Y/TS-1395/R1

Y-12

OAK RIDGE
Y-12
PLANT

MARTIN MARIETTA

Y-12 INDUSTRIAL LANDFILL V

PERMIT APPLICATION MODIFICATIONS

NOVEMBER
~~September~~ 1995

Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831-8169
managed by
Lockheed Martin Energy Systems, Inc.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

MASTER

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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Technical Specifications

Design and Operating Procedure

Ground Water Sampling and Analysis Plan

Closure/Post Closure Plan

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Drawings

Permit Application Update Instructions

This upgrade package (YT/S-1395) contains changes/additions to the existing approved ILF-V permit document (YT/S-835) dated June 1992. The following instructions should be used to upgrade (YT/S-835) to meet the intent of (YT/S-1395).

Revised Section	Action
Engineering Calculations	Add
Technical Specifications	Add
Design and Operating Procedure	Replace
Groundwater Sampling and Analysis Plan	Replace
Closure/Post Closure Plan	Replace
Construction Quality Assurance Plan	Replace
Drawings	
C2E900000A703	Replace
C2E900000A627	Replace
C2E900000A925	Add
C2E900000A926	Add
C2E900000A603	Replace
C2E900000A631	Replace
C2E900000A632	Replace
C2E900000A633	Replace
C2E900000A634	Replace
C2E900000A927	Add
C2E900000A635	Replace
C2E900000A636	Replace
C2E900000A928	Add
C2E900000A929	Add
C2E900000A930	Add
C2E900000A931	Add

Y-12 INDUSTRIAL LANDFILL V STABILITY ANALYSIS

1/95

CALCULATION COVER SHEET

Calculation Body Sheet 1 of 46

CLIENT U.S. DOE ERWM Program

PROJECT Landfill V, Y-12 PROJECT ORDER NUMBER 940046.01

SUBJECT Stability Analysis

CALCULATION NO. CIV-ERWM-182 Design Classification Level III

TOTAL NUMBER OF SHEETS INCLUDING ATTACHMENTS 46+204 (Attachments)

OFF-PROJECT CALCULATION PREPARER (COMPANY) N/A

OFF-PROJECT CALCULATION REVIEWED BY N/A DATE N/A

CONTAINS ASSUMPTIONS THAT REQUIRE CONFIRMATION Yes ____ No ✓

ASSUMPTIONS CONFIRMED BY N/A ON N/A

Each participant shall print name clearly, initial, and date below.

Rev. No.	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
0	6,31,34,35,41,42	W. Pat Taylor 6/27/95 WPT	David T. Tso 6/28/95 DTT	
0	1-5, 7-30 32,33 36-40	David T. Tso 6/27/95 DTT	W. Pat Taylor 6/28/95 WPT	
—	43-46 Attachments	—	—	
1	Revised Sht's 3, 29, 32, E5	David T. Tso DTT 8/4/95	W. Pat Taylor 8/19/95 WPT	
1	Added Sht's 5a, 5b, 6a, 6b	David T. Tso DTT 8/4/95	W. Pat Taylor 8/19/95 WPT	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

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REVISION SHEET

Revision No.	Revision Date	Affected Pages, Sections, and Para.	Reason for Revision
0	6/27/95	ALL	INITIAL ISSUE
1	8/4/95	REVISED SHTS: 3, 29, 32, ES ADDED SHTS 5a, 5b, 6a, 6b	INCORP. CLIENT COMMENTS

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A:	SEISMIC SLOPE STABILITY PARAMETRIC STUDIES	A1-A85
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C:	STATIC SLOPE STABILITY ANALYSIS COMPUTER PRINTOUT	C1-C24
D:	STATIC VENEER STABILITY ANALYSIS RESULTS FROM PROGRAM "LINERB"	D1-D17
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1.0 PURPOSE OF ANALYSIS

To assess the stability of the proposed solid waste Landfill V under static and seismic loading conditions. Analyses performed include the general (global) slope stability, veneer stability of the bottom liner and cover system, and liquefaction potential assessment of the foundation soils.

2.0 CRITERIA

Maximum Horizontal Acceleration for Seismic Analysis: 0.22g

Minimum factor of safety for stability assessment:

Global, static	1.5	(Reference E)
Global, seismic (pseudo-static)	1.0	(Reference E)
Veneer, static	1.3	(Reference G)
Veneer, seismic (pseudo-static)	1.0	(Reference B)
Liquefaction	1.2	(Reference B)

Maximum deformation (seismic): 6 inches without impacting leachate piping.

3.0 APPLICABLE CODES AND STANDARDS

Earthquake Evaluation Guidance Document by Tennessee Division of Solid Waste (1993)

4.0 METHODOLOGY

Global slope stability analysis was performed by using a limiting equilibrium slope stability computer code "PCSTABL 5M" developed by Purdue University under the sponsorship of the Federal Highway Administration.

Circular and block failure modes were investigated separately to determine the most critical failure surface and associated factors of safety for each mode. The model was developed using cross-section C, on Drawing C2E900000A632, which was judged the most critical section with the height of the waste reaching approximately 120 feet. Two hundred trial surfaces were generated for the circular analyses and one hundred trial surfaces were generated for the block analyses. Only the ten most critical surfaces are presented in graphic form for each mode in Attachment A. Complete printout for location coordinates and respective factors of safety are included in Attachments B and C.

Maximum horizontal acceleration (bedrock) used for pseudo-static slope stability and landfill deformation analyses was obtained from the USGS Map of Maximum Horizontal Accelerations contained in Reference B. This is the acceleration with a 90% or greater probability of not being exceeded in 250 years. Parametric studies were performed to get a better understanding of the sensitivity of slope stability to variations in principal strength parameters of different materials and to the seismic coefficient.

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Procedures for calculating global landfill deformation under seismic loads and for determining the factor of safety for cover system veneer under seismic loads were as prescribed in Reference B. In accordance with Reference B, the undrained shear strengths of the in situ soils were reduced by 20% from the values shown in Section 7, GEOSYNTHETICS/SOILS PARAMETERS. The yield acceleration was determined by setting the factor of safety equal to 1.0 in the pseudo-static analysis.

Veneer stability and stresses for cover and bottom liner systems under static loads were analyzed using limit equilibrium methods. A spreadsheet program "LINERB" developed at Purdue University based on a limit equilibrium model was used to calculate the factors of safety for cover and liner stability.

5.0 ASSUMPTIONS

The following assumptions were made by the author and do not require confirmation.

The material properties listed as Geosynthetics/Soils Parameters (Section 7) are assumed to be applicable to the in-place properties of the constructed landfill.

.0 REFERENCES

A. Report of Geotechnical and Geosynthetic Testing, Landfill V, Y-12 Plant, U.S. DOE Oak Ridge, TN, by J&L Testing Co., Inc., June 16, 1995.

B. Earthquake Evaluation Guidance Document by Tennessee Division of Solid Waste, (1993).

C. RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities, EPA, (Draft) (1994).

D. RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities, EPA/600/R-95/051 (1995).

E. Static and Seismic Slope Stability for Waste Containment Facilities-University of Wisconsin Seminar Document, (1995).

F. Geomembrane/Geotextile Interface Shear Strengths, ASCE Paper No. 005450-GT, by Stark, T. D. et al (1995).

G. Designing with Geosynthetics by R. M. Koerner, 3rd Edition, (1994).

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5.0 ASSUMPTIONS

A. Material properties listed as Geosynthetic / Soils Parameters in section 7 are assumed to be applicable to the in-place properties of the constructed landfill.

B. Entire failure surface reaches failure simultaneously.

C. Entire failing mass moves at once as a rigid body with a well defined slip surface when critical acceleration is exceeded.

D. No displacement at acceleration below yield acceleration

E, slide mass is a rigid-plastic body (i.e. it does not deform internally).

F. static and dynamic shearing resistance are identical.

G. Effect of dynamic pore pressures are neglected.

H. Critical acceleration is not strain dependent and remains constant throughout the deformation analysis.

I. Waste fill exhibits soft soil response in wave propagation. Unit weight of the waste is 65 pcf.

J. No vertical seismic component is considered in stability or deformation analysis.

K. Relations between the maximum average acceleration for the sliding mass and the maximum crest acceleration as well as the strain-dependent shear modulus and damping developed by H.B. Seed (1978) and adopted by Reference A can be used for analysis.

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7.0 GEOSYNTHETICS/SOILS PARAMETERS

	Range of Test Values (Residual)	Value Used for Analysis Static/(Seismic)
7.1 Clay/Geomembrane Interface Friction		
Clay—PP[1] (Smooth)	16.6° @ 30.1% Moisture/15.4° @ 28% Moisture 19.4° @ 27.8% Moisture	16°
Clay (Sprayed)—PP (Smooth)	10.5°	NA
Clay—PP (Textured)	36.2° @ 27.8% Moisture/32.9° @ 27.8% Moisture 30.4° @ 30.5% Moisture/29.0° @ 32.6% Moisture	24°
Clay (Soaked)—PP (Textured)	17.6° @ 27.6% Moisture	NA
Clay (Sprayed)—PP (Textured)	No Test	NA
7.2 Geotextile/Geomembrane Interface Friction		
Geotextile—PP (Smooth)	11.4°	11°
Geotextile—PP (Textured)	24.7°, (16° by Stark—Reference F)	20°
Geotextile (FF)[2]—PP (Smooth)	22.5°	20°
Geotextile/Stone	No Test, (37° by Trevira)	37°
Geotextile/Protective Soil Layer	No Test, (34° by Trevira)	34°
7.3 Geonet/Membrane Interface Strength		
Geonet—PP (Smooth)	14.9°	NA
Geonet—PP (Textured)	14°	NA
Geocomposite—PP (Textured)	No Test	20°
Geocomposite (FF)—PP (Smooth)	No Test	20°

7.4 Geotextile Properties (M.A.R.V.)*

16 oz/sy—	Grab Tensile	350# (Quline); 500# (Trevira)	350#
	Wide Width Tensile	185#/in (Quline); 205.5#/in (Trevira)	185#/in
	Min. Elongation @ Ultimate	60% (Quline); 60% (Trevira)	60%
8 oz/sy—	Grab Tensile	165# (Quline); 230# (Trevira)	165#
	Wide Width Tensile	60#/in (Quline); 104.6#/in (Trevira)	60#/in

* M.A.R.V.—Minimum Average Roll Values (See Quline by Wellman, Inc. & Trevira by Hoechst Celanese)

7.5 Soil Strengths (Undrained—Compacted @ 95% Std. Proctor)

Clay @ 26.2% Moisture—	C = 2561 psf, ϕ = 2.2°	C = 500 psf, ϕ = 18°[3]
	C = 1989 psf, ϕ = 17°	(C = 400 psf, ϕ = 14.4°)
Clay @ 26.7% Moisture—	C = 753 psf, ϕ = 22.2°	
Clay 32.5% Moist.—(Max. Moist. Allowed)	No Test	
Clay @ 33%—	C = 785 psf, ϕ = 9°	

7.6 Soil Weights & Moisture

(Wettest Clay Fill) ω_1 = 32.5%;	γ_d = 86 pcf min; 90 pcf max	γ_d = 90 pcf, γ_t = 120 pcf
(Driest Clay Fill) ω_2 = 25%;	γ_d = 94 pcf min; 100 pcf max	γ_d = 90 pcf, γ_t = 120 pcf
(In Situ Clay) ω_3 = 35%	γ_t = 115 pcf	γ_t = 115 pcf
7.7 Wastes	No Test γ = 65 pcf Per Reference D (EPA):, C = 200 psf, ϕ = 33°	γ = 65 pcf C = 200 psf, ϕ = 33°

1 PP—Polypropylene
2 FF—Friction Face w/Polyester Pellets
3 Equivalent per Parametric Studies to C = 2750 psf, ϕ = 0; C = 0, ϕ = 22° and C = 250 psf, ϕ = 20°

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8.0 SUMMARY OF CONCLUSIONS

A. The proposed 3.5 H : 1 V side slope is stable under static and seismic loading.

B. Predicted maximum seismically induced deformation is approximately 0.8 inches, well below the 6-inch allowable limit.

C. Liquefaction of the foundation soils underneath the landfill is unlikely.

D. Cover soils of the cap may suffer damages when subjected to the specified design earthquake. However, such damages will be easy to repair and will not adversely impact the integrity of the geomembrane cover.

E. 40-mil thick polypropylene geomembrane should perform satisfactorily as the landfill liner and cover.

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F. Smooth geomembrane can be used on the bottom and along slopes where the slope height does not exceed 10 feet. Use textured geomembrane where slope height is greater than 10 feet.

G. Although the geomembrane possesses adequate reserve to withstand temporary stressing, proper construction procedures should be specified to minimize overstressing.

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Summary of Material Properties

		Normal Properties[1]		
Soil No.	**Material Description**	**Unit wt. (pcf)**	**Ø (degree)**	**C (psf)**
1	Waste	65	33	200
2	Drainage Layer	120	11[2]	0
3	Compacted Clay	120	18	500
4	In Situ Clay	115	18	500

Notes:

(1) Material properties were taken from Geosynthetics/Soils Parameter sheet. Shear strength of in situ clay is a conservative estimate from previous laboratory test results in similar soils.

(2) The interface friction angle of smooth geomembrane and overlying geotextile was used for stability analysis.

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SEISMIC COEFFICIENT DETERMINATION

1. Determine the bedrock acceleration

$a_{bedrock} = 0.22\,g$ — Ref. B

2. Determine the peak ground acceleration for medium stiff soil

$a_{ground} = \frac{1}{2}(a_{bedrock} + a_{soft\ soil})$ — Ref. C

$a_{bedrock} = 0.22\,g$

$a_{soft\ soil} = 0.3\,g$ — Ref. C. Fig. 4.2

$\Rightarrow a_{ground} = \frac{1}{2}(0.22 + 0.3)\,g$

$= 0.26\,g$

3. Determine the crest acceleration of the landfill

$a_{crest} = a_{soft\ soil}$ — Ref. C, P.41

$a_{ground} = 0.26\,g \Rightarrow a_{soft\ soil} = 0.34\,g$

$\Rightarrow a_{crest} = 0.34\,g$

4. Determine the Seismic Coefficient, Ks

$K_s = 0.5\ a_{max}/g$ — Ref. C, P 84

For liner, $a_{max} = 0.26g$

For cover, $a_{max} = 0.34g$

⇒ Liner design, $K_s = (0.5)(0.26)$

$= \underline{0.13}$ ← use for block surface

Cover design, $K_s = (0.5)(0.34)$

$= 0.17$

$K_{s(Ave)} = \frac{0.13+.17}{2} = 0$

$K_{s(Ave)} = \underline{0.15}$ ← use for Circular surface

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CIRCULAR FAILURE SURFACES

	Soil strength parameters									
		Waste		Liner		In situ clay				
	Data file	Ø (degree)	C (psf)	Ø (degree)	C (psf)	Ø (degree)	C (psf)	Seismic coefficient (g)	Factor of safety
C1.DAT		23	320	0	1000	0	2000	0.15	0.87
C2.DAT		23	320	0	2000	0	2000	0.15	0.87
C3.DAT		26	200	0	2000	0	2000	00.15	0.87
C4.DAT		26	200	0	2000	0	2500	0.15	1.06
C5.DAT		23	200	0	2000	15	600	0.15	1.10
C6.DAT		23	200	0	2000	20	600	0.15	1.37
C6A.DAT		23	200	0	2000	20	300	0.15	1.25
C7.DAT		23	200	0	2000	25	600	0.15	1.45
C7A.DAT		23	200	0	2000	25	300	0.15	1.45
C7B.DAT		26	200	0	2000	25	300	0.15	1.54
C8.DAT		26	200	0	2000	18	500	0.15	1.24
C8A.DAT		26	200	0	2000	18	500	0.2	1.05
C8B.DAT		23	200	0	2000	18	500	0.15	1.22
C8C.DAT		23	200	0	2000	18	500	0.2	1.03
C8D.DAT		23	200	0	2000	18	500	0.21	1.00
C8E.DAT		26	200	0	2000	18	500	0.21	1.01
C9.DAT		23	200	0	2000	20	250	0.15	1.23
C9A.DAT		23	200	0	2000	20	250	0.19	1.07
C9B.DAT		23	200	0	2000	20	250	0.21	1.00
C10.DAT		23	200	0	2000	20	200	0.15	1.21
C10A.DAT		23	200	0	2000	20	200	0.17	1.12
C10B.DAT		23	200	0	2000	20	500	0.21	0.99
C11.DAT		33	200	11	0	18	500	0.00	2.30
C11A.DAT		27.5	160	11	0	14.4	400	0.13	1.00

See sheets A2 to A49 for computer runs.

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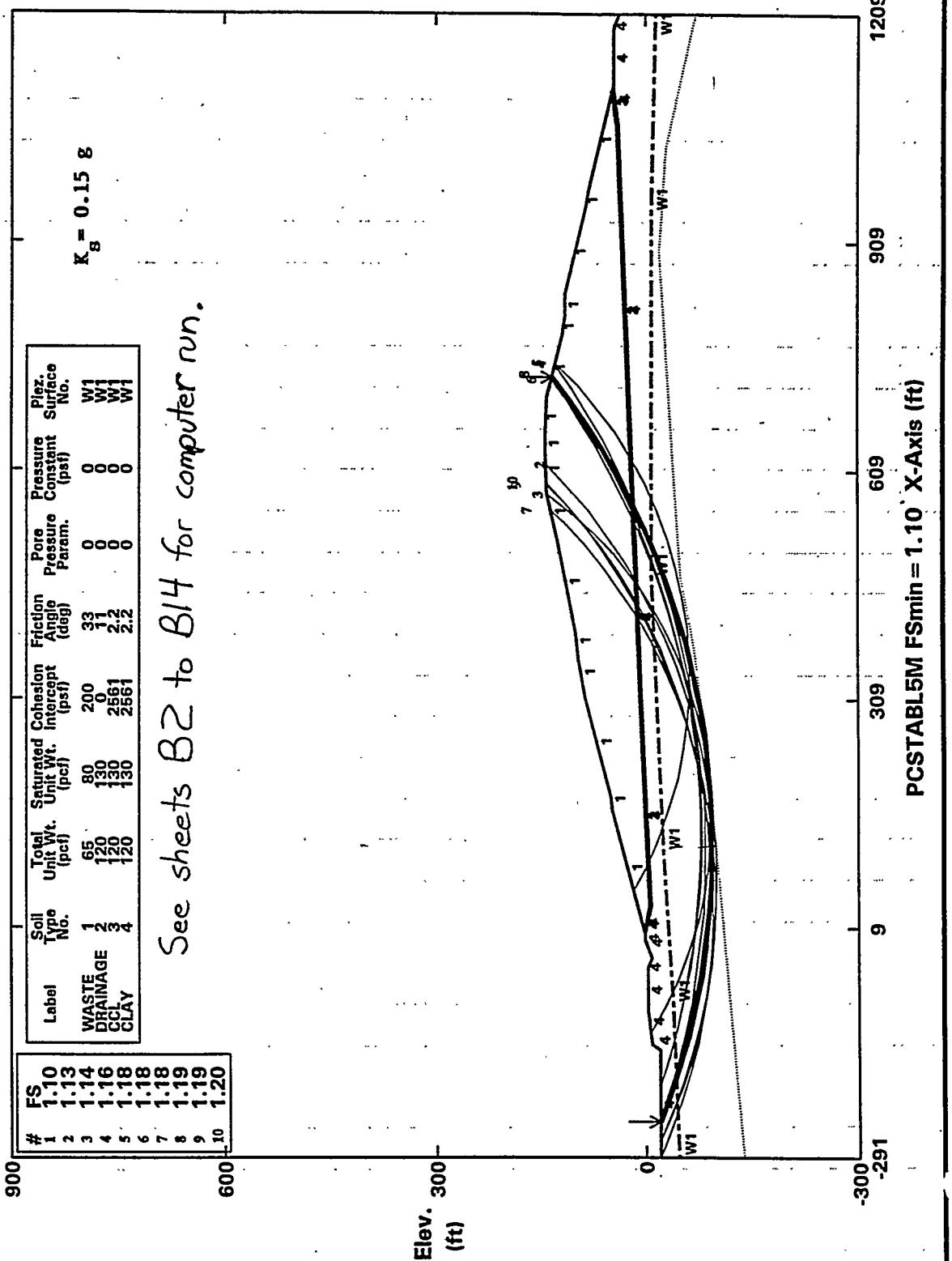
BLOCK FAILURE SURFACES

	Soil strength parameters							
		Waste		Liner		In situ clay		
	Data file	Ø (degree)	C (psf)	Ø (degree)	C (psf)	Ø (degree)	C (psf)	Seismic coefficient (g)	Factor of safety
	B1.DAT	26	200	15	0	0	2000	0.15	1.03
	B1A.DAT	26	200	15	0	0	2000	0.0	1.77
	B1B.DAT	26	200	15	0	0	2000	0.2	0.9
	B1C.DAT	26	200	15	0	0	2000	0.16	1.00
	B2.DAT	23	200	15	0	0	2000	0.15	1.00
	B2A.DAT	23	200	19	0	0	2000	0.15	1.20
	B2B.DAT	23	200	19	0	0	2000	0.2	1.05
	B2C.DAT	23	200	19	0	0	2000	0.22	1.00
	B3.DAT	23	200	18	0	0	2000	0.15	1.15
	B3A.DAT	23	200	18	0	0	2000	0.17	1.08
	B3B.DAT	23	200	18	0	0	2000	0.19	1.03
	B3C.DAT	23	200	18	0	0	2000	0.2	1.00
	B4.DAT	23	200	17	0	0	2000	0.15	1.10
	B4A.DAT	23	200	17	0	0	2000	0.17	1.04
	B4B.DAT	23	200	17	0	0	2000	0.18	1.01
	B5.DAT	23	200	11	0	0	2000	0.1	0.95
	B5A.DAT	23	200	11	0	0	2000	0.009	0.99
	B5B.DAT	23	200	11	0	0	2000	0.0	1.41

See sheets A50 to A85 for computer runs.

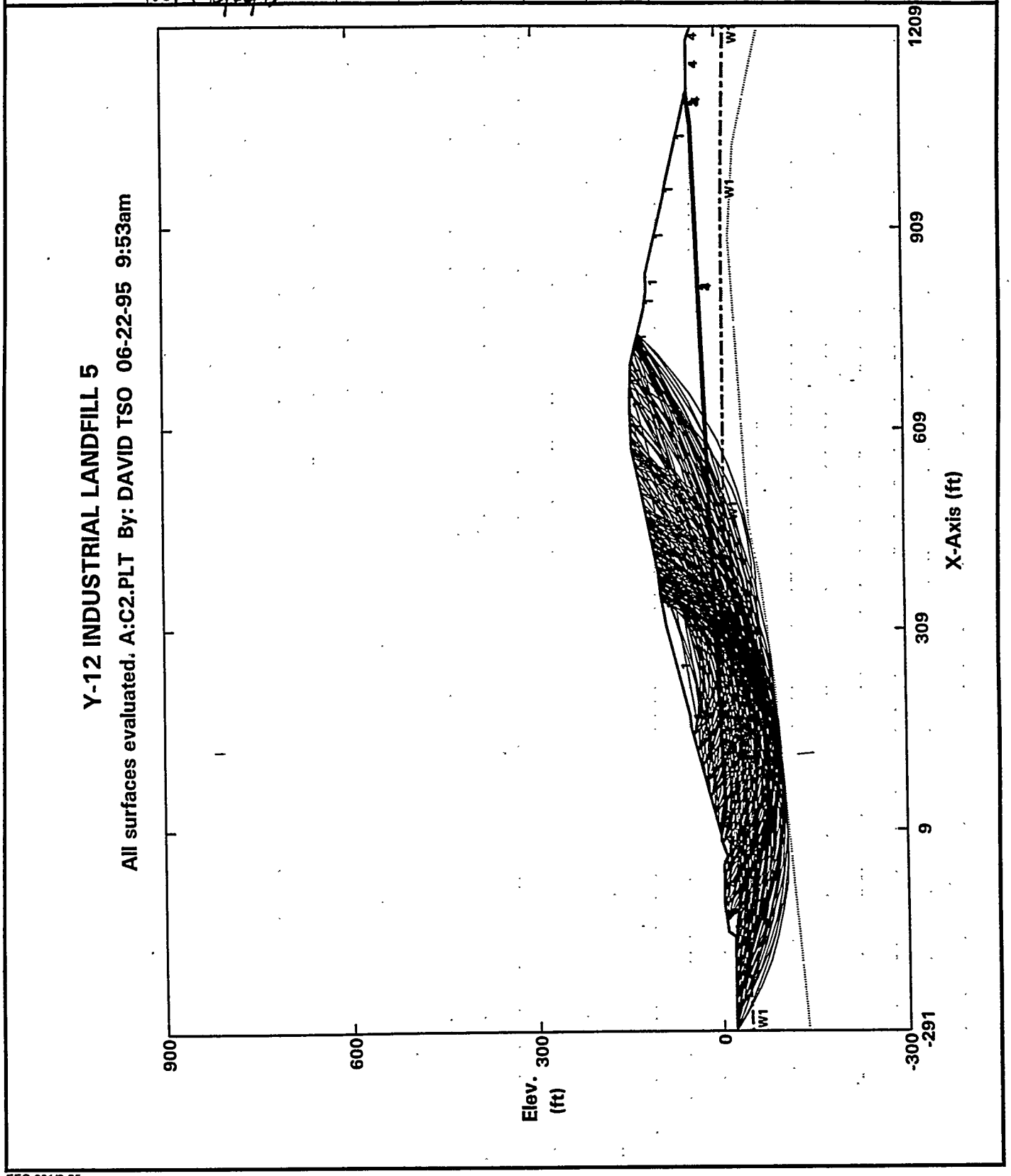
FOSTER WHEELER ENVIRONMENTAL CORPORATION

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REV #	0	SHEET	13 OF 46
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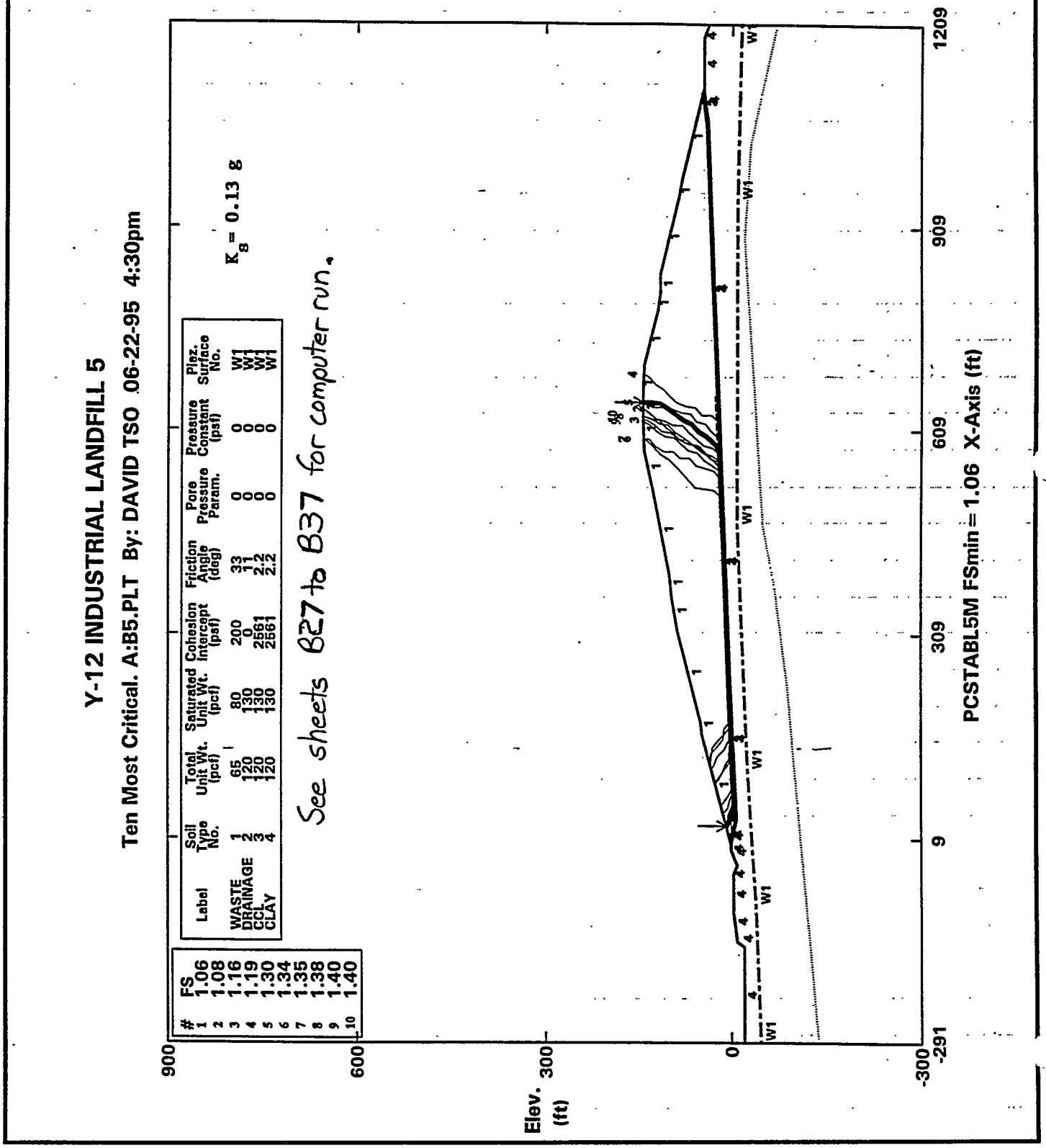
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CHKD & DATE	WPT	6/26/95								CALC NO.	CIV-ERWM-182				

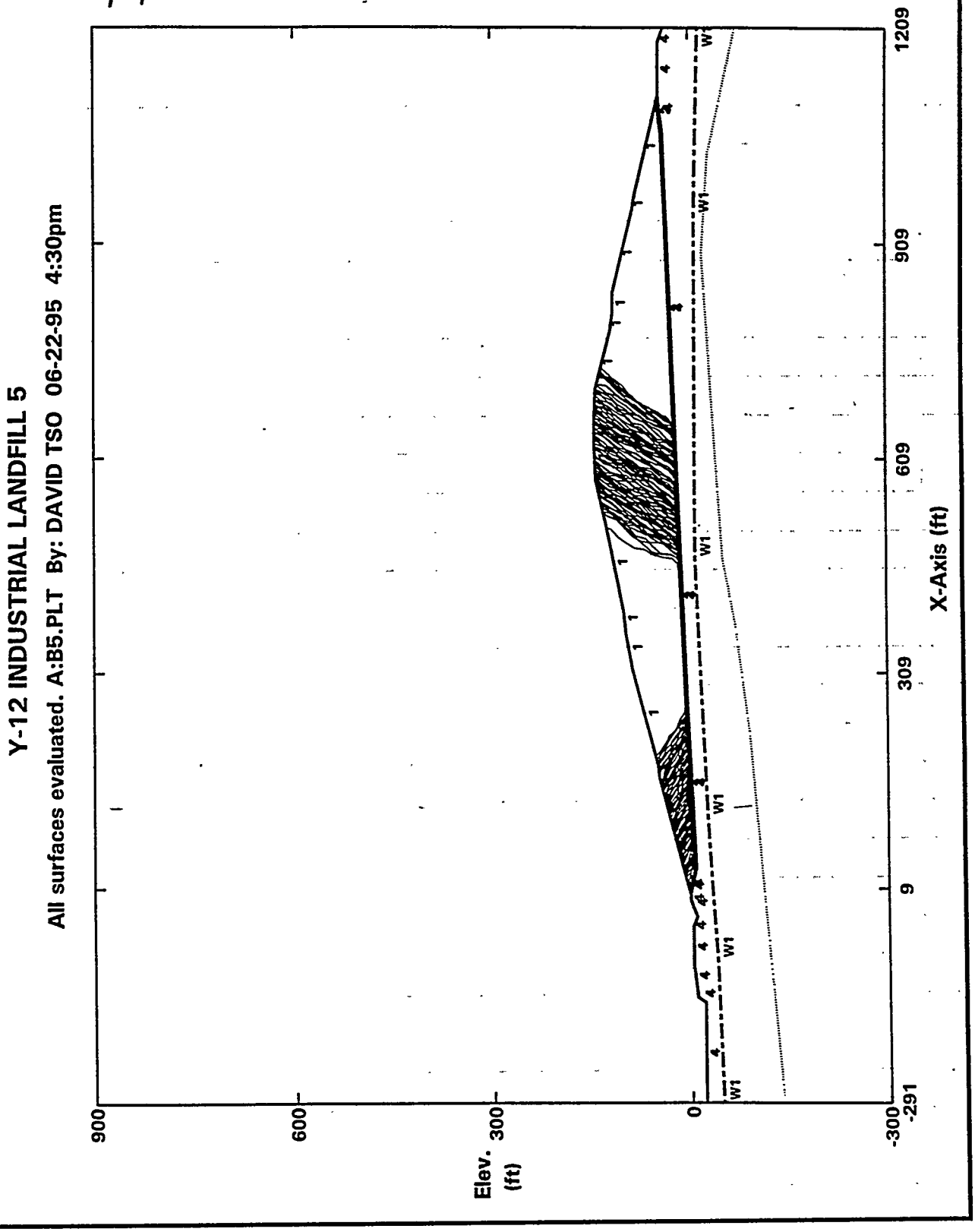


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	65	80	200	33	0	0	W1
DRAINAGE	2	120	130	0	11	0	0	W1
CCL	3	120	130	2561	2.2	0	0	W1
CLAY	4	120	130	2561	2.2	0	0	W1

#	FS
1	1.06
2	1.08
3	1.16
4	1.19
5	1.30
6	1.34
7	1.35
8	1.38
9	1.40
10	1.40

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FOSTER WHEELER ENVIRONMENTAL CORPORATION

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REV #	0	SHEET	17 OF 46
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Calc. the Yield Acceleration, Ky

1. Determine the max. undrained shear strength of the waste

$\tau_{max.} = (0.8)(\tau_{waste})$ Ref. B

$= (0.8)(c + \sigma \tan\phi)$

$= (0.8)(200 + \sigma \tan 33°)$ P. 6

$= 160 + (\sigma)(0.8)(\tan 33°)$

$= 160 + \sigma(0.5195) = 160 + \sigma \tan 27.5°$

2. Determine the max. shear strength of the clay liner and in-situ clay

$\tau_{max} = (0.8)(\tau_{clay})$

$= (0.8)(500 + \sigma \tan 18°)$

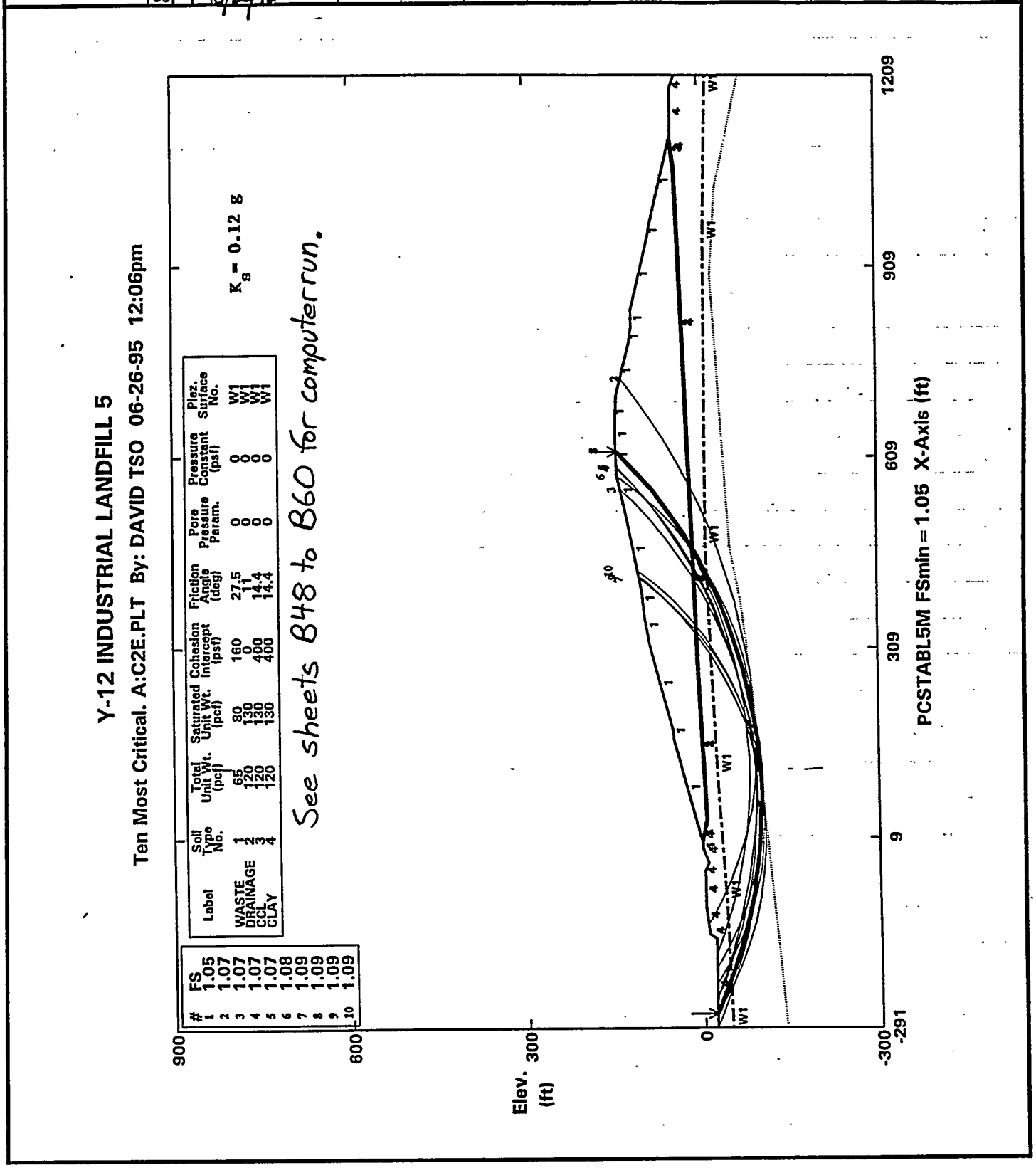
$= 400 + \sigma \tan 14.4°$ P. 6

3. Yield Acceleration, Ky

$K_y = 0.12\,g$ based on block failure surface P. 18, 19

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PROJECT	Y-12 Industrial Landfill V	SUBJECT	Yield Acceleration
REV #	0	SHEET	18 OF 46
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| | | |

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT	Landfill V, Y-12	SUBJECT	Stability Analysis
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BY & DATE	D. Tso 3/23/95	OFS NO.	
CHKD & DATE	WPT 6/26/95	CALC NO.	CIV-ERWM-182

LANDFILL DEFORMATION ANALYSIS

1. Determine the landfill and subsurface soil properties

Height of landfill, $h = 150$ ft.

Unit weight of waste fill, $\gamma_g = 65$ pcf

unit weight of site soil, $\gamma_s = 115$ pcf

Mass density of waste fill, $\rho = \gamma_g / 32.2 = 65/32.2$

$= 2.0$ lb-sec^2/ft^4

Max. shear modulus, $G_{max} = 65 \times N$

$= (65)(14)$

$= 910$ Kg/cm^2

$= (910)(2048) = 1,863,680$ psf

Max. shear wave velocity, $V_{max} = (G_{max}/\rho)^{1/2}$

$= 965$ ft/sec

Max. horizontal acceleration, $a_{max} = 0.22\,g$.

2. Perform 1st iteration to determine shear strain, γ, and damping, λ

Assume shear wave velocity $V_s = 600$ ft/sec.

$G/G_{max} = (V_s/V_{max})^2$

$= (600/965)^2 = 0.387 \approx 0.4$

From Fig. 1 (Sheet E2), $G/G_{max} = 0.4$

$\Rightarrow \gamma = 0.06\%$, $\lambda = 13\%$.

3. Calc. the natural frequencies and period

$\omega_1 = 2.4 (V_s/h) = 2.4 (600/150) = 9.6$ rad/sec.

$T_1 = 2\pi/\omega_1 = (2)(3.14)/9.6 = 0.65$ sec.

$\omega_2 = 5.52 (V_s/h) = 22.1$ rad/sec

$T_2 = 2\pi/\omega_2 = (2)(3.14)/22.1 = 0.284$ sec.

$\omega_3 = 8.65 (V_s/h) = 34.6$ rad/sec

$T_3 = 2\pi/\omega_3 = 0.182$

4. Determine the spectral accelerations for the three frequencies

From Fig. 2: (Sheet E3) $\lambda = 13\%$, $T_1 = 0.65$ sec

$\Rightarrow S_1/a_{max} = 1.3$

$\lambda = 13\%$, $T_2 = 0.284$ sec

$\Rightarrow S_2/a_{max} = 1.58$

$\lambda = 13\%$, $T_3 = 0.182$ sec

$\Rightarrow S_3/a_{max} = 1.45$

$S_1/a_{max} = 1.3$ $\quad a_{max} = 0.22g$

$S_1/0.22 = 1.3$ $\quad S_1 = 0.29\ g$

$S_2/0.22 = 1.58$ $\quad S_2 = 0.35\ g$

$S_3/0.22 = 1.45$ $\quad S_3 = 0.32\ g$

5. Determine the max. crest accelerations for each of the natural frequencies

$u_{1\,max} = (1.6)(S_1) = (1.6)(0.29) = 0.464\ g$

$u_{2\,max} = (1.06)(S_2) = (1.06)(0.35) = 0.371\ g$

$u_{3\,max} = (0.86)(S_3) = (0.86)(0.32) = 0.275\ g$

6. Determine the max. crest acceleration, u_{max}

$$u_{max} = [(u_{1\,max})^2 + (u_{2\,max})^2 + (u_{3\,max})^2]^{1/2}$$

$$= [(0.464)^2 + (0.371)^2 + (0.275)^2]^{1/2}$$

$$= (0.215 + 0.138 + 0.076)^{1/2}$$

$$= 0.655\ g$$

7. Calc. the average equivalent shear strain

$$(\gamma_{ave})_{eq} = 0.65 \times 0.3 \times h / V_s^2\ (S_1)$$

$$= 0.65 \times 0.3 \times 150 / (600)^2\ (0.29)(32.2)$$

$$= 0.076\%$$

$(\gamma_{ave})_{eq} \neq (\gamma = 0.06\%$ from step 2)

$\Rightarrow$ Perform 2nd iteration

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8. Determine the shear wave velocity, Vs

From Fig. 1 (Sheet E2), $\gamma = 0.076\%$

$\Rightarrow G/G_{max} = 0.34$

$\lambda = 14.5\%$

$G/G_{max} = (V_s/V_{max})^2 = 0.34$

$V_s/V_{max} = 0.583$ $\quad V_s = (955)(0.583) = 557$ fps

9. Calc. the natural frequencies + period

$\omega_1 = 2.4 (V_s/h) = (2.4)(557/150) = 8.9$

$T_1 = 2\pi/\omega_1 = 0.706$

$\omega_2 = 5.52 (V_s/h) = 20.5$

$T_2 = 2\pi/\omega_2 = 0.306$

$\omega_3 = 8.65 (V_s/h) = 32.12$

$T_3 = 2\pi/\omega_3 = 0.196$

10. Determine the spectral accelerations for the three frequencies

From Fig. 2 (Sheet E3)

$\lambda = 14.5\%$ $T_1 = 0.706 \Rightarrow S_1/a_{max} = 1.17$

$\lambda = 14.5\%$ $T_2 = 0.306 \Rightarrow S_2/a_{max} = 1.63$

$\lambda = 14.5\%$ $T_3 = 0.196 \Rightarrow S_3/a_{max} = 1.48$

$S_1/a_{max} = 1.17$ $S_1 = (1.17)(0.22) = 0.257\ g$

$S_2/a_{max} = 1.63$ $S_2 = 0.359\ g$

$S_3/a_{max} = 1.48$ $S_3 = 0.326\ g$

11. Calc. the average equivalent shear strain

$(\gamma_{ave})_{eq} = 0.65 \times 0.3 \times h / V_s^2\ (S_1)$

$= (0.65)(0.3)(150)/(557)^2\ (0.257)(32.2)$

$= 0.078\% \approx$ ($\gamma = 0.076\%$ from step 8)

Say $(\gamma_{ave})_{eq} = 0.077\%$.

12. Determine the shear wave velocity, Vs

From Fig. 1 (Sheet E2) $\gamma = 0.077$

$\Rightarrow G/G_{max} = 0.343 \quad \lambda = 14.4\%$

$G/G_{max} = (V_s/V_{max})^2 = 0.343$

$V_s/V_{max} = 0.5857$

$V_s = (955)(0.5857) = 559.3$ ft/sec.

13. Calc. the natural frequencies and period

$\omega_1 = 2.4 (V_s/h) = 2.4 (559/150) = 8.944$

$T_1 = 2\pi/\omega_1 = 0.70$ sec.

$\omega_2 = 5.52 (V_s/h) = 20.57$

$T_2 = 2\pi/\omega_2 = 0.305$ sec.

$\omega_3 = 8.65 (V_s/h) = 32.236$

$T_3 = 2\pi/\omega_3 = 0.195$ sec.

14. Determine the spectral acceleration for the 3 frequencies

From Fig. 2 (Sheet E3): $\lambda = 14.4\%$, $T_1 = 0.70$ sec.

$\Rightarrow S_1/a_{max} = 1.19 \quad S_1 = 0.26\ g$

$\lambda = 14.4\%$, $T_2 = 0.305$ sec.

$\Rightarrow S_2/a_{max} = 1.69 \quad S_2 = 0.37\ g$

$\lambda = 14.4\%$, $T_3 = 0.195$ sec.

$\Rightarrow S_3/a_{max} = 1.47 \quad S_3 = 0.32\ g$

15. Determine the max. crest accelerations for each of the natural frequencies

$U_{1\,max} = (1.6)(S_1) = (1.6)(0.26g) = 0.416\ g$

$U_{2\,max} = (1.06)(S_2) = (1.06)(0.37g) = 0.392\ g$

$U_{3\,max} = (0.86)(S_3) = (0.86)(0.32g) = 0.275\ g$

16. Determine the max. crest acceleration, U_{max}

$$U_{max} = [(U_{1max})^2 + (U_{2max})^2 + (U_{3max})^2]^{1/2}$$

$$= [(0.416)^2 + (0.392)^2 + (0.275)^2]^{1/2}$$

$$= (0.173 + 0.154 + 0.076)^{1/2} = 0.635\ g$$

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17. summary:

$U_{max} = 0.635g$

$T_o = 0.7$ sec.

$\gamma_{ave} = 0.077$ %

$G_{max} = 1278$ KSF

$\lambda = 14.4$ %.

18. Determine the max. acceleration, K_{max}, at the sliding plane.

From Fig 3, (Sheet E4): $Y/h = 1. \Rightarrow K_{max}/U_{max} = 0.34$

$K_{max} = (0.34)(U_{max}) = (0.34)(0.635g)$

$= 0.216g.$

19. Determine the permanent displacement, u, for the yield accelcration, K_y.

$K_y / K_{max} = 0.129 / 0.216g = 0.556$

R1

From Fig. 4 (Sheet E5): $u/(K_{max})(T_o) = 0.035$

$u = (K_{max})(T_o)(0.035)$

$= (0.216)(32.2)(0.7)(0.035)$

$= 0.170$ ft $= 2.0$ in < 6 in. O.K.

Revision:

From Fig. 4 (sheet E5)

$u/(K_{max})(g)(T_o) = 0.013$

$u = (K_{max})(g)(T_o)(0.013)$

$= (0.216)(32.2)(0.7)(0.013)$

$= 0.063$ ft $= 0.76$ in. < 6 in. O.K.

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Liquefaction Assessment

Liquefaction is the phenomenon in which essentially cohesionless soils liquefy so that the material takes on the characteristics of a fluid and thus becomes unstable in the presence of shearing forces such as induced by earthquake ground motion.

Liquefaction screening criteria defined in Reference D state that clayey soils having: 1) more than 15% (by weight) finer than 0.005 mm (e.g., clay size), 2) a liquid limit above 35%, and 3) in situ water content less than 0.9 times the liquid limit, generally do not liquefy.

The landfill site soils tested all have clay contents exceeding 50% and liquid limits exceeding 50%. Almost all in situ moisture contents were less than 0.8 times the liquid limit (when the on-site soils were tested in 1992).

Since all of the screening criteria are easily satisfied, the potential for liquefaction is considered non-existent.

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VENEER STABILITY (SEISMIC)

REF B, p. 14

$$F.S. = \frac{[\cos\alpha - a_{max}\sin\alpha]\tan\phi}{\sin\alpha + a_{max}\cos\alpha}$$

$\alpha = 15.9°$; $\phi = 20°$; $a_{max} = .22$ ←2500-YR. EQ. PER USGS/EPA

$$F.S. = \frac{[\cos 15.9° - a_{max}\times\sin 15.9°]\tan 20°}{\sin 15.9° + a_{max}\cos 15.9°}$$

$$F.S. = \frac{[.962 - .274\,a_{max}]\times .364}{.274 + .962\,a_{max}}$$

$a = 0.22$ ∴

$$F.S. = \frac{[.962 - .274(.22)]\times .364}{.274 + .962(.22)}$$

$$F.S. = \frac{.328}{.486} = .675 < 1.0 \sim NG$$

$F.S. = 1.0$ ∴

$$2.747(.274 + .962\,a_{max}) = .962 - .274\,a_{max}$$

$$.274 + .962\,a_{max} = .350 - .100\,a_{max}$$

$$1.062\,a_{max} = .076$$

$$a_{max} = .072\,g \text{ for } F.S. = 1.0$$

650-YR. E.Q. PER O.R. SITE SEISMIC DATA IN FIGS 1 AND TABLES 1&2, ATTACHMENT E

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CHKD & DATE	WPT	6/26/95	WPT	8/4/95			CALC NO.	CIV-ERWM-182

PART I CONCLUSIONS:

Parametric studies revealed that the global stability of the block (or translational) failure mode was slightly more critical than that of the circular (or rotational) failure mode under seismic loading.

The pseudo-static global stability factors of safety for the block and circular potential failure modes are 1.06 and 1.10, respectively. Both satisfy the required minimum of 1.0 for stability under seismic loading.

R1 The predicted maximum seismically induced deformation is approximately 2 inches. This is below the acceptable limit of 6 inches as discussed in Reference B regarding impact on leachate collection system piping.

Since the site soils are almost exclusively clays, the potential for liquefaction is essentially non-existent.

The veneer factor of safety is approximately 0.7 and indicates that the cover system veneer will probably be damaged if and when it is subjected to the specified design earthquake, which is very severe. However, damage of this nature should not be catastrophic and should be readily repairable considering that it would be located at or very near the surface. Furthermore, simplified analysis indicates that the cover veneer should be stable under earthquakes with peak bedrock accelerations not exceeding 0.07 g. According to recently (1995) released data for the site area this peak acceleration should occur approximately once every 650 years. By comparison, the specified design earthquake has an expected frequency of once every 2,400 years.

R1 Revision: The predicted maximum seismically induced deformation is approximately 0.8 inches. This is below the acceptable limit of 6 inches as discussed in Reference B regarding impact on leachate collection system piping.

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PART I CONCLUSIONS:

Parametric studies revealed that the global stability of the block (or translational) failure mode was slightly more critical than that of the circular (or rotational) failure mode under seismic loading.

The pseudo-static global stability factors of safety for the block and circular potential failure modes are 1.06 and 1.10, respectively. Both satisfy the required minimum of 1.0 for stability under seismic loading.

The predicted maximum seismically induced deformation is approximately 2 inches. This is below the acceptable limit of 6 inches as discussed in Reference B regarding impact on leachate collection system piping.

Since the site soils are almost exclusively clays, the potential for liquefaction is essentially non-existent.

The veneer factor of safety is approximately 0.7 and indicates that the cover system veneer will probably be damaged if and when it is subjected to the specified design earthquake, which is very severe. However, damage of this nature should not be catastrophic and should be readily repairable considering that it would be located at or very near the surface. Furthermore, simplified analysis indicates that the cover veneer should be stable under earthquakes with peak bedrock accelerations not exceeding 0.07 g. According to recently (1995) released data for the site area this peak acceleration should occur approximately once every 650 years. By comparison, the specified design earthquake has an expected frequency of once every 2,400 years.

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PART II-COVER/LINER VENEER SYSTEMS AND STATIC STABILITY OF LANDFILL

		Page
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II-2	Anchor Trench Design	35
II-3	Summary for Factors of Safety	36
II-4	Global Stability (Static)	37
II-5	Veneer Stability	41
II-6	Conclusions	46

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LINER THICKNESS FOR PUNCTURE PROT.

$$t_{reqd} = \frac{P}{\cos\beta}\,\frac{X}{\sigma_{allow}}\left(\tan\delta_u + \tan\delta_L\right)$$ ← SECT 5.6.6, REF G

$\gamma_{waste} = 65$ pcf ; $H = 75'$ ave

$P = 65 \times 75 = 4875$ PSF $= 33$ PSI

$\sigma_y = 900$ PSI ; $\beta = 18.4°$ FOR 3:1 SLOPE ON CRATER

$X \cong 2"$ ← SEE FIG 5.9 C, REF G

$\delta_u = 11°$ (GEOTEXTILE/MEMBRANE)

$\delta_L = 16°$ (MEMBRANE/CLAY)

$$t_{reqd} = \frac{75 \times 65\ \#/FT^2}{\cos 18.4°}\,\frac{2\ IN}{900\ \#/IN^2\,(144\ IN^2/FT^2)}\left(\tan 11° + \tan 16°\right)$$

$$t_{reqd} = \frac{4875}{.949} \times .0000154\ (.194 + .287)$$

$t_{reqd} = .038"$ ~ USE 40 MIL PP

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ANCHOR TRENCH

$T_{allow} = F_U + F_L + 2F_{AT}$ ← SECT 5.3.6 REF G

$T_{allow}(t) = 0 + q \tan\delta (L_{RO}) + 2(K_o T_{ave}) \tan\delta (d_{AT})$

$T_{yield} = T_{allow} = 700$ PSI Cross Dir. (900 PSI Mach Dir.)

$q = 1.25\,ft \times 120\,\#/ft^3 = 150$ PSF

$L_{RO} = 3'$; $d_{AT} = 2'$;

$\delta = 16°$ (GEOMEMBRANE/SOIL); $\Phi = 22°$ (TRENCH B.F.) ← SEE GEOSYNTHETICS /SOILS PARAMETERS

$K_o = 1 - \sin\Phi = 1 - \sin 22° = .625$; $\delta = 16°$

$T_v = \gamma H_{ave} = 120 \times 3.25 = 390$ PSF

$(700 \times 144)\left(\frac{0.040}{12}\right) = 0 + 150 \tan 16°(3') + 2 \times .625 \times 390 \times \tan 16° \times 2'$

$336\ \#/FT^3 = 0 + 450 \times .287 + 975 \times .287$

$336 = 129 + 280$

Driving 336 = Resist. 409 #

F.S. = 1.22 FOR GEOMEMBRANE ANCHORAGE

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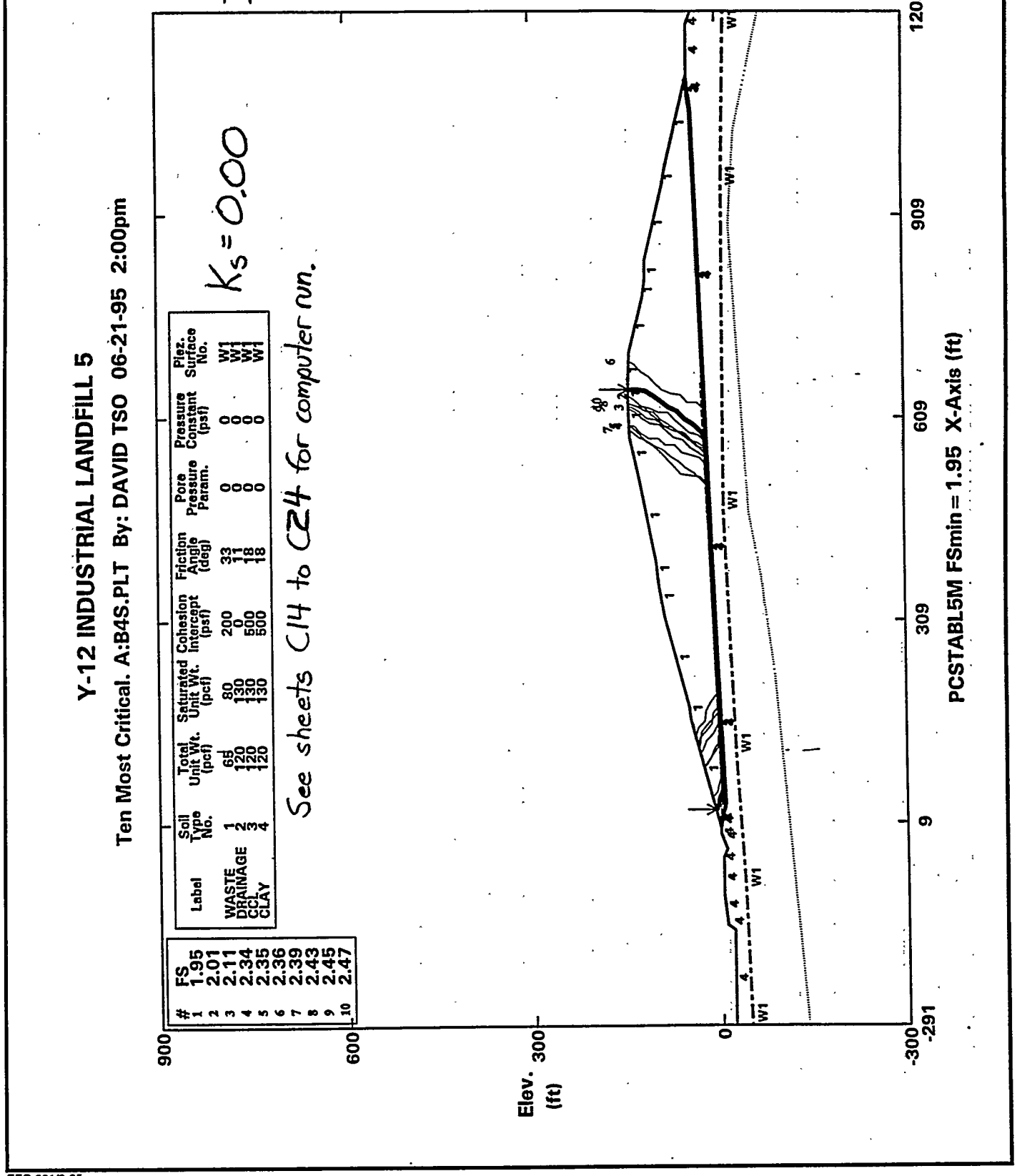
PROJECT	Landfill V, Y-12						SUBJECT	STABILITY ANALYSIS	
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Summary for Factors of Safety (Static)

Case	Factors of Safety	Criteria - Minimum Value	
Global slope stability Circular failure surface	2.4	1.5	Sheet 39
Global slope stability Sliding block failure surface	2.0	1.5	Sheet 37
Veneer stability Cover soil/geonet composite interface	2.5	1.3	Sheet D7
Veneer stability Geonet composite/geomembrane interface	1.4	1.3	Sheet D13
Veneer stability Geomembrane/clay liner interface	1.7	1.3	Sheet D16

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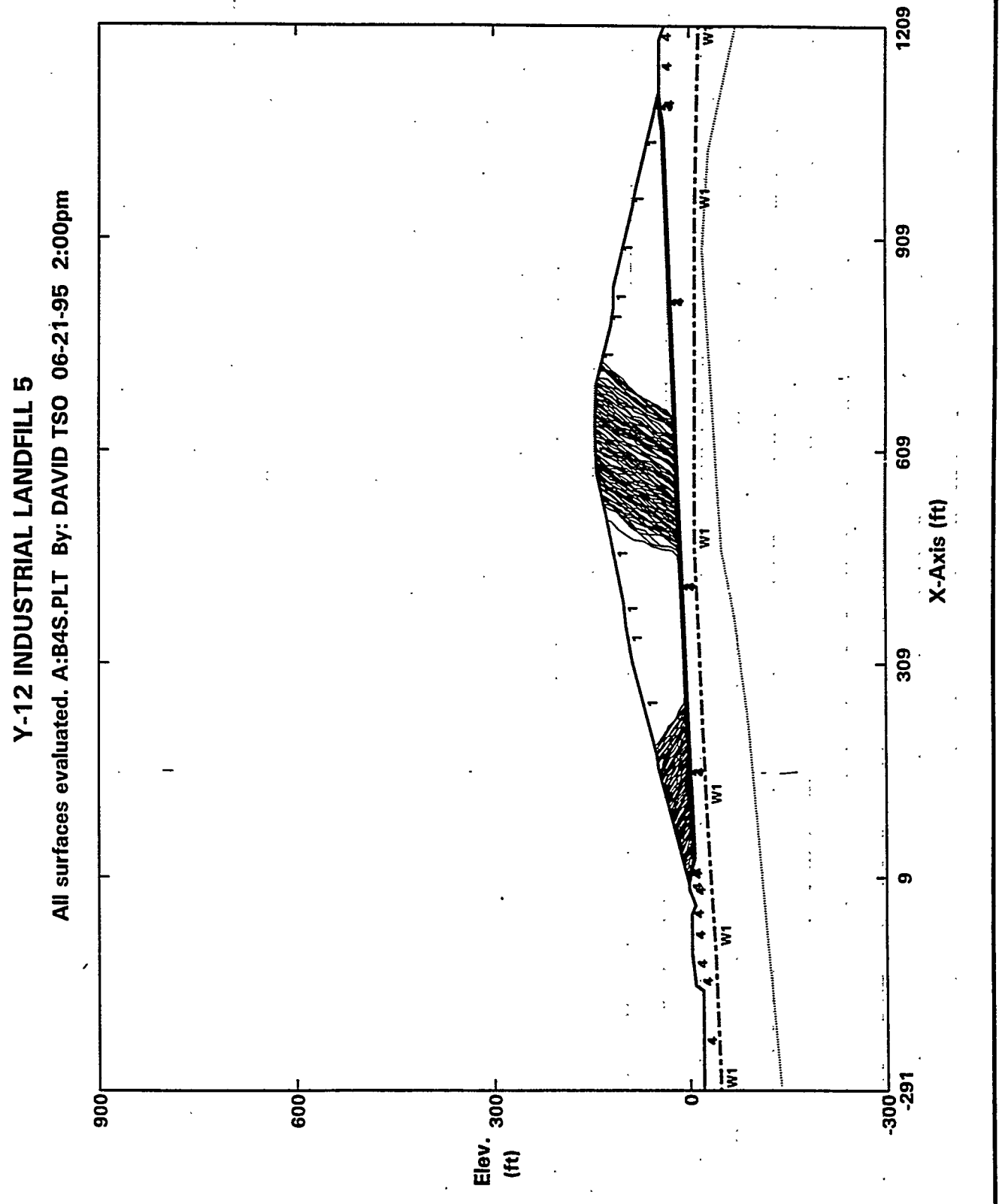
$K_s = 0.00$

See sheets C14 to C24 for computer run.

EEC-001/2-95

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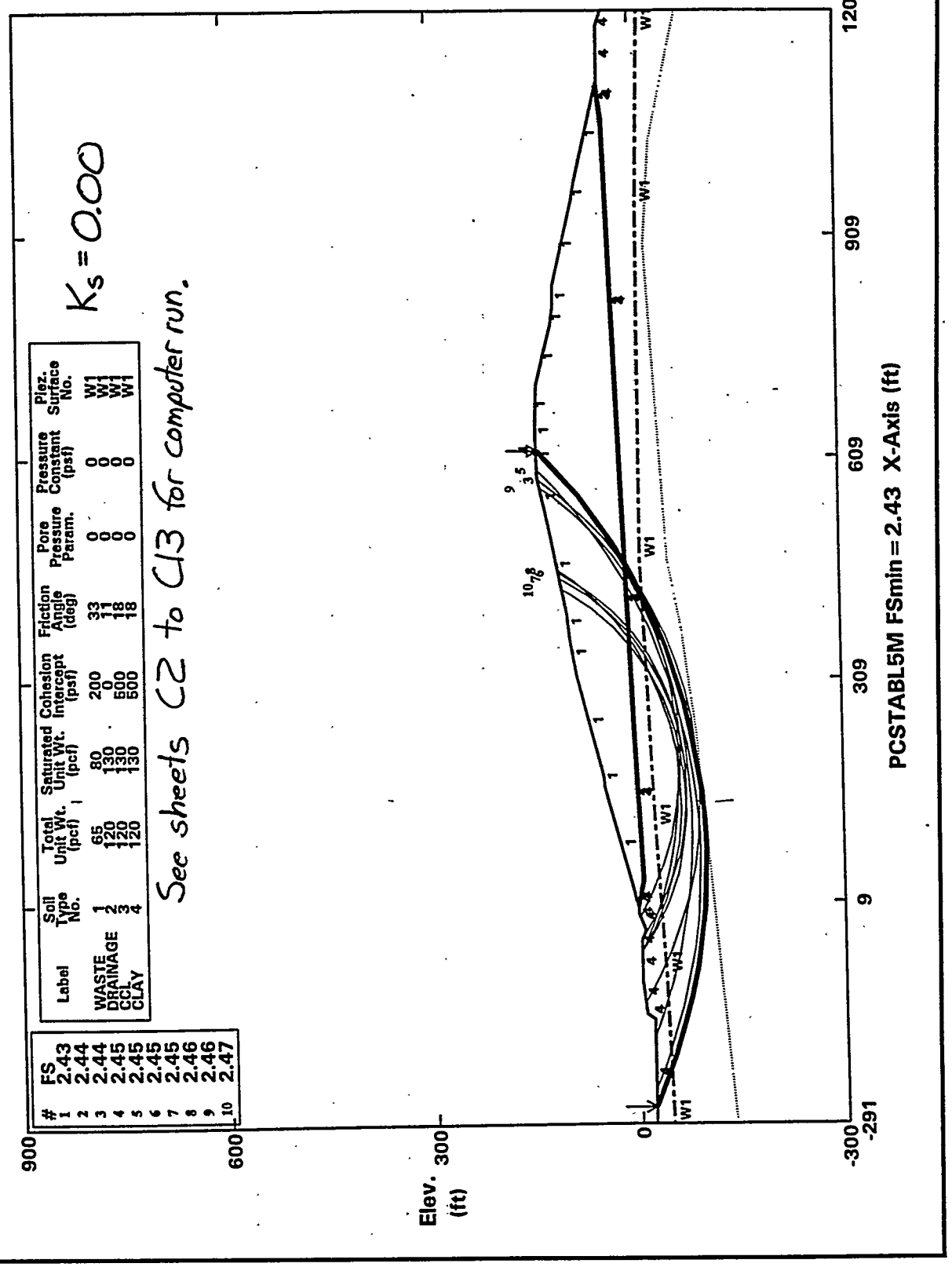
PROJECT Y-12 Industrial Landfill V		SUBJECT Slope Stability Analysis- Static	
REV #	0	SHEET	38 OF 46
BY & DATE	DTT 6/21/96	OFS NO.	
CHKD & DATE	WPT 6/21/96	CALC NO.	CIV-ERWM-182



EEC-001/2-95

FOSTER WHEELER ENVIRONMENTAL CORPORATION

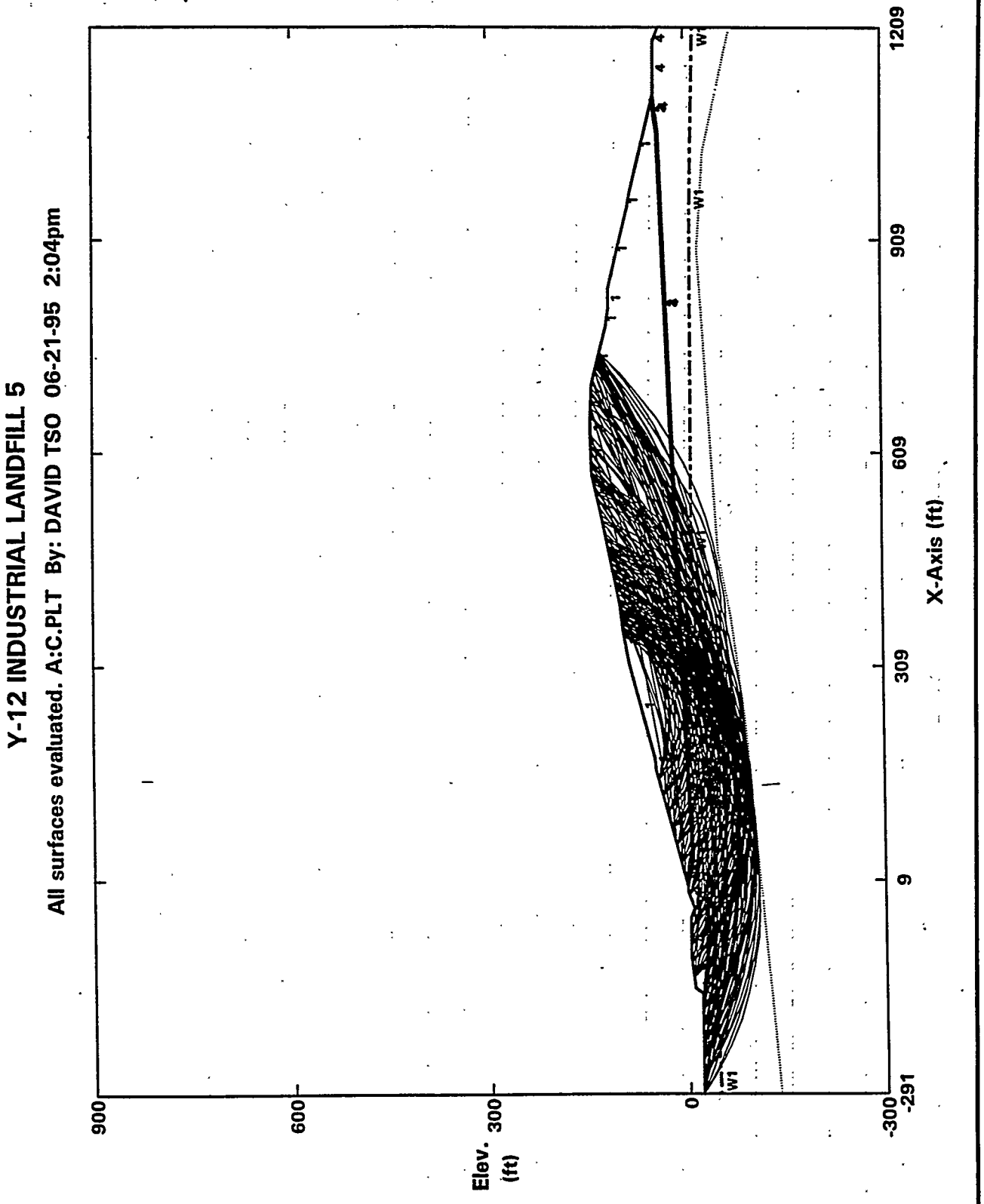
PROJECT	Y-12 Industrial Landfill V	SUBJECT	Slope Stability Analysis- Static
REV #	0	SHEET	39 OF 46
BY & DATE	DTT 6/21/95	OFS NO.	
CHKD & DATE	WPT 6/27/95	CALC NO.	CIV-ERWM-182



EEC-001/2-95

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT	Y-12 Industrial Landfill V	SUBJECT	Slope Stability Analysis- Static
REV #	0	SHEET	40 OF 46
BY & DATE	DTT 6/21/95	OFS NO.	
CHKD & DATE	WPT 6/27/95	CALC NO.	CIV-ERWM-182



H_{max} = Max. Slope Ht. w/o Tension in Geosynthetics

$$H_{max} = \frac{T_c}{2\cos\beta}\left[1 + \frac{\sin\phi_c \cos\phi_i}{\cos(\beta+\phi_c)\sin(\beta-\phi_i)}\right]$$

Ref E, Tab. 15 Limit Equilibrium Approach

Liner System - Areas 2, 3 & 4 (East Side)

$T_c = 3'$; $\beta = 15.9°$; $\phi_c = 22°$, $\phi_i = 11°$ ← Based on Smooth Geomemb. with Geotextile

$$H_{max} = \frac{3'}{2\cos 15.9°}\left[1 + \frac{\sin(22°)\cos(11°)}{\cos(15.9°+22°)\sin(15.9°-11°)}\right]$$

$$H_{max} = \frac{3}{1.923}\left[1 + \frac{.375 \times .982}{.789 \times .085}\right]$$

$H_{max} = 1.56 \times 6.49 = 10.12$ ← Max. Ht. w/o stress in Geosynthics

Liner System - Areas 5 & 4 (West Side)

$T_c = 3'$; $\beta = 15.9°$; $\phi_c = 22°$; $\phi_i = 20°$ ← Based on Textured Geomemb. with Geotextile

$$H_{max} = \frac{3'}{2\cos 15.9°}\left[1 + \frac{.375 \times .940}{.789 \times 0}\right]$$

$H_{max} = \infty$

Cover System -

$T_c = 1.5'$; $\beta = 15.9°$; $\phi_c = 22°$; $\phi_i = 20°$ ← Based on Textured Geomemb. with Geotextile/ Geonet Composite

$$H_{max} = \frac{1.5'}{2\cos 15.9°}\left[1 + \frac{.375 \times .940}{.789 \times 0}\right]$$

$H_{max} = \infty$

T_{gs} = Total Tension in Geomemb./Geotextile

$$T_{gs} = \frac{\gamma T_c^2}{\sin(2\beta)}\left[\left(\frac{2H\cos\beta}{T_c} - 1\right)\left(\frac{\sin(\beta-\phi_i)}{\cos\phi_i'}\right) - \frac{\sin\phi_c}{\cos(\beta+\phi_c)}\right]$$

$$T_{gs} = \frac{120\times(3)^2}{\sin(2\times 15.9)}\left[\left(\frac{2\times 15\times\cos 15.9^\circ}{3} - 1\right)\left(\frac{\sin(15.9^\circ-11^\circ)}{\cos 11^\circ}\right) - \frac{\sin 22^\circ}{\cos(15.9+22)^\circ}\right]$$

$$T_{gs} = \frac{1080}{.527}\left[\left(\frac{30\times.962}{3} - 1\right)\left(\frac{.085}{.982}\right) - \frac{.375}{.789}\right]$$

$$T_{gs} = 2049.5\left[8.62\times.087 - .475\right]$$

$T_{gs} = 2049.5\times.275 = 563\ \#/ft = 47\ \#/in$ ← Stresses in Bottom Liner Geosynthetics w/smooth Geomembrane & Slope Ht. = 15' max

T_{allow} in Geotextile $= \frac{185}{F.S.=2} = 92\ \#/in$

T_{allow} in Geombrane $= T_y = 900\times.04 = 36\ \#/in$

Combined Allow stress = $128\ \#/in$

Geosynthetics stress for Slope Ht = 15 Ft are O.K. since T_{allow} $128\ \#/in > T_{gs}$ $47\ \#/in$. However, <u>do not</u> use smooth membrane on slope heights exceeding 10 ft. since anchor trench modifications might be required to fully mobilize the geotextile.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT	Y-12 Industrial Landfill V								SUBJECT	Veneer Stability - Static	
REV #	0								SHEET	43 OF 46	
BY & DATE	DTT	6/23/95							OFS NO.		
CHKD & DATE	WPT	6/27/95							CALC NO.	CIV-ERWM-182	

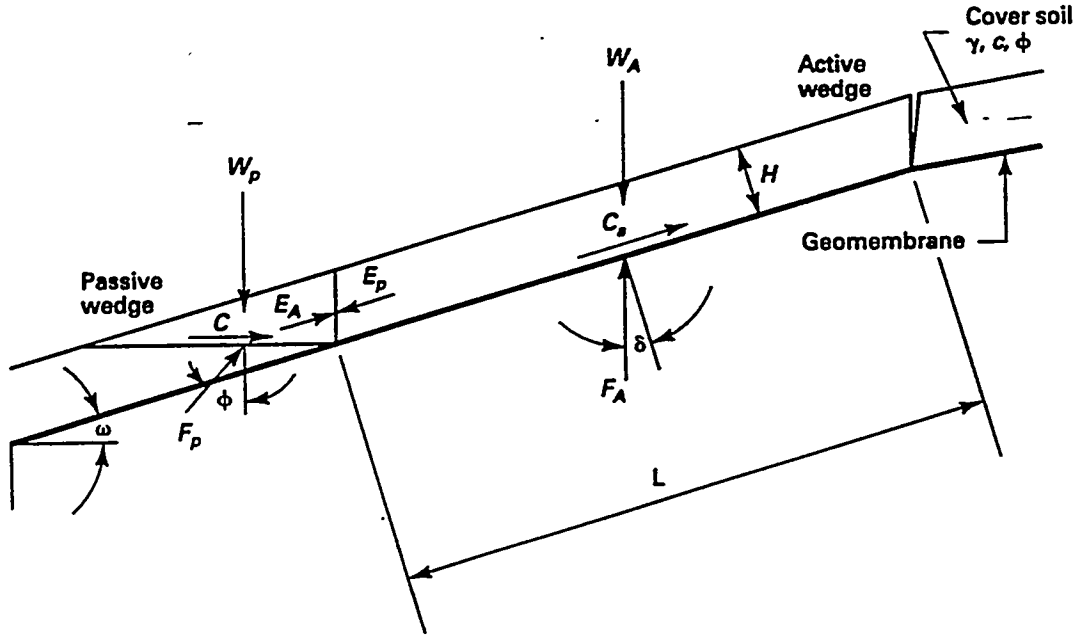
$$F.S. = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Ref. G, P. 384

$$a = 0.5\,\gamma H \sin^2 2\omega$$

$$b = -[\gamma L H \cos^2\omega \tan\delta \sin(2\omega) + C_a L \cos\omega \sin(2\omega) + \gamma L H \sin^2\omega \tan\phi \sin(2\omega) + 2CH\cos\omega + \gamma H^2 \tan\phi]$$

$$c = [(\gamma L H \cos\omega \tan\delta + C_a L)(\tan\phi \sin\omega \sin(2\omega)]$$



$\gamma = 120$ pcf

$H = 1.5$ ft

$\omega = 15.9°$

$L = 120 / \sin 15.9° = 438$ ft

$\delta = 20°$ (most critical, @ geonet composite / geomembrane interface)

$c_a = 0$

$c = 500$ psf

$\phi = 18°$

$$\Rightarrow a = (0.5)(120)(438)(1.5)(\sin 2 \times 15.9°)^2$$

$$= (39420)(0.278) = 10946$$

$$b = -[(120)(438)(1.5)\cos^2(15.9°) \tan(20°) \sin(2 \times 15.9°) + 0 +$$

$$(120)(438)(1.5)\sin^2(15.9°) \tan 18° \sin(2 \times 15.9°) + (2)(500)$$

$$(1.5)\cos 15.9° + (120)(1.5)^2 \tan 18°]$$

$$= -[(78840)(0.925)(0.364)(0.527) + (78840)(0.075)(0.325)(0.527) + (1500)(0.962) + (270)(0.325)]$$

$$= -(13989 + 1013 + 1443 + 88)$$

$$= -16533$$

$$c = [(120)(438)(1.5)(\cos 15.9°)(\tan 20°) + 0][(\tan 18°)(\sin 15.9°)(\sin 31.8°)]$$

$$= (78840)(0.962)(0.364)(0.325)(0.274)(0.527)$$

$$= 1296$$

$$F.S. = \frac{+16533 \pm \sqrt{(-16533)^2 - (4)(10946)(1296)}}{(2)(10946)}$$

$$= (16533 + 14717) / 21892 = \underline{1.43}$$

Factor of safety for cover soil / geonet composite interface and geomembrane / clay liner interface were calculated as shown in Attachment D and summarized on Sht. 36.

