. The soil strength determined from the laboratory test can be directly correlated to the in situ soil strength under similar drainage conditions.

Consolidation tests were performed to determine the degree of compressibility of the subsurface soils. Such data allows for selection of the type of failure analysis to be performed when analyzing the shear strength data.

Laboratory permeability tests were also performed. These tests assist in estimating potential seepage paths. The unit weights used for stability analysis were also obtained from triaxial compression, consolidation, and permeability test results.

2.3 Slope Stability Analysis

The slope stability analysis consisted of preliminary data reduction and analysis of field and laboratory data to identify parameters, methods, and assumptions of the analysis. Computer analysis using these established parameters was then performed. These elements are described below.

2.3.1 Data Reduction and Analysis

Raw data from the laboratory tests required reduction and analysis to provide the coefficients and parameters necessary to perform an engineering slope stability analysis. The raw laboratory data are contained in *Soil Investigation for Dike Stability Analysis* (SAIC 1991). For determination of shear strength parameters and consolidation characteristics, standard graphical techniques were employed to evaluate the data. The results of the data analysis and reduction are presented in Section 3.

2.3.2 General Approach

Slope stability analyses were conducted with the aid of a computer to investigate a large number of potential failure surfaces for eight idealized cross sections developed from data resulting from field and geotechnical laboratory activities. Each cross section was analyzed for instability. Figures 2-1 and 2-2 show the locations of the eight cross sections and borings performed during the field investigation. Due to uniformity of the slope, only one cross section was used for the Clearwell. Two profiles were used for Waste Pit 3. The remaining five cross sections represent the variability of Waste Pit 5. The idealized profiles were developed based on survey data of the area, construction drawings of the dikes, and the soil boring logs. Each cross section was analyzed using total stress soil strength parameters. The phreatic surface was varied. Hypothetical earthquake loadings were also applied.

2.3.3 Method of Analysis

A total stress analysis was utilized for structural stability analyses to account for the overconsolidated nature (see Section 3) of the clay soils making up the dike. A total stress approach is more appropriate for conditions typical of overconsolidated clays upon shear failure. This analysis models the build up of negative pore pressures during shearing in earthen dikes. The total stress analysis is conservative since it introduces lower shear strength that accounts for long-term creep failure conditions of overconsolidated clay soils that typically produce negative pore water pressures at shear failure.

The computer program utilized was XSTABL. XSTABL uses a modified version of the popular STABL program originally developed at Purdue University. The program uses two-dimensional limit equilibrium techniques for stability analyses. In this technique, a free body of a slope is considered to be acted upon by known or assumed forces. Shear stresses induced on an assumed failure surface by the body and external forces are compared with the available shear strength of the soil material. A factor of safety is computed which, in a simplified description, is the ratio of the forces resisting the movement of the slope (shear strength of the soil) to the driving forces in the slope (weight of the material in the slope and other driving forces). For the earthquake (seismic) loading analyses, the above procedures used a pseudo-static analysis of slope stability as recommended for low design accelerations.

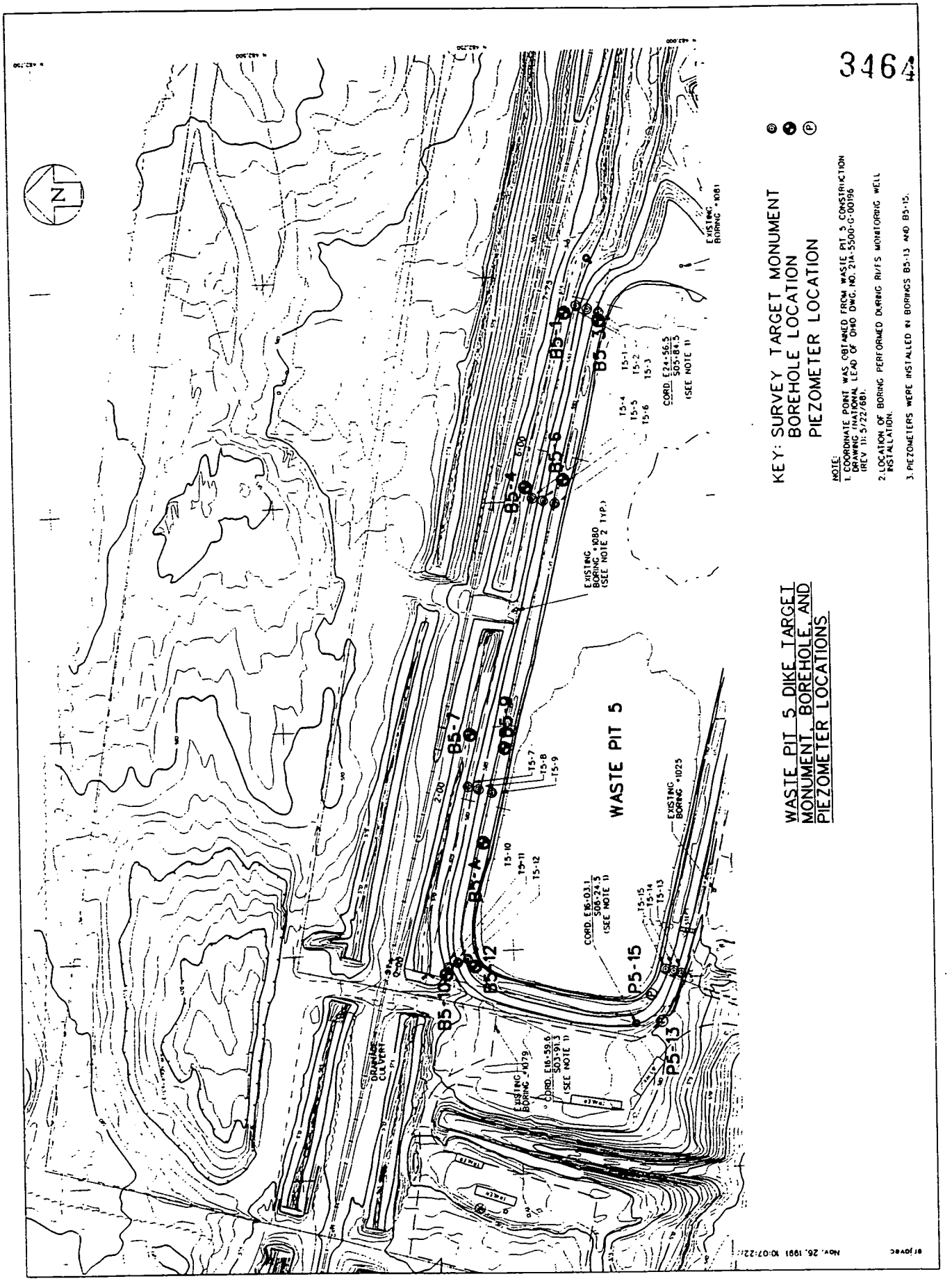

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Figure 2-1 - Waste Pit 5, Target Monument, Borehole, and Piezometer Locations

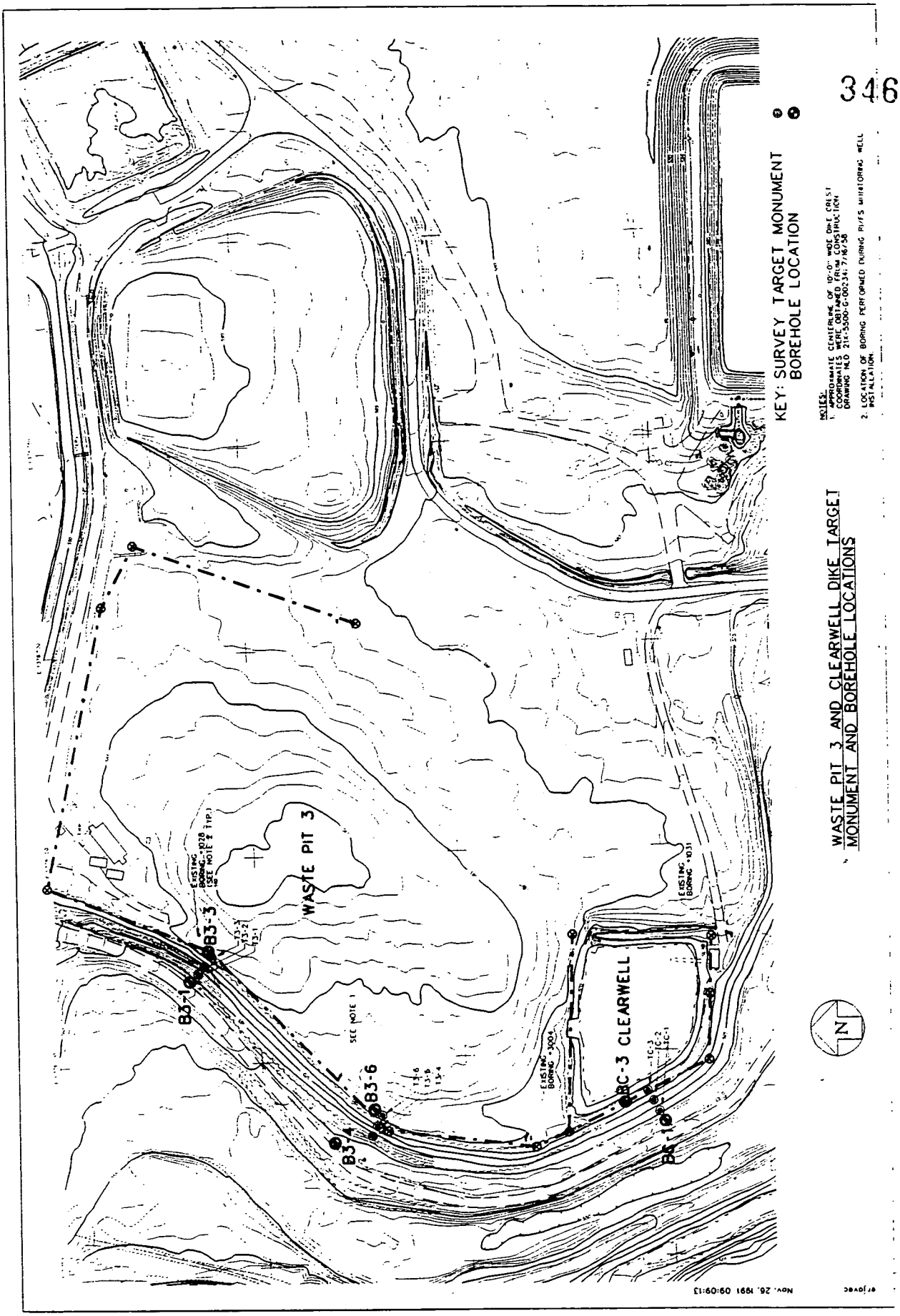

Figure 2-2 - Waste Pit 3 and Clearwell Dike Target Monument and Borehole Locations

2.3.4 Assumptions

The structural stability analyses were performed utilizing conservative assumptions. These assumptions include:

1) The use of total stress analyses (conservative soil strength parameters, i.e., cohesion and the angle of internal friction).

2) The synthetic (Pit 5) and clay (Pit 3 and Clearwell) liners were assumed to have failed allowing seepage through the dikes.

3) The worst case groundwater elevation at the crest of the Waste Pit 3 dike was assumed to be at the crest's ground surface elevation.

4) For the north dike of Waste Pit 5, the worst case groundwater surface extended from the pit water surface at the crest of the dike to the drainage ditch at the toe.

5) For the west dike of Waste Pit 5, Waste Pit 3, and the Clearwell, a worst case groundwater surface extended from the known water surface (Waste Pit 5, Clearwell) or an assumed (Waste Pit 3) groundwater elevation to exit at the ground surface near the toe.

6) The waste material was assumed to contribute no shear strength to the dike structure.

2.3.5 Cases Analyzed

The following three general cases were analyzed for each of the eight cross sections:

Case 1 - Low Groundwater Table - This case assumes seepage through the dike with a steep hydraulic gradient to a groundwater elevation near the top of the aquifer.

Case 2 - High Groundwater Table - This case assumes seepage through the dike with a shallow hydraulic gradient to a groundwater elevation at the ground surface elevation at the toe of the slope.

Case 3 - Low Groundwater Table with Earthquake Loading - This case applies a 0.1g horizontal acceleration to the dike.

Case 1 models groundwater characteristics typical of a low permeability, highly compacted, and overconsolidated clay dike. Flow resistance provided by the pit liners was neglected. The static groundwater table is located below the toe elevation of the dike.

Case 2 models conditions of seepage through the dike to a static groundwater surface at the toe elevation of the dike. The case allows for evaluation of the dikes structural stability during worst case seepage conditions. These conditions might be encountered as a result of a low probability natural event such a long duration, high intensity (100-year) rain storm that saturates the ground surface in the vicinity of the dikes or one that results in Paddy's Run flooding to the toe elevation of the Pit 3 or Clearwell dikes.

Case 3 allows for evaluation of the dikes structural stability during an earthquake. Forces associated with a 0.1g horizontal acceleration are applied to the dike. This value (0.1g) is consistent with the provisions of the UBC and general evaluation guidelines published by the Lawrence Livermore National Laboratory for existing low hazards facilities (UCRL 1990). The Lawrence Livermore National Laboratory developed uniform design criteria for the FEMP site (UCRL 1984). This information indicated that an earthquake producing 0.1g peak acceleration has a return period of 500 years.

SECTION 3

RESULTS

3.1 Field Investigation

3.1.1 Dike Geometry

Topographic survey data and construction drawings were used to determine the geometry of the eight cross sections used for stability analyses. In general, the dike heights are about 20 feet, and the exterior side slopes are approximately 1.5 Horizontal to 1 Vertical (1.5H:1V). The interior side slopes for the Clearwell and Waste Pit 3 are also 1.5H:1V, while the interior sides of Waste Pit 5 slope at 2.5H:1V. Figures 3-1 through 3-3 show typical cross sections of the Waste Pit 3, Waste Pit 5, and Clearwell dikes.

3.1.2 Dike Stratigraphy

The earthen dikes around Waste Pits 3 and 5 and the Clearwell and underlying soils are generally comprised of four soil layers to the depths explored. The dike itself is generally composed of an approximate 8 to 14.5 feet layer of upper yellowish brown clay underlain by an olive clay layer that ranges from about 2.5 to 10.5 feet in thickness. The olive clay layer is underlain by a lower layer of yellowish brown clay which in turn is underlain by gray lean clay to the depths explored. The lower yellowish brown clay layer ranges in thickness from approximately 2.5 to 18 feet. At the southwest corner of Waste Pit 5, an apparent discontinuous pocket of silty sand was encountered within the lower yellowish brown clay and gray clay stratum. Additionally, the top elevation of the underlying sand and gravel Great Miami Aquifer was estimated from borings logs from the *Task 6 Report of the Remedial Investigation Report for Operable Unit 1* (DOE 1990a). Boring logs providing details of the dike stratigraphy are included in Appendix A.

3.1.3 Groundwater Conditions

During the field exploration, groundwater was found at only two borings located at the southwest corner of Waste Pit 5 (see Figure 2-1). At this location, groundwater was encountered at an elevation of 568 feet in a silty sand lens. The elevation of the crest of the dike at this location is approximately 590 feet, the toe of the slope is 580 feet, and the pit bottom is 560 feet. Groundwater elevation readings from two temporary piezometers (PZ-13 and PZ-15) screened at the silty sand lens were taken for 4 weeks. The data showed no indication of piezometric head gradient in the down slope direction or excess water pressures due to a confined situation. Water levels varied no greater than 0.2 feet over the monitoring period. These data and stratigraphic data indicate that the groundwater encountered at this location is a zone of perched groundwater typical of that encountered in the glacial till throughout the site.

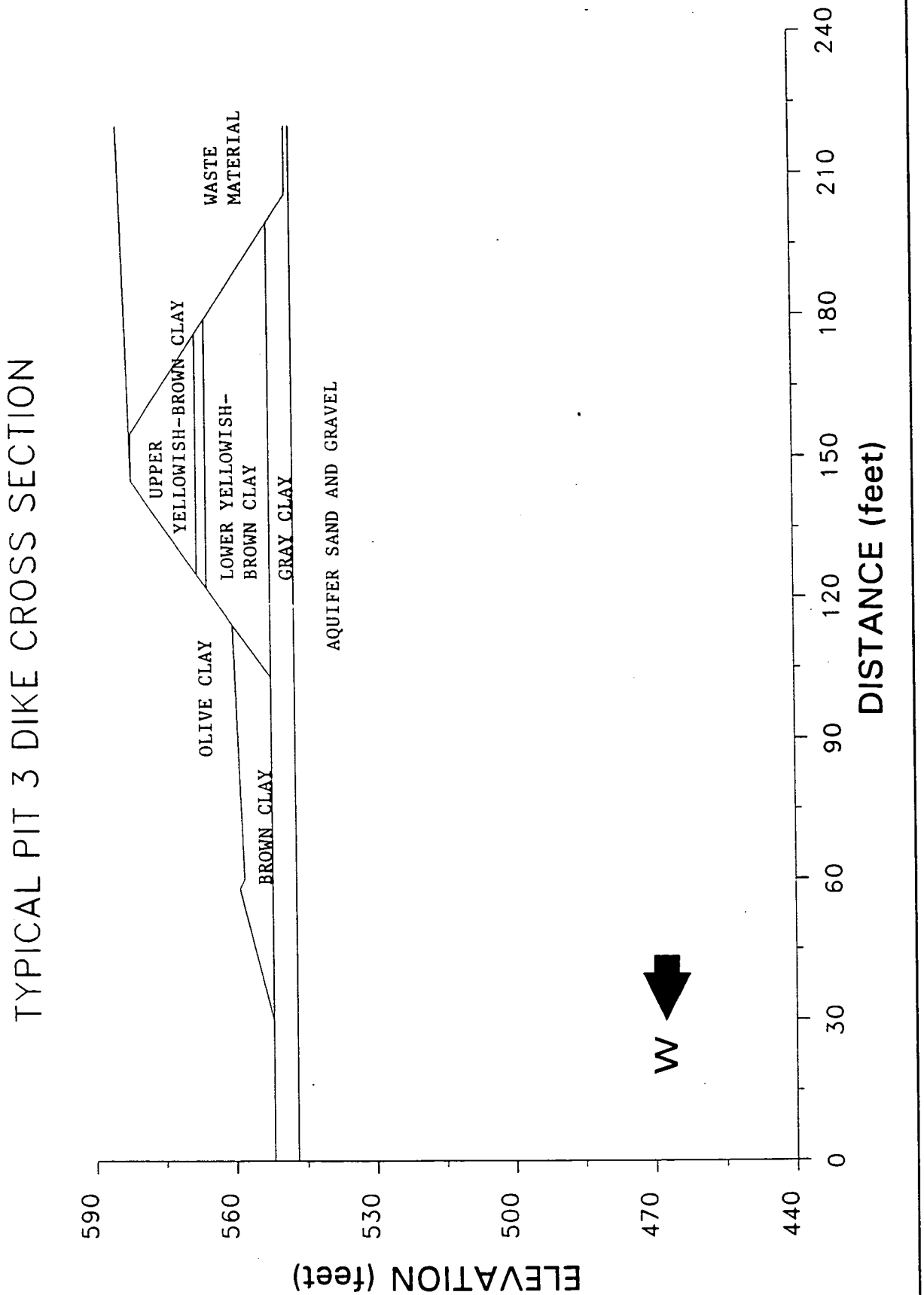

Figure 3-1 - Typical Waste Pit 3 Cross Section

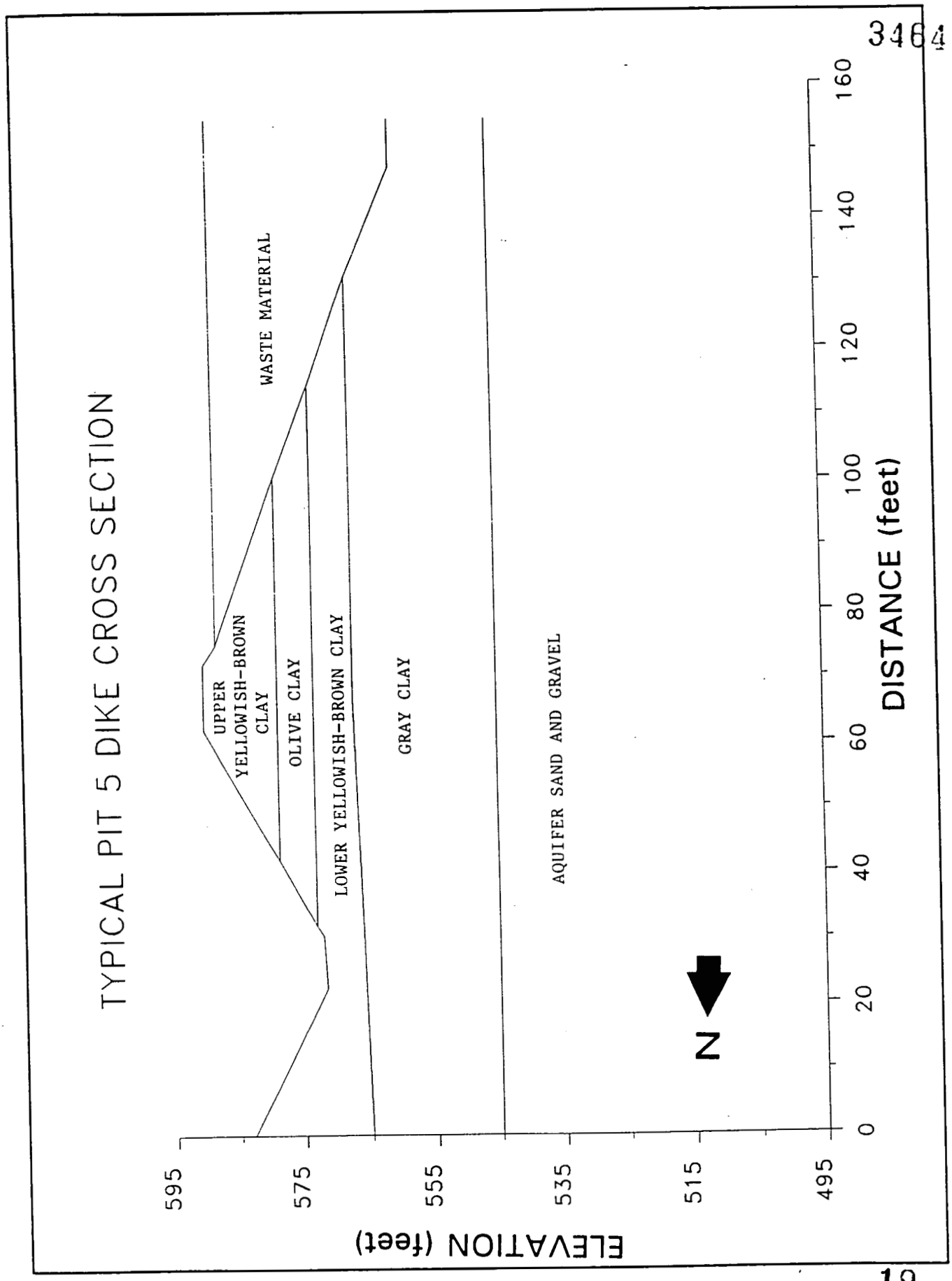

Figure 3-2 - Typical Waste Pit 5 Cross Section

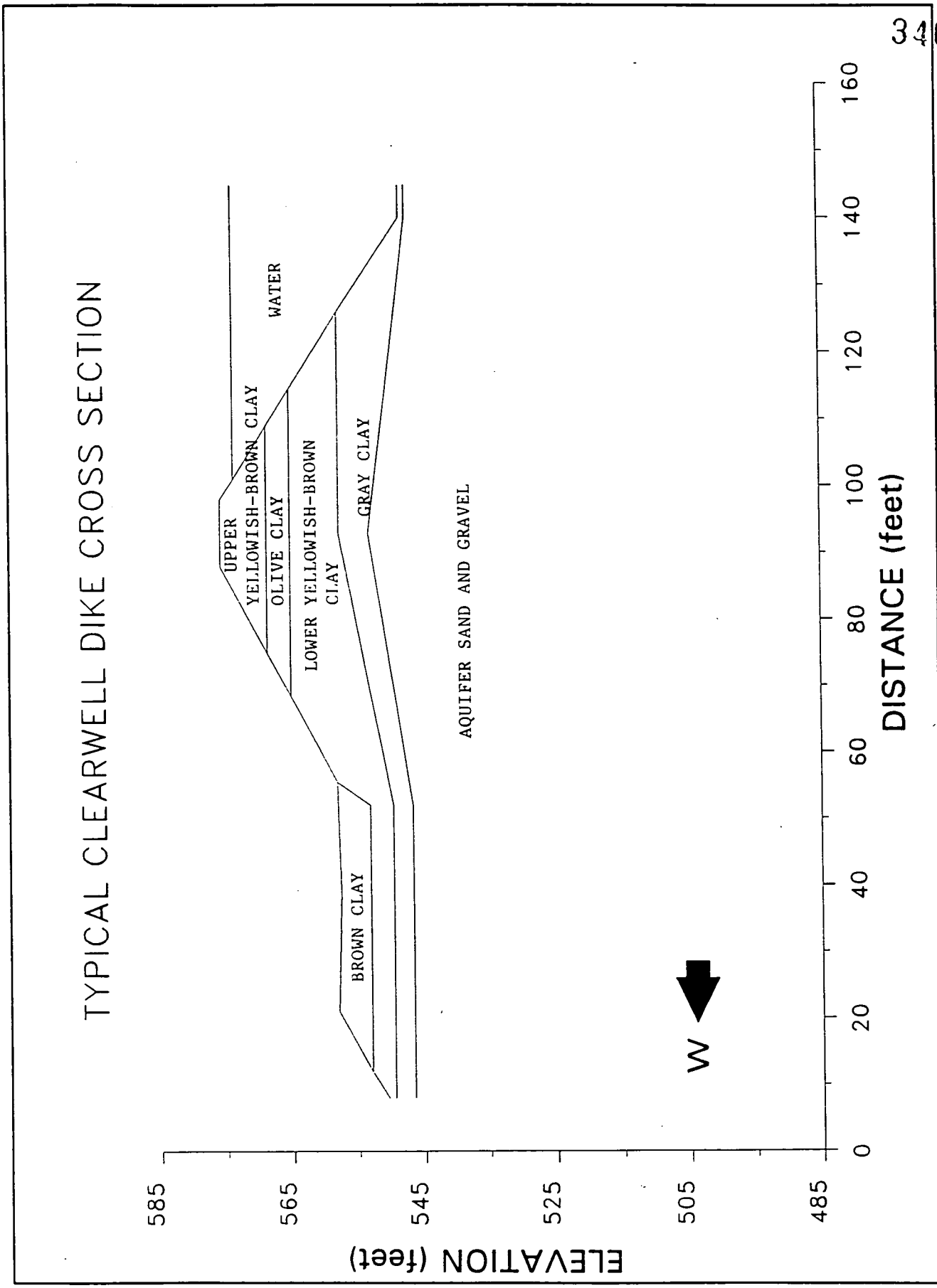

Figure 3-3 - Typical Clearwell Cross Section

In addition, boring logs of Waste Pit 3 (Weston 1988) and groundwater levels of 1000 Series wells installed in the vicinity of Waste Pit 3 (DOE 1990b) were reviewed to estimate the depth to groundwater in Waste Pit 3. From blow count data and boring log descriptions of borings performed at Waste Pit 3, the groundwater depth was estimated to range between 6 and 12 feet below the ground surface. Review of 2000 Series well groundwater elevations showed the aquifer groundwater elevation in the vicinity of the Waste Storage Area to be relatively constant at an elevation of 530 feet, well below the toe elevation of the dikes.

3.2 Geotechnical Laboratory Testing

3.2.1 Index Properties Testing

The results of index properties testing are summarized in Table 3-1 for each of the soil stratum encountered. In general, the clay soils classify as lean to silty clays (CL, CL-ML) with varying amounts of sand and gravel according to the Unified Soil Classification System (USCS).

Detailed index properties results can be found in Appendix B, Tables B-1 and B-2.

Table 3-1 - Soil Index Properties Summary

Soil Description	Grain Size Distribution				Natural Moisture Content (%)	Atterberg Limits			USCS Classification
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)		Liquid Limit LL	Plastic Limit PL	Plasticity Index PI	
Upper Yellowish Brown Clay	2-28	20-35	31-45	16-30	6-19	25-38	13-20	10-20	CL
Olive Clay	0-8	23-30	40-54	20-27	10-23	25-35	14-20	10-17	CL
Lower Yellowish Brown Clay	0-19	2-40	31-62	15-47	7-25	23-48	14-23	8-26	CL
Gray Clay	0-25	15-44	32-58	13-30	8-19	19-36	13-20	5-17	CL, CL-ML
Dark Brown Clay	1-10	32-44	42-54	12-15	13-17	28	17	11	CL
Silty Sand	9-46	42-59	10-25	4-7	19-26	34	20	14	SM

3.2.2 Physical Properties Testing

Shear strength properties for each soil layer were determined based on the results of the strength tests performed on the soil samples as discussed in Section 2.2.2. Table 3-2 presents the design parameters used in the slope stability analyses for each soil layer. These values were based on the evaluation of results from triaxial compression tests performed on samples obtained during the field investigation. Appendix B, Table B-3 provides the details of the triaxial compression test results.

Table 3-2 - Soil Design Parameters

Soil Stratum	Soil Description	USCS Classification	Total Unit Weight (PCF)	Undrained (Total) Shear Strength Parameters	
				Cohesion (PSF)	Friction Angle (Degrees)
1	Waste Material	---	140	0[1]	0[1]
2	Upper Yellowish-Brown Clay	CL	135	200	25
3	Olive Clay	CL	146	250	26
4	Lower Yellowish-Brown Clay	CL	129	250	20
5	Gray Clay	CL-ML	140	200	20
6	Silty Sand	SM	135	125	19
7	Dark Brown Clay	CL	137	200	24
8	Aquifer Sand and Gravel	SW	140[1]	0[1]	40[1]

Notes:

1. Assumed Values

Laboratory consolidation testing of soil samples taken within, beneath, and near the earthen dikes showed the soils to be overconsolidated. These results mean that the state of stress experienced by the soils due to the existing overburden is less than previous stress conditions encountered during the soil's history. These conditions are common in this region and would also be expected as a result of compaction during construction of the dikes. Appendix B, Table B-4 provides the details of the consolidation test results.

Permeability tests performed on samples indicated low permeabilities ranging from about 1 x 10^{-7} to 9 x 10^{-9} cm/sec for clay layers tested. Soils with permeabilities in this range are described as being practically impervious (Holtz et.al. 1981). Appendix B, Table B-5 summarizes permeability test results.

3.3 Slope Stability Analysis

Slope stability analyses were performed on each of the eight dike cross sections for the three cases described in Section 2.3.3. Figure 3-4 shows the typical results from an XSTABL stability analysis run. This figure shows the soil stratigraphy, soil properties, failure surfaces, and Factors of Safety for the case analyzed. Table 3-3 presents a summary of the minimum Factors of Safety obtained for each case. Minimum Factors of Safety based on published recommendations by the Naval Facilities Engineering Command (NAVFAC) are also presented (NAVFAC 1986). A descriptive summary of the stability analyses shown in Table 3-3 is included in Appendix C.

Waste Pit 5 and the Clearwell dike cross sections had Factors of Safety greater than the NAVFAC recommended minimum Factor of Safety for each case analyzed. Waste Pit 3 exceeded the NAVFAC recommended Factor of Safety for Case 1 (Low Groundwater). For Case 2 (High Groundwater), the stability analysis of section T3-4,5,6 resulted in a Factor of Safety of 1.22. This value is less than the NAVFAC recommended value of 1.25. Additionally, Waste Pit 3 Sections T3-1,2,3 and T3-4,5,6 had Factors of Safety of 1.10 and 1.11, respectively, for the earthquake loading case. The NAVFAC recommended minimum Factor of Safety for earthquake loading is 1.15.

Table 3-3 - Summary of Stability Analysis Results

Item or Location	Dike Cross Section[1]	Minimum Factor of Safety		
		Case 1 Low Groundwater Table	Case 2 High Groundwater Table	Case 3 Low Groundwater Table with Earthquake Loading
NAVFAC Recommended Minimum Factor of Safety[2]	All	1.25	1.25	1.15
Waste Pit 5	T5-1,2,3	1.75	1.36	1.43
	T5-4,5,6	1.74	1.39	1.41
	T5-7,8,9	1.69	1.37	1.36
	T5-10,11,12	2.02	1.55	1.60
	T5-13,14,15	2.31	1.88	1.83
Waste Pit 3	T3-1,2,3	1.43	1.30	1.10
	T3-4,5,6	1.42	1.22	1.11
Clearwell	TC-1,2,3	1.94	1.61	1.51

Notes:

1. See Figures 2-1 and 2-2 for cross section locations.
2. NAVFAC: Naval Facilities Engineering Command

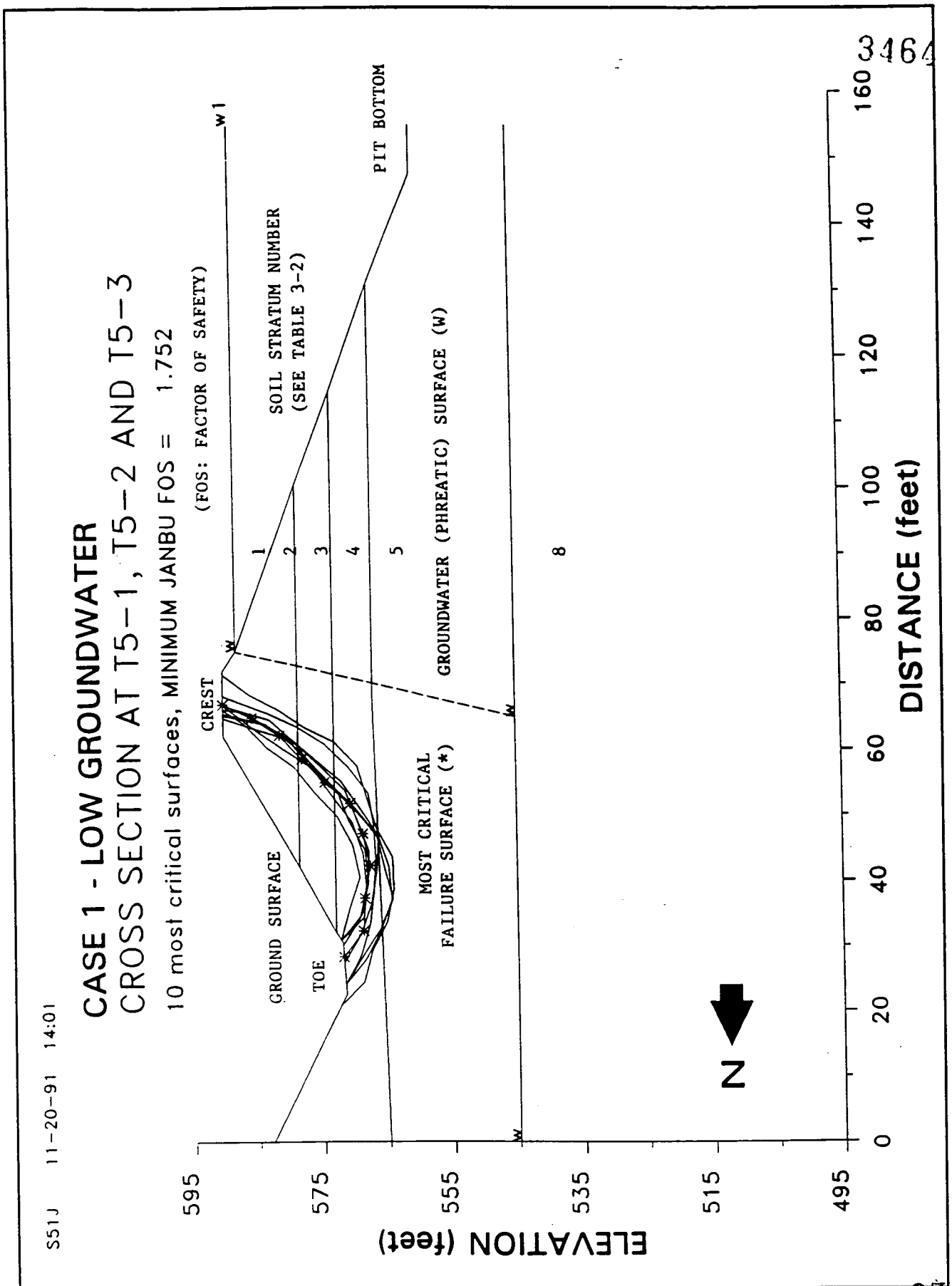

Figure 3-4 - Typical Dike Stability Analysis Results

SECTION 4

CONCLUSIONS

4.1 Probability of Failure

The potential for structural slope failure occurring for analyses which resulted in Factors of Safety greater than the NAVFAC minimum is very low. These analyses include Waste Pit 5 and the Clearwell. Extensive studies have shown that failures almost never occur when the Factor of Safety is greater than 1.25 (Bowles 1984). However, these studies have shown that failures may occur when the Factor of Safety is greater than 1.07 and less than or equal to 1.25 and that failures are common when Factors of Safety are less than 1.07. Figure 4-1 presents the stability analysis results relative to this failure occurrence. The occurrence probability of an extreme event such as high groundwater (100-year) or an earthquake (500-year) should also be considered when viewing Figure 4-1.

From the results of the field investigation and geotechnical laboratory testing, the present conditions of the dikes are best represented as those modeled in Case 1. Therefore, based on present conditions, the Factors of Safety are in a range where failure almost never occurs.

Based on the stability analyses results, the dike around Waste Pit 3 has a potential for failure during conditions of hypothetical worst case seepage modeled in Case 2. The probability of this occurring is evaluated as low since:

1) Seepage conditions were not encountered during the field exploration of the dikes.

2) Existing groundwater elevations in the vicinity of Waste Pit 3 are significantly lower than the worst case elevations of the High Groundwater Case (Case 2). A low probability natural event such as a long duration, high intensity (100-year) rainstorm, or major flood of Paddy's Run would be required to create conditions of the High Groundwater Case (Case 2). Because of the relatively impermeable clay surface soils, it is questionable that even a major rainfall event would result in the water infiltration necessary to cause the groundwater conditions modeled by this case.

3) With a Factor of Safety of 1.22, a margin to failure exists. The margin to failure can best be illustrated by a discussion of the additional conditions that would have to be imposed on the Waste Pit 3 Dike to cause it to fail, that is, reduce the factor of safety from 1.22 to less than one. XSTABL runs were performed to evaluate the magnitude of uniform surcharge load (pounds per square foot: PSF) which, when placed on the crest of the Waste Pit 3 dike at Section T3-4,5,6, 26

Factor of Safety	Potential for Failure Occurrence	Waste Storage Area Dike Analysis Results: Case 1 - Low Groundwater Case 2 - High Groundwater (100-year) Case 3 - Earthquake Loading (500-year)
2.00	Failure Almost Never Occurs	Waste Pit 3 Dike - Case 1 Waste Pit 5 Dike - All Cases Clearwell Dike - All Cases
1.25	Failure May Occur	Waste Pit 3 Dike - Case 2 & 3
1.07	Failure Common	
1.00	Failure Occurs	
0		

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27

Figure 4-1 - Potential for Failure Occurrence (After Bowles, 1984)

would cause the dike to fail during high groundwater conditions (Case 2). A uniform surcharge load of 1800 PSF placed over the 10-foot wide crest was necessary to cause failure. This surcharge load would be equivalent to that of a 12-foot high, 10-foot wide solid concrete wall placed at the crest of the Waste Pit 3 dike.

Results of the stability analyses also show the Waste Pit 3 Dike has Factors of Safety less than the NAVFAC recommended minimum values when exposed to 0.1g horizontal acceleration forces associated with a 500-year earthquake. Mathematically, the probability of a 500-year event is 1/500 or 2×10^{-3}. XSTABL runs were performed to estimate the horizontal acceleration necessary to cause the Waste Pit 3 Dike to fail. This acceleration was estimated to be approximately 0.14g. This value corresponds to a return period of 1,000 years or a probability of 1×10^{-3}.

4.2 Methods to Reduce the Probability of Failure

The technical evaluation results of Section 3 indicate that there is no immediate need to remove the contents of Waste Pit 3, 5, and the Clearwell based on the structural integrity of the earthen dikes. The following lists some methods and activities that would further reduce the probability of failure of the Waste Storage Area dikes due to slope instability:

1) Performance of periodic visual inspections of the dikes. These inspections would include looking for signs of seepage at the toe, any sloughing or cracking of the dike's surface, burrowing animals, and erosion or other tell-tale signs of problems with the dikes structural integrity.

2) Utilization of installed wells and piezometers in the vicinity of the dikes to monitor groundwater elevations. These elevations would indicate seepage trends and presence of hydrostatic conditions.

3) Periodic survey of the dikes utilizing the established survey network. Heavily overconsolidated clays have shown creep rates of roughly 0.5 to 1.0 feet per year for a slope varying from 17 degrees (3.3H:1V) near the top to 8 degrees (7.1H:1V) in the lower part of the slope (Winterkorn et. al 1975).

4) Prevention of activities that would permanently steepen the slope, increase the height, or otherwise lessen the stability of the dike. Additionally, activities that could increase soil erosion of the slopes should be prevented.

5) Employment of engineering design measures to provide additional stability to the slope. Stability analysis indicates Factors of Safety below the NAVFAC recommended values for the hypothetical events of high groundwater and a 500-year earthquake. Engineering measures can be taken to stabilize the slope against such events. One such measure would be to flatten the angle of the

exterior slope. Table 4-1 presents the results of XSTABL runs which show how the Factors of Safety for the Waste Pit 3 cross sections would improve if the slope is flattened from the existing 1.5H:1V to 2.5H:1V. Table 4-1 summarizes the effect of a flatter exterior slope. A descriptive summary of the stability analyses of the flattened slope (2.5H:1V) case are included in Appendix D.

Table 4-1 - Effect of Flatter Waste Pit 3 Exterior Slope

Item or Location	Dike Cross Section	Minimum Factor of Safety					
		Case 1 Low Groundwater Table		Case 2 High Groundwater Table		Case 3 Low Groundwater Table with Earthquake Loading	
		Existing (1.5:1) Exterior Slope	Flatter (2.5:1) Exterior Slope	Existing (1.5:1) Exterior Slope	Flatter (2.5:1) Exterior Slope	Existing (1.5:1) Exterior Slope	Flatter (2.5:1) Exterior Slope
NAVFAC[1] Recommended Minimum Factor of Safety	All	1.25	1.25	1.25	1.25	1.15	1.15
Waste Pit 3	T3-1,2,3	1.43	1.85	1.30	1.68	1.10	1.34
	T3-4,5,6	1.42	1.95	1.22	1.72	1.11	1.32

1. NAVFAC: Naval Facilities Engineering Command

SECTION 5

RECOMMENDATIONS

Based on the technical evaluation presented in this report, the following actions are recommended:

1) Perform weekly visual inspections of the dikes for evidence of fissures, cracking and slumping on the inside and outside slopes.

2) Monitor existing wells and piezometers in the vicinity of the dikes monthly to check groundwater elevations and to determine if piping or seepage paths are present due to breaching of the pit liners.

3) Perform semi-annual surveys of the dike to verify whether creep of overconsolidated clays is occurring. Such a condition may lead to failure of the slope over time.

4) Maintain exterior grass covered slopes free of vegetative overgrowth.

5) Assess the impacts of construction or remediation activities on short-term dike stability during planning phases of these activities.

6) Perform prompt corrective maintenance on the dike work areas following construction or remediation activities that could affect long-term slope stability or lead to erosion.

7) If in-place remediation is selected as the final remedial action for Waste Pit 3, employ an engineering design measure to increase the dike's long-term stability in the event of an earthquake.

SECTION 6

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APPENDIX A

BORING LOGS

Appendix A

CONTENTS

A-1 Description of Soil Boring Log Terminology ii

A-2 Borehole Land Surface Elevations ii

A-3 Legend . . . . . .

A-4 Log of Soil Boring . . . . . .

B5-1 . . . . . A-1
B5-3 . . . . . A-3
B5-4 . . . . . A-7
B5-6 . . . . . A-10
B5-7 . . . . . A-14
B5-9 . . . . . A-16
B5-10 . . . . . A-20
B5-12 . . . . . A-23
B5-13 . . . . . A-27
B5-15 . . . . . A-30
B5-A A-34
B3-1 . . . . . A-38
B3-3 . . . . . A-40
B3-4 . . . . . A-43
B3-6 . . . . . A-45
BC-1 . . . . . A-48
BC-3 . . . . . A-50

A.1 DESCRIPTION OF SOIL BORING LOG TERMINOLOGY

"Background": this presents the daily background readings for the Alpha, Beta/Gamma, and HNu meters.

"Depth (ft BLS)": this shows the depth, in feet, below land surface (BLS) from which samples were removed.

"B5-1-6": this is the sample number. The "B" stands for boring. The "5" indicates that the sample is from Waste Pit 5. The "1" indicates that the sample is from boring B5-1. The final "6" indicates that this was the sixth sample to be removed from this borehole.

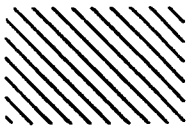
"5-8-6-12": these are the number of blows required to drive a splitspoon sample through each 6-inch interval for a total of 24 inches. When only three numbers are shown, the spoon was only driven 18 inches.

"400 PSI": this is the maximum pressure applied by the rig hydraulic to push a given Shelby tube sample.

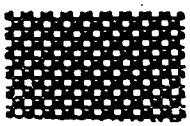
A.2 BOREHOLE LAND SURFACE ELEVATIONS

Boring No.	Elevation (Ft. MSL)
B5-1	572.0
B5-3	590.3
B5-4	571.2
B5-6	590.5
B5-7	570.4
B5-9	590.2
B5-10	576.1
B5-12	590.4
B5-13	580.0
B5-15	590.1
B5-A	590.3
B3-1	563.4
B3-3	585.8
B3-4	558.9
B3-6	580.9
BC-1	557.7
BC-3	576.4

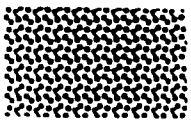
A.3 LEGEND



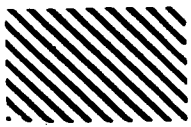
BROWNISH-YELLOW CLAYS



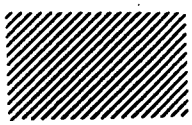
GRAY CLAYS



YELLOW/VERY PALE BROWN CLAYS

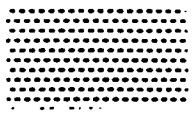


YELLOWISH-BROWN CLAYS

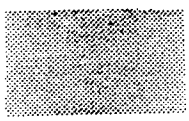


DARK YELLOWISH-BROWN CLAYS

OLIVE CLAYS



DARK BROWN CLAYS



SANDS

NOTE: The colors are based on the Munsell Color Book descriptions, whose specific codes can be seen in the boring logs.

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

SOIL BORING NO.: B5-1
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/30/91
BORING COMPLETED: 9/30/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 19.0
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 70; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0								TOP & BOTTOM: BROWNISH-YELLOW (10YR 6/8) CLAY WITH SOME FINE (1/8") GRAVEL, DRY.	BKGD	0	1108
		AUGERED THROUGH THIS INTERVAL									
2.0	B5-1-1	5-6-11-11	2	4	1.9			STIFF BROWNISH-YELLOW (10YR 6/8) CLAY WITH TRACE TO SOME GRAVEL (1/4"), DRY.	BKGD	0	1533
3.0											
4.0	B5-1-2	3-4-7-9	4	6	1.9			STIFF BROWNISH-YELLOW (10YR 6/8) CLAY WITH TRACE TO SOME GRAVEL (1/4"), DRY.	BKGD	0	1537
5.0											
6.0	B5-1-3	350 PSI	6	8.5	2.3			TOP: BROWNISH-YELLOW (10YR 6/8) CLAY WITH TRACE TO SOME GRAVEL (1/4"), DRY. BOTTOM: GRAY (10YR 5/1) CLAY WITH TRACE GRAVEL (1/2"), DRY.	BKGD	0	1605
7.0											
8.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0											
		AUGERED THROUGH THIS INTERVAL									
9.0	B5-1-4	400 PSI	9	11.5	2.3			TOP & BOTTOM: GRAY (10YR 5/1) CLAY WITH TRACE GRAVEL (1/2"), DRY TO MOIST.	BKGD	0	1630
10.0											
11.0											
		AUGERED THROUGH THIS INTERVAL									
12.0	B5-1-5	380 PSI	12	14.5	2.3			TOP & BOTTOM: GRAY (10YR 5/1) CLAY WITH TRACE GRAVEL (1/2"), DRY TO MOIST.	BKGD	0	1650
13.0											
14.0											
		AUGERED THROUGH THIS INTERVAL									
15.0	B5-1-6	4-7-6-8	15	17	1.6			MEDIUM GRAY (10YR 5/1) CLAY WITH SOME COARSE (3/4") GRAVEL, DRY TO MOIST. * SAND LENS FROM 0.4 TO 0.8'.	BKGD	0	1659
16.0											
17.0	B5-1-7	5-10-15-21	17	19	1.9			HARD GRAY (10YR 5/1) CLAY WITH TRACE TO SOME COARSE (1") ANGULAR GRAVEL (IN LOWER 1.0'), DRY TO MOIST.	BKGD	0	1706

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

An Employee-Owned Company

SOIL BORING NO.: B5-3
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/12/91
BORING COMPLETED: 9/13/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 35.5
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 200; HNu: 1.5ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
		AUGERED THROUGH THIS INTERVAL									
1.0	B5-3-1	5-9-17	1	2.5	1			TOP 0.3': LOOSE TOPSOIL BOTTOM 0.7': HARD YELLOW (5Y 7/6) CLAY, DRY.	BKGD	1	1028
2.0											
	B5-3-2A/B	7-24-20	2.5	4	1.2			A: TOP 0.7': HARD YELLOW (5Y 7/6) CLAY, DRY. B: BOTTOM 0.5': HARD YELLOWISH-BROWN (10YR 5/4) CLAY WITH SOME ROUNDED GRAVEL (1/8"), DRY.	BKGD	1	1035
3.0								* 2 SAMPLES			
4.0	B5-3-3	800 PSI	4	5	0.8			YELLOWISH-BROWN (10YR 5/4) CLAY WITH SOME ANGULAR LIMESTONE GRAVEL (1/4"), DRY. * FAILED SHELBY TUBE	BKGD	1	1045
5.0	B5-3-4	12-16-17	5	6.5	0.9			HARD YELLOWISH-BROWN (10YR 5/4) CLAY WITH SOME ANGULAR LIMESTONE GRAVEL (1/4"), DRY.	BKGD	1	1055
6.0											
	B5-3-5	10-11-8	6.5	8	0			* NO SAMPLE RECOVERED	BKGD	1	1100
7.0											
8.0			SEE P.2								

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0	B5-3-6	600 PSI	8	9	1			DARK YELLOWISH-BROWN (10YR 4/4) CLAY WITH LARGE ANGULAR LIMESTONE GRAVEL AND TRACE TO SOME SILT AND FINE SAND, DRY.	BKGD	1	1110
9.0	B5-3-7	14-16-13	9	10.5	0.87			DARK YELLOWISH-BROWN (10YR 4/6) CLAY WITH SOME ANGULAR LIMESTONE GRAVEL (1/8 - 1/2"), DRY.	BKGD	0.2	820
10.0	B5-3-8A/B	9-10-4	10.5	12	0.82			A: TOP 0.32': DARK YELLOWISH-BROWN (10YR 4/6) CLAY WITH ANGULAR LIMESTONE GRAVEL (1/8 - 1/2"), DRY. B: BOTTOM 0.5': STIFF OLIVE (5Y 5/3) CLAY WITH TRACE FINE (1/8") ROUNDED GRAVEL, DRY.	BKGD	0.2	830
11.0											
12.0	B5-3-9	7-9-15	12	13.5	0.3			STIFF OLIVE (5Y 5/3) CLAY WITH TRACE FINE (1/8") ROUNDED GRAVEL, DRY.	BKGD	0.2	835
13.0	B5-3-10	5-8-9	13.5	15	1.5			STIFF OLIVE (5Y 5/3) CLAY, DRY.	BKGD	0.2	840
14.0											
15.0	B5-3-11	5-7-10	15	16.5	1.5			STIFF OLIVE (5Y 5/3) CLAY, DRY.	BKGD	0.2	845
16.0	B5-3-12A/B	4-5-8	16.5	18	1.37			A: TOP 0.6': MEDIUM OLIVE (5Y 5/3) CLAY, DRY. B: BOTTOM 0.77': MEDIUM DARK BROWN (7.5YR 3/4) CLAY, DRY.	BKGD	0.2	855
17.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0	B5-3-13	800 PSI	18	19	0.3			MEDIUM DARK BROWN (7.5YR 3/4) CLAY WITH FINE (1/8") ROUNDED GRAVEL, DRY.	BKGD	0.2	910
19.0	B5-3-14A/B	9-10-11	19	20.5	1.5			A: TOP 0.4': STIFF DARK BROWN (7.5YR 3/4) CLAY WITH FINE (1/8") ROUNDED GRAVEL, DRY. B: BOTTOM 1.1': STIFF YELLOWISH-BROWN (10YR 5/8) CLAY WITH TRACE COARSE GRAVEL, DRY.	BKGD	0.2	940
20.0	B5-3-15	5-7-10	20.5	22	1.5			STIFF YELLOWISH-BROWN (10YR 5/8) CLAY, DRY.	BKGD	0.2	948
21.0											
22.0	B5-3-16	11-19-12	22	23.5	1			HARD YELLOWISH-BROWN (10YR 5/8) CLAY WITH SOME TO MANY GRAVEL (1/8 - 1"), DRY.	BKGD	0.2	955
23.0	B5-3-17	4-3-9	23.5	25	1.5			MEDIUM GRAY (10YR 5/1) CLAY, DRY TO MOIST.	BKGD	0.2	1000
24.0											
25.0	B5-3-18	4-3-6	25	26.5	1.27			TOP 0.2': MEDIUM BROWN CLAY, DRY. BOTTOM 1.07': MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE GRAVEL, DRY TO MOIST.	BKGD	0.2	1005
26.0	B5-3-19	5-5-8	26.5	28	1.17			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE GRAVEL, DRY TO MOIST.	BKGD	0.2	1015
27.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
28.0	B5-3-20	3-6-7	28	29.5	1.38			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0.2	1020
29.0	B5-3-21	2-3-7	29.5	31	1.37			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0.2	1023
30.0											
31.0	B5-3-22	2-4-6	31	32.5	1.42			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0.2	1030
32.0	B5-3-23	2-5-7	32.5	34	1.47			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0.2	1035
33.0											
34.0	B5-3-24	4-6-7	34	35.5	1.3			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0.2	1040
35.0											

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SAIC
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SITE: WASTE PIT #5

SOIL BORING NO.: B5-4
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 10/1/91
BORING COMPLETED: 10/1/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 21.5
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 70; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
		AUGERED THROUGH THIS INTERVAL									
1.0	B5-4-1	200 PSI	1	3.5	2.3			TOP & BOTTOM: BROWNISH-YELLOW (10YR 6/8) CLAY WITH SOME FINE (1/8") GRAVEL, DRY.	BKGD	0	1108
2.0											
3.0											
		AUGERED THROUGH THIS INTERVAL									
4.0	B5-4-2	600 PSI	4	6	1.3			TOP & BOTTOM: BROWNISH-YELLOW (10YR 6/8) CLAY WITH SOME FINE (1/8") GRAVEL, DRY.	BKGD	0	1125
5.0											
6.0											
		AUGERED THROUGH THIS INTERVAL									
7.0	B5-4-3	4-5-8-9	7	9	1.5			TOP 0.5': BROWNISH-YELLOW (10YR 6/8) CLAY WITH SOME FINE (1/8") GRAVEL, DRY. BOTTOM 1': MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE (1/8") ANGULAR GRAVEL, MOIST TO DRY.	BKGD	0	1134
8.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0											
9.0	B5-4-4	4-5-6-8	9	11	1.8			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE (1/8") ANGULAR GRAVEL, MOIST TO DRY.	BKGD	0	1228
10.0											
11.0											
		AUGERED THROUGH THIS INTERVAL									
12.0	B5-4-5	250 PSI	12	14.5	2.3			GRAY (10YR 5/1) CLAY, MOIST TO DRY.	BKGD	0	1248
13.0											
14.0											
		AUGERED THROUGH THIS INTERVAL									
15.0	B5-4-6	200 PSI	15	17.5	2.3			GRAY (10YR 5/1) CLAY, MOIST TO DRY.	BKGD	0	1306
16.0											
17.0											
	B5-4-7	3-4-5-5	17.5	19.5	1.9			MEDIUM GRAY (10YR 5/1) CLAY, MOIST TO DRY.	BKGD	0	1310

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0											
19.0	B5-4-8	5-7-6-9	19.5	21.5	1.9			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE (1/8") WELL-ROUNDED GRAVEL, MOIST TO DRY.	BKGD	0	1315
20.0											
21.0											

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

SOIL BORING NO.: B5-6
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/14/91
BORING COMPLETED: 9/14/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 37.0
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 20; BETA/GAMMA: 60; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
		AUGERED THROUGH THIS INTERVAL									
1.0	B5-6-1	7-17-20	1	2.5	1.32			HARD YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE FINE ANGULAR GRAVEL, VERY DRY.	BKGD	0	802
2.0											
	B5-6-2	8-10-4	2.5	4	1.2			TOP 0.3': MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE FINE ANGULAR GRAVEL, VERY DRY. BOTTOM 0.9': MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY, DRY.	BKGD	0	806
3.0											
4.0	B5-6-3	6-8-8	4	5.5	1.5			MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY, DRY.	BKGD	0	810
5.0											
	B5-6-4	5-10-13	5.5	7	0.9			MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY, DRY TO MOIST.	BKGD	0	813
6.0											
7.0	B5-6-5	6-22-9	7	8.5	1			TOP 0.7': HARD YELLOWISH-BROWN (10YR 5/4) CLAY, DRY TO MOIST. BOTTOM 0.3': HARD YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE ANGULAR GRAVEL (1"), DRY.	BKGD	0	822
8.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0											
	B5-6-6	12-7-8	8.5	10	1.2			MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE FINE (1/8") GRAVEL, DRY TO MOIST.	BKGD	0	825
9.0											
10.0	B5-6-7	8-7-7	10	11.5	0.9			TOP 0.6': MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE FINE (1/8") GRAVEL, DRY TO MOIST. BOTTOM 0.3': MEDIUM OLIVE (5Y 5/6) CLAY WITH TRACE FINE GRAVEL, DRY TO MOIST.	BKGD	0	830
11.0											
	B5-6-8	9-17-12	11.5	13	0.1			HARD OLIVE (5Y 5/6) CLAY WITH TRACE FINE GRAVEL, DRY TO MOIST. * NO SAMPLE	BKGD	0	835
12.0											
13.0	B5-6-9	3-6-8	13	14.5	1.1			MEDIUM OLIVE (5Y 5/6) CLAY WITH BLACK MOTTLING AND TRACE FINE GRAVEL, DRY TO MOIST.	BKGD	0	838
14.0											
	B5-6-10	5-7-8	14.5	16	1.1			MEDIUM OLIVE (5Y 5/6) CLAY WITH TRACE FINE GRAVEL, DRY TO MOIST.	BKGD	0	841
15.0											
16.0	B5-6-11	3-5-7	16	17.5	1.3			MEDIUM OLIVE (5Y 5/6) CLAY WITH BLACK MOTTLING, DRY TO MOIST.	BKGD	0	849
17.0											
	B5-6-12	2-3-4	17.5	19	1.1			SOFT OLIVE (5Y 5/6) CLAY WITH BLACK MOTTLING, DRY TO MOI	BKGD	0	853