PROJECT	Landfill V, Y-12						SUBJECT	Stability Analysis
REV #	0						SHEET	46 OF 46
BY & DATE	DTT	6/23/95					OFS NO.	
CHKD & DATE	WPT	6/27/95					CALC NO.	CIV-ERWM-182

PART II CONCLUSIONS:

A polypropylene geomembrane 40 mils thick is sufficient for requirements of the landfill bottom liner as well as for the cover system. An anchor trench which is two feet deep combined with at least three feet of horizontal runout provides sufficient anchorage to hold the smooth geomembrane beyond its yield strength and will resist pullout. Where textured geomembrane is used, the anchor trench design will be conservative.

The global stability of the landfill under static conditions is very adequate with the factor of safety considerably above the required minimum.

The critical interface for stability in the veneer is between the geomembrane and the geonet composite (cover system) and between the geomembrane and the protective geotextile (bottom liner).

A smooth geomembrane and overlying geotextile are satisfactory for bottom liner construction in those areas where overall slope height does not exceed 10 feet, such as Area 2, Area 3, and most of Area 4. The calculations indicate a limiting height of 10.1 feet at which point the geosynthetics become stressed and the factor of safety against sliding becomes 1.0 under static landfill loading.

For slopes higher than 10 feet (bottom liner for the west side of Area 4 and all of Area 5, and the entire composite cover system), the geomembrane will be textured. This provides a factor of safety against sliding of 1.4 at the critical interface and prevents stressing the geomembrane under static loading.

Many times the most severe loading to the veneer systems may occur during construction or while waste placement is under way. These loading scenarios are difficult to quantify and therefore make rigorous stability assessment impractical. In addition, there are considerable variations in test results from laboratory to laboratory for friction values obtained by standardized direct shear tests such as reported in Reference A. These types of variations may occur on identical geosynthetic elements.

The factors of safety generated in these stability analyses for static loading are considered, along with the acceptability of stressing the geosynthetics, to provide ample reserve to withstand reasonable temporary overload or to provide adequate contingency to compensate for possible testing variations.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT	Landfill V, Y-12					SUBJECT	Stability Analysis		
REV #	0						SHEET	A1 OF A85	
BY & DATE	DTT	6/23/95					OFS NO.		
CHKD & DATE	WPT	6/26/95					CALC NO.	CIV-ERWM-182	

ATTACHMENT A

85 sheets

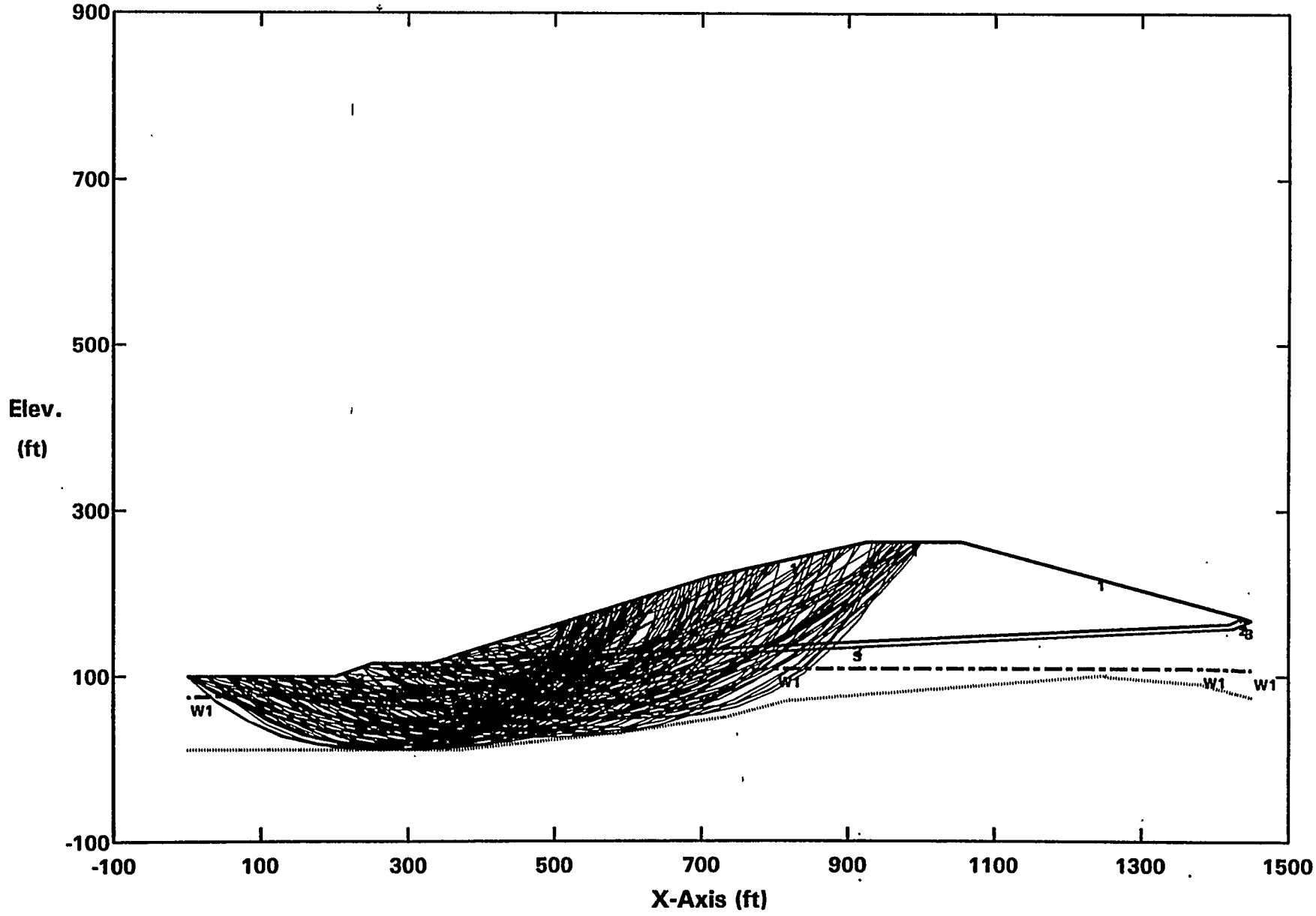
Circular surfaces : A2 to A49

Block surfaces : A50 to A85

These computer runs constitute the seismic slope stability parametric studies. Results are summarized on sheets 11 and 12.

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C1.PLT By: DAVID TSO 03-06-95 4:09pm



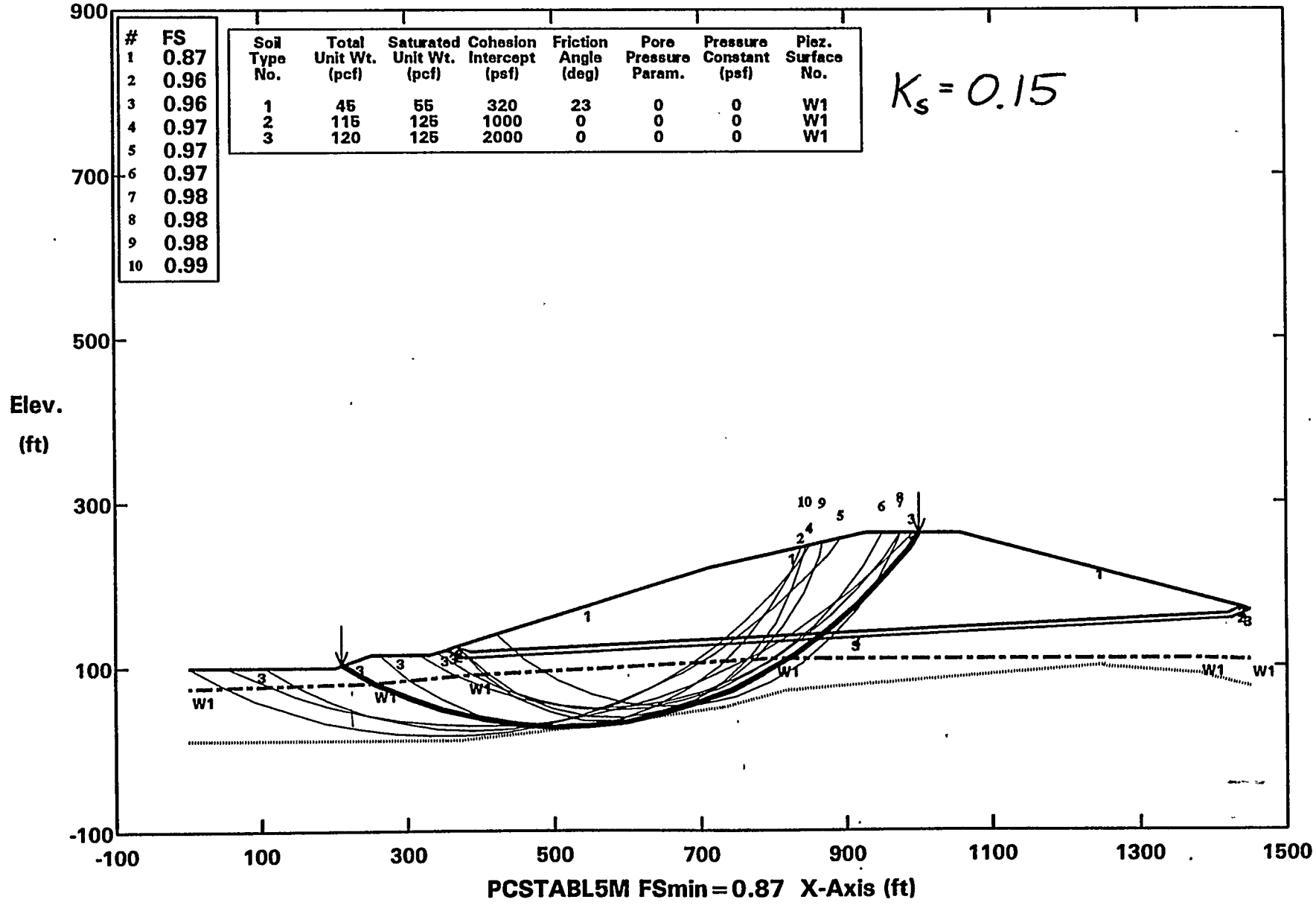
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C1.PLT By: DAVID TSO 03-06-95 4:09pm

#	FS
1	0.87
2	0.96
3	0.96
4	0.97
5	0.97
6	0.97
7	0.98
8	0.98
9	0.98
10	0.99

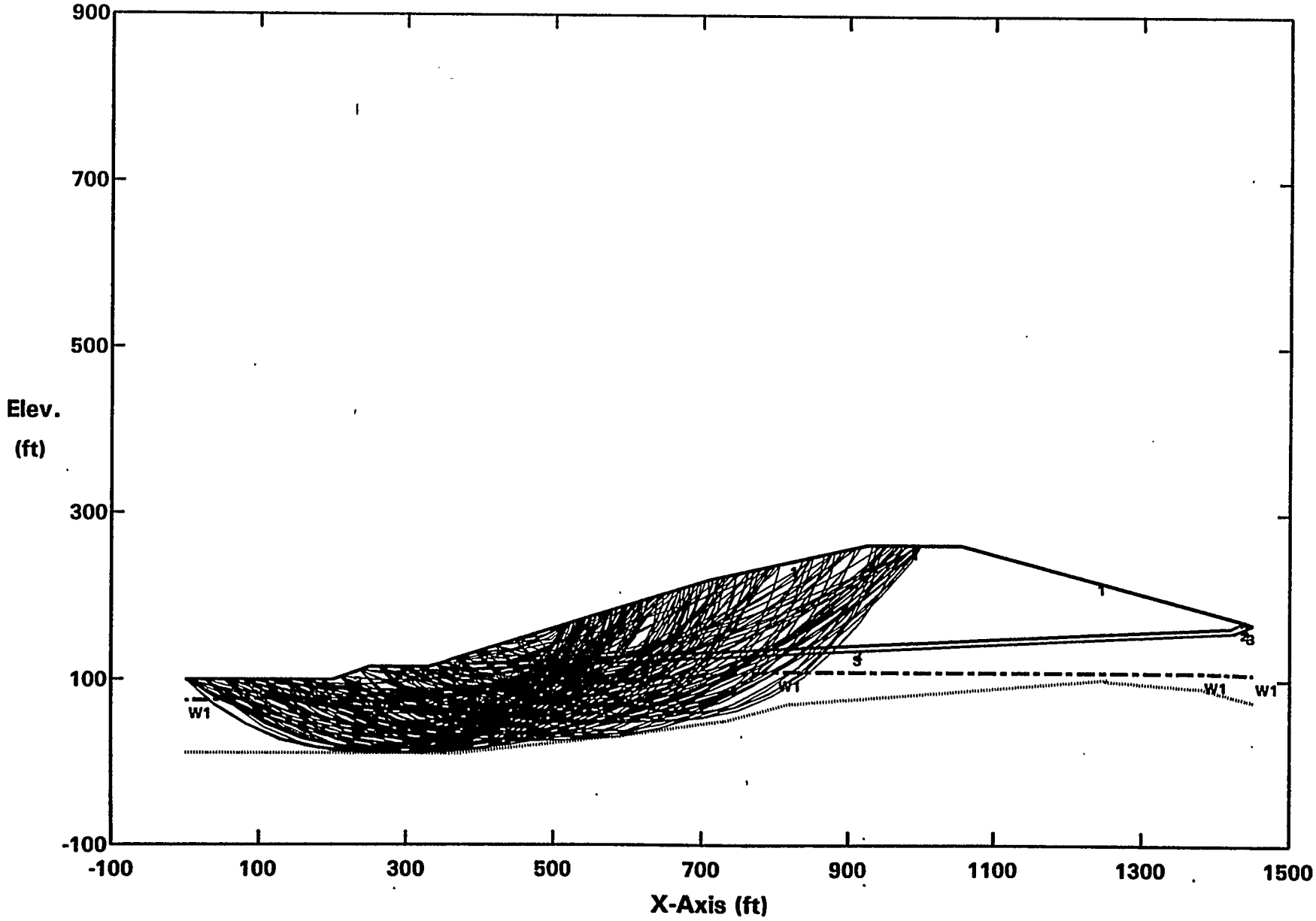
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	320	23	0	0	W1
2	115	125	1000	0	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.15$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C2.PLT By: DAVID TSO 03-06-95 4:10pm



A

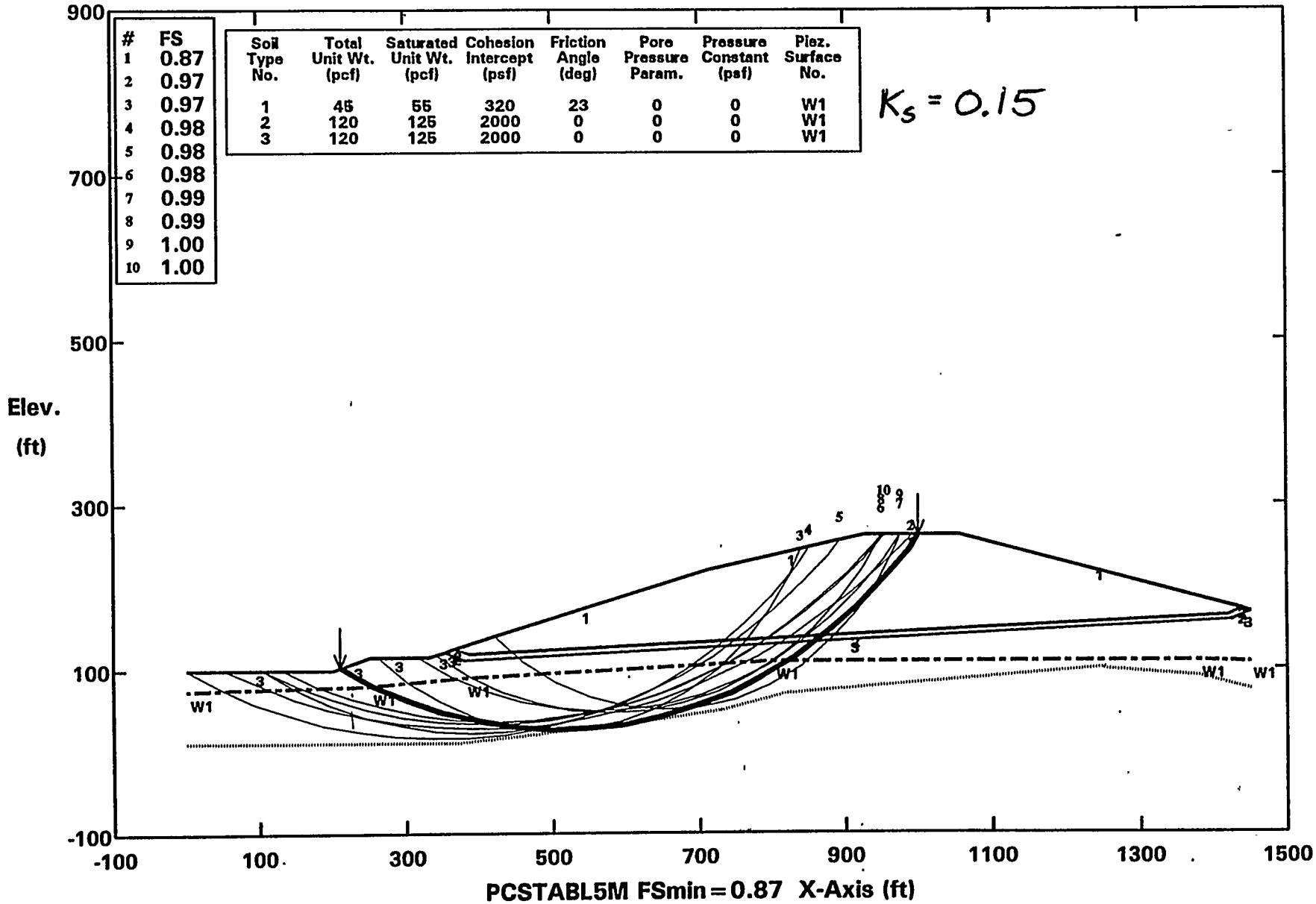
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C2.PLT By: DAVID TSO 03-06-95 4:10pm

#	FS
1	0.87
2	0.97
3	0.97
4	0.98
5	0.98
6	0.98
7	0.99
8	0.99
9	1.00
10	1.00

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	320	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	2000	0	0	0	W1

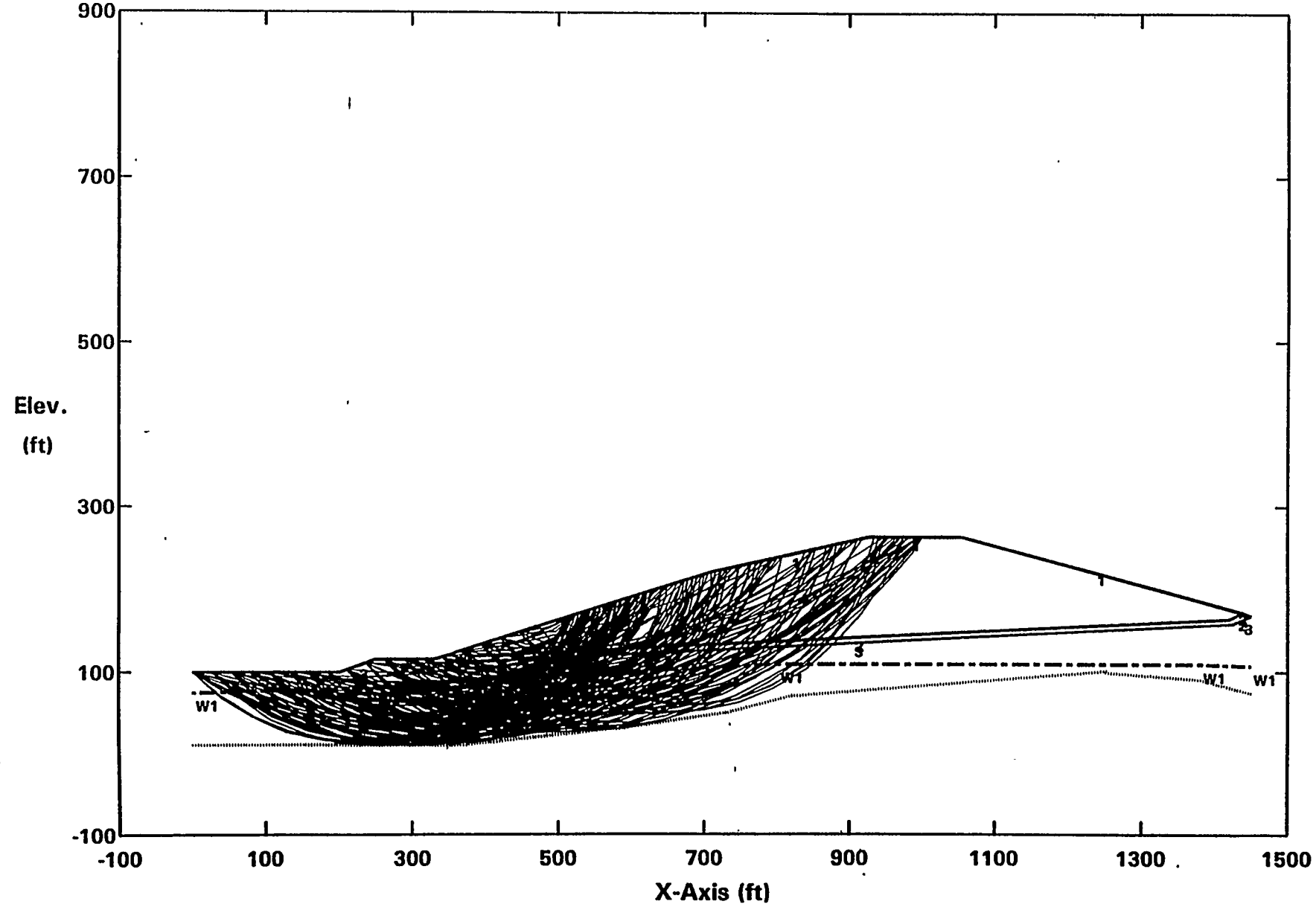
$K_s = 0.15$



PCSTABL5M FSmin = 0.87 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C3.PLT By: DAVID TSO 03-06-95 4:11pm



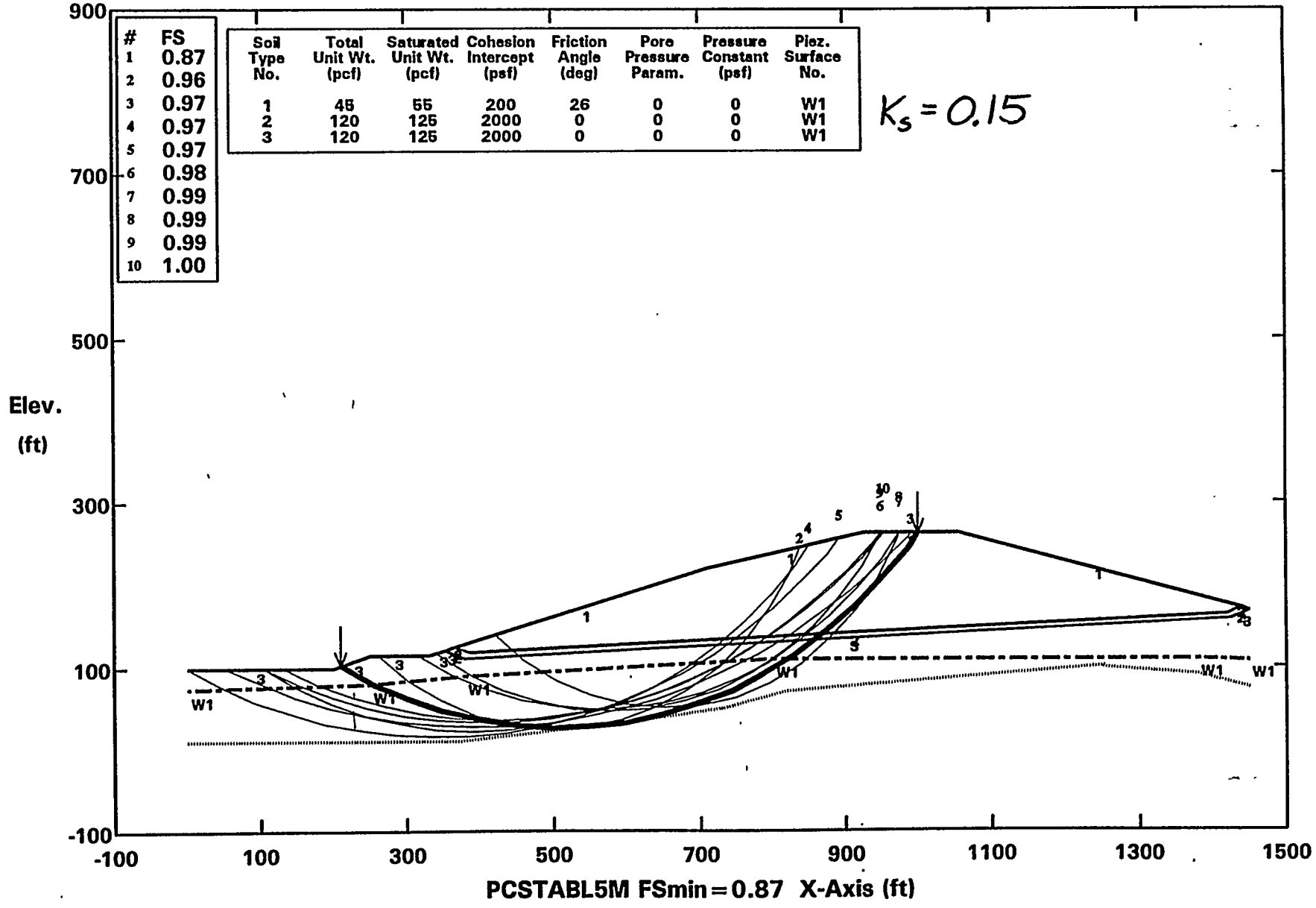
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C3.PLT By: DAVID TSO 03-06-95 4:11pm

#	FS
1	0.87
2	0.96
3	0.97
4	0.97
5	0.97
6	0.98
7	0.99
8	0.99
9	0.99
10	1.00

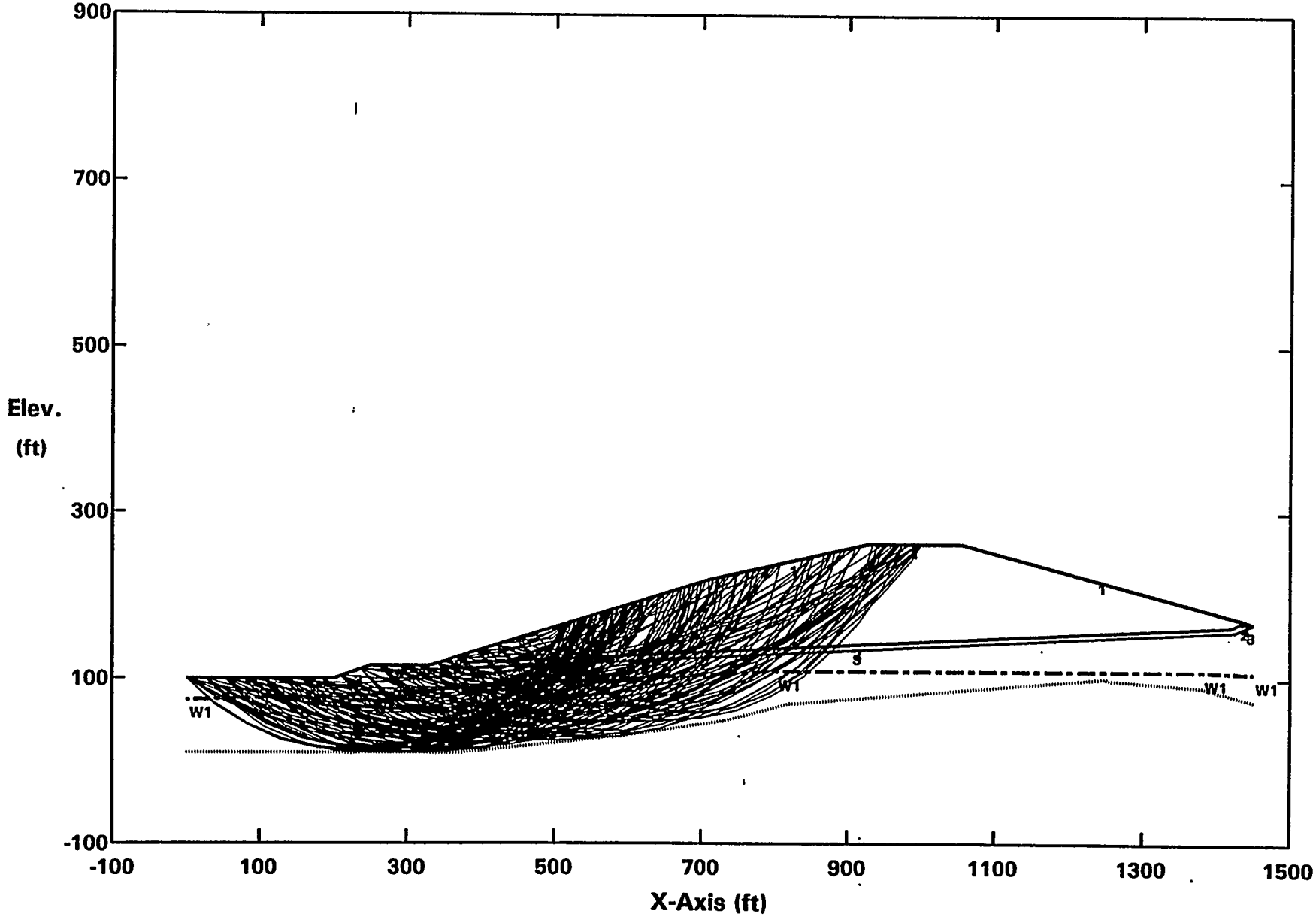
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	26	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.15$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C4.PLT By: DAVID TSO 03-06-95 4:12pm



A2

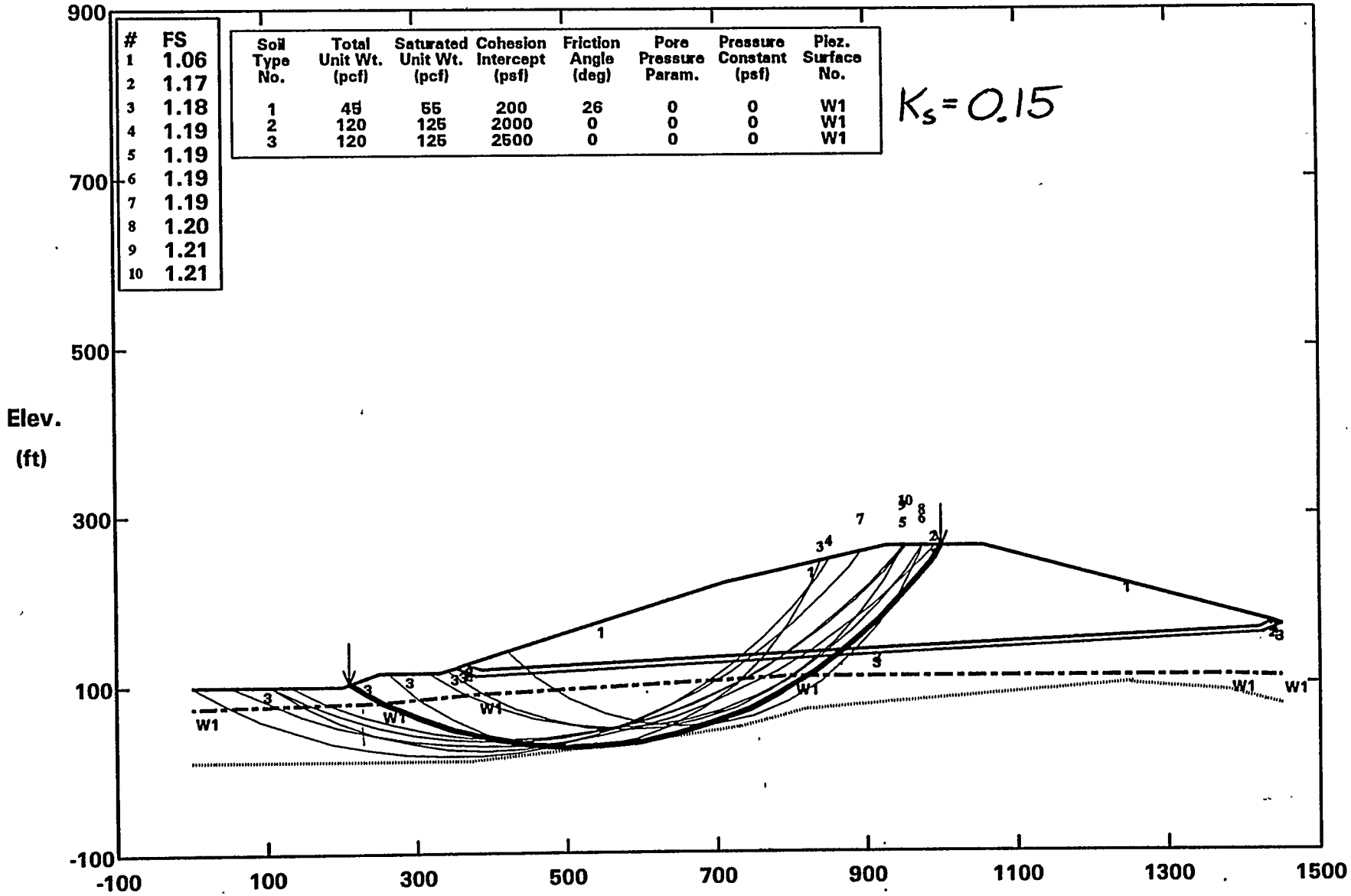
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C4.PLT By: DAVID TSO 03-06-95 4:12pm

#	FS
1	1.06
2	1.17
3	1.18
4	1.19
5	1.19
6	1.19
7	1.19
8	1.20
9	1.21
10	1.21

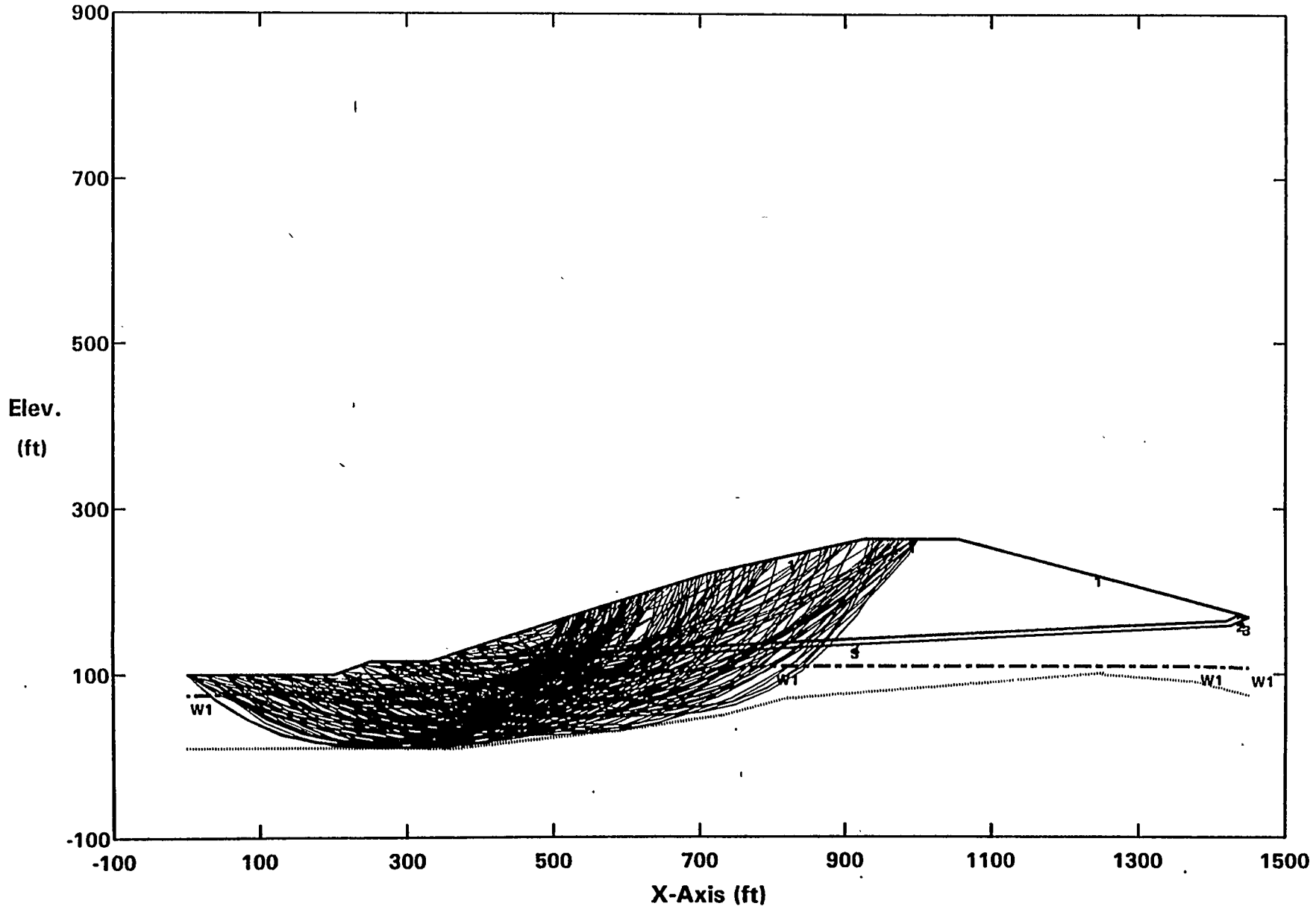
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	26	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	2500	0	0	0	W1

$K_s = 0.15$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C5.PLT By: DAVID TSO 03-07-95 12:56pm



AIO

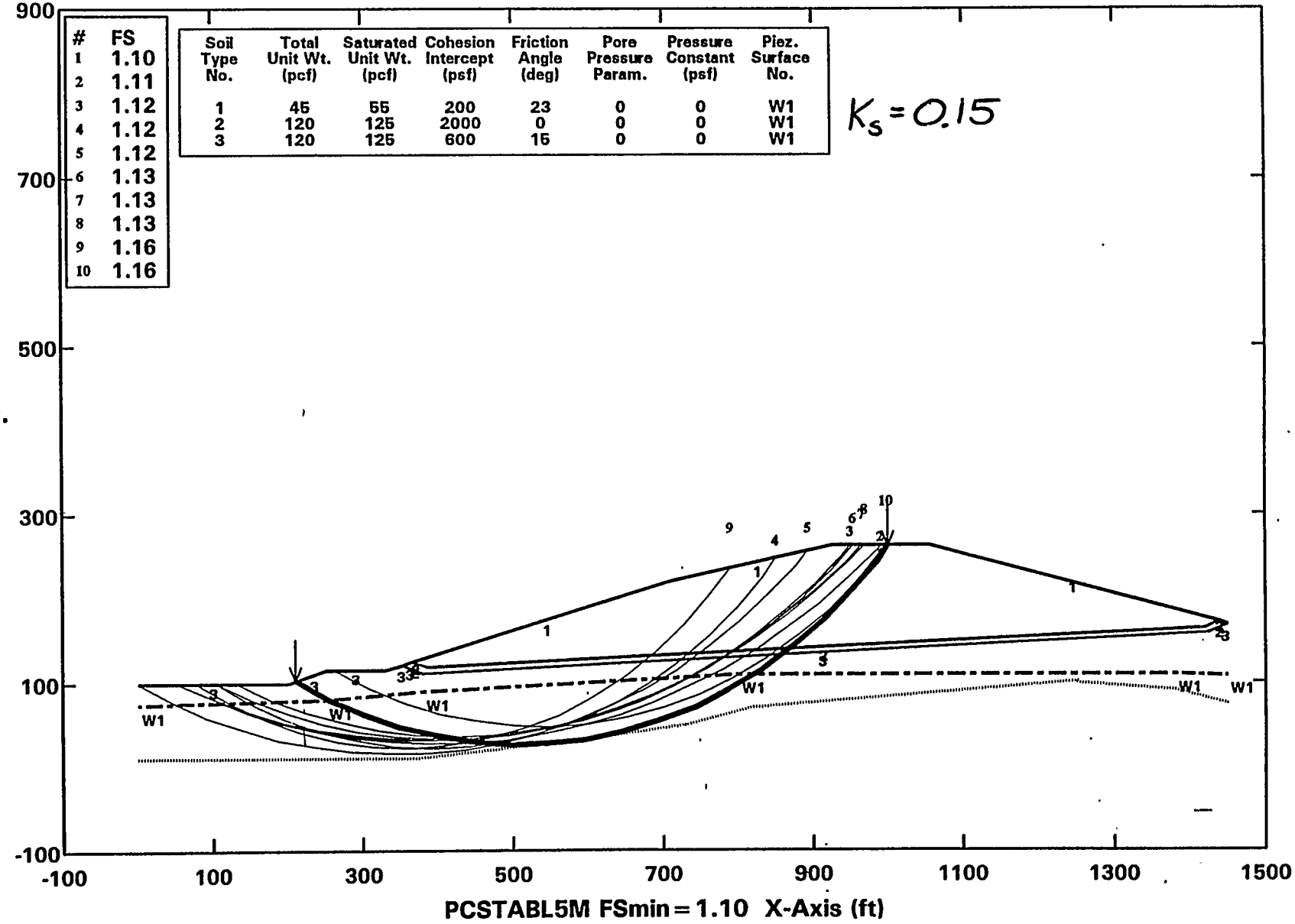
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C5.PLT By: DAVID TSO 03-07-95 12:56pm

#	FS
1	1.10
2	1.11
3	1.12
4	1.12
5	1.12
6	1.13
7	1.13
8	1.13
9	1.16
10	1.16

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	600	15	0	0	W1

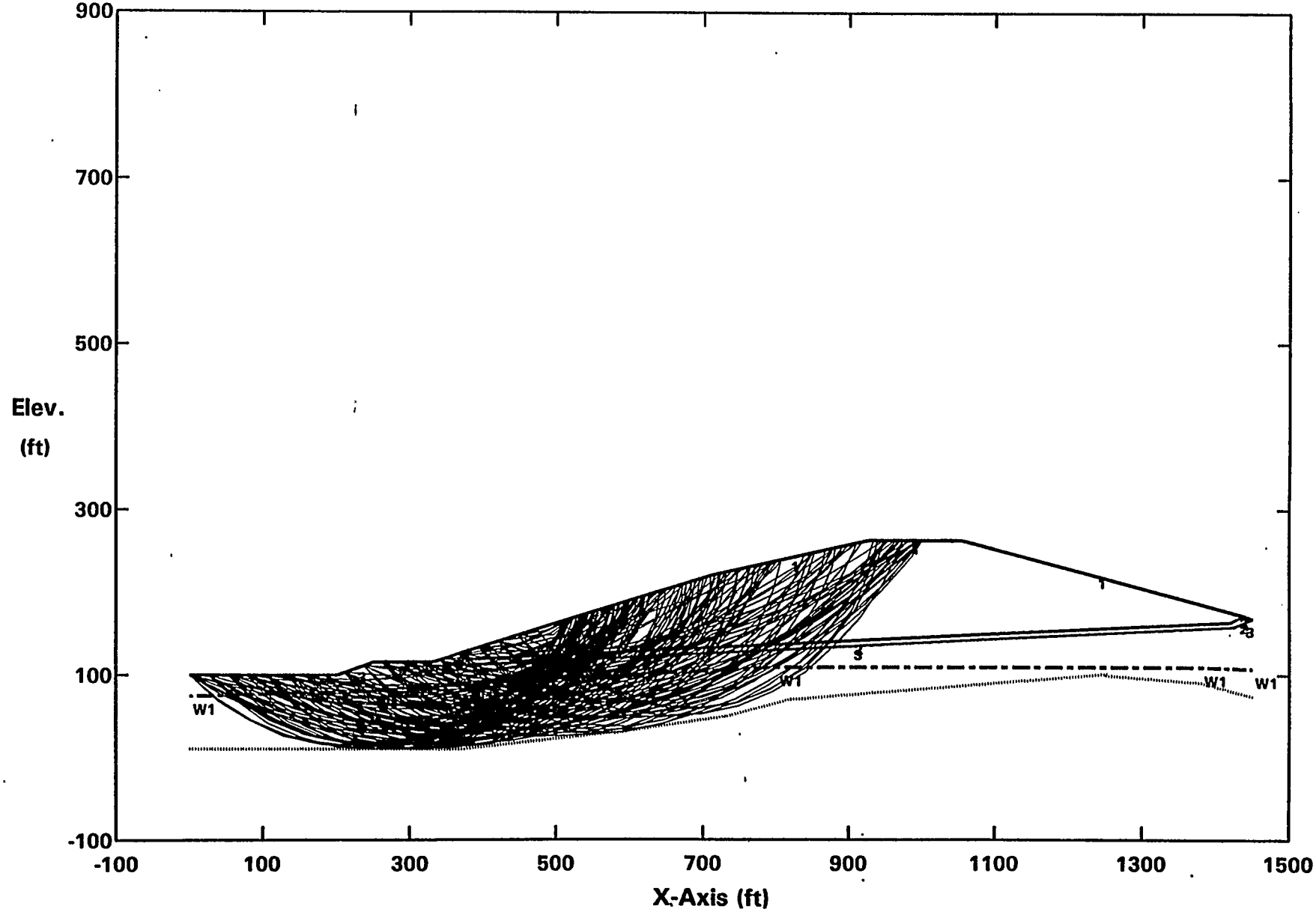
$K_s = 0.15$



PCSTABL5M FSmin = 1.10 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C6.PLT By: DAVID TSO 03-07-95 12:57pm



A12

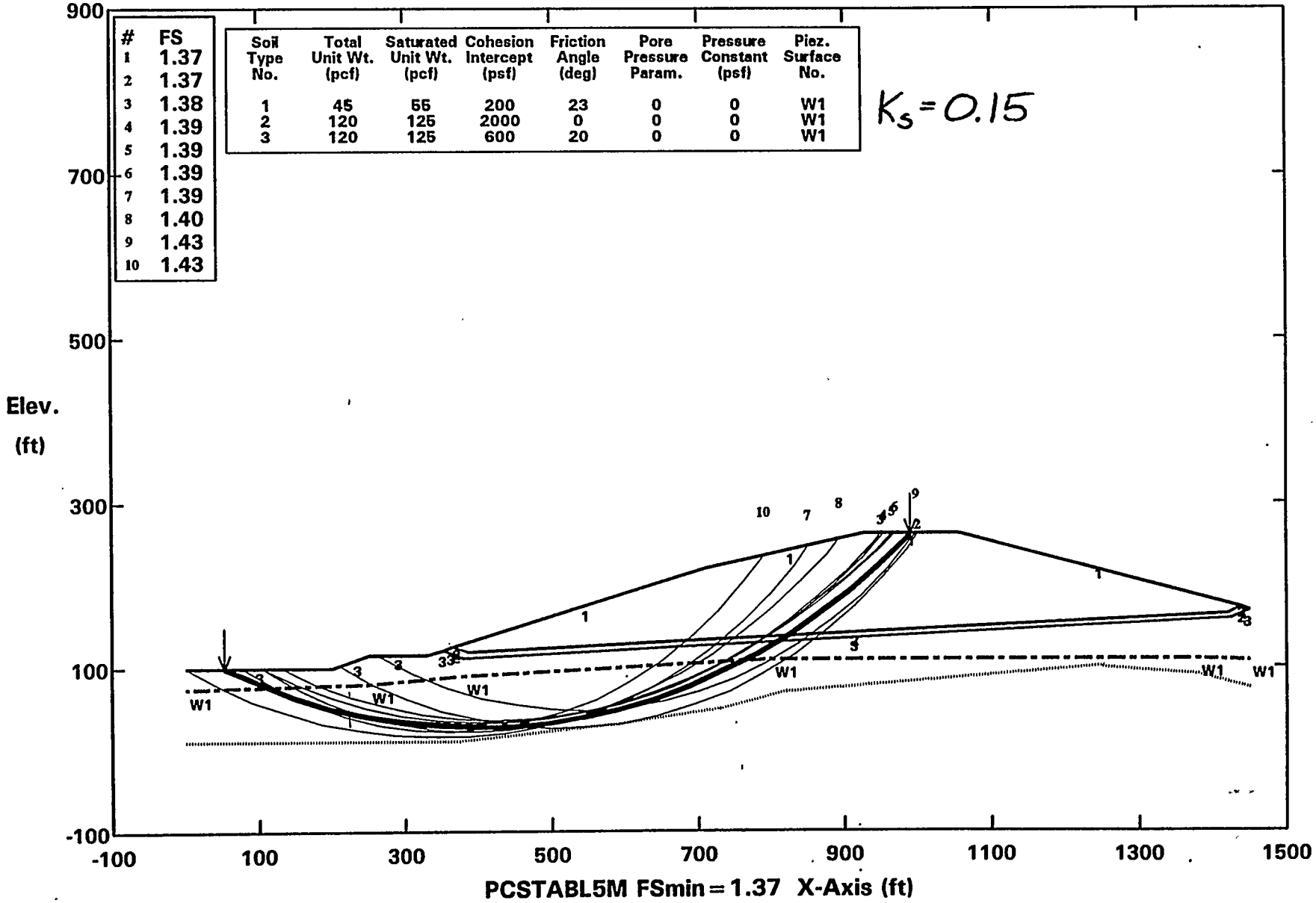
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C6.PLT By: DAVID TSO 03-07-95 12:57pm

#	FS
1	1.37
2	1.37
3	1.38
4	1.39
5	1.39
6	1.39
7	1.39
8	1.40
9	1.43
10	1.43

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	600	20	0	0	W1

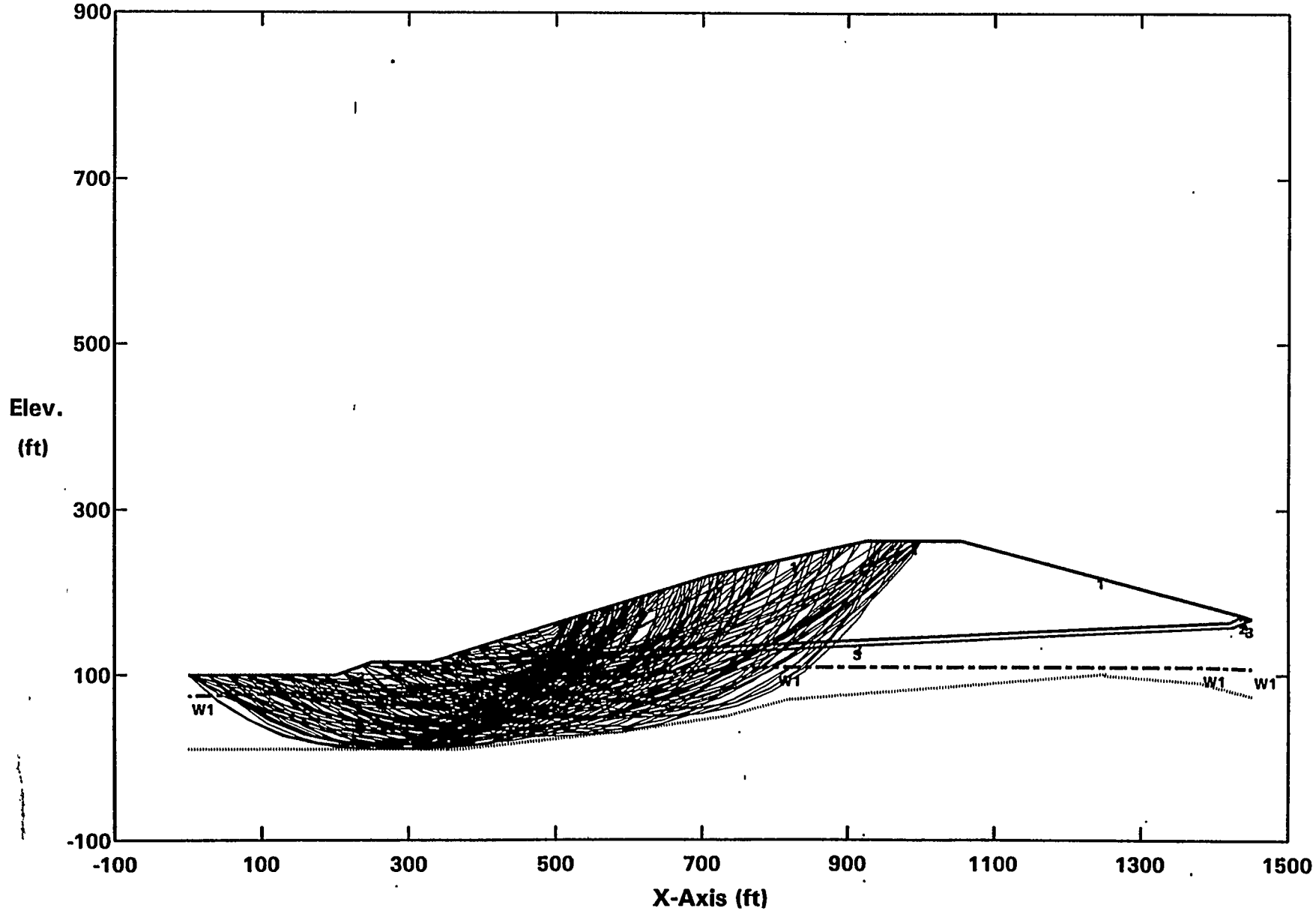
$K_s = 0.15$



A1

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C6A.PLT By: DAVID TSO 03-07-95 12:58pm



A1-

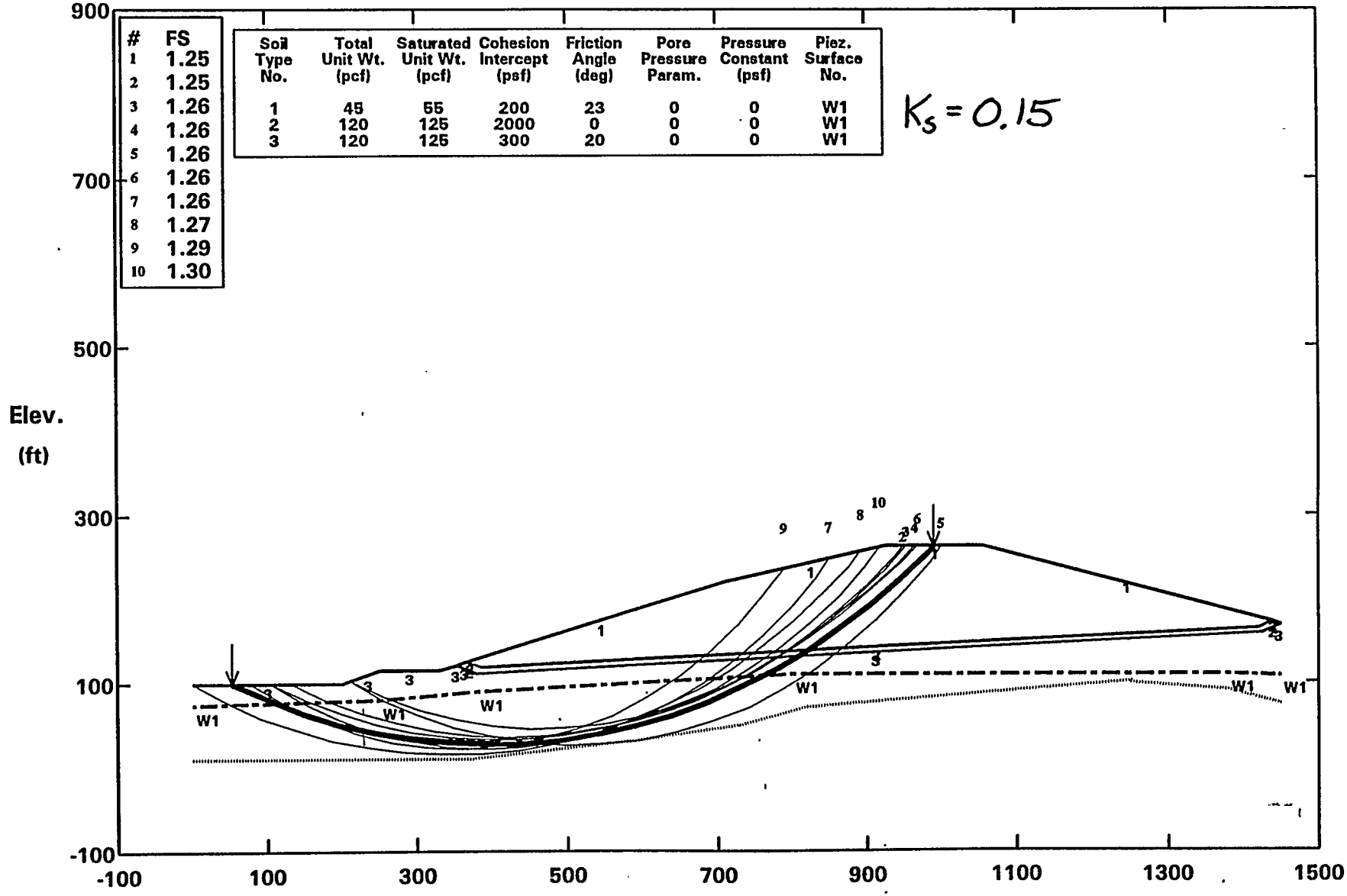
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C6A.PLT By: DAVID TSO 03-07-95 12:58pm

#	FS
1	1.25
2	1.25
3	1.26
4	1.26
5	1.26
6	1.26
7	1.26
8	1.27
9	1.29
10	1.30

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	300	20	0	0	W1

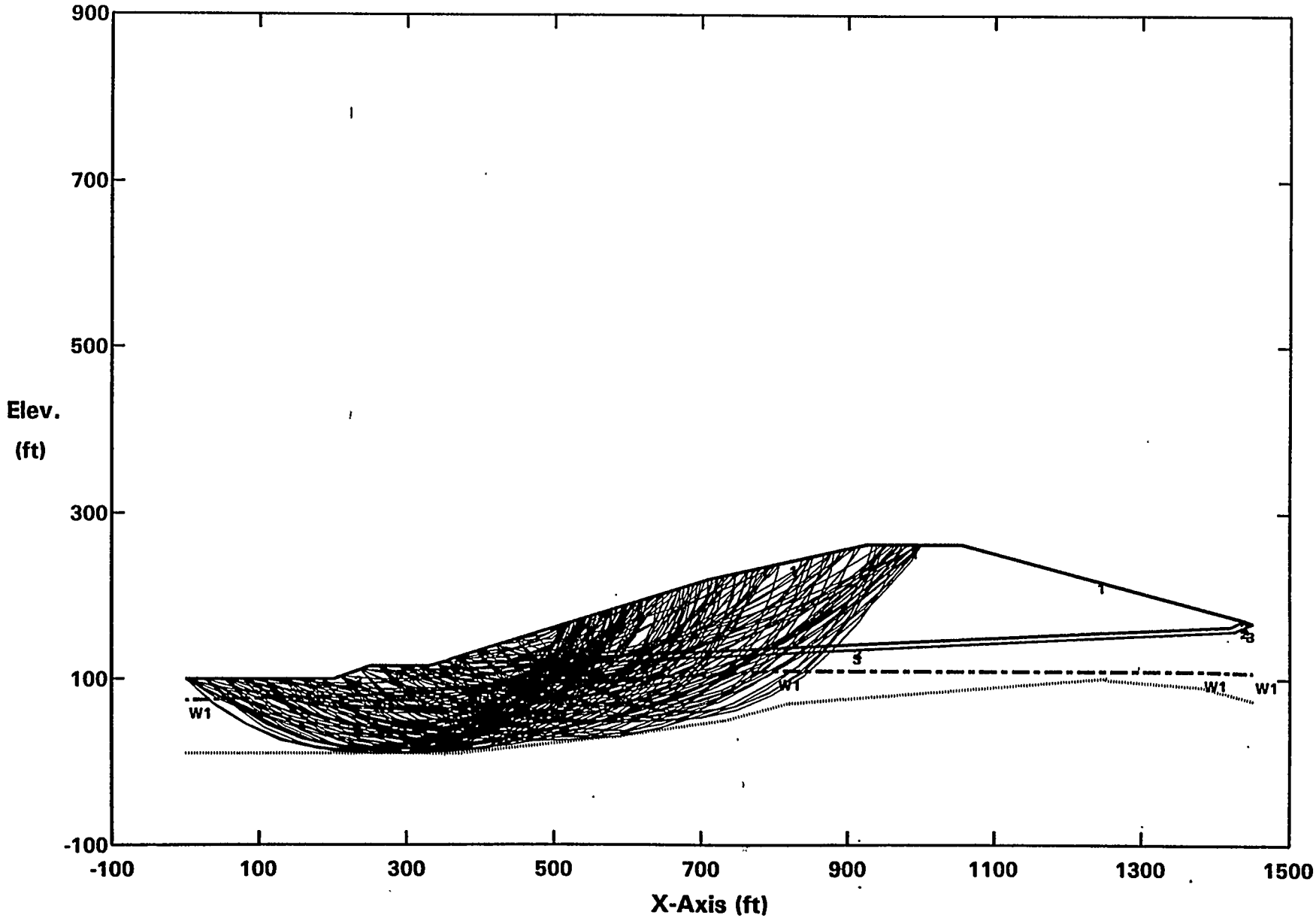
$K_s = 0.15$



A15

Y-12 INDUSTRIAL LANDFILL V

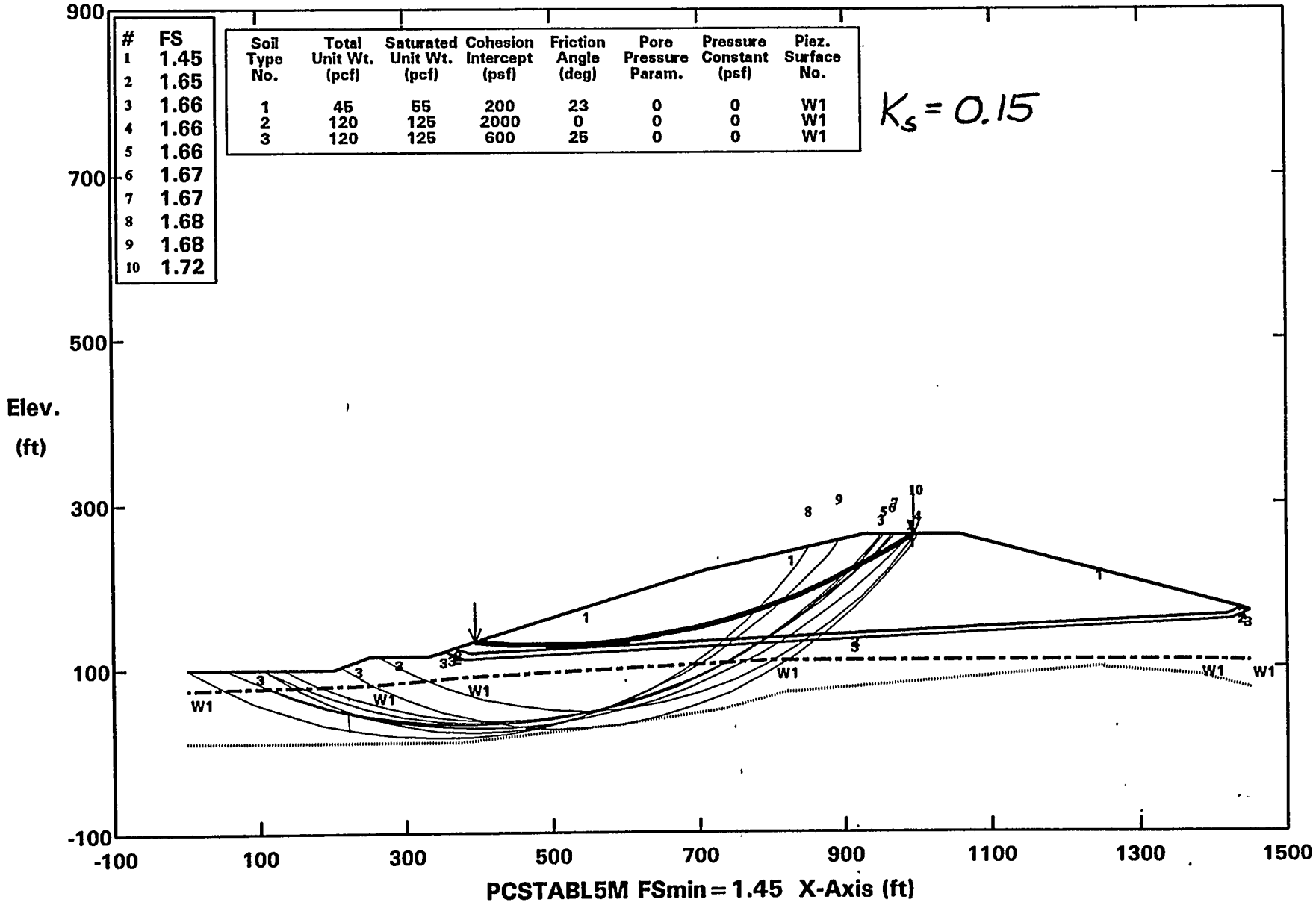
All surfaces evaluated. C:C7.PLT By: DAVID TSO 03-07-95 12:59pm



A16

Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C7.PLT By: DAVID TSO 03-07-95 12:59pm