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0											
19.0	B5-6-13	400 PSI	19	20.5	1.5			OLIVE (5Y 5/6) CLAY WITH TRACE FINE (1/4") GRAVEL, DRY TO MOIST.	BKGD	0	902
20.0	B5-6-14A/B	4-8-13	20.5	22	1.2			A: TOP 0.5': STIFF OLIVE (5Y 5/6) CLAY, DRY TO MOIST. B: BOTTOM 0.7': STIFF YELLOWISH-BROWN (10YR 5/8) CLAY, DRY TO MOIST.	BKGD	0	1024
21.0											
22.0	B5-6-15	5-10-16	22	23.5	1.4			HARD YELLOWISH-BROWN (10YR 5/8) CLAY, DRY TO MOIST.	BKGD	0	1029
23.0	B5-6-16	5-9-14	23.5	25	1.5			STIFF YELLOWISH-BROWN (10YR 5/8) CLAY, DRY TO MOIST.	BKGD	0	1034
24.0											
25.0	B5-6-17	4-8-12	25	26.5	1.2			STIFF YELLOWISH-BROWN (10YR 5/8) CLAY WITH TRACE ANGULAR GRAVEL, DRY TO MOIST.	BKGD	0	1037
26.0	B5-6-18	2-6-8	26.5	28	1.2			TOP 0.4': MEDIUM YELLOWISH-BROWN (10YR 5/8) CLAY WITH TRACE ANGULAR GRAVEL, DRY TO MOIST. BOTTOM 0.8': MEDIUM GRAY (10YR 5/1) CLAY, MOIST TO DRY.	BKGD	0	1048
27.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
28.0	B5-6-19	3-5-8	28	29.5	1.4			MEDIUM GRAY (10YR 5/1) CLAY, MOIST TO DRY.	BKGD	0	1052
29.0	B5-6-20	5-8-7	29.5	31	1.4			MEDIUM GRAY (10YR 5/1) CLAY, MOIST TO DRY.	BKGD	0	1058
30.0											
31.0	B5-6-21	400 PSI	31	33	2			GRAY (10YR 5/1) CLAY, MOIST TO DRY.	BKGD	0	1115
32.0											
33.0	B5-6-22	5-4-7	33	34.5	1.45			MEDIUM GRAY (10YR 5/1) CLAY, MOIST TO DRY.	BKGD	0	1121
34.0											
35.0	B5-6-23	6-15-12-12	35	37	1.95			TOP 1.0': HARD GRAY (10YR 5/1) CLAY, MOIST TO DRY. 1.0-1.6': HARD GRAY (10YR 5/1) CLAY WITH TRACE TO SOME GRAVEL, MOIST TO DRY. 1.6-1.95': HARD, V. POORLY SORTED GRAY (10YR 5/1) SAND, MEDIUM TO COARSE, WITH SOME GRAVEL, SILT AND CLAY.	BKGD	0	1140

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

SOIL BORING NO.: B5-7
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/29/91
BORING COMPLETED: 9/29/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 17.0
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 80; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0		AUGERED THROUGH THIS INTERVAL									
2.0	B5-7-1	3-9-9-11	2	4	1.7			STIFF BROWNISH-YELLOW (10YR 6/6) CLAY WITH TRACE TO SOME COARSE (1") ANGULAR GRAVEL, DRY TO MOIST. BOTTOM 0.2': STIFF GRAY (10YR 5/1) CLAY, DRY.	BKGD	0	929
3.0											
4.0	B5-7-2	3-4-6-6	4	6	1.6			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE TO NO FINE (1/8") GRAVEL, MOIST.	BKGD	0	936
5.0											
6.0		AUGERED THROUGH THIS INTERVAL									
7.0	B5-7-3	380 PSI	7	9.5	2.3			GRAY (10YR 5/1) CLAY WITH TRACE TO NO FINE (1/8") GRAVEL, MOIST.	BKGD	0	1005

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0											
9.0											
		AUGERED THROUGH THIS INTERVAL									
10.0	B5-7-4	200 PSI	10	12.5	2.3			GRAY (10YR 5/1) CLAY WITH TRACE TO NO FINE (1/8") GRAVEL, MOIST.	BKGD	0	1031
11.0											
12.0											
		AUGERED THROUGH THIS INTERVAL									
13.0	B5-7-5	2-3-4-8	13	15	1.6			GRAY (10YR 5/1) CLAY, MOIST.	BKGD	0	1049
14.0											
15.0	B5-7-6	4-10-13-19	15	17	1.8			TOP 1.4': MEDIUM GRAY (10YR 5/1) CLAY, MOIST. BOTTOM 0.4': MEDIUM GRAY (10YR 5/1) CLAY WITH ANGULAR GRAVEL (1/2"), DRY.	BKGD	0	1052
16.0											
17.0											

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

SOIL BORING NO.: B5-9
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/15/91
BORING COMPLETED: 9/15/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 37.0
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 90; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0		AUGERED THROUGH THIS INTERVAL									
	B5-9-1	4-4-7-10	0.5	2.5	0.8			TOP 0.3': BROWN TOPSOIL, LOOSE, MOIST. BOTTOM 0.5': MEDIUM DARK YELLOWISH-BROWN (10YR 4/6) CLAY, DRY TO MOIST.	BKGD	0	808
1.0											
2.0		AUGERED THROUGH THIS INTERVAL									
3.0	B5-9-2	7-6-8-8	3	5	1.4			TOP 0.4': MEDIUM DARK YELLOWISH-BROWN (10YR 4/6) CLAY WITH TRACE TO SOME ANGULAR GRAVEL, DRY TO MOIST. BOTTOM 1.0': MEDIUM DARK YELLOWISH-BROWN (10YR 4/6) CLAY, DRY TO MOIST.	BKGD	0	812
4.0											
5.0	B5-9-3	5-8-9-12	5	7	1.8			STIFF DARK YELLOWISH-BROWN (10YR 4/6) CLAY, DRY TO MOIST.	BKGD	0	818
6.0											
7.0	B5-9-4	11-9-15-13	7	9	0.6			STIFF DARK YELLOWISH-BROWN (10YR 4/6) CLAY, DRY TO MOIST.	BKGD	0	823
8.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0											
9.0	B5-9-5	6-6-7-9	9	11	1.6			MEDIUM DARK YELLOWISH-BROWN (10 YR 4/6) CLAY, DRY TO MOIST, WITH A LAYER OF OLIVE (5Y 5/6) CLAY WITH BLACK MOTTLING FROM 0.9 - 1.1'.	BKGD	0	828
10.0											
11.0	B5-9-6	4-6-7-10	11	13	1.5			TOP 0.4': MEDIUM DARK YELLOWISH-BROWN (10YR 4/6) CLAY, DRY TO MOIST. BOTTOM 0.9': MEDIUM OLIVE (5Y 5/6) CLAY WITH BLACK MOTTLING, DRY TO MOIST.	BKGD	0	834
12.0											
13.0	B5-9-7	4-6-7-14	13	15	1.6			TOP 0.6': MEDIUM OLIVE (5Y 5/6) CLAY WITH BLACK MOTTLING, DRY TO MOIST. BOTTOM 1.0': MEDIUM OLIVE (5Y 5/6) CLAY WITH GRAY MOTTLING, DRY TO MOIST.	BKGD	0	838
14.0											
15.0	B5-9-8	5-10-12-14	15	17	1.6			STIFF OLIVE (5Y 5/6) CLAY WITH BLACK MOTTLING, DRY TO MOIST.	BKGD	0	848
16.0											
17.0	B5-9-9	4-4-7-9	17	19	1.6			TOP 0.6': MEDIUM OLIVE (5Y 5/6) CLAY WITH BLACK MOTTLING, DRY TO MOIST. BOTTOM 1.1': MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY, DRY TO MOIST.	BKGD	0	856

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0											
19.0	B5-9-10	3-3-4-5	19	21	1.55			A: TOP 0.5': MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY, DRY TO MOIST. B: BOTTOM 1.05': MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE TO SOME GRAVEL, MOIST.	BKGD	0	901
20.0											
21.0	B5-9-11	600 PSI	21	23	1			* NO DESCRIPTION AVAILABLE - MATERIAL IN CRUMPLED TUBE APPEARED TO BE SIMILAR TO THAT IN SAMPLE B5-9-10. * NO SAMPLE TAKEN.	BKGD	0	922
22.0											
23.0	B5-9-12	3-9-10-12	23	25	0.5			MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE TO SOME ANGULAR GRAVEL (1/8"), DRY TO MOIST.	BKGD	0	930
24.0											
25.0	B5-9-13	5-8-7-8	25	27	0.2			MEDIUM GRAY (10YR 5/1) CLAY, MOIST. * NO SAMPLE.	BKGD	0	937
26.0											
27.0	B5-9-14	4-5-7-7	27	29	1.1			MEDIUM GRAY (10YR 5/1) CLAY, MOIST.	BKGD	0	940

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
28.0											
29.0	B5-9-15	6-7-5-5	29	31	0.9			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE (1/16") WELL-ROUNDED GRAVEL, MOIST.	BKGD	0	945
30.0											
31.0	B5-9-16	200 PSI	31	33	2			MEDIUM GRAY (10YR 5/1) CLAY, MOIST.	BKGD	0	1040
32.0											
33.0	B5-9-17	400 PSI	33	35	1			MEDIUM GRAY (10YR 5/1) CLAY, MOIST. * LOST/RECAUGHT SHELBY SAMPLE.	BKGD	0	1100
34.0											
35.0	B5-9-18	8-10-25-50	35	37	1.3			HARD GRAY (10YR 5/1) CLAY, MOIST. * HIGH BLOWS MAY BE A RESULT OF SAND LOST IN THE UPLIFT OF THE SPOON.	BKGD	0	1123
36.0											
37.0											

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

SOIL BORING NO.: B5-10
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/28/91
BORING COMPLETED: 9/28/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 21.5
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 80; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0											
		AUGERED THROUGH THIS INTERVAL									
2.0	B5-10-1A/B	6-7-6-9	2	4	1.4			A: TOP 0.6': MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY WITH ANGULAR GRAVEL (1/8"), DRY. B: BOTTOM 0.8': MEDIUM BROWNISH-YELLOW (10YR 6/8) CLAY, DRY TO MOIST.	BKGD	0	1344
3.0											
4.0	B5-10-2	3-3-3-3	4	6	1.3			MEDIUM BROWNISH-YELLOW (10YR 6/8) CLAY, DRY TO MOIST.	BKGD	0	1347
5.0											
6.0	B5-10-3	380 PSI	6	8	2.3*			BROWNISH-YELLOW (10YR 6/8) CLAY, DRY TO MOIST. * SLOUGH IN TOP.	BKGD	0	1416
7.0											
8.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0											
		AUGERED THROUGH THIS INTERVAL									
9.0	B5-10-4	380 PSI	9	10	1.9*			BROWNISH-YELLOW (10YR 6/8) CLAY, DRY TO MOIST. * SLOUGH IN TOP.	BKGD	0	1430
10.0											
11.0											
		AUGERED THROUGH THIS INTERVAL									
12.0	B5-10-5	6-6-8-8	12	14	1			MEDIUM BROWNISH-YELLOW (10YR 6/8) CLAY WITH TRACE ANGULAR GRAVEL (1/4"), DRY.	BKGD	0	1444
13.0											
14.0	B5-10-6	4-4-5-8	14	16	1.3			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE ROUNDED GRAVEL (1/8"), DRY TO MOIST.	BKGD	0	1453
15.0											
16.0	B5-10-7	380 PSI	16	18.5	2.2			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE ROUNDED GRAVEL (1/8"), DRY TO MOIST.	BKGD	0	1518
17.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0											
		AUGERED THROUGH THIS INTERVAL									
19.0	B5-10-8	380 PSI	19	21.5	2.1			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE ROUNDED GRAVEL (1/8"), DRY TO MOIST.	BKGD	0	1541
20.0											
21.0											

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

SOIL BORING NO.: B5-12
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/16/91
BORING COMPLETED: 9/16/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 37.0
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 50; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0											
2.0											
3.0											
		AUGERED THROUGH THIS INTERVAL									
4.0											
5.0											
6.0											
7.0											
8.0	B5-12-1	250 PSI	8	10	1.8			DARK YELLOWISH-BROWN (10YR 4/6) CLAY WITH COARSE (UP TO 1.5") ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0	1325

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Doc. Control No.: 01TE01069202
Rev. No.: 0

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3464

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
9.0											
10.0											
11.0		AUGERED THROUGH THIS INTERVAL									
12.0	B5-12-2	300 PSI	12	14	1.3			OLIVE (5Y 5/6) CLAY WITH TRACE FINE (1/8") ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0	1412
13.0											
14.0											
15.0											
16.0											
		AUGERED THROUGH THIS INTERVAL									
17.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0											
		AUGERED THROUGH THIS INTERVAL									
19.0											
20.0	B5-12-3	100 PSI	20	22	2			YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE FINE (1/8") GRAVEL, DRY TO MOIST.	BKGD	0	1500
21.0											
22.0											
23.0											
24.0		AUGERED THROUGH THIS INTERVAL									
25.0											
26.0	B5-12-4A/B	4-5-7-8	26	28	1.1			A: TOP 0.6': MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY, DRY TO MOIST. B: BOTTOM 0.5': MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE (1/8") WELL-ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0	1520
27.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
28.0											
29.0											
30.0		AUGERED THROUGH THIS INTERVAL									
31.0											
32.0											
33.0	B5-12-5	4-5-7-10	33	35	1.5			GRAY (10YR 5/1) CLAY WITH TRACE FINE (1/8") WELL-ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0	1535
34.0											
35.0	B5-12-6	3-6-11-20	35	37	1.3			GRAY (10YR 5/1).CLAY WITH TRACE FINE (1/8") WELL-ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0	1544
36.0											
37.0											

An Employee-Owned Company

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

SOIL BORING NO.: B5-13
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/27/91
BORING COMPLETED: 9/27/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 22.5
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 80; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0		AUGERED THROUGH THIS INTERVAL									
2.0	B5-13-1	9-12-10-9	2	4	2			STIFF YELLOWISH-BROWN (10YR 5/4) CLAY WITH SOME ANGULAR GRAVEL (1/4"), DRY.	BKGD	0	1020
3.0											
4.0	B5-13-2A/B	5-5-5-6	4	6	1.5			A: TOP 1': MEDIUM YELLOWISH-BROWN 910YR 5/4) CLAY WITH SOME ANGULAR GRAVEL (1/4"), DRY. B: BOTTOM 0.5': MEDIUM DARK OLIVE (5Y 3/2) CLAY, DRY TO MOIST.	BKGD	0	1028
5.0											
6.0	N/A	400 PSI	6	7	0.5			YELLOWISH-BROWN (10YR 5/4) CLAY WITH MEDIUM (1/2") GRAVEL, DRY. * SHELBY TUBE HIT ROCK.	BKGD	0	NR
7.0	B5-13-3	3-4-7-8	7	9	1.6			MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY, MOIST.	BKGD	0	1043
8.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
9.0	B5-13-4	180 PSI	9	11.5	1.9			TOP: YELLOWISH-BROWN (10YR 5/4) CLAY, MOIST. BOTTOM: YELLOW (10YR 7/8) SANDY SILT, MOIST TO DRY.	BKGD	0	1102
10.0											
11.0											
		AUGERED THROUGH THIS INTERVAL									
12.0	B5-13-5	100 PSI	12	14.5	2.3			TOP: YELLOW (10YR 7/8) SANDY SILT, MOIST TO DRY. BOTTOM: YELLOW (10YR 7/8) SANDY SILT, DRY.	BKGD	0	1447
13.0											
14.0											
		AUGERED THROUGH THIS INTERVAL									
15.0	B5-13-6A/B	5-4-3-9	15	17	1.4			A: TOP 0.7': MEDIUM YELLOW (10YR 7/8) SANDY SILT, MOIST. B: BOTTOM 0.7': MEDIUM GRAY (10YR 5/1) CLAY WITH NO TO TRACE FINE (1/8") GRAVEL, MOIST.	BKGD	0	1509
16.0											
17.0	B5-13-7	200 PSI	17	19.5	2			TOP: YELLOW (10YR 7/8) SANDY SILT, MOIST. BOTTOM: GRAY (10YR 5/1) CLAY, DRY.	BKGD	0	1541

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0											
19.0		AUGERED THROUGH THIS INTERVAL									
20.0	B5-13-8	700 PSI	20	22.5	1.5			TOP & BOTTOM: GRAY (10YR 5/1) CLAY WITH TRACE WELL-ROUNDED GRAVEL (1/8"), DRY.	BKGD	0	1605
21.0											
22.0											

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

SOIL BORING NO.: B5-15
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/17/91
BORING COMPLETED: 9/18/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 30.0
TOTAL DEPTH ELEVATION:
BACKGROUND (9/17/91): ALPHA: 0; BETA/GAMMA: 100; HNu: 0ppm
BACKGROUND (9/18/91): ALPHA: 0; BETA/GAMMA: 50; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0											
2.0											
3.0											
4.0		AUGERED THROUGH THIS INTERVAL									
5.0											
6.0											
7.0											
8.0	B5-15-1	300 PSI	8	10	1.65			YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE FINE (1/8") ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0	1111

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
9.0											
10.0	B5-15-2	5-6-4-5	10	12	1.3			MEDIUM OLIVE (5Y 5/4) CLAY WITH SOME ANGULAR GRAVEL (1/8 - 1/2"), DRY.	BKGD	0	1133
11.0											
12.0	B5-15-3	6-11-11-19	12	14	1.7			TOP 1.4': STIFF DARK YELLOWISH-BROWN (10YR 4/4) CLAY WITH TRACE GRAVEL (1/4"), DRY. BOTTOM 0.3': STIFF DARK OLIVE (5Y 2.5/2) CLAY, MOIST.	BKGD	0	1542
13.0											
14.0	B5-15-4	6-8-8-9	14	16	1.5			STIFF DARK OLIVE (5Y 2.5/2) CLAY, MOIST.	BKGD	0	1549
15.0											
16.0	B5-15-5	300 PSI	16	18	2			TOP: DARK OLIVE (5Y 2.5/2) CLAY, MOIST. BOTTOM: YELLOWISH-BROWN (10YR 5/4) CLAY, DRY.	BKGD	0	1619
17.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0	B5-15-6	5-6-6-6	18	20	1.3			TOP 0.9': MEDIUM DARK YELLOWISH-BROWN (10YR 4/6) CLAY, DRY. BOTTOM 0.4': MEDIUM DARK GRAY (5Y 4/1) CLAY, MOIST.	BKGD	0	808
19.0											
20.0	B5-15-7	4-5-7-7	20	22	2			TOP 1.3': MEDIUM DARK GREY (5Y 4/1) CLAY, MOIST. BOTTOM 0.7': MEDIUM LIGHT GRAY (5Y 7/1) CLAY, DRY TO MOIST.	BKGD	0	815
21.0											
22.0	B5-15-8	200 PSI	22	24	1.9			TOP: DARK GRAY (5Y 4/1) CLAY WITH LIGHT GRAY (5Y 7/1) MOTTLING, DRY. BOTTOM: YELLOW (10YR 7/8) SILTY SAND, SATURATED TO MOIST.	BKGD	0	850
23.0											
24.0	B5-15-9	4-8-8-10	24	26	2			STIFF YELLOW (10YR 7/8) SILTY SAND WITH TRACE TO SOME CLAY, SATURATED. 0.4-1.65': LIGHT GRAY (5Y 7/1) CLAY, DRY.	BKGD	0	905
25.0											
26.0	B5-15-10	400 PSI	26	28	1.8			TOP: YELLOW (10YR 7/8) SILTY SAND WITH SOME LIGHT GRAY (5Y 7/1) CLAY, SATURATED. BOTTOM 0.1': LIGHT GRAY (5Y 7/1) CLAY, DRY.	BKGD	0	955
27.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
28.0	B5-15-11	4-8-10-13	28	30	NR			STIFF GRAY (10YR 5/1) CLAY, DRY TO MOIST.	BKGD	0	1005
29.0											
30.0	B5-15-12	4-4-6-10	30	32	NR			STIFF GRAY (10YR 5/1) CLAY, DRY TO MOIST.	BKGD	0	1055
31.0											
32.0											

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #5

An Employee-Owned Company

SOIL BORING NO.: B5-A
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/19/91
BORING COMPLETED: 9/24/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 38.0
TOTAL DEPTH ELEVATION:
BACKGROUND (9/19/91): ALPHA: 0; BETA/GAMMA: 50; HNu: 0ppm
BACKGROUND (9/24/91): ALPHA: 0; BETA/GAMMA: 50; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
		AUGERED THROUGH THIS INTERVAL									
1.0	B5-A-1	10-16-16-21	1	3	1.7			HARD DARK YELLOWISH-BROWN (10YR 4/6) CLAY WITH SOME COARSE (1") ANGULAR GRAVEL, DRY.	BKGD	0	1006
2.0											
3.0											
		AUGERED THROUGH THIS INTERVAL									
4.0	B5-A-2	650 PSI	4	6.5	1.85			YELLOWISH-BROWN (10YR 5/6) CLAY WITH SOME FINE (1/8 - 1/2") GRAVEL, DRY TO MOIST.	BKGD	0	1055
5.0											
6.0											
7.0		FAILED/EMPTY SHELBY TUBE									
8.0	B5-A-3	600 PSI	8	10.5	1.5			TOP: YELLOWISH-BROWN (10YR 5/6) CLAY, DRY TO MOIST. BOTTOM: OLIVE (5Y 5/1) CLAY, DRY TO MOIST.	BKGD	0	1500

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
9.0											
10.0											
		AUGERED THROUGH THIS INTERVAL									
11.0	B5-A-4	625 PSI	11	13.5	1.6			TOP & BOTTOM: OLIVE (5Y 5/1) CLAY WITH TRACE TO SOME FINE (1/8 - 1/4") ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0	1549
12.0											
13.0											
14.0			ROCK LODGED IN TUBE								
15.0											
16.0											
17.0	N/A	10-12-10-11	17	19	0			* NO RECOVERY	BKGD	0	856

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0											
19.0	B5-A-5	6-13-18-24	19	21	1.8			HARD YELLOWISH-BROWN (10YR 5/6) CLAY WITH COARSE (1") ROUNDED GRAVEL, DRY.	BKGD	0	904
	B5-A-C1/C2	N/A	CUTTINGS: APPROXIMATELY 21'.								
20.0											
21.0											
22.0		AUGERED THROUGH THIS INTERVAL									
23.0	B5-A-6	8-13-16-22	23	25	1.2			HARD YELLOWISH-BROWN (10YR 5/6) CLAY WITH COARSE (1") ROUNDED GRAVEL, DRY.	BKGD	0	941
24.0											
25.0	N/A	700 PSI	25	27	0			* NO RECOVERY	BKGD	0	NR
26.0											
27.0	N/A	8-11-15-15	27	29	0			* NO RECOVERY			
	B5-A-C3	N/A	CUTTINGS: APPROXIMATELY 27'.								

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
28.0											
29.0	B5-A-7	4-5-7-8	29	31	1.3			MEDIUM GRAY (10YR 5/1) CLAY WITH TRACE FINE (1/8") ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0	1051
	B5-A-C4	N/A	CUTTINGS: APPROXIMATELY 31'.								
30.0											
31.0	B5-A-8	200 PSI	31	33.5	1.6			TOP & BOTTOM: GRAY (10YR 5/1) CLAY WITH TRACE FINE (1/8") WELL-ROUNDED GRAVEL, DRY TO MOIST.	BKGD	0	1120
32.0											
33.0											
		AUGERED THROUGH THIS INTERVAL									
34.0	B5-A-9	200 PSI *	34	36	1.6			GRAY (10YR 5/1) CLAY, DRY TO MOIST. * TO 400 PSI TO PLUG END OF TUBE.	BKGD	0	1501
35.0											
36.0	B5-A-10	12-22-31-55	36	38	1.4			TOP 0.6': HARD GRAY (10YR 5/1) CLAY, DRY TO MOIST. 0.6-1.1': HARD GRAY (10YR 5/1) CLAY WITH MEDIUM (1/4") ANGULAR GRAVEL, DRY TO MOIST. 1.1-1.4': HARD GRAY (10YR 5/1) SAND, MEDIUM TO COARSE, DRY.	BKGD	0	1520
37.0											
38.0											

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #3

SAIC
An Employee-Owned Company

SOIL BORING NO.: B3-1
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/28/91
BORING COMPLETED: 9/28/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 13.0
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 80; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0		AUGERED THROUGH THIS INTERVAL									
2.0	B3-1-1A/B	5-5-8-7	2	4	1.5			TOP 1.2': MEDIUM DARK BROWN (10YR 3/3) CLAY, DRY. BOTTOM 0.3': MEDIUM BROWNISH-YELLOW (10YR 6/6) CLAY WITH SOME GRAVEL, DRY.	BKGD	0	951
3.0											
4.0		AUGERED THROUGH THIS INTERVAL									
5.0	B3-1-2	4-5-10-14	5	7	1.6			STIFF BROWNISH-YELLOW (10YR 6/6) CLAY WITH NO TO TRACE GRAVEL (1/8"), DRY.	BKGD	0	1000
6.0											
7.0	B3-1-3	8-8-10-15	7	9	1.9			STIFF BROWNISH-YELLOW (10YR 6/6) CLAY WITH TRACE TO SOME GRAVEL (1/4"), DRY.	BKGD	0	1007
8.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0											
9.0	B3-1-4	3-10-20-26	9	11	1.9			HARD GRAY (10YR 5/1) CLAY WITH TRACE TO SOME ROUNDED GRAVEL (1/8 - 1"), DRY.	BKGD	0	1014
10.0											
11.0	B3-1-5	4-12-16-16	11	13	1.3			TOP 0.3': HARD GRAY (10YR 5/1) CLAY WITH TRACE TO SOME ROUNDED GRAVEL (1/8 - 1"), DRY. BOTTOM 1': HARD GRAY (10YR 5/1) SAND, MEDIUM TO FINE, MOIST. * BOTTOM 0.1': SATURATED.	BKGD	0	1020
12.0											
13.0											

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #3

SOIL BORING NO.: B3-3
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 9/25/91
BORING COMPLETED: 9/25/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 24.0
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 100; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0		AUGERED THROUGH THIS INTERVAL									
1.0	B3-3-1	5-6-7-10	1	3	1.3			MEDIUM BROWNISH-YELLOW (10YR 6/8) CLAY WITH TRACE TO SOME GRAVEL (1/2"), DRY.	BKGD	0	1044
2.0											
3.0	B3-3-2	5-10-13-10	3	5	1.3			TOP 0.4': STIFF BROWNISH-YELLOW (10YR 6/8) CLAY WITH TRACE TO SOME GRAVEL (1/2"), DRY. BOTTOM 0.9': STIFF VERY DARK GRAY (10YR 3/1) CLAY (FLY ASH) WITH FINE GRAVEL, DRY.	BKGD	0	1049
4.0											
5.0	B3-3-3	425 PSI	5	7.5	1.95			TOP: VERY DARK GRAY (10YR 3/1) CLAY (FLY ASH) WITH FINE GRAVEL, DRY. BOTTOM: DARK YELLOW (10YR 4/4) CLAY WITH SOME GRAVEL (1/8 - 1/2"), DRY.	BKGD	0	1116
6.0											
7.0		AUGERED THROUGH THIS INTERVAL									
8.0		SEE P.2							BKGD	0	1500

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0	B3-3-4	180 PSI	8	10.5	2			TOP: DARK YELLOWISH-BROWN (10YR 4/4) CLAY WITH SOME GRAVEL (1/8 - 1/2"), DRY. BOTTOM: DARK OLIVE GRAY (5Y 3/2) CLAY WITH TRACE 1/4" GRAVEL, MOIST.	BKGD	0	1427
9.0											
10.0											
		AUGERED THROUGH THIS INTERVAL									
11.0	B3-3-5	700 PSI	11	13.5	1.95			TOP: OLIVE GRAY (5Y 3/2) CLAY WITH TRACE 1/4" GRAVEL, MOIST. BOTTOM: DARK YELLOWISH-BROWN (10YR 4/4) CLAY WITH GRAVEL, DRY.	BKGD	0	1503
12.0											
13.0											
		AUGERED THROUGH THIS INTERVAL									
14.0	B3-3-6	9-11-12-12	14	16	1.5			STIFF DARK YELLOWISH-BROWN (10YR 4/4) CLAY WITH TRACE COARSE SAND AND ANGULAR GRAVEL (1/8 - 1/2"), DRY.	BKGD	0	1515
15.0											
16.0	B3-3-7	6-9-11-20	16	18	1.2			STIFF DARK YELLOWISH-BROWN (10YR 4/4) CLAY WITH TRACE COARSE SAND AND ANGULAR GRAVEL (1/8 - 1/2"), DRY.	BKGD	0	1532
17.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0	N/A	6-7-10-12	18	20	0			• NO RECOVERY	BKGD	0	1546
19.0											
20.0	B3-3-9	4-6-9-11	20	22	1.5			STIFF DARK YELLOWISH-BROWN (10YR 4/4) CLAY WITH TRACE COARSE SAND AND ANGULAR GRAVEL (1/8 - 1/2"), DRY.	BKGD	0	1532
21.0											
22.0											
	AUGERED TO 24' WHERE SOIL BECAME EXCESSIVELY HARD TO DRILL.										
23.0											
24.0											

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #3

SOIL BORING NO.: B3-4
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 10/1/91
BORING COMPLETED: 10/1/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 14.0
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 75; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0		AUGERED THROUGH THIS INTERVAL									
2.0	B3-4-1	4-4-6-10	2	4	1.3			MEDIUM DARK BROWN (10YR 3/3) CLAY WITH TRACE GRAVEL (1/4"), DRY TO MOIST. * SAND LENS IN THE BOTTOM 0.2'.	BKGD	0	1512
3.0											
4.0	B3-4-2	3-3-6-17	4	6	0.5			MEDIUM DARK BROWN (10YR 3/3) CLAY WITH SOME 1/4" GRAVEL , DRY TO MOIST.	BKGD	0	1515
5.0											
6.0	B3-4-3A/B	5-7-8-12	6	8	1.6			A: TOP 0.6': STIFF DARK BROWN (10YR 3/3) CLAY WITH SOME 1/4" GRAVEL, DRY TO MOIST. B: BOTTOM 1': STIFF GRAY (10YR 5/1) CLAY WITH SOME COARSE (3/4") GRAVEL, DRY TO MOIST.	BKGD	0	1518
7.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0 - 9.0	B3-4-4	7-7-9-11	8	10	1.4			STIFF GRAY (10YR 5/1) CLAY WITH SOME COARSE (1") ANGULAR GRAVEL, DRY TO MOIST.	BKGD	0	1522
10.0 - 11.0	B3-4-5	5-5-7-8	10	12	1.6			MEDIUM GRAY (10YR 5/1) CLAY WITH SOME COARSE (3/4") GRAVEL, DRY TO MOIST. * BOTTOM 0.2': GRAY (10YR 5/1) MEDIUM SAND, DRY TO MOIST.	BKGD	0	1525
12.0 - 13.0 - 14.0	B3-4-6	9-8-10-12	12	14	1.2			TOP 0.3': LOOSE SLOUGH. BOTTOM 0.9': STIFF BROWNISH-YELLOW (10YR 6/6) SAND, MEDIUM, DRY TO MOIST.	BKGD	0	1530

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: WASTE PIT #3

An Employee-Owned Company

SOIL BORING NO.: B3-6
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 10/3/91
BORING COMPLETED: 10/3/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 26
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 80; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0		AUGERED THROUGH THIS INTERVAL									
2.0	B3-6-1	9-19-15-17	2	4	0.9			HARD YELLOWISH-BROWN (10YR 5/4) SILTY CLAY WITH SOME GRAVEL (1/2"), DRY.	BKGD	0	1047
3.0											
4.0	B3-6-2	10-9-13-14	4	6	1.3			TOP 0.4': HARD YELLOWISH-BROWN (10YR 5/4) SILTY CLAY WITH SOME GRAVEL (1/2"), DRY. BOTTOM 0.9': STIFF BROWNISH-YELLOW (10YR 6/6) CLAY WITH SOME COARSE (3/4") ANGULAR GRAVEL, VERY DRY.	BKGD	0	1051
5.0											
6.0	B3-6-3	15-8-9-10	6	8	1.2			STIFF BROWNISH-YELLOW (10YR 6/6) CLAY WITH SOME COARSE (3/4") ANGULAR GRAVEL, VERY DRY.	BKGD	0	1101
7.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0	B3-6-4	9-13-13-14	8	10	0.8			HARD BROWNISH-YELLOW (10YR 6/6) CLAY WITH SOME COARSE (3/4") ANGULAR GRAVEL, VERY DRY.	BKGD	0	1110
9.0											
10.0	N/A	5-50/3"	10	10.75	0						
11.0											
		AUGERED THROUGH THIS INTERVAL									
12.0	B3-6-5	NR	12	14	1.1			HARD BROWNISH-YELLOW (10YR 6/6) CLAY WITH SOME COARSE (3/4") ANGULAR GRAVEL, VERY DRY.	BKGD	0	1130
13.0											
14.0	B3-6-6	15-13-13-15	14	16	1.3			HARD OLIVE (5Y 4/4) CLAY WITH COARSE (3/4") ANGULAR GRAVEL, MOIST TO DRY.	BKGD	0	1345
15.0											
16.0	B3-6-7	14-15-13-13	16	18	1			HARD YELLOWISH-BROWN (10YR 5/4) CLAY WITH COARSE (3/4") ANGULAR GRAVEL, DRY.	BKGD	0	1407
17.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0 - 19.0	B3-6-8	16-10-14-16	18	20	0.7			STIFF YELLOWISH-BROWN (10YR 5/4) CLAY WITH COARSE (3/4") ANGULAR GRAVEL, DRY.	BKGD	0	1418
20.0 - 21.0	B3-6-9A/B	15-7-11-15	20	22	1.1			A: TOP 0.5': STIFF YELLOWISH-BROWN (10YR 5/4) CLAY WITH COARSE (3/4") ANGULAR GRAVEL, DRY. B: BOTTOM 0.6': STIFF YELLOWISH-BROWN (10YR 5/4) CLAY WITH TRACE FINE (1/8") ANGULAR GRAVEL, MOIST TO DRY.	BKGD	0	1442
22.0 - 23.0	B3-6-10	13-24-13-12	22	24	0.5			HARD YELLOWISH-BROWN (10YR 5/4) CLAY WITH COARSE (1") ANGULAR GRAVEL AND TRACE COARSE SAND, MOIST TO DRY.	BKGD	0	1455
24.0 - 25.0 - 26.0	B3-6-11	8-5-7-9	24	26	1			HARD YELLOWISH-BROWN (10YR 5/4) CLAY WITH COARSE (1") ANGULAR GRAVEL AND TRACE COARSE SAND, MOIST TO DRY.	BKGD	0	1534

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SITE: CLEARWELL

SOIL BORING NO.: BC1
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 10/2/91
BORING COMPLETED: 10/2/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 14.0
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 80; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
		AUGERED THROUGH THIS INTERVAL									
1.0	BC1-1	400 PSI	1	3.5	2.1			TOP & BOTTOM: DARK BROWN (10YR 3/3) SILTY CLAY, DRY.	BKGD	NR	1010
2.0											
3.0											
		AUGERED THROUGH THIS INTERVAL									
4.0	BC1-2A/B	4-6-13-15	4	6	1.5			A: TOP 0.9': STIFF DARK BROWN (10YR 3/3) SILTY CLAY, DRY TO MOIST. B: BOTTOM 0.6': STIFF BROWNISH-YELLOW (10YR 6/6) SAND WITH GRAVEL (1/2"), DRY.	BKGD	NR	1015
5.0											
6.0	BC1-3	4-8-8-13	6	8	1.6			STIFF YELLOWISH-BROWN (10YR 6/6) CLAY WITH SOME COARSE (3/4") ANGULAR GRAVEL, DRY. * SAND IN THE BOTTOM 0.05'.	BKGD	NR	1023
7.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0	BC1-4	6-6-7-10	8	10	1.7			TOP 0.2': MEDIUM YELLOWISH-BROWN (10YR 5/4) CLAY WITH SOME COARSE (3/4") ANGULAR GRAVEL, DRY. BOTTOM 1.5': STIFF GRAY (10YR 5/1) CLAY WITH SOME ANGULAR GRAVEL (1/8 - 1/2"), DRY TO MOIST.	BKGD	NR	1028
9.0											
10.0			FAILED SHELBY TUBE.								
11.0											
		AUGERED THROUGH THIS INTERVAL									
12.0	BC1-5	11-8-15-15	12	14	1.5			STIFF BROWNISH-YELLOW (10YR 6/6) SAND WITH TRACE ANGULAR GRAVEL (1/4"), DRY.	BKGD	NR	1042
13.0											
14.0											

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT DIKE STABILITY ANALYSIS
SOIL BORING LOG

SAIC
An Employee-Owned Company

SITE: CLEARWELL

SOIL BORING NO.: BC3
SUPERVISORY GEOLOGIST: GREG WELLS
PARSONS ENGINEER: KEVIN ERNST
DRILLING STARTED: 10/2/91
BORING COMPLETED: 10/2/91

LAND SURFACE ELEVATION:
TOTAL DEPTH DRILLED: 26
TOTAL DEPTH ELEVATION:
BACKGROUND: ALPHA: 0; BETA/GAMMA: 80; HNu: 0ppm

DRILLING COMPANY: WESTINGHOUSE ENVIRONMENTAL
DRILLER: JAMES MURPHY
RIG TYPE: CME-55

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
0.0											
1.0		AUGERED THROUGH THIS INTERVAL									
2.0	BC3-1	7-16-11-14	2	4	1.9			HARD VERY PALE BROWN (10YR 7/3) CLAY WITH SOME COARSE (1") ANGULAR GRAVEL, DRY.	BKGD	0	1408
3.0											
4.0	BC3-2	12-17-20-24	4	6	1.1			HARD VERY PALE BROWN (10YR 7/3) CLAY WITH SOME COARSE (1") ANGULAR GRAVEL, DRY.	BKGD	0	1414
5.0											
6.0	BC3-3A/B	10-6-7-7	6	8	1.7			A: TOP 1': HARD VERY PALE BROWN (10YR 7/3) CLAY WITH SOME COARSE (1") ANGULAR GRAVEL, DRY. B: BOTTOM 0.7': MEDIUM GRAY (10YR 5/1) CLAY WITH FINE (1/8") GRAVEL, DRY TO MOIST.	BKGD	0	1426
7.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
8.0	BC3-4	5-7-7-8	8	10	1.5			MEDIUM GRAY (10YR 5/1) CLAY WITH FINE (1/8") GRAVEL, DRY TO MOIST.	BKGD	0	1430
9.0											
10.0	BC3-5	7-5-5-7	10	12	1.6			TOP 0.6': MEDIUM GRAY (10YR 5/1) CLAY WITH FINE (1/8") GRAVEL, DRY TO MOIST. BOTTOM 1': MEDIUM YELLOWISH-BROWN (10YR 5/6) CLAY WITH SOME ANGULAR GRAVEL (1/2"), MOIST TO DRY.	BKGD	0	1436
11.0											
12.0											
		AUGERED THROUGH THIS INTERVAL									
13.0		FAILED SHELBY TUBE (13-13.5')									
		AUGERED THROUGH THIS INTERVAL									
14.0	BC3-6	4-5-8-10	14	16	1.7			MEDIUM YELLOWISH-BROWN (10YR 5/6) CLAY WITH MANY ANGULAR GRAVEL (1/2"), DRY.	BKGD	0	1450
15.0											
16.0	BC3-7	3-6-7-12	16	18	1.8			MEDIUM YELLOWISH-BROWN (10YR 5/6) CLAY WITH MANY ROUNDED GRAVEL (1/2"), DRY.	BKGD	0	1511
17.0											

DEPTH (FT BLS)	SAMPLE NUMBER	BLOW COUNT/ psi	TOP OF SAMPLE (FT BLS)	BOTTOM SAMPLE (FT BLS)	RECOVERY (FT)	SOIL TYPE (USCS)	LITHOLOGIC SYMBOLS	LITHOLOGIC DESCRIPTION	ALPHA BETA/GAMMA (COUNTS)	HNU RESULTS (PPM)	TIME
18.0 - 19.0	BC3-8	4-8-9-16	18	20	1.5			STIFF GRAY (10YR 5/1) CLAY WITH YELLOWISH-BROWN (10YR 5/6) BLOTCHING AND SOME ANGULAR GRAVEL (1/4"), DRY TO MOIST.	BKGD	0	1522
20.0 - 21.0	BC3-9	5-5-8-11	20	22	1.5			MEDIUM YELLOWISH-BROWN (10YR 5/6) CLAY WITH TRACE FINE SAND AND ANGULAR GRAVEL (1/4"), DRY TO MOIST.	BKGD	0	1531
22.0 - 23.0	BC3-10	7-27-26-22	22	24	1.6			TOP 0.5': HARD YELLOWISH-BROWN (10YR 5/6) CLAY WITH TRACE FINE SAND AND ANGULAR GRAVEL (1/4"), DRY TO MOIST. BOTTOM 1.1': HARD YELLOWISH-BROWN (10YR 5/6) SAND, MEDIUM TO COARSE, DRY.	BKGD	0	1543
24.0 - 26.0	BC3-11	10-22-15-13	24	26	0.6			HARD DARK YELLOWISH-BROWN (10YR 4/4) SILTY SAND, MEDIUM TO COARSE, DRY.	BKGD	0	1550

APPENDIX B

GEOTECHNICAL LABORATORY TESTING RESULTS

APPENDIX B

GEOTECHNICAL LABORATORY TESTING RESULTS

P:\OU-1\PO-11\APPB

Appendix B

CONTENTS

TABLE

B-1 Summary of Natural Moisture Contents B-1

B-2 Summary of Index Properties B-4

B-3 Summary of Triaxial Test Results B-7

B-4 Consolidation Data B-8

B-5 Permeability Summary B-9

TABLE B-1 SUMMARY OF NATURAL MOISTURE CONTENTS

BORING NO.	SAMPLE NO.	DEPTH (feet)	MOISTURE CONTENT (%)
B5-1	S-1	2-4	14
	S-2	4-6	13
	S-3	6-8.5	12
	S-4	9-11.5	14
	S-5	12-14.5	14
	S-6	15-17	15
	S-7	17-19	11
B5-3	S-2A	2.5-4	8
	S-2B	2.5-4	6
	S-4	5-6.5	9
	S-6	8-9	12
	S-7	9-10.5	12
	S-8A	10.5-12	13
	S-8B	10.5-12	13
	S-9	12-13.5	12
	S-10	13.5-15	13
	S-11	15-16.5	17
	S-12A	16.5-18	22
	S-12B	16.5-18	25
	S-14A	19-20.5	23
	S-14B	19-20.5	9
	S-15	20.5-22	13
	S-16	22-23.5	12
	S-17	23.5-25	12
	S-18	25-26.5	10
	S-19	26.5-28	8
	S-20	28-29.5	10
	S-21	29.5-31	12
	S-22	31-32.5	13
	S-23	32.5-34	13
	S-24	34-35.5	14
B5-4	S-1A	1-3.5	13
	S-2B	4-6	10
	S-3	7-9	16
	S-4	9-11	15
	S-5	12-14.5	15
	S-6	15-17.5	15
	S-7	17.5-19	15
	S-8	19.5-21.5	15
B5-6	S-1	1-2.5	8
	S-2	2.5-4	11
	S-3	4-5.5	11
	S-4	5.5-7	12
	S-5	7-8.5	13
	S-6	8.5-10	12
	S-7	10-11.5	20
	S-9	13-14.5	11
	S-10	14.5-16	12
	S-11	16-17.5	23
	S-12	17.5-19	19
	S-13A	19-20.5	23
	S-14B	21-22	18
	S-15	22-23.5	14
	S-16	23.5-25	13
	S-17	25-26.5	13
	S-18	26.5-28	13
	S-19	28-29.5	12
	S-20	29.5-31	14
	S-21	31-33	13
	S-22	33-34.5	14
	S-23	35-37	13
B5-7	S-1	2-4	15
	S-2	4-6	12
	S-3E	7-9.5	15
	S-4D	10-12.5	15
	S-5	13-15	16
	S-6	15-17	14

TABLE B-1 SUMMARY OF NATURAL MOISTURE CONTENTS

BORING NO.	SAMPLE NO.	DEPTH (feet)	MOISTURE CONTENT (%)
B5-9	S-1	0.5-2.5	17
	S-2	3-5	16
	S-3	5-7	14
	S-5	9-11	19
	S-6	11-13	15
	S-7	13-15	20
	S-8	15-17	21
	S-9	17-19	22
	S-10A	19-19.5	22
	S-10B	20-21	15
	S-12	23-25	14
	S-14	27-29	8
	S-15	29-31	10
	S-16A	31-33	16
	S-16B	31-33	13
	S-17	33-35	14
	S-18	35-37	14
B5-10	S-1A	2-2.6	11
	S-1B	2.6-4	21
	S-2	4-6	18
	S-3	6-8.5	20
	S-4C	9-10	18
	S-5	12-14	16
	S-6	14-16	13
	S-7D	16-18.5	15
	S-8E	19-21.5	15
B5-12	S-1B	8-10	12
	S-3A	20-22	21
	S-4A	26-27	19
	S-4B	27-28	14
	S-5	33-35	14
	S-6	35-37	13
	S-1	2-4	9
	S-2A	4-5	14
	2B	5-5.5	21
		7-9	24
		9-11.5	19
		2-14.5	22
		15.7	20
		4	12
			10
			15
B5-15	S-1	8-9	11
	S-2	10-12	12
	S-3A	12-14	12
	S-3B	12-14	14
	S-3C	12-14	16
	S-4A	14-16	18
	S-4B	14-16	15
	S-6B	18-20	21
	S-7A	20-22	23
	S-7B	20-22	23
	S-7C	20-22	24
	S-8A	22-24	21
	S-9A	24-26	20
	S-9B	24-26	23
	S-9C	24-26	26
	S-10	26-28	14
	S-11	28-30	14
	S-12A	30-32	15
	S-12B	30-32	12
	S-12C	30-32	12
B5-A	S-1	1-3	6
	S-3	8-10	13
	S-4C	11-13	12
	S-5	19-21	14
	S-6	23-25	9
	S-7	29-31	14
	S-10	36-38	11
	S-C1	19	13
	S-C2	21	12
	S-C3	27	14
	S-C4	30	14

P:\OU-1\PO-11\APPB

TABLE B-1 SUMMARY OF NATURAL MOISTURE CONTENTS

BORING NO.	SAMPLE NO.	DEPTH (feet)	MOISTURE CONTENT (%)	BORING NO.	SAMPLE NO.	DEPTH (feet)	MOISTURE CONTENT (%)
B3-1	S-1	2-4	16	BC-1	S-2A	4-4.9	13
	S-2	5-7	14		S-3	6-8	12
	S-3	7-9	13		S-4	8-10	11
	S-4	9-11	11				
	S-5	11-13	17	BC-3	S-1	2-4	8
					S-2	4-6	9
B3-3	S-1	1-3	15		S-3A	6-8	9
	S-2	3-5	13		S-3B	6-8	10
	S-3	5-7.5	14		S-4	8-10	12
	S-4D	8-10.5	14		S-5	10-12	12
	S-5B	11-13	12		S-6	14-16	12
	S-6	14-16	12		S-7	16-18	17
	S-7	16-18	13		S-8	18-20	19
	S-9	20-22	12		S-9	20-22	11
					S-11	24-26	11
B3-4	S-1	2-4	17				
	S-2	4-6	16				
	S-3A	6-8	15				
	S-3B	6-8	12				
	S-4	8-10	15				
	S-5	10-12	13				
B3-6	S-1	2-4	5				
	S-2	4-6	11				
	S-3	6-8	11				
	S-4	8-10	12				
	S-5	12-14	13				
	S-6	14-16	11				
	S-7	16-18	12				
	S-8	18-20	15				
	S-9A	20-22	12				
	S-9B	20-22	16				
	S-10	22-24	7				
	S-11	24-26	18				

PO-11
DIKE STABILITY ANALYSIS

TABLE B-2 SUMMARY OF INDEX PROPERTIES

BORING NO.	DEPTH (feet)	SOIL DESCRIPTION	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	USCS CLASSI-FICATION
B5-1-6	15-17	gray clay	25	20	35	20	26	16	9	CL
B5-1-7	17-19	gray clay	6	32	40	22				
B5-3-2,4,&5	2.5-9	upper yellowish brown clay	8	39	33	20	25	14	11	CL
B5-3-6	8-9	upper yellowish brown clay	2	35	40	23	35	15	20	CL
B5-3-7	9-10.5	upper yellowish brown clay					28	15	13	CL
B5-3-9,10,11,&12	12-18	olive clay	2	20	50	27	30	15	15	CL
B5-3-14,15,&16	19-20.5	lower yellowish brown clay	7	31	40	22	25	14	11	CL
B5-3-17,18,19,&20	23.5-29.5	gray clay	15	40	32	13	21	14	7	CL-ML
B5-3-21,22,23,&24	29.9-35.5	gray clay	3	34	43	20	19	13	5	CL-ML
B5-4-1A	1-3.5	lower yellowish brown clay	6	30	39	25	28	18	10	CL
B5-4-2B	4-6	lower yellowish brown clay	6	28	40	26	28			
B5-4-4	9-11	gray clay					23	17	7	CL-ML
B5-4-7	17.5-19	gray clay	5	24	46	25				
B5-4-8	19.5-21.5	gray clay					26	17	9	CL
B5-6-1,2,&3	1-5.5	upper yellowish brown clay	2	24	47	27	33	18	16	CL
B5-6-4,5,&6	5.5-10	upper yellowish brown clay	5	20	45	30	38	19	19	CL
B5-6-10&11	14.5-17.5	olive clay					29	16	13	CL
B5-6-13A	19-20.5	olive clay					35	18	17	CL
B5-6-14,15,&16	21-25	lower yellowish brown clay	10	25	42	23	26	17	9	CL
B5-6-19&20	28-31	gray clay					26	15	10	CL
B5-6-21,22,&23	31-37	gray clay	2	26	47	25	27	17	10	CL
B5-7-1	2-4	lower yellowish brown clay	10	23	40	27	30	18	12	CL
B5-7-5	13-15	gray clay	5	15	55	25	27	17	10	CL
B5-7-6	15-17	gray clay	22	23	36	19				
B5-9-2&3	3-7	upper yellowish brown clay					36	19	17	CL
B5-9-7	13-15	olive clay					29	14	15	CL
B5-9-10A	19-19.5	lower yellowish brown clay	0	30	44	26			8	
B5-9-10B	20-21	lower yellowish brown clay	3	40	39	18	23	16	8	CL
B5-9-14&15	27-31	gray clay	11	44	32	13	19	14	5	CL-ML
B5-9-16B	31-33	gray clay					27	17	10	CL

PO-11
DIKE STABILITY ANALYSIS

TABLE B-2 SUMMARY OF INDEX PROPERTIES

BORING NO.	DEPTH (feet)	SOIL DESCRIPTION	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	USCS CLASSI-FICATION
B5-10-2	4-6	lower yellowish brown clay					35	18	17	CL
B5-10-4C	9-10	lower yellowish brown clay	0	2	51	47	38	22	17	CL
B5-10-6	14-16	gray clay	6	25	43	26	28	17	11	CL
B5-12-1B	8-10	upper yellowish brown clay	10	28	41	21				
B5-12-3A	20-22	lower yellowish brown clay					48	23	26	CL
B5-12-4A	26-27	lower yellowish brown clay					24	15		CL
B5-12-4B	27-28	gray clay					26	16	10	CL
B5-12-5&6	33-37	gray clay	4	25	43	28	23	16	7	CL-ML
B5-13-4	9-11.5	lower yellowish brown clay	0	23	62	15	25	17	8	
B5-13-8	20-22.5	gray clay	5	30	45	20	22	15	7	CL-ML
B5-15-1	8-9	upper yellowish brown clay	9	24	42	25	28	15	13	CL
B5-15-4A	14-16	olive clay	0	26	54	20	30	20	10	CL
B5-15-6B	18-20	gray clay					34	19	16	CL
B5-15-7A	20-22	gray clay	0	17	53	30				
B5-15-7C	20-22	gray clay					35	20	15	CL
B5-15-8A	22-24	gray clay	4	22	48	26	36	20	17	CL
B5-15-9B	24-26	lower yellowish brown clay					33	20	13	CL
B5-15-9C	24-26	gray silty sand	9	59	25	7	34	20	14	SM
B5-15-10	26-28	yellowish brown silty sand	5	62	27	6				
B5-15-11	28-30	gray clay	15	36	36	13				
B5-15-12A	30-32	gray clay	12	24	58	22	25	16	9	CL
B5-15-12B	30-32	gray clay					25	16	10	CL
B5-A-1	1-3	upper yellowish brown clay	13	24	41	22				
B5-A-3	8-10	upper yellowish brown clay	9	31	40	20	26	16	10	CL
B5-A-4C	11-13	olive clay	6	30	40	24	27	16	11	CL
B5-A-7	29-31	gray clay	9	25	41	25	29	18	11	CL
B5-A-C1	19	lower yellowish brown clay	7	24	41	28				
B5-A-C2	21	lower yellowish brown clay	5	24	41	30				
B5-A-C3	27	gray clay	2	24	44	30				
B5-A-C4	30	gray clay	6	20	44	30				

PO-11
DIKE STABILITY ANALYSIS

TABLE B-2 SUMMARY OF INDEX PROPERTIES

BORING NO.	DEPTH (feet)	SOIL DESCRIPTION	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	USCS CLASSI-FICATION
B3-1-1	2-4	dark brown clay	1	40	54	15				
B3-1-2&3	5-9	lower yellowish brown clay	4	25	41	30				
B3-1-4	9-11	gray clay					29	17	11	CL
B3-1-5	11-13	gray silty sand	0	81	15	4				
B3-3-1	1-3	upper yellowish brown clay					33	19	14	CL
B3-3-3&4	5-10.5	upper yellowish brown clay	9	29	41	21				
B3-3-4D	8-10.5	olive clay	8	23	45	24				
B3-3-5B	11-13	lower yellowish brown clay	19	26	35	20	26	16	10	CL
B3-3-6&7	14-18	lower yellowish brown clay	7	37	31	25				
B3-3-C1	9	olive clay	4	28	42	26				
B3-4-2&6	2-6	dark brown clay	10	32	43	15				
B3-4-4	8-10	gray clay	15	23	39	23				
B3-4-5	10-12	gray clay					27	16	11	CL
B3-6-2	4-6	upper yellowish brown clay					30	17	13	CL
B3-6-3	6-8	upper yellowish brown clay	28	24	32	16				
B3-6-5	12-14	upper yellowish brown clay					29	18	11	CL
B3-6-6&7	16-20	lower yellowish brown clay	20	25	34	21				
B3-6-9A	20-22	lower yellowish brown clay					28	17	12	CL
B3-6-11	24-26	lower yellowish brown clay					30	17	13	CL
B3-6-C1	10	upper yellowish brown clay	26	23	31	20				
B3-6-C3	18	lower yellowish brown clay	5	26	44	25				
BC-1-1	1-3.5	dark brown clay	2	44	42	12	28	17	11	
BC-1-4	8-10	lower yellowish brown clay					25	16	9	CL
BC-1-C1	5	yellowish brown silty sand	46	42	10	6				
BC-3-1&2	2-6	upper yellowish brown clay	15	26	39	20				
BC-3-3A	6-8	upper yellowish brown clay					28	17	11	CL
BC-3-3&4	6-10	olive clay					25	15	10	CL
BC-3-6&7	14-18	lower yellowish brown clay	6	24	43	27	30	17	13	CL
BC-3-8	18-20	gray clay					25	17	9	CL
BC-3-9	20-22	lower yellowish brown clay	10	28	42	20				
BC-3-10	22-24	yellowish brown silty sand	41	45	10	4				

PO-11
DIKE STABILITY ANALYSIS

TABLE B-3 SUMMARY OF TRIAXIAL TEST RESULTS

BORING NO.	DEPTH (feet)	SOIL DESRCIPTION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	WET UNIT WEIGHT (pcf)	UNDRAINED (TOTAL) PARAMETERS COHESION (psf)	PHI ANGLE (degrees)
B5-6-21	31-33	Gray Clay	14	126	0	115	22
			13	126	43		
			19	111	133		
B5-7-3	7-9.5	Gray Clay	15	121	121	250	18
			14	122	139		
			15	122	122		
B5-7-4	10-12.5	Gray Clay	15	123	141	250	19
			13	125	125		
			15	122	140		
B5-9-16	31-33	Gray Clay	15	124	142	115	22
B5-A-8&9	31-33.5	Gray Clay	15	122	140	250	20
			14	125	143		
			14	121	138		
B3-3-3	5-7.5	Upper Yellowish Brown Clay	13	121	137	200	22
			14	118	135		
			17	116	136		
B3-3-4	8-10.5	Upper Yellowish Brown Clay	16	105	122	200	20
			19	105	125		
			22	105	128		
B5-12-1	8-10	Upper Yellowish Brown Clay	12	126	142	200	26
B5-A-2	4-6.5	Upper Yellowish Brown Clay	14	125	142	150	27
			12	127	142		
			10	131	144		
B5-12-2	12-13.3	Olive Clay	13	126	142	250	26
			13	129	146		
			13	132	149		
B5-13-5	12-14.5	Yellowish Brown Silty Sand	20	112	134	125	19
			19	112	133		
			23	106	130		
B5-15-10	26-28	Yellowish Brown Silty Sand	20	111	134	125	19
			15	122	140		
			13	124	141		
B5-10-3&4	9-10	Lower Yellowish Brown Clay	21	108	131	250	20
			23	98	121		
			17	116	136		
B5-15-5A	16-18	Lower Yellowish Brown Clay	23	103	126	200	24
B5-15-5B	16-18	Lower Yellowish Brown Clay	22	105	128	250	25
BC-1-1	1-3.5	Dark Brown Clay	13	126	142	200	24
			15	117	135		
			17	115	135		

97

PO-11
DIKE STABILITY ANALYSIS

TABLE B-4 CONSOLIDATION DATA

BORING/ SAMPLE NO.	DEPTH (feet)	SOIL DESCRIPTION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	VOID RATIO	PRECONSOLIDATION PRESSURE P'c (psf)	OVERBURDEN PRESSURE P'o (ksf)	OVER-CONSOLIDATION RATIO OCR	COEFFICIENT OF CONSOLIDATION Cv (sq. in./day)	COMPRESSION INDEX Cc	RECOMPRESSION INDEX Cr
B5-3-6	8-9	Upper Yellowish Brown Clay	13	124	0.3333	16,595	1165	14.2	0.1129	0.059	0.0073
B5-12-1B	8-10	Upper Yellowish Brown Clay	12	122	0.3567	14,678	1233	11.9	0.0572	0.096	0.0067
B5-6-13A	19-20.5	Olive Clay	18	101	0.6315	4,467	2740	1.6	0.0725	0.2000	0.0155
B5-12-2	12-13.5	Olive Clay	45	96	0.6973	23,449	1822	12.8	0.1688	0.0867	0.0039
B5-13-4	9-11.5	Lower Yellowish Brown Clay	57	84	0.9518	8,254	1576	5.2	0.1920	0.2280	0.0490
B3-3-3	5-7.5	Lower Yellowish Brown Clay	14	97	0.6831	27,543	1028	26.8	0.1708	0.1600	0.0050
B5-9-16B	31-33	Gray Clay	16	119	0.3859	4,074	4384	0.9	0.0577	0.0590	0.0050
B5-4-5	12-14.5	Gray Clay	46	97	0.6458	21,813	1815	12	0.1508	0.0667	0.0160
B5-10-8	19-21.5	Gray Clay	15	121	0.3223	23,539	2946	8	0.1393	0.0567	0.0042
BC-1-1	1-3.5	Dark Brown Clay	21	108	0.5032	4,074	308	13.2	0.1633	0.0875	0.0167