#	FS
1	1.45
2	1.65
3	1.66
4	1.66
5	1.66
6	1.67
7	1.67
8	1.68
9	1.68
10	1.72

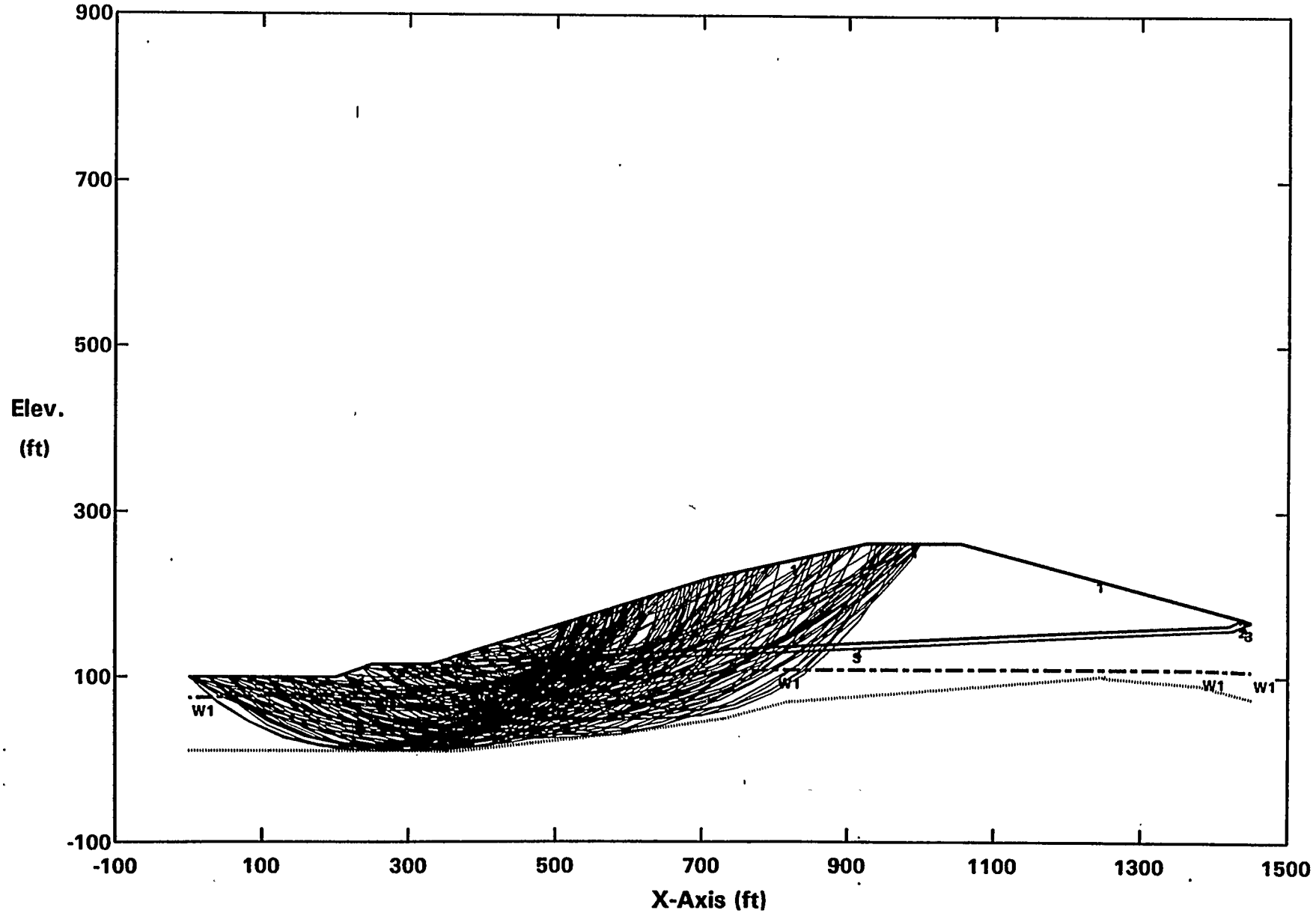
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	600	25	0	0	W1

$K_s = 0.15$

A1

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C7A.PLT By: DAVID TSO 03-07-95 12:59pm



A12

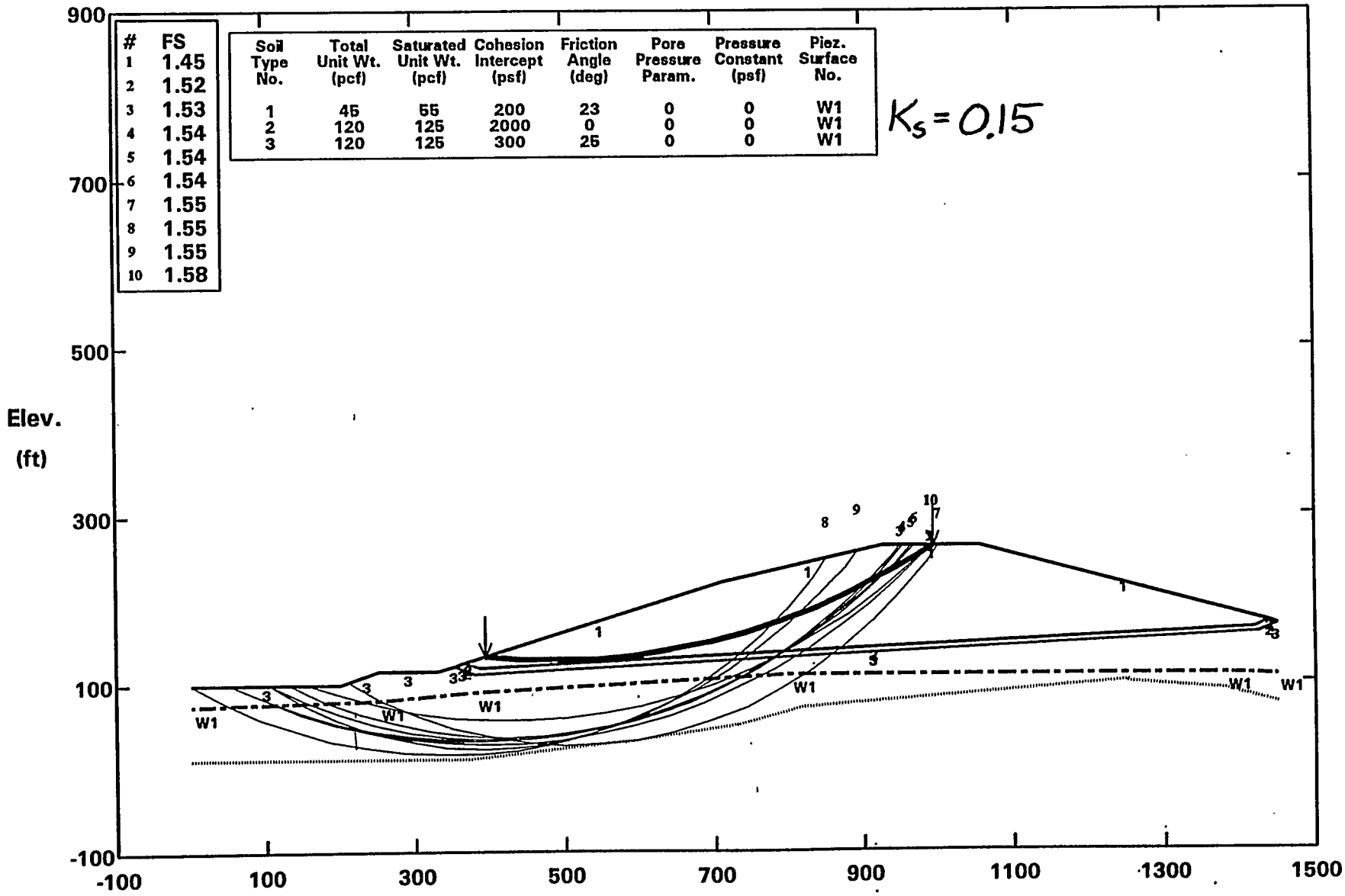
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C7A.PLT By: DAVID TSO 03-07-95 12:59pm

#	FS
1	1.45
2	1.52
3	1.53
4	1.54
5	1.54
6	1.54
7	1.55
8	1.55
9	1.55
10	1.58

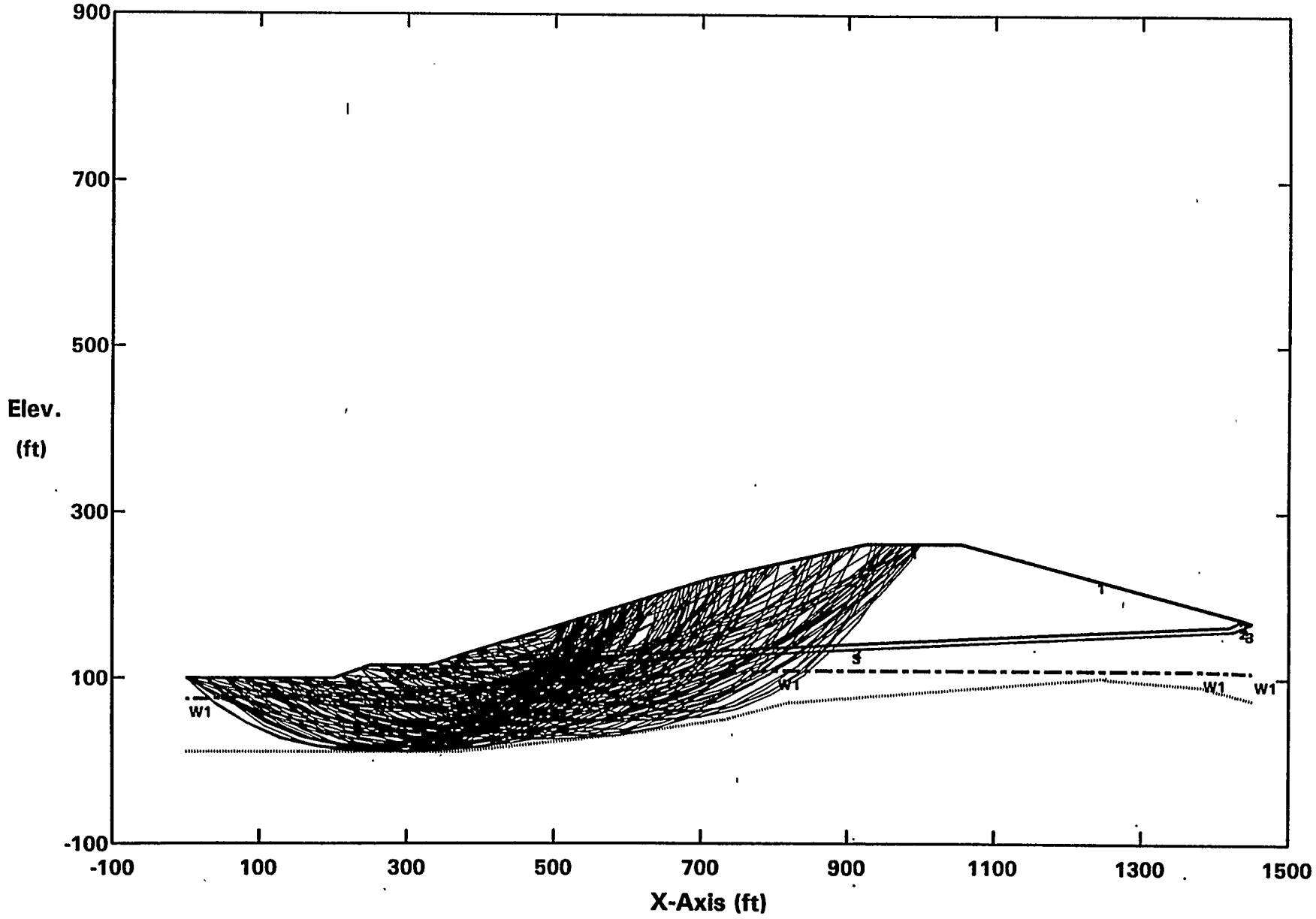
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	300	25	0	0	W1

$K_s = 0.15$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C7B.PLT By: DAVID TSO 03-07-95 1:01pm



A20

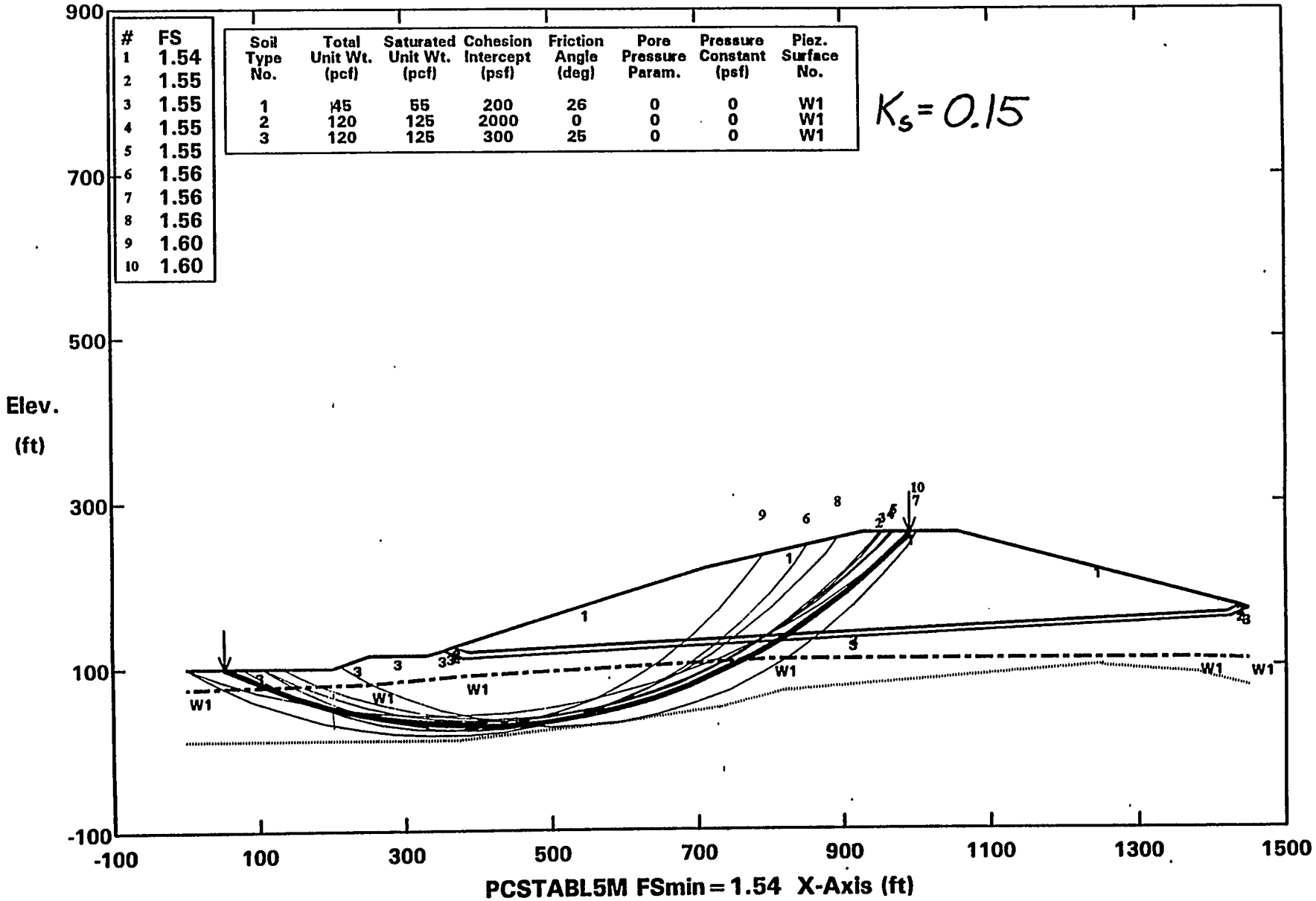
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C7B.PLT By: DAVID TSO 03-07-95 1:01pm

#	FS
1	1.54
2	1.55
3	1.55
4	1.55
5	1.55
6	1.56
7	1.56
8	1.56
9	1.60
10	1.60

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	145	55	200	26	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	300	25	0	0	W1

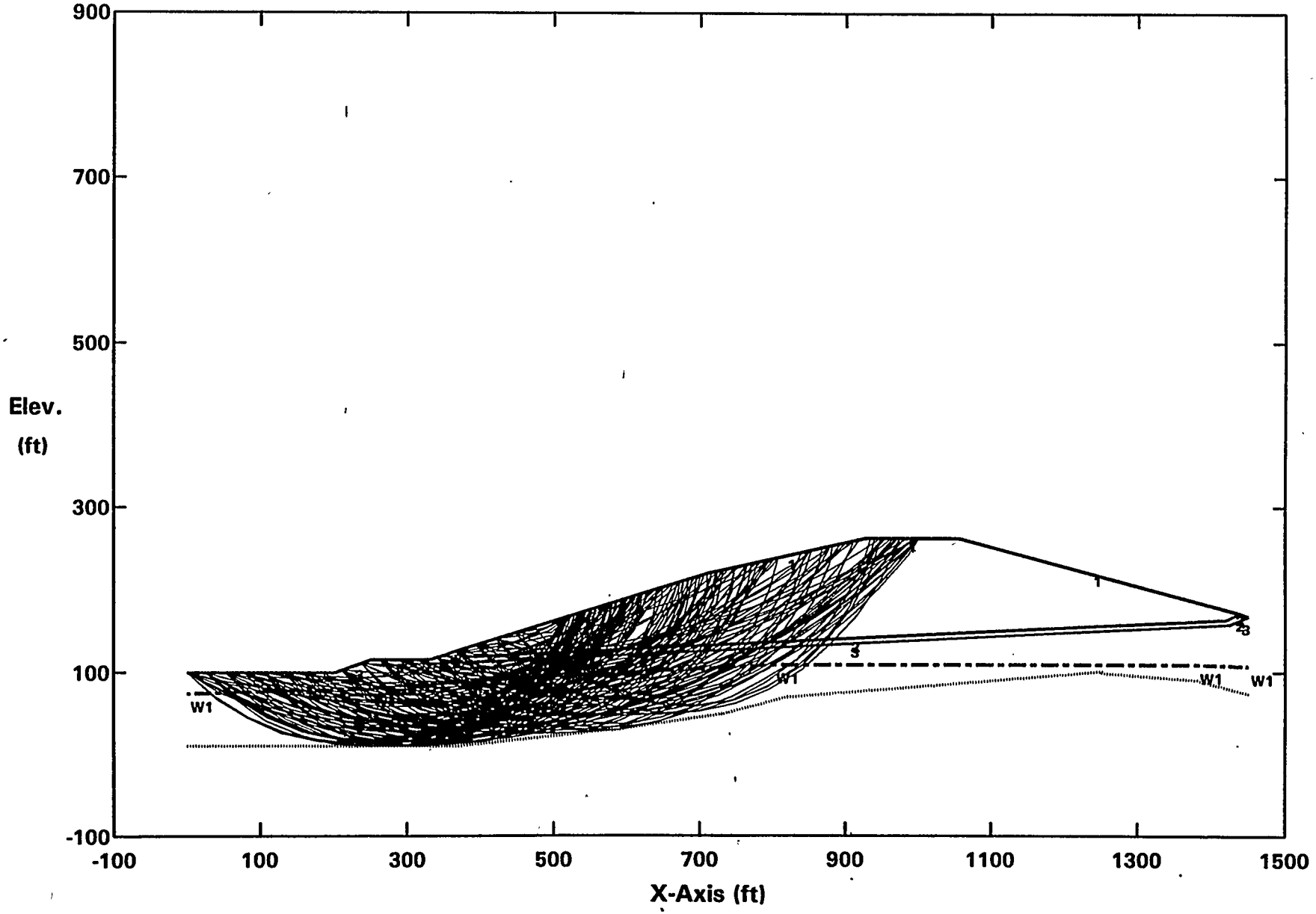
$K_s = 0.15$



A21

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C8.PLT By: DAVID TSO 03-07-95 4:02pm



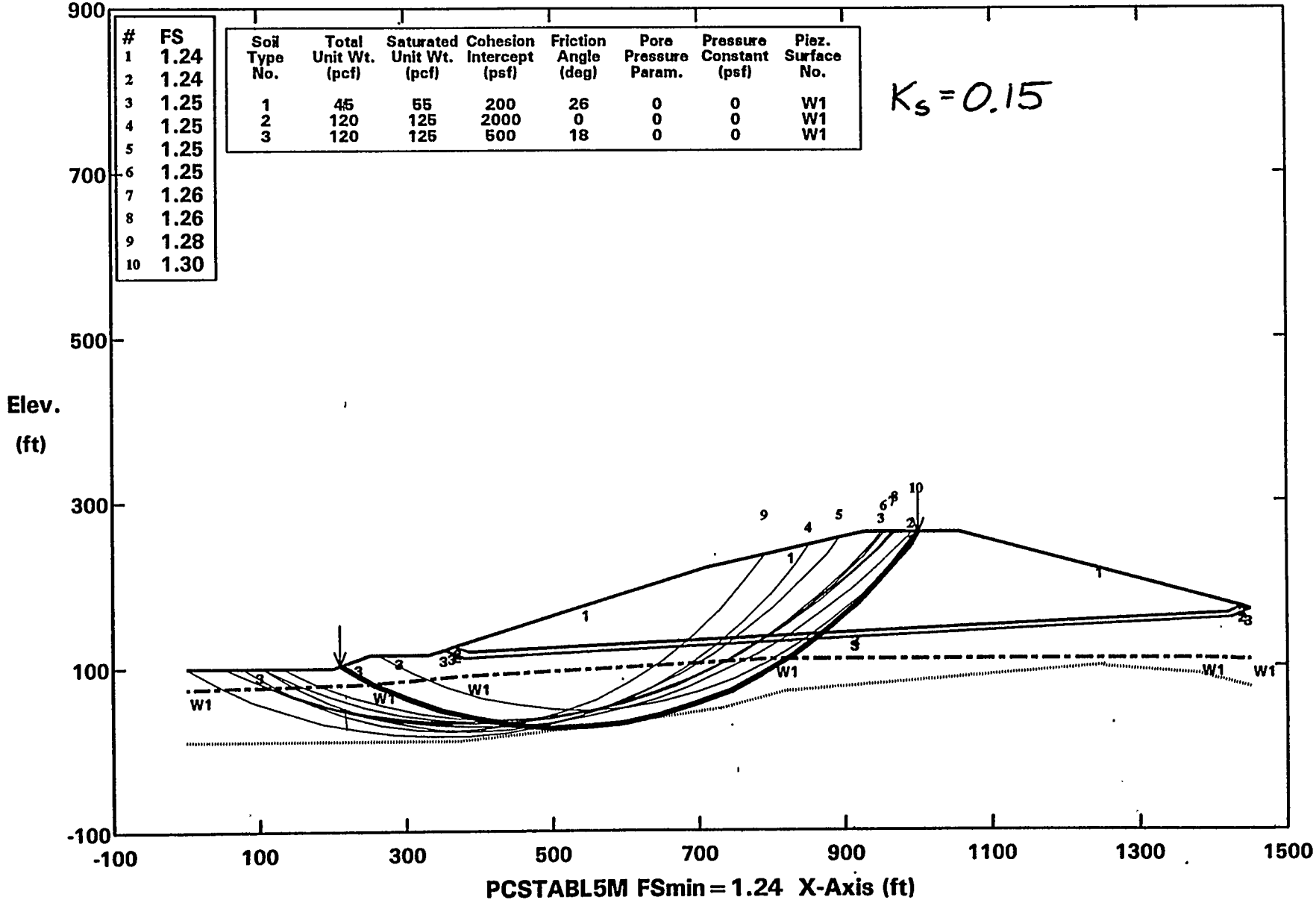
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C8.PLT By: DAVID TSO 03-07-95 4:02pm

#	FS
1	1.24
2	1.24
3	1.25
4	1.25
5	1.25
6	1.25
7	1.26
8	1.26
9	1.28
10	1.30

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	26	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	500	18	0	0	W1

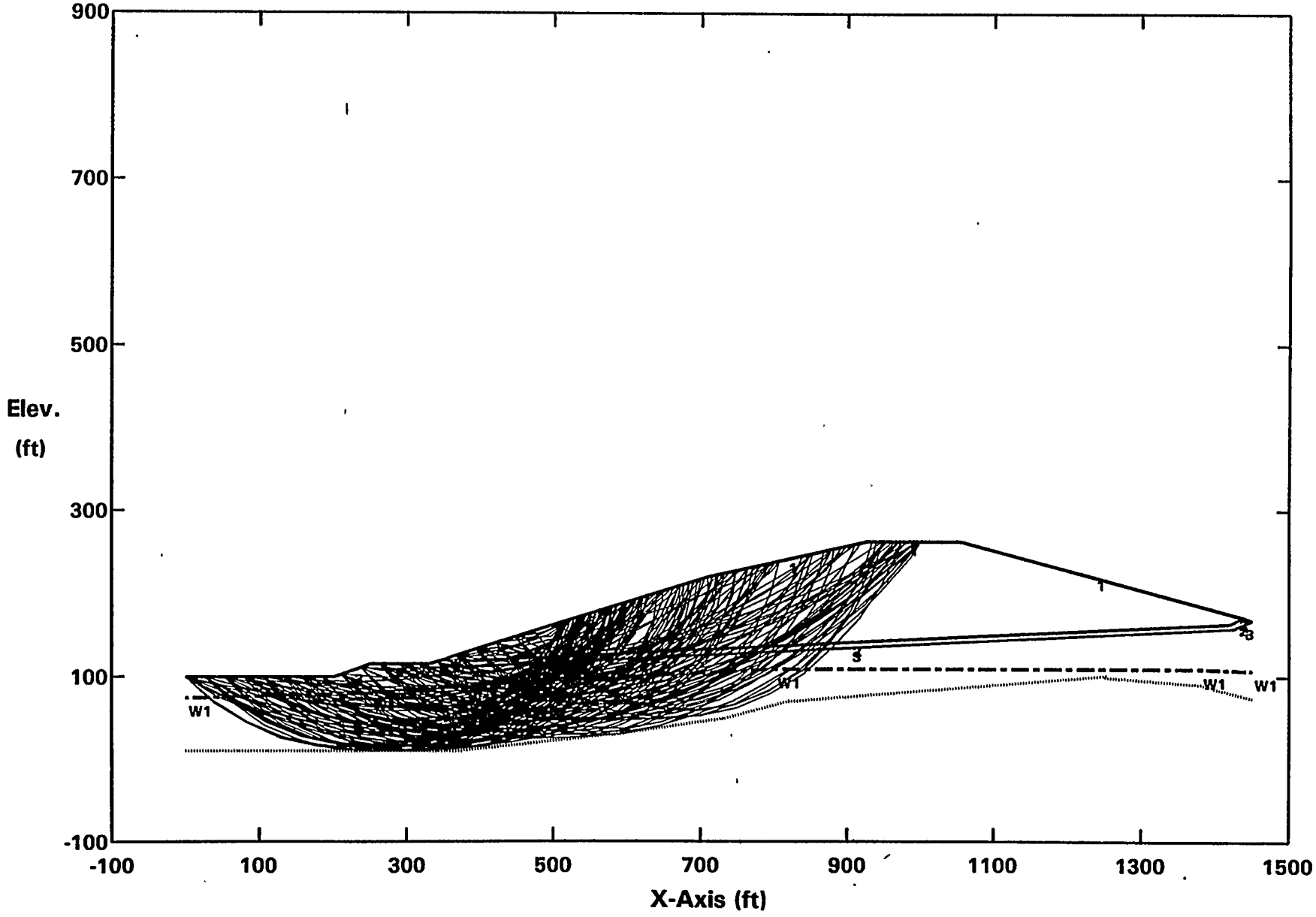
$K_s = 0.15$



A24

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C8A.PLT By: DAVID TSO 03-07-95 4:03pm



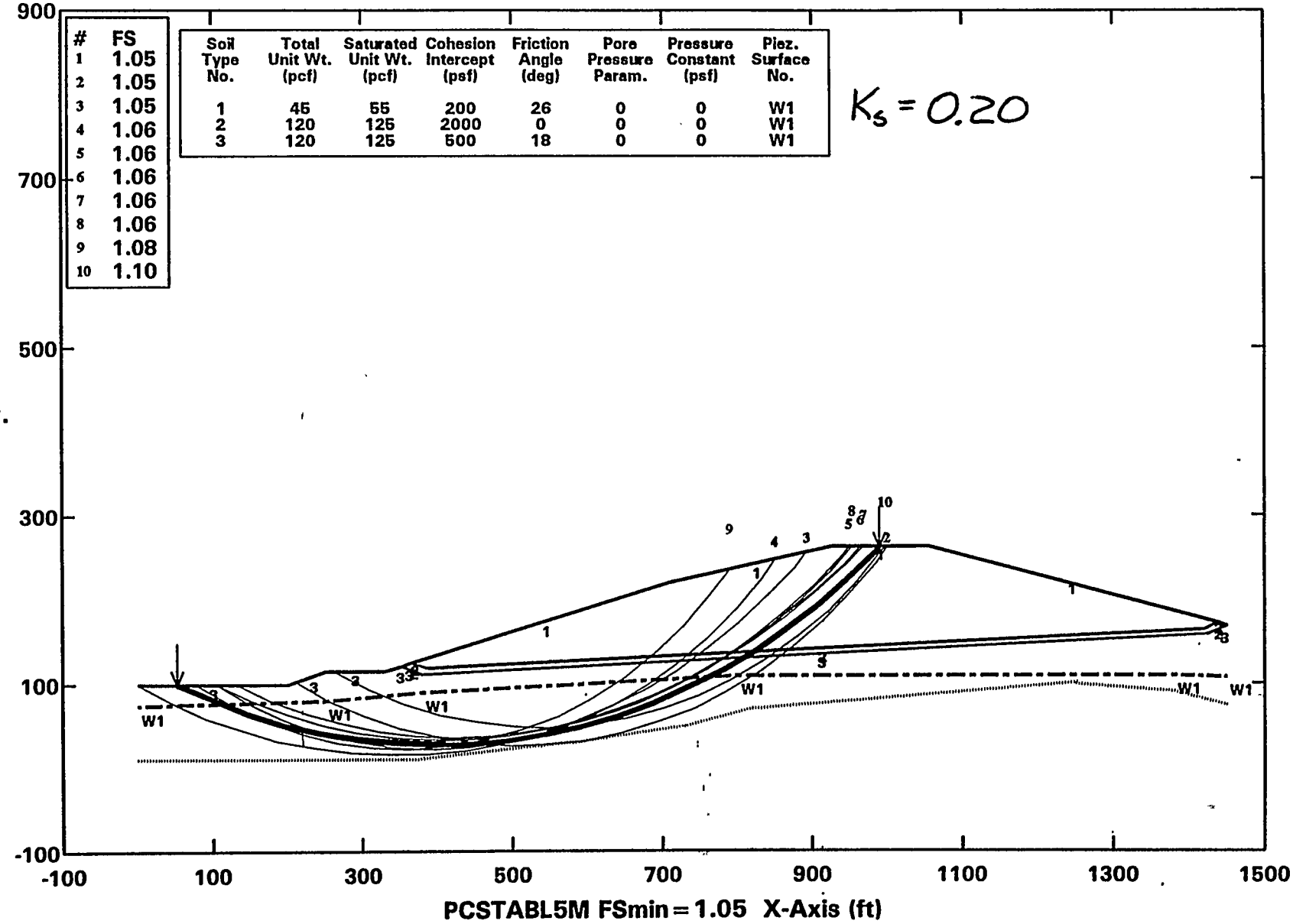
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C8A.PLT By: DAVID TSO 03-07-95 4:03pm

#	FS
1	1.05
2	1.05
3	1.05
4	1.06
5	1.06
6	1.06
7	1.06
8	1.06
9	1.08
10	1.10

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	26	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	500	18	0	0	W1

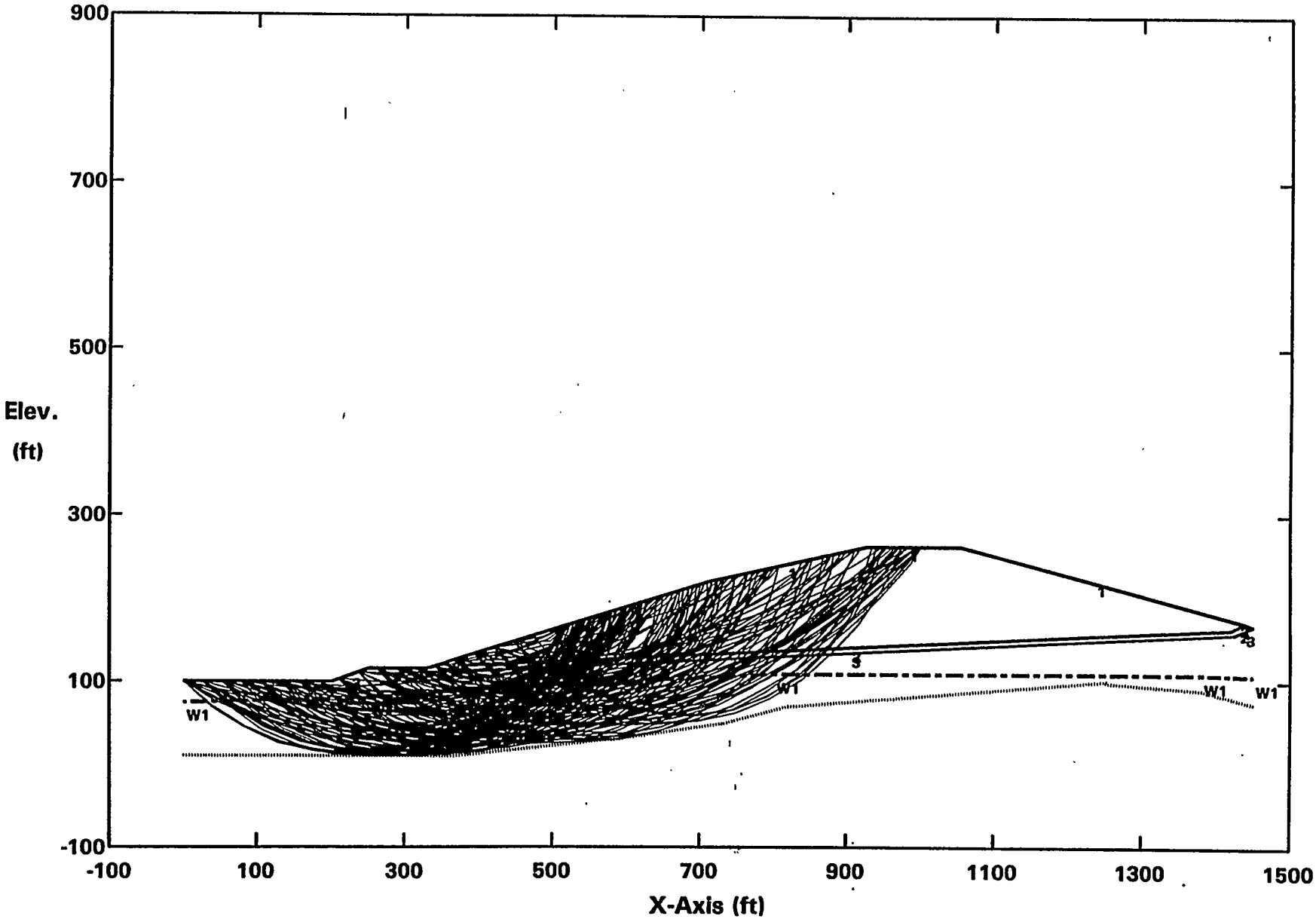
$K_s = 0.20$



A25

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C8B.PLT By: DAVID TSO 03-25-95 4:15pm



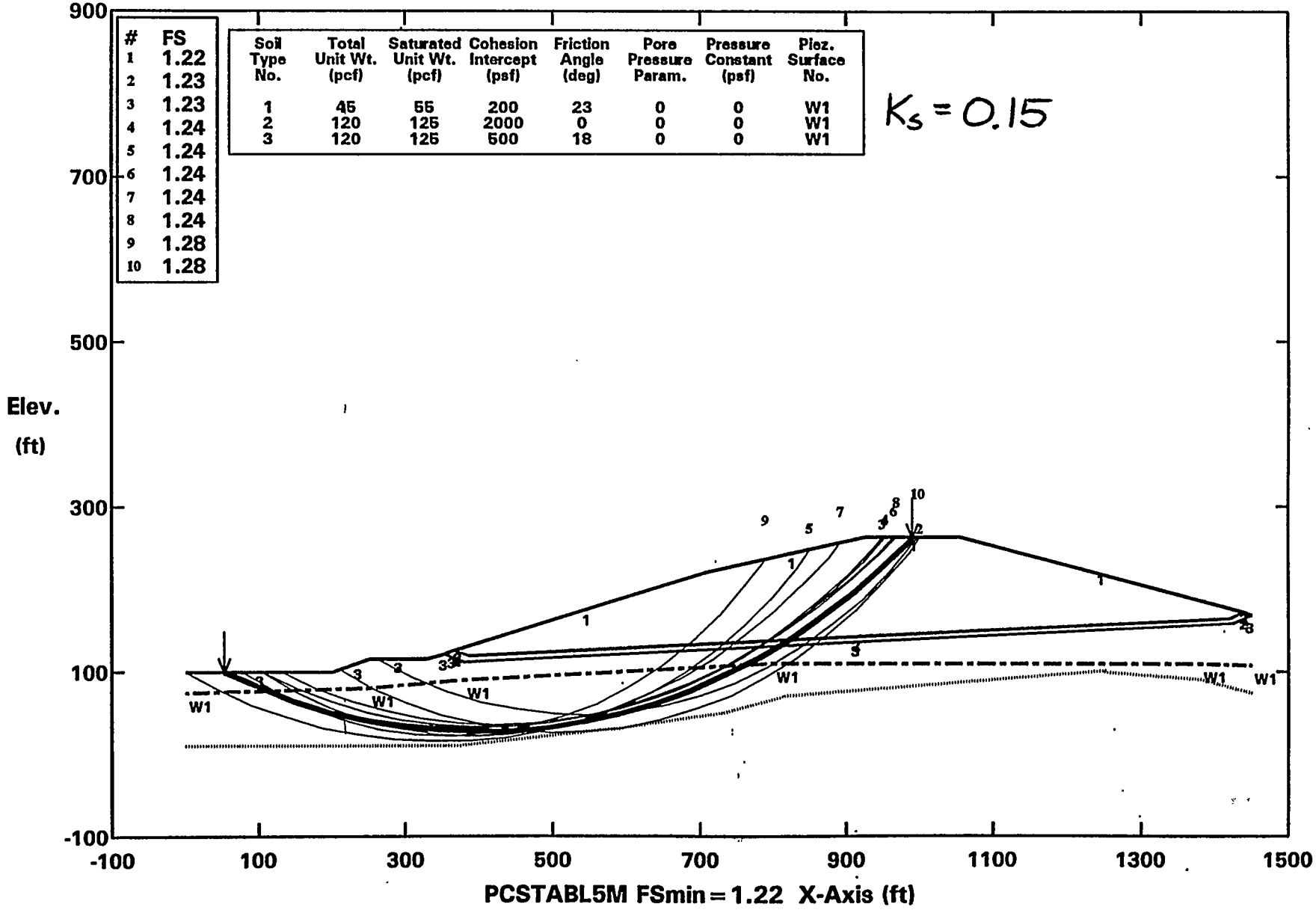
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C8B.PLT By: DAVID TSO 03-25-95 4:15pm

#	FS
1	1.22
2	1.23
3	1.23
4	1.24
5	1.24
6	1.24
7	1.24
8	1.24
9	1.28
10	1.28

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	500	18	0	0	W1

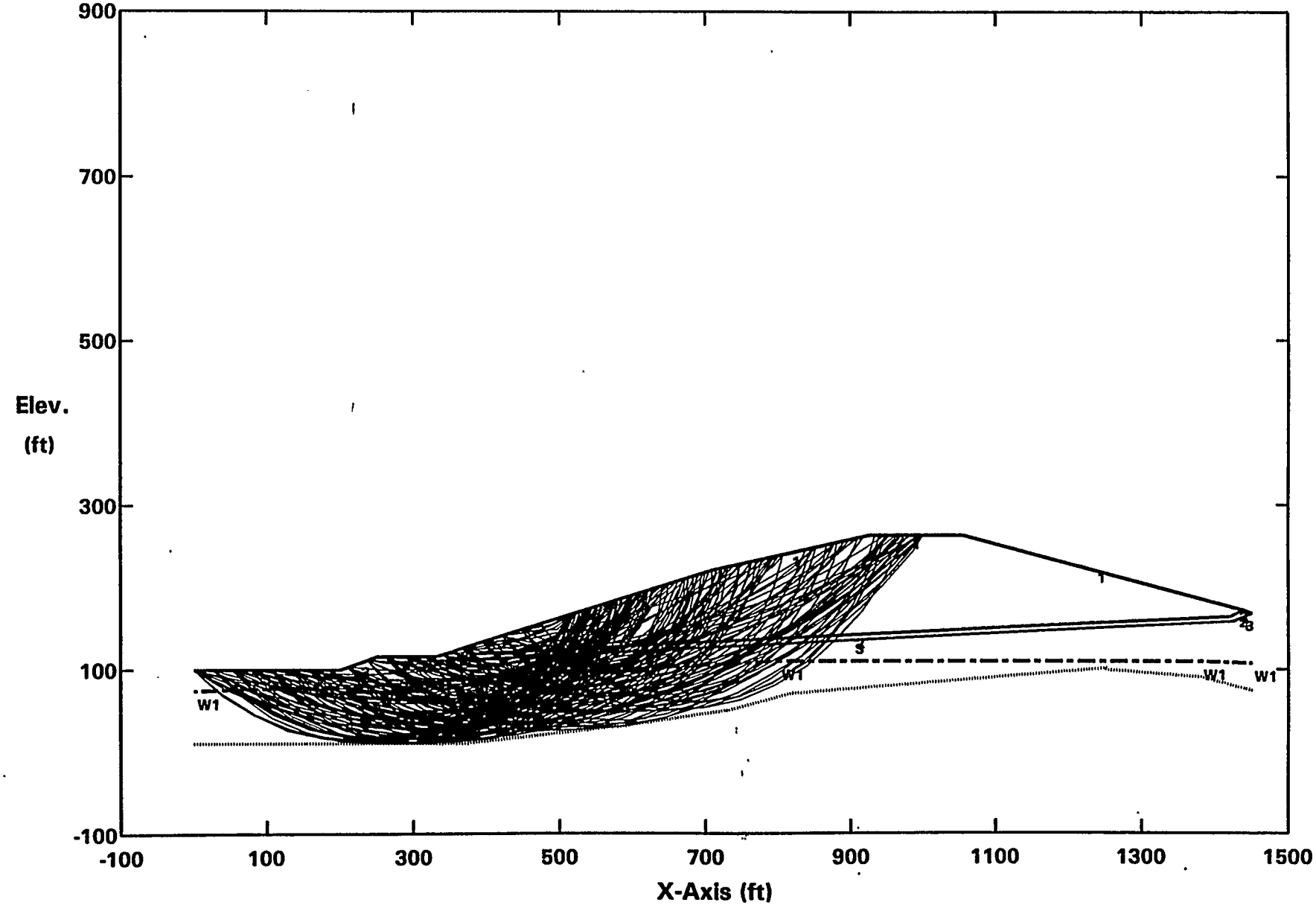
$K_s = 0.15$



A27

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C8C.PLT By: DAVID TSO 03-25-95 4:16pm



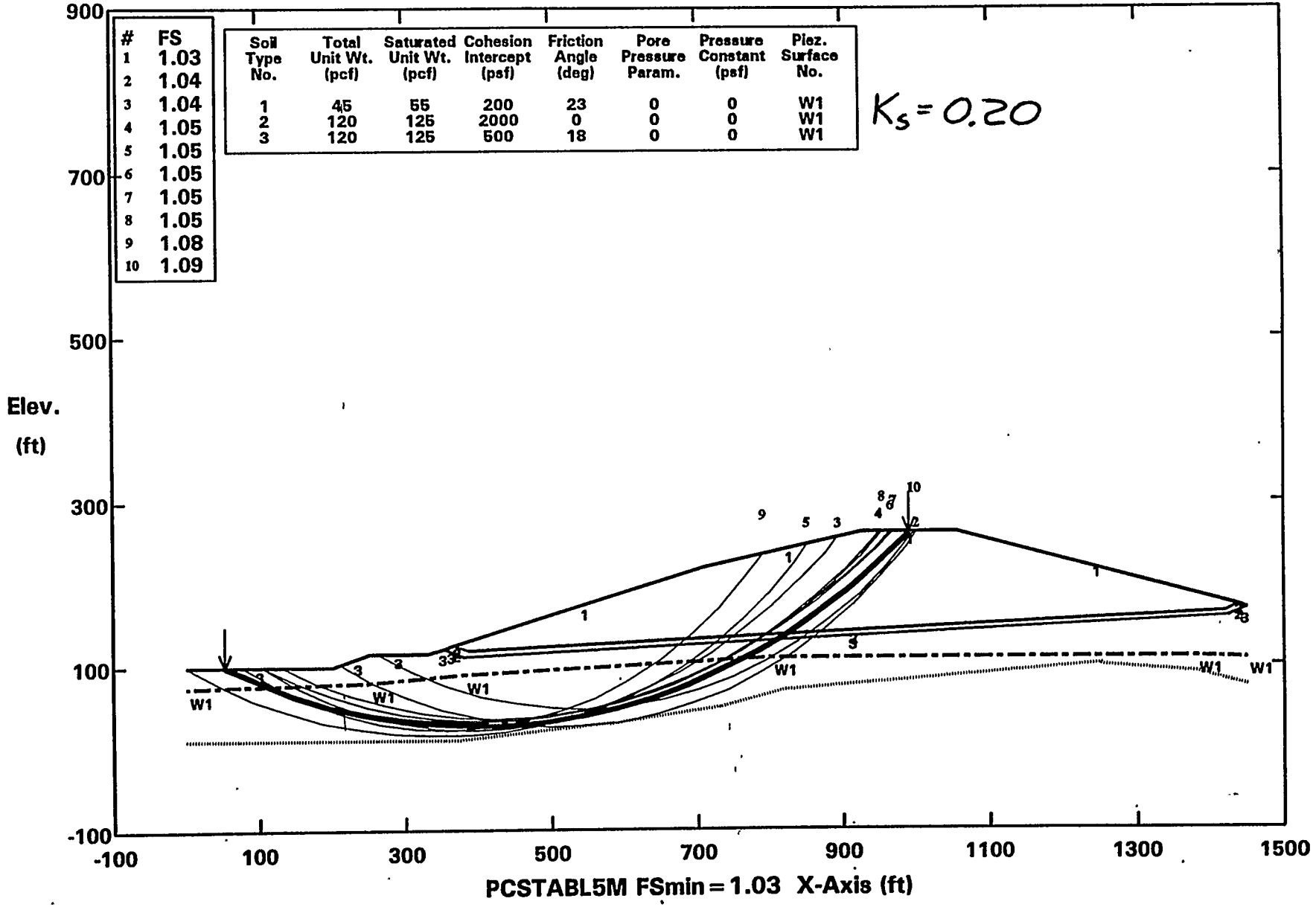
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C8C.PLT By: DAVID TSO 03-25-95 4:16pm

#	FS
1	1.03
2	1.04
3	1.04
4	1.05
5	1.05
6	1.05
7	1.05
8	1.05
9	1.08
10	1.09

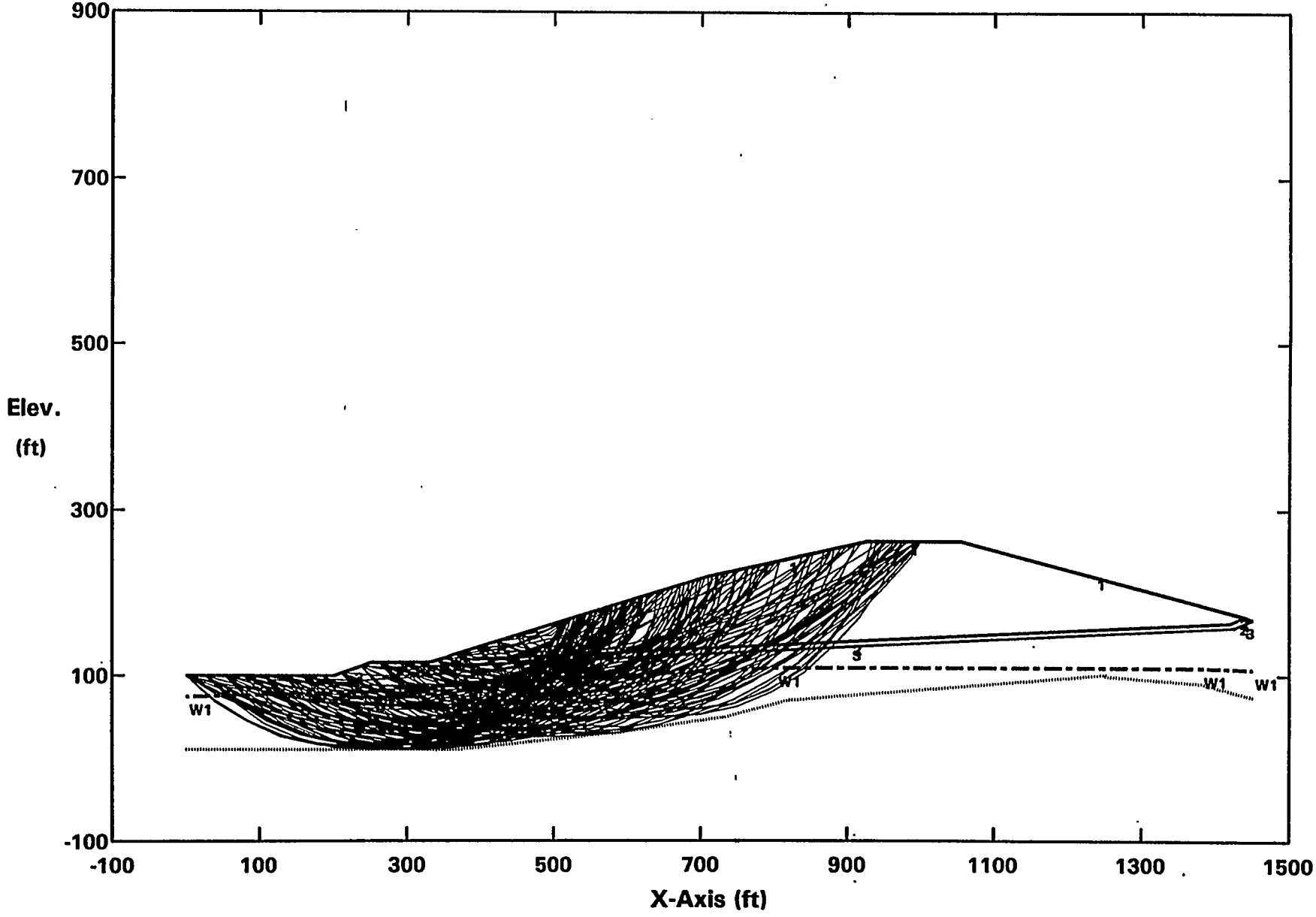
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	500	18	0	0	W1

$K_s = 0.20$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C8D.PLT By: DAVID TSO 03-25-95 4:17pm



A3C

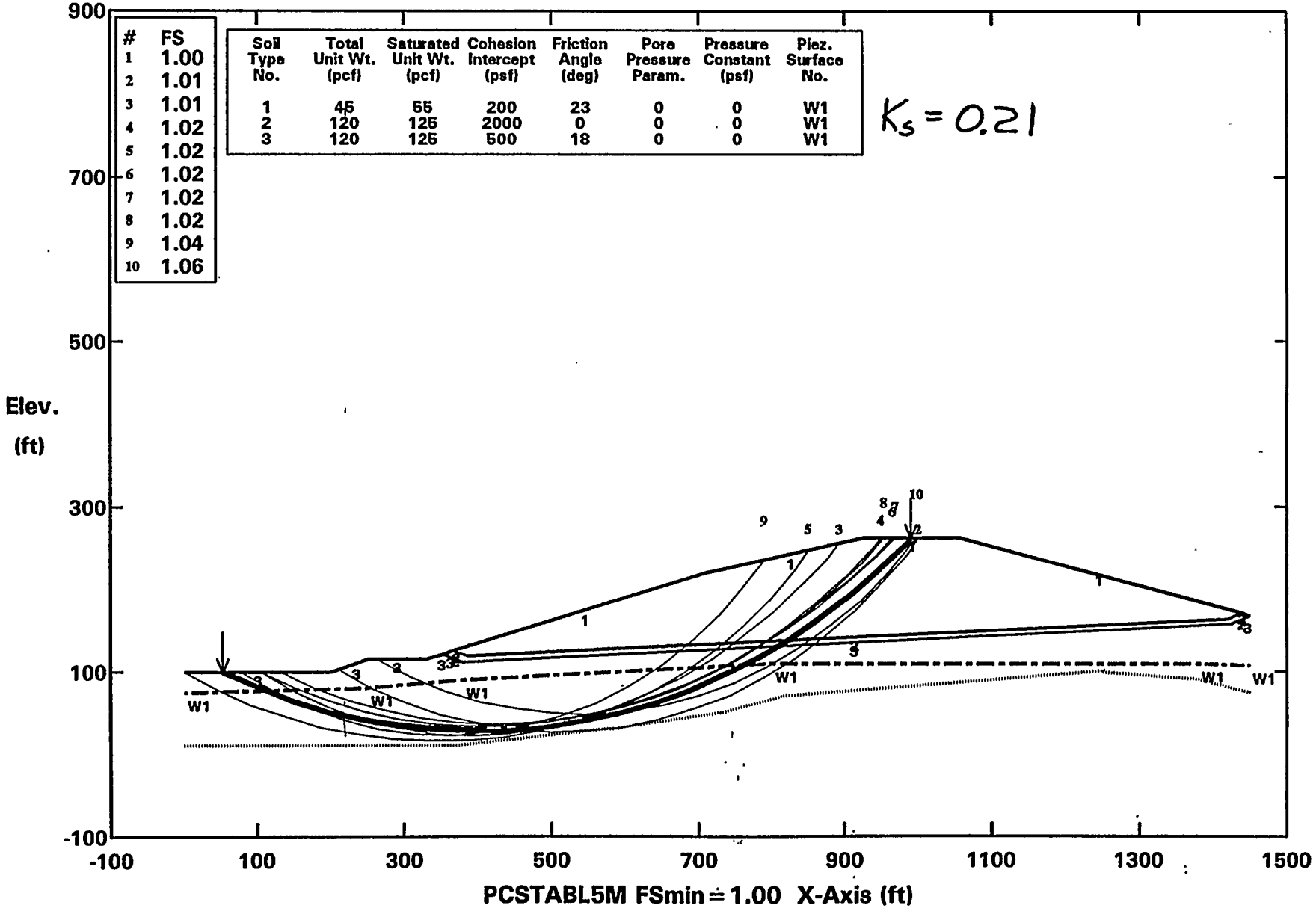
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C8D.PLT By: DAVID TSO 03-25-95 4:17pm

#	FS
1	1.00
2	1.01
3	1.01
4	1.02
5	1.02
6	1.02
7	1.02
8	1.02
9	1.04
10	1.06

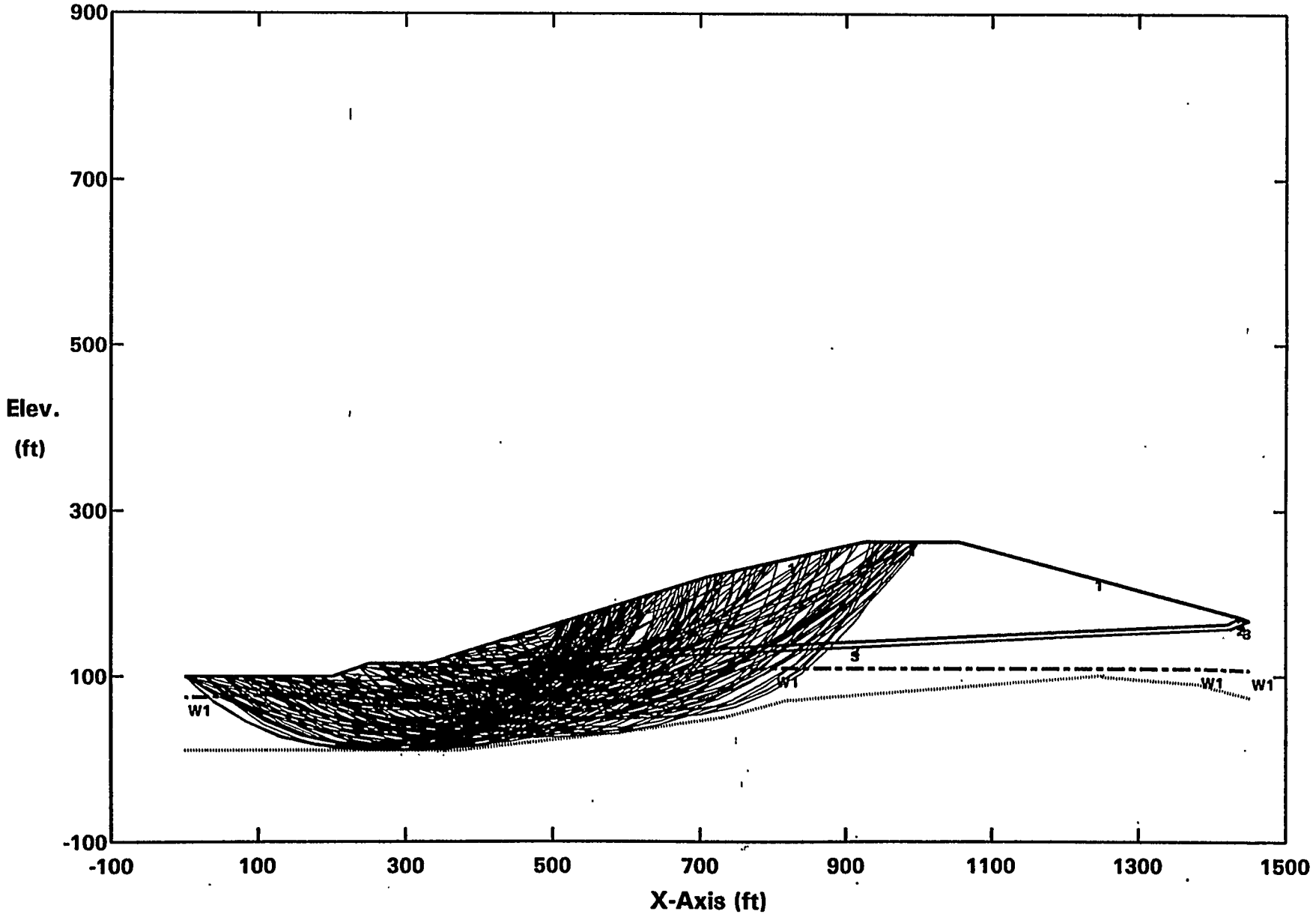
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	500	18	0	0	W1

$K_s = 0.21$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C8E.PLT By: DAVID TSO 03-25-95 4:17pm



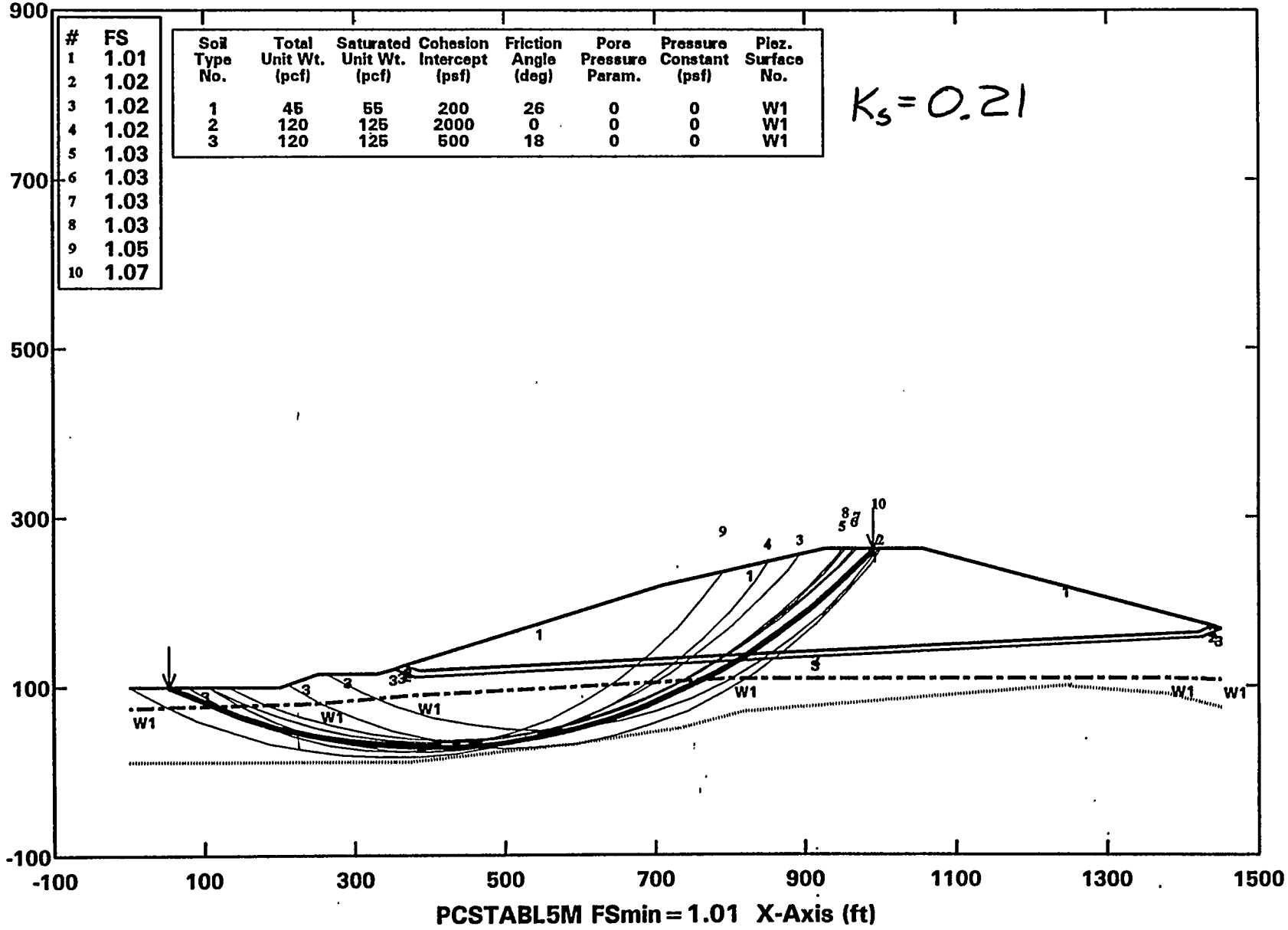
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C8E.PLT By: DAVID TSO 03-25-95 4:17pm

#	FS
1	1.01
2	1.02
3	1.02
4	1.02
5	1.03
6	1.03
7	1.03
8	1.03
9	1.05
10	1.07

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	26	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	500	18	0	0	W1

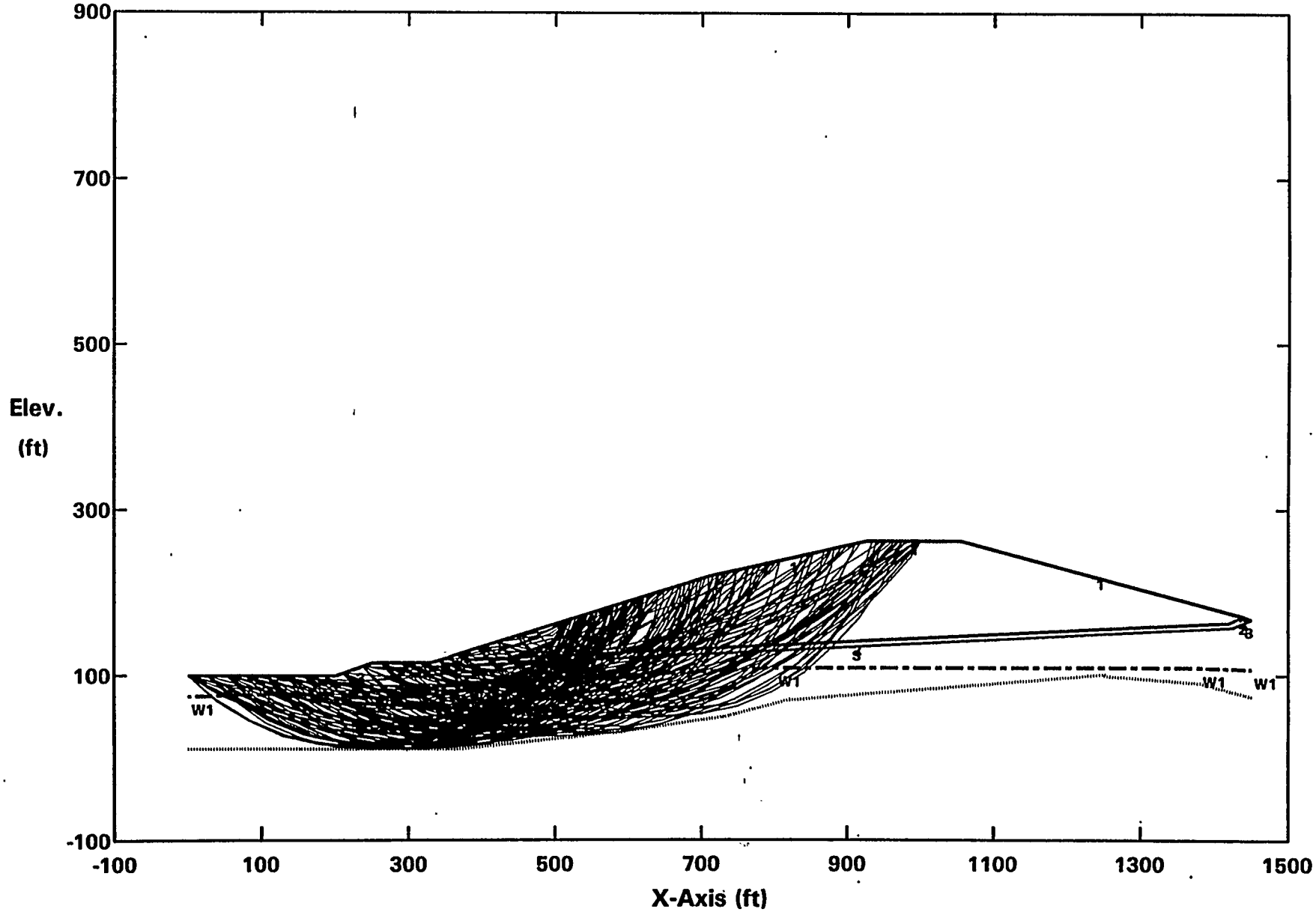
$K_s = 0.21$



A33

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C9.PLT By: DAVID TSO 03-25-95 4:18pm



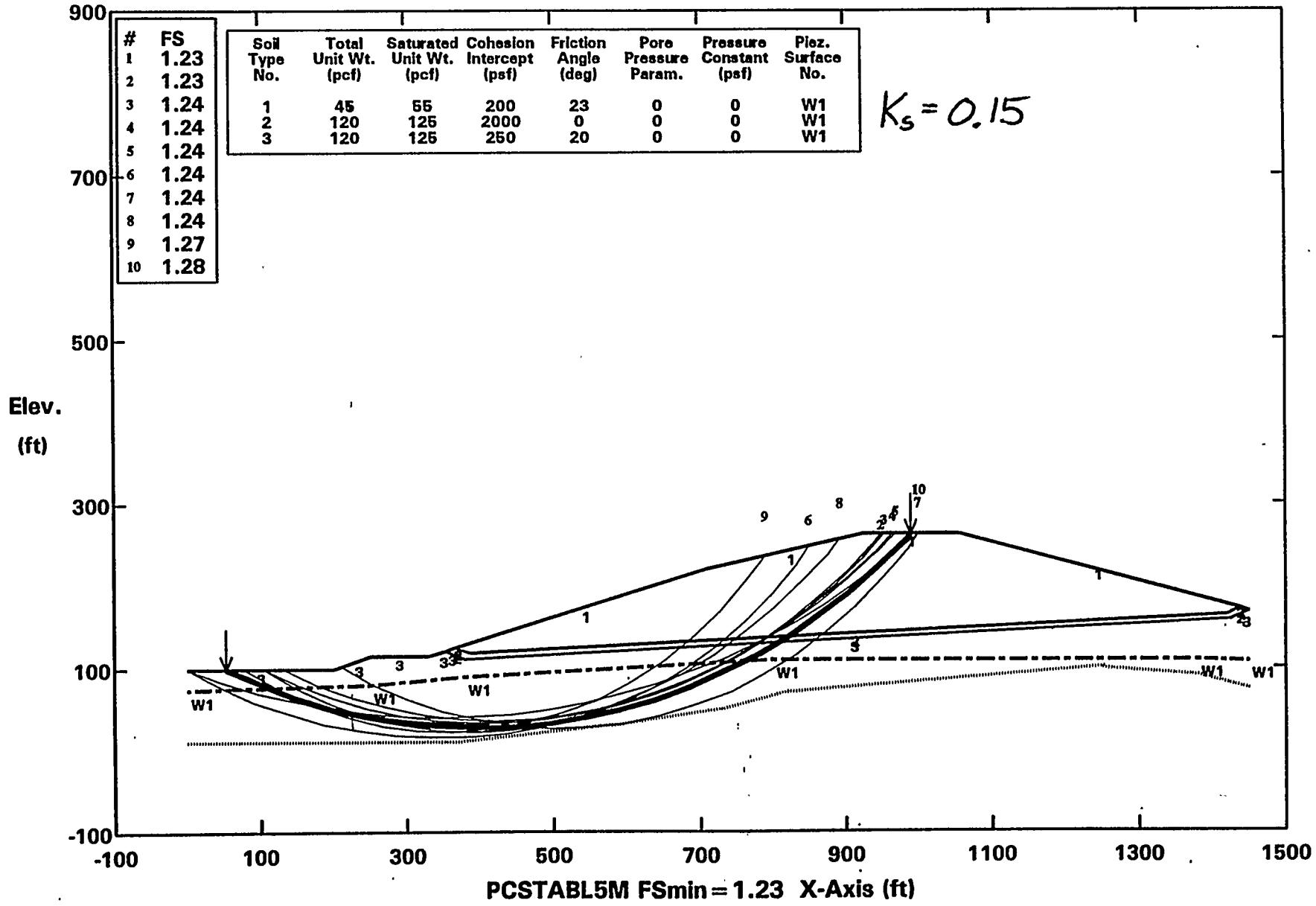
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C9.PLT By: DAVID TSO 03-25-95 4:18pm

#	FS
1	1.23
2	1.23
3	1.24
4	1.24
5	1.24
6	1.24
7	1.24
8	1.24
9	1.27
10	1.28

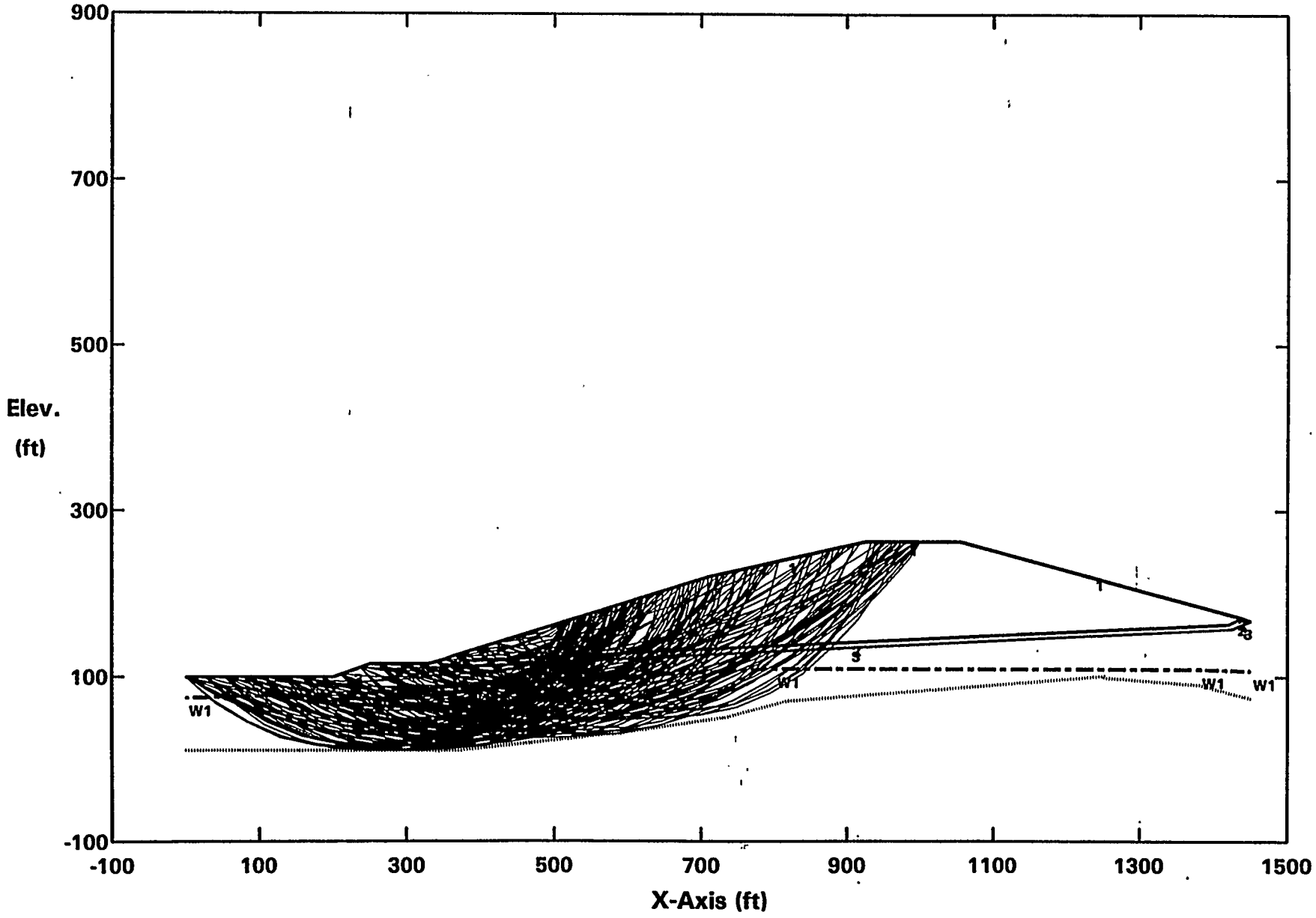
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	250	20	0	0	W1

$K_s = 0.15$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C9A.PLT By: DAVID TSO 03-25-95 4:19pm



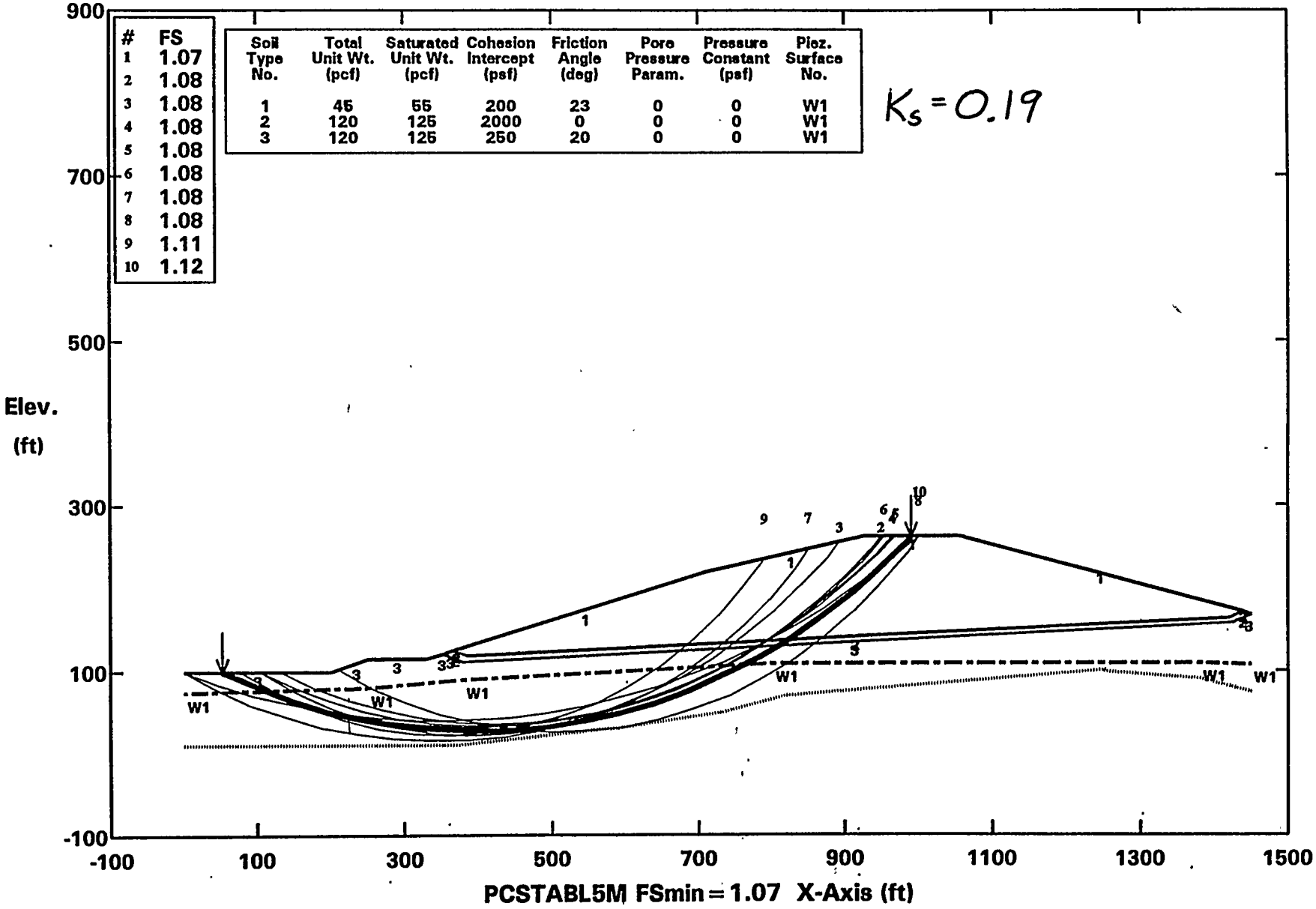
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C9A.PLT By: DAVID TSO 03-25-95 4:19pm

#	FS
1	1.07
2	1.08
3	1.08
4	1.08
5	1.08
6	1.08
7	1.08
8	1.08
9	1.11
10	1.12

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	250	20	0	0	W1

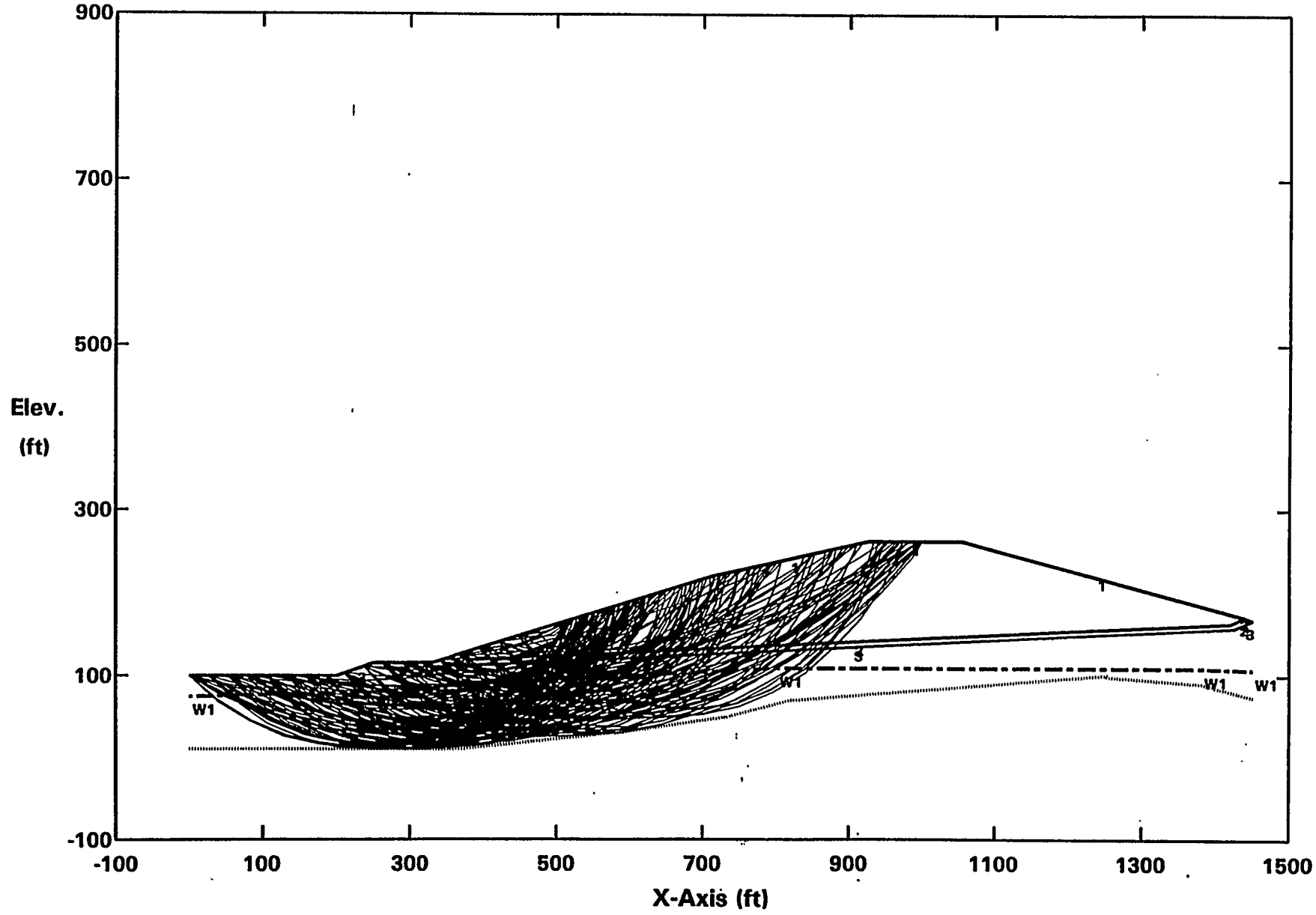
$K_s = 0.19$



A37

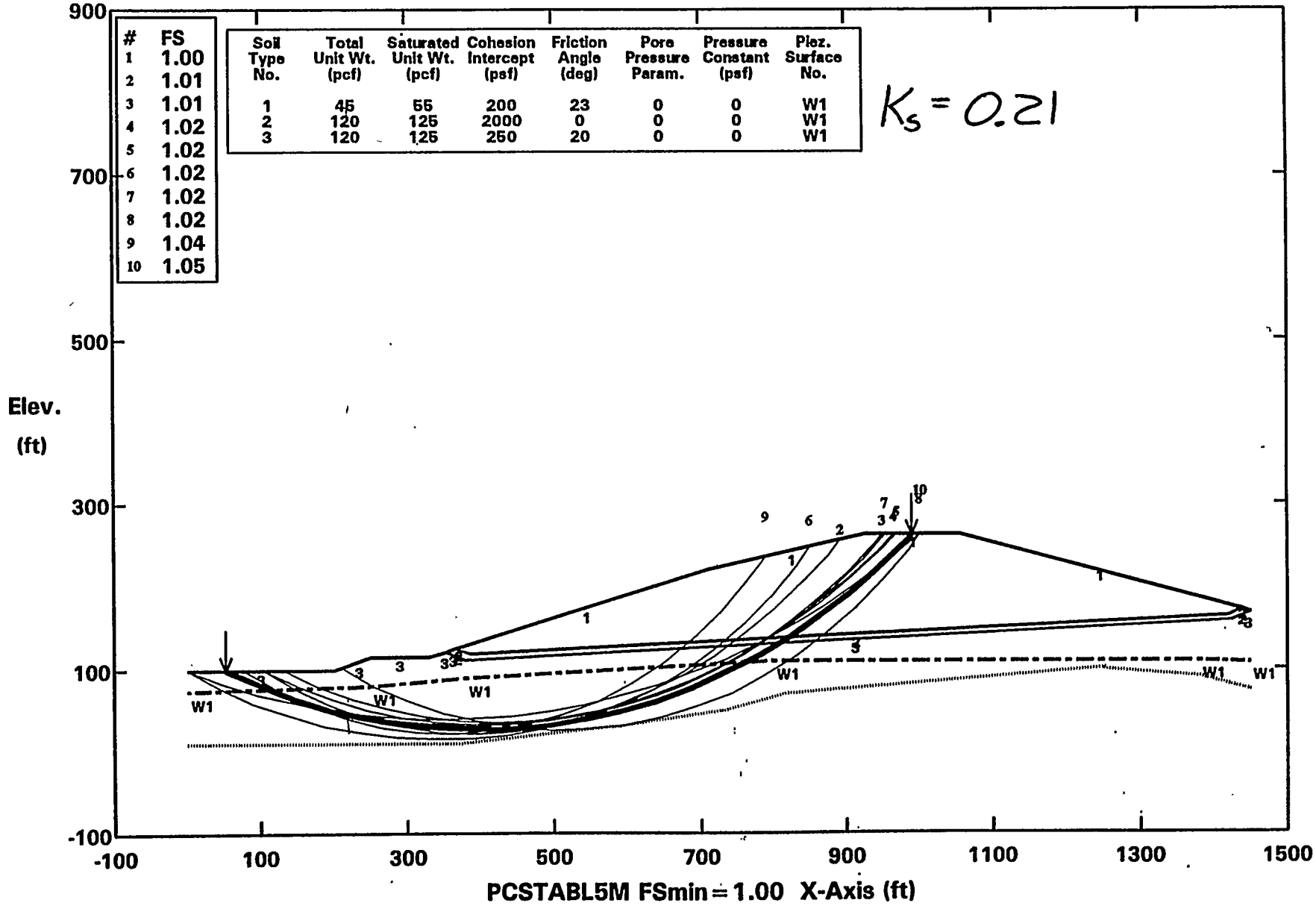
Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C9B.PLT By: DAVID TSO 03-25-95 4:20pm



Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C9B.PLT By: DAVID TSO 03-25-95 4:20pm



#	FS
1	1.00
2	1.01
3	1.01
4	1.02
5	1.02
6	1.02
7	1.02
8	1.02
9	1.04
10	1.05

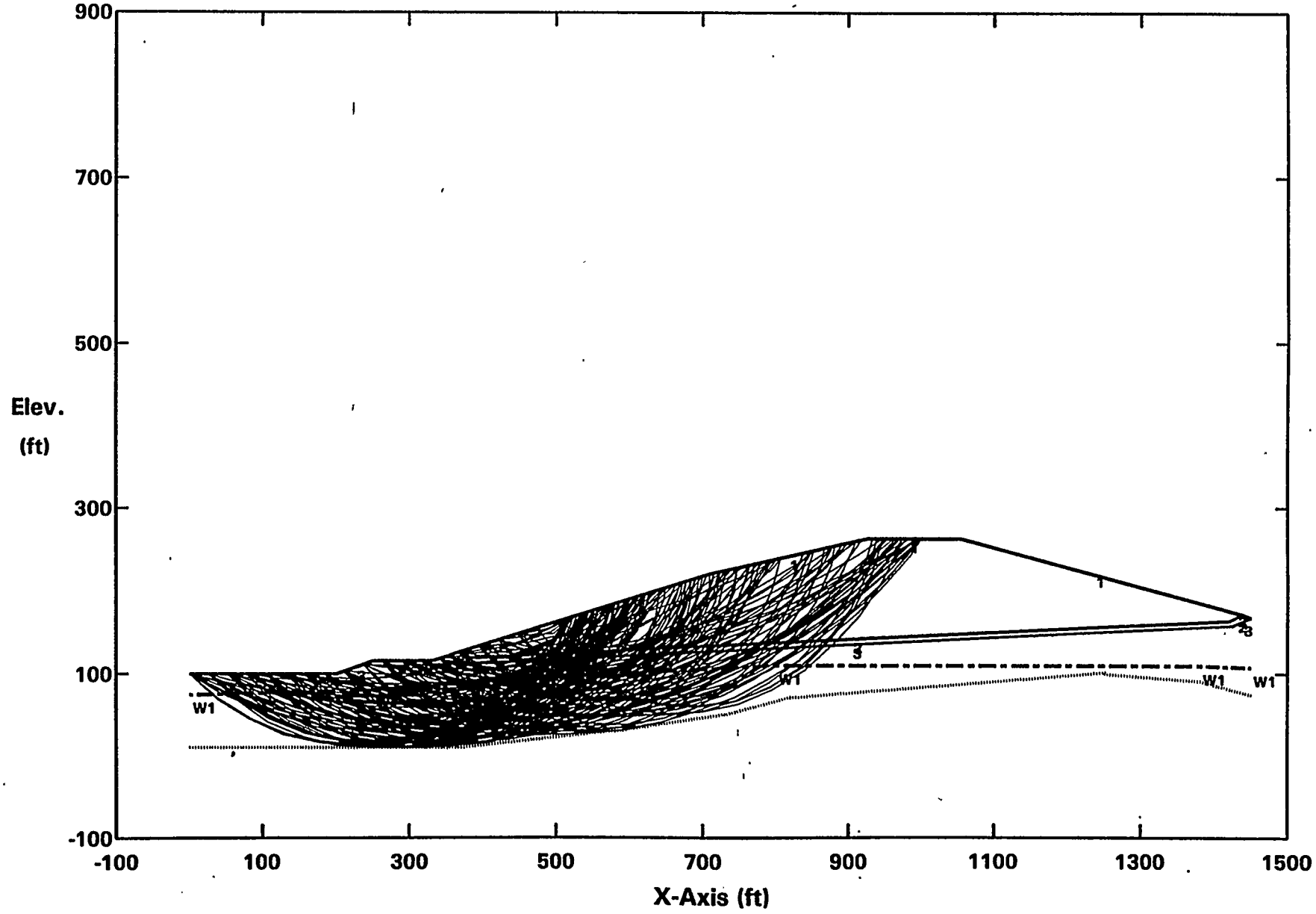
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	250	20	0	0	W1

$K_s = 0.21$

A39

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C10.PLT By: DAVID TSO 03-25-95 4:08pm



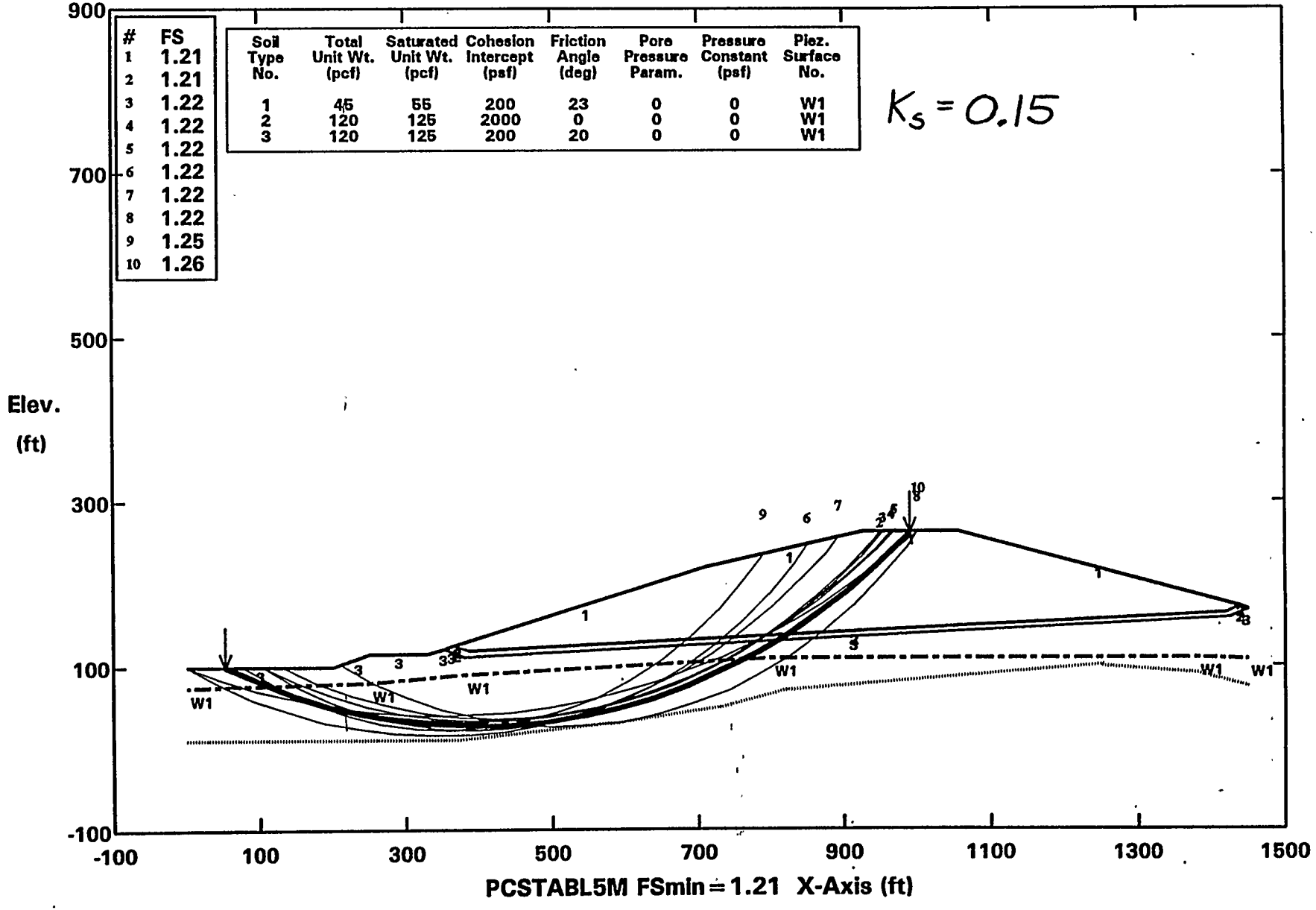
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C10.PLT By: DAVID TSO 03-25-95 4:08pm

#	FS
1	1.21
2	1.21
3	1.22
4	1.22
5	1.22
6	1.22
7	1.22
8	1.22
9	1.25
10	1.26

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	200	20	0	0	W1

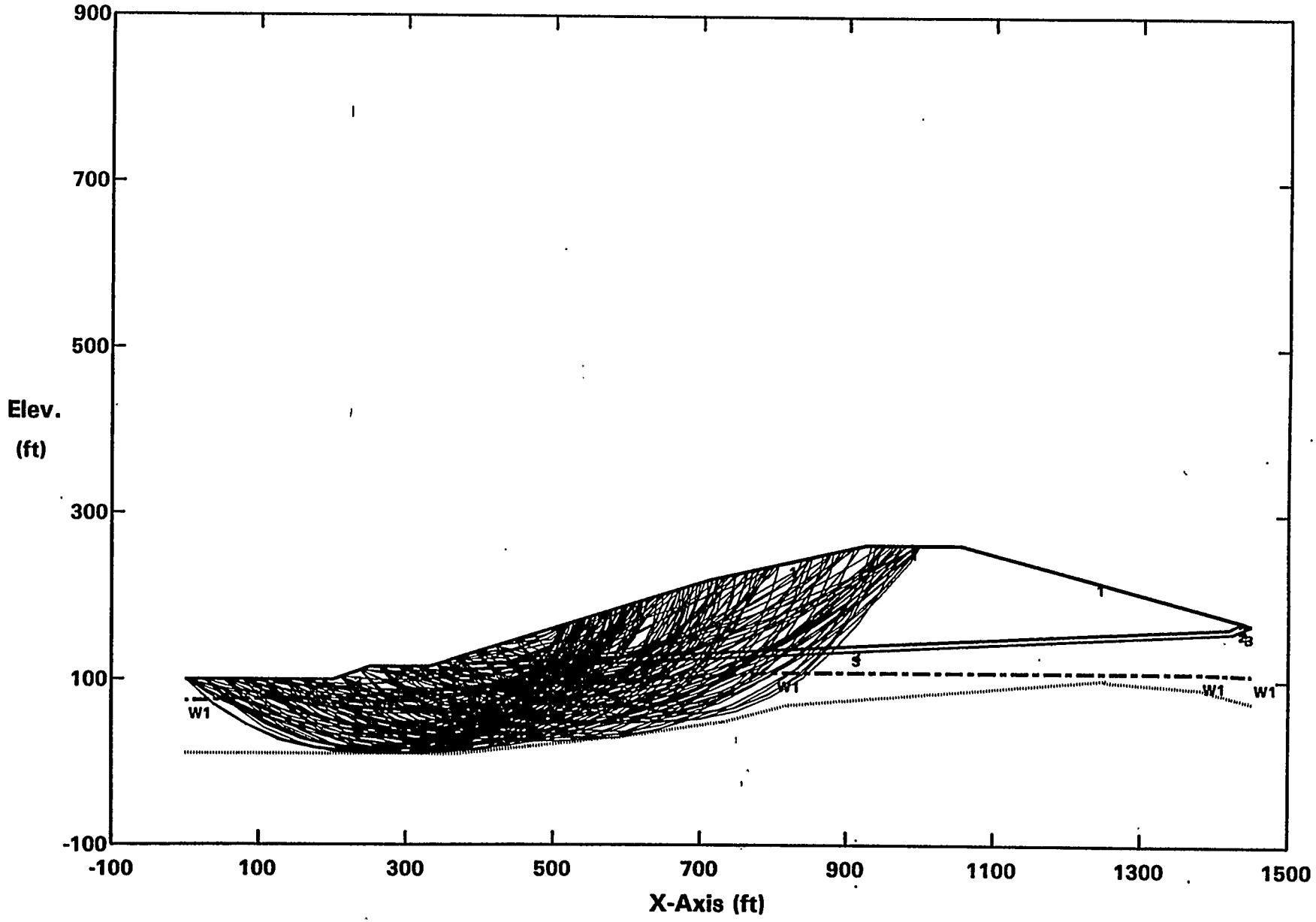
$K_s = 0.15$



A41

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C10A.PLT By: DAVID TSO 03-25-95 4:10pm



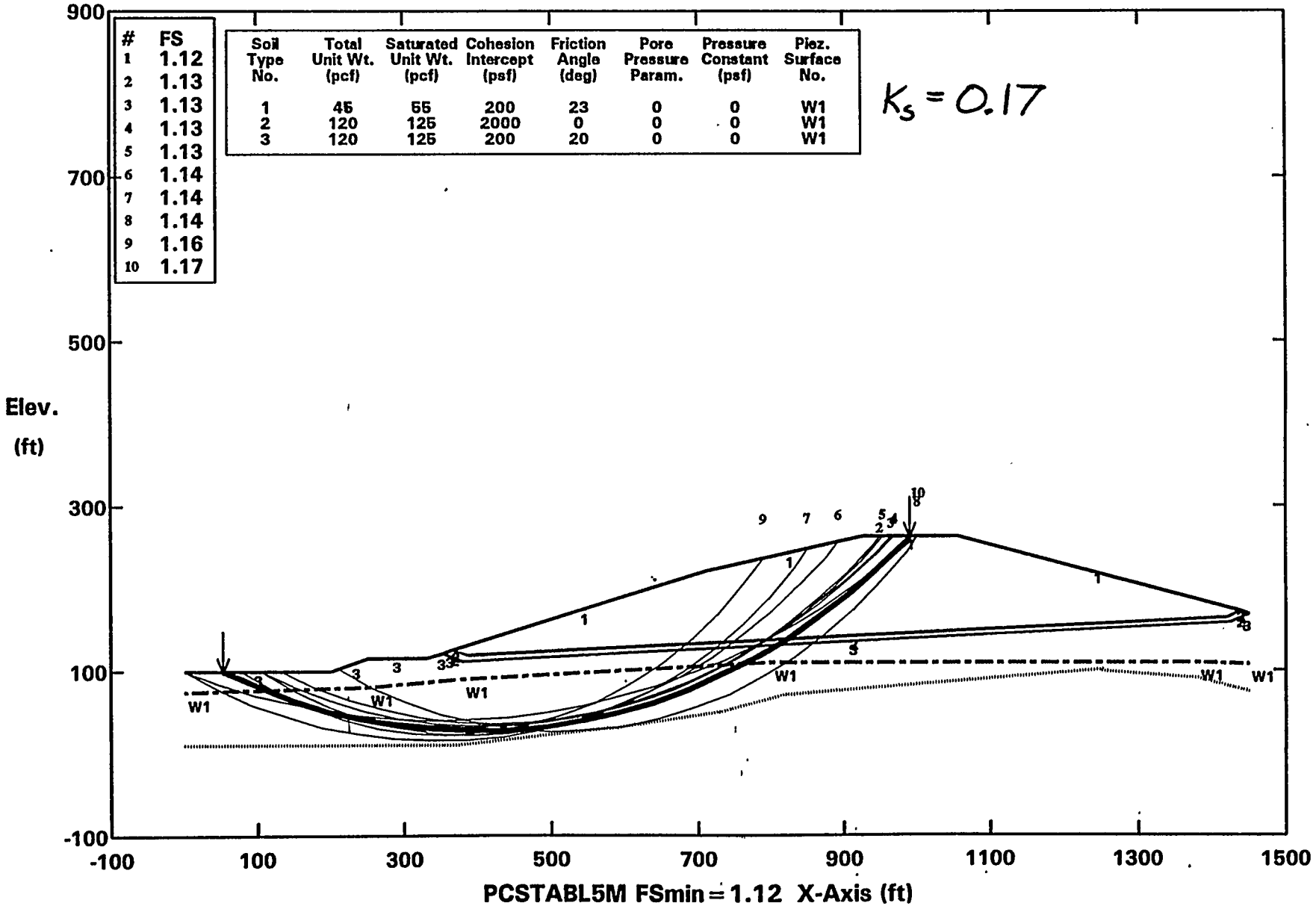
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C10A.PLT By: DAVID TSO 03-25-95 4:10pm

#	FS
1	1.12
2	1.13
3	1.13
4	1.13
5	1.13
6	1.14
7	1.14
8	1.14
9	1.16
10	1.17

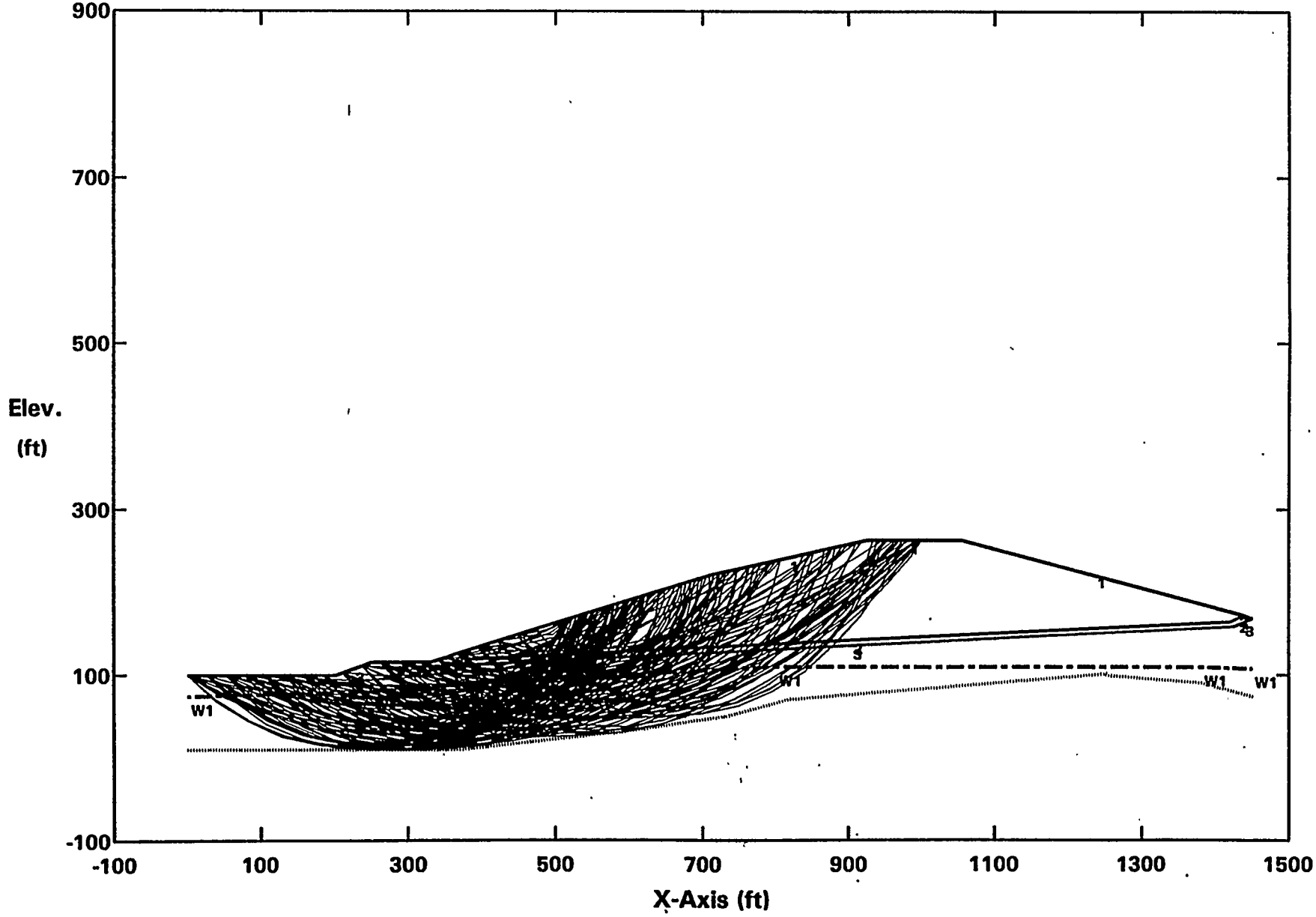
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	200	20	0	0	W1

$K_s = 0.17$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:C10B.PLT By: DAVID TSO 03-25-95 4:11pm



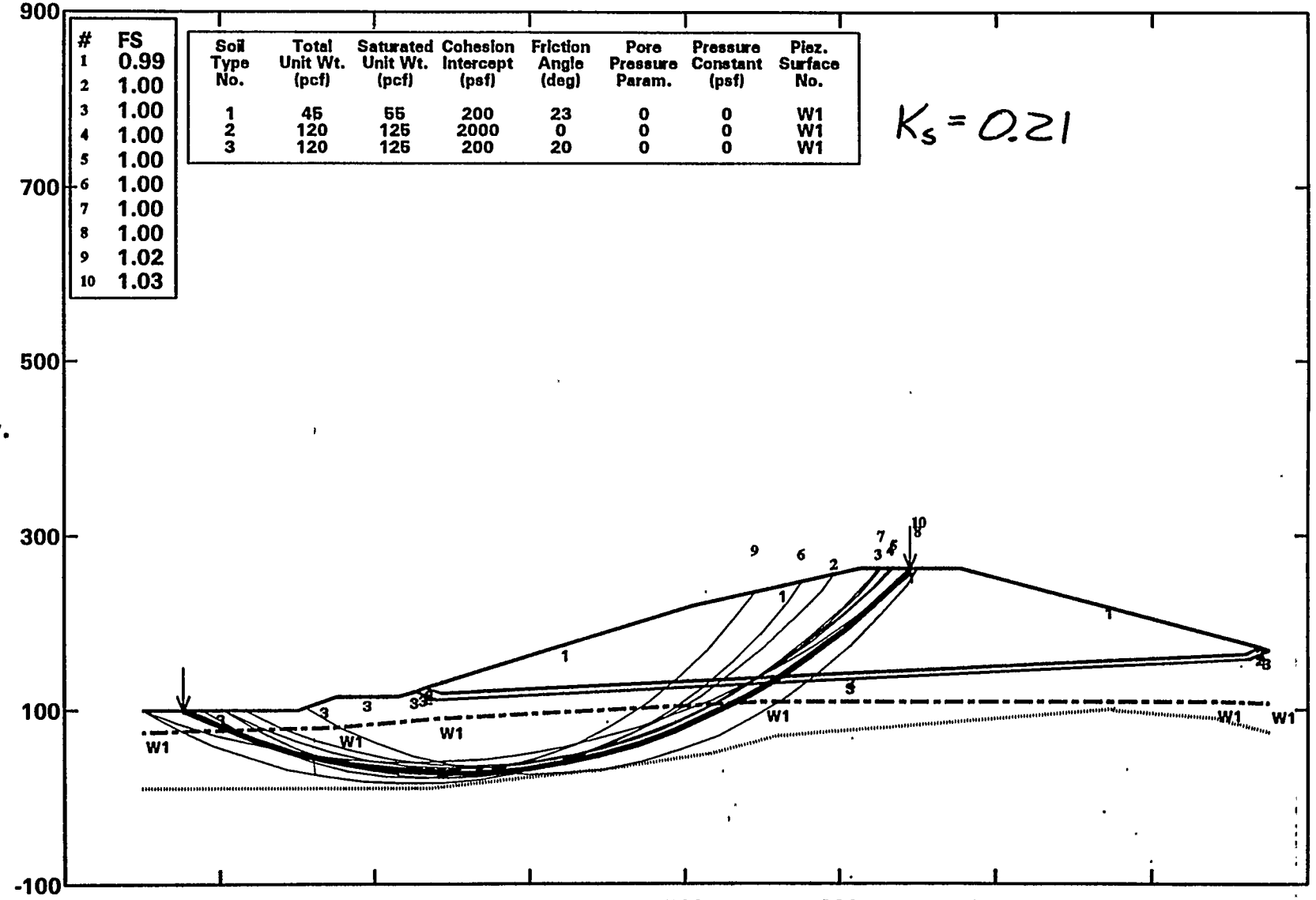
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:C10B.PLT By: DAVID TSO 03-25-95 4:11pm

#	FS
1	0.99
2	1.00
3	1.00
4	1.00
5	1.00
6	1.00
7	1.00
8	1.00
9	1.02
10	1.03

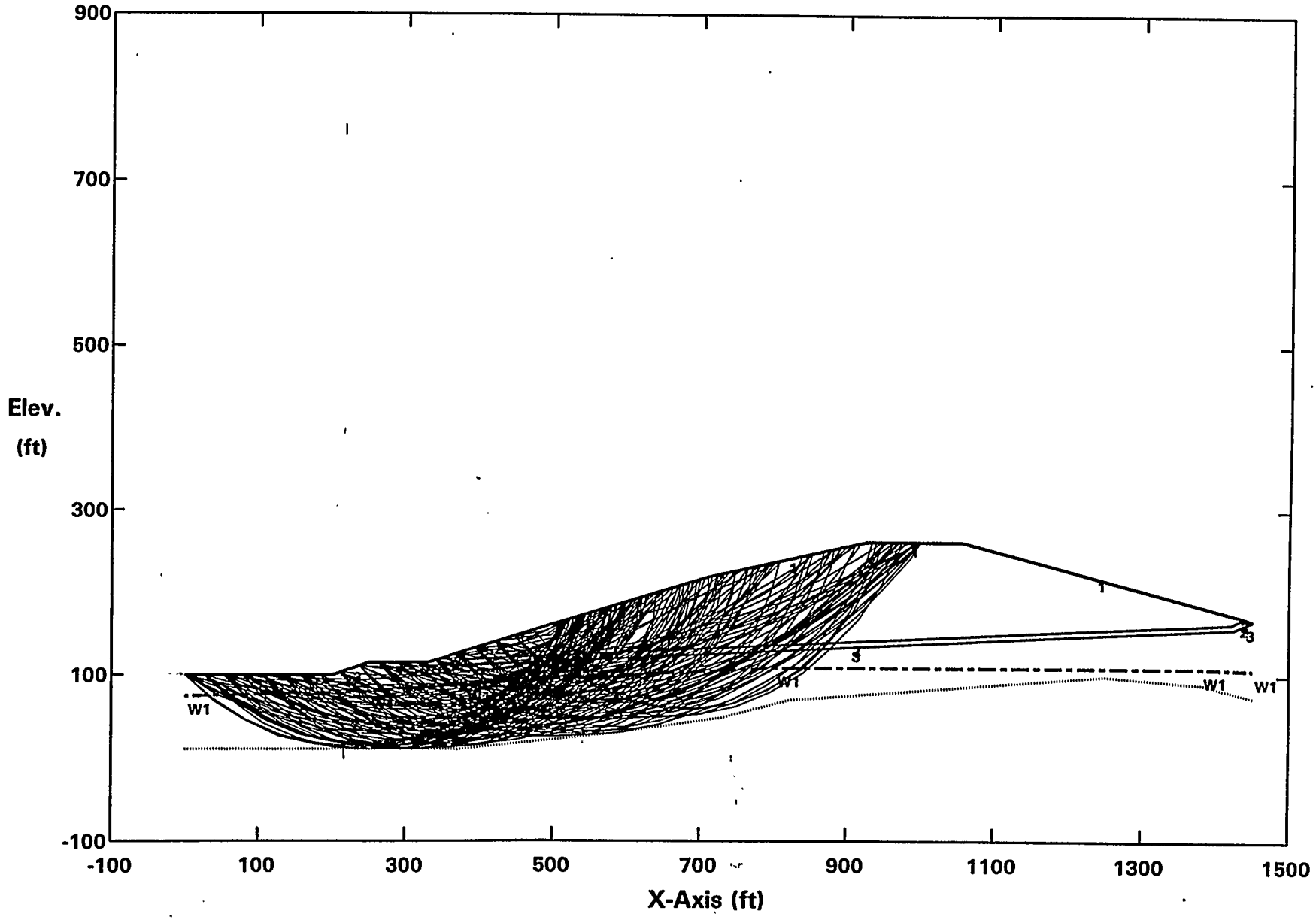
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	120	125	2000	0	0	0	W1
3	120	125	200	20	0	0	W1

$K_s = 0.21$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. A:C11.PLT By: DAVID TSO 06-26-95 2:02pm



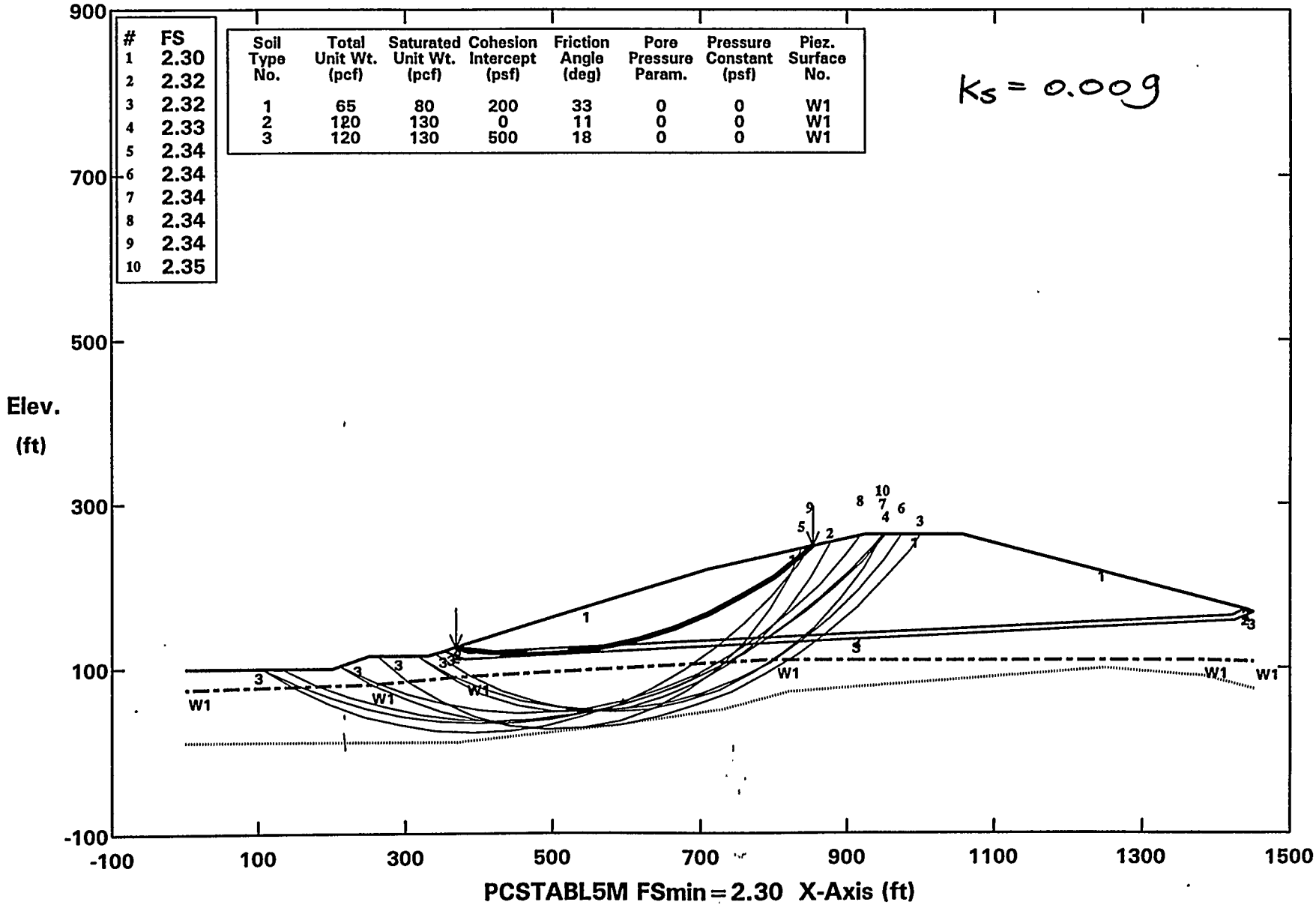
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. A:C11.PLT By: DAVID TSO 06-26-95 2:02pm

#	FS
1	2.30
2	2.32
3	2.32
4	2.33
5	2.34
6	2.34
7	2.34
8	2.34
9	2.34
10	2.35

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	65	80	200	33	0	0	W1
2	120	130	0	11	0	0	W1
3	120	130	500	18	0	0	W1

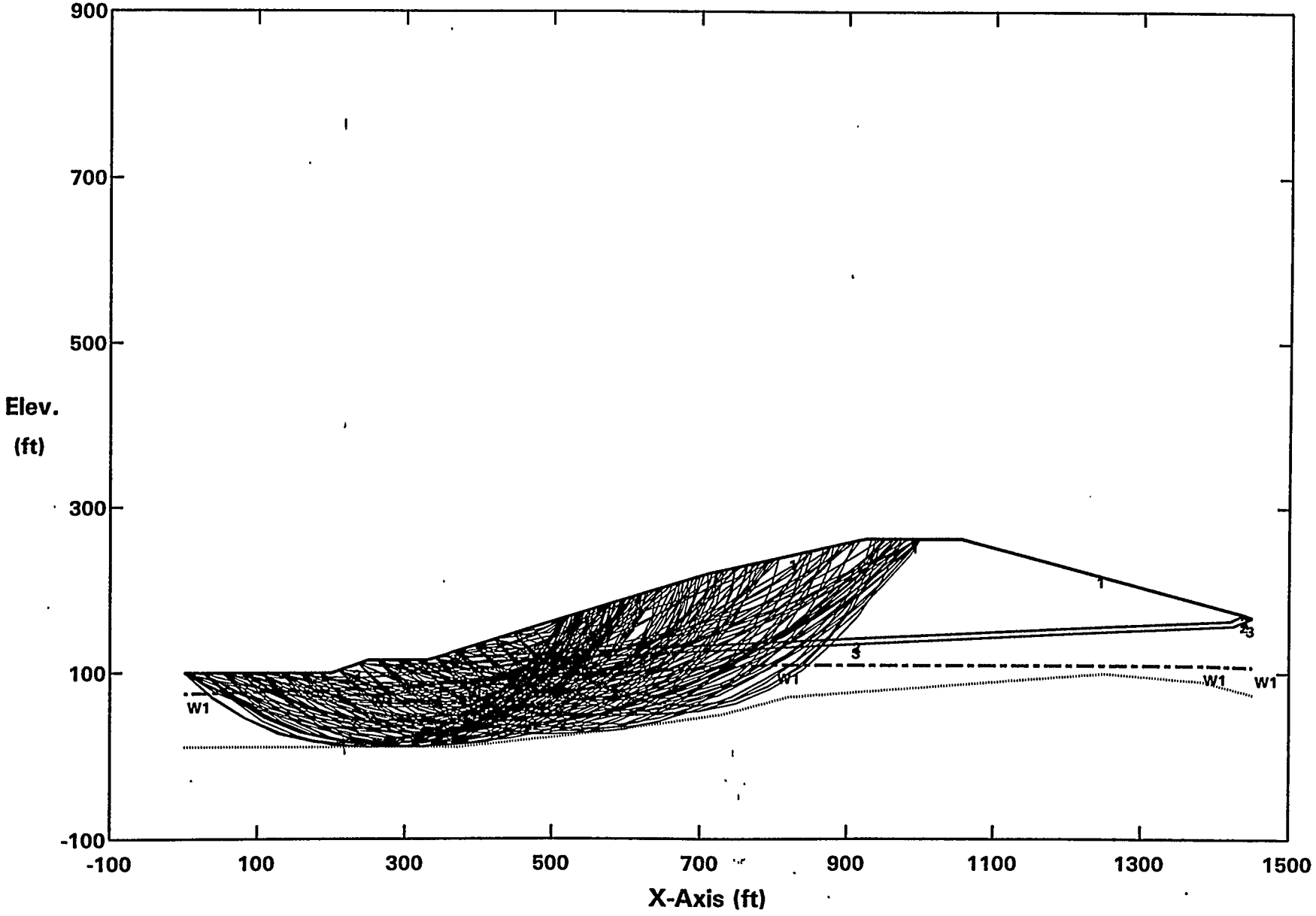
$K_s = 0.009$



PCSTABL5M FSmin = 2.30 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. A:C11A.PLT By: DAVID TSO 06-26-95 1:53pm



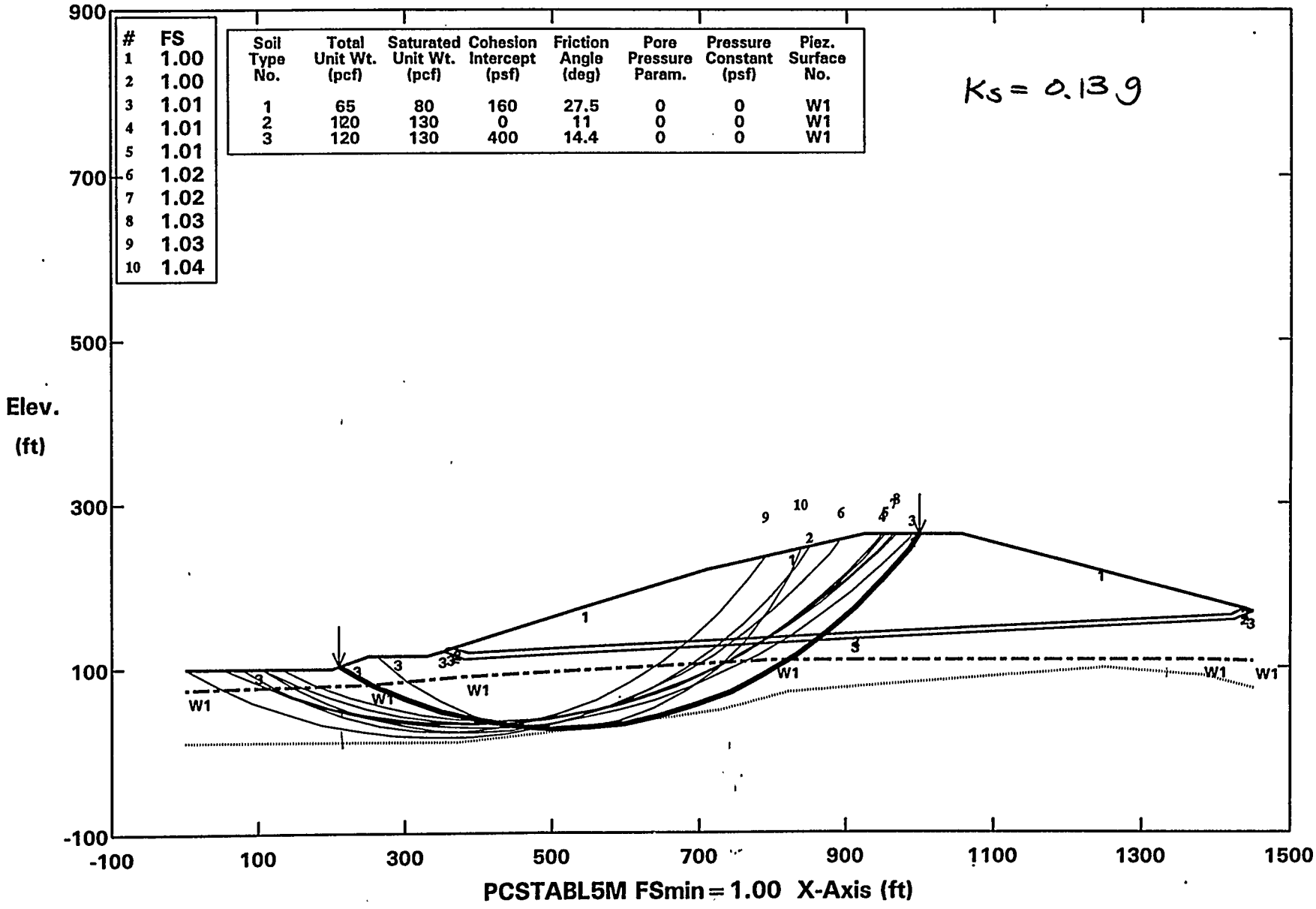
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. A:C11A.PLT By: DAVID TSO 06-26-95 1:53pm

#	FS
1	1.00
2	1.00
3	1.01
4	1.01
5	1.01
6	1.02
7	1.02
8	1.03
9	1.03
10	1.04

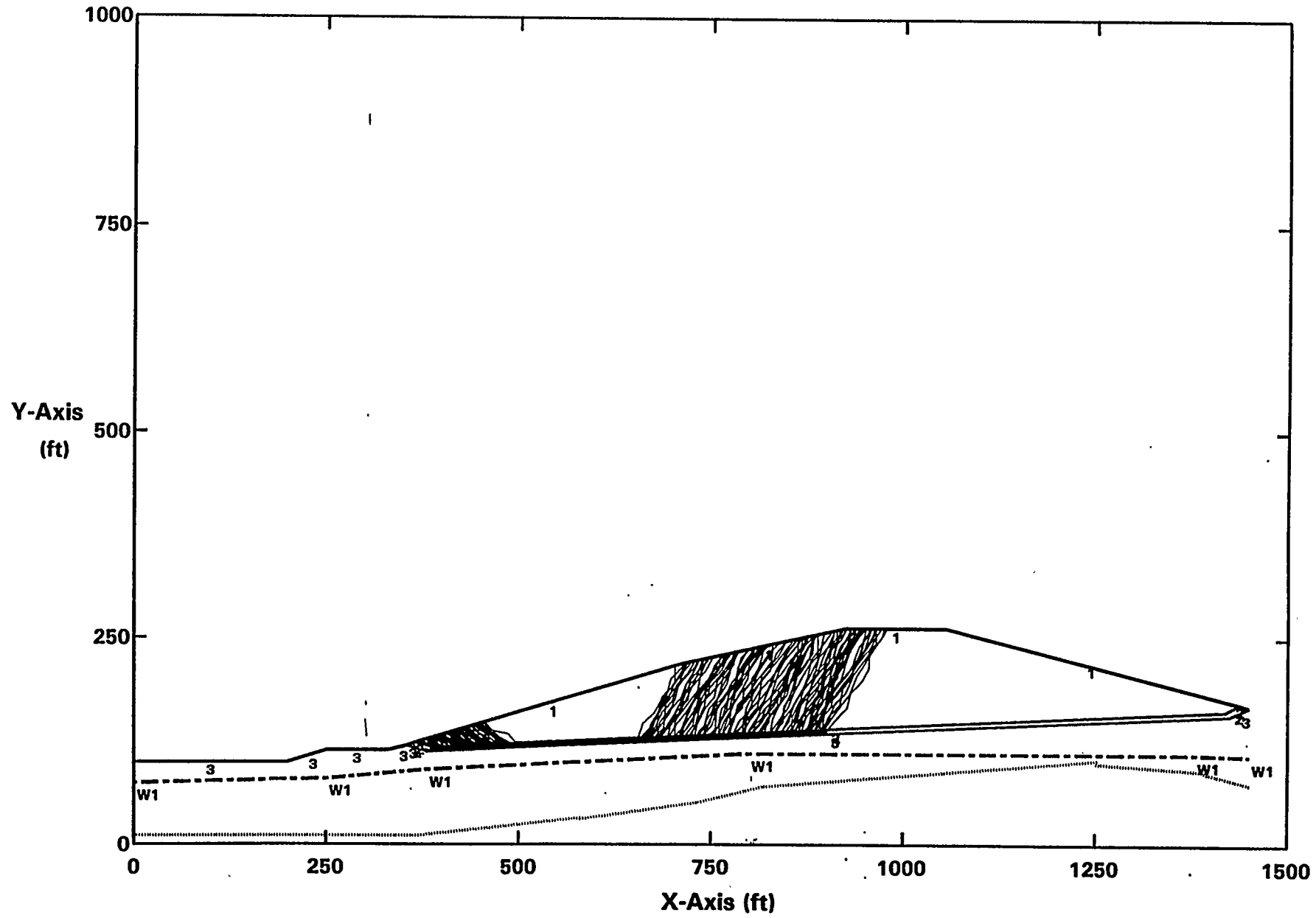
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	65	80	160	27.5	0	0	W1
2	120	130	0	11	0	0	W1
3	120	130	400	14.4	0	0	W1

$K_s = 0.139$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B1.PLT By: DAVID TSO 03-06-95 4:03pm



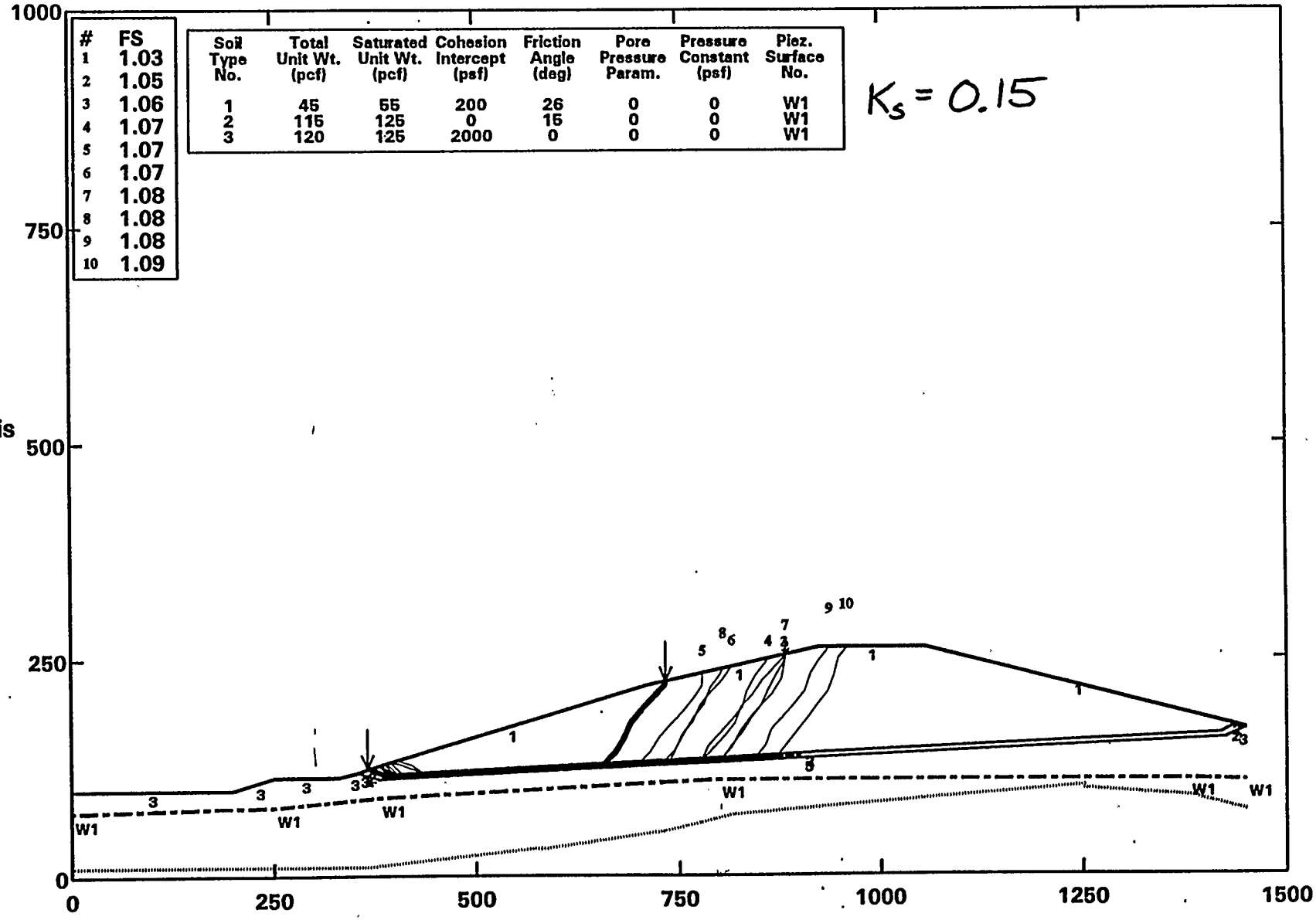
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B1.PLT By: DAVID TSO 03-06-95 4:03pm

#	FS
1	1.03
2	1.05
3	1.06
4	1.07
5	1.07
6	1.07
7	1.08
8	1.08
9	1.08
10	1.09

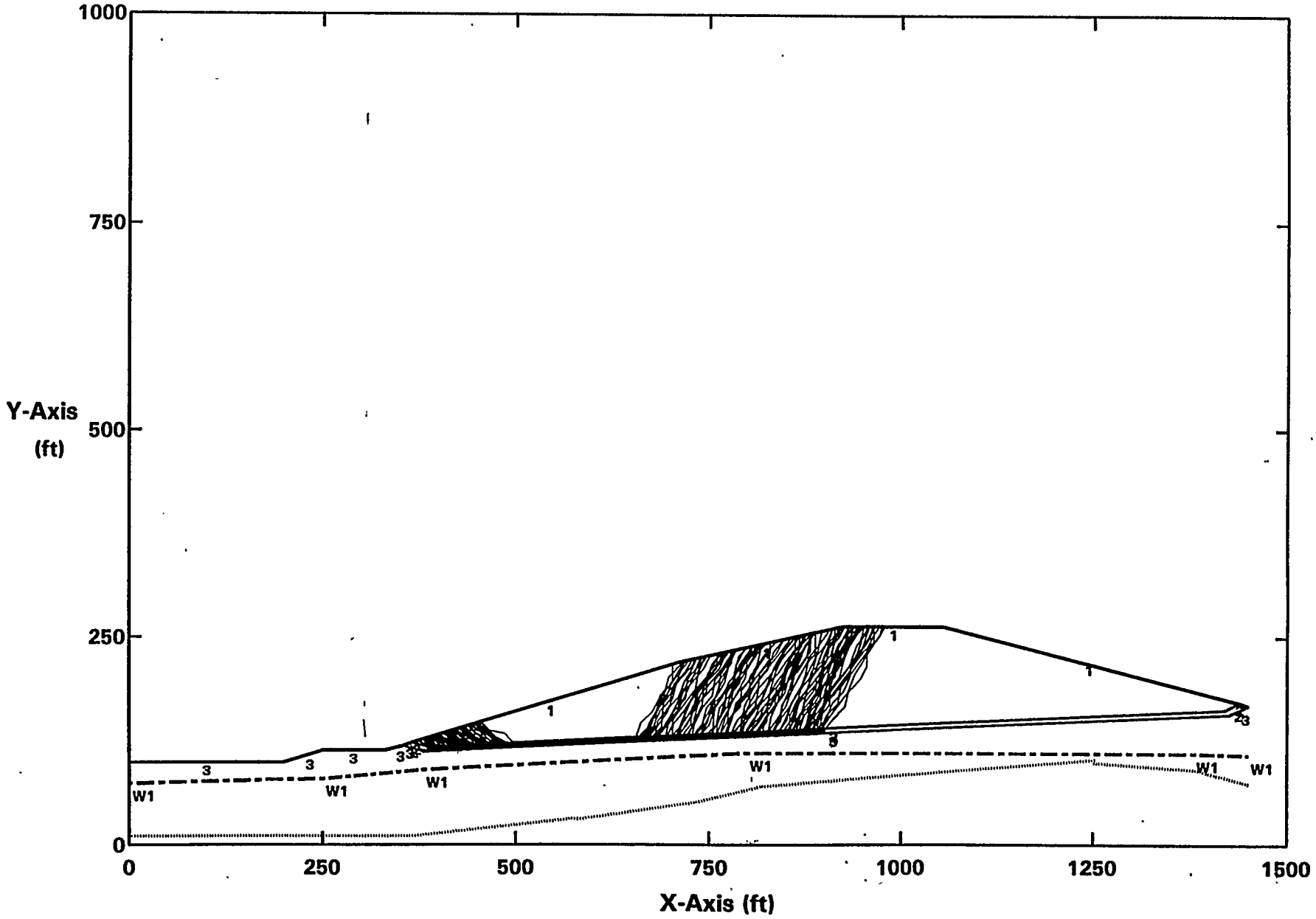
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	26	0	0	W1
2	115	125	0	15	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.15$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B1A.PLT By: DAVID TSO 03-09-95 2:04pm



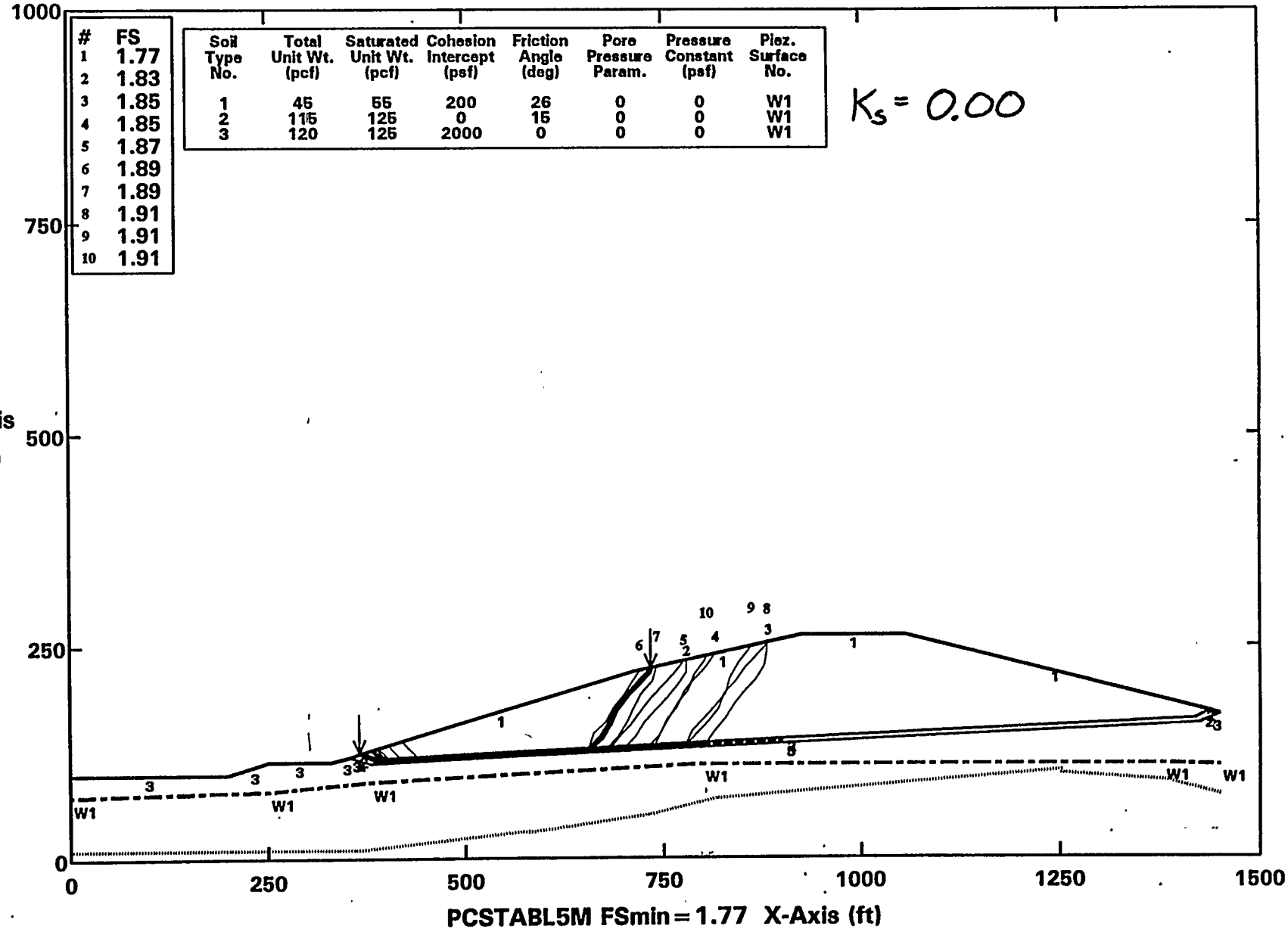
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B1A.PLT By: DAVID TSO 03-09-95 2:04pm

#	FS
1	1.77
2	1.83
3	1.85
4	1.85
5	1.87
6	1.89
7	1.89
8	1.91
9	1.91
10	1.91

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	26	0	0	W1
2	115	125	0	15	0	0	W1
3	120	125	2000	0	0	0	W1

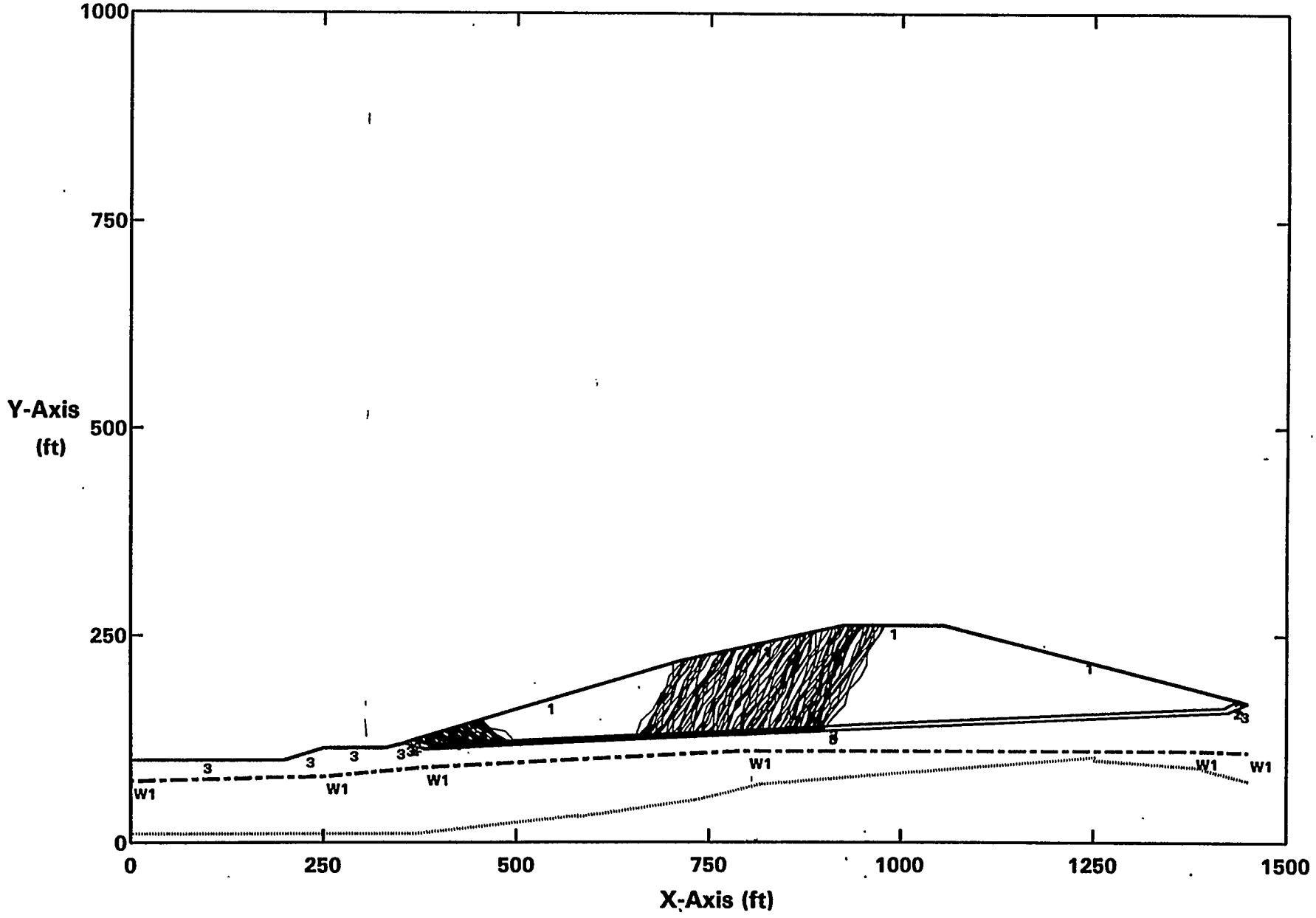
$K_s = 0.00$



PCSTABL5M FSmin = 1.77 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B1B.PLT By: DAVID TSO 03-25-95 3:07pm