PO-11
DIKE STABILITY ANALYSIS

TABLE B-5 PERMEABILTIY SUMMARY

BORING/ SAMPLE NO	DEPTH (FEET)	SOIL DESCRIPTION	PERMEABILITY (CM/SEC)
B3-3-3	5-7.5	Upper Yellowish Brown Clay	2.6E-08
B3-3-4	8-10.5	Upper Yellowish Brown Clay	5.3E-07
B5-3-6	8-9	Upper Yellowish Brown Clay	9.3E-08
B5-6-13	19-20.5	Olive Clay	3.1E-08
B5-12-3	20-22	Silty Sand Brown Clay	6.5E-09
B5-13-4	9-11.5	Silty Sand	1.0E-06
B5-7-3	7-9.5	Gray Clay	7.9E-08
B5-9-16	31-33	Gray Clay	9.3E-09
BC-1-1	1-3.5	Dark Brown Clay	2.0E-07

APPENDIX C

SLOPE STABILITY ANALYSIS RESULTS
CASES 1 - 3

Appendix C

CONTENTS

FIGURE

C1	Cross Section T5-1,2,3 - Case 1	C-1
C2	Cross Section T5-1,2,3 - Case 2	C-2
C3	Cross Section T5-1,2,3 - Case 3	C-3
C4	Cross Section T5-4,5,6 - Case 1	C-4
C5	Cross Section T5-4,5,6 - Case 2	C-5
C6	Cross Section T5-4,5,6 - Case 3	C-6
C7	Cross Section T5-7,8,9 - Case 1	C-7
C8	Cross Section T5-7,8,9 - Case 2	C-8
C9	Cross Section T5-7,8,9 - Case 3	C-9
C10	Cross Section T5-10,11,12 - Case 1	C-10
C11	Cross Section T5-10,11,12 - Case 2	C-11
C12	Cross Section T5-10,11,12 - Case 3	C-12
C13	Cross Section T5-13,14,15 - Case 1	C-13
C14	Cross Section T5-13,14,15 - Case 2	C-14
C15	Cross Section T5-13,14,15 - Case 3	C-15
C16	Cross Section T3-1,2,3 - Case 1	C-16
C17	Cross Section T3-1,2,3 - Case 2	C-17
C18	Cross Section T3-1,2,3 - Case 3	C-18
C19	Cross Section T3-4,5,6 - Case 1	C-19
C20	Cross Section T3-4,5,6 - Case 2	C-20
C21	Cross Section T3-4,5,6 - Case 3	C-21
C22	Cross Section TC-1,2,3 - Case 1	C-22
C23	Cross Section TC-1,2,3 - Case 2	C-23
C24	Cross Section TC-1,2,3 - Case 3	C-24

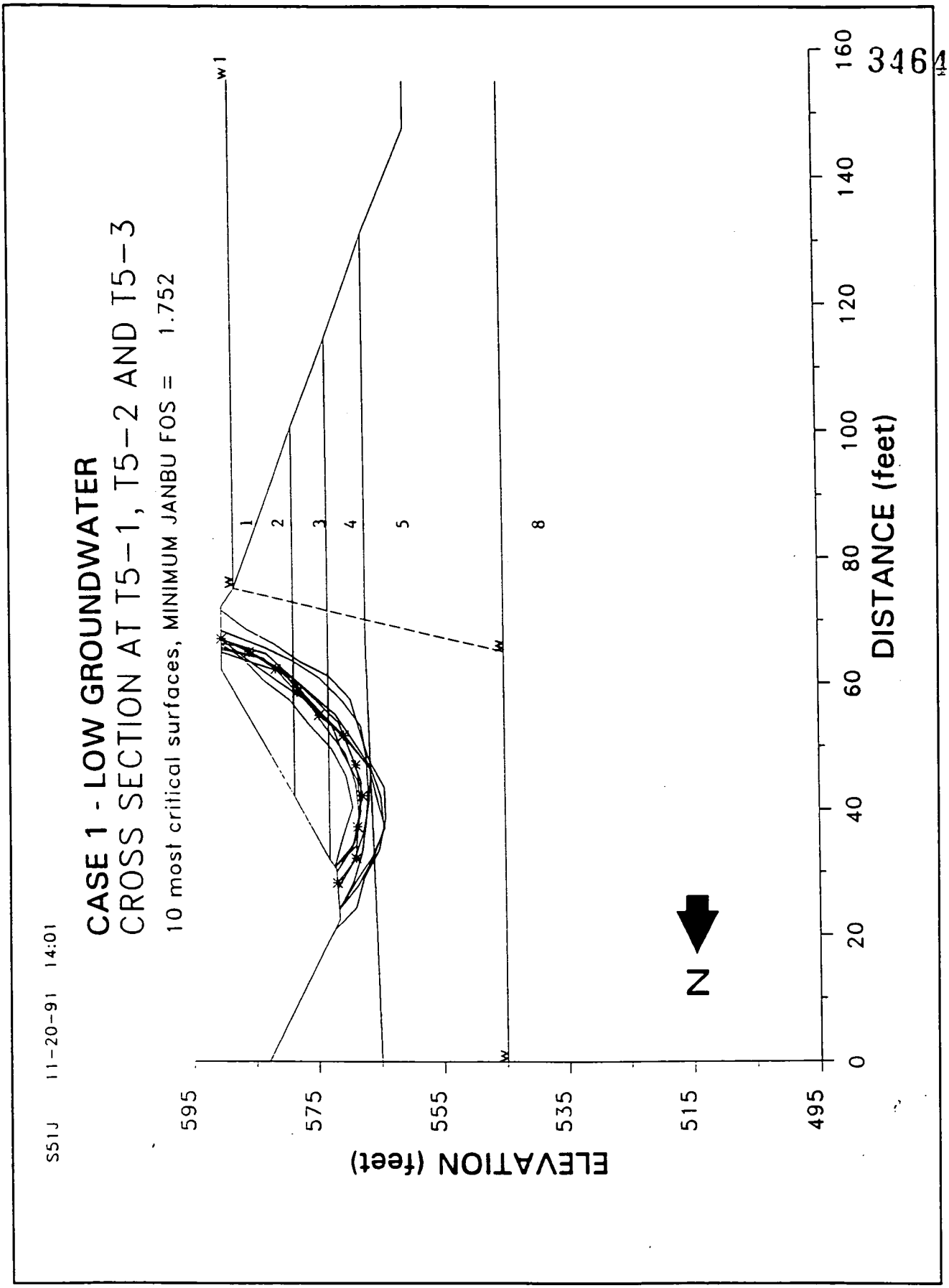

Figure C1 - Cross Section T5-1,2,3 - Case 1

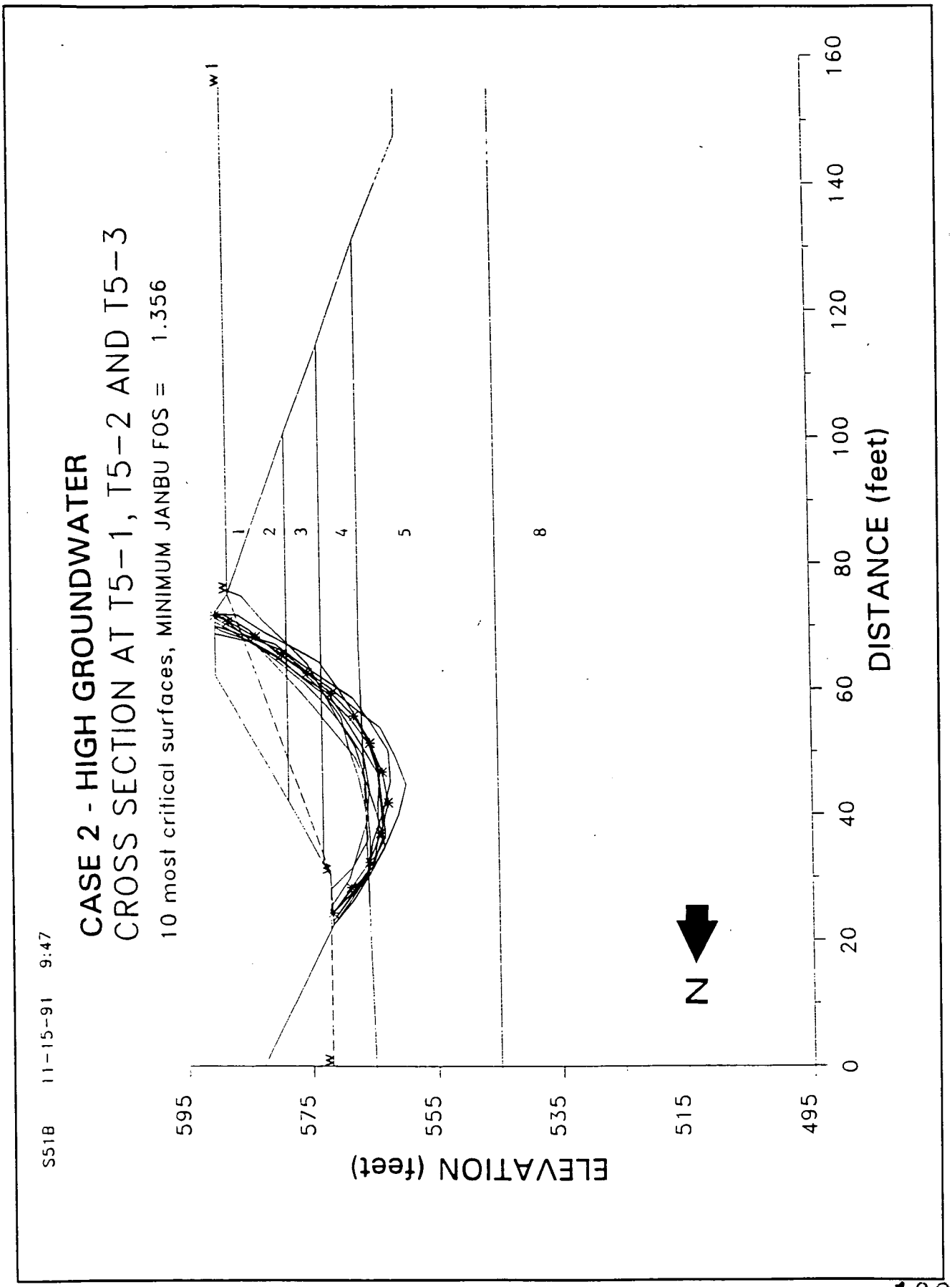

Figure C2 - Cross Section T5-1,2,3 - Case 2

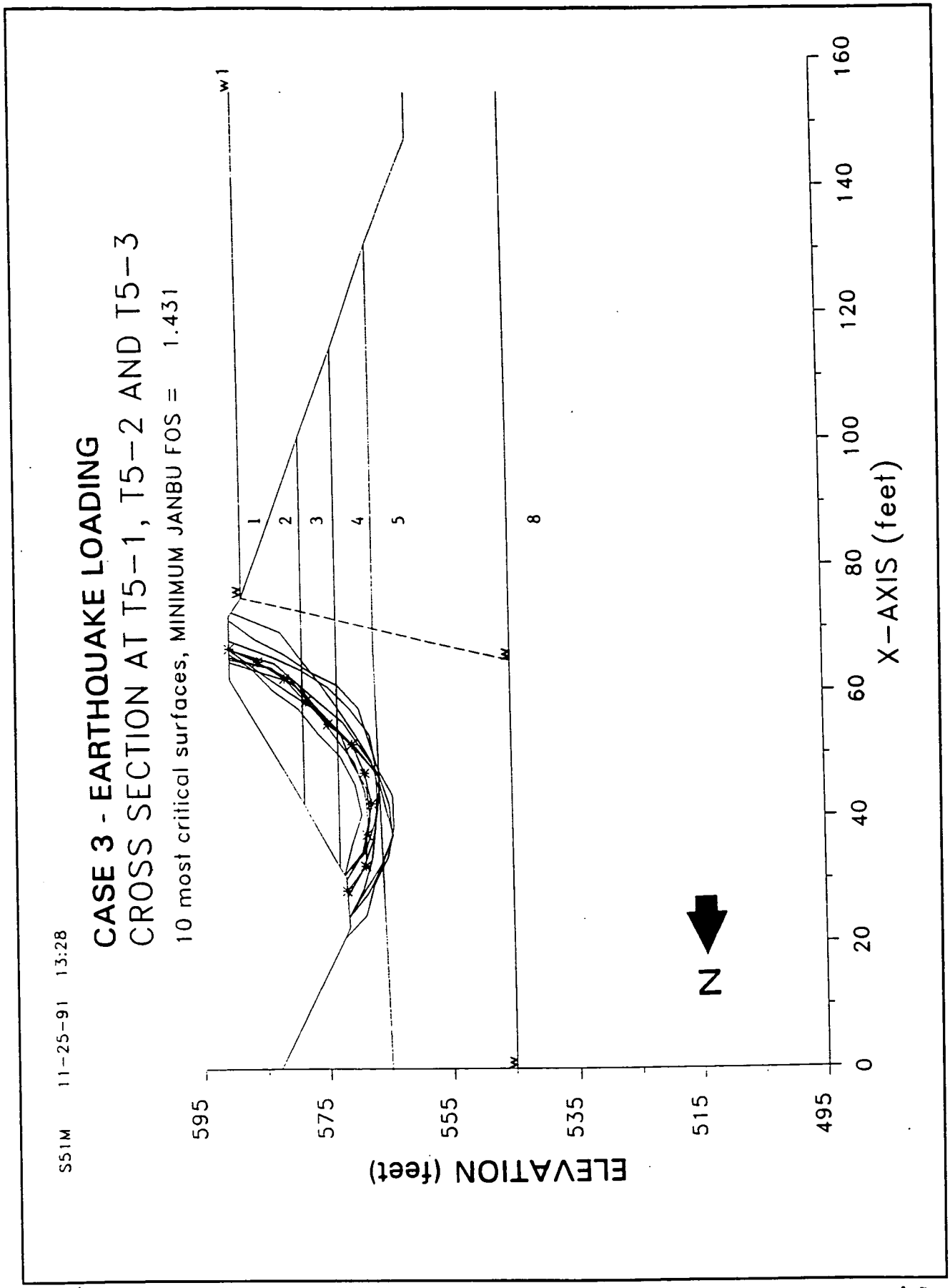

Figure C3 - Cross Section T5-1,2,3 - Case 3

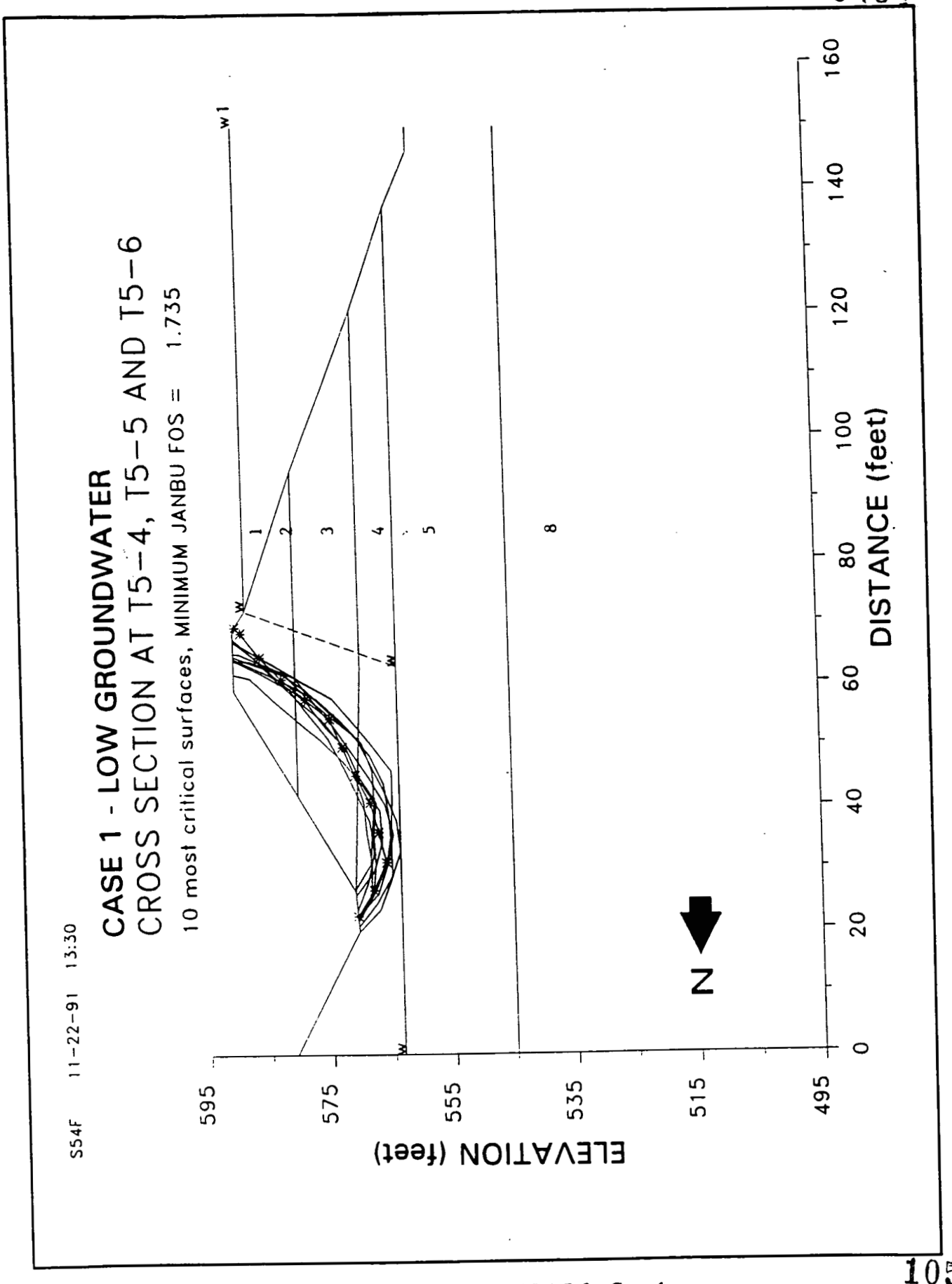

Figure C4 - Cross Section T5-4,5,6 - Case 1

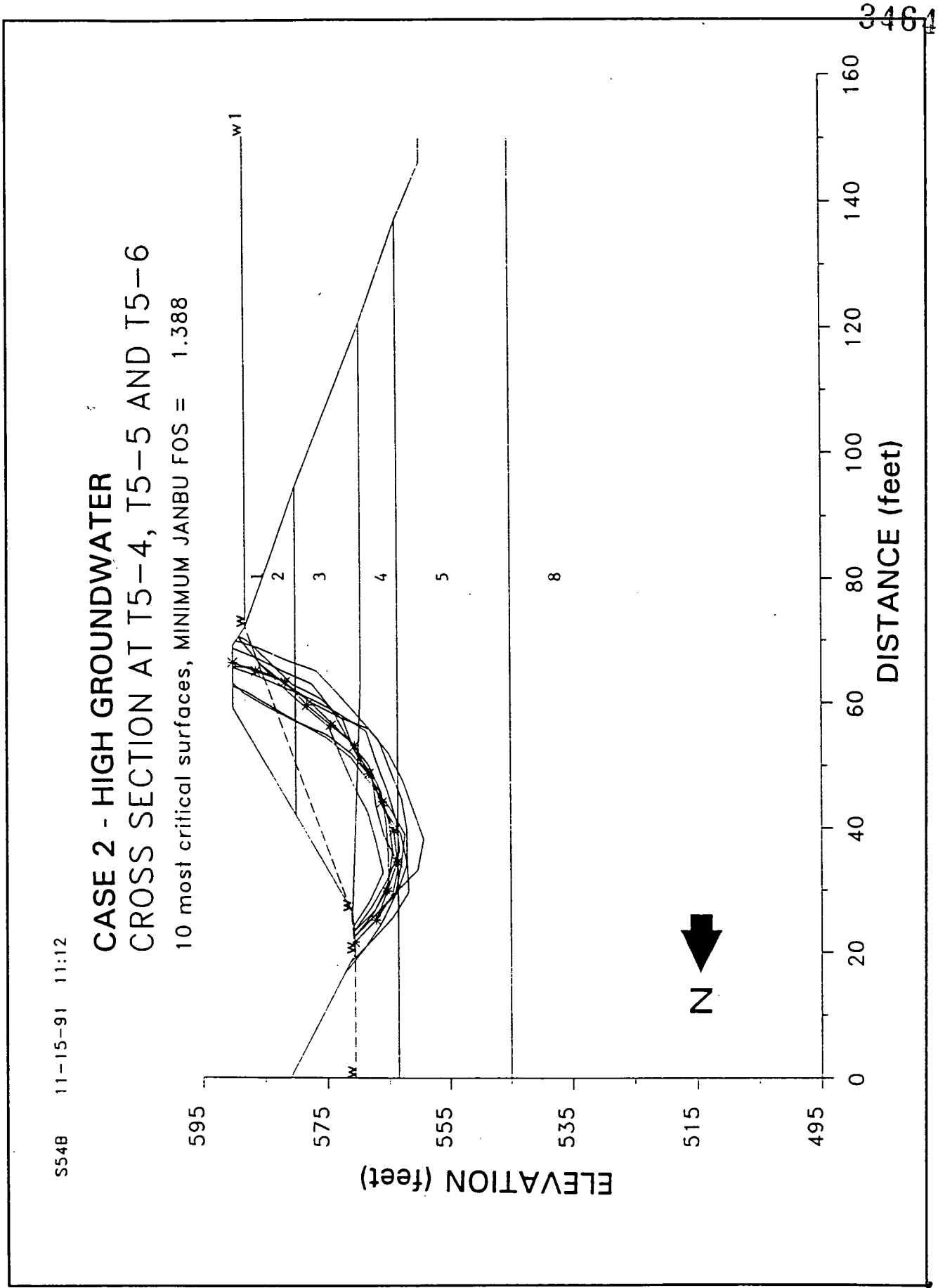

Figure C5 - Cross Section T5-4,5,6 - Case 2

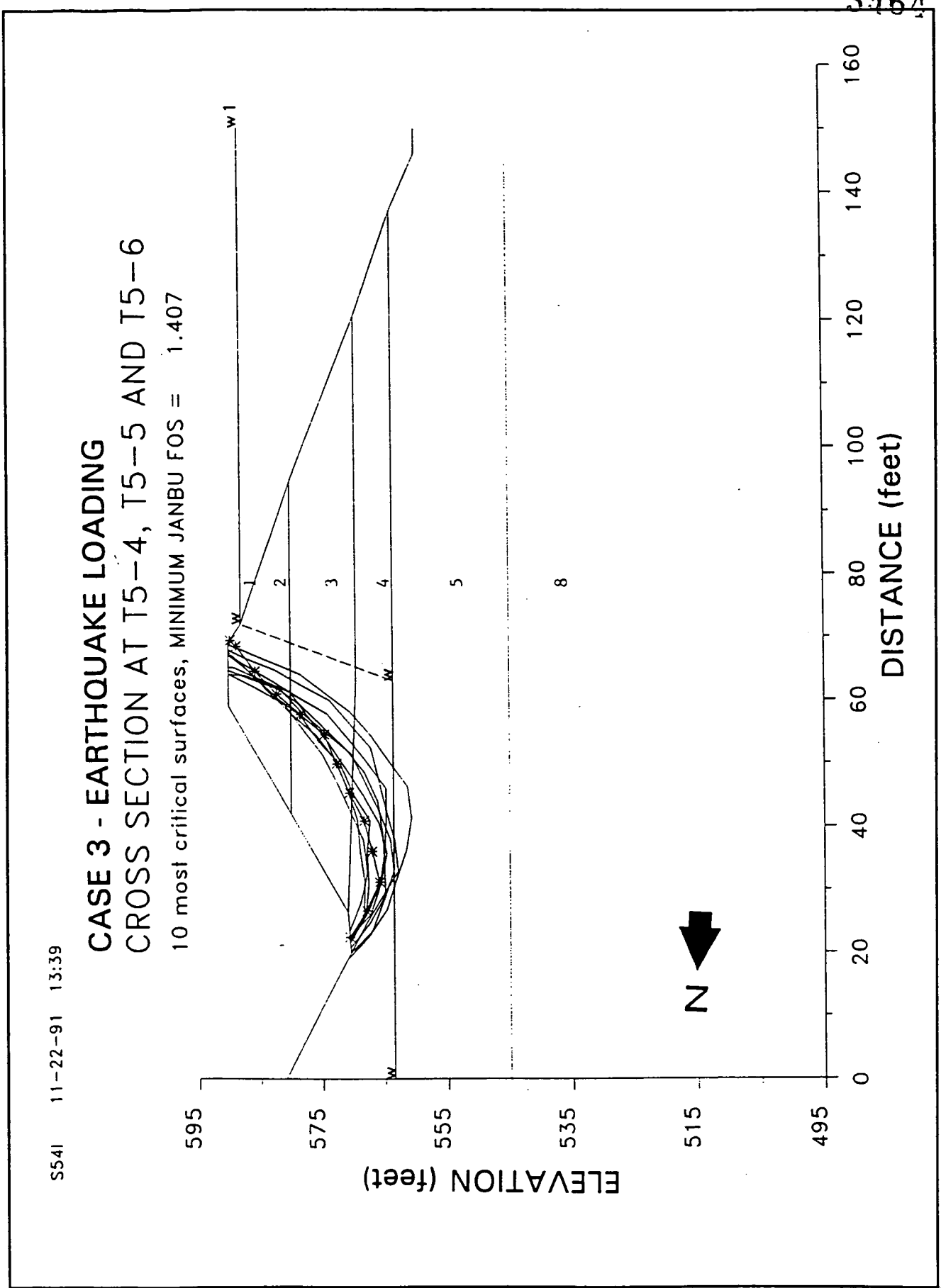

Figure C6 - Cross Section T5-4,5,6 - Case 3

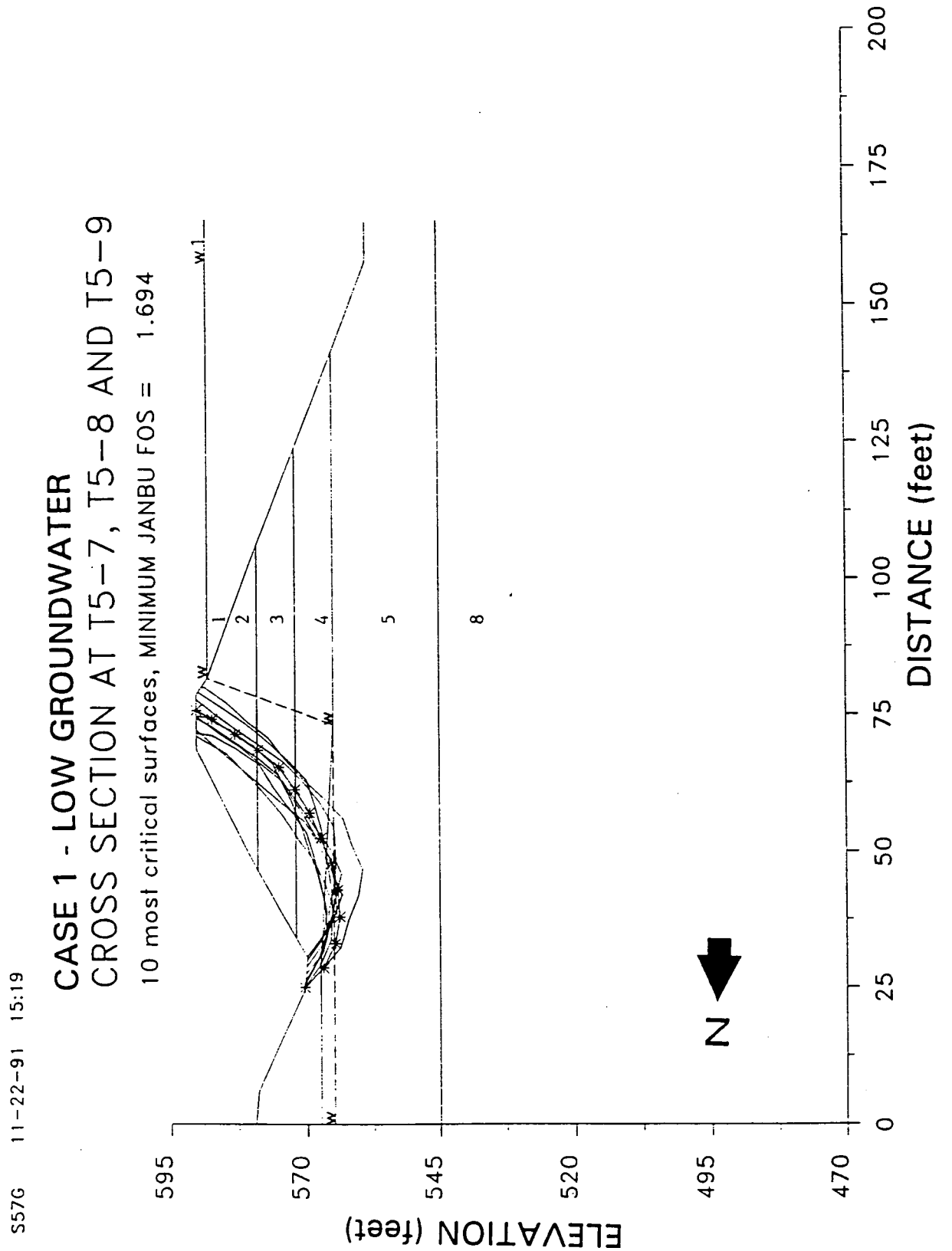

Figure C7 - Cross Section T5-7,8,9 - Case 1

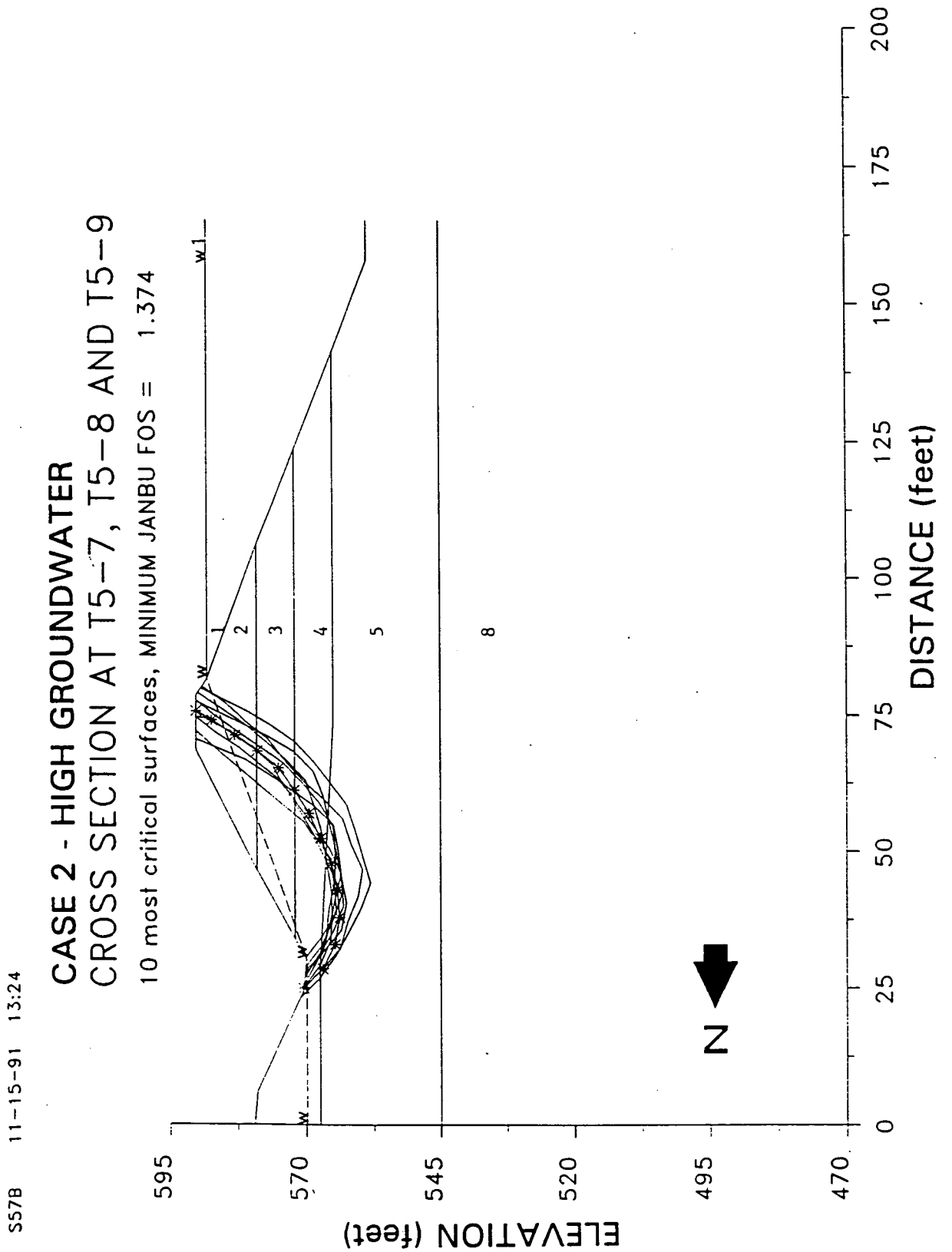

Figure C8 - Cross Section T5-7,8,9 - Case 2

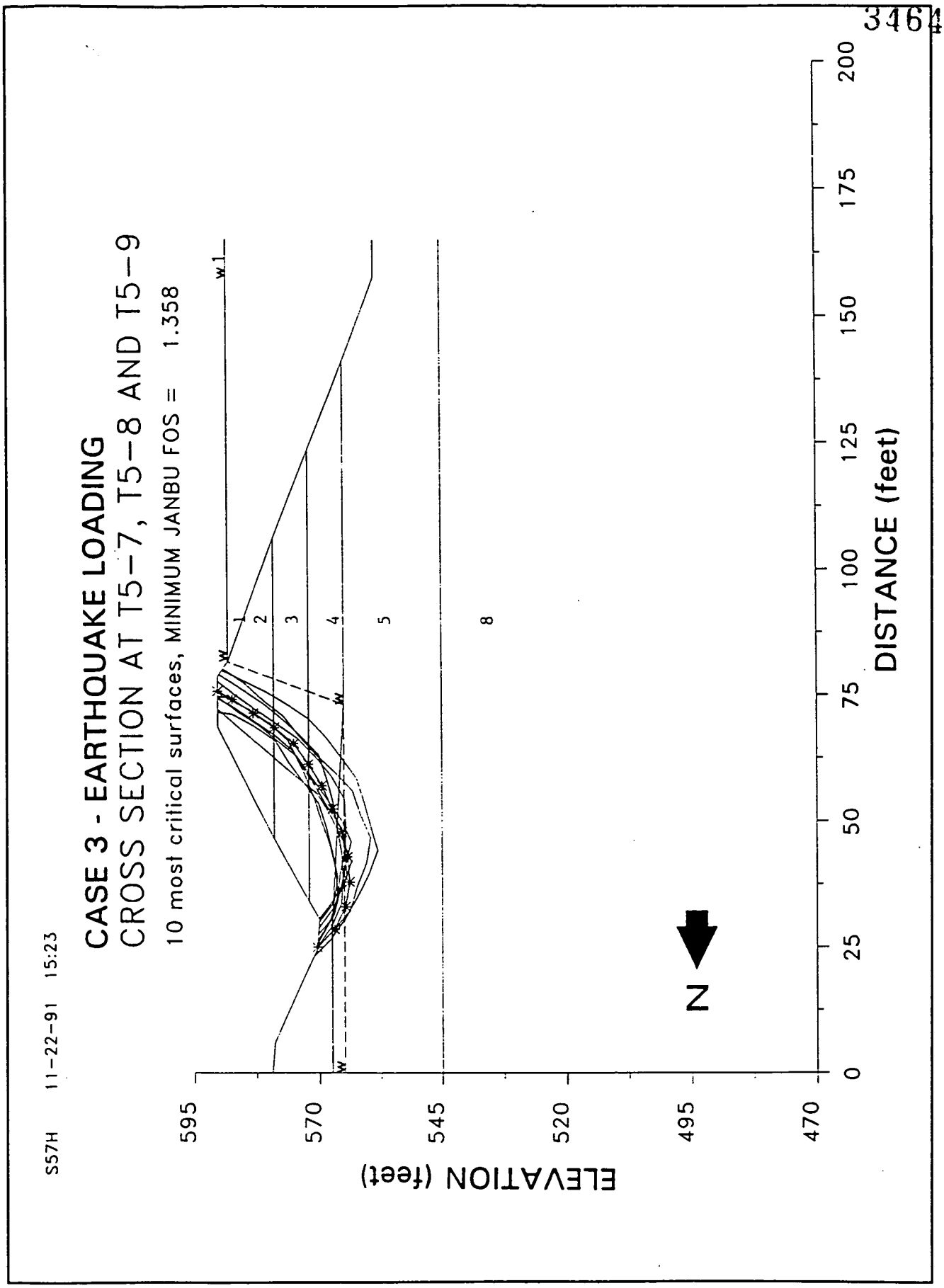

Figure C9 - Cross Section T5-7,8,9 - Case 3

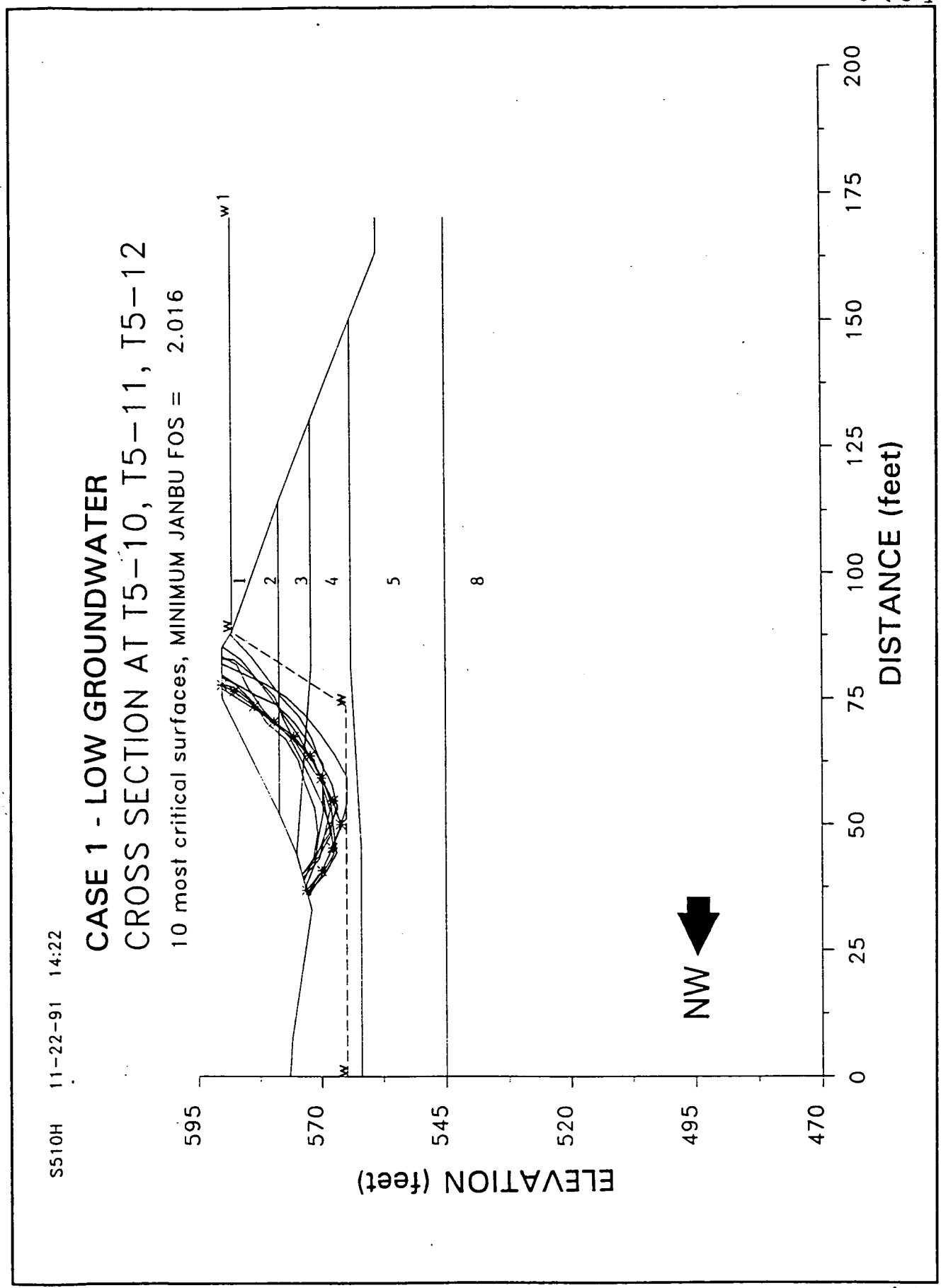

Figure C10 - Cross Section T5-10,11,12 - Case 1

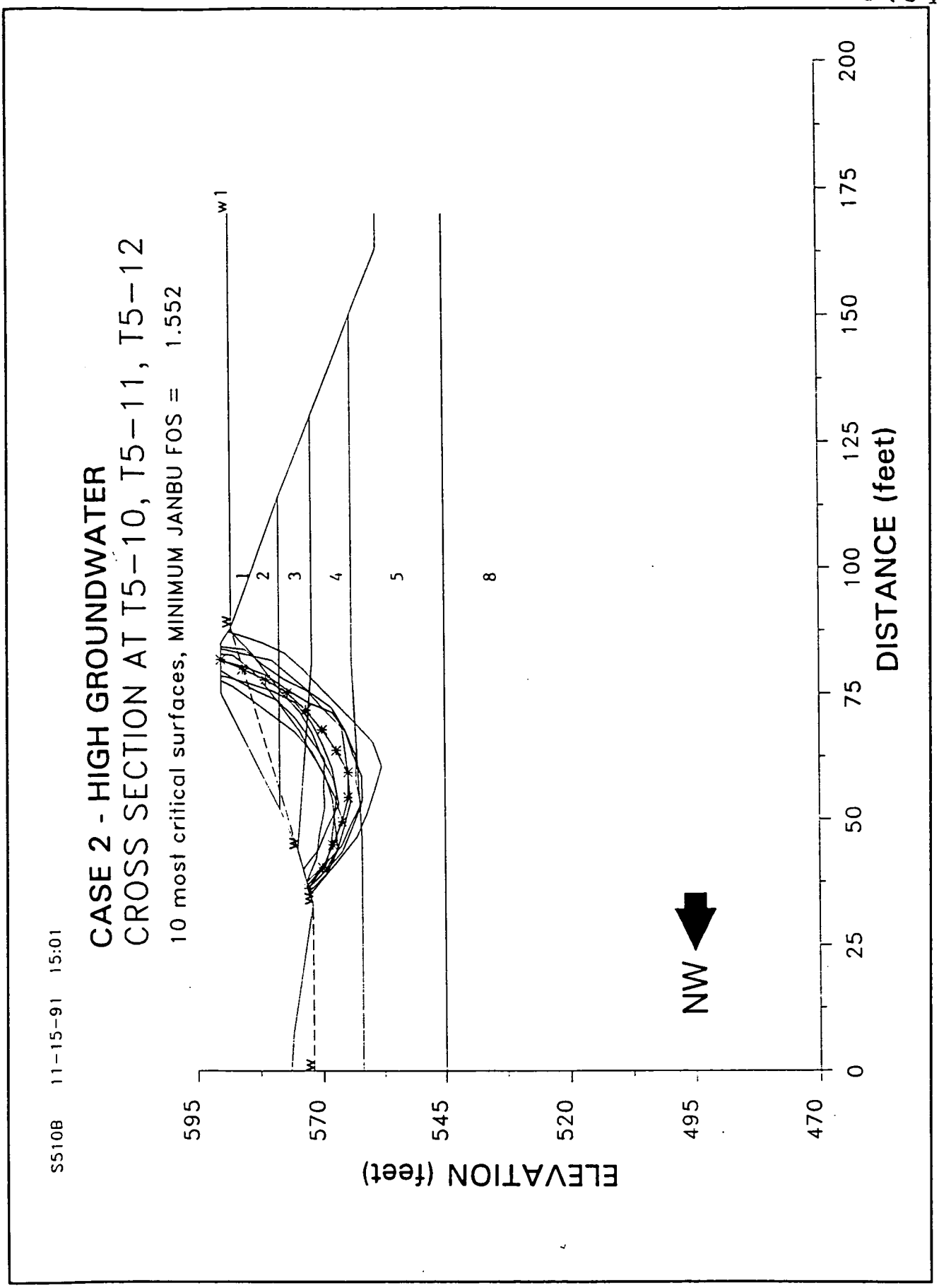

Figure C11 - Cross Section T5-10,11,12 - Case 2

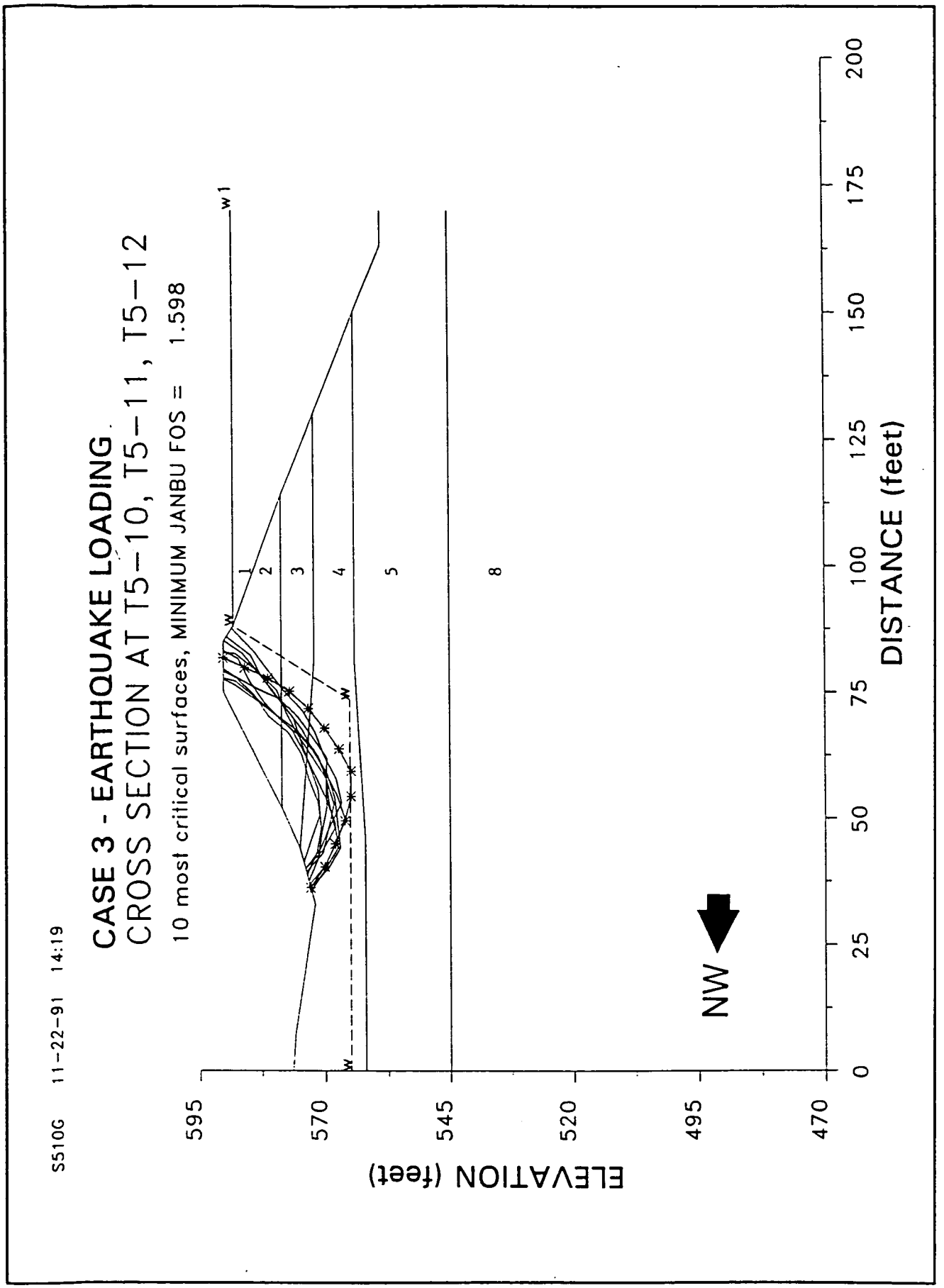

Figure C12 - Cross Section T5-10,11,12 - Case 3