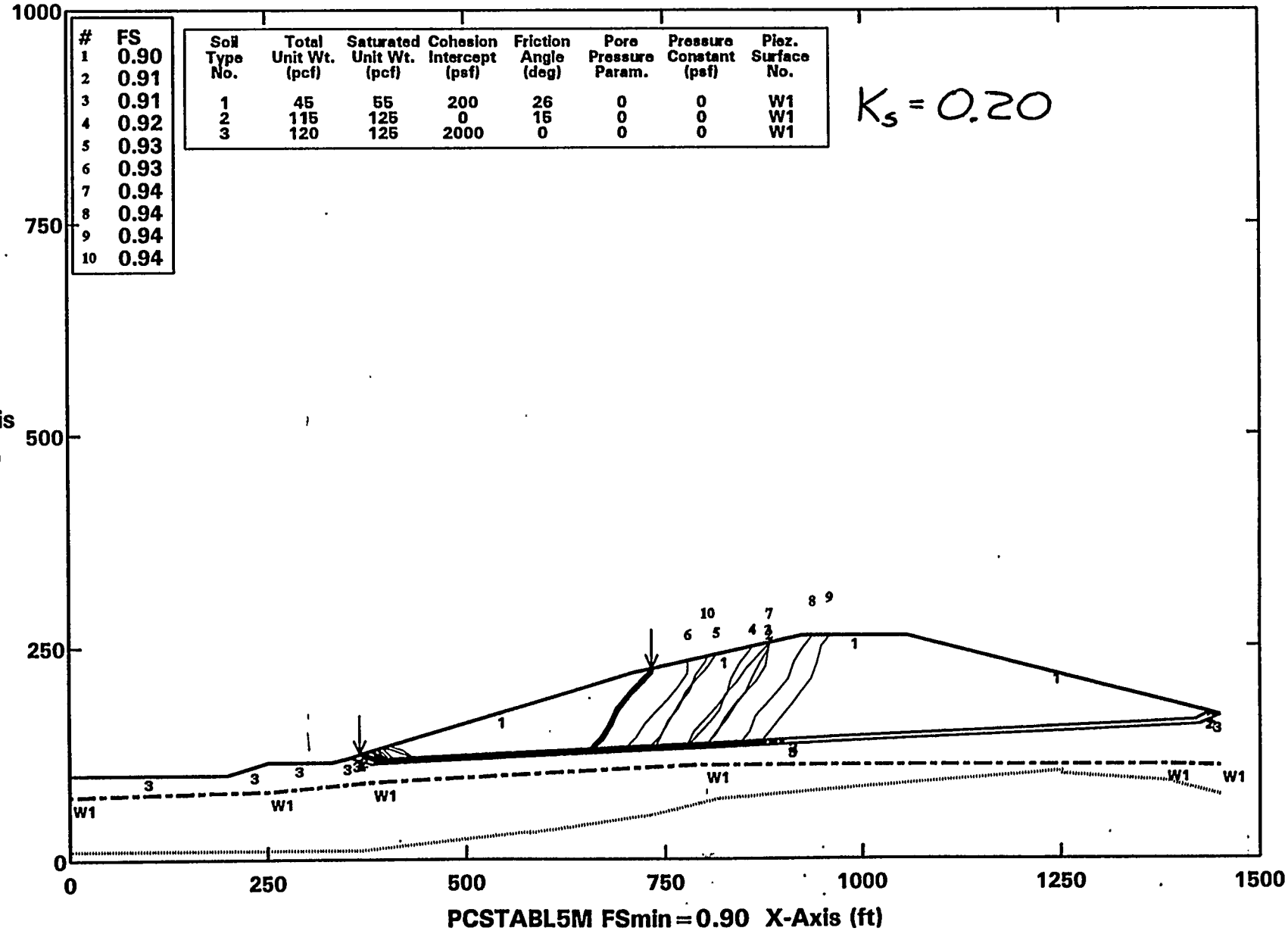
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B1B.PLT By: DAVID TSO 03-25-95 3:07pm

#	FS
1	0.90
2	0.91
3	0.91
4	0.92
5	0.93
6	0.93
7	0.94
8	0.94
9	0.94
10	0.94

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	26	0	0	W1
2	115	125	0	15	0	0	W1
3	120	125	2000	0	0	0	W1

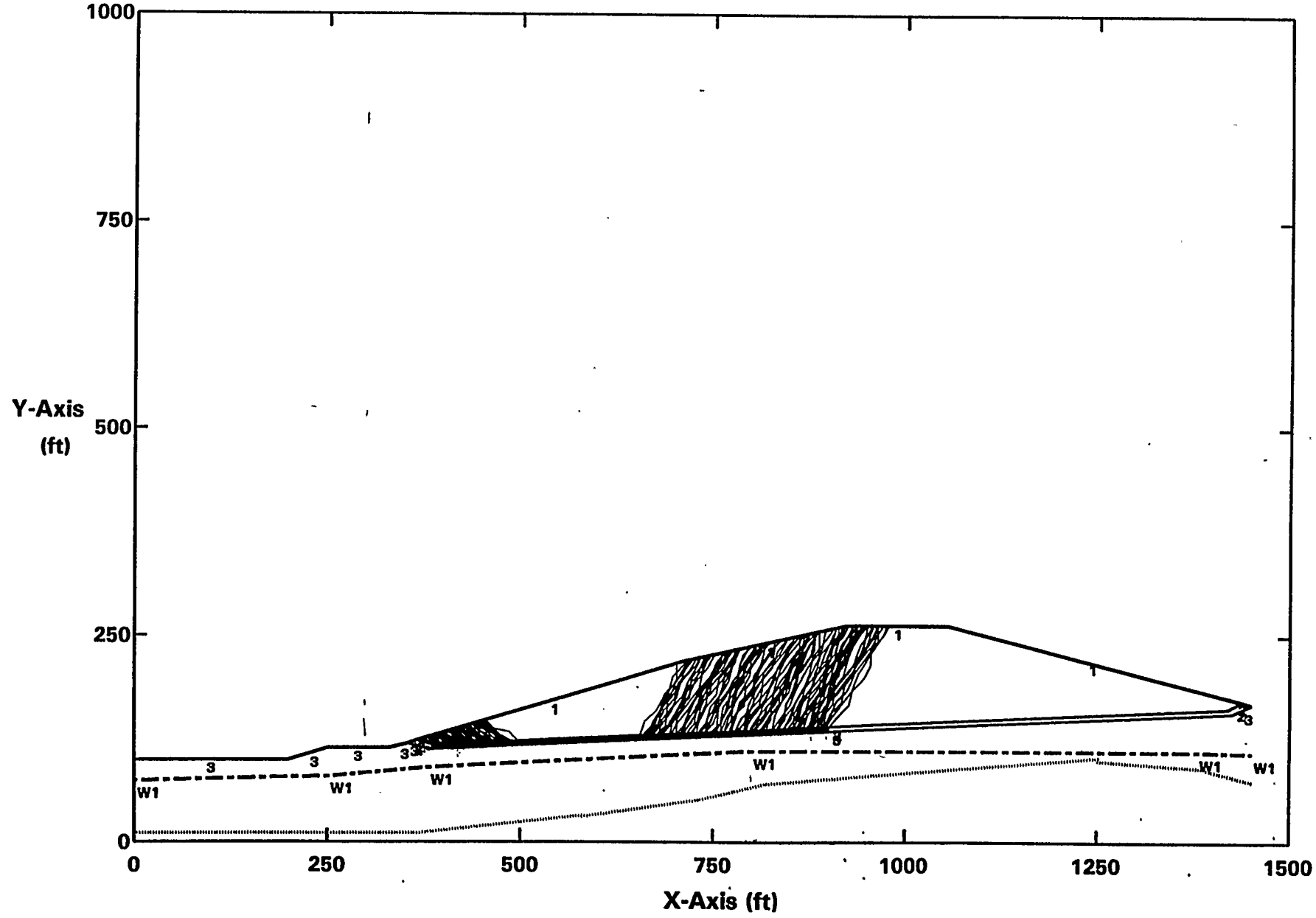
$K_s = 0.20$



PCSTABL5M FSmin = 0.90 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B1C.PLT By: DAVID TSO 03-25-95 3:08pm



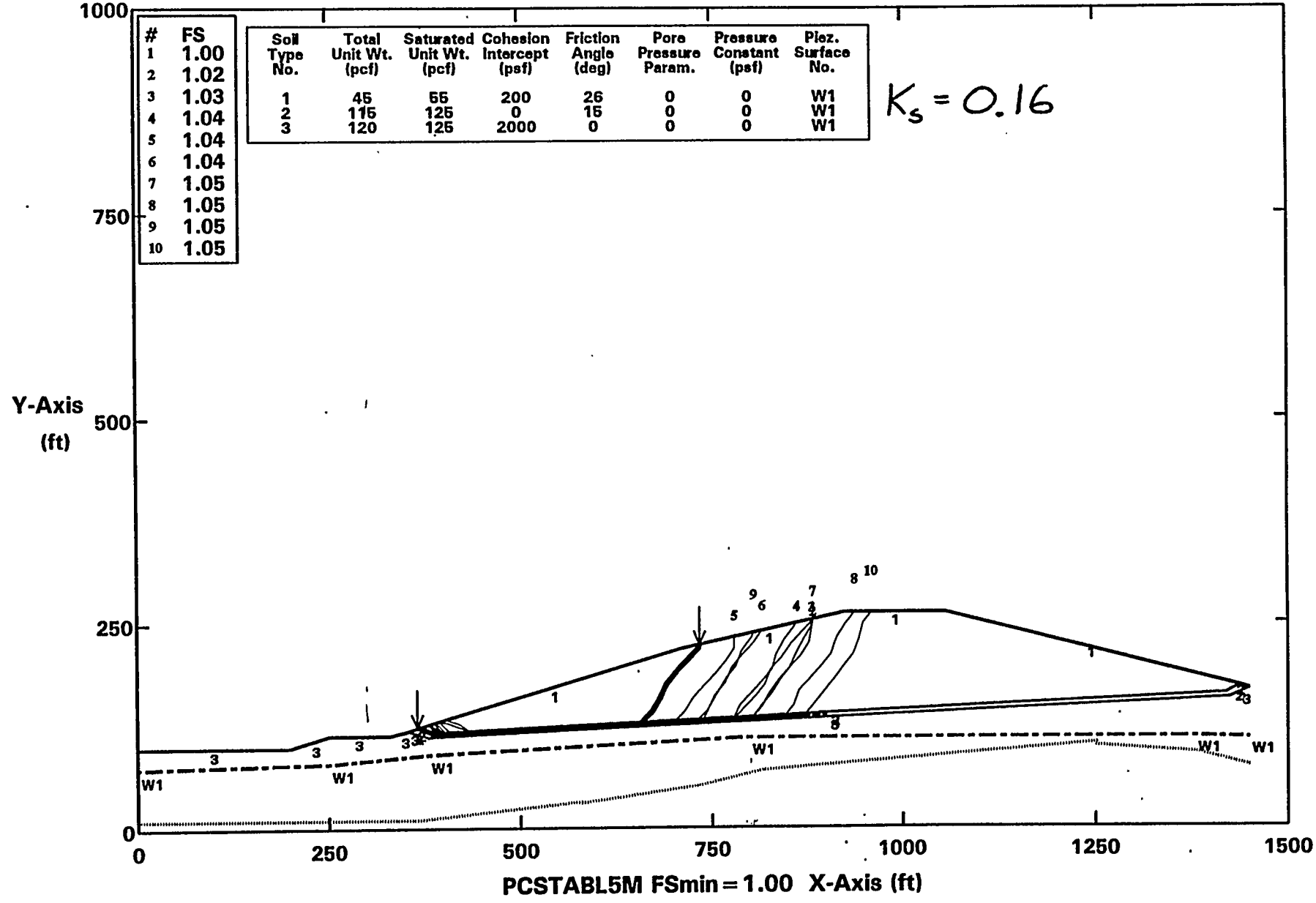
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B1C.PLT By: DAVID TSO 03-25-95 3:08pm

#	FS
1	1.00
2	1.02
3	1.03
4	1.04
5	1.04
6	1.04
7	1.05
8	1.05
9	1.05
10	1.05

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	26	0	0	W1
2	115	125	0	15	0	0	W1
3	120	125	2000	0	0	0	W1

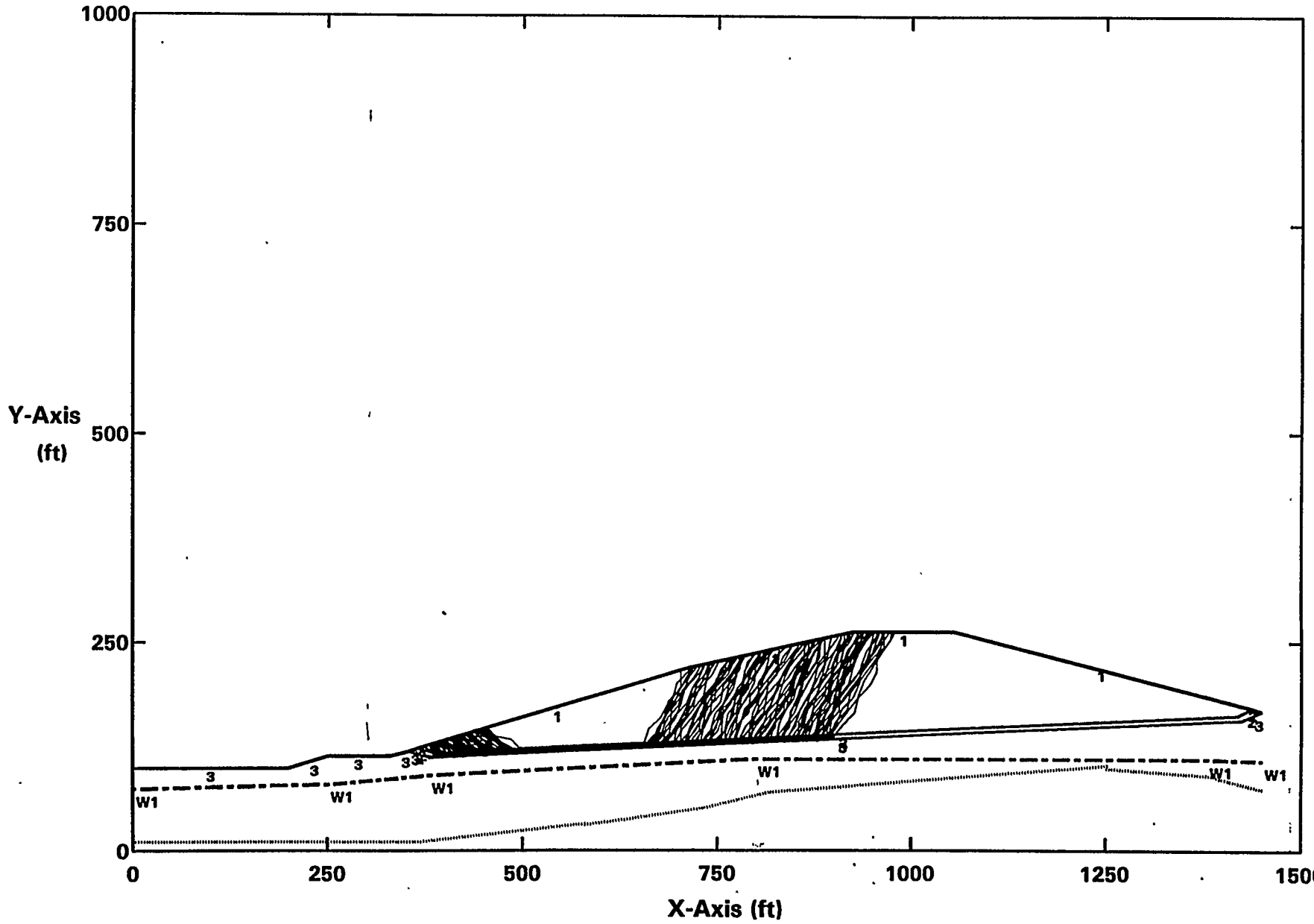
$K_s = 0.16$



A57

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B2.PLT By: DAVID TSO 03-06-95 4:04pm



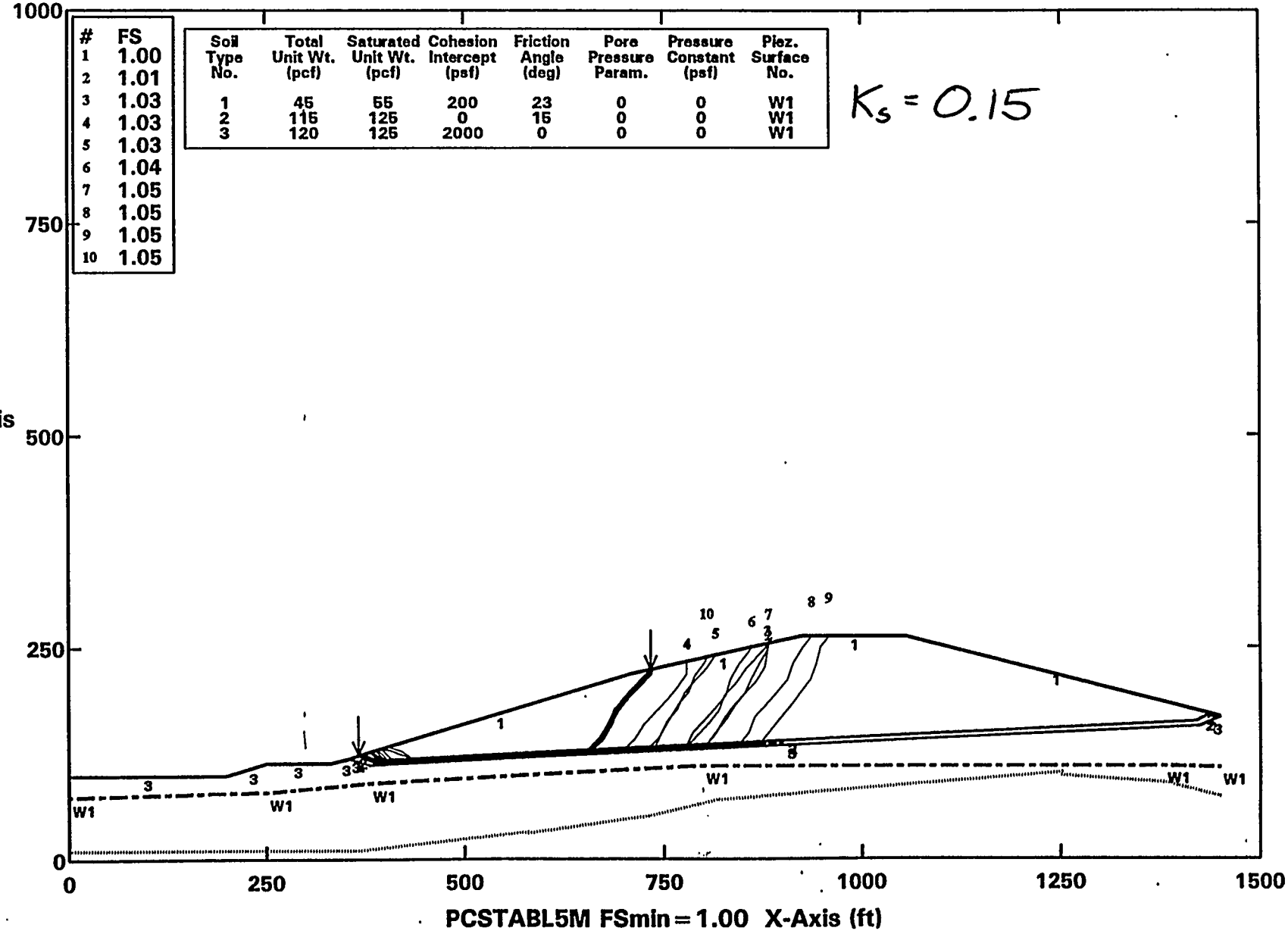
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B2.PLT By: DAVID TSO 03-06-95 4:04pm

#	FS
1	1.00
2	1.01
3	1.03
4	1.03
5	1.03
6	1.04
7	1.05
8	1.05
9	1.05
10	1.05

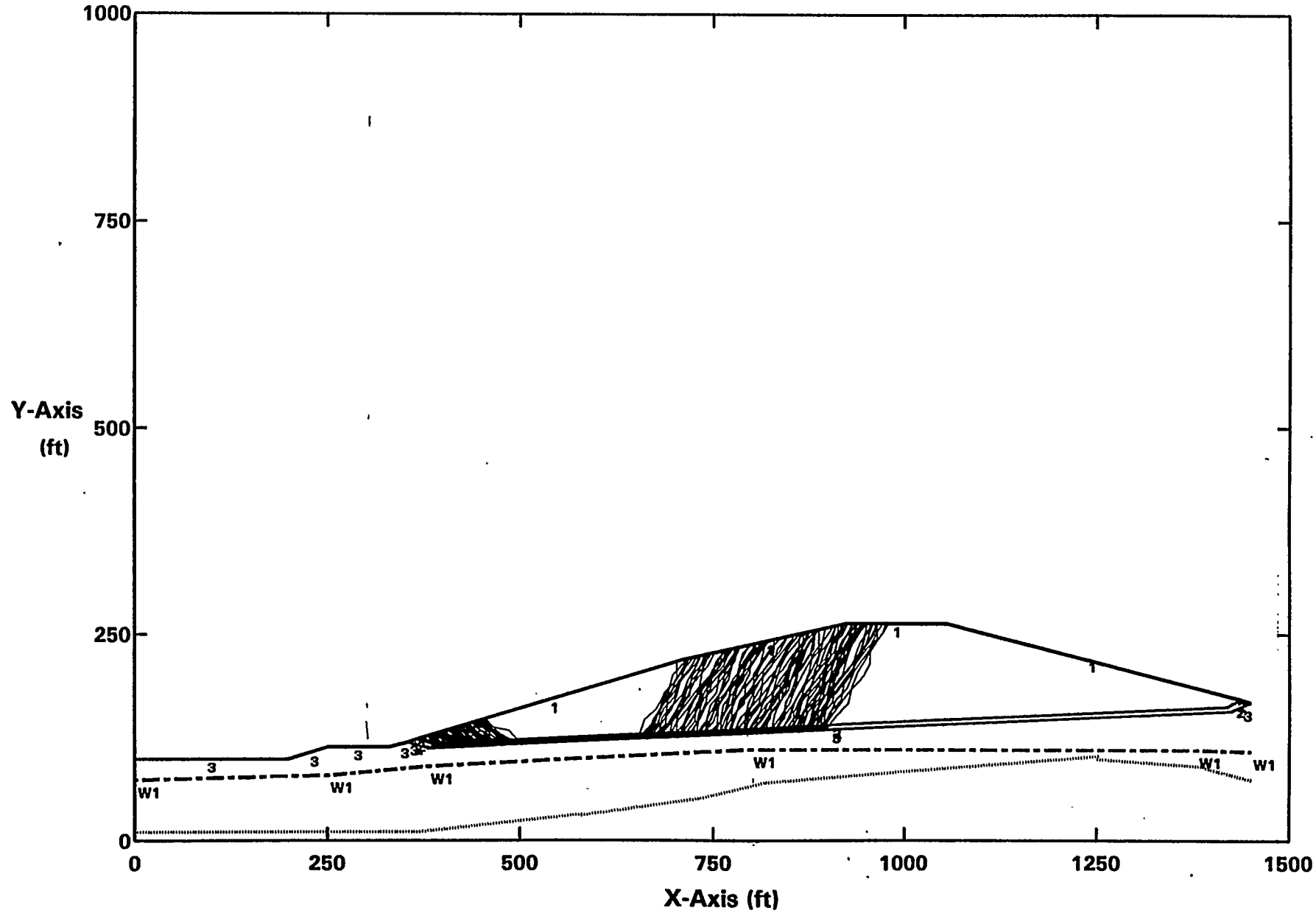
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	15	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.15$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B2A.PLT By: DAVID TSO 03-25-95 3:13pm



A60

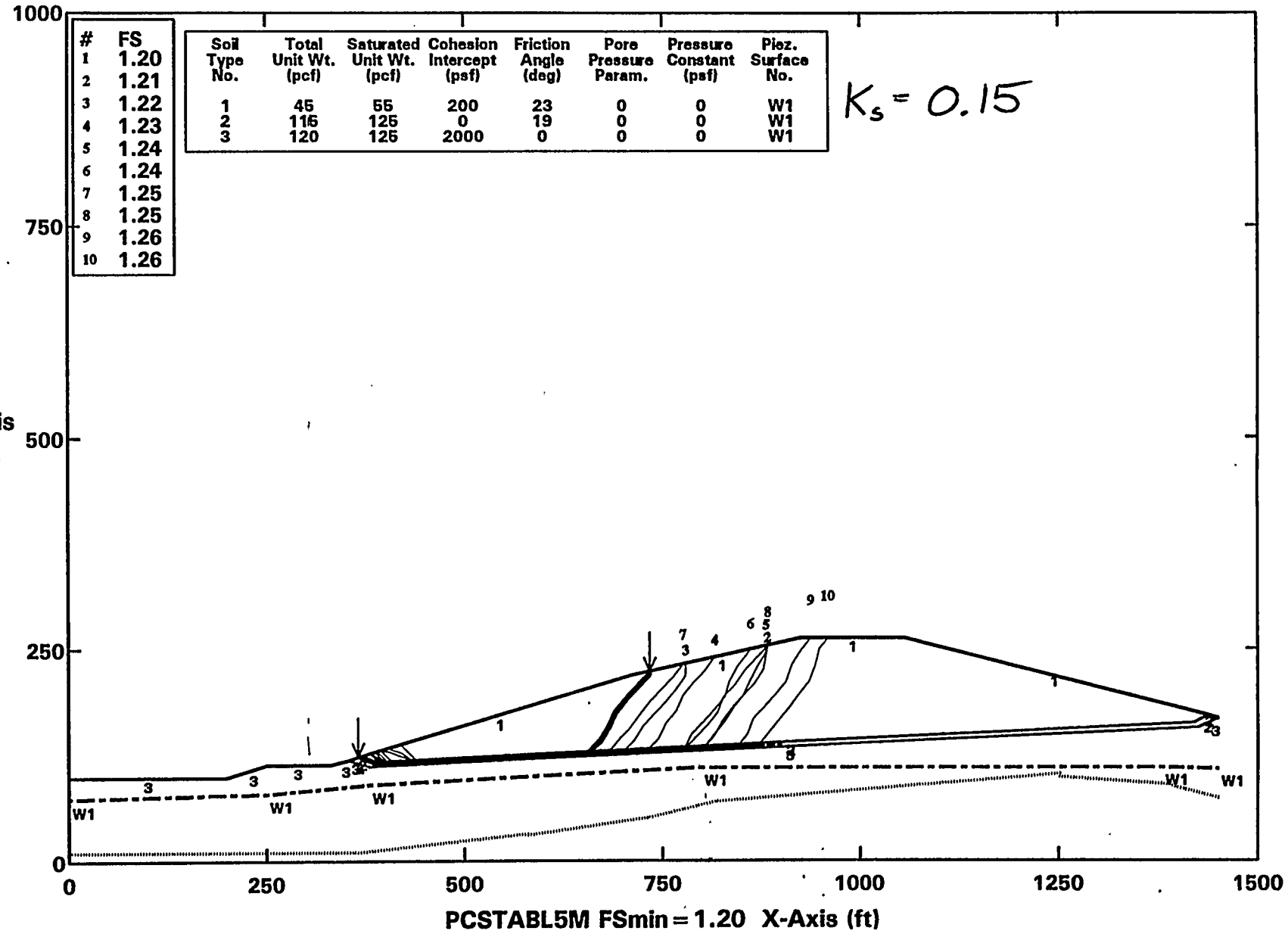
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B2A.PLT By: DAVID TSO 03-25-95 3:13pm

#	FS
1	1.20
2	1.21
3	1.22
4	1.23
5	1.24
6	1.24
7	1.25
8	1.25
9	1.26
10	1.26

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	116	125	0	19	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.15$

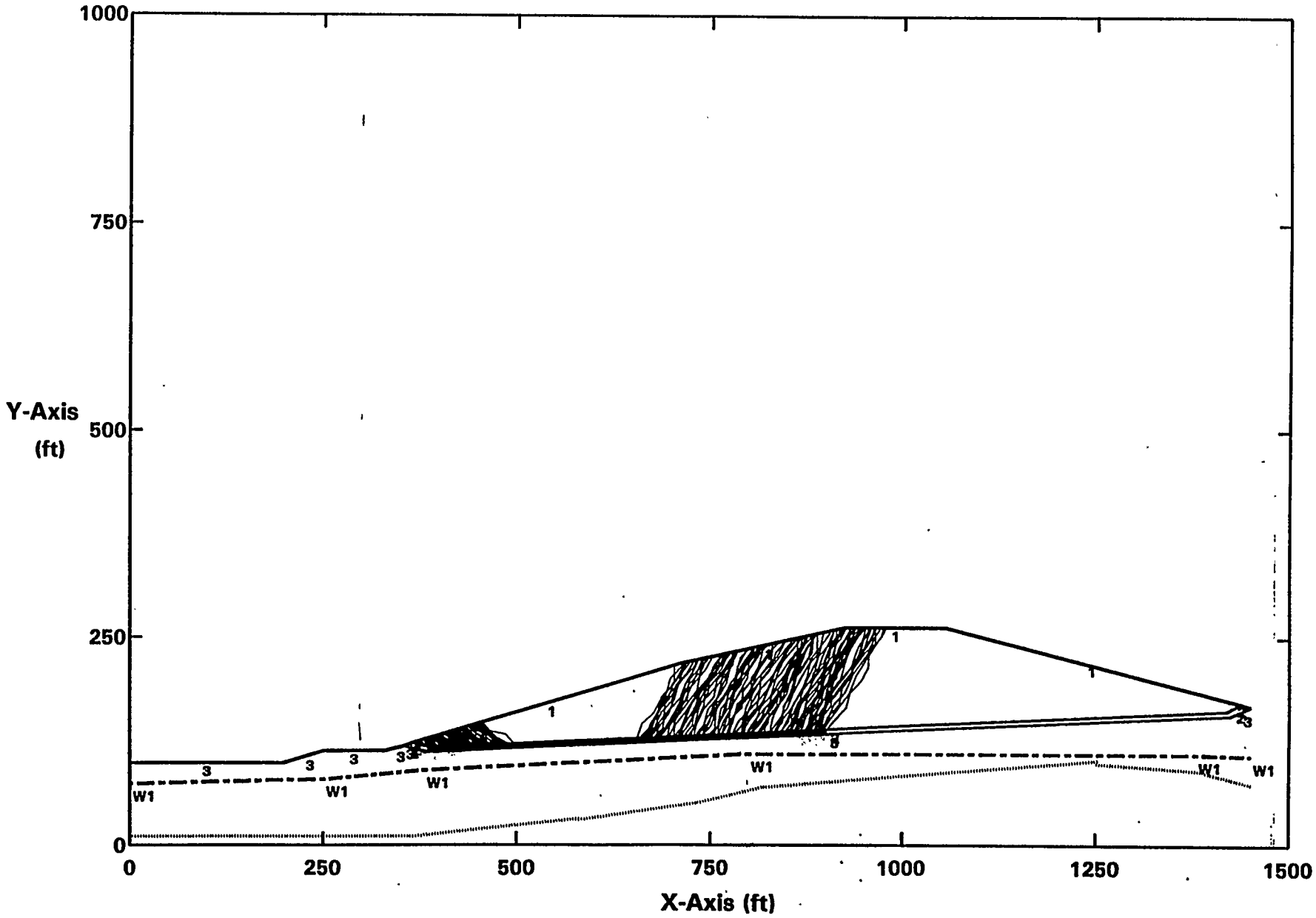


PCSTABL5M FSmin = 1.20 X-Axis (ft)

A61

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B2B.PLT By: DAVID TSO 03-25-95 3:14pm



A62

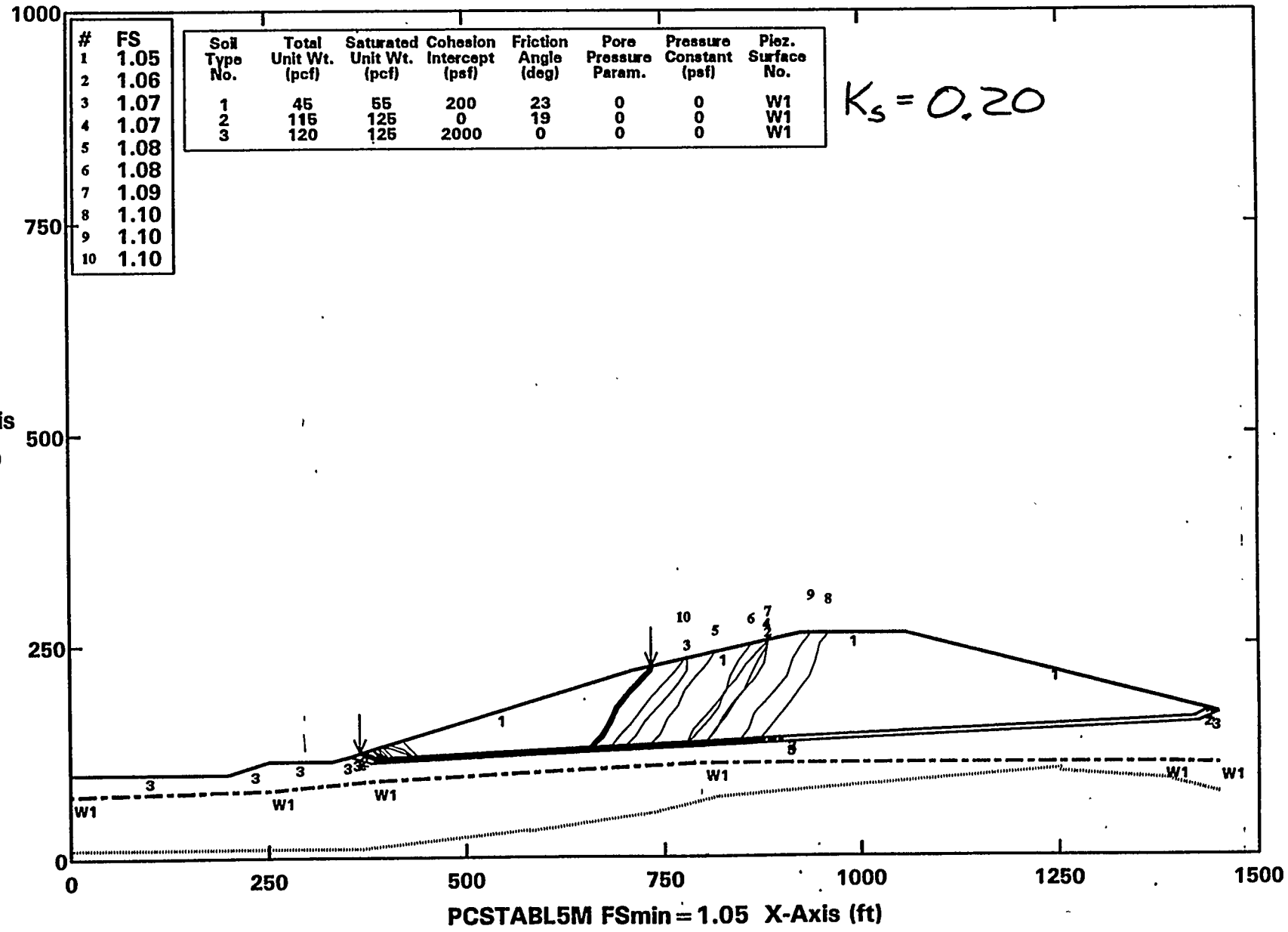
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B2B.PLT By: DAVID TSO 03-25-95 3:14pm

#	FS
1	1.05
2	1.06
3	1.07
4	1.07
5	1.08
6	1.08
7	1.09
8	1.10
9	1.10
10	1.10

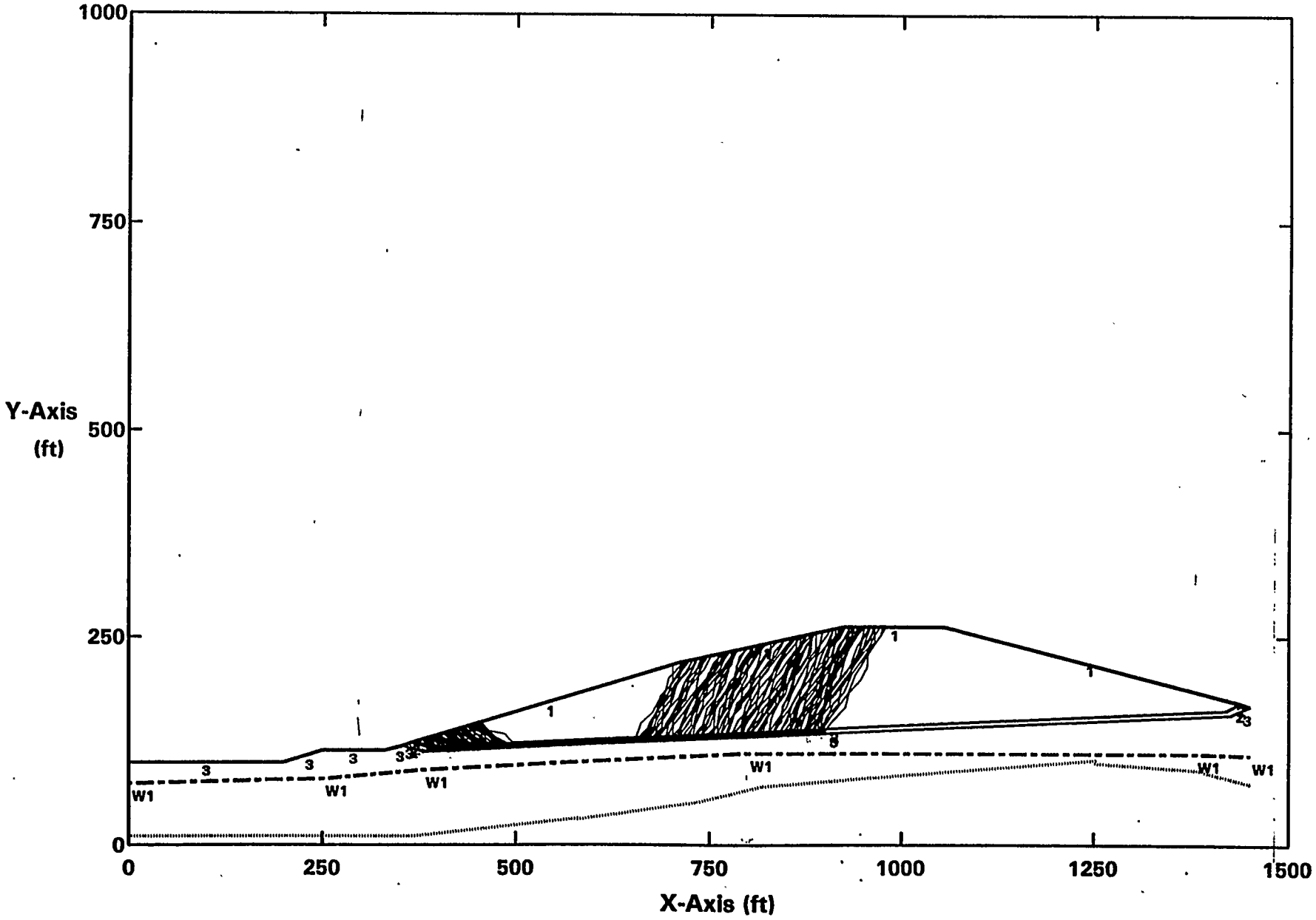
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	19	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.20$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B2C.PLT By: DAVID TSO 03-25-95 3:16pm



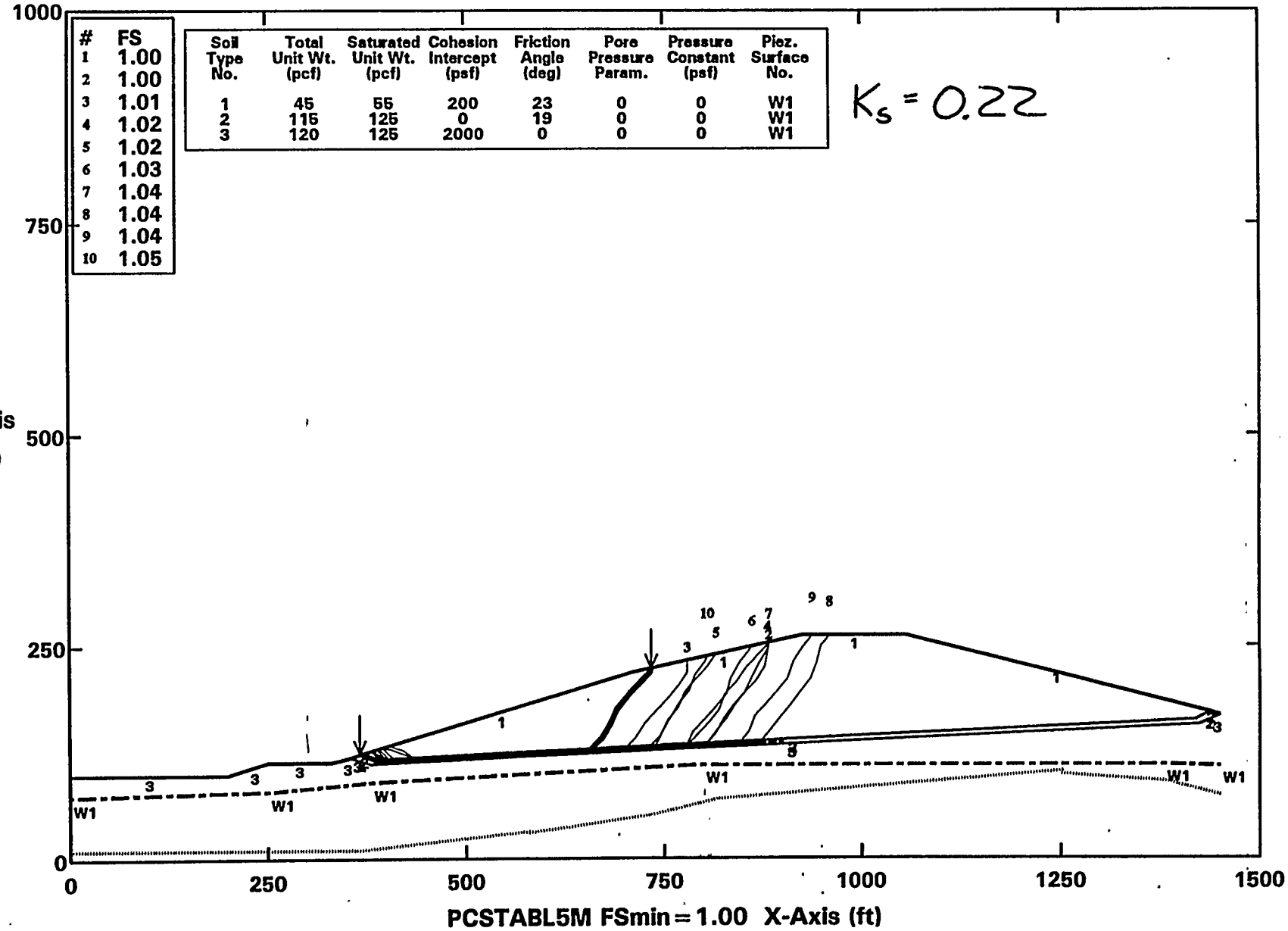
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B2C.PLT By: DAVID TSO 03-25-95 3:16pm

#	FS
1	1.00
2	1.00
3	1.01
4	1.02
5	1.02
6	1.03
7	1.04
8	1.04
9	1.04
10	1.05

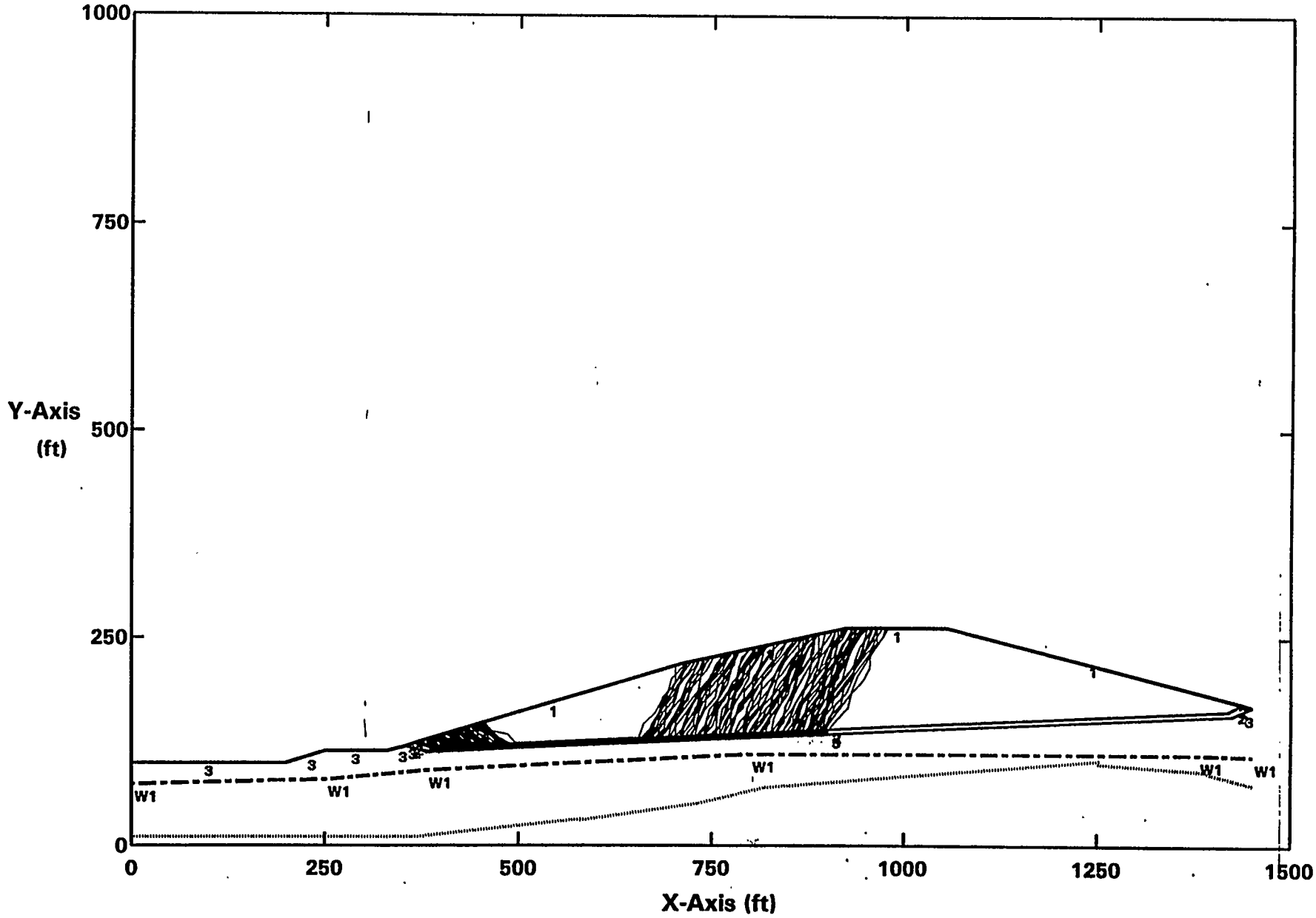
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	19	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.22$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B3.PLT By: DAVID TSO 03-25-95 3:24pm



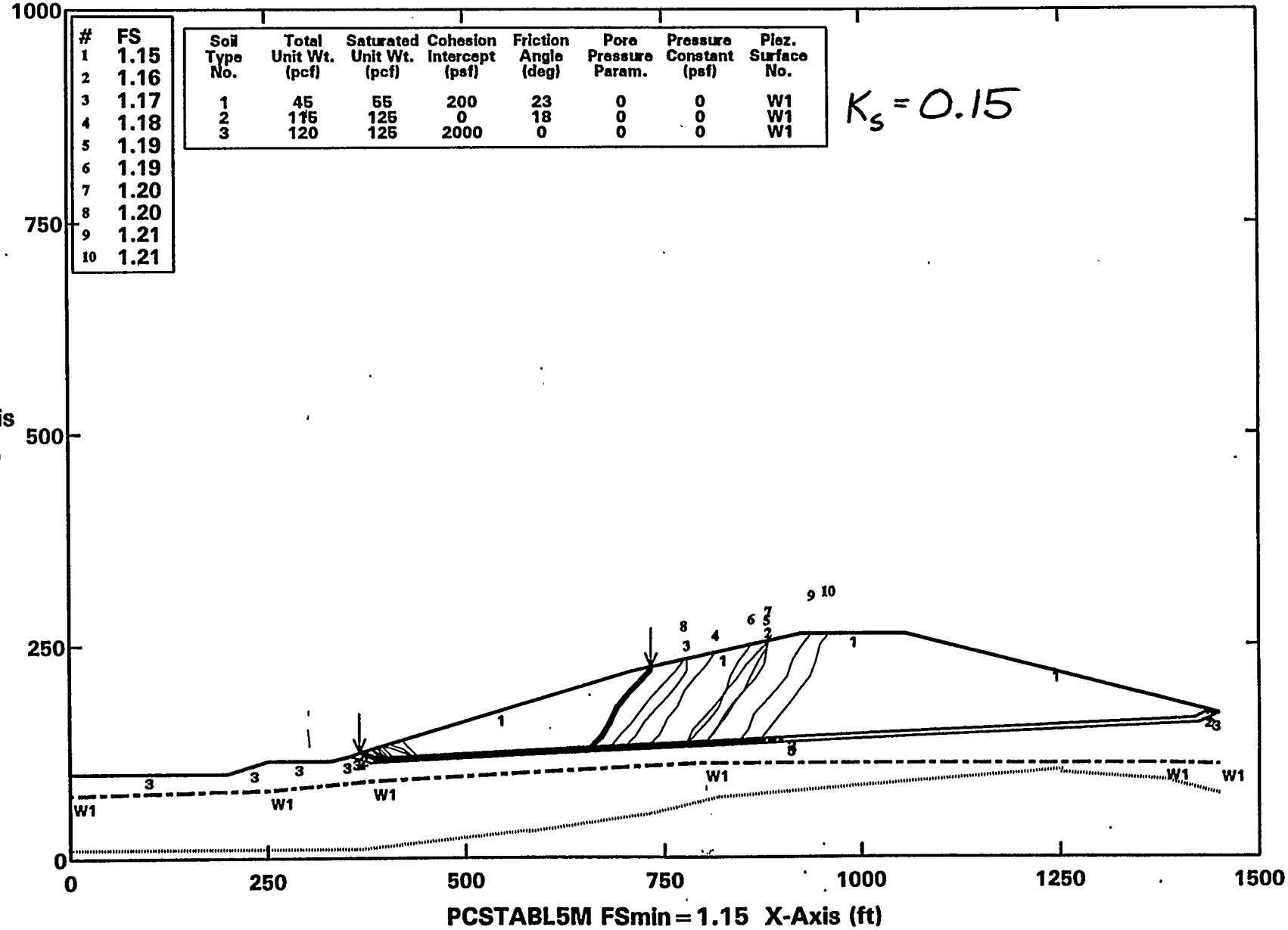
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B3.PLT By: DAVID TSO 03-25-95 3:24pm

#	FS
1	1.15
2	1.16
3	1.17
4	1.18
5	1.19
6	1.19
7	1.20
8	1.20
9	1.21
10	1.21

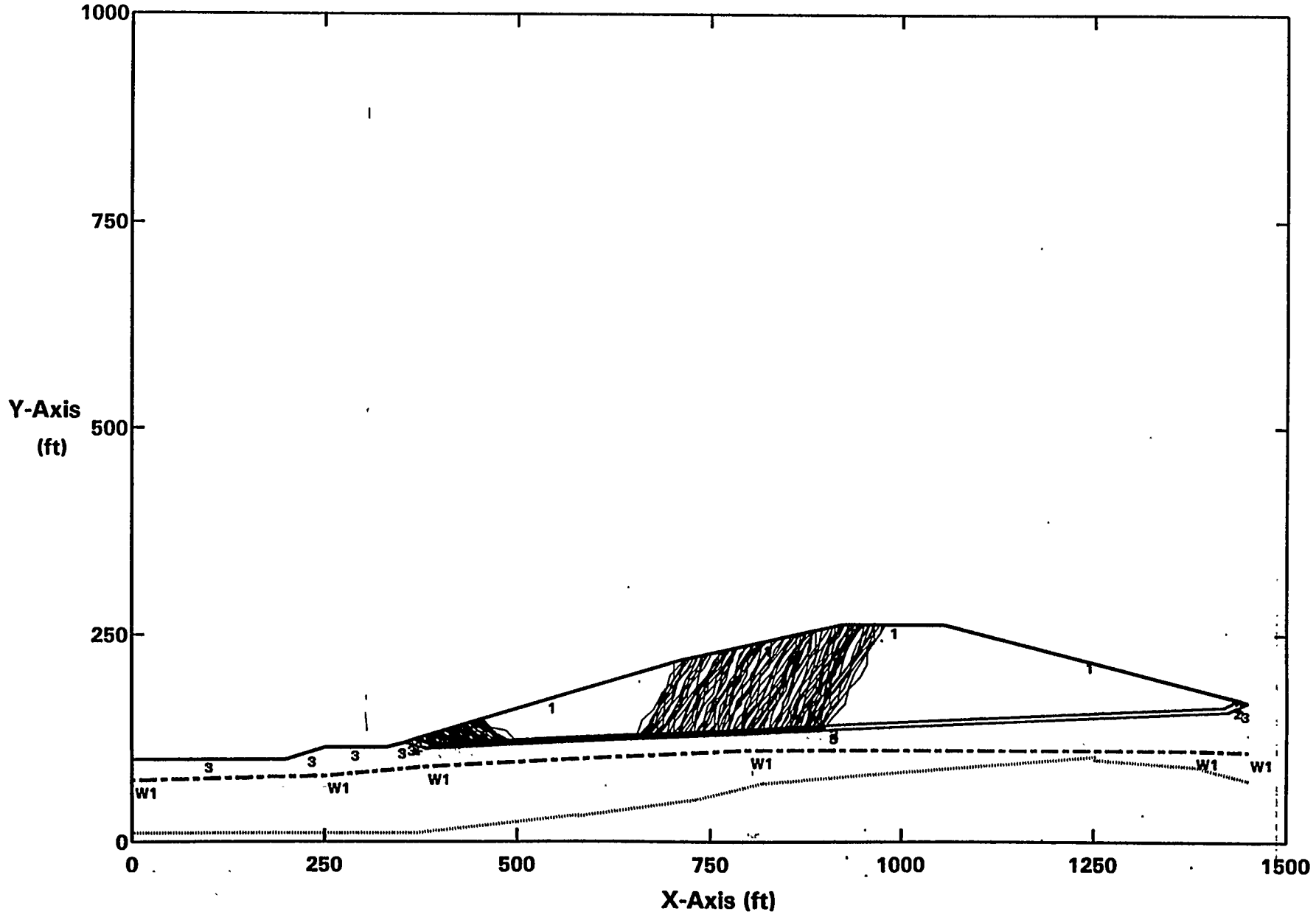
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	18	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.15$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B3A.PLT By: DAVID TSO 03-25-95 3:36pm



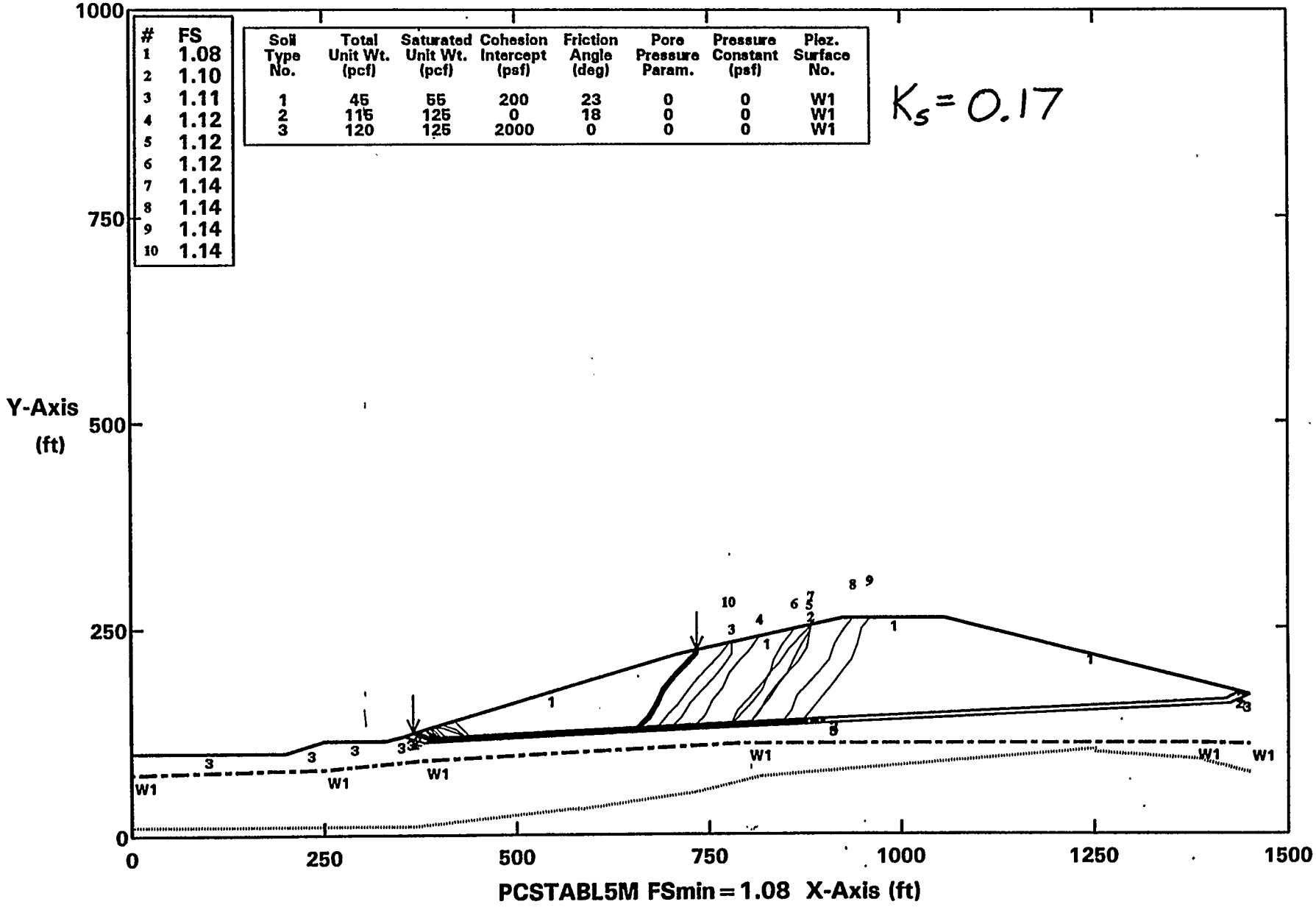
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B3A.PLT By: DAVID TSO 03-25-95 3:36pm

#	FS
1	1.08
2	1.10
3	1.11
4	1.12
5	1.12
6	1.12
7	1.14
8	1.14
9	1.14
10	1.14

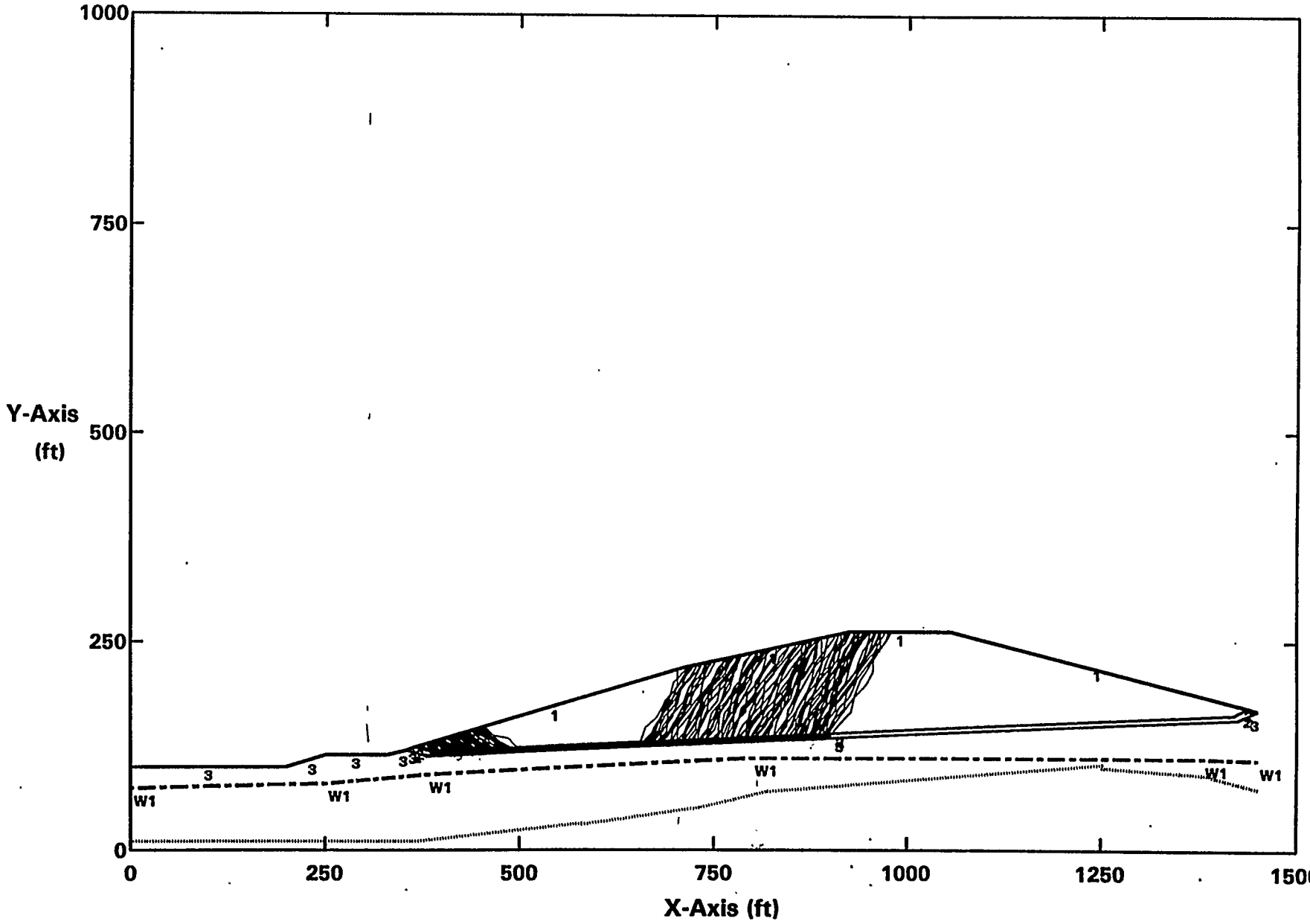
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	18	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.17$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B3B.PLT By: DAVID TSO 03-25-95 3:37pm



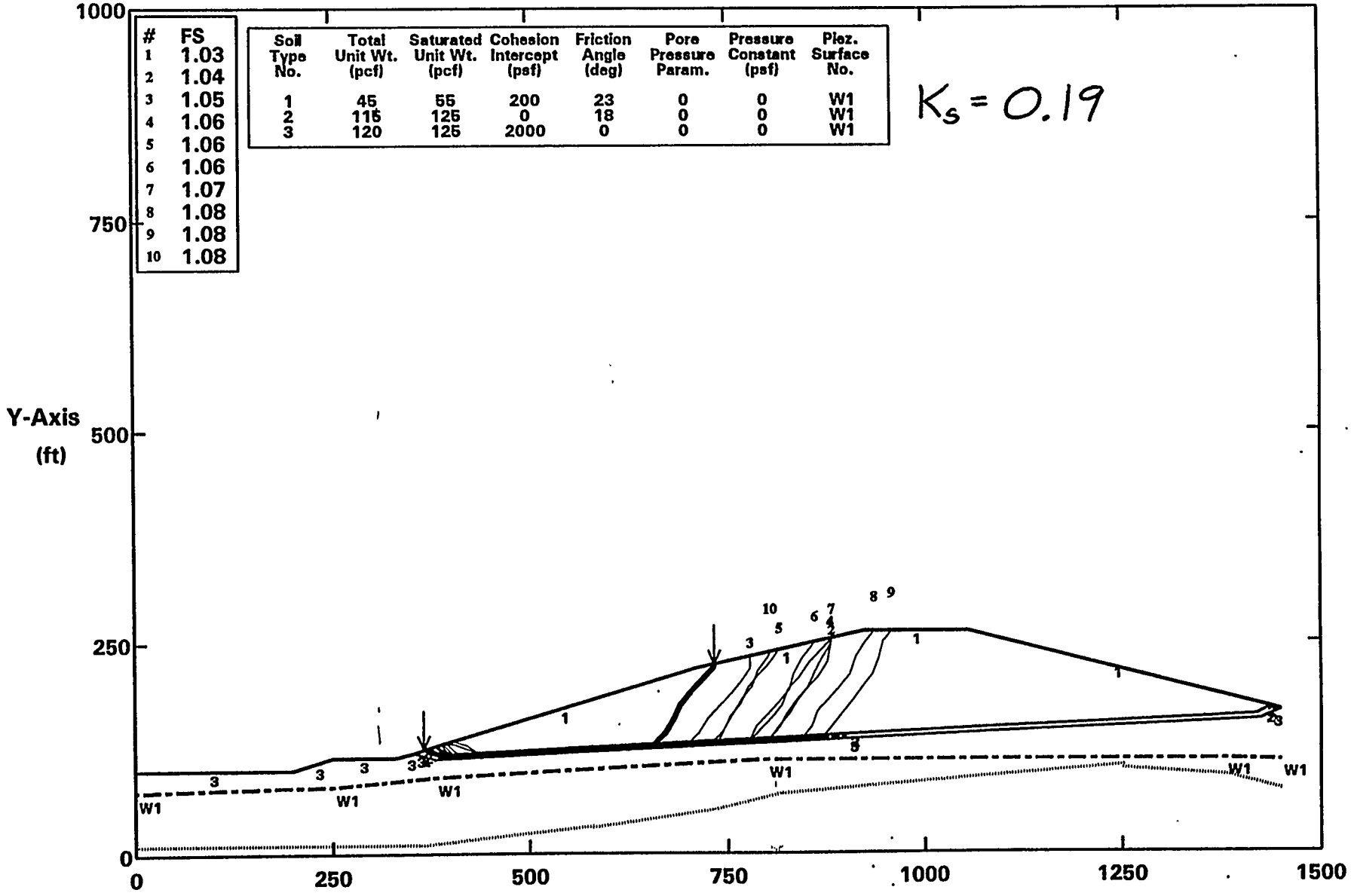
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B3B.PLT By: DAVID TSO 03-25-95 3:37pm

#	FS
1	1.03
2	1.04
3	1.05
4	1.06
5	1.06
6	1.06
7	1.07
8	1.08
9	1.08
10	1.08

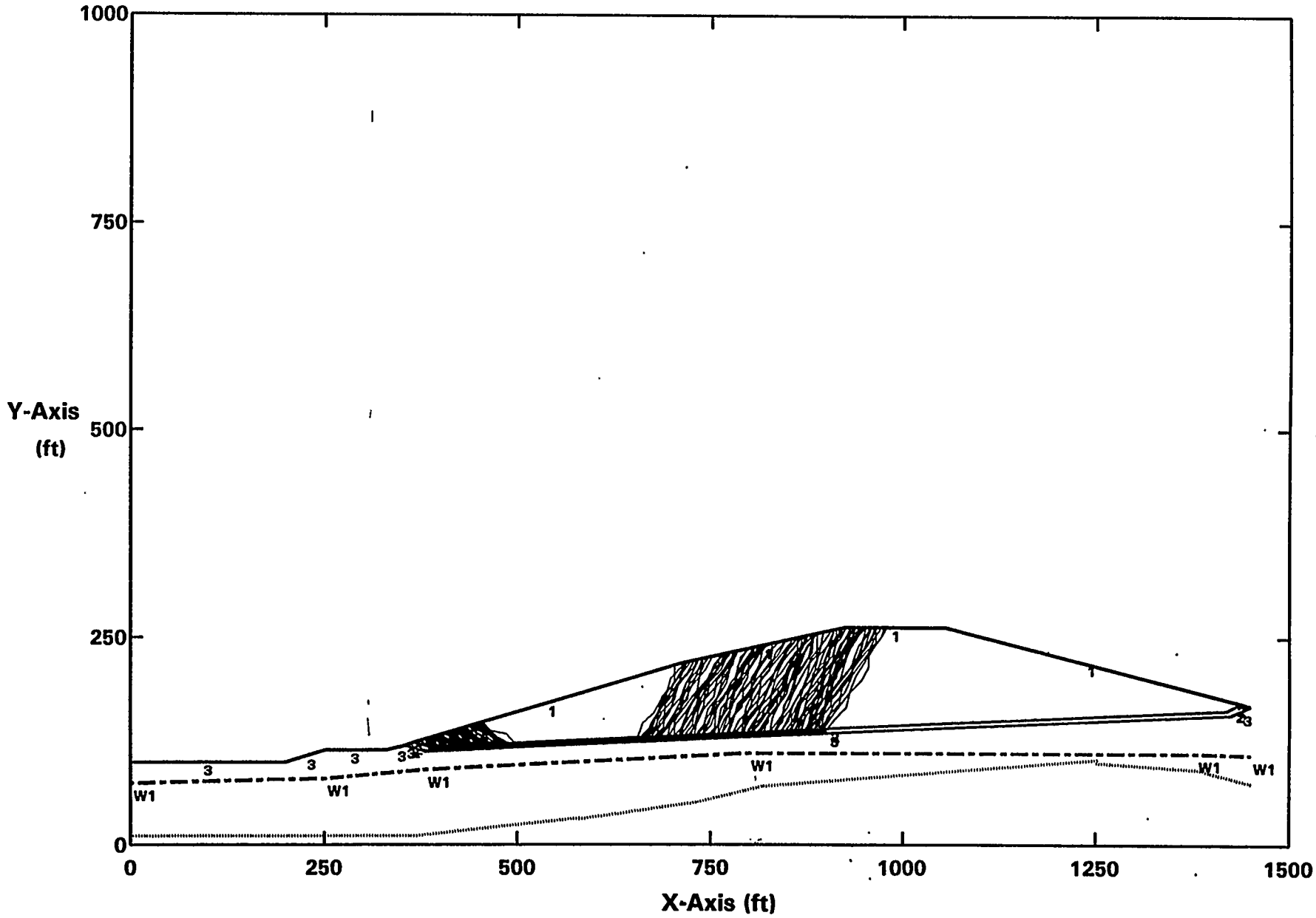
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	18	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.19$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B3C.PLT By: DAVID TSO 03-25-95 3:38pm