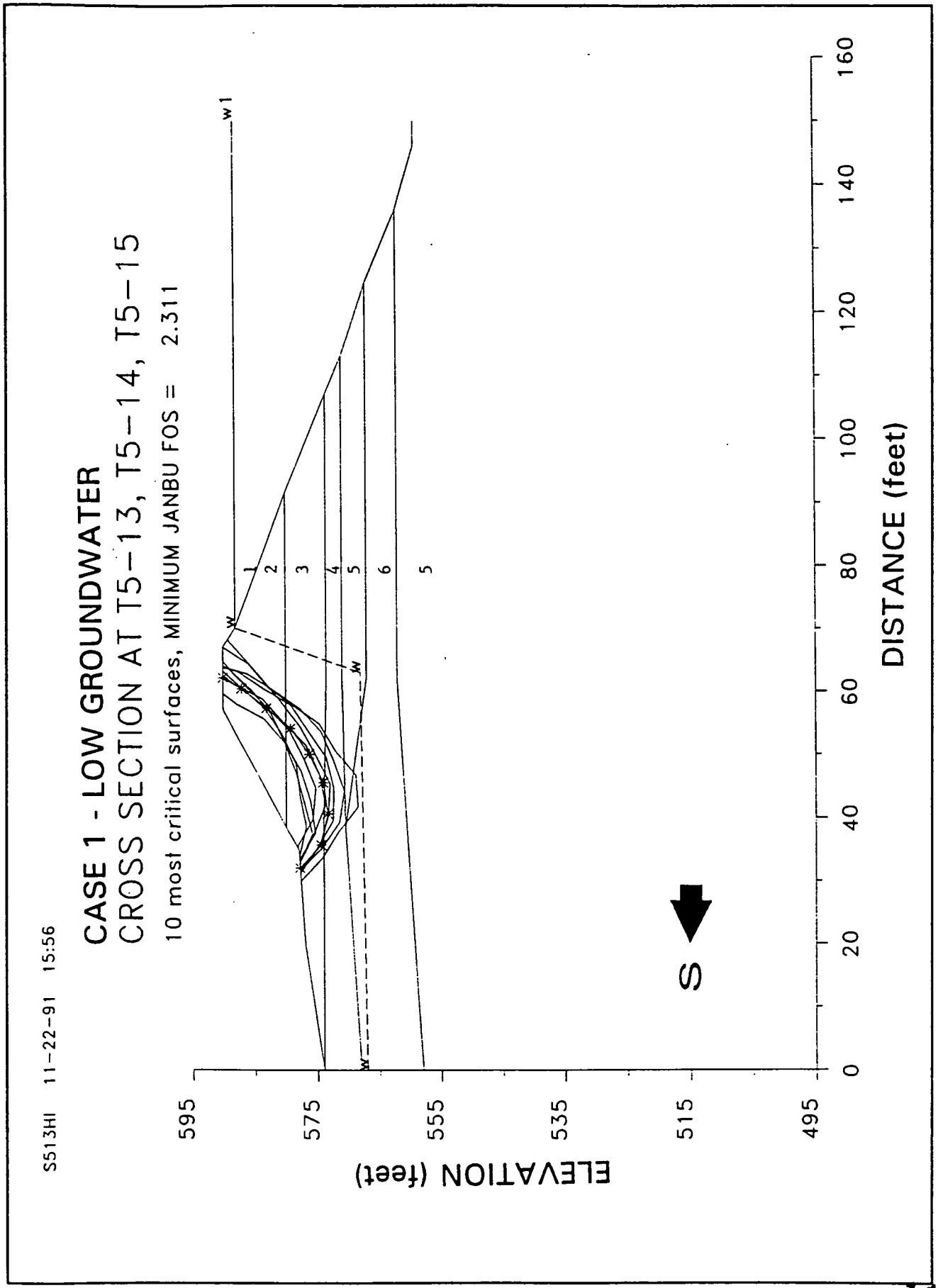

Figure C13 - Cross Section T5-13,14,15 - Case 1

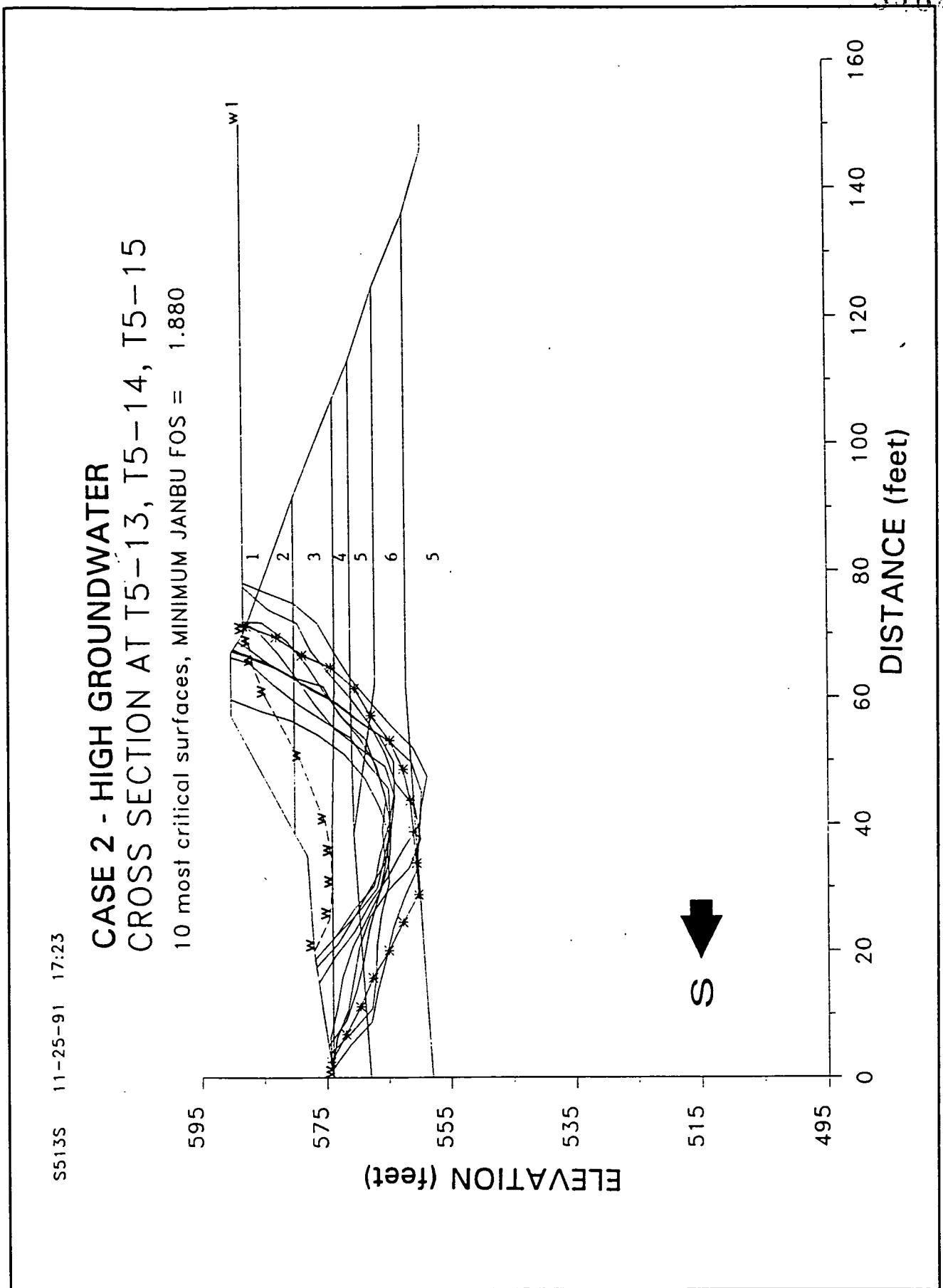

Figure C14 - Cross Section T5-13,14,15 - Case 2

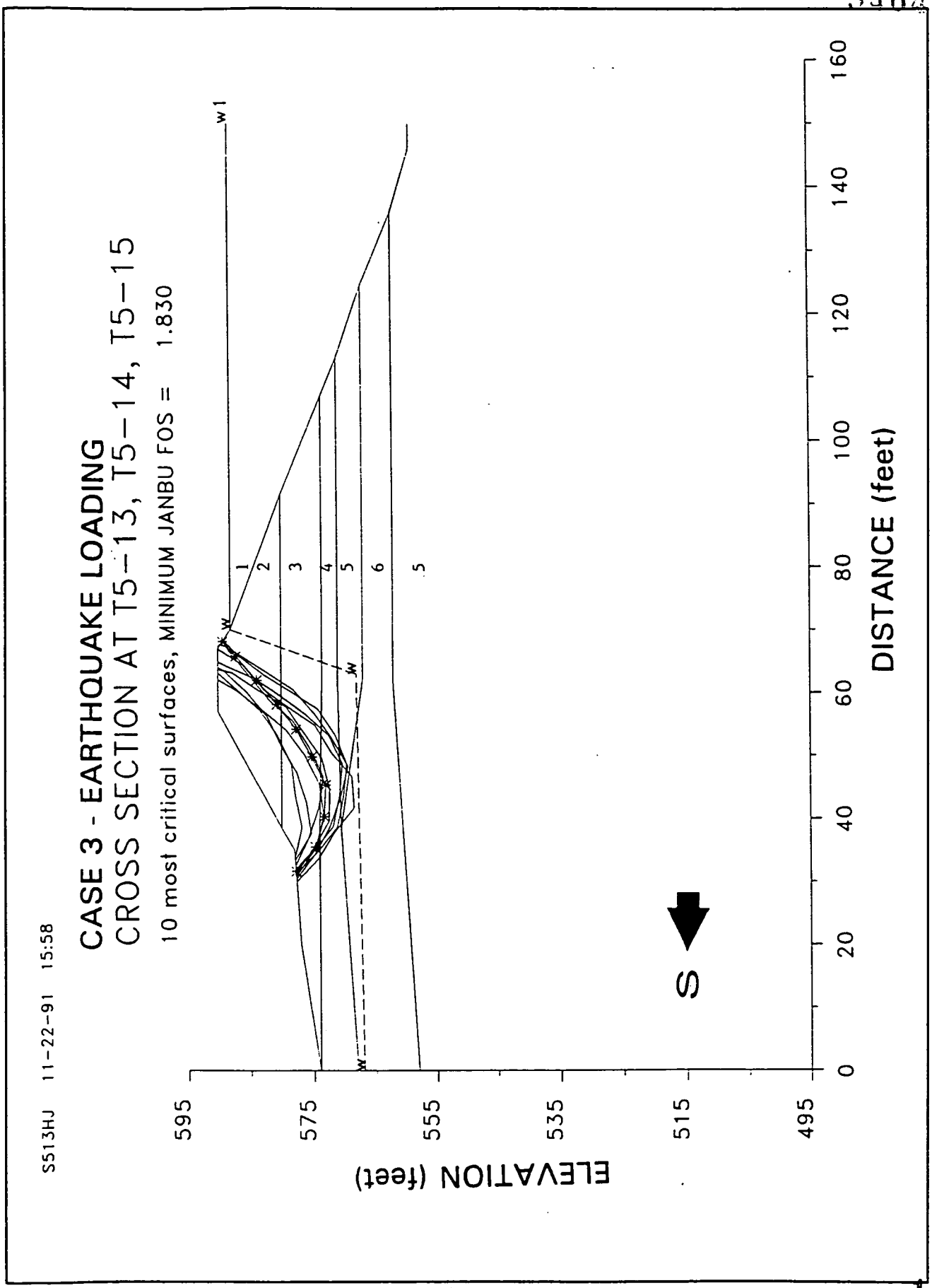

Figure C15 - Cross Section T5-13,14,15 - Case 3

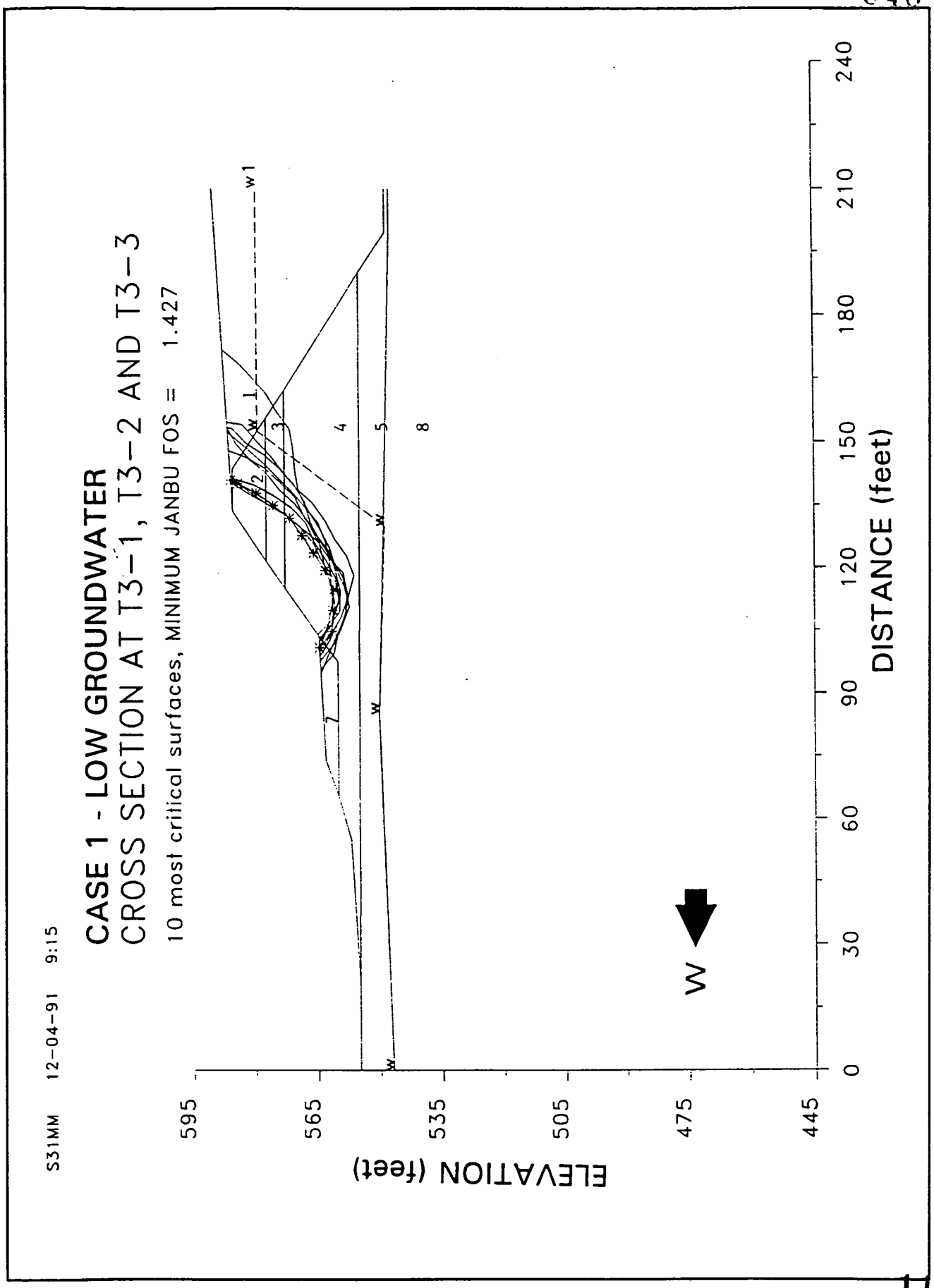

Figure C16 - Cross Section T3-1,2,3 - Case 1

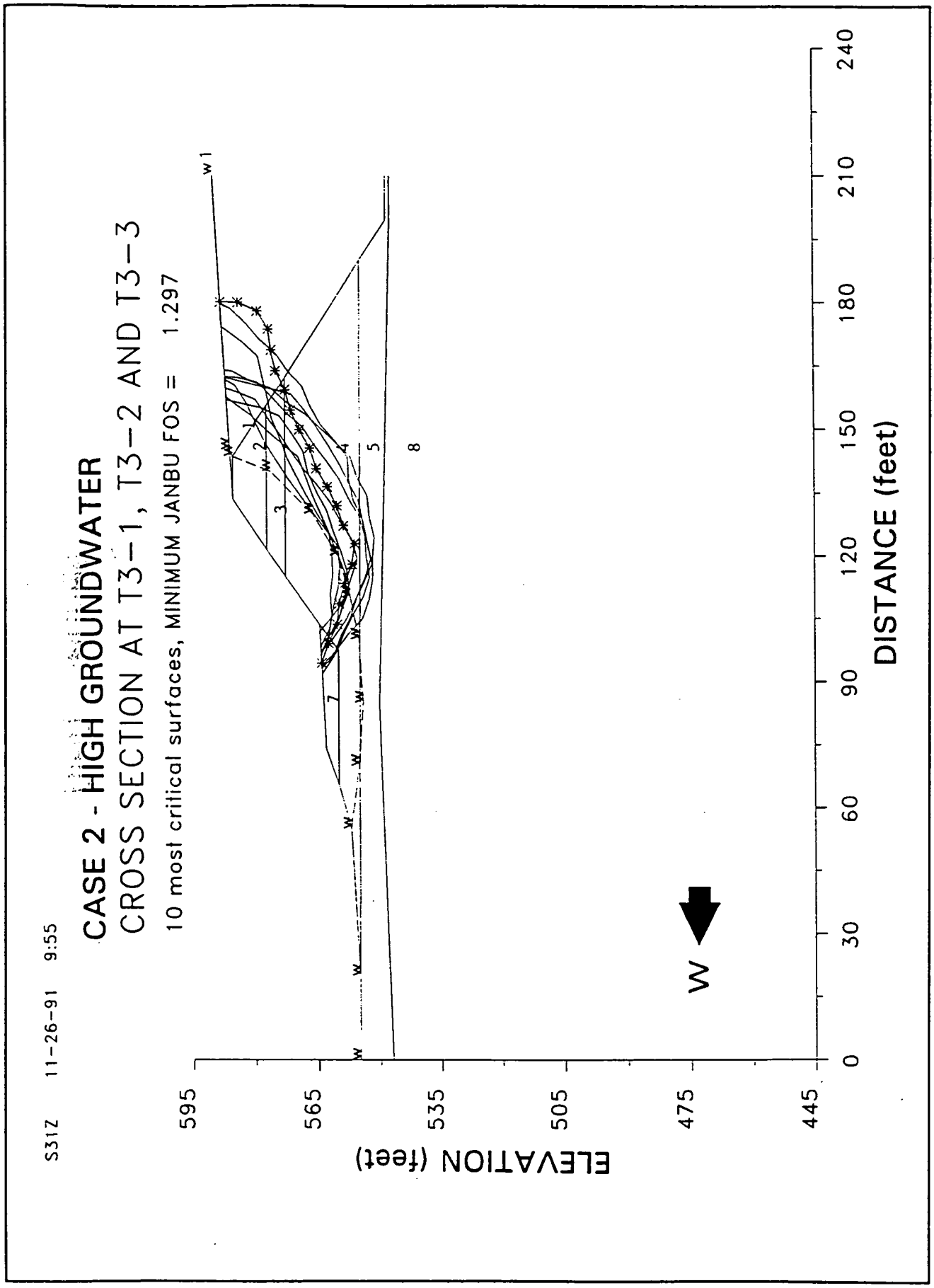

Figure C17 - Cross Section T3-1,2,3 - Case 2

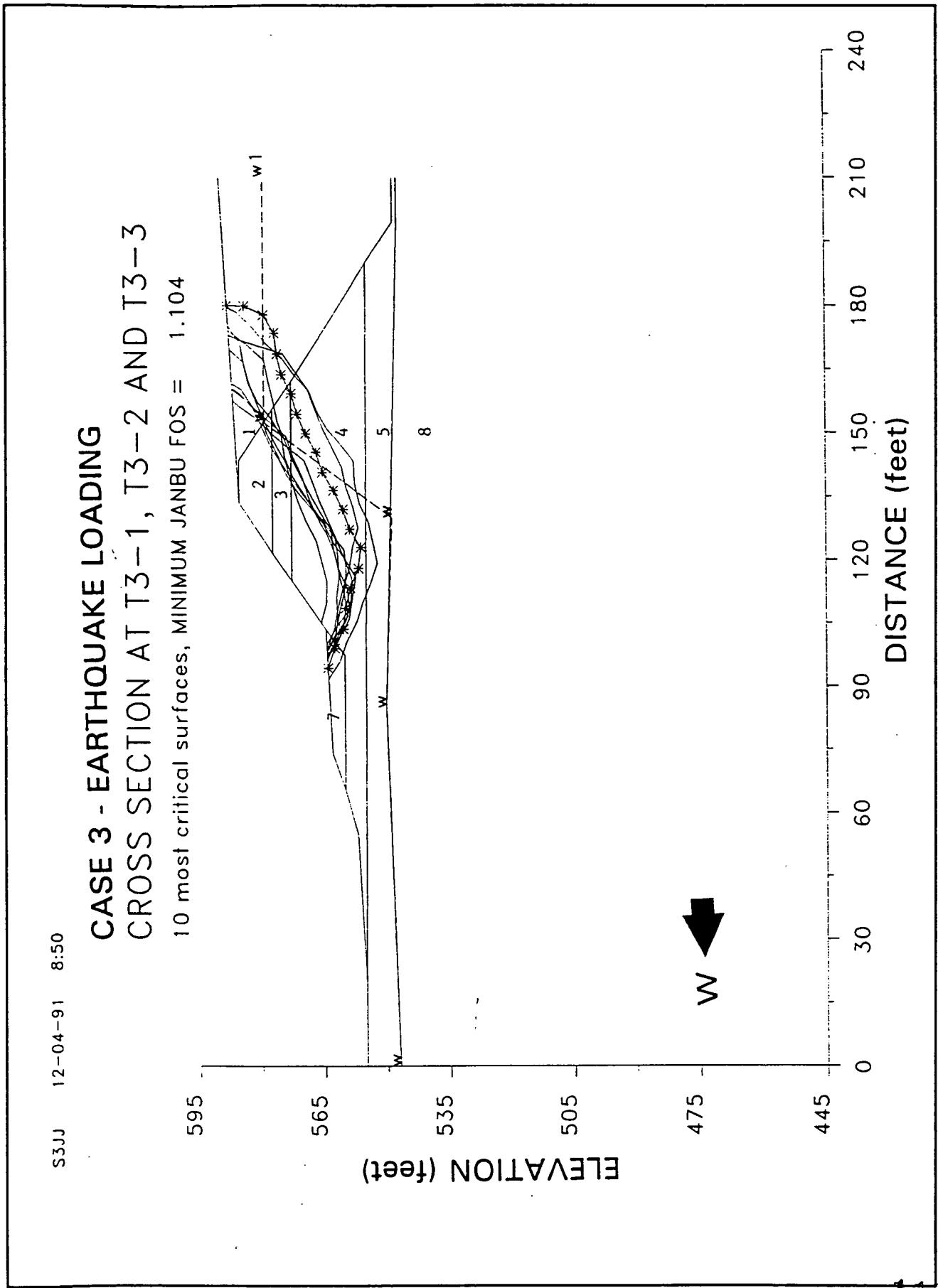

Figure C18 - Cross Section T3-1,2,3 - Case 3

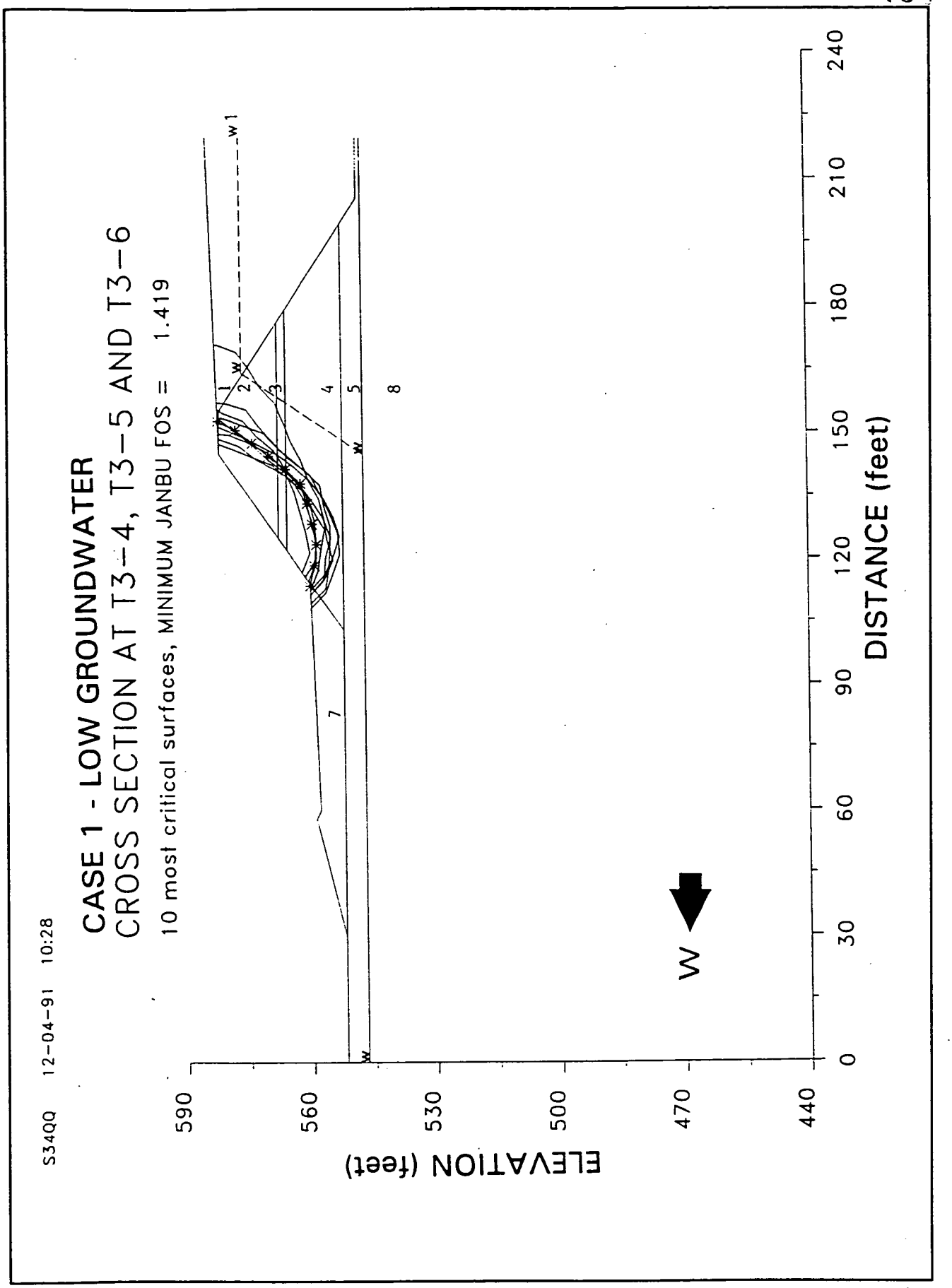

Figure C19 - Cross Section T3-4,5,6 - Case 1

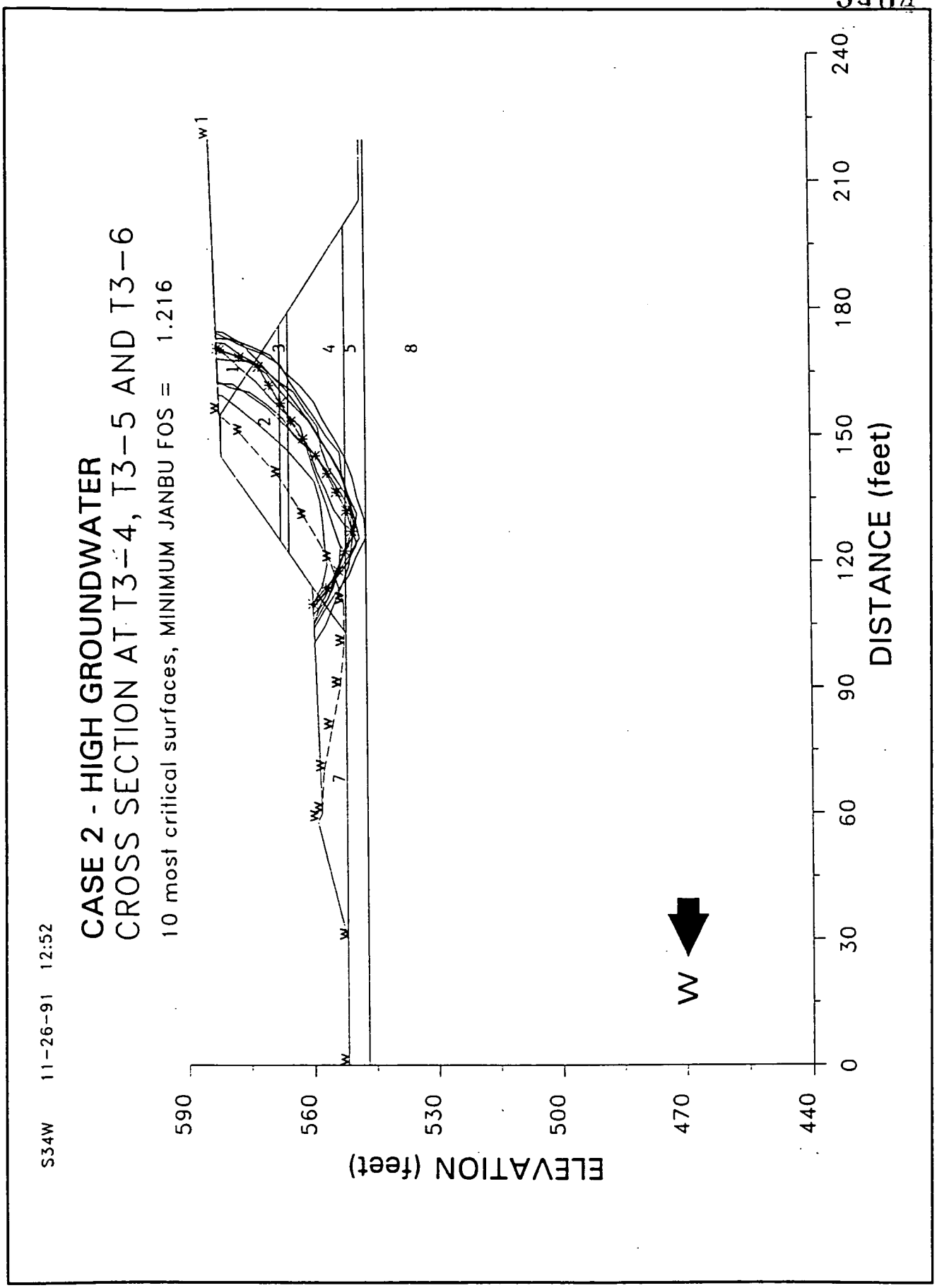

Figure C20 - Cross Section T3-4,5,6 - Case 2

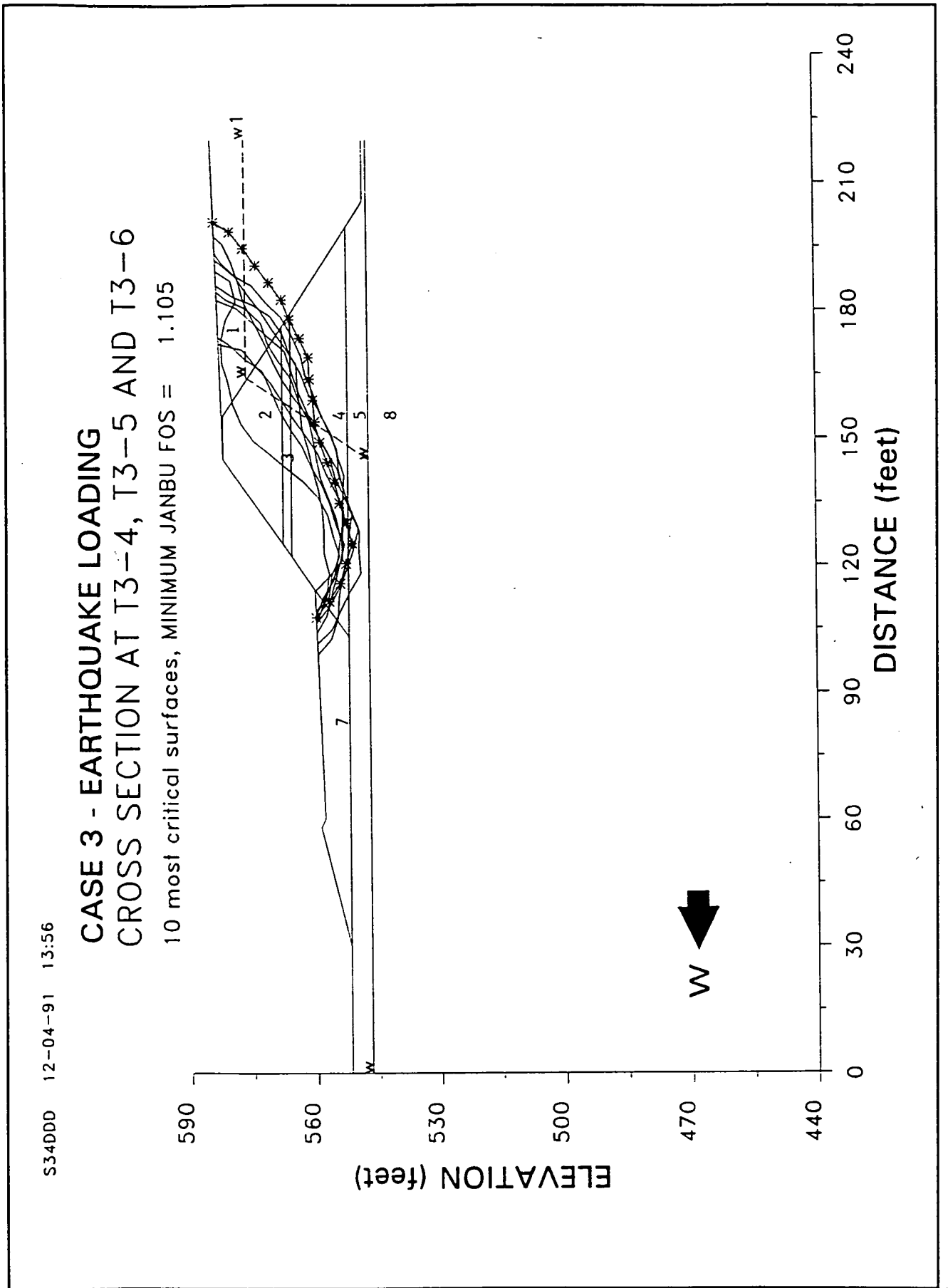

Figure C21 - Cross Section T3-4,5,6 - Case 3

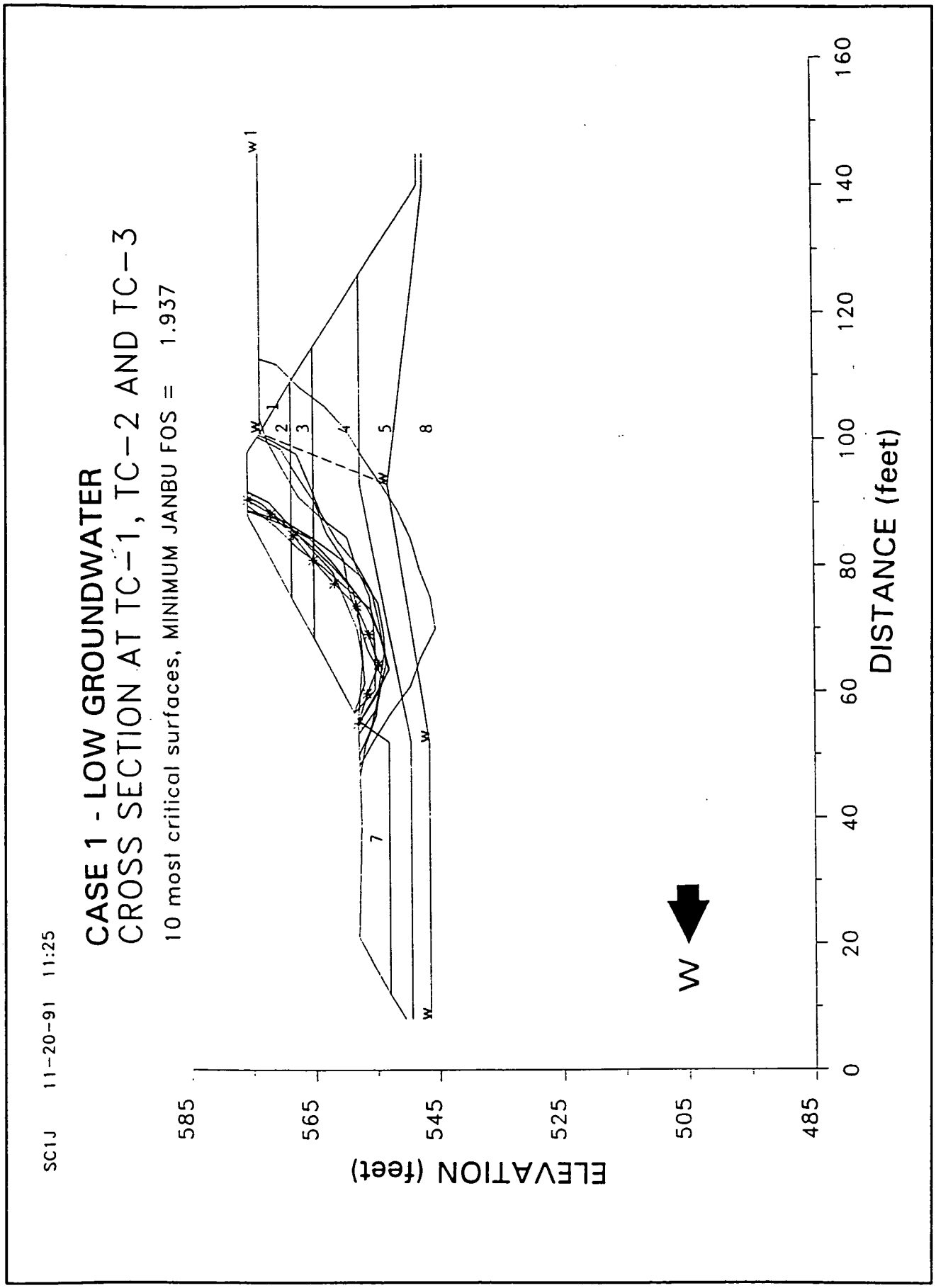

Figure C22 - Cross Section TC-1,2,3 - Case 1

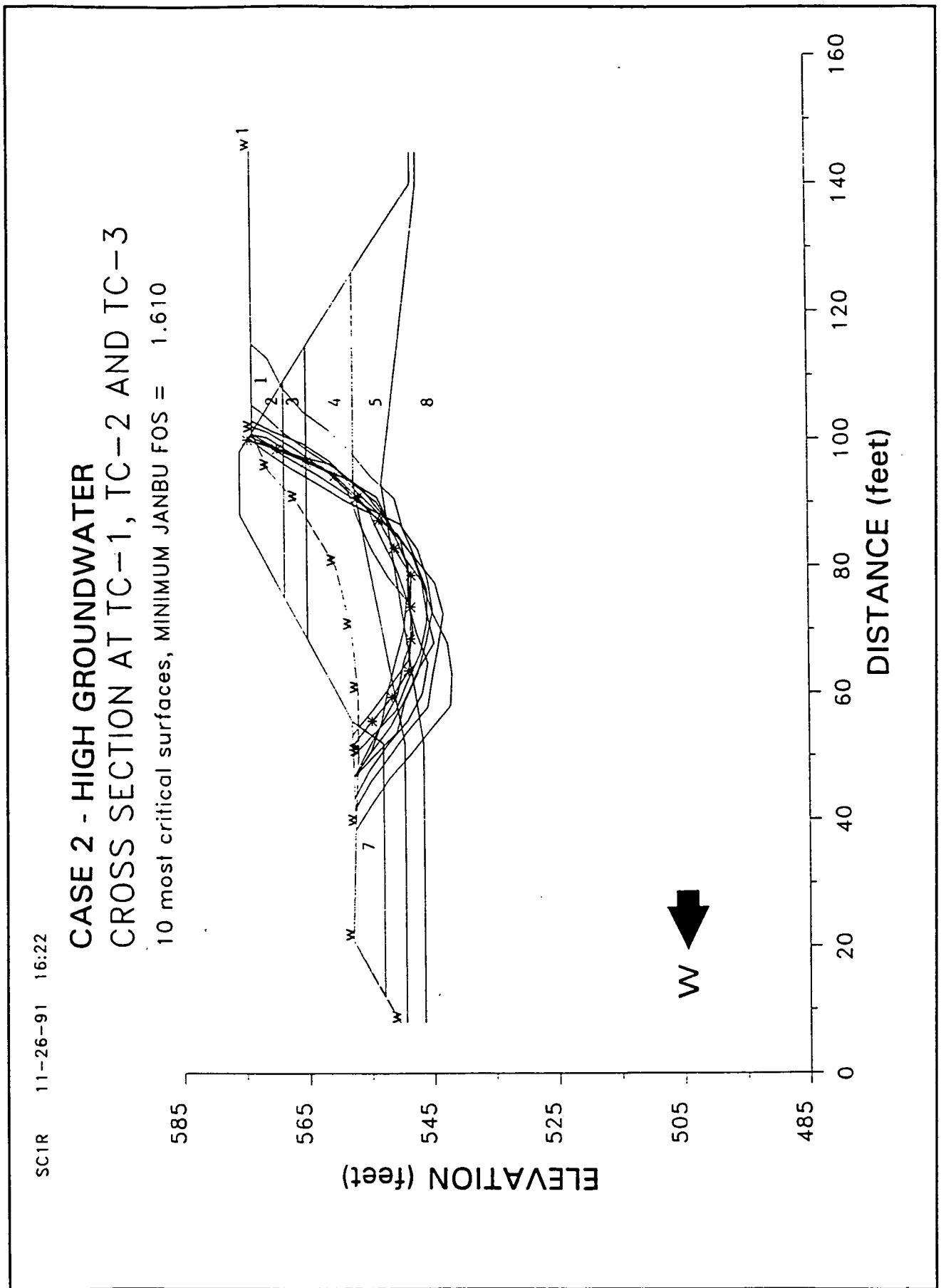

Figure C23 - Cross Section TC-1,2,3 - Case 2

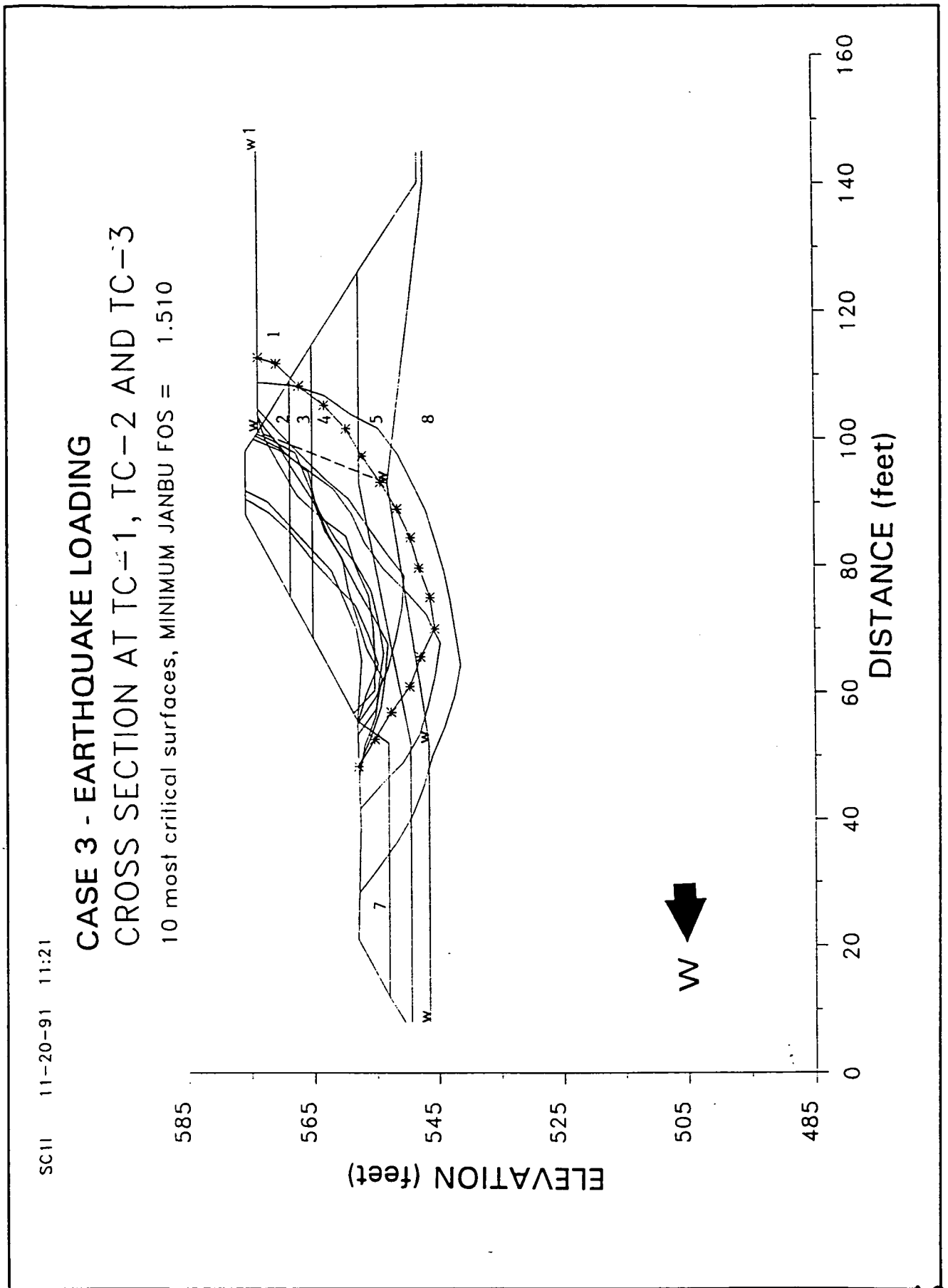

Figure C24 - Cross Section TC-1,2,3 - Case 3

APPENDIX D