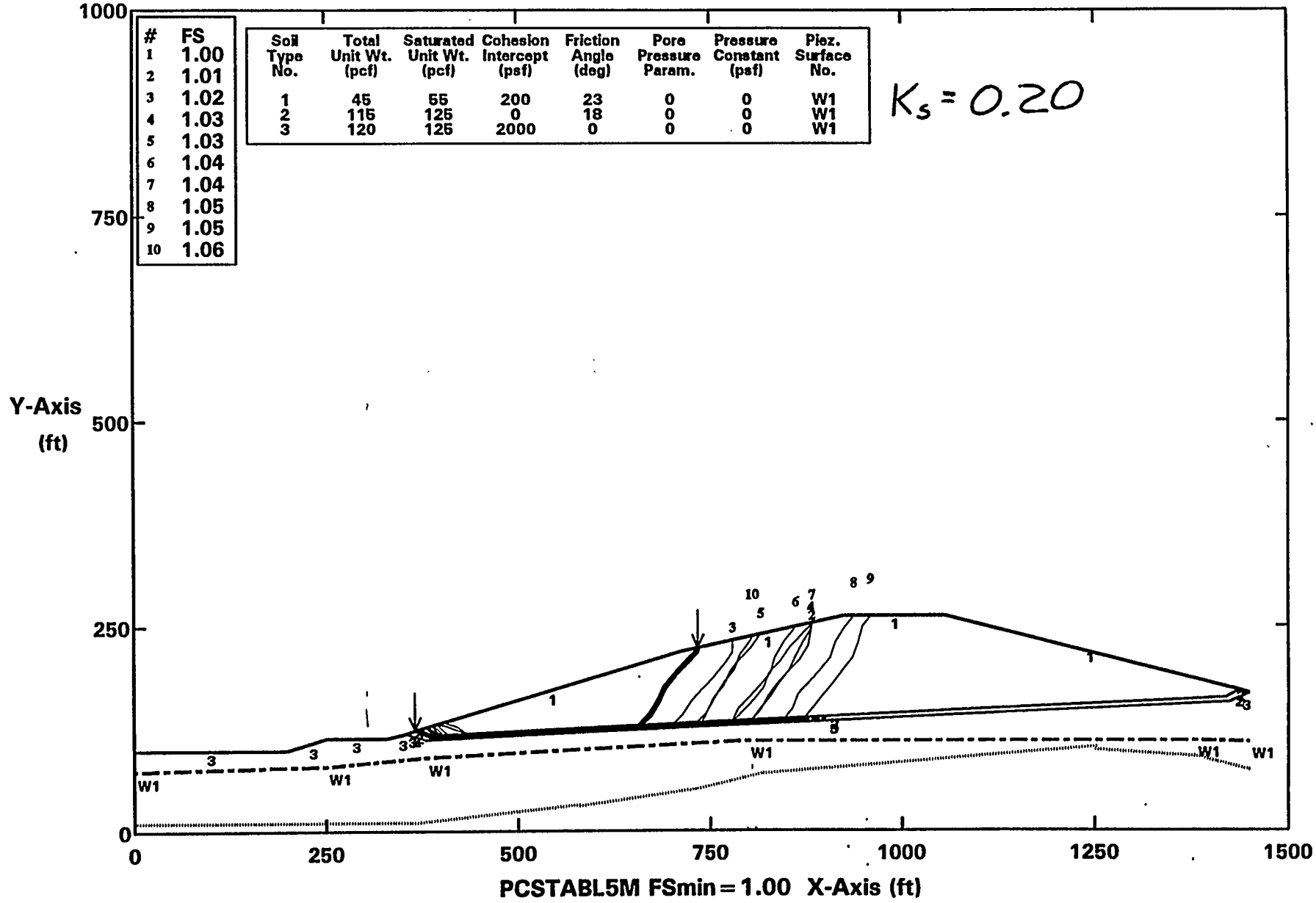
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B3C.PLT By: DAVID TSO 03-25-95 3:38pm

#	FS
1	1.00
2	1.01
3	1.02
4	1.03
5	1.03
6	1.04
7	1.04
8	1.05
9	1.05
10	1.06

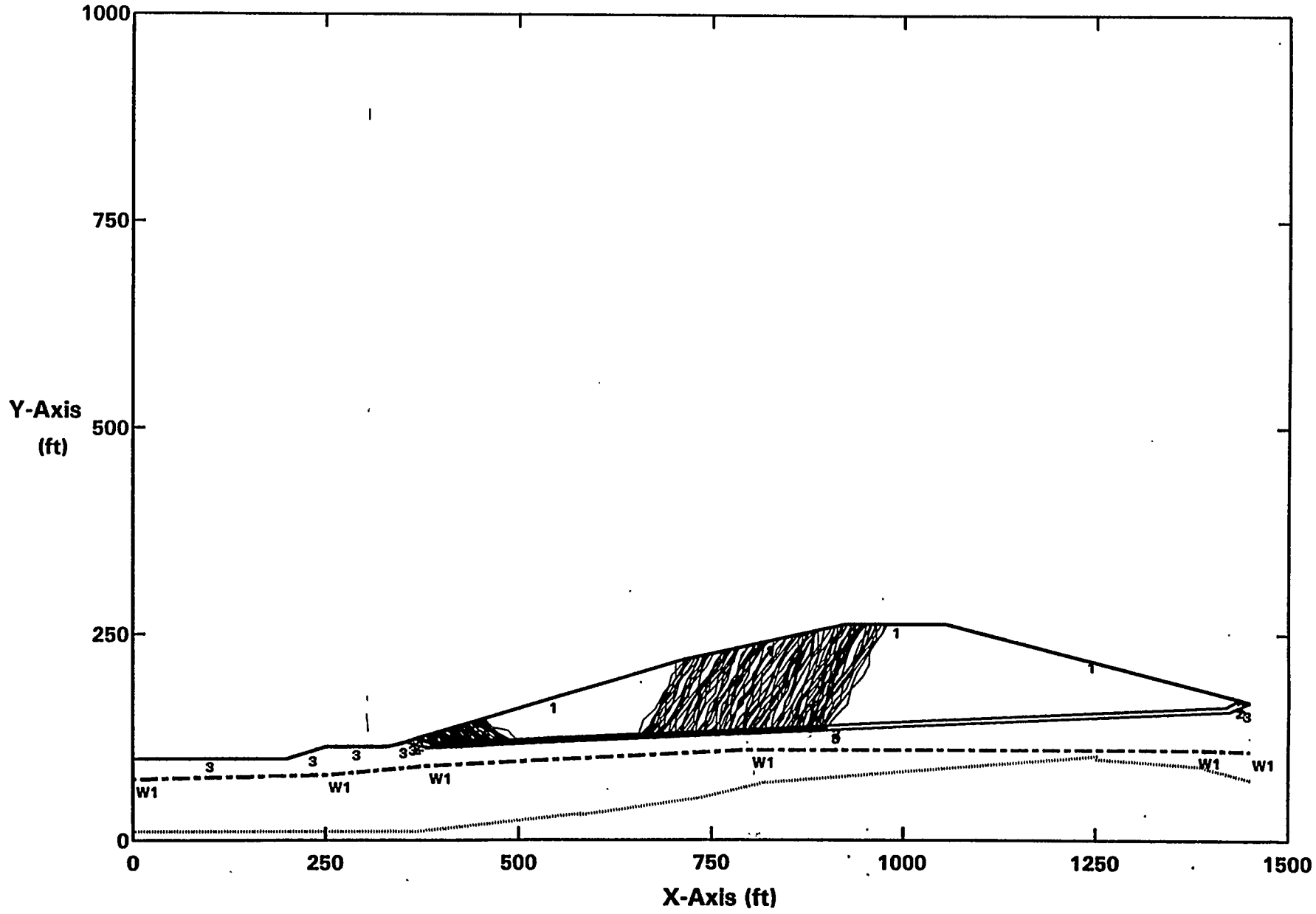
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	18	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.20$



Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B4.PLT By: DAVID TSO 03-25-95 3:42pm



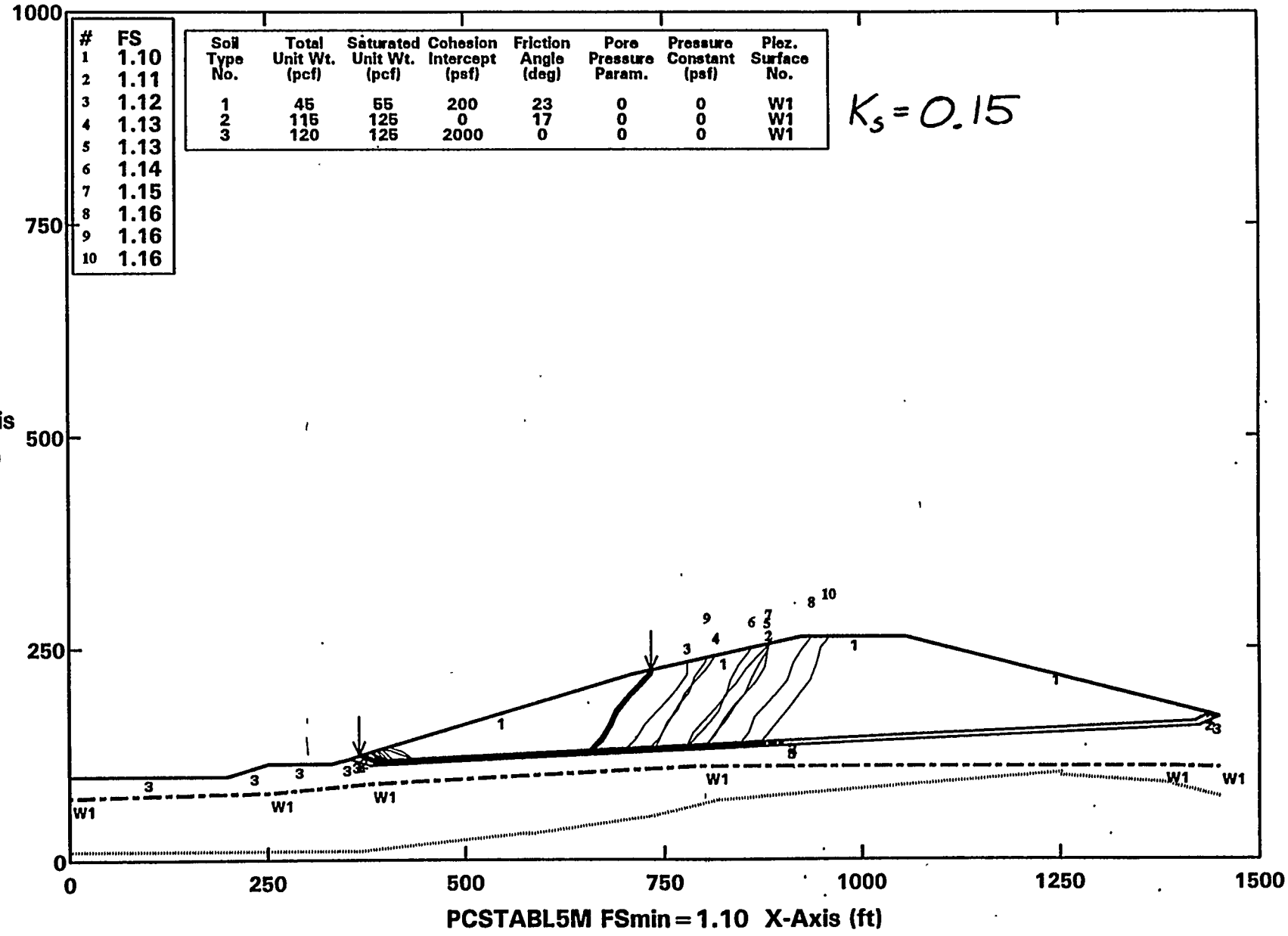
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B4.PLT By: DAVID TSO 03-25-95 3:42pm

#	FS
1	1.10
2	1.11
3	1.12
4	1.13
5	1.13
6	1.14
7	1.15
8	1.16
9	1.16
10	1.16

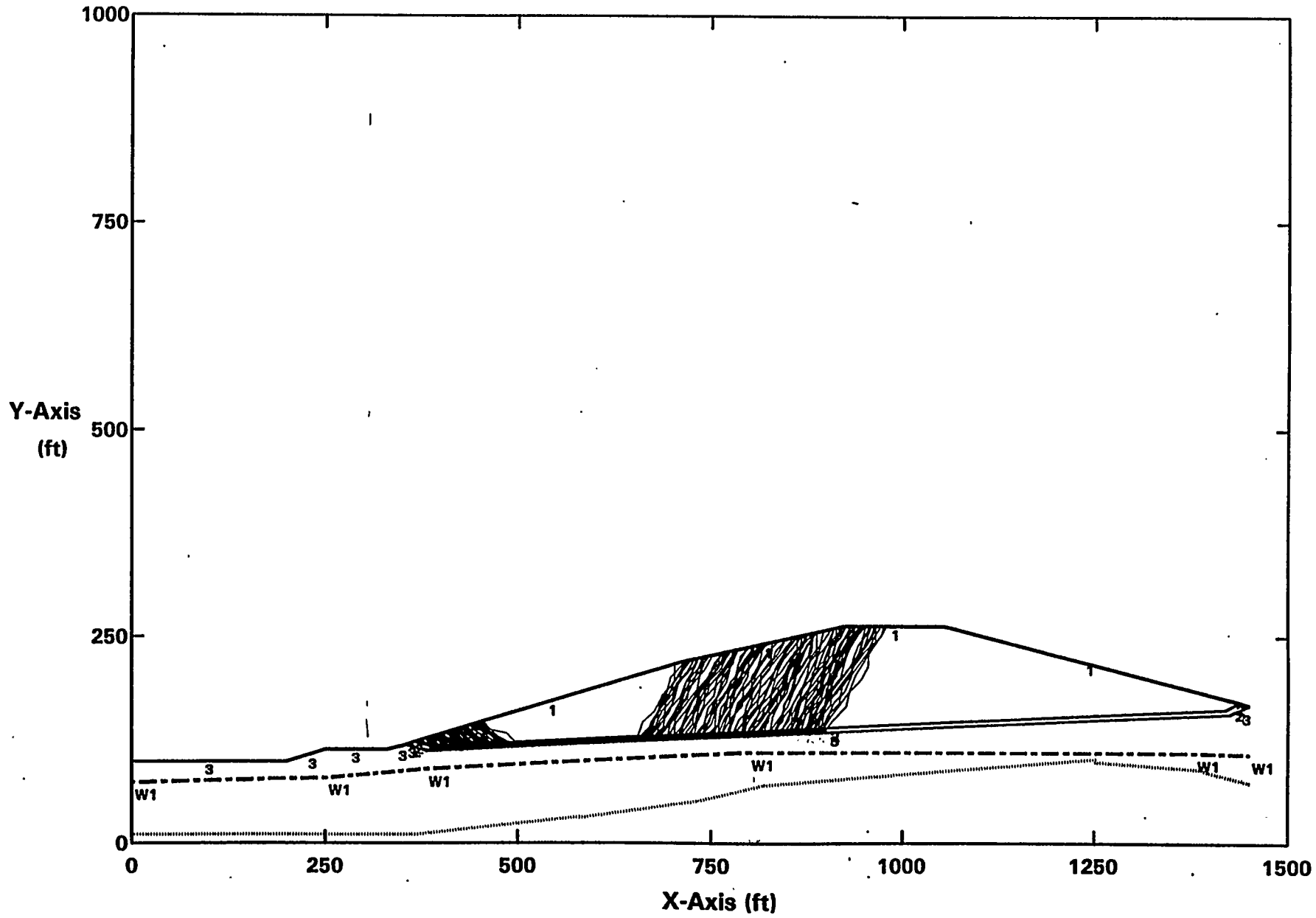
Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	17	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.15$



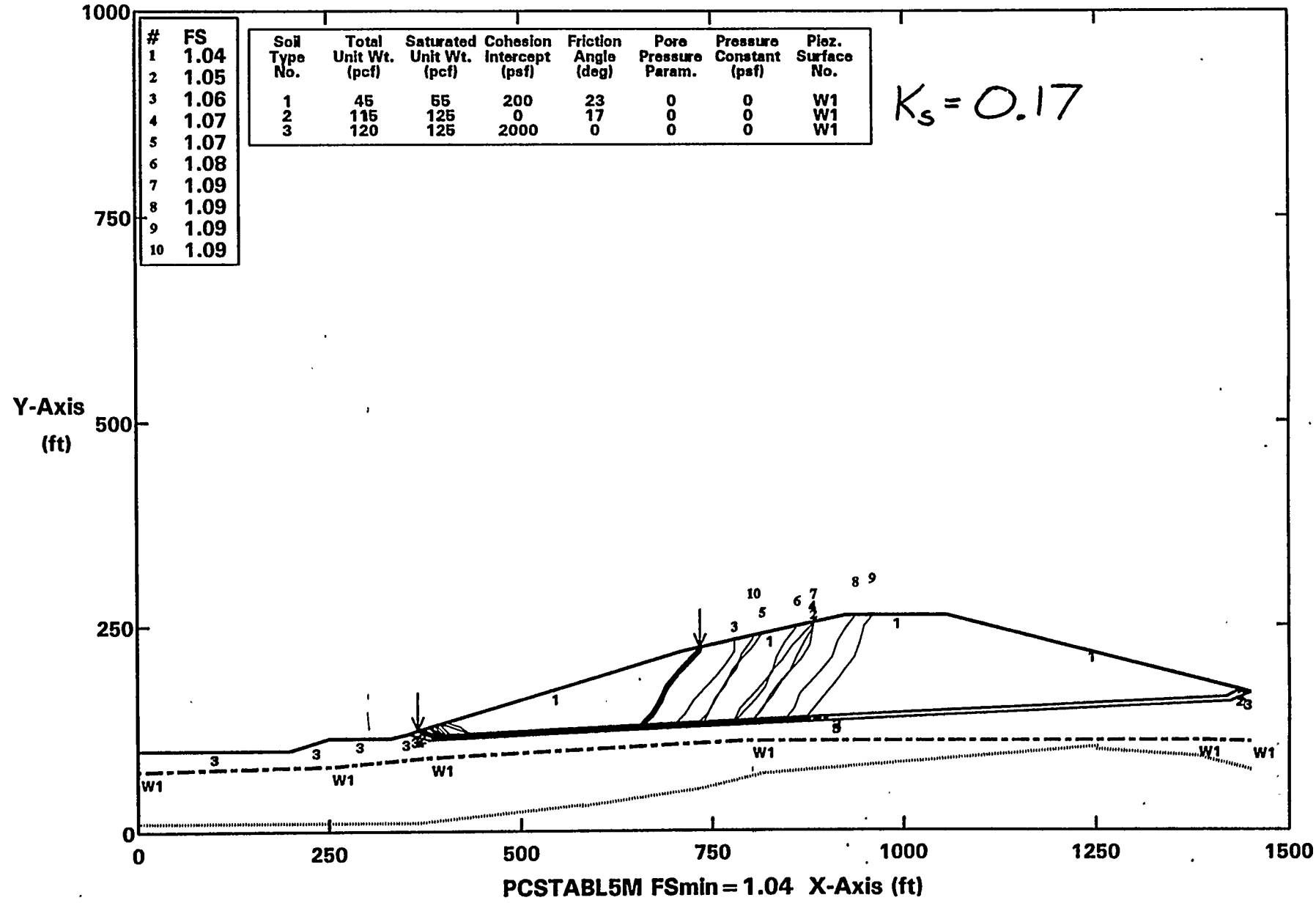
Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B4A.PLT By: DAVID TSO 03-25-95 3:45pm



Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B4A.PLT By: DAVID TSO 03-25-95 3:45pm



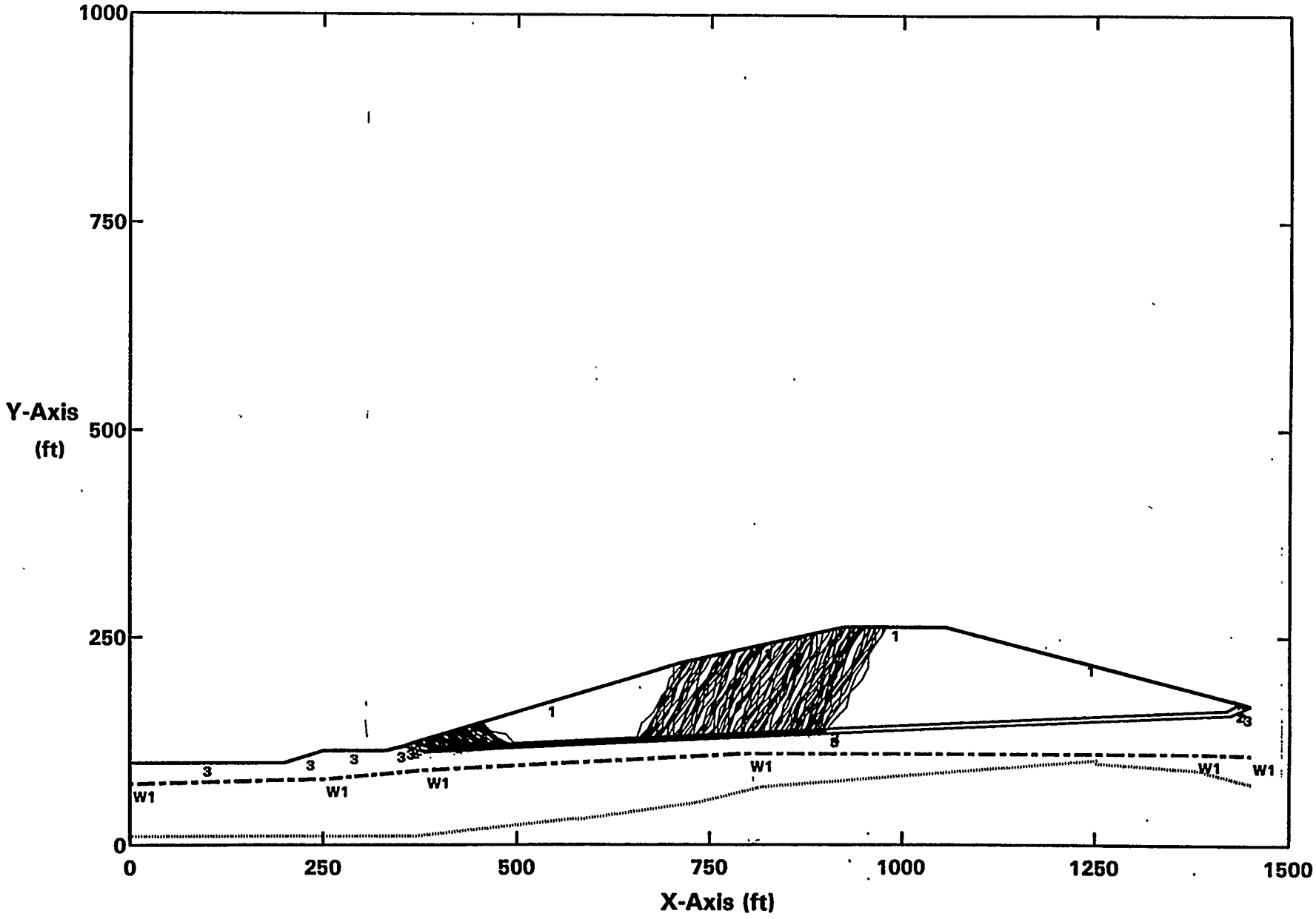
#	FS
1	1.04
2	1.05
3	1.06
4	1.07
5	1.07
6	1.08
7	1.09
8	1.09
9	1.09
10	1.09

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	17	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.17$

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. C:B4B.PLT By: DAVID TSO 03-25-95 3:47pm



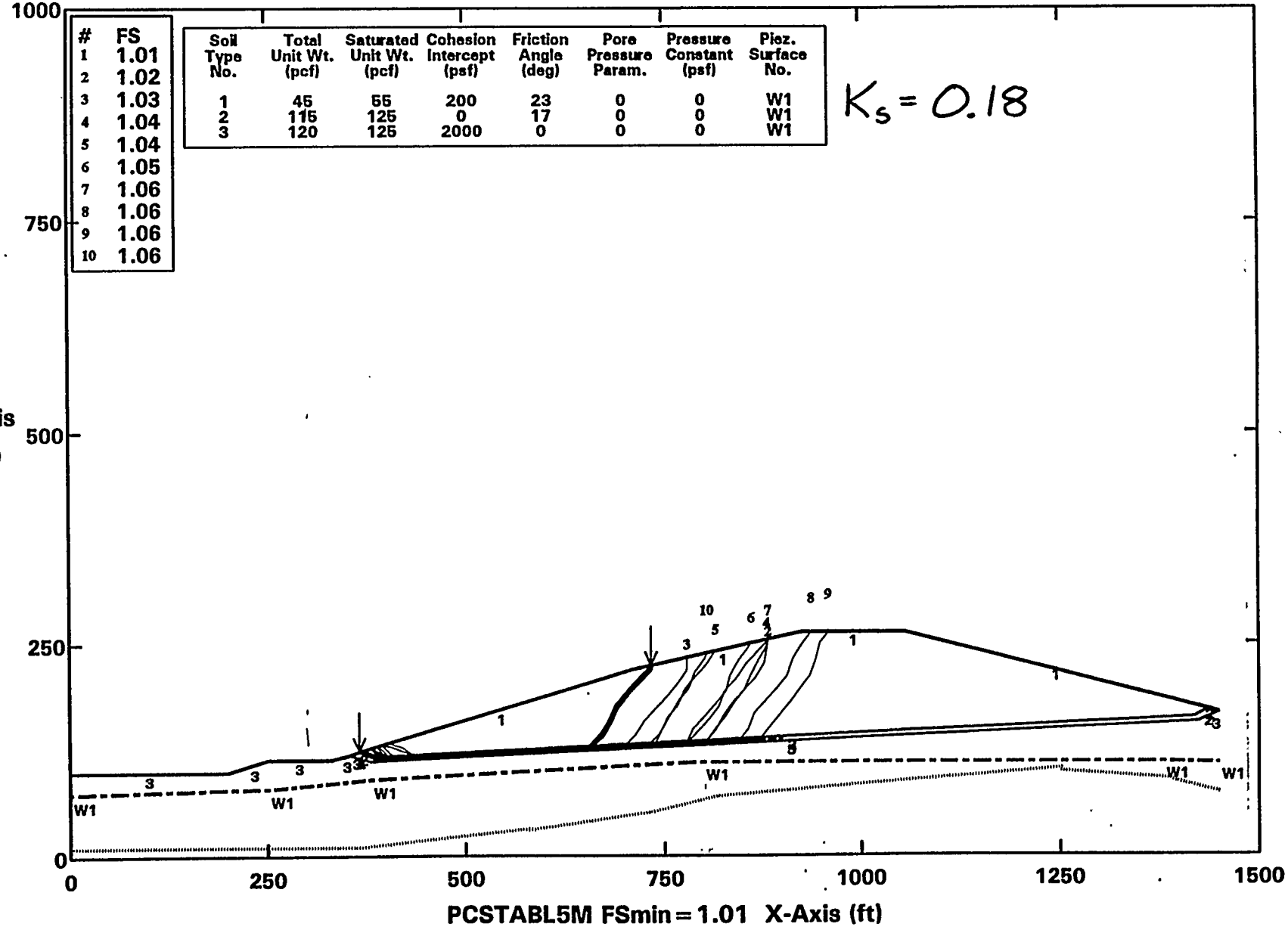
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. C:B4B.PLT By: DAVID TSO 03-25-95 3:47pm

#	FS
1	1.01
2	1.02
3	1.03
4	1.04
5	1.04
6	1.05
7	1.06
8	1.06
9	1.06
10	1.06

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	17	0	0	W1
3	120	125	2000	0	0	0	W1

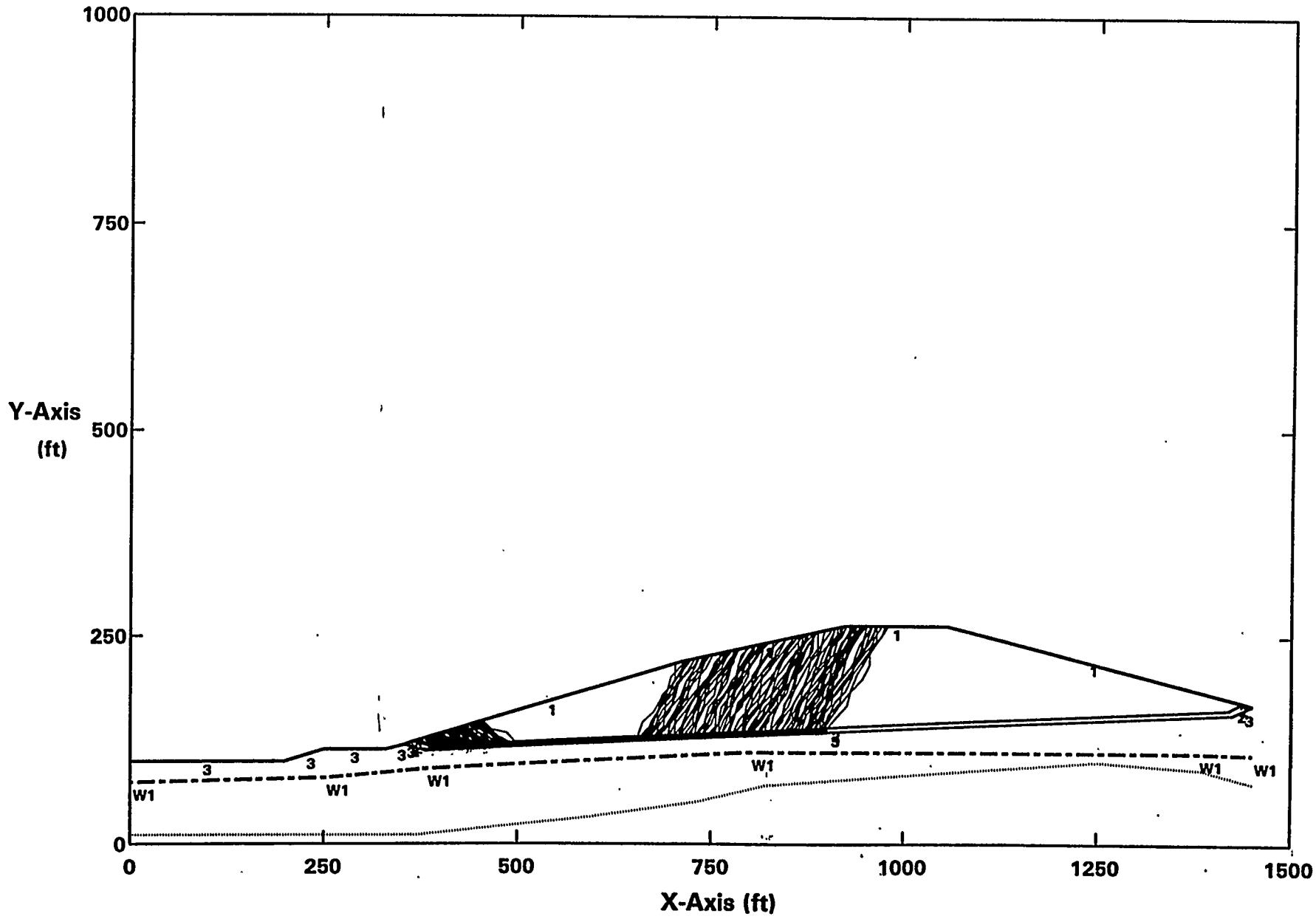
$K_s = 0.18$



A79

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. A:B5.PLT By: DAVID TSO 06-12-95 2:21pm



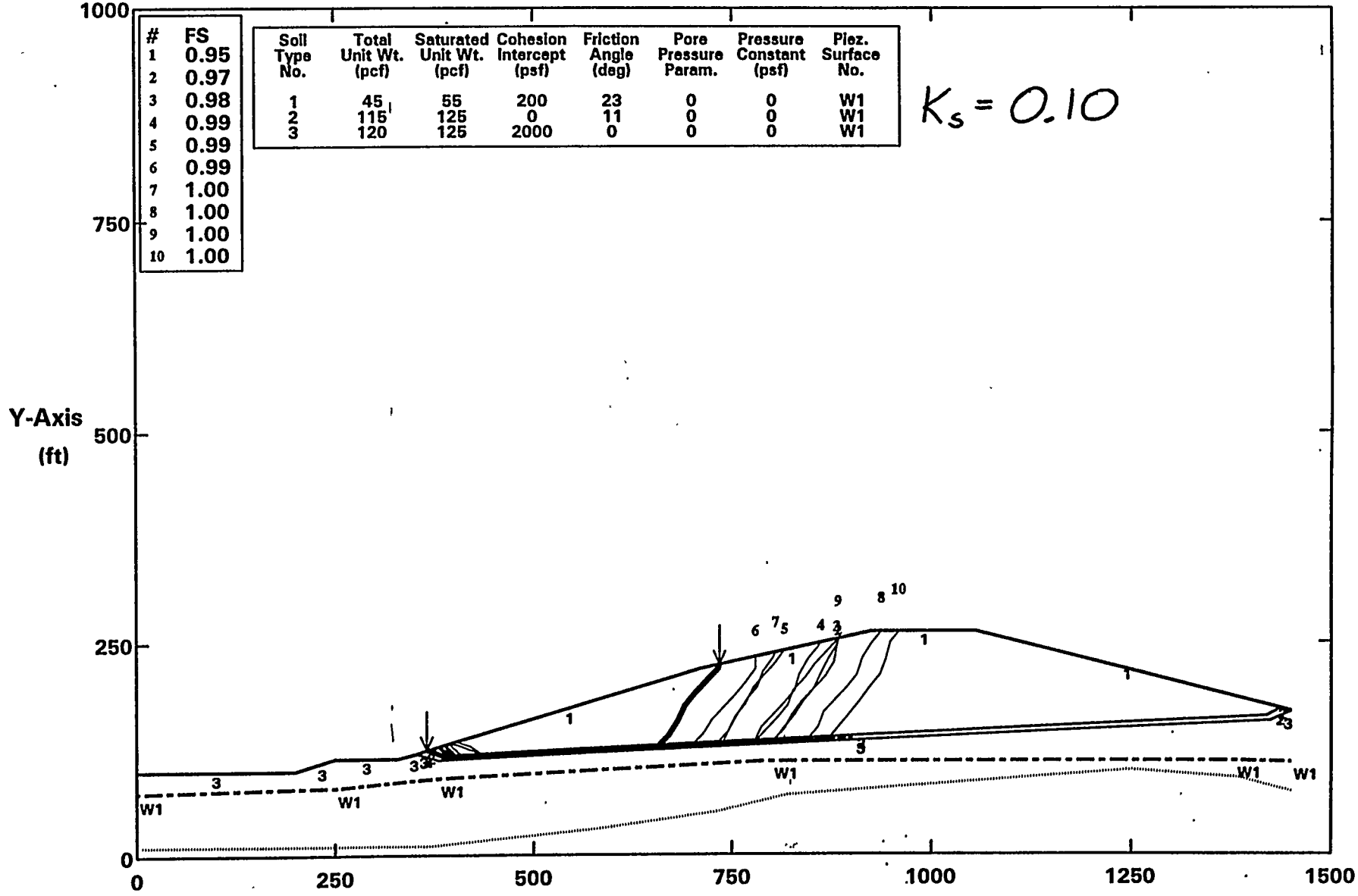
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. A:B5.PLT By: DAVID TSO 06-12-95 2:21pm

#	FS
1	0.95
2	0.97
3	0.98
4	0.99
5	0.99
6	0.99
7	1.00
8	1.00
9	1.00
10	1.00

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	11	0	0	W1
3	120	125	2000	0	0	0	W1

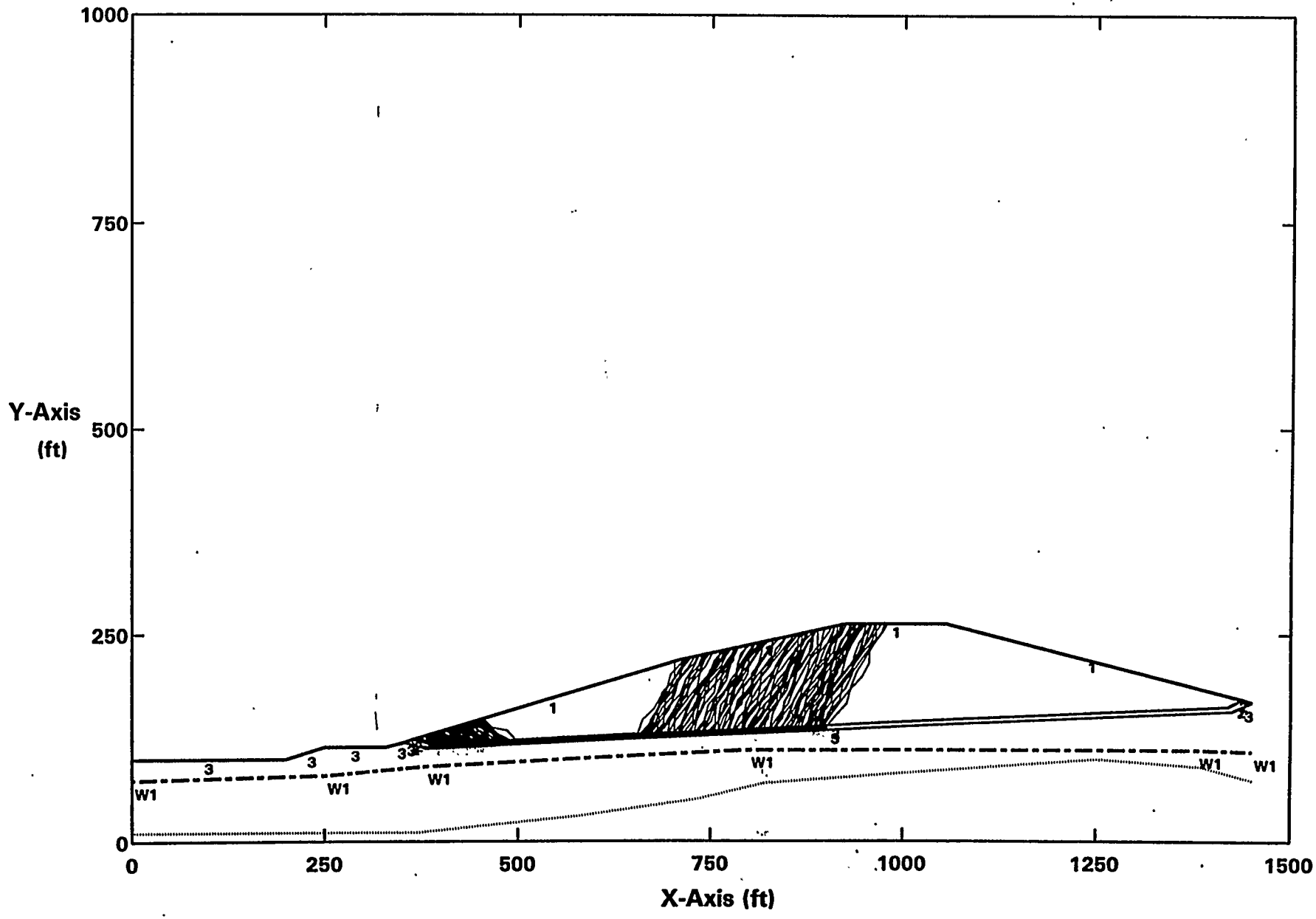
$K_s = 0.10$



A81

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. A:B5A.PLT By: DAVID TSO 06-12-95 2:29pm



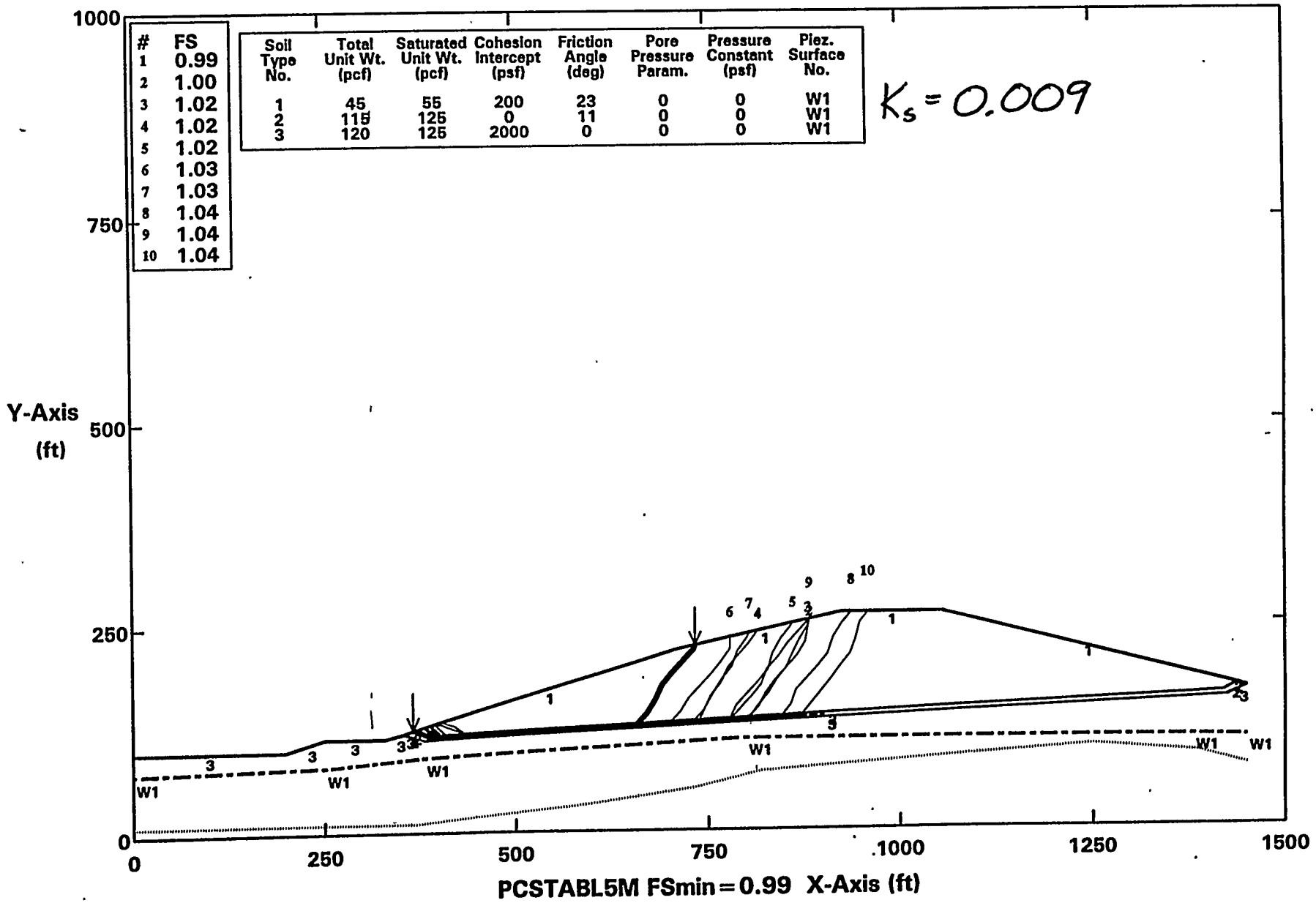
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. A:B5A.PLT By: DAVID TSO 06-12-95 2:29pm

#	FS
1	0.99
2	1.00
3	1.02
4	1.02
5	1.02
6	1.03
7	1.03
8	1.04
9	1.04
10	1.04

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	11	0	0	W1
3	120	125	2000	0	0	0	W1

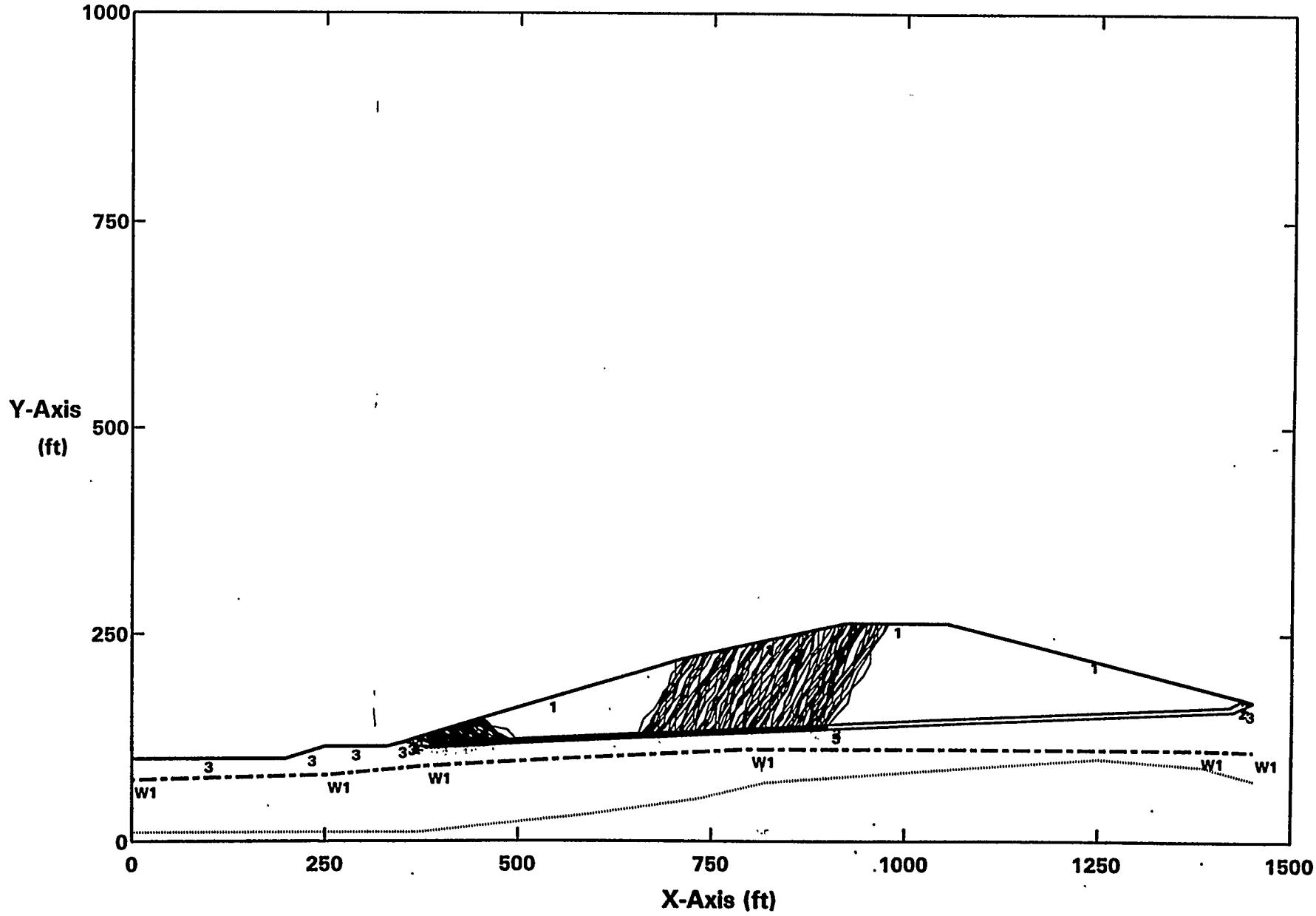
$K_s = 0.009$



A83

Y-12 INDUSTRIAL LANDFILL V

All surfaces evaluated. A:B5B.PLT By: DAVID TSO 06-12-95 2:31pm



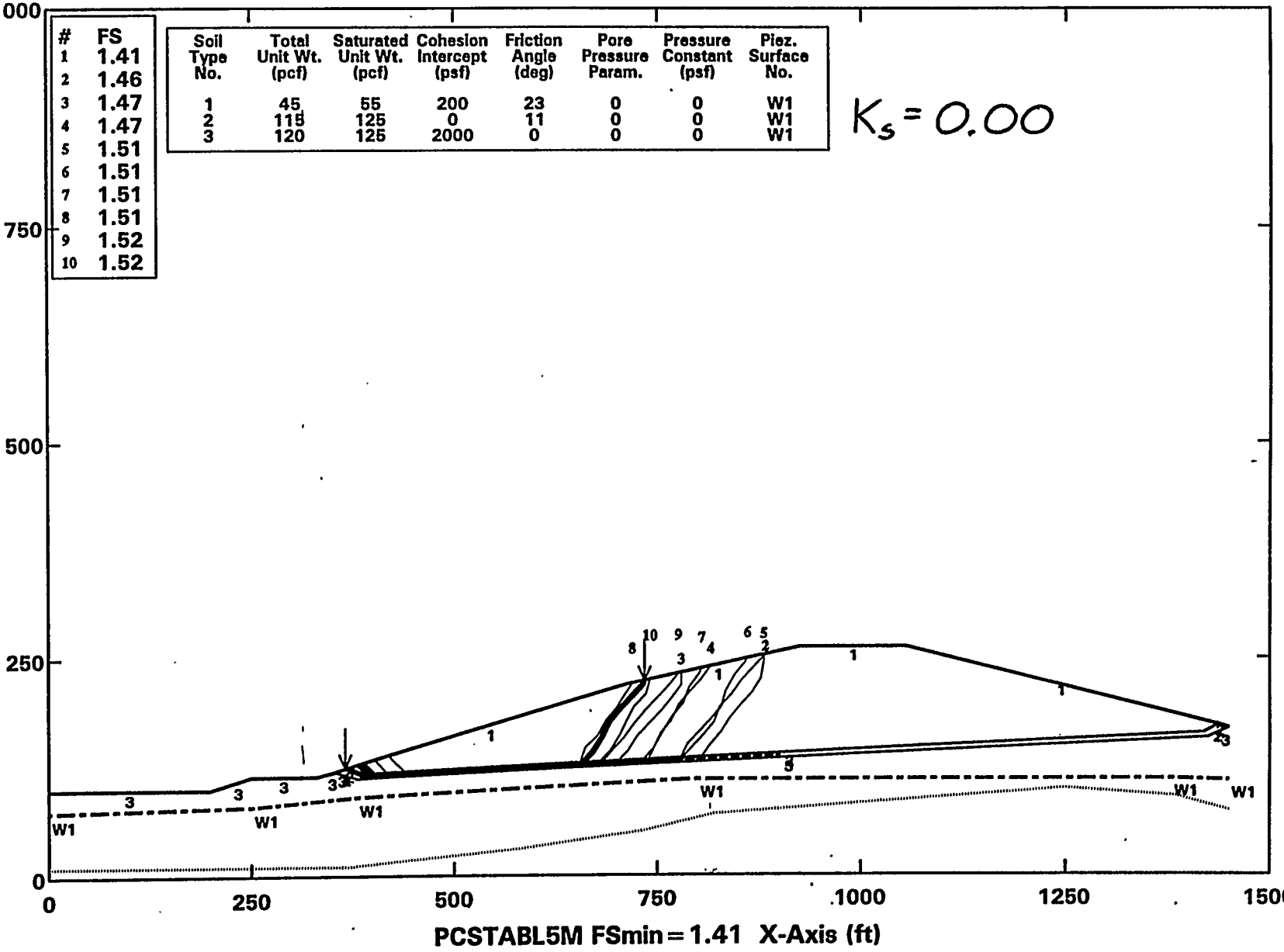
Y-12 INDUSTRIAL LANDFILL V

Ten Most Critical. A:B5B.PLT By: DAVID TSO 06-12-95 2:31pm

#	FS
1	1.41
2	1.46
3	1.47
4	1.47
5	1.51
6	1.51
7	1.51
8	1.51
9	1.52
10	1.52

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	45	55	200	23	0	0	W1
2	115	125	0	11	0	0	W1
3	120	125	2000	0	0	0	W1

$K_s = 0.00$



PCSTABL5M FSmin = 1.41 X-Axis (ft)

A85

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT	Landfill V, Y-12					SUBJECT	Stability Analysis		
REV #	0						SHEET	B1 OF B71	
BY & DATE	DTT	6/23/95					OFS NO.		
CHKD & DATE	WPT	6/26/95					CALC NO.	CIV-ERWM-182	

ATTACHMENT B

71 sheets

Pseudo-Static Slope Stability Analysis

File - C2	sheets B2 to B14
File - C1	sheets B15 to B26
File - B5	sheets B27 to B37
File - B4	sheets B38 to B47
File - C2E	sheets B48 to B60
File - B6A	sheets B61 to B71

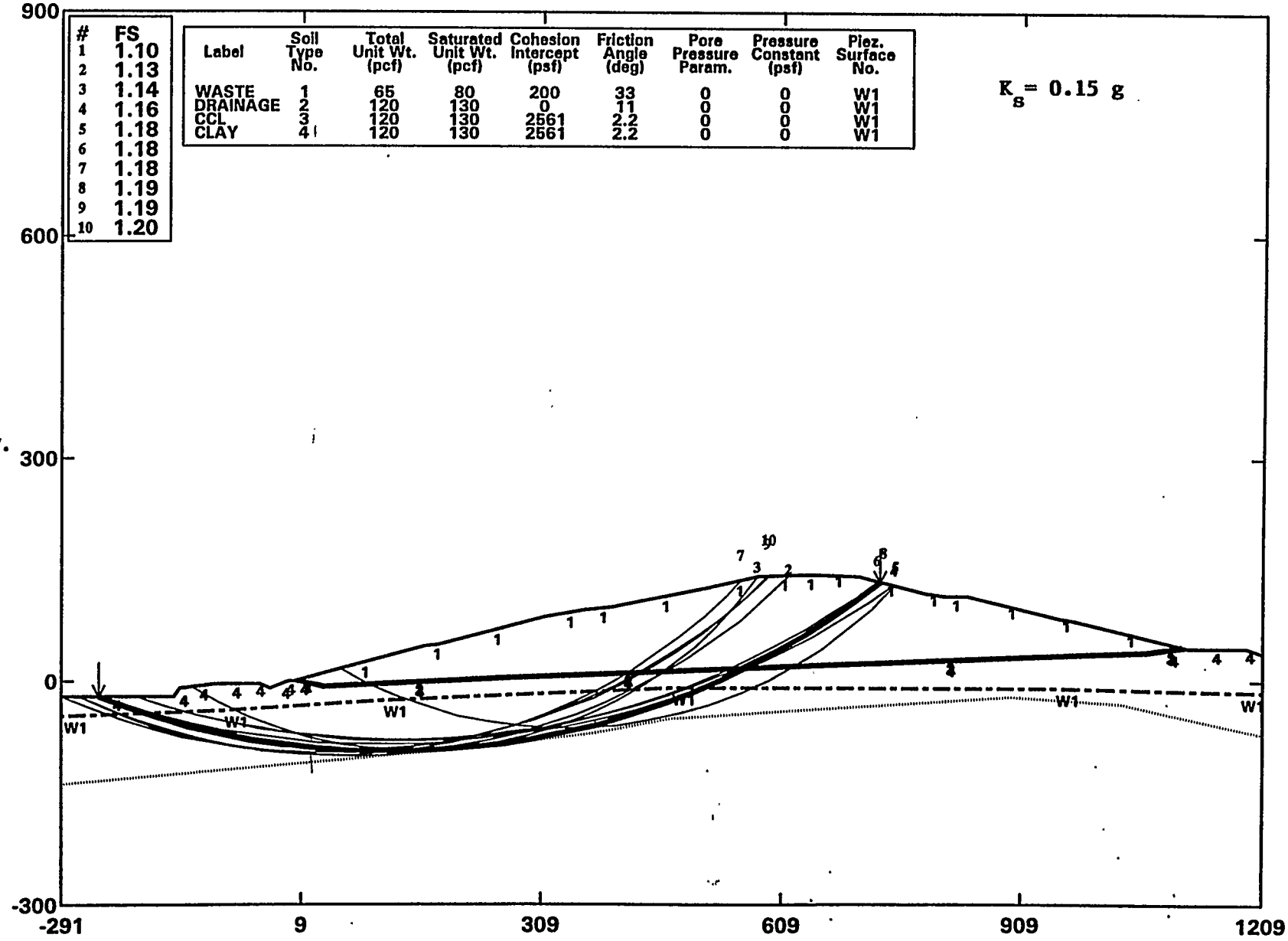
Y-12 INDUSTRIAL LANDFILL 5

Ten Most Critical. A:C2.PLT By: DAVID TSO 06-22-95 9:53am

#	FS
1	1.10
2	1.13
3	1.14
4	1.16
5	1.18
6	1.18
7	1.18
8	1.19
9	1.19
10	1.20

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	65	80	200	33	0	0	W1
DRAINAGE	2	120	130	0	11	0	0	W1
CCL	3	120	130	2561	2.2	0	0	W1
CLAY	4	120	130	2561	2.2	0	0	W1

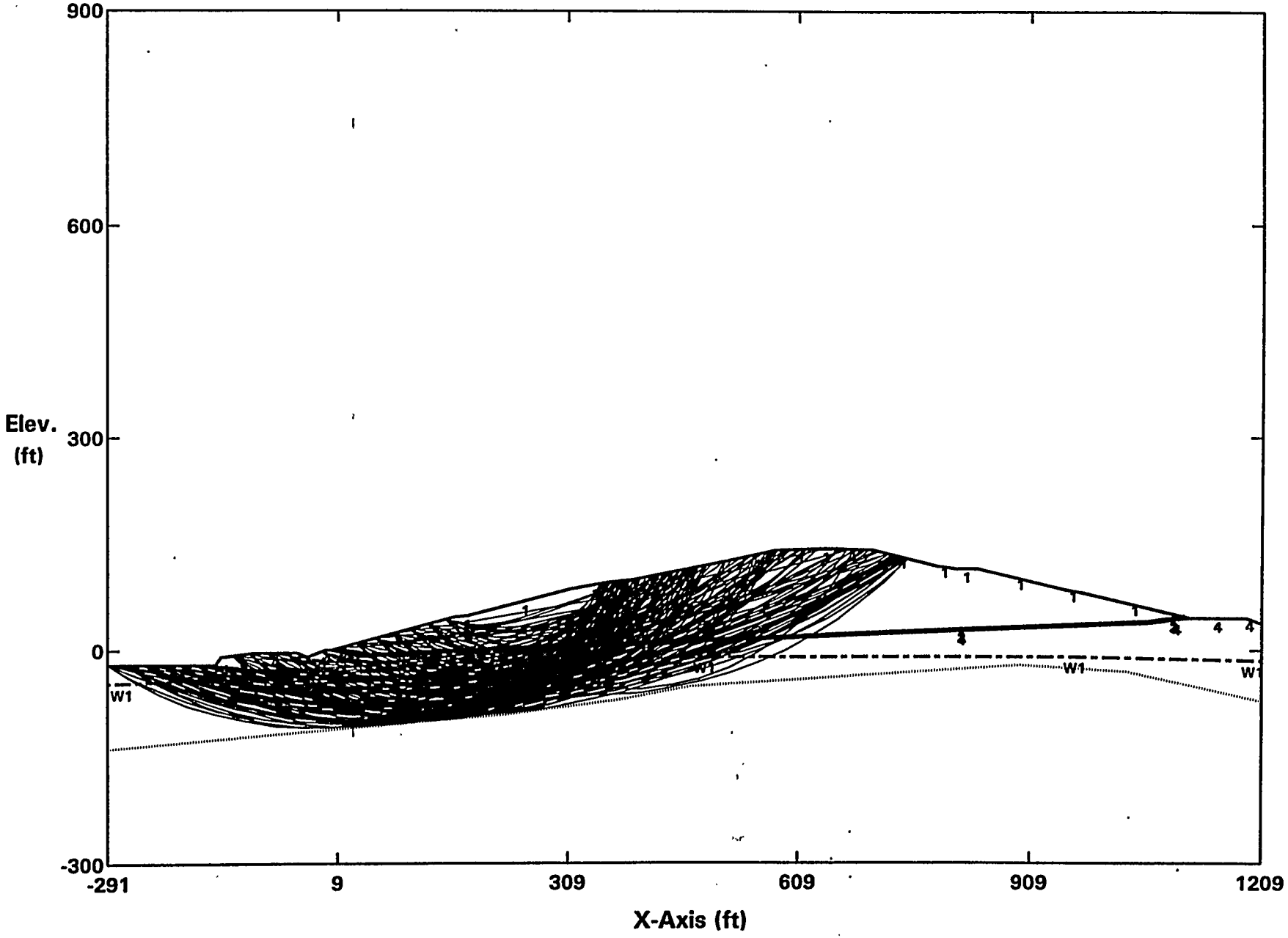
$K_s = 0.15$ g



PCSTABL5M FSmin = 1.10 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL 5

All surfaces evaluated. A:C2.PLT By: DAVID TSO 06-22-95 9:53am



B3

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	06-22-95
Time of Run:	9:53am
Run By:	DAVID TSO
Input Data Filename:	A:C2.I
Output Filename:	A:C2.OUT
Plotted Output Filename:	A:C2.PLT

PROBLEM DESCRIPTION Y-12 INDUSTRIAL LANDFILL 5

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -291.00 to X values and -300.00 to Y values listed.

25 Top Boundaries
40 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	280.00	140.00	280.00	4
2	140.00	280.00	149.00	290.00	4
3	149.00	290.00	192.00	296.00	4
4	192.00	296.00	248.00	296.00	4
5	248.00	296.00	260.00	291.00	4
6	260.00	291.00	283.00	300.00	4
7	283.00	300.00	291.00	300.00	4
8	291.00	300.00	454.00	346.50	1
9	454.00	346.50	471.00	349.00	1
10	471.00	349.00	604.00	387.00	1
11	604.00	387.00	653.00	396.00	1
12	653.00	396.00	687.00	400.00	1
13	687.00	400.00	809.00	425.70	1
14	809.00	425.70	870.00	440.00	1
15	870.00	440.00	920.00	442.00	1
16	920.00	442.00	949.00	442.00	1
17	949.00	442.00	995.00	440.00	1
18	995.00	440.00	1079.00	418.40	1
19	1079.00	418.40	1103.00	415.00	1
20	1103.00	415.00	1131.00	413.50	1

First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.42	280.00
2	83.53	265.07
3	121.25	251.75
4	159.51	240.07
5	198.23	230.05
6	237.35	221.70
7	276.79	215.04
8	316.48	210.09
9	356.35	206.85
10	396.32	205.33
11	436.32	205.53
12	476.27	207.45
13	516.11	211.09
14	555.75	216.44
15	595.12	223.50
16	634.16	232.24
17	672.78	242.65
18	710.91	254.72
19	748.49	268.42
20	785.45	283.72
21	821.72	300.60
22	857.22	319.02
23	891.90	338.95
24	925.69	360.36
25	958.52	383.21
26	990.35	407.44
27	1021.09	433.03
28	1021.32	433.23

*** 1.095 ***

Individual data on the 58 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	37.1	33240.8	.0	.0	.0	.0	4986.1	.0	.0
2	22.4	50642.2	.0	.0	.0	.0	7596.3	.0	.0
3	15.4	47520.5	.0	2989.5	.0	.0	7128.1	.0	.0

4	18.8	71694.1	.0	11041.0	.0	.0	10754.1	.0	.0
5	9.0	44805.9	.0	8030.6	.0	.0	6720.9	.0	.0
6	10.5	63622.9	.0	11614.2	.0	.0	9543.4	.0	
7	32.5	233254.3	.0	49006.5	.0	.0	34988.1	.0	.0
8	6.2	50498.0	.0	11637.8	.0	.0	7574.7	.0	.0
9	1.8	14594.0	.0	3402.6	.0	.0	2189.1	.0	.0
10	37.3	328413.2	.0	84684.5	.0	.0	49262.0	.0	.0
11	10.7	100612.1	.0	28370.4	.0	.0	15091.8	.0	.0
12	12.0	112816.5	.0	34008.1	.0	.0	16922.5	.0	.0
13	16.8	164898.9	.0	51225.3	.0	.0	24734.8	.0	.0
14	6.2	65853.0	.0	19844.5	.0	.0	9877.9	.0	.0
15	8.0	86959.6	.0	26258.2	.0	.0	13043.9	.0	.0
16	4.0	43929.9	.0	13422.3	.0	.0	6589.5	.0	.0
17	2.0	22313.2	.0	6784.5	.0	.0	3347.0	.0	.0
18	19.5	223109.7	.0	68644.3	.0	.0	33466.5	.0	.0
19	11.5	135549.7	.0	42395.7	.0	.0	20332.5	.0	.0
20	1.0	11881.7	.0	3739.9	.0	.0	1782.3	.0	.0
21	27.4	337568.2	.0	*******	.0	.0	50635.2	.0	.0
22	40.0	532563.6	.0	*******	.0	.0	79884.5	.0	.0
23	3.7	51130.1	.0	15692.9	.0	.0	7669.5	.0	.0
24	36.3	520183.8	.0	*******	.0	.0	78027.6	.0	.0
25	17.7	262353.5	.0	77293.7	.0	.0	39353.0	.0	.0
26	17.0	255524.8	.0	74257.5	.0	.0	38328.7	.0	.0
27	5.3	79788.4	.0	23027.4	.0	.0	11968.3	.0	.0
28	39.8	611956.6	.0	*******	.0	.0	91793.5	.0	.0
29	32.9	513978.7	.0	*******	.0	.0	77096.8	.0	.0
30	6.7	106016.0	.0	27503.7	.0	.0	15902.4	.0	.0
31	39.4	617614.4	.0	*******	.0	.0	92642.2	.0	.0
32	8.9	138642.5	.0	33108.0	.0	.0	20796.4	.0	
33	30.2	463435.7	.0	*******	.0	.0	69515.4	.0	.0
34	18.8	281971.9	.0	60891.3	.0	.0	42295.8	.0	.0
35	19.8	287360.8	.0	58349.0	.0	.0	43104.1	.0	.0
36	14.2	200147.5	.0	38630.3	.0	.0	30022.1	.0	.0
37	23.9	324275.1	.0	56836.2	.0	.0	48641.3	.0	.0
38	37.6	476897.3	.0	67541.6	.0	.0	71534.6	.0	.0
39	11.5	136883.6	.0	14708.2	.0	.0	20532.5	.0	.0
40	25.5	285174.6	.0	19857.8	.0	.0	42776.2	.0	.0
41	13.5	140747.3	.0	2919.0	.0	.0	21112.1	.0	.0
42	10.0	99747.5	.0	.0	.0	.0	14962.1	.0	.0
43	12.7	120623.5	.0	.0	.0	.0	18093.5	.0	.0
44	27.3	235590.3	.0	.0	.0	.0	35338.5	.0	.0
45	1.6	12566.2	.0	.0	.0	.0	1884.9	.0	.0
46	4.2	33087.1	.0	.0	.0	.0	4963.1	.0	.0
47	2.1	16247.2	.0	.0	.0	.0	2437.1	.0	.0
48	.3	2587.2	.0	.0	.0	.0	388.1	.0	.0
49	12.8	96193.4	.0	.0	.0	.0	14429.0	.0	.0
50	21.9	153423.1	.0	.0	.0	.0	23013.5	.0	.0
51	28.1	170927.8	.0	.0	.0	.0	25639.2	.0	.0
52	5.7	30850.8	.0	.0	.0	.0	4627.6	.0	.0
53	23.3	111414.6	.0	.0	.0	.0	16712.2	.0	.0
54	9.5	38318.7	.0	.0	.0	.0	5747.8	.0	.0
55	31.8	94257.6	.0	.0	.0	.0	14138.6	.0	.0
56	4.7	9294.8	.0	.0	.0	.0	1394.2	.0	.0
57	26.1	24552.0	.0	.0	.0	.0	3682.8	.0	.0
58	.2	2.0	.0	.0	.0	.0	.3	.0	.0

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.21	280.00
2	59.36	262.87
3	96.37	247.71
4	134.15	234.57
5	172.58	223.47
6	211.55	214.45
7	250.95	207.55
8	290.67	202.77
9	330.58	200.13
10	370.58	199.64
11	410.54	201.31
12	450.36	205.12
13	489.91	211.07
14	529.09	219.13
15	567.78	229.29
16	605.87	241.51
17	643.24	255.77
18	679.80	272.01
19	715.42	290.19
20	750.02	310.27
21	783.49	332.17
22	815.73	355.85
23	846.66	381.22
24	876.17	408.22
25	904.19	436.76
26	908.40	441.54

*** 1.128 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	162.47	291.88
2	196.63	271.07
3	232.33	253.02
4	269.34	237.84
5	307.43	225.63
6	346.37	216.47
7	385.90	210.41
8	425.80	207.50
9	465.80	207.74
10	505.65	211.14
11	545.12	217.67
12	583.94	227.30
13	621.88	239.97
14	658.70	255.59

15	694.18	274.07
16	728.08	295.30
17	760.21	319.13
18	790.35	345.43
19	818.32	374.02
20	843.94	404.74
21	867.06	437.38
22	868.40	439.63

*** 1.138 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	92.84	280.00
2	130.62	266.86
3	168.91	255.27
4	207.63	245.26
5	246.74	236.84
6	286.15	230.03
7	325.82	224.84
8	365.66	221.28
9	405.61	219.34
10	445.61	219.05
11	485.59	220.39
12	525.48	223.36
13	565.21	227.97
14	604.72	234.19
15	643.95	242.03
16	682.82	251.46
17	721.27	262.48
18	759.24	275.06
19	796.67	289.18
20	833.48	304.83
21	869.62	321.96
22	905.04	340.56
23	939.66	360.60
24	973.43	382.03
25	1006.30	404.83
26	1038.15	428.90

*** 1.162 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	348.16	316.31
2	382.99	296.65
3	419.20	279.64
4	456.57	265.37
5	494.90	253.93
6	533.97	245.38
7	573.58	239.76
8	613.49	237.11
9	653.49	237.44
10	693.35	240.75
11	732.85	247.02
12	771.78	256.21
13	809.92	268.28
14	847.05	283.16
15	882.97	300.77
16	917.47	321.00
17	950.38	343.74
18	981.50	368.88
19	1010.65	396.26
20	1037.69	425.74
21	1039.85	428.47

*** 1.176 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.42	280.00
2	84.08	266.51
3	122.25	254.55
4	160.87	244.14
5	199.88	235.31
6	239.22	228.06
7	278.82	222.41
8	318.62	218.37
9	358.54	215.94
10	398.53	215.13
11	438.52	215.94
12	478.45	218.36
13	518.25	222.40
14	557.85	228.04
15	597.19	235.29
16	636.20	244.11
17	674.82	254.51
18	713.00	266.47
19	750.65	279.96
20	787.73	294.96
21	824.18	311.45

22	859.92	329.40
23	894.91	348.78
24	929.09	369.56
25	962.40	391.71
26	994.78	415.19
27	1018.56	433.94

*** 1.176 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.21	280.00
2	59.03	262.19
3	95.84	246.55
4	133.53	233.14
5	171.95	222.00
6	210.96	213.18
7	250.43	206.70
8	290.22	202.59
9	330.18	200.86
10	370.18	201.52
11	410.06	204.57
12	449.69	209.99
13	488.93	217.77
14	527.63	227.88
15	565.66	240.28
16	602.88	254.94
17	639.16	271.78
18	674.37	290.77
19	708.38	311.82
20	741.07	334.86
21	772.33	359.82
22	802.05	386.60
23	830.11	415.10
24	847.18	434.65

*** 1.177 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	92.84	280.00

2	130.68	267.01
3	169.02	255.61
4	207.80	245.81
5	246.95	237.63
6	286.41	231.08
7	326.11	226.18
8	365.98	222.94
9	405.95	221.35
10	445.95	221.43
11	485.91	223.17
12	525.77	226.56
13	565.44	231.61
14	604.88	238.31
15	644.00	246.64
16	682.75	256.59
17	721.04	268.14
18	758.83	281.27
19	796.03	295.96
20	832.59	312.18
21	868.45	329.91
22	903.54	349.11
23	937.80	369.76
24	971.17	391.81
25	1003.60	415.22
26	1025.20	432.23

*** 1.188 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.42	280.00
2	82.82	263.41
3	120.10	248.91
4	158.14	236.54
5	196.82	226.35
6	236.01	218.36
7	275.60	212.60
8	315.44	209.10
9	355.42	207.85
10	395.41	208.87
11	435.27	212.15
12	474.89	217.69
13	514.13	225.45
14	552.86	235.43
15	590.97	247.58
16	628.33	261.87
17	664.82	278.26
18	700.33	296.68
19	734.73	317.08

20	767.93	339.40
21	799.81	363.56
22	830.27	389.49
23	859.21	417.10
24	881.06	440.44

*** 1.190 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	.00	280.00
2	36.42	263.45
3	73.66	248.85
4	111.61	236.23
5	150.18	225.62
6	189.25	217.06
7	228.72	210.57
8	268.48	206.17
9	308.42	203.87
10	348.42	203.68
11	388.37	205.59
12	428.17	209.61
13	467.70	215.71
14	506.85	223.89
15	545.52	234.13
16	583.60	246.38
17	620.98	260.62
18	657.55	276.82
19	693.22	294.91
20	727.89	314.86
21	761.46	336.61
22	793.84	360.10
23	824.94	385.26
24	854.67	412.03
25	882.94	440.32
26	883.13	440.53

*** 1.196 ***

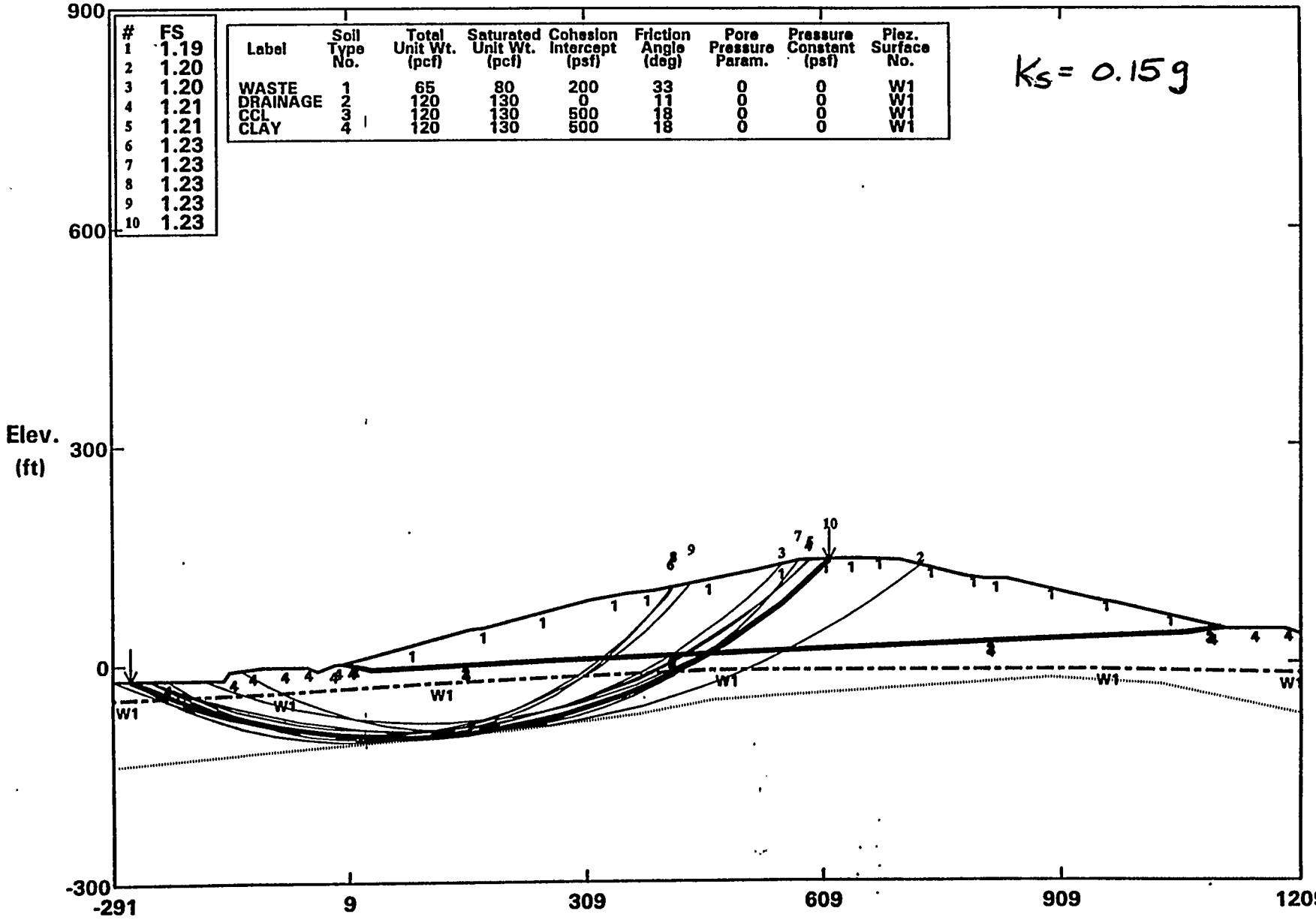
Y-12 INDUSTRIAL LANDFILL 5

Ten Most Critical. A:C1.PLT By: DAVID TSO 06-21-95 1:29pm

#	FS
1	1.19
2	1.20
3	1.20
4	1.21
5	1.21
6	1.23
7	1.23
8	1.23
9	1.23
10	1.23

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	65	80	200	33	0	0	W1
DRAINAGE	2	120	130	0	11	0	0	W1
CCL	3	120	130	500	18	0	0	W1
CLAY	4	120	130	500	18	0	0	W1

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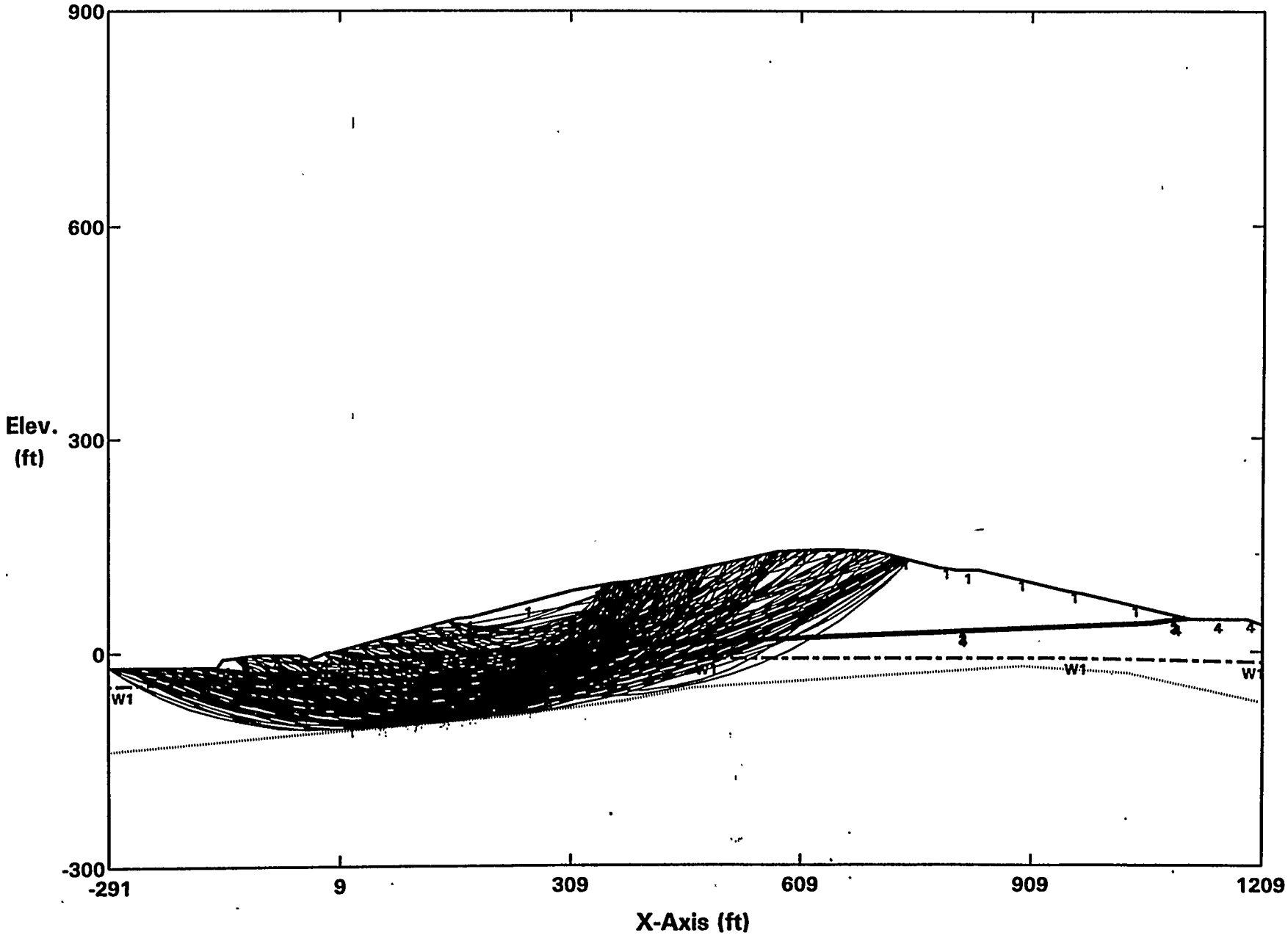


PCSTABL5M FSmin = 1.19 X-Axis (ft)

B15

Y-12 INDUSTRIAL LANDFILL 5

All surfaces evaluated. A:C1.PLT By: DAVID TSO 06-21-95 1:29pm



B16

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	06-21-95
Time of Run:	1:29pm
Run By:	DAVID TSO
Input Data Filename:	A:C1.I
Output Filename:	A:C1.OUT
Plotted Output Filename:	A:C1.PLT

PROBLEM DESCRIPTION Y-12 INDUSTRIAL LANDFILL 5

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -291.00 to X values and -300.00 to Y values listed.

25 Top Boundaries
40 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	280.00	140.00	280.00	4
2	140.00	280.00	149.00	290.00	4
3	149.00	290.00	192.00	296.00	4
4	192.00	296.00	248.00	296.00	4
5	248.00	296.00	260.00	291.00	4
6	260.00	291.00	283.00	300.00	4
7	283.00	300.00	291.00	300.00	4
8	291.00	300.00	454.00	346.50	1
9	454.00	346.50	471.00	349.00	1
10	471.00	349.00	604.00	387.00	1
11	604.00	387.00	653.00	396.00	1
12	653.00	396.00	687.00	400.00	1
13	687.00	400.00	809.00	425.70	1
14	809.00	425.70	870.00	440.00	1
15	870.00	440.00	920.00	442.00	1
16	920.00	442.00	949.00	442.00	1
17	949.00	442.00	995.00	440.00	1
18	995.00	440.00	1079.00	418.40	1
19	1079.00	418.40	1103.00	415.00	1
20	1103.00	415.00	1131.00	413.50	1

21	1131.00	413.50	1246.00	384.00	1
22	1246.00	384.00	1267.00	381.00	1
23	1267.00	381.00	1407.00	345.00	1
24	1407.00	345.00	1480.00	345.00	4
25	1480.00	345.00	1500.00	338.00	4
26	297.00	301.50	328.00	294.20	2
27	328.00	294.20	549.00	305.00	2
28	549.00	305.00	849.00	318.50	2
29	849.00	318.50	1353.50	340.50	2
30	1353.50	340.50	1398.00	348.00	2
31	295.00	301.00	328.00	293.00	3
32	328.00	293.00	549.00	304.00	3
33	549.00	304.00	849.00	317.50	3
34	849.00	317.50	1353.50	339.50	3
35	1353.50	339.50	1401.00	347.00	3
36	291.00	300.00	329.00	291.00	4
37	329.00	291.00	549.00	302.00	4
38	549.00	302.00	849.00	315.50	4
39	849.00	315.50	1353.50	337.50	4
40	1353.50	337.50	1407.00	345.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	65.0	80.0	200.0	33.0	.00	.0	1
2	120.0	130.0	.0	11.0	.00	.0	1
3	120.0	130.0	500.0	18.0	.00	.0	1
4	120.0	130.0	500.0	18.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	254.00
2	200.00	260.00
3	400.00	274.00
4	760.00	290.00
5	1240.00	290.00

6 1500.00 285.00

A Horizontal Earthquake Loading Coefficient
Of .150 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

Searching Routine Will Be Limited To An Area Defined By 6 Boundaries
Of Which The First 6 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	161.00	520.00	210.00
2	520.00	210.00	668.00	230.00
3	668.00	230.00	760.00	250.00
4	760.00	250.00	1187.00	280.00
5	1187.00	280.00	1324.00	270.00
6	1324.00	270.00	1500.00	228.00

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

Janbus Empirical Coef. is being used for the case of c & phi both >
200 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = .00 ft.
and X = 441.00 ft.

Each Surface Terminates Between X = 641.00 ft.
and X =1041.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y =150.00 ft.

40.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical

First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.21	280.00
2	59.36	262.87
3	96.37	247.71
4	134.15	234.57
5	172.58	223.47
6	211.55	214.45
7	250.95	207.55
8	290.67	202.77
9	330.58	200.13
10	370.58	199.64
11	410.54	201.31
12	450.36	205.12
13	489.91	211.07
14	529.09	219.13
15	567.78	229.29
16	605.87	241.51
17	643.24	255.77
18	679.80	272.01
19	715.42	290.19
20	750.02	310.27
21	783.49	332.17
22	815.73	355.85
23	846.66	381.22
24	876.17	408.22
25	904.19	436.76
26	908.40	441.54

*** 1.189 ***

Individual data on the 51 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	36.1	37147.5	.0	.0	.0	.0	5572.1	.0	.(
2	16.1	39556.7	.0	.0	.0	.0	5933.5	.0	.(
3	20.9	71150.4	.0	6459.2	.0	.0	10672.6	.0	.(
4	37.8	182331.1	.0	40713.8	.0	.0	27349.7	.0	.(
5	5.8	33901.9	.0	9260.1	.0	.0	5085.3	.0	.(

6	9.0	60103.9	.0	15634.2	.0	.0	9015.6	.0	.0
7	23.6	190826.3	.0	48915.3	.0	.0	28624.0	.0	.0
8	19.4	178512.4	.0	47545.7	.0	.0	26776.9	.0	.0
9	8.0	78176.3	.0	21423.1	.0	.0	11726.4	.0	.0
10	11.6	116340.8	.0	32931.7	.0	.0	17451.1	.0	.0
11	36.4	389112.7	.0	*******	.0	.0	58366.9	.0	.0
12	3.0	32663.0	.0	10383.4	.0	.0	4899.4	.0	.0
13	9.0	98383.5	.0	32268.2	.0	.0	14757.5	.0	.0
14	23.0	263328.0	.0	86423.0	.0	.0	39499.2	.0	.0
15	7.7	93822.2	.0	30205.8	.0	.0	14073.3	.0	.0
16	.3	4115.6	.0	1327.2	.0	.0	617.3	.0	.0
17	4.0	49339.5	.0	15944.5	.0	.0	7400.9	.0	.0
18	2.0	24972.1	.0	8023.2	.0	.0	3745.8	.0	.0
19	31.0	396344.2	.0	*******	.0	.0	59451.6	.0	.0
20	1.0	13031.1	.0	4287.4	.0	.0	1954.7	.0	.0
21	1.6	20632.0	.0	6785.1	.0	.0	3094.8	.0	.0
22	40.0	542549.0	.0	*******	.0	.0	81382.4	.0	.0
23	29.4	420119.1	.0	*******	.0	.0	63017.9	.0	.0
24	10.5	153978.2	.0	48105.8	.0	.0	23096.7	.0	.0
25	39.8	592381.9	.0	*******	.0	.0	88857.3	.0	.0
26	3.6	54851.3	.0	16279.3	.0	.0	8227.7	.0	.0
27	17.0	255180.3	.0	74837.9	.0	.0	38277.0	.0	.0
28	18.9	283205.5	.0	80999.6	.0	.0	42480.8	.0	.0
29	39.2	583540.6	.0	*******	.0	.0	87531.1	.0	.0
30	19.9	292063.7	.0	74976.0	.0	.0	43809.6	.0	.0
31	18.8	271006.4	.0	65631.4	.0	.0	40651.0	.0	.0
32	36.2	505030.6	.0	*******	.0	.0	75754.6	.0	.0
33	1.9	25318.6	.0	5124.3	.0	.0	3797.8	.0	.0
34	37.4	481330.7	.0	88124.1	.0	.0	72199.6	.0	.0
35	9.8	117294.9	.0	18034.3	.0	.0	17594.2	.0	.0
36	26.8	299548.8	.0	36163.2	.0	.0	44932.3	.0	.0
37	7.2	74532.6	.0	6427.5	.0	.0	11179.9	.0	.0
38	23.8	226953.5	.0	9201.6	.0	.0	34043.0	.0	.0
39	4.7	41352.8	.0	.0	.0	.0	6202.9	.0	.0
40	34.6	270836.1	.0	.0	.0	.0	40625.4	.0	.0
41	1.3	8759.5	.0	.0	.0	.0	1313.9	.0	.0
42	3.3	22055.7	.0	.0	.0	.0	3308.3	.0	.0
43	1.6	10775.8	.0	.0	.0	.0	1616.4	.0	.0
44	27.3	166985.9	.0	.0	.0	.0	25047.9	.0	.0
45	25.5	135096.6	.0	.0	.0	.0	20264.5	.0	.0
46	6.7	31998.5	.0	.0	.0	.0	4799.8	.0	.0
47	30.9	125366.5	.0	.0	.0	.0	18805.0	.0	.0
48	23.3	68840.0	.0	.0	.0	.0	10326.0	.0	.0
49	6.2	13930.3	.0	.0	.0	.0	2089.5	.0	.0
50	28.0	33363.2	.0	.0	.0	.0	5004.5	.0	.0
51	4.2	629.7	.0	.0	.0	.0	94.4	.0	.0

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.42	280.00
2	83.53	265.07
3	121.25	251.75
4	159.51	240.07
5	198.23	230.05

6	237.35	221.70
7	276.79	215.04
8	316.48	210.09
9	356.35	206.85
10	396.32	205.33
11	436.32	205.53
12	476.27	207.45
13	516.11	211.09
14	555.75	216.44
15	595.12	223.50
16	634.16	232.24
17	672.78	242.65
18	710.91	254.72
19	748.49	268.42
20	785.45	283.72
21	821.72	300.60
22	857.22	319.02
23	891.90	338.95
24	925.69	360.36
25	958.52	383.21
26	990.35	407.44
27	1021.09	433.03
28	1021.32	433.23

*** 1.201 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.21	280.00
2	59.03	262.19
3	95.84	246.55
4	133.53	233.14
5	171.95	222.00
6	210.96	213.18
7	250.43	206.70
8	290.22	202.59
9	330.18	200.86
10	370.18	201.52
11	410.06	204.57
12	449.69	209.99
13	488.93	217.77
14	527.63	227.88
15	565.66	240.28
16	602.88	254.94
17	639.16	271.78
18	674.37	290.77
19	708.38	311.82
20	741.07	334.86
21	772.33	359.82

22	802.05	386.60
23	830.11	415.10
24	847.18	434.65

*** 1.204 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.42	280.00
2	82.82	263.41
3	120.10	248.91
4	158.14	236.54
5	196.82	226.35
6	236.01	218.36
7	275.60	212.60
8	315.44	209.10
9	355.42	207.85
10	395.41	208.87
11	435.27	212.15
12	474.89	217.69
13	514.13	225.45
14	552.86	235.43
15	590.97	247.58
16	628.33	261.87
17	664.82	278.26
18	700.33	296.68
19	734.73	317.08
20	767.93	339.40
21	799.81	363.56
22	830.27	389.49
23	859.21	417.10
24	881.06	440.44

*** 1.210 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	.00	280.00
2	36.42	263.45
3	73.66	248.85
4	111.61	236.23

5	150.18	225.62
6	189.25	217.06
7	228.72	210.57
8	268.48	206.17
9	308.42	203.87
10	348.42	203.68
11	388.37	205.59
12	428.17	209.61
13	467.70	215.71
14	506.85	223.89
15	545.52	234.13
16	583.60	246.38
17	620.98	260.62
18	657.55	276.82
19	693.22	294.91
20	727.89	314.86
21	761.46	336.61
22	793.84	360.10
23	824.94	385.26
24	854.67	412.03
25	882.94	440.32
26	883.13	440.53

*** 1.211 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	69.63	280.00
2	102.91	257.81
3	138.06	238.72
4	174.79	222.88
5	212.80	210.42
6	251.79	201.45
7	291.42	196.04
8	331.38	194.23
9	371.34	196.04
10	410.97	201.45
11	449.95	210.41
12	487.96	222.87
13	524.69	238.70
14	559.84	257.79
15	593.13	279.98
16	624.27	305.08
17	653.02	332.90
18	679.13	363.19
19	702.41	395.73
20	707.44	404.31

*** 1.228 ***

13	481.72	225.66
14	518.49	241.41
15	553.87	260.06
16	587.64	281.50
17	619.58	305.58
18	649.49	332.14
19	677.16	361.03
20	702.42	392.04
21	711.45	405.15

*** 1.230 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.42	280.00
2	81.12	260.09
3	117.25	242.94
4	154.61	228.64
5	192.96	217.29
6	232.08	208.94
7	271.73	203.66
8	311.67	201.48
9	351.66	202.40
10	391.46	206.42
11	430.82	213.52
12	469.52	223.66
13	507.31	236.77
14	543.97	252.77
15	579.28	271.57
16	613.02	293.06
17	644.99	317.09
18	674.99	343.54
19	702.86	372.24
20	728.41	403.02
21	733.15	409.72

*** 1.232 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	116.05	280.00

2	153.01	264.69
3	190.78	251.53
4	229.25	240.56
5	268.28	231.84
6	307.76	225.37
7	347.54	221.19
8	387.49	219.31
9	427.49	219.73
10	467.40	222.45
11	507.08	227.47
12	546.41	234.77
13	585.25	244.32
14	623.48	256.09
15	660.97	270.05
16	697.59	286.14
17	733.22	304.31
18	767.75	324.51
19	801.06	346.66
20	833.03	370.69
21	863.57	396.52
22	892.57	424.07
23	908.97	441.56

*** 1.233 ***

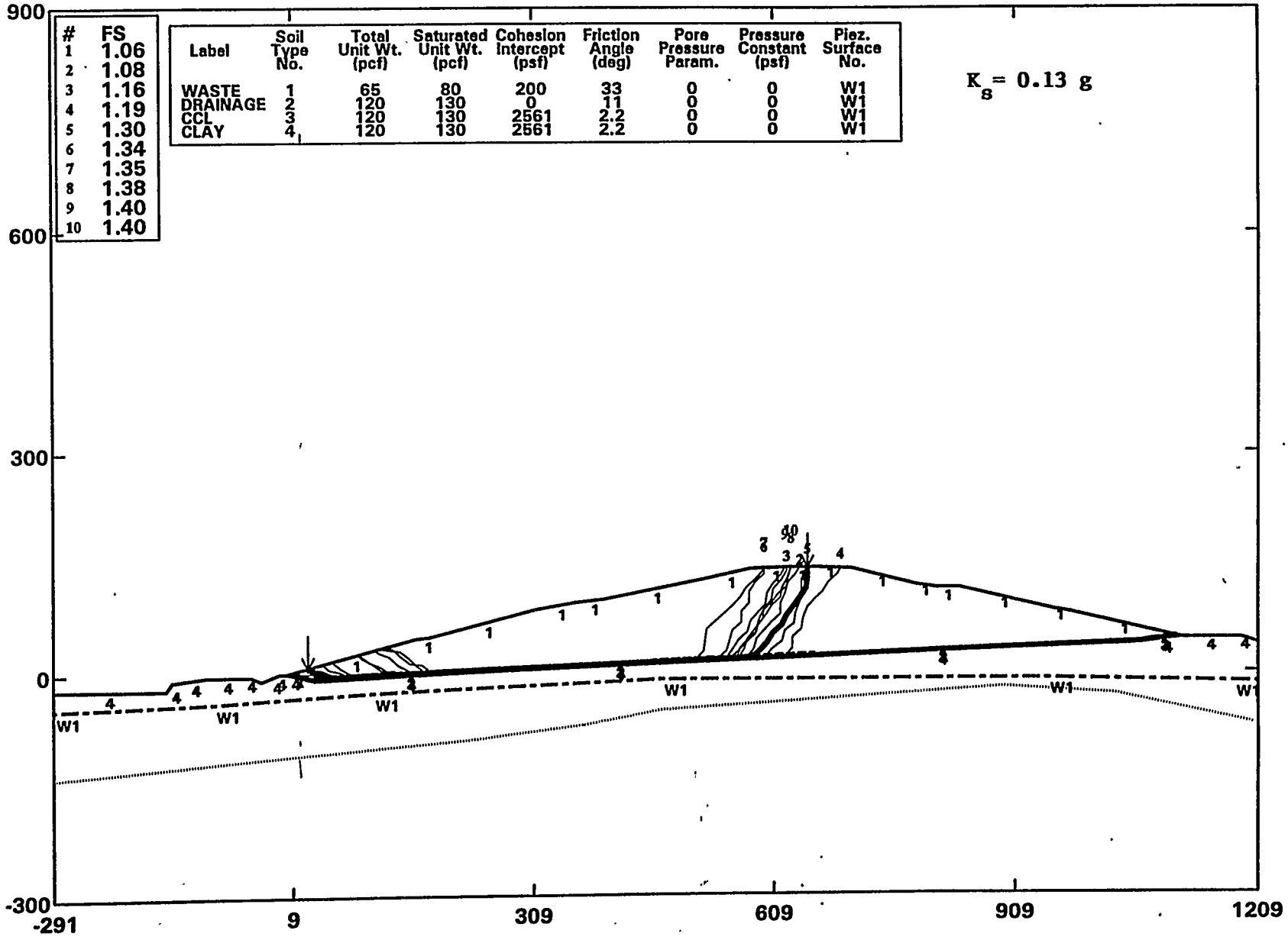
Y-12 INDUSTRIAL LANDFILL 5

Ten Most Critical. A:B5.PLT By: DAVID TSO 06-22-95 4:30pm

#	FS
1	1.06
2	1.08
3	1.16
4	1.19
5	1.30
6	1.34
7	1.35
8	1.38
9	1.40
10	1.40

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	65	80	200	33	0	0	W1
DRAINAGE	2	120	130	0	11	0	0	W1
CCL	3	120	130	2561	2.2	0	0	W1
CLAY	4	120	130	2561	2.2	0	0	W1

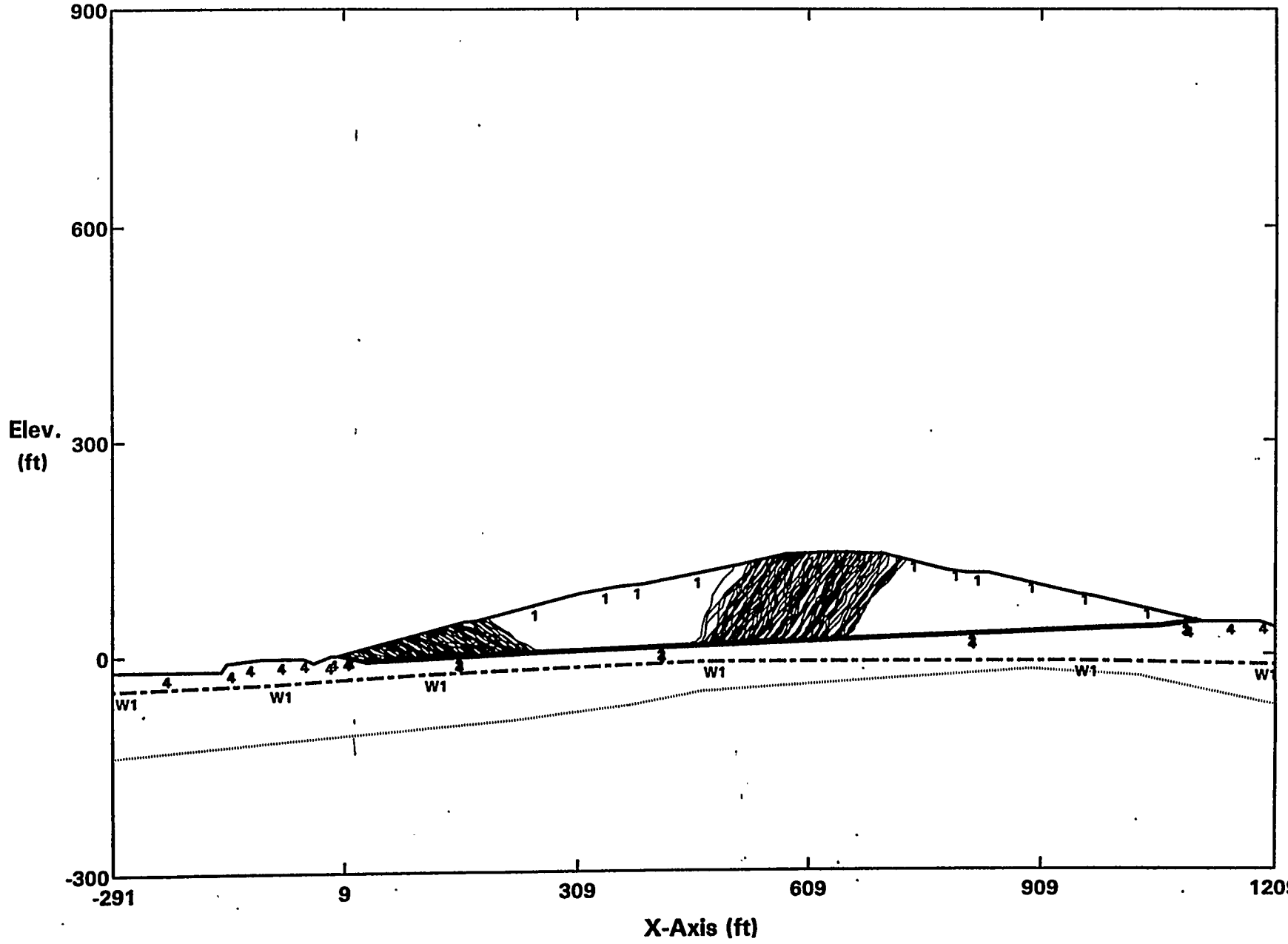
$K_s = 0.13$ g



PCSTABL5M FSmin = 1.06 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL 5

All surfaces evaluated. A:B5.PLT By: DAVID TSO 06-22-95 4:30pm



** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	06-22-95
Time of Run:	4:30pm
Run By:	DAVID TSO
Input Data Filename:	A:B5.I
Output Filename:	A:B5.OUT
Plotted Output Filename:	A:B5.PLT

PROBLEM DESCRIPTION Y-12 INDUSTRIAL LANDFILL 5

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -291.00 to X values and -300.00 to Y values listed.

25 Top Boundaries
40 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	280.00	140.00	280.00	4
2	140.00	280.00	149.00	290.00	4
3	149.00	290.00	192.00	296.00	4
4	192.00	296.00	248.00	296.00	4
5	248.00	296.00	260.00	291.00	4
6	260.00	291.00	283.00	300.00	4
7	283.00	300.00	291.00	300.00	4
8	291.00	300.00	454.00	346.50	1
9	454.00	346.50	471.00	349.00	1
10	471.00	349.00	604.00	387.00	1
11	604.00	387.00	653.00	396.00	1
12	653.00	396.00	687.00	400.00	1
13	687.00	400.00	809.00	425.70	1
14	809.00	425.70	870.00	440.00	1
15	870.00	440.00	920.00	442.00	1
16	920.00	442.00	949.00	442.00	1
17	949.00	442.00	995.00	440.00	1
18	995.00	440.00	1079.00	418.40	1
19	1079.00	418.40	1103.00	415.00	1
20	1103.00	415.00	1131.00	413.50	1

21	1131.00	413.50	1246.00	384.00	1
22	1246.00	384.00	1267.00	381.00	1
23	1267.00	381.00	1407.00	345.00	1
24	1407.00	345.00	1480.00	345.00	4
25	1480.00	345.00	1500.00	338.00	4
26	297.00	301.50	328.00	294.20	2
27	328.00	294.20	549.00	305.00	2
28	549.00	305.00	849.00	318.50	2
29	849.00	318.50	1353.50	340.50	2
30	1353.50	340.50	1398.00	348.00	2
31	295.00	301.00	328.00	293.00	3
32	328.00	293.00	549.00	304.00	3
33	549.00	304.00	849.00	317.50	3
34	849.00	317.50	1353.50	339.50	3
35	1353.50	339.50	1401.00	347.00	3
36	291.00	300.00	329.00	291.00	4
37	329.00	291.00	549.00	302.00	4
38	549.00	302.00	849.00	315.50	4
39	849.00	315.50	1353.50	337.50	4
40	1353.50	337.50	1407.00	345.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	65.0	80.0	200.0	33.0	.00	.0	1
2	120.0	130.0	.0	11.0	.00	.0	1
3	120.0	130.0	2561.0	2.2	.00	.0	1
4	120.0	130.0	2561.0	2.2	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	254.00
2	200.00	260.00
3	400.00	274.00
4	760.00	290.00
5	1240.00	290.00

6	1500.00	285.00

A Horizontal Earthquake Loading Coefficient
Of .130 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

Searching Routine Will Be Limited To An Area Defined By 6 Boundaries
Of Which The First 6 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	161.00	520.00	210.00
2	520.00	210.00	668.00	230.00
3	668.00	230.00	760.00	250.00
4	760.00	250.00	1187.00	280.00
5	1187.00	280.00	1324.00	270.00
6	1324.00	270.00	1500.00	228.00

Janbus Empirical Coef is being used for the case of c & phi both > C

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Sliding Block Surfaces, Has Been
Specified.

100 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of
Sliding Block Is 15.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	328.00	294.20	549.00	305.00	3.00
2	749.00	314.00	949.00	322.50	3.00

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	317.93	307.68
2	321.38	305.62
3	335.79	301.46
4	349.51	295.41
5	869.94	318.41
6	880.53	329.03
7	890.81	339.95
8	898.79	352.65
9	908.54	364.05
10	914.96	377.61
11	924.30	389.35
12	932.60	401.84
13	939.66	415.07
14	941.83	429.91
15	942.13	442.00

*** 1.062 ***

Individual data on the 27 slices

Slice No.	Width Ft (m)	Weight Lbs (kg)	Water Force Top Lbs (kg)	Water Force Bot Lbs (kg)	Tie Force Norm Lbs (kg)	Tie Force Tan Lbs (kg)	Earthquake Force Hor Lbs (kg)	Earthquake Force Ver Lbs (kg)	Surcharge Load Lbs (kg)
1	3.5	341.9	.0	.0	.0	.0	44.4	.0	.0
2	14.4	6726.7	.0	.0	.0	.0	874.5	.0	.0
3	13.7	14538.3	.0	.0	.0	.0	1890.0	.0	.0
4	33.8	55787.6	.0	.0	.0	.0	7252.4	.0	.0
5	70.6	174936.8	.0	.0	.0	.0	22741.8	.0	.0
6	17.0	52663.7	.0	.0	.0	.0	6846.3	.0	.0
7	78.0	294772.3	.0	.0	.0	.0	38320.4	.0	.0
8	55.0	265887.1	.0	.0	.0	.0	34565.3	.0	.0
9	49.0	269030.8	.0	.0	.0	.0	34974.0	.0	.0
10	34.0	197047.9	.0	.0	.0	.0	25616.2	.0	.0
11	122.0	797894.8	.0	.0	.0	.0	*******	.0	.0
12	40.0	298039.4	.0	.0	.0	.0	38745.1	.0	.0
13	20.9	163884.8	.0	.0	.0	.0	21305.0	.0	.0
14	.0	11.7	.0	.0	.0	.0	1.5	.0	.0
15	.1	504.9	.0	.0	.0	.0	65.6	.0	.0
16	1.0	7741.0	.0	.0	.0	.0	1006.3	.0	.0
17	9.6	72027.7	.0	.0	.0	.0	9363.6	.0	.0
18	10.3	70912.2	.0	.0	.0	.0	9218.6	.0	.0

19	8.0	49080.7	.0	.0	.0	.0	6380.5	.0	.0
20	9.8	52631.5	.0	.0	.0	.0	6842.1	.0	.0
21	6.4	29523.3	.0	.0	.0	.0	3838.0	.0	.0
22	5.0	20042.6	.0	.0	.0	.0	2605.5	.0	.0
23	4.3	15457.3	.0	.0	.0	.0	2009.4	.0	.0
24	8.3	25053.7	.0	.0	.0	.0	3257.0	.0	.0
25	7.1	15387.5	.0	.0	.0	.0	2000.4	.0	.0
26	2.2	2753.7	.0	.0	.0	.0	358.0	.0	.0
27	.3	117.9	.0	.0	.0	.0	15.3	.0	.0

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	320.02	308.28
2	327.14	305.37
3	337.75	294.77
4	864.76	318.82
5	874.16	330.51
6	877.26	345.19
7	887.00	356.59
8	897.08	367.70
9	906.71	379.20
10	907.15	394.19
11	913.77	407.65
12	916.06	422.48
13	926.26	433.48
14	931.05	442.00

*** 1.075 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	380.37	325.49
2	385.76	320.41
3	399.12	313.58
4	410.99	304.41
5	425.94	303.13
6	440.32	298.88
7	854.85	318.65
8	862.32	331.66
9	867.18	345.85
10	875.42	358.38
11	884.21	370.53
12	886.70	385.33
13	896.21	396.93
14	897.72	411.85

15	907.46	423.26
16	914.47	436.52
17	915.02	441.80

*** 1.158 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	304.91	303.97
2	308.54	300.52
3	323.51	299.59
4	337.86	295.22
5	912.51	320.46
6	921.77	332.26
7	922.77	347.23
8	932.95	358.25
9	936.40	372.84
10	940.51	387.27
11	950.37	398.58
12	960.55	409.59
13	968.42	422.37
14	978.10	433.82
15	982.16	440.56

*** 1.191 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	349.88	316.80
2	351.40	315.32
3	362.42	305.15
4	375.69	298.14
5	390.68	297.63
6	888.05	319.97
7	897.98	331.22
8	908.57	341.83
9	913.79	355.90
10	924.38	366.52
11	925.64	381.47
12	932.57	394.77
13	932.82	409.77

14	932.86	424.77
15	938.45	438.69
16	941.66	442.00

*** 1.301 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	336.74	313.05
2	345.76	304.84
3	360.36	301.41
4	374.28	295.81
5	829.46	316.93
6	840.06	327.54
7	843.64	342.10
8	847.46	356.61
9	858.02	367.26
10	858.41	382.26
11	868.19	393.62
12	868.86	408.61
13	875.65	421.98
14	886.26	432.59
15	887.56	440.70

*** 1.340 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	406.83	333.04
2	417.72	331.53
3	432.61	329.70
4	444.69	320.80
5	455.35	310.25
6	466.87	300.64
7	802.31	316.20
8	811.07	328.38
9	814.45	342.99
10	816.55	357.84
11	827.09	368.51
12	837.18	379.61
13	847.33	390.66

14	857.63	401.56
15	864.55	414.87
16	874.78	425.84
17	884.28	437.45
18	886.34	440.65

*** 1.349 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	408.87	333.63
2	408.96	333.55
3	423.96	333.30
4	434.57	322.70
5	446.11	313.11
6	460.86	310.41
7	472.86	301.41
8	852.65	317.63
9	856.15	332.22
10	866.72	342.87
11	877.24	353.56
12	879.98	368.31
13	884.97	382.45
14	895.52	393.12
15	903.74	405.66
16	914.34	416.28
17	917.73	430.89
18	920.45	442.00

*** 1.379 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	380.39	325.50
2	383.64	324.70
3	395.22	315.17
4	408.76	308.71
5	421.23	300.37
6	436.22	299.92
7	840.20	317.89
8	848.27	330.53

9	855.56	343.64
10	865.66	354.73
11	870.00	369.09
12	878.57	381.40
13	889.18	392.01
14	890.66	406.93
15	897.75	420.15
16	908.29	430.83
17	913.31	441.73

*** 1.395 ***

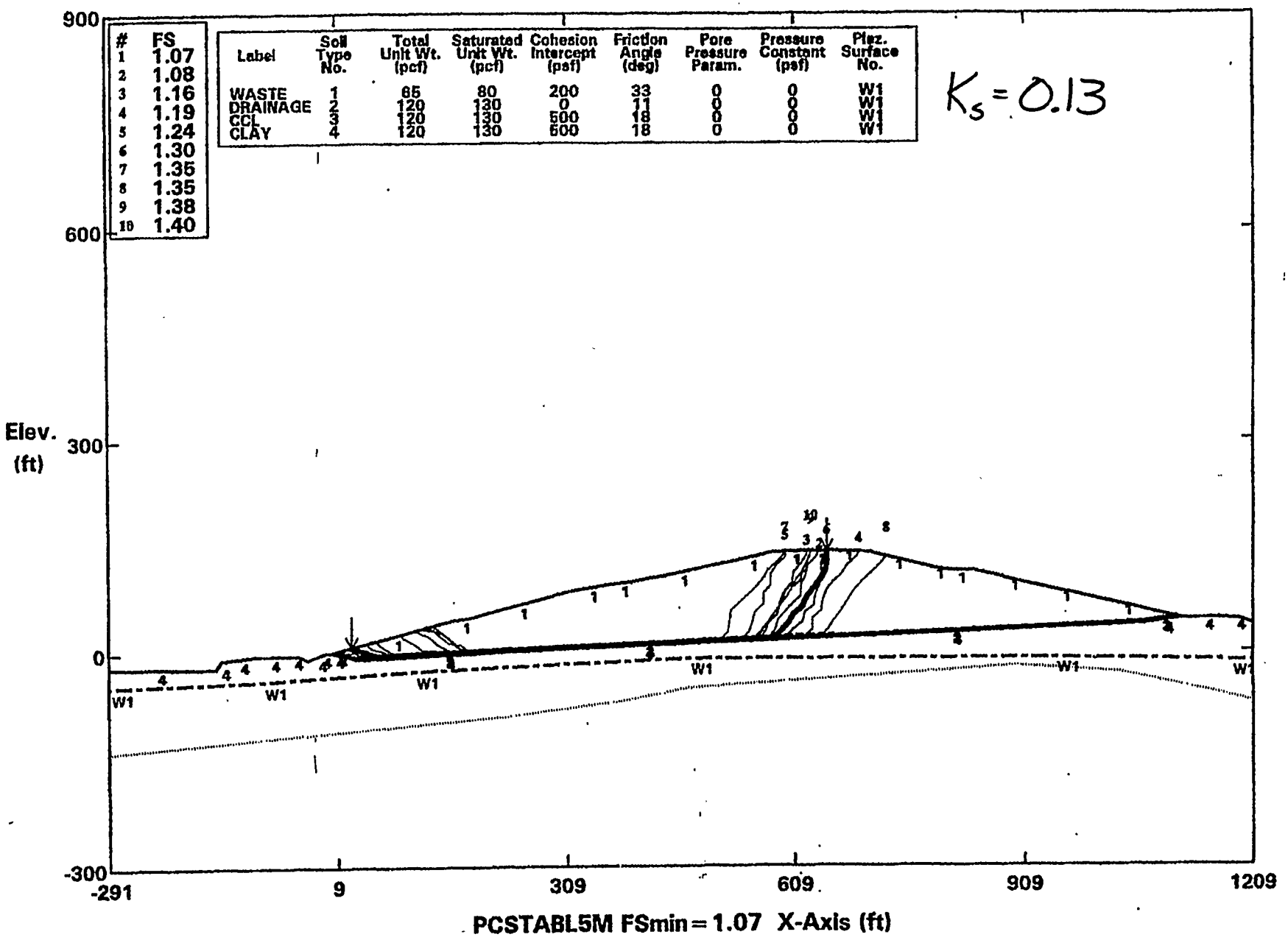
Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	400.66	331.28
2	406.91	328.19
3	420.46	321.74
4	431.28	311.36
5	444.20	303.74
6	458.83	300.40
7	844.64	317.14
8	854.42	328.51
9	864.43	339.69
10	874.93	350.40
11	880.13	364.47
12	889.25	376.38
13	897.15	389.12
14	906.99	400.44
15	909.54	415.23
16	916.52	428.50
17	921.52	442.00

*** 1.404 ***

Y-12 INDUSTRIAL LANDFILL 5

Ten Most Critical. A:B4.PLT By: DAVID TSO 06-27-95 11:54am



#	FS
1	1.07
2	1.08
3	1.16
4	1.19
5	1.24
6	1.30
7	1.35
8	1.35
9	1.38
10	1.40

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	65	80	200	33	0	0	W1
DRAINAGE	2	120	130	0	11	0	0	W1
CCL	3	120	130	500	18	0	0	W1
CLAY	4	120	130	500	18	0	0	W1

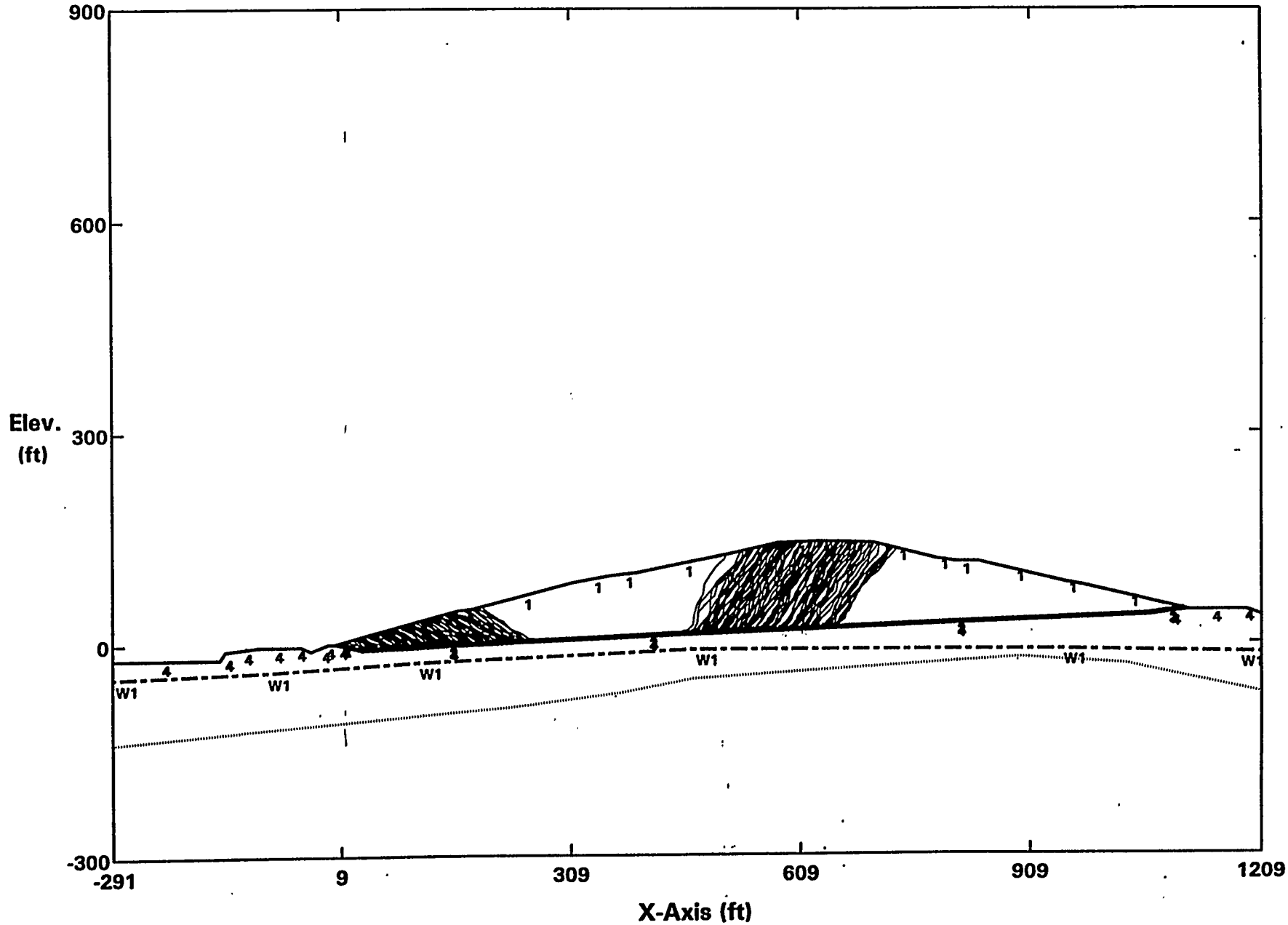
$K_s = 0.13$

PCSTABL5M FSmin = 1.07 X-Axis (ft)

B38

Y-12 INDUSTRIAL LANDFILL 5

All surfaces evaluated. A:B4.PLT By: DAVID TSO 06-21-95 1:26pm



B3

B40

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 06-21-95
Time of Run: 1:26pm
Run By: DAVID TSO
Input Data Filename: A:B4.I
Output Filename: A:B4.OUT
Plotted Output Filename: A:B4.PLT

PROBLEM DESCRIPTION Y-12 INDUSTRIAL LANDFILL 5

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -291.00 to X values and -300.00 to Y values listed.

25 Top Boundaries
40 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	280.00	140.00	280.00	4
2	140.00	280.00	149.00	290.00	4
3	149.00	290.00	192.00	296.00	4
4	192.00	296.00	248.00	296.00	4
5	248.00	296.00	260.00	291.00	4
6	260.00	291.00	283.00	300.00	4
7	283.00	300.00	291.00	300.00	4
8	291.00	300.00	454.00	346.50	1
9	454.00	346.50	471.00	349.00	1
10	471.00	349.00	604.00	387.00	1
11	604.00	387.00	653.00	396.00	1
12	653.00	396.00	687.00	400.00	1
13	687.00	400.00	809.00	425.70	1
14	809.00	425.70	870.00	440.00	1
15	870.00	440.00	920.00	442.00	1
16	920.00	442.00	949.00	442.00	1
17	949.00	442.00	995.00	440.00	1
18	995.00	440.00	1079.00	418.40	1
19	1079.00	418.40	1103.00	415.00	1
20	1103.00	415.00	1131.00	413.50	1

21	1131.00	413.50	1246.00	384.00	1
22	1246.00	384.00	1267.00	381.00	1
23	1267.00	381.00	1407.00	345.00	1
24	1407.00	345.00	1480.00	345.00	4
25	1480.00	345.00	1500.00	338.00	4
26	297.00	301.50	328.00	294.20	2
27	328.00	294.20	549.00	305.00	2
28	549.00	305.00	849.00	318.50	2
29	849.00	318.50	1353.50	340.50	2
30	1353.50	340.50	1398.00	348.00	2
31	295.00	301.00	328.00	293.00	3
32	328.00	293.00	549.00	304.00	3
33	549.00	304.00	849.00	317.50	3
34	849.00	317.50	1353.50	339.50	3
35	1353.50	339.50	1401.00	347.00	3
36	291.00	300.00	329.00	291.00	4
37	329.00	291.00	549.00	302.00	4
38	549.00	302.00	849.00	315.50	4
39	849.00	315.50	1353.50	337.50	4
40	1353.50	337.50	1407.00	345.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	65.0	80.0	200.0	33.0	.00	.0	1
2	120.0	130.0	.0	11.0	.00	.0	1
3	120.0	130.0	500.0	18.0	.00	.0	1
4	120.0	130.0	500.0	18.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	254.00
2	200.00	260.00
3	400.00	274.00
4	760.00	290.00
5	1240.00	290.00

6	1500.00	285.00

A Horizontal Earthquake Loading Coefficient
Of .130 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

Searching Routine Will Be Limited To An Area Defined By 6 Boundaries
Of Which The First 6 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	161.00	520.00	210.00
2	520.00	210.00	668.00	230.00
3	668.00	230.00	760.00	250.00
4	760.00	250.00	1187.00	280.00
5	1187.00	280.00	1324.00	270.00
6	1324.00	270.00	1500.00	228.00

Janbus Empirical Coef is being used for the case of c & phi both >

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Sliding Block Surfaces, Has Been
Specified.

100 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of
Sliding Block Is 15.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	328.00	294.20	549.00	305.00	3.00
2	749.00	314.00	949.00	322.50	3.00

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

19	8.0	49080.7	.0	.0	.0	.0	6380.5	.0	.0
20	9.8	52631.5	.0	.0	.0	.0	6842.1	.0	.0
21	6.4	29523.3	.0	.0	.0	.0	3838.0	.0	.0
22	5.0	20042.6	.0	.0	.0	.0	2605.5	.0	.0
23	4.3	15457.3	.0	.0	.0	.0	2009.4	.0	.0
24	8.3	25053.7	.0	.0	.0	.0	3257.0	.0	.0
25	7.1	15387.5	.0	.0	.0	.0	2000.4	.0	.0
26	2.2	2753.7	.0	.0	.0	.0	358.0	.0	.0
27	.3	117.9	.0	.0	.0	.0	15.3	.0	.0

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	320.02	308.28
2	327.14	305.37
3	337.75	294.77
4	864.76	318.82
5	874.16	330.51
6	877.26	345.19
7	887.00	356.59
8	897.08	367.70
9	906.71	379.20
10	907.15	394.19
11	913.77	407.65
12	916.06	422.48
13	926.26	433.48
14	931.05	442.00

*** 1.075 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	380.37	325.49
2	385.76	320.41
3	399.12	313.58
4	410.99	304.41
5	425.94	303.13
6	440.32	298.88
7	854.85	318.65
8	862.32	331.66
9	867.18	345.85
10	875.42	358.38
11	884.21	370.53
12	886.70	385.33
13	896.21	396.93
14	897.72	411.85

15	907.46	423.26
16	914.47	436.52
17	915.02	441.80

*** 1.158 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	304.91	303.97
2	308.54	300.52
3	323.51	299.59
4	337.86	295.22
5	912.51	320.46
6	921.77	332.26
7	922.77	347.23
8	932.95	358.25
9	936.40	372.84
10	940.51	387.27
11	950.37	398.58
12	960.55	409.59
13	968.42	422.37
14	978.10	433.82
15	982.16	440.56

*** 1.191 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	336.74	313.05
2	345.76	304.84
3	360.36	301.41
4	374.28	295.81
5	829.46	316.93
6	840.06	327.54
7	843.64	342.10
8	847.46	356.61
9	858.02	367.26
10	858.41	382.26
11	868.19	393.62
12	868.86	408.61
13	875.65	421.98

14	886.26	432.59
15	887.56	440.70

*** 1.240 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	349.88	316.80
2	351.40	315.32
3	362.42	305.15
4	375.69	298.14
5	390.68	297.63
6	888.05	319.97
7	897.98	331.22
8	908.57	341.83
9	913.79	355.90
10	924.38	366.52
11	925.64	381.47
12	932.57	394.77
13	932.82	409.77
14	932.86	424.77
15	938.45	438.69
16	941.66	442.00

*** 1.301 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	406.83	333.04
2	417.72	331.53
3	432.61	329.70
4	444.69	320.80
5	455.35	310.25
6	466.87	300.64
7	802.31	316.20
8	811.07	328.38
9	814.45	342.99
10	816.55	357.84
11	827.09	368.51
12	837.18	379.61
13	847.33	390.66

14	857.63	401.56
15	864.55	414.87
16	874.78	425.84
17	884.28	437.45
18	886.34	440.65

*** 1.349 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	425.83	338.46
2	426.42	338.36
3	437.37	328.11
4	448.79	318.38
5	459.93	308.34
6	472.59	300.29
7	933.27	322.04
8	943.72	332.79
9	951.24	345.77
10	959.45	358.33
11	967.98	370.66
12	975.70	383.53
13	984.56	395.63
14	994.67	406.71
15	1005.25	417.35
16	1015.18	428.59
17	1017.76	434.15

*** 1.349 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	408.87	333.63
2	408.96	333.55
3	423.96	333.30
4	434.57	322.70
5	446.11	313.11
6	460.86	310.41
7	472.86	301.41
8	852.65	317.63
9	856.15	332.22

10	866.72	342.87
11	877.24	353.56
12	879.98	368.31
13	884.97	382.45
14	895.52	393.12
15	903.74	405.66
16	914.34	416.28
17	917.73	430.89
18	920.45	442.00

*** 1.381 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	400.66	331.28
2	406.91	328.19
3	420.46	321.74
4	431.28	311.36
5	444.20	303.74
6	458.83	300.40
7	844.64	317.14
8	854.42	328.51
9	864.43	339.69
10	874.93	350.40
11	880.13	364.47
12	889.25	376.38
13	897.15	389.12
14	906.99	400.44
15	909.54	415.23
16	916.52	428.50
17	921.52	442.00

*** 1.395 ***

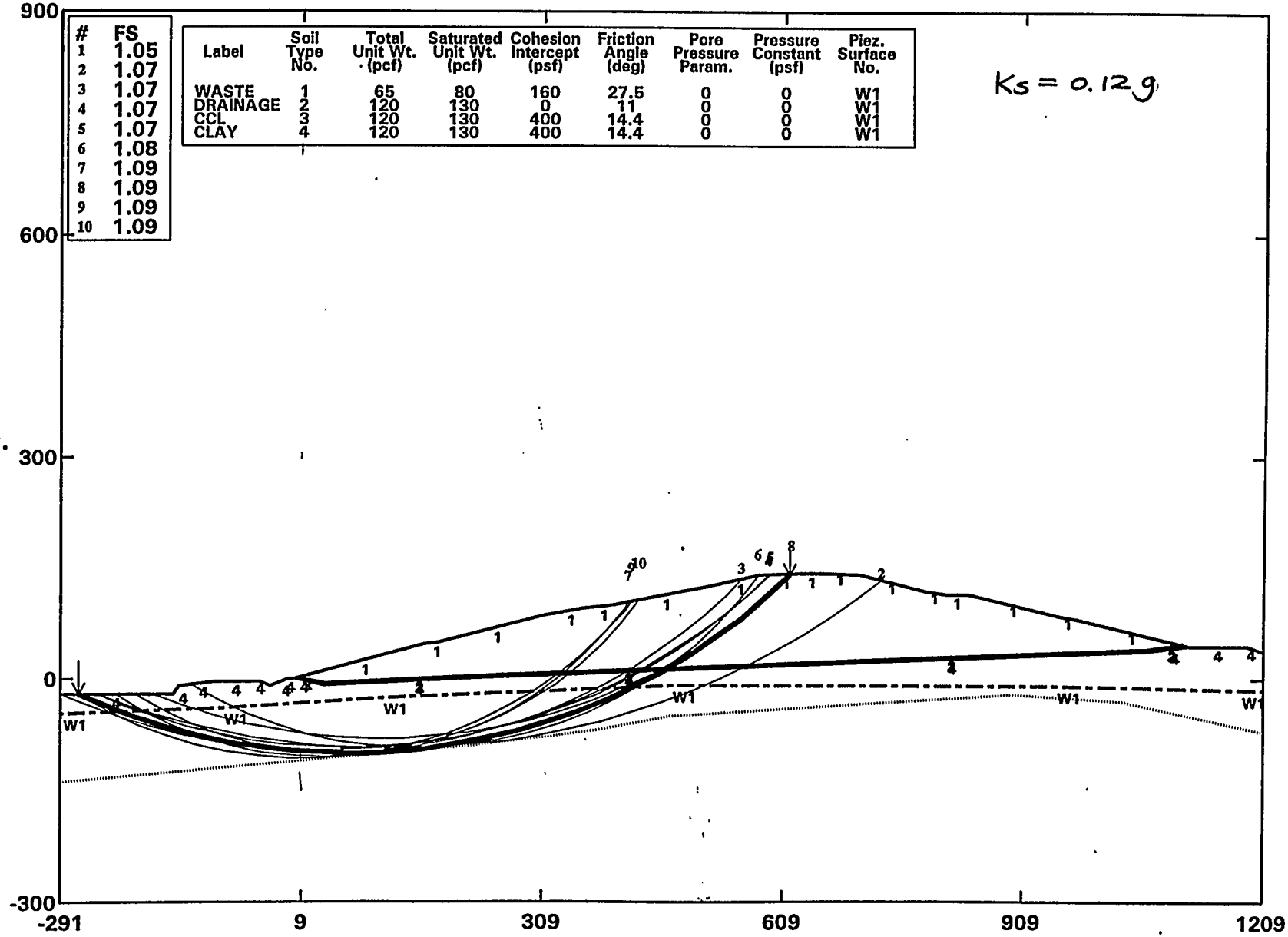
Y-12 INDUSTRIAL LANDFILL 5

Ten Most Critical. A:C2E.PLT By: DAVID TSO 06-26-95 12:06pm

#	FS
1	1.05
2	1.07
3	1.07
4	1.07
5	1.07
6	1.08
7	1.09
8	1.09
9	1.09
10	1.09

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	65	80	160	27.5	0	0	W1
DRAINAGE	2	120	130	0	11	0	0	W1
CCL	3	120	130	400	14.4	0	0	W1
CLAY	4	120	130	400	14.4	0	0	W1

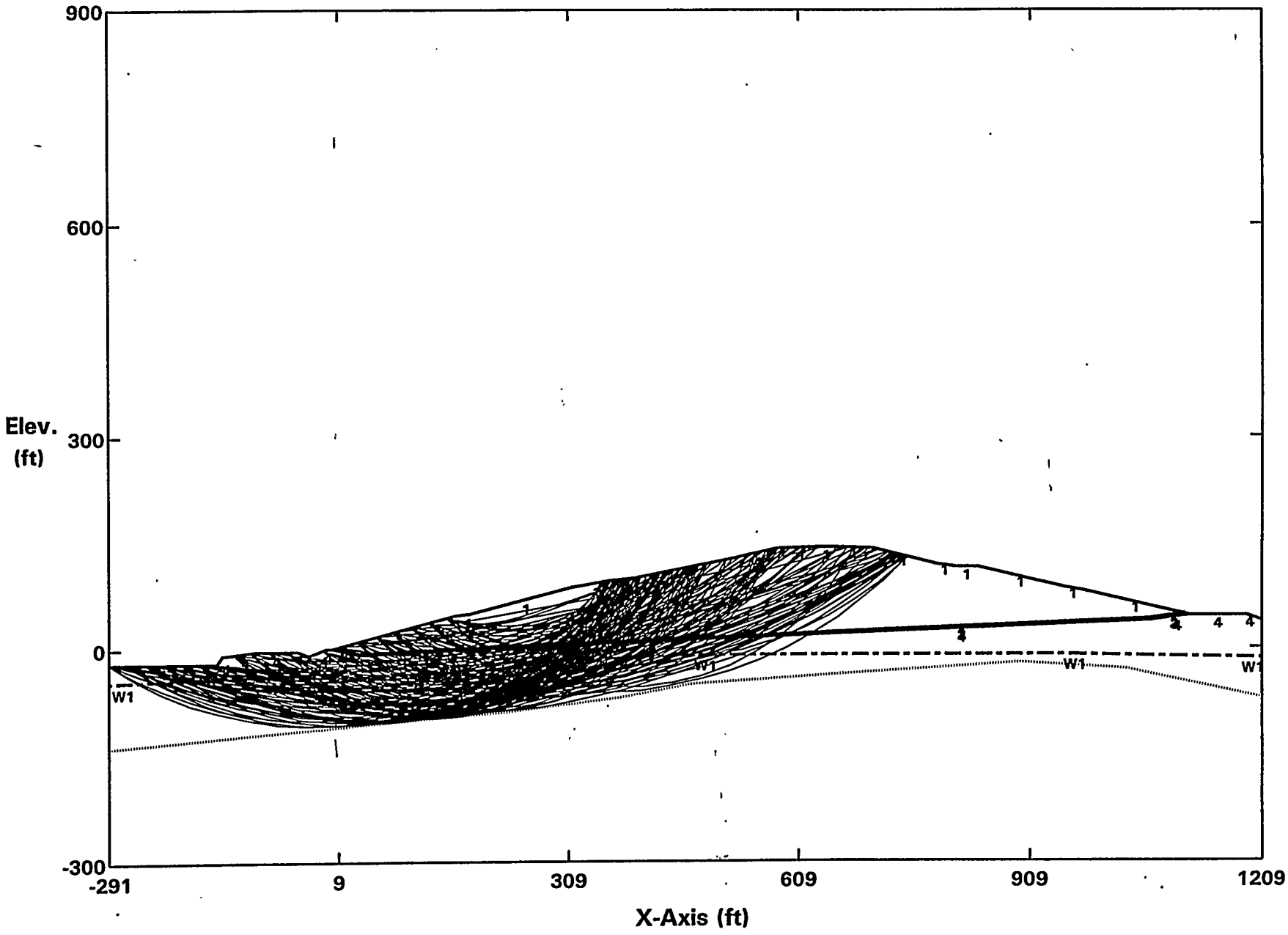
$K_s = 0.12g$



PCSTABL5M FSmin = 1.05 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL 5

All surfaces evaluated. A:C2E.PLT By: DAVID TSO 06-26-95 12:06pm



B50

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 06-26-95
Time of Run: 12:06pm
Run By: DAVID TSO
Input Data Filename: A:C2E.I
Output Filename: A:C2E.OUT
Plotted Output Filename: A:C2E.PLT

PROBLEM DESCRIPTION Y-12 INDUSTRIAL LANDFILL 5

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -291.00 to X values and -300.00 to Y values listed.

25 Top Boundaries
40 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	280.00	140.00	280.00	4
2	140.00	280.00	149.00	290.00	4
3	149.00	290.00	192.00	296.00	4
4	192.00	296.00	248.00	296.00	4
5	248.00	296.00	260.00	291.00	4
6	260.00	291.00	283.00	300.00	4
7	283.00	300.00	291.00	300.00	4
8	291.00	300.00	454.00	346.50	1
9	454.00	346.50	471.00	349.00	1
10	471.00	349.00	604.00	387.00	1
11	604.00	387.00	653.00	396.00	1
12	653.00	396.00	687.00	400.00	1
13	687.00	400.00	809.00	425.70	1
14	809.00	425.70	870.00	440.00	1
15	870.00	440.00	920.00	442.00	1
16	920.00	442.00	949.00	442.00	1
17	949.00	442.00	995.00	440.00	1
18	995.00	440.00	1079.00	418.40	1
19	1079.00	418.40	1103.00	415.00	1
20	1103.00	415.00	1131.00	413.50	1

21	1131.00	413.50	1246.00	384.00	1
22	1246.00	384.00	1267.00	381.00	1
23	1267.00	381.00	1407.00	345.00	1
24	1407.00	345.00	1480.00	345.00	4
25	1480.00	345.00	1500.00	338.00	4
26	297.00	301.50	328.00	294.20	2
27	328.00	294.20	549.00	305.00	2
28	549.00	305.00	849.00	318.50	2
29	849.00	318.50	1353.50	340.50	2
30	1353.50	340.50	1398.00	348.00	2
31	295.00	301.00	328.00	293.00	3
32	328.00	293.00	549.00	304.00	3
33	549.00	304.00	849.00	317.50	3
34	849.00	317.50	1353.50	339.50	3
35	1353.50	339.50	1401.00	347.00	3
36	291.00	300.00	329.00	291.00	4
37	329.00	291.00	549.00	302.00	4
38	549.00	302.00	849.00	315.50	4
39	849.00	315.50	1353.50	337.50	4
40	1353.50	337.50	1407.00	345.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	65.0	80.0	160.0	27.5	.00	.0	1
2	120.0	130.0	.0	11.0	.00	.0	1
3	120.0	130.0	400.0	14.4	.00	.0	1
4	120.0	130.0	400.0	14.4	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	254.00
2	200.00	260.00
3	400.00	274.00
4	760.00	290.00
5	1240.00	290.00

6 1500.00 285.00

A Horizontal Earthquake Loading Coefficient
Of .120 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

Searching Routine Will Be Limited To An Area Defined By 6 Boundaries
Of Which The First 6 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	161.00	520.00	210.00
2	520.00	210.00	668.00	230.00
3	668.00	230.00	760.00	250.00
4	760.00	250.00	1187.00	280.00
5	1187.00	280.00	1324.00	270.00
6	1324.00	270.00	1500.00	228.00

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

Janbus Empirical Coef. is being used for the case of c & phi both > 0
200 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = .00 ft.
and X = 441.00 ft.

Each Surface Terminates Between X = 641.00 ft.
and X =1041.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y =150.00 ft.

40.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical

First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.21	280.00
2	59.36	262.87
3	96.37	247.71
4	134.15	234.57
5	172.58	223.47
6	211.55	214.45
7	250.95	207.55
8	290.67	202.77
9	330.58	200.13
10	370.58	199.64
11	410.54	201.31
12	450.36	205.12
13	489.91	211.07
14	529.09	219.13
15	567.78	229.29
16	605.87	241.51
17	643.24	255.77
18	679.80	272.01
19	715.42	290.19
20	750.02	310.27
21	783.49	332.17
22	815.73	355.85
23	846.66	381.22
24	876.17	408.22
25	904.19	436.76
26	908.40	441.54

*** 1.053 ***

Individual data on the 51 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	36.1	37147.5	.0	.0	.0	.0	4457.7	.0	.0
2	16.1	39556.7	.0	.0	.0	.0	4746.8	.0	.0
3	20.9	71150.4	.0	6459.2	.0	.0	8538.0	.0	.0
4	37.8	182331.1	.0	40713.8	.0	.0	21879.7	.0	.0
5	5.8	33901.9	.0	9260.1	.0	.0	4068.2	.0	.0

6	9.0	60103.9	.0	15634.2	.0	.0	7212.5	.0	.0
7	23.6	190826.3	.0	48915.3	.0	.0	22899.2	.0	.0
8	19.4	178512.4	.0	47545.7	.0	.0	21421.5	.0	.0
9	8.0	78176.3	.0	21423.1	.0	.0	9381.2	.0	.0
10	11.6	116340.8	.0	32931.7	.0	.0	13960.9	.0	.0
11	36.4	389112.7	.0	*******	.0	.0	46693.5	.0	.0
12	3.0	32663.0	.0	10383.4	.0	.0	3919.6	.0	.0
13	9.0	98383.5	.0	32268.2	.0	.0	11806.0	.0	.0
14	23.0	263328.0	.0	86423.0	.0	.0	31599.4	.0	.0
15	7.7	93822.2	.0	30205.8	.0	.0	11258.7	.0	.0
16	.3	4115.6	.0	1327.2	.0	.0	493.9	.0	.0
17	4.0	49339.5	.0	15944.5	.0	.0	5920.7	.0	.0
18	2.0	24972.1	.0	8023.2	.0	.0	2996.7	.0	.0
19	31.0	396344.2	.0	*******	.0	.0	47561.3	.0	.0
20	1.0	13031.1	.0	4287.4	.0	.0	1563.7	.0	.0
21	1.6	20632.0	.0	6785.1	.0	.0	2475.8	.0	.0
22	40.0	542549.0	.0	*******	.0	.0	65105.9	.0	.0
23	29.4	420119.1	.0	*******	.0	.0	50414.3	.0	.0
24	10.5	153978.2	.0	48105.8	.0	.0	18477.4	.0	.0
25	39.8	592381.9	.0	*******	.0	.0	71085.8	.0	.0
26	3.6	54851.3	.0	16279.3	.0	.0	6582.2	.0	.0
27	17.0	255180.3	.0	74837.9	.0	.0	30621.6	.0	.0
28	18.9	283205.5	.0	80999.6	.0	.0	33984.7	.0	.0
29	39.2	583540.6	.0	*******	.0	.0	70024.9	.0	.0
30	19.9	292063.7	.0	74976.0	.0	.0	35047.6	.0	.0
31	18.8	271006.4	.0	65631.4	.0	.0	32520.8	.0	.0
32	36.2	505030.6	.0	*******	.0	.0	60603.7	.0	.0
33	1.9	25318.6	.0	5124.3	.0	.0	3038.2	.0	.0
34	37.4	481330.7	.0	88124.1	.0	.0	57759.7	.0	.0
35	9.8	117294.9	.0	18034.3	.0	.0	14075.4	.0	.0
36	26.8	299548.8	.0	36163.2	.0	.0	35945.9	.0	.0
37	7.2	74532.6	.0	6427.5	.0	.0	8943.9	.0	.0
38	23.8	226953.5	.0	9201.6	.0	.0	27234.4	.0	.0
39	4.7	41352.8	.0	.0	.0	.0	4962.3	.0	.0
40	34.6	270836.1	.0	.0	.0	.0	32500.3	.0	.0
41	1.3	8759.5	.0	.0	.0	.0	1051.1	.0	.0
42	3.3	22055.7	.0	.0	.0	.0	2646.7	.0	.0
43	1.6	10775.8	.0	.0	.0	.0	1293.1	.0	.0
44	27.3	166985.9	.0	.0	.0	.0	20038.3	.0	.0
45	25.5	135096.6	.0	.0	.0	.0	16211.6	.0	.0
46	6.7	31998.5	.0	.0	.0	.0	3839.8	.0	.0
47	30.9	125366.5	.0	.0	.0	.0	15044.0	.0	.0
48	23.3	68840.0	.0	.0	.0	.0	8260.8	.0	.0
49	6.2	13930.3	.0	.0	.0	.0	1671.6	.0	.0
50	28.0	33363.2	.0	.0	.0	.0	4003.6	.0	.0
51	4.2	629.7	.0	.0	.0	.0	75.6	.0	.0

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.42	280.00
2	83.53	265.07
3	121.25	251.75
4	159.51	240.07
5	198.23	230.05

6	237.35	221.70
7	276.79	215.04
8	316.48	210.09
9	356.35	206.85
10	396.32	205.33
11	436.32	205.53
12	476.27	207.45
13	516.11	211.09
14	555.75	216.44
15	595.12	223.50
16	634.16	232.24
17	672.78	242.65
18	710.91	254.72
19	748.49	268.42
20	785.45	283.72
21	821.72	300.60
22	857.22	319.02
23	891.90	338.95
24	925.69	360.36
25	958.52	383.21
26	990.35	407.44
27	1021.09	433.03
28	1021.32	433.23

*** 1.066 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.21	280.00
2	59.03	262.19
3	95.84	246.55
4	133.53	233.14
5	171.95	222.00
6	210.96	213.18
7	250.43	206.70
8	290.22	202.59
9	330.18	200.86
10	370.18	201.52
11	410.06	204.57
12	449.69	209.99
13	488.93	217.77
14	527.63	227.88
15	565.66	240.28
16	602.88	254.94
17	639.16	271.78
18	674.37	290.77
19	708.38	311.82
20	741.07	334.86
21	772.33	359.82

22	802.05	386.60
23	830.11	415.10
24	847.18	434.65

*** 1.067 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.42	280.00
2	82.82	263.41
3	120.10	248.91
4	158.14	236.54
5	196.82	226.35
6	236.01	218.36
7	275.60	212.60
8	315.44	209.10
9	355.42	207.85
10	395.41	208.87
11	435.27	212.15
12	474.89	217.69
13	514.13	225.45
14	552.86	235.43
15	590.97	247.58
16	628.33	261.87
17	664.82	278.26
18	700.33	296.68
19	734.73	317.08
20	767.93	339.40
21	799.81	363.56
22	830.27	389.49
23	859.21	417.10
24	881.06	440.44

*** 1.071 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	.00	280.00
2	36.42	263.45
3	73.66	248.85
4	111.61	236.23

5	150.18	225.62
6	189.25	217.06
7	228.72	210.57
8	268.48	206.17
9	308.42	203.87
10	348.42	203.68
11	388.37	205.59
12	428.17	209.61
13	467.70	215.71
14	506.85	223.89
15	545.52	234.13
16	583.60	246.38
17	620.98	260.62
18	657.55	276.82
19	693.22	294.91
20	727.89	314.86
21	761.46	336.61
22	793.84	360.10
23	824.94	385.26
24	854.67	412.03
25	882.94	440.32
26	883.13	440.53

*** 1.074 ***

Failure Surface Specified By 22 Coordinate Points.