SLOPE STABILITY ANALYSIS RESULTS
FLATTER EXTERIOR SLOPE (2.5H: 1V) CASE

Appendix D

CONTENTS

FIGURE

D1 Cross Section T3-1,2,3-2.5:1 Slope - Case 1 . . . . . D-1

D2 Cross Section T3-1,2,3-2.5:1 Slope - Case 2 . . . . . D-2

D3 Cross Section T3-1,2,3-2.5:1 Slope - Case 3 . . . . . D-3

D4 Cross Section T3-4,5,6-2.5:1 Slope - Case 1 . . . . . D-4

D5 Cross Section T3-4,5,6-2.5:1 Slope - Case 2 . . . . . D-5

D6 Cross Section T3-4,5,6-2.5:1 Slope - Case 3 . . . . . D-6

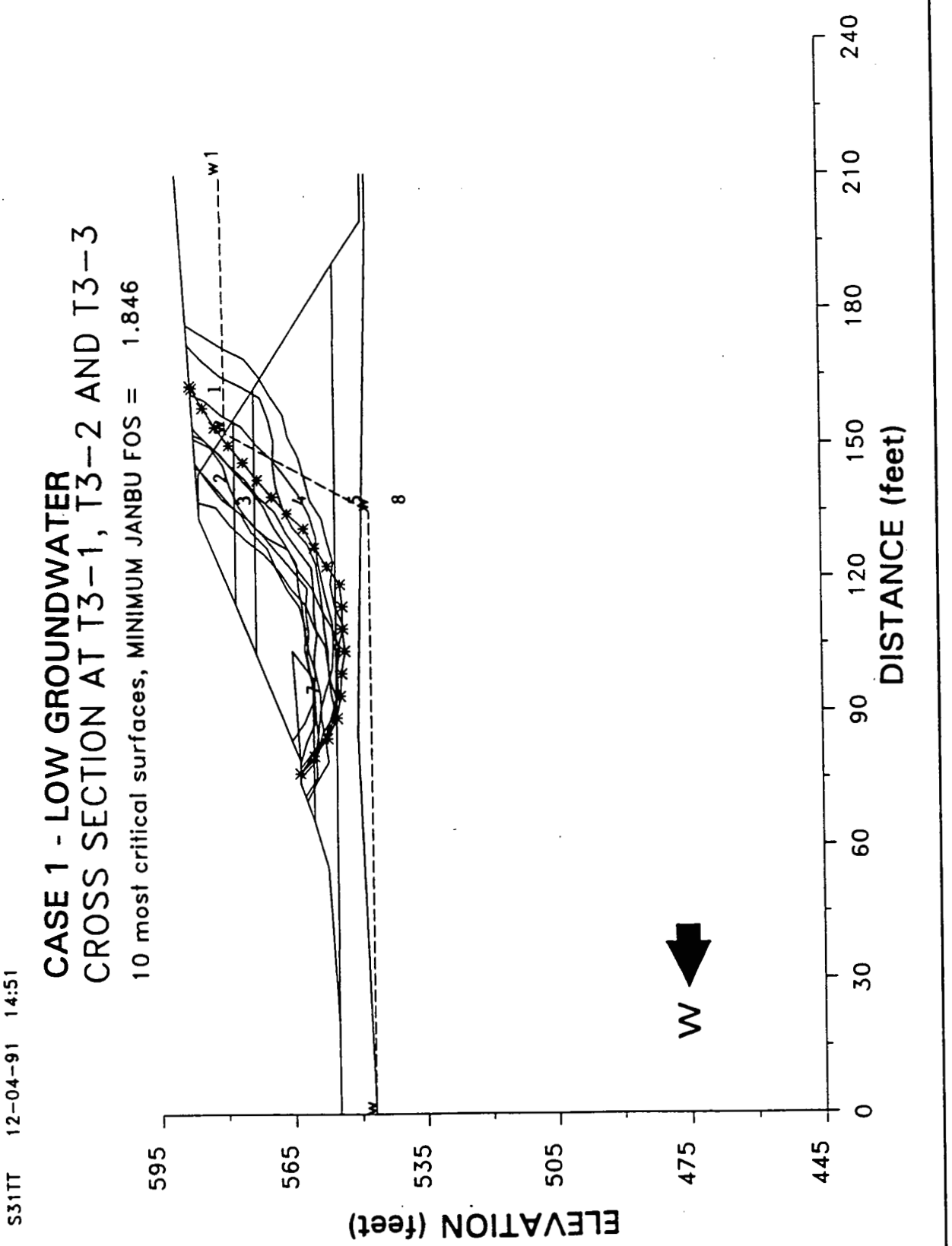

Figure D1 - Cross Section T3-1,2,3-2.5:1 Slope - Case 1

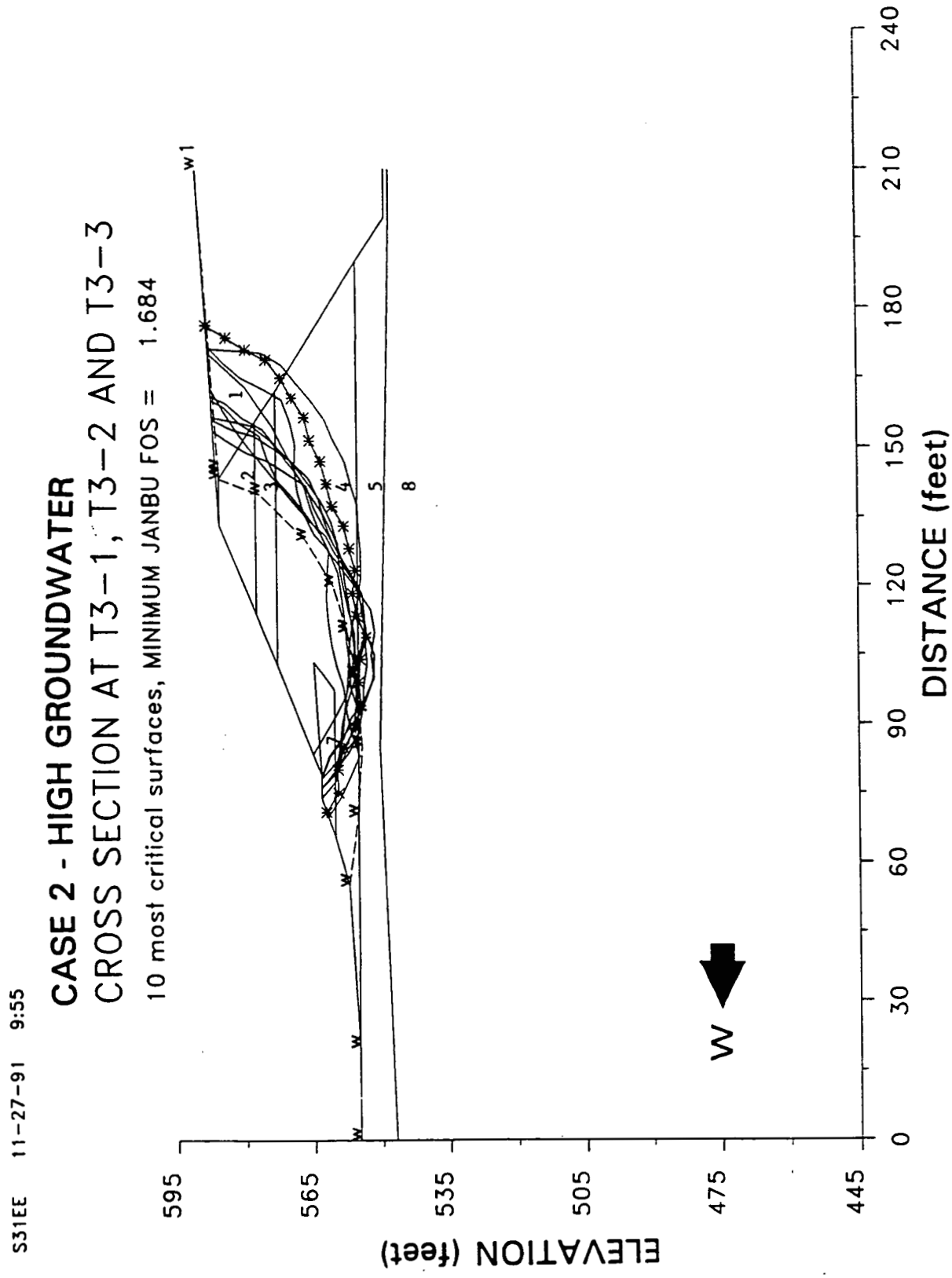

Figure D2 - Cross Section T3-1,2,3-2.5:1 Slope - Case 2

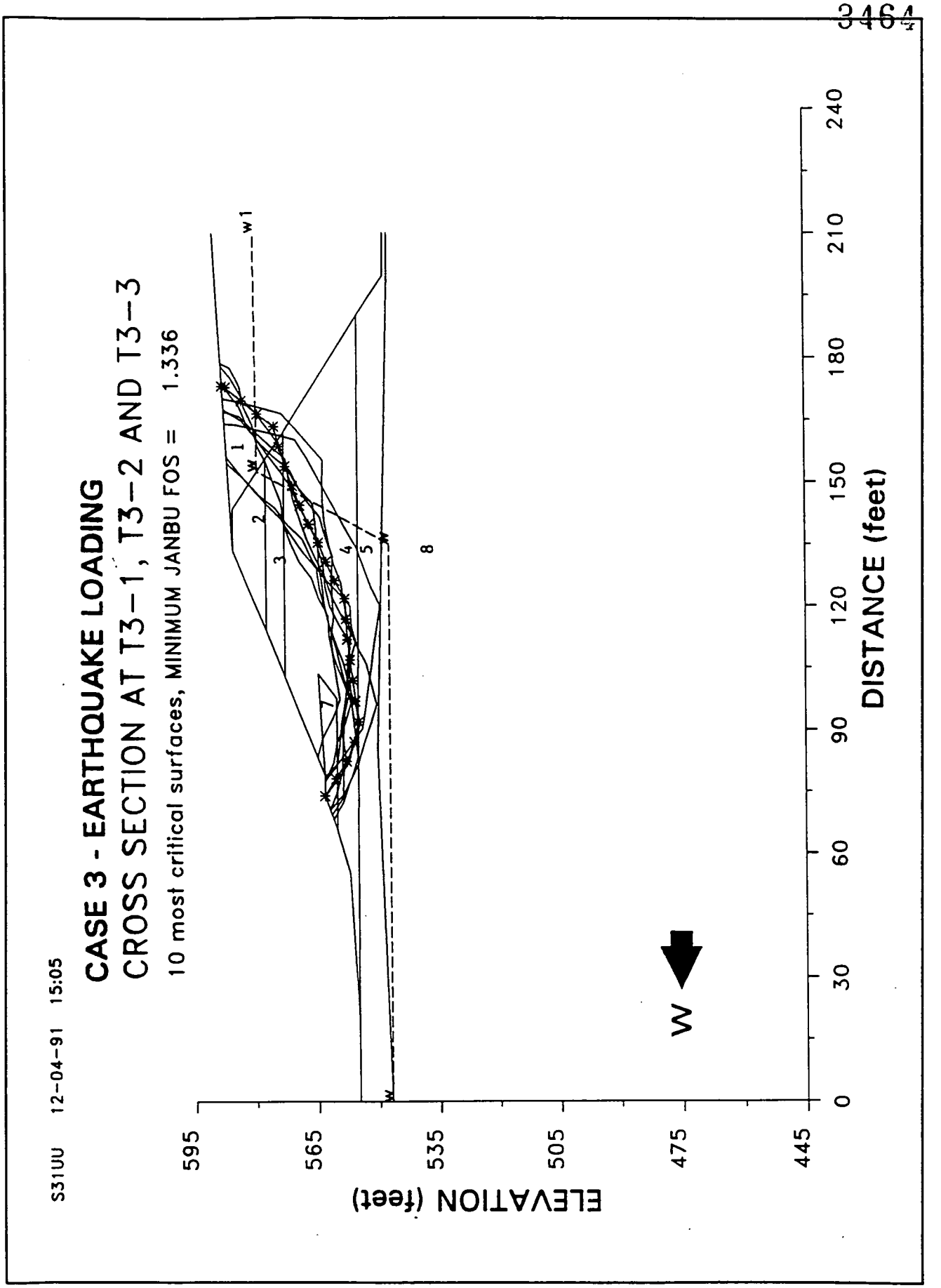

Figure D3 - Cross Section T3-1,2,3-2.5:1 Slope - Case 3

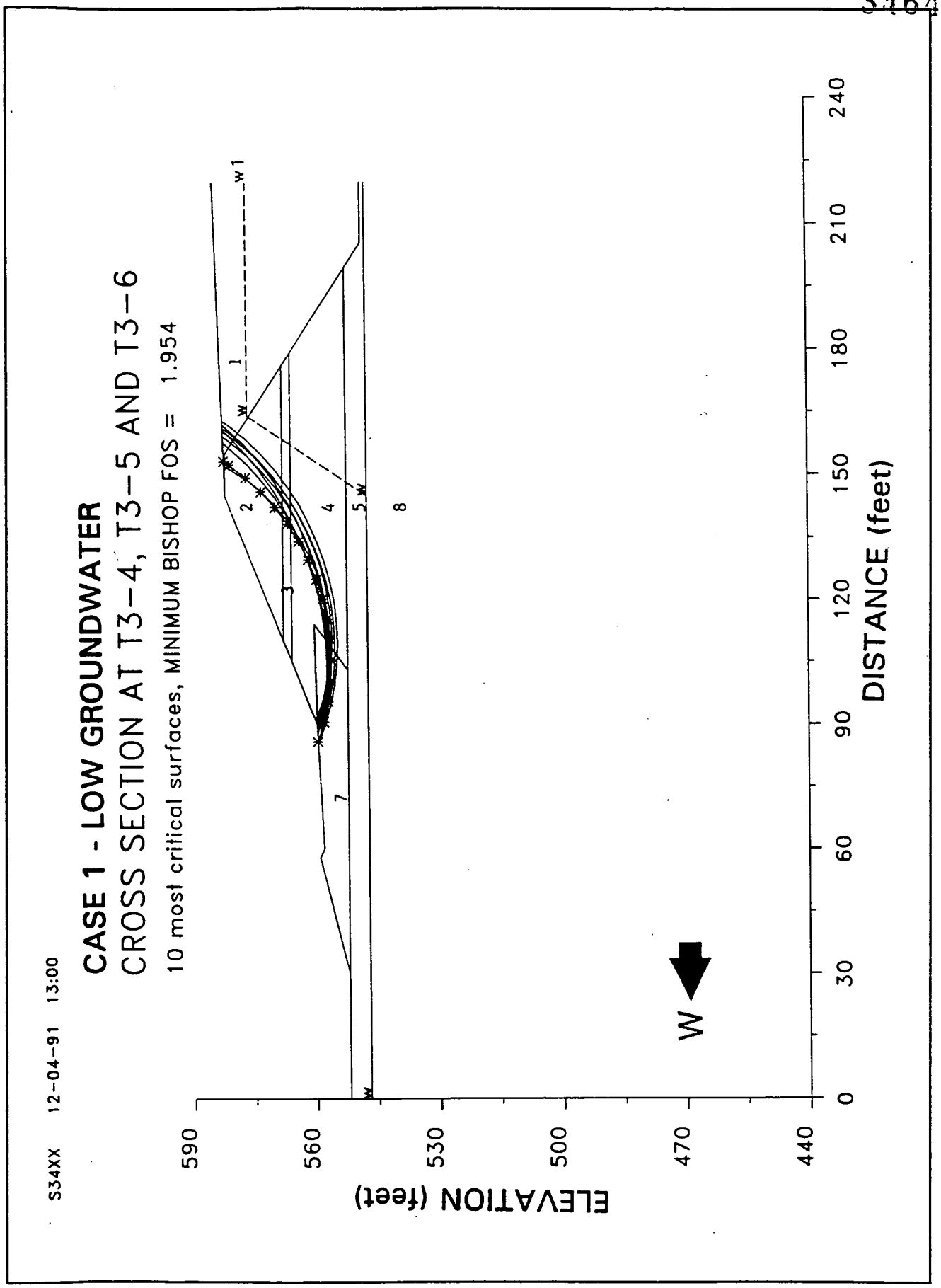

Figure D4 - Cross Section T3-4,5,6-2.5:1 Slope - Case 1

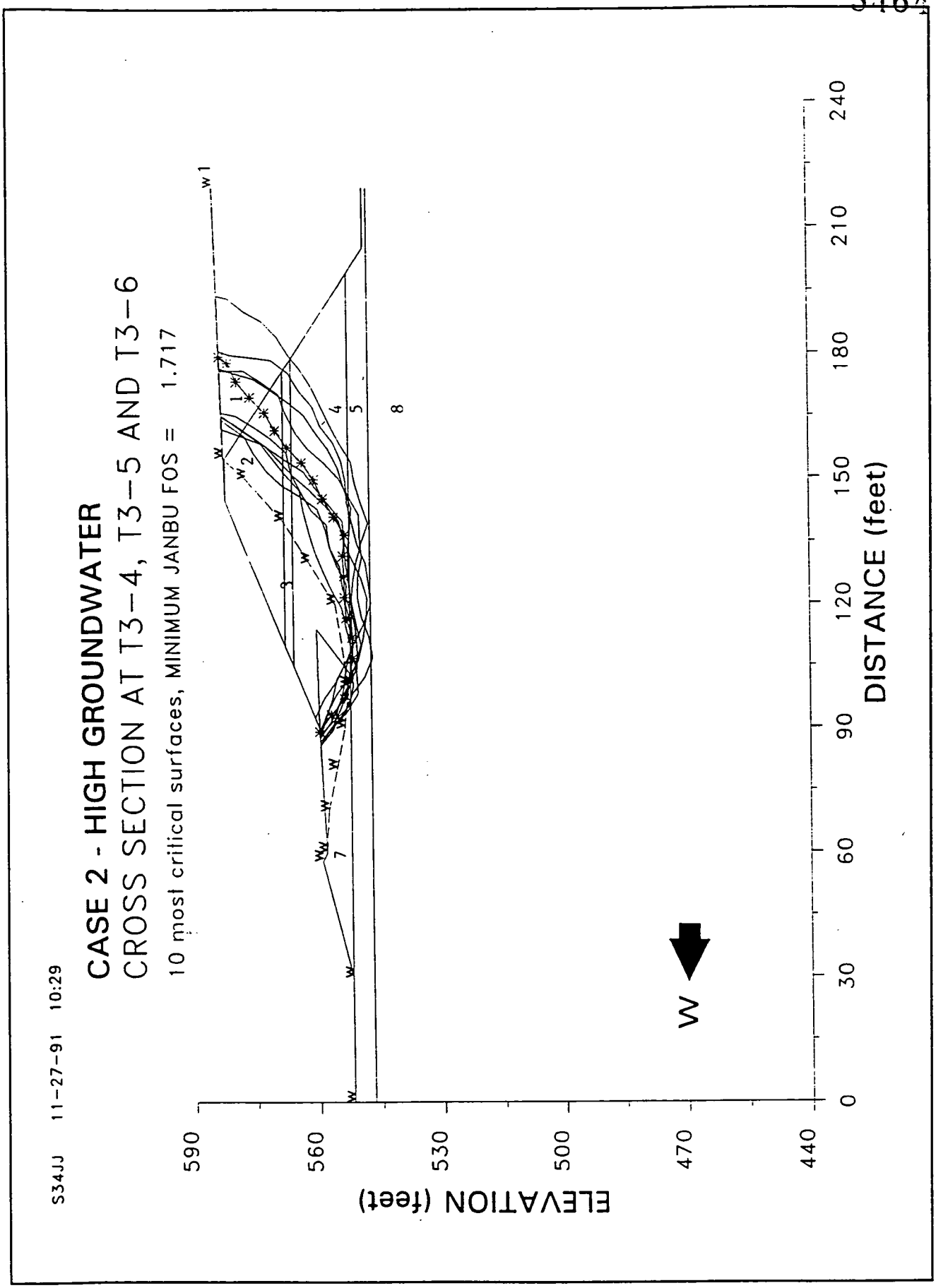

Figure D5 - Cross Section T3-4,5,6-2.5:1 Slope - Case 2

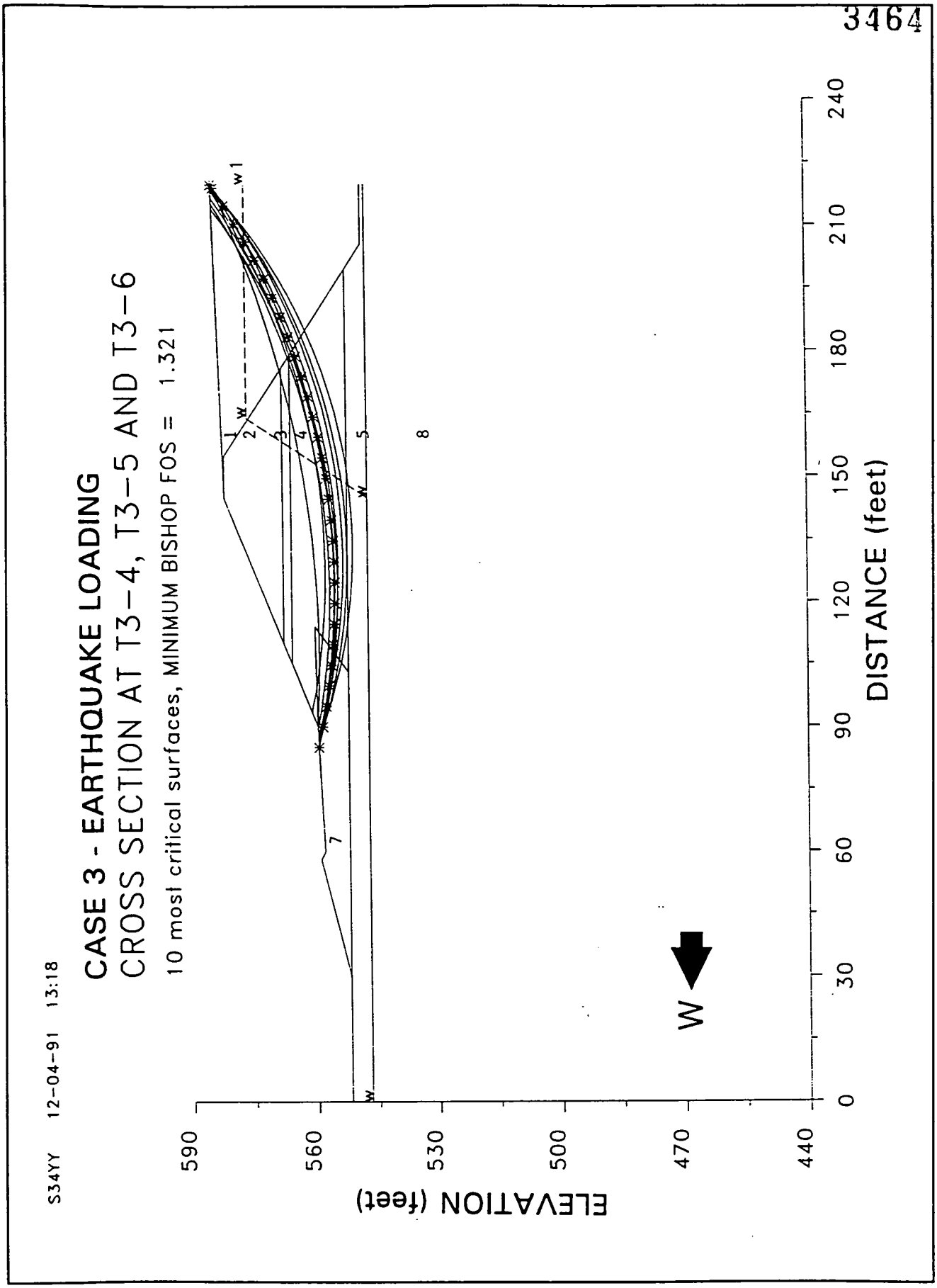

Figure D6 - Cross Section T3-4,5,6-2.5:1 Slope - Case 3