Point No.	X-Surf (ft)	Y-Surf (ft)
1	162.47	291.88
2	196.63	271.07
3	232.33	253.02
4	269.34	237.84
5	307.43	225.63
6	346.37	216.47
7	385.90	210.41
8	425.80	207.50
9	465.80	207.74
10	505.65	211.14
11	545.12	217.67
12	583.94	227.30
13	621.88	239.97
14	658.70	255.59
15	694.18	274.07
16	728.08	295.30
17	760.21	319.13
18	790.35	345.43
19	818.32	374.02
20	843.94	404.74
21	867.06	437.38
22	868.40	439.63

*** 1.084 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	69.63	280.00
2	102.91	257.81
3	138.06	238.72
4	174.79	222.88
5	212.80	210.42
6	251.79	201.45
7	291.42	196.04
8	331.38	194.23
9	371.34	196.04
10	410.97	201.45
11	449.95	210.41
12	487.96	222.87
13	524.69	238.70
14	559.84	257.79
15	593.13	279.98
16	624.27	305.08
17	653.02	332.90
18	679.13	363.19
19	702.41	395.73
20	707.44	404.31

*** 1.087 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	116.05	280.00
2	153.01	264.69
3	190.78	251.53
4	229.25	240.56
5	268.28	231.84
6	307.76	225.37
7	347.54	221.19
8	387.49	219.31
9	427.49	219.73
10	467.40	222.45
11	507.08	227.47
12	546.41	234.77

13	585.25	244.32
14	623.48	256.09
15	660.97	270.05
16	697.59	286.14
17	733.22	304.31
18	767.75	324.51
19	801.06	346.66
20	833.03	370.69
21	863.57	396.52
22	892.57	424.07
23	908.97	441.56

*** 1.089 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.21	280.00
2	57.10	258.74
3	92.58	240.28
4	129.43	224.72
5	167.41	212.18
6	206.28	202.72
7	245.78	196.42
8	285.66	193.32
9	325.66	193.42
10	365.52	196.74
11	404.99	203.25
12	443.80	212.91
13	481.72	225.66
14	518.49	241.41
15	553.87	260.06
16	587.64	281.50
17	619.58	305.58
18	649.49	332.14
19	677.16	361.03
20	702.42	392.04
21	711.45	405.15

*** 1.091 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	92.84	280.00
2	126.62	258.57
3	162.20	240.29
4	199.28	225.29
5	237.57	213.72
6	276.74	205.65
7	316.49	201.16
8	356.48	200.28
9	396.39	203.02
10	435.88	209.36
11	474.64	219.24
12	512.35	232.59
13	548.69	249.29
14	583.38	269.22
15	616.12	292.19
16	646.65	318.04
17	674.72	346.54
18	700.10	377.46
19	720.15	406.98

*** 1.091 ***

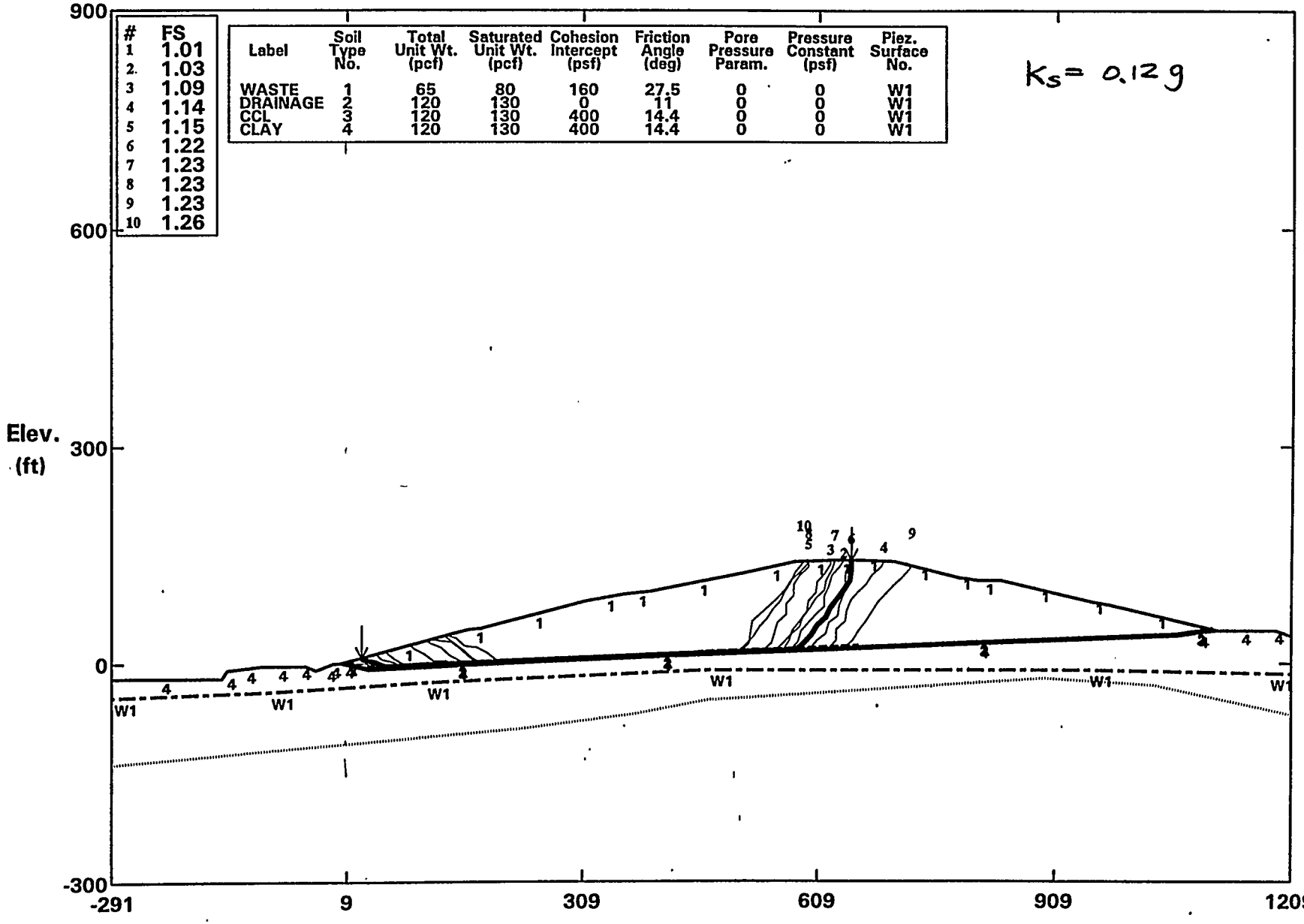
Y-12 INDUSTRIAL LANDFILL 5

Ten Most Critical. A:B6A.PLT By: DAVID TSO 06-26-95 11:49am

#	FS
1	1.01
2	1.03
3	1.09
4	1.14
5	1.15
6	1.22
7	1.23
8	1.23
9	1.23
10	1.26

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	65	80	160	27.5	0	0	W1
DRAINAGE	2	120	130	0	11	0	0	W1
CCL	3	120	130	400	14.4	0	0	W1
CLAY	4	120	130	400	14.4	0	0	W1

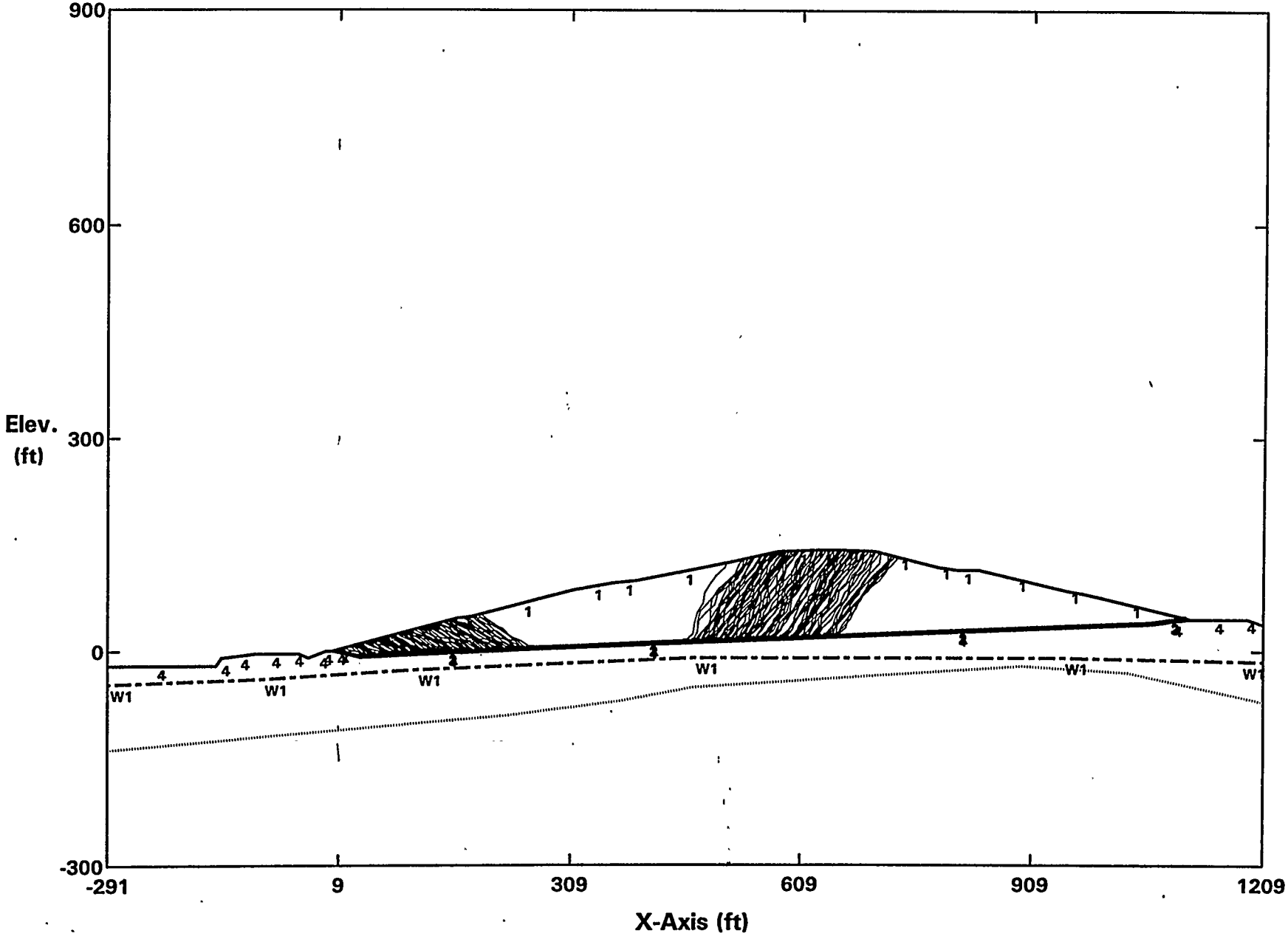
$K_s = 0.12g$



PCSTABL5M FSmin = 1.01 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL 5

All surfaces evaluated. A:B6A.PLT By: DAVID TSO 06-26-95 11:49am



** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	06-26-95
Time of Run:	11:49am
Run By:	DAVID TSO
Input Data Filename:	A:B6A.I
Output Filename:	A:B6A.OUT
Plotted Output Filename:	A:B6A.PLT

PROBLEM DESCRIPTION Y-12 INDUSTRIAL LANDFILL 5

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -291.00 to X values and -300.00 to Y values listed.

25 Top Boundaries
40 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	280.00	140.00	280.00	4
2	140.00	280.00	149.00	290.00	4
3	149.00	290.00	192.00	296.00	4
4	192.00	296.00	248.00	296.00	4
5	248.00	296.00	260.00	291.00	4
6	260.00	291.00	283.00	300.00	4
7	283.00	300.00	291.00	300.00	4
8	291.00	300.00	454.00	346.50	1
9	454.00	346.50	471.00	349.00	1
10	471.00	349.00	604.00	387.00	1
11	604.00	387.00	653.00	396.00	1
12	653.00	396.00	687.00	400.00	1
13	687.00	400.00	809.00	425.70	1
14	809.00	425.70	870.00	440.00	1
15	870.00	440.00	920.00	442.00	1
16	920.00	442.00	949.00	442.00	1
17	949.00	442.00	995.00	440.00	1
18	995.00	440.00	1079.00	418.40	1
19	1079.00	418.40	1103.00	415.00	1
20	1103.00	415.00	1131.00	413.50	1

21	1131.00	413.50	1246.00	384.00	1
22	1246.00	384.00	1267.00	381.00	1
23	1267.00	381.00	1407.00	345.00	1
24	1407.00	345.00	1480.00	345.00	4
25	1480.00	345.00	1500.00	338.00	4
26	297.00	301.50	328.00	294.20	2
27	328.00	294.20	549.00	305.00	2
28	549.00	305.00	849.00	318.50	2
29	849.00	318.50	1353.50	340.50	2
30	1353.50	340.50	1398.00	348.00	2
31	295.00	301.00	328.00	293.00	3
32	328.00	293.00	549.00	304.00	3
33	549.00	304.00	849.00	317.50	3
34	849.00	317.50	1353.50	339.50	3
35	1353.50	339.50	1401.00	347.00	3
36	291.00	300.00	329.00	291.00	4
37	329.00	291.00	549.00	302.00	4
38	549.00	302.00	849.00	315.50	4
39	849.00	315.50	1353.50	337.50	4
40	1353.50	337.50	1407.00	345.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	65.0	80.0	160.0	27.5	.00	.0	1
2	120.0	130.0	.0	11.0	.00	.0	1
3	120.0	130.0	400.0	14.4	.00	.0	1
4	120.0	130.0	400.0	14.4	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	254.00
2	200.00	260.00
3	400.00	274.00
4	760.00	290.00
5	1240.00	290.00

6	1500.00	285.00

A Horizontal Earthquake Loading Coefficient
Of .120 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

Searching Routine Will Be Limited To An Area Defined By 6 Boundaries
Of Which The First 6 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	161.00	520.00	210.00
2	520.00	210.00	668.00	230.00
3	668.00	230.00	760.00	250.00
4	760.00	250.00	1187.00	280.00
5	1187.00	280.00	1324.00	270.00
6	1324.00	270.00	1500.00	228.00

Janbus Empirical Coef is being used for the case of c & phi both > 0

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Sliding Block Surfaces, Has Been
Specified.

100 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of
Sliding Block Is 15.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	328.00	294.20	549.00	305.00	3.00
2	749.00	314.00	949.00	322.50	3.00

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	317.93	307.68
2	321.38	305.62
3	335.79	301.46
4	349.51	295.41
5	869.94	318.41
6	880.53	329.03
7	890.81	339.95
8	898.79	352.65
9	908.54	364.05
10	914.96	377.61
11	924.30	389.35
12	932.60	401.84
13	939.66	415.07
14	941.83	429.91
15	942.13	442.00

*** 1.009 ***

Individual data on the 27 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	3.5	341.9	.0	.0	.0	.0	41.0	.0	.0
2	14.4	6726.7	.0	.0	.0	.0	807.2	.0	.0
3	13.7	14538.3	.0	.0	.0	.0	1744.6	.0	.0
4	33.8	55787.6	.0	.0	.0	.0	6694.5	.0	.0
5	70.6	174936.8	.0	.0	.0	.0	20992.4	.0	.0
6	17.0	52663.7	.0	.0	.0	.0	6319.6	.0	.0
7	78.0	294772.3	.0	.0	.0	.0	35372.7	.0	.0
8	55.0	265887.1	.0	.0	.0	.0	31906.5	.0	.0
9	49.0	269030.8	.0	.0	.0	.0	32283.7	.0	.0
10	34.0	197047.9	.0	.0	.0	.0	23645.7	.0	.0
11	122.0	797894.8	.0	.0	.0	.0	95747.4	.0	.0
12	40.0	298039.4	.0	.0	.0	.0	35764.7	.0	.0
13	20.9	163884.8	.0	.0	.0	.0	19666.2	.0	.0
14	.0	11.7	.0	.0	.0	.0	1.4	.0	.0
15	.1	504.9	.0	.0	.0	.0	60.6	.0	
16	1.0	7741.0	.0	.0	.0	.0	928.9	.0	.0
17	9.6	72027.7	.0	.0	.0	.0	8643.3	.0	.0
18	10.3	70912.2	.0	.0	.0	.0	8509.5	.0	.0

19	8.0	49080.7	.0	.0	.0	.0	5889.7	.0	.0
20	9.8	52631.5	.0	.0	.0	.0	6315.8	.0	.0
21	6.4	29523.3	.0	.0	.0	.0	3542.8	.0	.0
22	5.0	20042.6	.0	.0	.0	.0	2405.1	.0	.0
23	4.3	15457.3	.0	.0	.0	.0	1854.9	.0	.0
24	8.3	25053.7	.0	.0	.0	.0	3006.4	.0	.0
25	7.1	15387.5	.0	.0	.0	.0	1846.5	.0	.0
26	2.2	2753.7	.0	.0	.0	.0	330.4	.0	.0
27	.3	117.9	.0	.0	.0	.0	14.1	.0	.0

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	320.02	308.28
2	327.14	305.37
3	337.75	294.77
4	864.76	318.82
5	874.16	330.51
6	877.26	345.19
7	887.00	356.59
8	897.08	367.70
9	906.71	379.20
10	907.15	394.19
11	913.77	407.65
12	916.06	422.48
13	926.26	433.48
14	931.05	442.00

*** 1.029 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	380.37	325.49
2	385.76	320.41
3	399.12	313.58
4	410.99	304.41
5	425.94	303.13
6	440.32	298.88
7	854.85	318.65
8	862.32	331.66
9	867.18	345.85
10	875.42	358.38
11	884.21	370.53
12	886.70	385.33
13	896.21	396.93
14	897.72	411.85

15	907.46	423.26
16	914.47	436.52
17	915.02	441.80

*** 1.094 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	304.91	303.97
2	308.54	300.52
3	323.51	299.59
4	337.86	295.22
5	912.51	320.46
6	921.77	332.26
7	922.77	347.23
8	932.95	358.25
9	936.40	372.84
10	940.51	387.27
11	950.37	398.58
12	960.55	409.59
13	968.42	422.37
14	978.10	433.82
15	982.16	440.56

*** 1.137 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	336.74	313.05
2	345.76	304.84
3	360.36	301.41
4	374.28	295.81
5	829.46	316.93
6	840.06	327.54
7	843.64	342.10
8	847.46	356.61
9	858.02	367.26
10	858.41	382.26
11	868.19	393.62
12	868.86	408.61
13	875.65	421.98

14	886.26	432.59
15	887.56	440.70

*** 1.150 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	349.88	316.80
2	351.40	315.32
3	362.42	305.15
4	375.69	298.14
5	390.68	297.63
6	888.05	319.97
7	897.98	331.22
8	908.57	341.83
9	913.79	355.90
10	924.38	366.52
11	925.64	381.47
12	932.57	394.77
13	932.82	409.77
14	932.86	424.77
15	938.45	438.69
16	941.66	442.00

*** 1.217 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	400.66	331.28
2	406.91	328.19
3	420.46	321.74
4	431.28	311.36
5	444.20	303.74
6	458.83	300.40
7	844.64	317.14
8	854.42	328.51
9	864.43	339.69
10	874.93	350.40
11	880.13	364.47
12	889.25	376.38
13	897.15	389.12

14	906.99	400.44
15	909.54	415.23
16	916.52	428.50
17	921.52	442.00

*** 1.231 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	406.83	333.04
2	417.72	331.53
3	432.61	329.70
4	444.69	320.80
5	455.35	310.25
6	466.87	300.64
7	802.31	316.20
8	811.07	328.38
9	814.45	342.99
10	816.55	357.84
11	827.09	368.51
12	837.18	379.61
13	847.33	390.66
14	857.63	401.56
15	864.55	414.87
16	874.78	425.84
17	884.28	437.45
18	886.34	440.65

*** 1.232 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	425.83	338.46
2	426.42	338.36
3	437.37	328.11
4	448.79	318.38
5	459.93	308.34
6	472.59	300.29
7	933.27	322.04
8	943.72	332.79
9	951.24	345.77

10	959.45	358.33
11	967.98	370.66
12	975.70	383.53
13	984.56	395.63
14	994.67	406.71
15	1005.25	417.35
16	1015.18	428.59
17	1017.76	434.15

*** 1.233 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	426.49	338.65
2	438.81	335.08
3	449.73	324.79
4	464.48	322.08
5	477.58	314.78
6	489.73	305.98
7	504.37	302.69
8	796.79	315.06
9	807.28	325.78
10	817.03	337.17
11	824.41	350.24
12	834.43	361.39
13	842.04	374.32
14	852.18	385.37
15	856.75	399.66
16	864.22	412.67
17	870.25	426.40
18	879.52	438.19
19	880.98	440.44

*** 1.257 ***

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT	Landfill V, Y-12	SUBJECT	Stability Analysis
REV #	0	SHEET	C1 OF C24
BY & DATE	DTT 6/23/95	OFS NO.	
CHKD & DATE	WPT 6/26/95	CALC NO.	CIV-ERWM-182

ATTACHMENT C

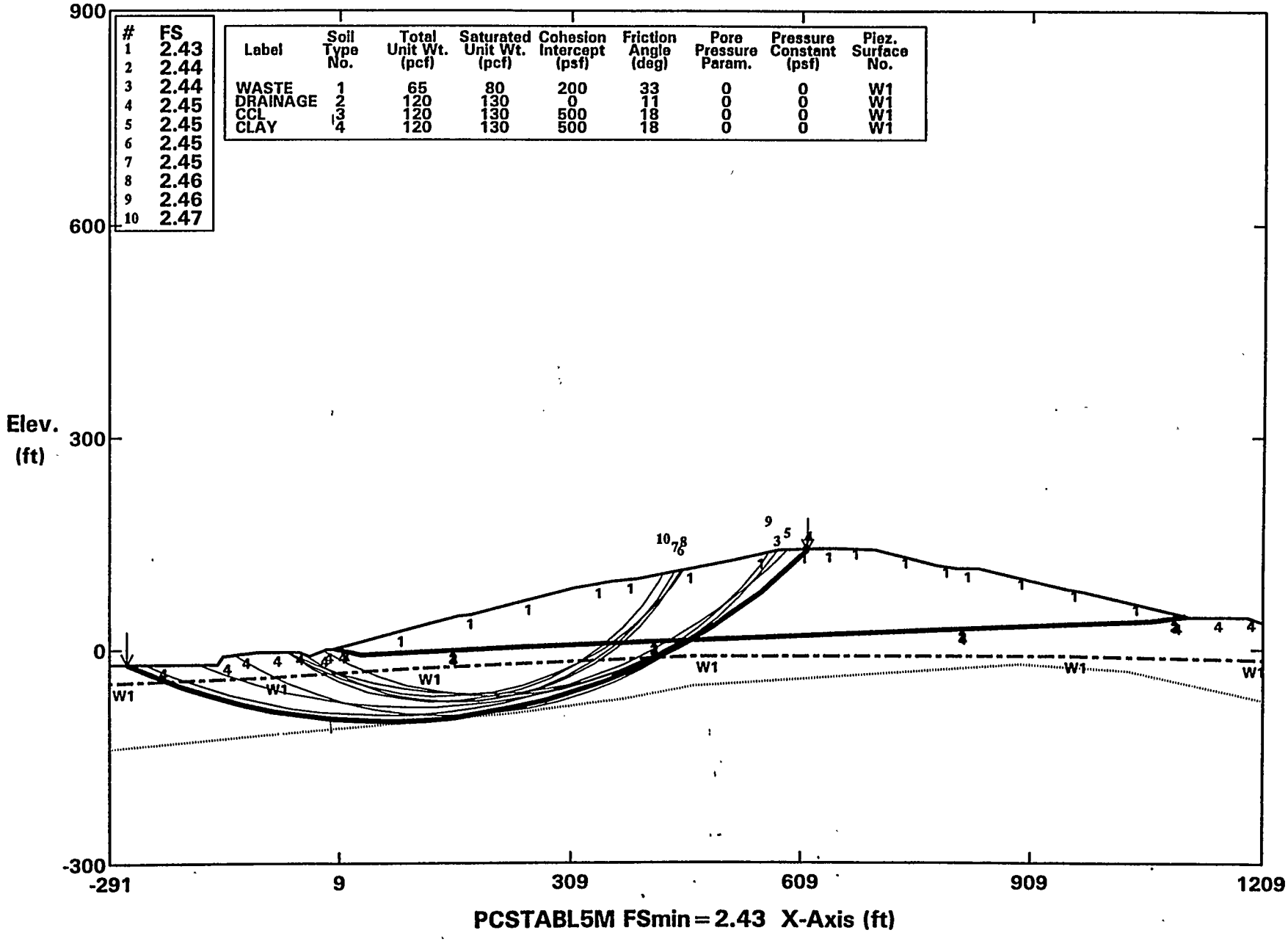
24 sheets

Static Slope Stability Analysis

File - C sheets C2 to C13
File - B4S sheets C14 to C24

Y-12 INDUSTRIAL LANDFILL 5

Ten Most Critical. A:C.PLT By: DAVID TSO 06-21-95 2:04pm



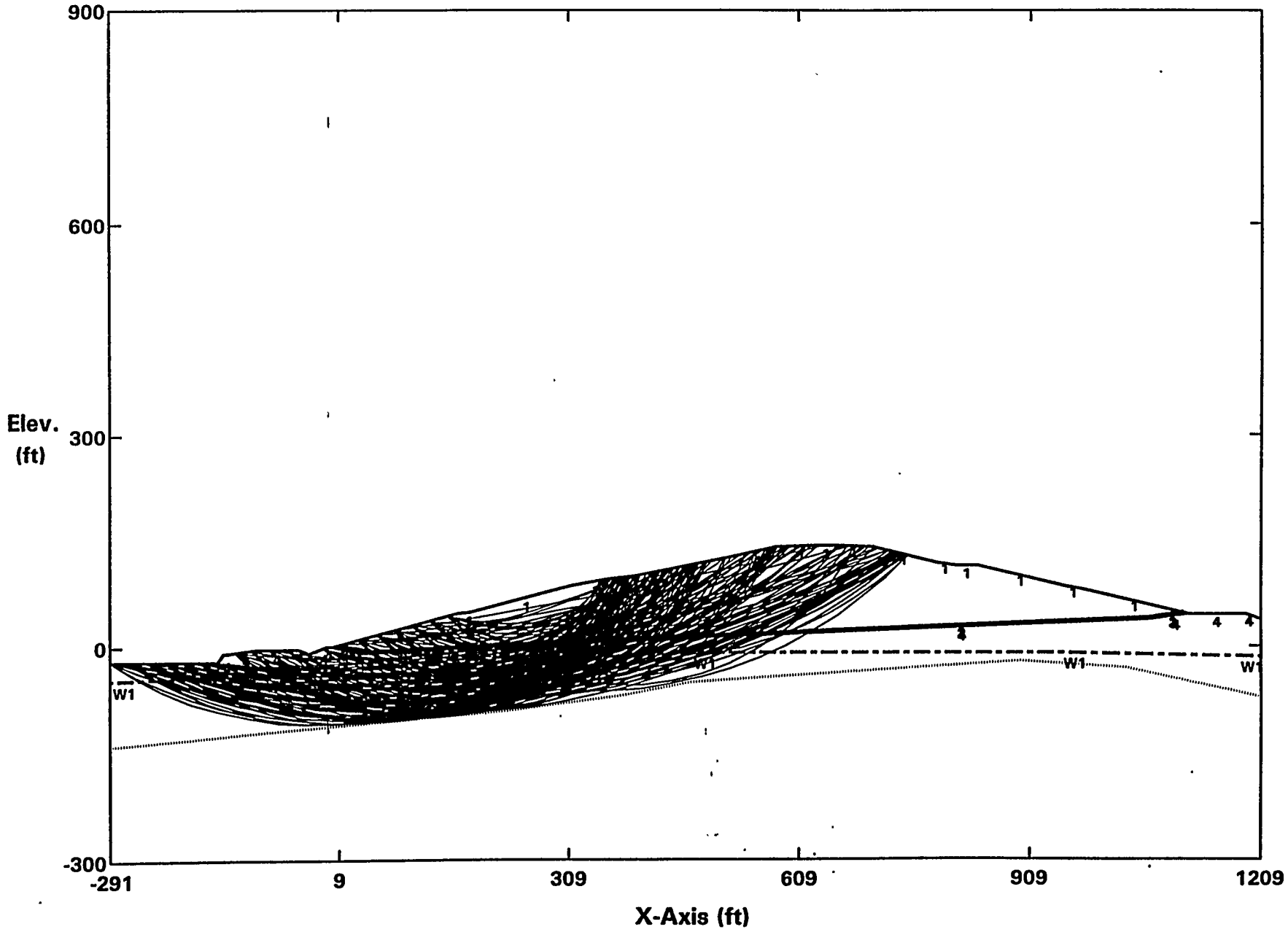
#	FS
1	2.43
2	2.44
3	2.44
4	2.45
5	2.45
6	2.45
7	2.45
8	2.46
9	2.46
10	2.47

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	65	80	200	33	0	0	W1
DRAINAGE	2	120	130	0	11	0	0	W1
CCL	3	120	130	500	18	0	0	W1
CLAY	4	120	130	500	18	0	0	W1

PCSTABL5M FSmin = 2.43 X-Axis (ft)

Y-12 INDUSTRIAL LANDFILL 5

All surfaces evaluated. A:C.PLT By: DAVID TSO 06-21-95 2:04pm



C4

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 06-21-95
Time of Run: 2:04pm
Run By: DAVID TSO
Input Data Filename: A:C.I
Output Filename: A:C.OUT
Plotted Output Filename: A:C.PLT

PROBLEM DESCRIPTION Y-12 INDUSTRIAL LANDFILL 5

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -291.00 to X values and -300.00 to Y values listed.

25 Top Boundaries
40 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	280.00	140.00	280.00	4
2	140.00	280.00	149.00	290.00	4
3	149.00	290.00	192.00	296.00	4
4	192.00	296.00	248.00	296.00	4
5	248.00	296.00	260.00	291.00	4
6	260.00	291.00	283.00	300.00	4
7	283.00	300.00	291.00	300.00	4
8	291.00	300.00	454.00	346.50	1
9	454.00	346.50	471.00	349.00	1
10	471.00	349.00	604.00	387.00	1
11	604.00	387.00	653.00	396.00	1
12	653.00	396.00	687.00	400.00	1
13	687.00	400.00	809.00	425.70	1
14	809.00	425.70	870.00	440.00	1
15	870.00	440.00	920.00	442.00	1
16	920.00	442.00	949.00	442.00	1
17	949.00	442.00	995.00	440.00	1
18	995.00	440.00	1079.00	418.40	1
19	1079.00	418.40	1103.00	415.00	1
20	1103.00	415.00	1131.00	413.50	1

21	1131.00	413.50	1246.00	384.00	1
22	1246.00	384.00	1267.00	381.00	1
23	1267.00	381.00	1407.00	345.00	1
24	1407.00	345.00	1480.00	345.00	4
25	1480.00	345.00	1500.00	338.00	4
26	297.00	301.50	328.00	294.20	2
27	328.00	294.20	549.00	305.00	2
28	549.00	305.00	849.00	318.50	2
29	849.00	318.50	1353.50	340.50	2
30	1353.50	340.50	1398.00	348.00	2
31	295.00	301.00	328.00	293.00	3
32	328.00	293.00	549.00	304.00	3
33	549.00	304.00	849.00	317.50	3
34	849.00	317.50	1353.50	339.50	3
35	1353.50	339.50	1401.00	347.00	3
36	291.00	300.00	329.00	291.00	4
37	329.00	291.00	549.00	302.00	4
38	549.00	302.00	849.00	315.50	4
39	849.00	315.50	1353.50	337.50	4
40	1353.50	337.50	1407.00	345.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	65.0	80.0	200.0	33.0	.00	.0	1
2	120.0	130.0	.0	11.0	.00	.0	1
3	120.0	130.0	500.0	18.0	.00	.0	1
4	120.0	130.0	500.0	18.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	254.00
2	200.00	260.00
3	400.00	274.00
4	760.00	290.00
5	1240.00	290.00

6	1500.00	285.00

Searching Routine Will Be Limited To An Area Defined By 6 Boundaries Of Which The First 6 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	161.00	520.00	210.00
2	520.00	210.00	668.00	230.00
3	668.00	230.00	760.00	250.00
4	760.00	250.00	1187.00	280.00
5	1187.00	280.00	1324.00	270.00
6	1324.00	270.00	1500.00	228.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

Janbus Empirical Coef. is being used for the case of c & phi both > 200 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = .00 ft.
and X = 441.00 ft.

Each Surface Terminates Between X = 641.00 ft.
and X =1041.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y =150.00 ft.

40.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.21	280.00
2	59.36	262.87
3	96.37	247.71
4	134.15	234.57
5	172.58	223.47
6	211.55	214.45
7	250.95	207.55
8	290.67	202.77
9	330.58	200.13
10	370.58	199.64
11	410.54	201.31
12	450.36	205.12
13	489.91	211.07
14	529.09	219.13
15	567.78	229.29
16	605.87	241.51
17	643.24	255.77
18	679.80	272.01
19	715.42	290.19
20	750.02	310.27
21	783.49	332.17
22	815.73	355.85
23	846.66	381.22
24	876.17	408.22
25	904.19	436.76
26	908.40	441.54

*** 2.432 ***

Individual data on the 51 slices

Slice No.	Width Ft (m)	Weight Lbs (kg)	Water Force Top Lbs (kg)	Water Force Bot Lbs (kg)	Tie Force Norm Lbs (kg)	Tie Force Tan Lbs (kg)	Earthquake Force Hor Lbs (kg)	Earthquake Force Ver Lbs (kg)	Surcharge Load Lbs (kg)
1	36.1	37147.5	.0	.0	.0	.0	.0	.0	.0
2	16.1	39556.7	.0	.0	.0	.0	.0	.0	.0
3	20.9	71150.4	.0	6459.2	.0	.0	.0	.0	.0
4	37.8	182331.1	.0	40713.8	.0	.0	.0	.0	.0
5	5.8	33901.9	.0	9260.1	.0	.0	.0	.0	.0
6	9.0	60103.9	.0	15634.2	.0	.0	.0	.0	.0
7	23.6	190826.3	.0	48915.3	.0	.0	.0	.0	.0
8	19.4	178512.4	.0	47545.7	.0	.0	.0	.0	.0
9	8.0	78176.3	.0	21423.1	.0	.0	.0	.0	.0
10	11.6	116340.8	.0	32931.7	.0	.0	.0	.0	.0
11	36.4	389112.7	.0	*******	.0	.0	.0	.0	.0
12	3.0	32663.0	.0	10383.4	.0	.0	.0	.0	.0
13	9.0	98383.5	.0	32268.2	.0	.0	.0	.0	.0
14	23.0	263328.0	.0	86423.0	.0	.0	.0	.0	.0
15	7.7	93822.2	.0	30205.8	.0	.0	.0	.0	.0

16	.3	4115.6	.0	1327.2	.0	.0	.0	.0	.C
17	4.0	49339.5	.0	15944.5	.0	.0	.0	.0	.C
18	2.0	24972.1	.0	8023.2	.0	.0	.0	.0	.C
19	31.0	396344.2	.0	*******	.0	.0	.0	.0	.C
20	1.0	13031.1	.0	4287.4	.0	.0	.0	.0	.C
21	1.6	20632.0	.0	6785.1	.0	.0	.0	.0	.C
22	40.0	542549.0	.0	*******	.0	.0	.0	.0	.C
23	29.4	420119.1	.0	*******	.0	.0	.0	.0	.C
24	10.5	153978.2	.0	48105.8	.0	.0	.0	.0	.C
25	39.8	592381.9	.0	*******	.0	.0	.0	.0	.C
26	3.6	54851.3	.0	16279.3	.0	.0	.0	.0	.C
27	17.0	255180.3	.0	74837.9	.0	.0	.0	.0	.C
28	18.9	283205.5	.0	80999.6	.0	.0	.0	.0	.C
29	39.2	583540.6	.0	*******	.0	.0	.0	.0	.C
30	19.9	292063.7	.0	74976.0	.0	.0	.0	.0	.C
31	18.8	271006.4	.0	65631.4	.0	.0	.0	.0	.C
32	36.2	505030.6	.0	*******	.0	.0	.0	.0	.C
33	1.9	25318.6	.0	5124.3	.0	.0	.0	.0	.C
34	37.4	481330.7	.0	88124.1	.0	.0	.0	.0	.C
35	9.8	117294.9	.0	18034.3	.0	.0	.0	.0	.0
36	26.8	299548.8	.0	36163.2	.0	.0	.0	.0	.0
37	7.2	74532.6	.0	6427.5	.0	.0	.0	.0	.0
38	23.8	226953.5	.0	9201.6	.0	.0	.0	.0	.0
39	4.7	41352.8	.0	.0	.0	.0	.0	.0	.0
40	34.6	270836.1	.0	.0	.0	.0	.0	.0	.0
41	1.3	8759.5	.0	.0	.0	.0	.0	.0	.0
42	3.3	22055.7	.0	.0	.0	.0	.0	.0	.0
43	1.6	10775.8	.0	.0	.0	.0	.0	.0	.0
44	27.3	166985.9	.0	.0	.0	.0	.0	.0	.0
45	25.5	135096.6	.0	.0	.0	.0	.0	.0	.0
46	6.7	31998.5	.0	.0	.0	.0	.0	.0	.0
47	30.9	125366.5	.0	.0	.0	.0	.0	.0	.0
48	23.3	68840.0	.0	.0	.0	.0	.0	.0	.0
49	6.2	13930.3	.0	.0	.0	.0	.0	.0	.0
50	28.0	33363.2	.0	.0	.0	.0	.0	.0	.0
51	4.2	629.7	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	232.11	296.00
2	268.43	279.25
3	305.88	265.19
4	344.25	253.91
5	383.35	245.46
6	422.96	239.89
7	462.87	237.22
8	502.87	237.48
9	542.75	240.66
10	582.28	246.73
11	621.27	255.68
12	659.49	267.46
13	696.76	281.99
14	732.87	299.21
15	767.62	319.01

16	800.83	341.30
17	832.33	365.96
18	861.94	392.85
19	889.51	421.83
20	905.59	441.42

*** 2.437 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	162.47	291.88
2	196.63	271.07
3	232.33	253.02
4	269.34	237.84
5	307.43	225.63
6	346.37	216.47
7	385.90	210.41
8	425.80	207.50
9	465.80	207.74
10	505.65	211.14
11	545.12	217.67
12	583.94	227.30
13	621.88	239.97
14	658.70	255.59
15	694.18	274.07
16	728.08	295.30
17	760.21	319.13
18	790.35	345.43
19	818.32	374.02
20	843.94	404.74
21	867.06	437.38
22	868.40	439.63

*** 2.440 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	116.05	280.00
2	153.01	264.69
3	190.78	251.53
4	229.25	240.56

5	268.28	231.84
6	307.76	225.37
7	347.54	221.19
8	387.49	219.31
9	427.49	219.73
10	467.40	222.45
11	507.08	227.47
12	546.41	234.77
13	585.25	244.32
14	623.48	256.09
15	660.97	270.05
16	697.59	286.14
17	733.22	304.31
18	767.75	324.51
19	801.06	346.66
20	833.03	370.69
21	863.57	396.52
22	892.57	424.07
23	908.97	441.56

*** 2.445 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.42	280.00
2	82.82	263.41
3	120.10	248.91
4	158.14	236.54
5	196.82	226.35
6	236.01	218.36
7	275.60	212.60
8	315.44	209.10
9	355.42	207.85
10	395.41	208.87
11	435.27	212.15
12	474.89	217.69
13	514.13	225.45
14	552.86	235.43
15	590.97	247.58
16	628.33	261.87
17	664.82	278.26
18	700.33	296.68
19	734.73	317.08
20	767.93	339.40
21	799.81	363.56
22	830.27	389.49
23	859.21	417.10
24	881.06	440.44

*** 2.447 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	255.32	292.95
2	288.44	270.53
3	324.10	252.41
4	361.74	238.86
5	400.77	230.10
6	440.58	226.26
7	480.56	227.40
8	520.10	233.50
9	558.56	244.47
10	595.37	260.14
11	629.93	280.27
12	661.73	304.53
13	690.26	332.57
14	715.09	363.93
15	735.82	398.14
16	741.81	411.55

*** 2.448 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	255.32	292.95
2	288.37	270.43
3	324.02	252.28
4	361.68	238.81
5	400.75	230.22
6	440.59	226.65
7	480.56	228.17
8	520.02	234.75
9	558.32	246.28
10	594.85	262.58
11	629.01	283.38
12	660.27	308.34
13	688.10	337.07
14	712.06	369.10
15	731.77	403.91
16	734.23	409.95

*** 2.450 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	232.11	296.00
2	266.54	275.64
3	302.99	259.18
4	341.04	246.83
5	380.21	238.73
6	420.03	234.97
7	460.03	235.62
8	499.71	240.65
9	538.60	250.00
10	576.23	263.57
11	612.14	281.19
12	645.90	302.65
13	677.10	327.68
14	705.36	355.99
15	730.34	387.23
16	746.34	412.50

*** 2.462 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	278.53	298.25
2	313.46	278.76
3	350.09	262.70
4	388.09	250.21
5	427.12	241.43
6	466.80	236.41
7	506.78	235.22
8	546.69	237.86
9	586.17	244.30
10	624.85	254.49
11	662.38	268.34
12	698.41	285.71
13	732.61	306.45
14	764.67	330.37
15	794.30	357.25

16	821.21	386.84
17	845.17	418.87
18	856.04	436.73

*** 2.464 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	232.11	296.00
2	265.04	273.29
3	300.52	254.84
4	338.02	240.92
5	376.96	231.75
6	416.73	227.46
7	456.72	228.14
8	496.33	233.76
9	534.93	244.24
10	571.94	259.42
11	606.78	279.06
12	638.93	302.87
13	667.88	330.47
14	693.19	361.44
15	714.47	395.31
16	719.89	406.93

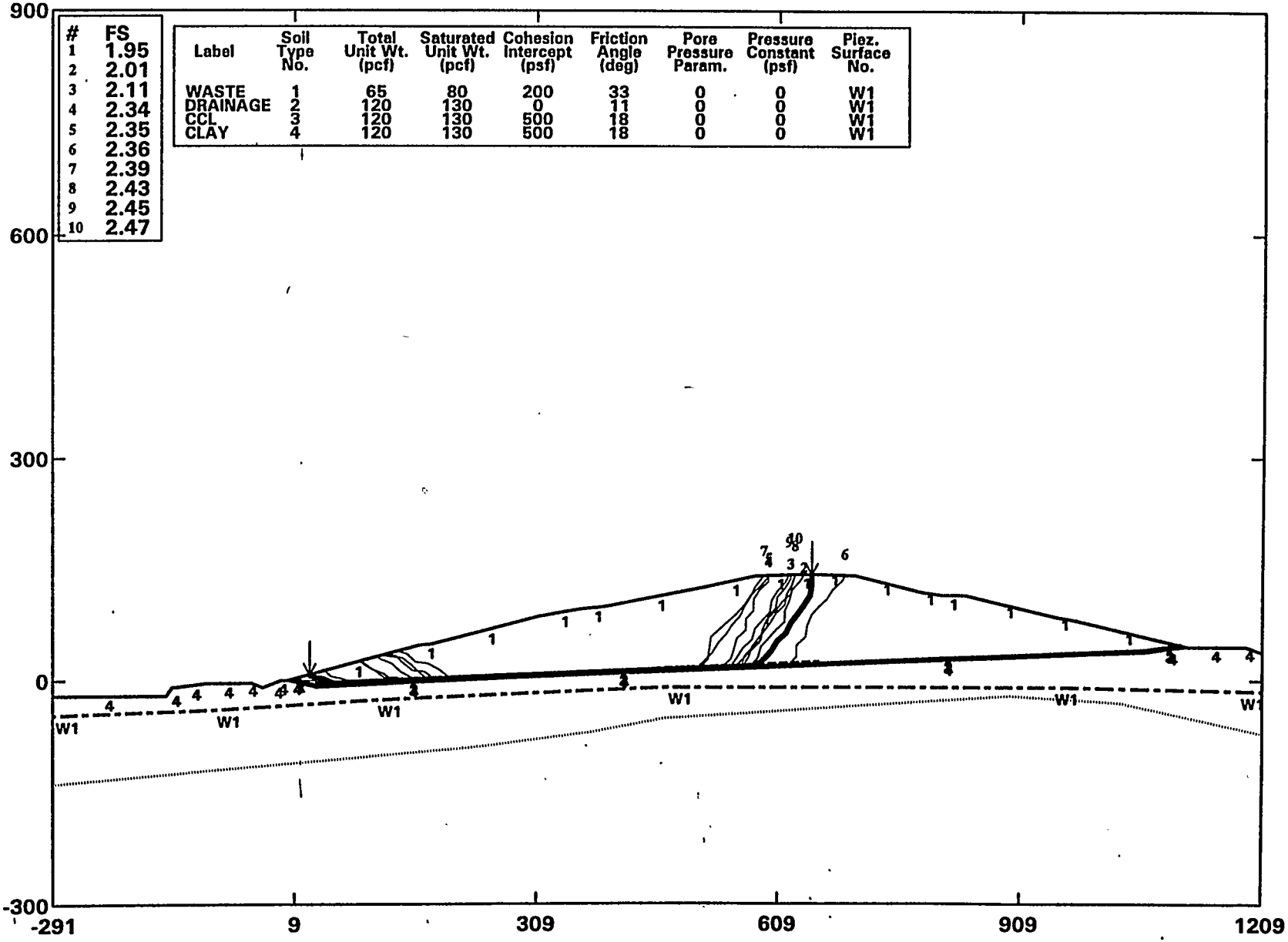
*** 2.465 ***

Y-12 INDUSTRIAL LANDFILL 5

Ten Most Critical. A:B4S.PLT By: DAVID TSO 06-21-95 2:00pm

#	FS
1	1.95
2	2.01
3	2.11
4	2.34
5	2.35
6	2.36
7	2.39
8	2.43
9	2.45
10	2.47

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	65	80	200	33	0	0	W1
DRAINAGE	2	120	130	0	11	0	0	W1
CCL	3	120	130	500	18	0	0	W1
CLAY	4	120	130	500	18	0	0	W1

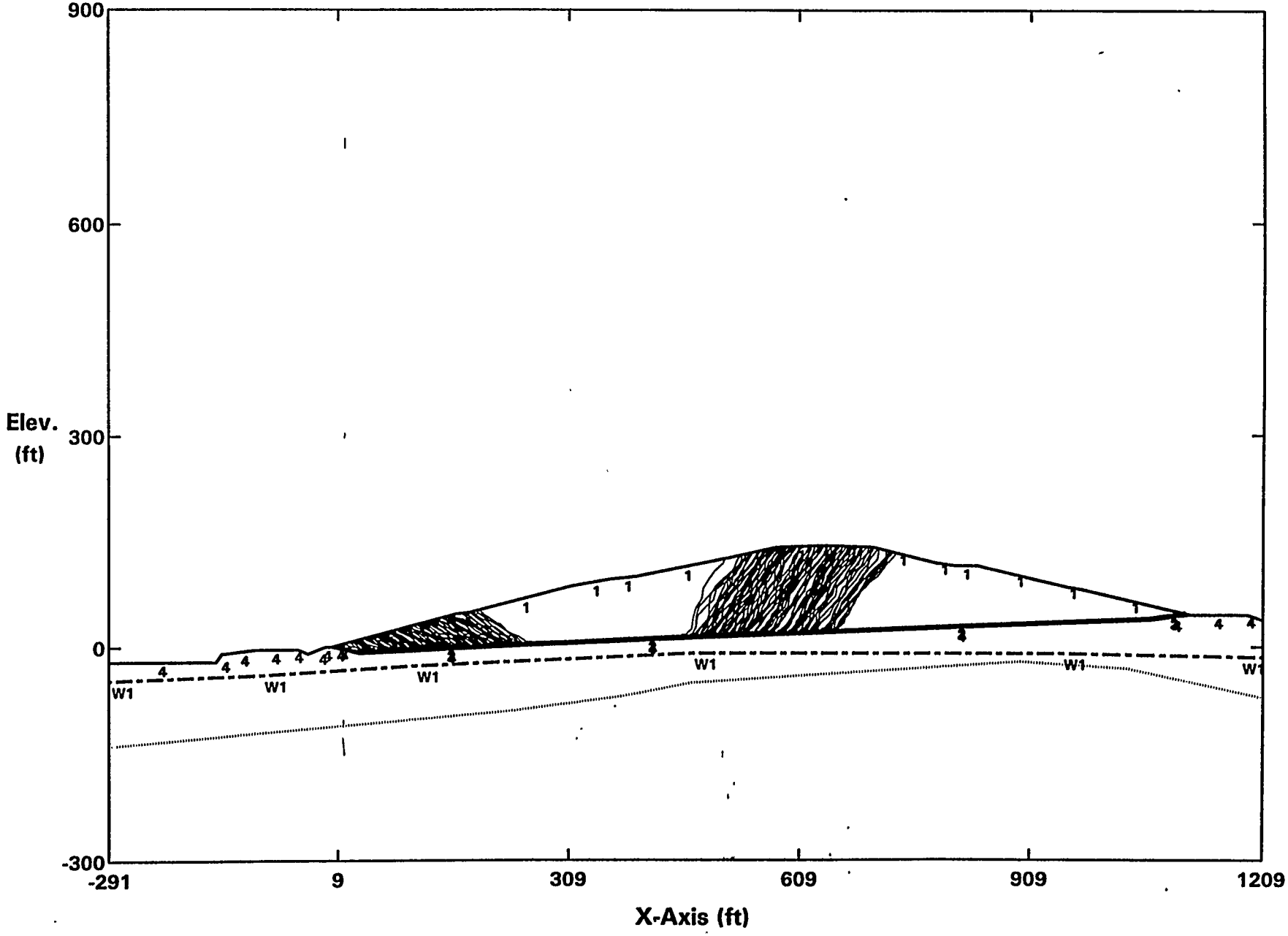


PCSTABL5M FSmin = 1.95 X-Axis (ft)

CH

Y-12 INDUSTRIAL LANDFILL 5

All surfaces evaluated. A:B4S.PLT By: DAVID TSO 06-21-95 2:00pm



C15

C16

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 06-21-95
Time of Run: 2:00pm
Run By: DAVID TSO
Input Data Filename: A:B4S.I
Output Filename: A:B4S.OUT
Plotted Output Filename: A:B4S.PLT

PROBLEM DESCRIPTION Y-12 INDUSTRIAL LANDFILL 5

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -291.00 to X values and -300.00 to Y values listed.

25 Top Boundaries
40 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	280.00	140.00	280.00	4
2	140.00	280.00	149.00	290.00	4
3	149.00	290.00	192.00	296.00	4
4	192.00	296.00	248.00	296.00	4
5	248.00	296.00	260.00	291.00	4
6	260.00	291.00	283.00	300.00	4
7	283.00	300.00	291.00	300.00	4
8	291.00	300.00	454.00	346.50	1
9	454.00	346.50	471.00	349.00	1
10	471.00	349.00	604.00	387.00	1
11	604.00	387.00	653.00	396.00	1
12	653.00	396.00	687.00	400.00	1
13	687.00	400.00	809.00	425.70	1
14	809.00	425.70	870.00	440.00	1
15	870.00	440.00	920.00	442.00	1
16	920.00	442.00	949.00	442.00	1
17	949.00	442.00	995.00	440.00	1
18	995.00	440.00	1079.00	418.40	1
19	1079.00	418.40	1103.00	415.00	1
20	1103.00	415.00	1131.00	413.50	1

21	1131.00	413.50	1246.00	384.00	1
22	1246.00	384.00	1267.00	381.00	1
23	1267.00	381.00	1407.00	345.00	1
24	1407.00	345.00	1480.00	345.00	4
25	1480.00	345.00	1500.00	338.00	4
26	297.00	301.50	328.00	294.20	2
27	328.00	294.20	549.00	305.00	2
28	549.00	305.00	849.00	318.50	2
29	849.00	318.50	1353.50	340.50	2
30	1353.50	340.50	1398.00	348.00	2
31	295.00	301.00	328.00	293.00	3
32	328.00	293.00	549.00	304.00	3
33	549.00	304.00	849.00	317.50	3
34	849.00	317.50	1353.50	339.50	3
35	1353.50	339.50	1401.00	347.00	3
36	291.00	300.00	329.00	291.00	4
37	329.00	291.00	549.00	302.00	4
38	549.00	302.00	849.00	315.50	4
39	849.00	315.50	1353.50	337.50	4
40	1353.50	337.50	1407.00	345.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	65.0	80.0	200.0	33.0	.00	.0	1
2	120.0	130.0	.0	11.0	.00	.0	1
3	120.0	130.0	500.0	18.0	.00	.0	1
4	120.0	130.0	500.0	18.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	254.00
2	200.00	260.00
3	400.00	274.00
4	760.00	290.00
5	1240.00	290.00

6	1500.00	285.00

Searching Routine Will Be Limited To An Area Defined By 6 Boundaries Of Which The First 6 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	161.00	520.00	210.00
2	520.00	210.00	668.00	230.00
3	668.00	230.00	760.00	250.00
4	760.00	250.00	1187.00	280.00
5	1187.00	280.00	1324.00	270.00
6	1324.00	270.00	1500.00	228.00

Janbus Empirical Coef is being used for the case of c & phi both > 0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 15.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	328.00	294.20	549.00	305.00	3.00
2	749.00	314.00	949.00	322.50	3.00

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	317.93	307.68
2	321.38	305.62
3	335.79	301.46
4	349.51	295.41
5	869.94	318.41
6	880.53	329.03
7	890.81	339.95
8	898.79	352.65
9	908.54	364.05
10	914.96	377.61
11	924.30	389.35
12	932.60	401.84
13	939.66	415.07
14	941.83	429.91
15	942.13	442.00

*** 1.954 ***

Individual data on the 27 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	3.5	341.9	.0	.0	.0	.0	.0	.0	.0
2	14.4	6726.7	.0	.0	.0	.0	.0	.0	.0
3	13.7	14538.3	.0	.0	.0	.0	.0	.0	.0
4	33.8	55787.6	.0	.0	.0	.0	.0	.0	.0
5	70.6	174936.8	.0	.0	.0	.0	.0	.0	.0
6	17.0	52663.7	.0	.0	.0	.0	.0	.0	.0
7	78.0	294772.3	.0	.0	.0	.0	.0	.0	.0
8	55.0	265887.1	.0	.0	.0	.0	.0	.0	.0
9	49.0	269030.8	.0	.0	.0	.0	.0	.0	.0
10	34.0	197047.9	.0	.0	.0	.0	.0	.0	.0
11	122.0	797894.8	.0	.0	.0	.0	.0	.0	.0
12	40.0	298039.4	.0	.0	.0	.0	.0	.0	.0
13	20.9	163884.8	.0	.0	.0	.0	.0	.0	.0
14	.0	11.7	.0	.0	.0	.0	.0	.0	.0
15	.1	504.9	.0	.0	.0	.0	.0	.0	.0
16	1.0	7741.0	.0	.0	.0	.0	.0	.0	.0
17	9.6	72027.7	.0	.0	.0	.0	.0	.0	.0
18	10.3	70912.2	.0	.0	.0	.0	.0	.0	.0
19	8.0	49080.7	.0	.0	.0	.0	.0	.0	.0
20	9.8	52631.5	.0	.0	.0	.0	.0	.0	.0
21	6.4	29523.3	.0	.0	.0	.0	.0	.0	.0
22	5.0	20042.6	.0	.0	.0	.0	.0	.0	.0
23	4.3	15457.3	.0	.0	.0	.0	.0	.0	.0
24	8.3	25053.7	.0	.0	.0	.0	.0	.0	.0
25	7.1	15387.5	.0	.0	.0	.0	.0	.0	.0
26	2.2	2753.7	.0	.0	.0	.0	.0	.0	.0
27	.3	117.9	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	320.02	308.28
2	327.14	305.37
3	337.75	294.77
4	864.76	318.82
5	874.16	330.51
6	877.26	345.19
7	887.00	356.59
8	897.08	367.70
9	906.71	379.20
10	907.15	394.19
11	913.77	407.65
12	916.06	422.48
13	926.26	433.48
14	931.05	442.00

*** 2.009 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	380.37	325.49
2	385.76	320.41
3	399.12	313.58
4	410.99	304.41
5	425.94	303.13
6	440.32	298.88
7	854.85	318.65
8	862.32	331.66
9	867.18	345.85
10	875.42	358.38
11	884.21	370.53
12	886.70	385.33
13	896.21	396.93
14	897.72	411.85
15	907.46	423.26
16	914.47	436.52
17	915.02	441.80

*** 2.112 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	406.83	333.04
2	417.72	331.53
3	432.61	329.70
4	444.69	320.80
5	455.35	310.25
6	466.87	300.64
7	802.31	316.20
8	811.07	328.38
9	814.45	342.99
10	816.55	357.84
11	827.09	368.51
12	837.18	379.61
13	847.33	390.66
14	857.63	401.56
15	864.55	414.87
16	874.78	425.84
17	884.28	437.45
18	886.34	440.65

*** 2.340 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	336.74	313.05
2	345.76	304.84
3	360.36	301.41
4	374.28	295.81
5	829.46	316.93
6	840.06	327.54
7	843.64	342.10
8	847.46	356.61
9	858.02	367.26
10	858.41	382.26
11	868.19	393.62
12	868.86	408.61
13	875.65	421.98
14	886.26	432.59
15	887.56	440.70

*** 2.349 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	304.91	303.97
2	308.54	300.52
3	323.51	299.59
4	337.86	295.22
5	912.51	320.46
6	921.77	332.26
7	922.77	347.23
8	932.95	358.25
9	936.40	372.84
10	940.51	387.27
11	950.37	398.58
12	960.55	409.59
13	968.42	422.37
14	978.10	433.82
15	982.16	440.56

*** 2.357 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	426.49	338.65
2	438.81	335.08
3	449.73	324.79
4	464.48	322.08
5	477.58	314.78
6	489.73	305.98
7	504.37	302.69
8	796.79	315.06
9	807.28	325.78
10	817.03	337.17
11	824.41	350.24
12	834.43	361.39
13	842.04	374.32
14	852.18	385.37
15	856.75	399.66
16	864.22	412.67
17	870.25	426.40
18	879.52	438.19
19	880.98	440.44

*** 2.390 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	400.66	331.28
2	406.91	328.19
3	420.46	321.74
4	431.28	311.36
5	444.20	303.74
6	458.83	300.40
7	844.64	317.14
8	854.42	328.51
9	864.43	339.69
10	874.93	350.40
11	880.13	364.47
12	889.25	376.38
13	897.15	389.12
14	906.99	400.44
15	909.54	415.23
16	916.52	428.50
17	921.52	442.00

*** 2.429 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	380.39	325.50
2	383.64	324.70
3	395.22	315.17
4	408.76	308.71
5	421.23	300.37
6	436.22	299.92
7	840.20	317.89
8	848.27	330.53
9	855.56	343.64
10	865.66	354.73
11	870.00	369.09
12	878.57	381.40
13	889.18	392.01
14	890.66	406.93
15	897.75	420.15
16	908.29	430.83

17	913.31	441.73

*** 2.453 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	408.87	333.63
2	408.96	333.55
3	423.96	333.30
4	434.57	322.70
5	446.11	313.11
6	460.86	310.41
7	472.86	301.41
8	852.65	317.63
9	856.15	332.22
10	866.72	342.87
11	877.24	353.56
12	879.98	368.31
13	884.97	382.45
14	895.52	393.12
15	903.74	405.66
16	914.34	416.28
17	917.73	430.89
18	920.45	442.00

*** 2.474 ***

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT	Landfill V, Y-12					SUBJECT	Stability Analysis		
REV #	0						SHEET	01 OF 017	
BY & DATE	DTT	6/23/95					OFS NO.		
CHKD & DATE	WPT	6/27/95					CALC NO.	CIV-ERWM-182	

ATTACHMENT D

17 sheets

Static Veneer Stability Analysis

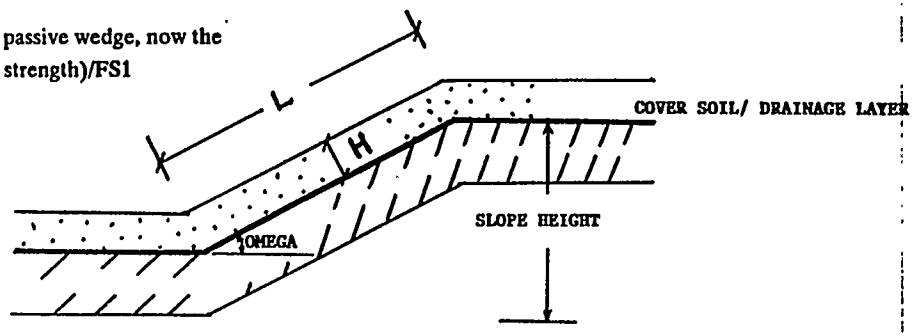
Cover soil / geonet composite
Geonet composite / geomembrane
Geomembrane / clay liner

after: Koerner, R.M. and Hwu, B.-L. (1991),
"Stability and Tension Considerations Regarding Cover Soils on
Geomembrane Lined Slopes", Geotextiles & Geomembranes, Vol.10, 335-355.
Version: LINERB
Created: June 28, 1991
Latest modification to program: July 17, 91
Corrected computation of FS3 to account for the passive wedge, now the mobilized strength at upper interface is (ultimate strength)/FS1

INPUT DATA: GENERAL

Slope Height (m)=	36.6		INPUT IN METERS
L[m]=	128		
H[m]=	0.46		
Omega[ ] 15.9	=	0.277507	[radians]

INPUT IN DEGREES



INPUT OF PARAMETERS AND COMPUTATION

Model 1: Stability of cover soil above a geomembrane

FRICTION ANGLE AT COVER SOIL/ GEOMEMBRANE INTERFACE (INPUT IN DEGREES)
COHESIVE INTERCEPT AT COVER SOIL/ GEOMEMBRANE INTERFACE
COHESION OF COVER SOIL
ANGLE OF INTERNAL FRICTION OF COVER SOIL (INPUT IN DEGREES)

UNIT WEIGHT OF COVER SOIL	gamma [kN/m3]	delta(u) [=>rad] 15	Ca(u) [kPa]	phi [=>rad] 14.4	C [kPa]
	19	0.261799	0	0.251327	24

Increments 1 → 0.017453 (VALUE IN RADIANS)

INCREMENT IN DEGREE ON DELTA(U) FOR PARAMETRIC STUDY

COMPUTED SAFETY FACTOR FOR THE STABILITY OF THE COVER SOIL AGAINST SLIDING

gamma	delta(u)	Ca(u)	phi	C	a	b	c	FS1	(FS)	delta(u)	phi
19	0.261799	0	0.251327	24	155.3244	-179.733	10.68596	1.094273	0.062871	15	14.4
19	0.279253	0	0.251327	24	155.3244	-189.982	11.43556	1.159639	0.063488	16	14.4
19	0.296706	0	0.251327	24	155.3244	-200.334	12.1927	1.225734	0.064042	17	14.4
19	0.314159	0	0.251327	24	155.3244	-210.797	12.95797	1.292599	0.064541	18	14.4
19	0.331613	0	0.251327	24	155.3244	-221.38	13.73197	1.360279	0.064993	19	14.4
19	0.349066	0	0.251327	24	155.3244	-232.09	14.51533	1.428823	0.065405	20	14.4
19	0.366519	0	0.251327	24	155.3244	-242.938	15.3087	1.498284	0.065782	21	14.4
19	0.383972	0	0.251327	24	155.3244	-253.931	16.11278	1.568717	0.066128	22	14.4
19	0.401426	0	0.251327	24	155.3244	-265.081	16.92828	1.640183	0.066448	23	14.4
19	0.418879	0	0.251327	24	155.3244	-276.398	17.75596	1.712744	0.066744	24	14.4

Model 3: Geomembrane tension due to unbalanced friction

delta(l) [=>rad]	Ca(l) [kPa]	Tm(allow) [kN/m]
14		
0.244346	0	60

FRICTION ANGLE AT GEOMEMBRANE/ CLAY INTERFACE (IN DEGREE)

ALLOWABLE (FAILURE) TENSILE FORCE IN GEOMEMBRANE (KN/UNIT WIDTH)

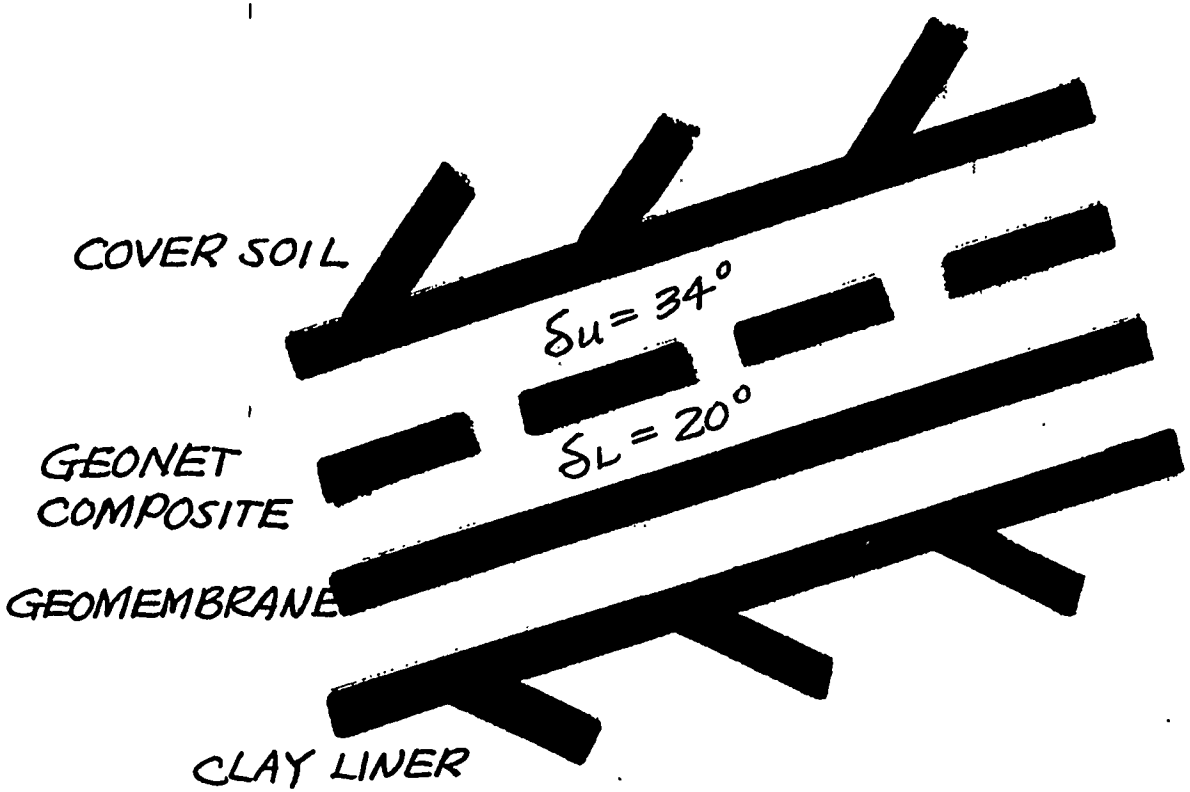
COHESIVE INTERCEPT FOR GEOMEMBRANE/ CLAY INTERFACE

delta(l)	Ca(l)	Tm(allow)	Tm(FS1>	Tm(FS1<	Tm(reqd)	FS3	delta(l)
0.244346	0	60	-4.80168	20.0349	0	UNDEFI	14
0.244346	0	60	-2.21297	40.25808	0	UNDEFI	14
0.244346	0	60	0.10603	60.68473	0.10603	565.8753	14
0.244346	0	60	2.196251	81.33056	2.196251	27.31929	14
0.244346	0	60	4.090799	102.2119	4.090799	14.66706	14
0.244346	0	60	5.816735	123.3458	5.816735	10.31506	14
0.244346	0	60	7.396387	144.7499	7.396387	8.112069	14
0.244346	0	60	8.848331	166.4428	8.848331	6.78094	14
0.244346	0	60	10.18815	188.4438	10.18815	5.889195	14
0.244346	0	60	11.42901	210.7733	11.42901	5.2498	14
0.244346	0	60	12.5821	233.4526	12.5821	4.768681	14

COMPUTATIONS FOR VALUES OF DELTA(U) CORRESPONDING TO TABLE OF MODEL 1

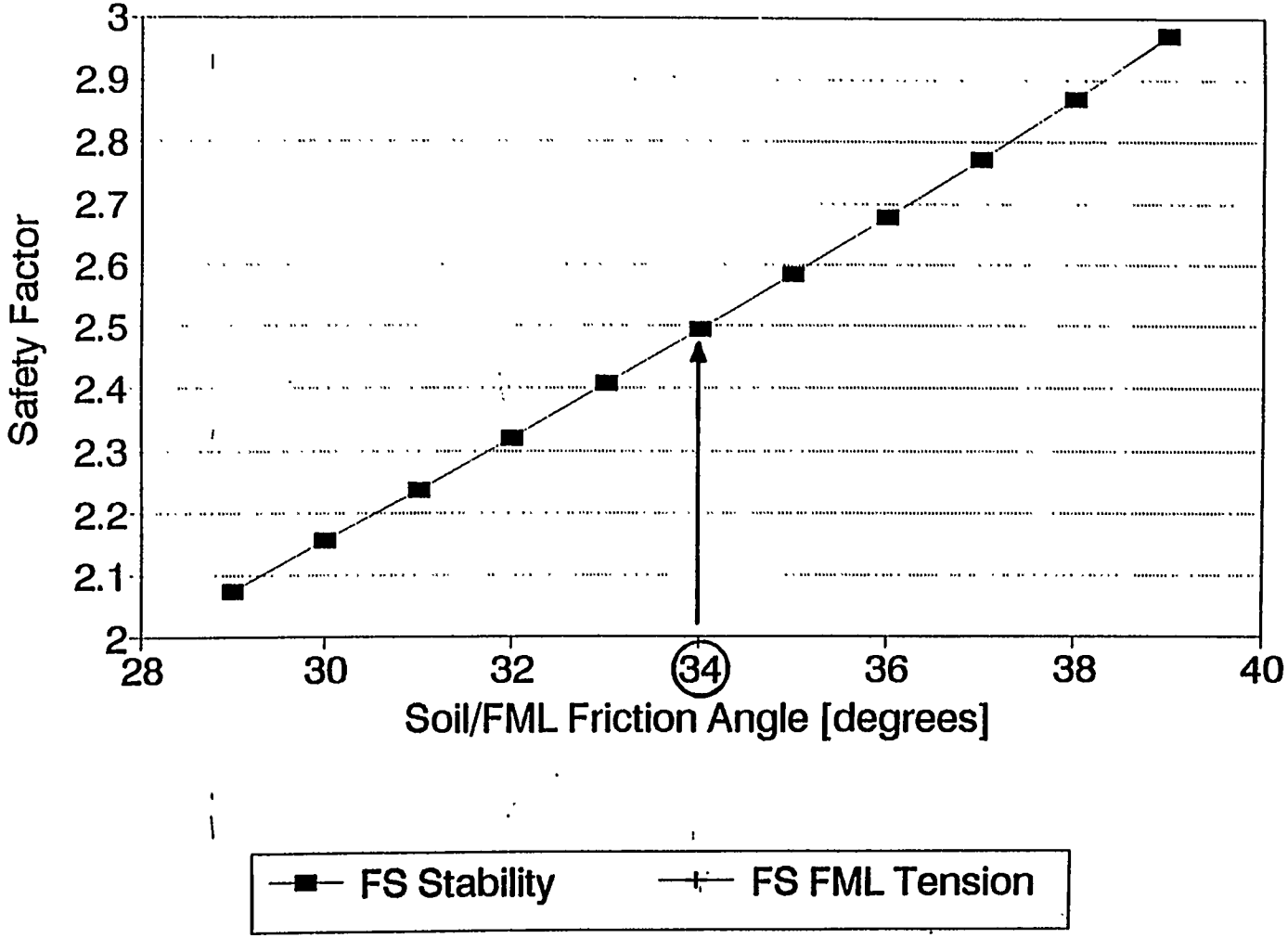
SAFETY FACTOR OF GEOMEMBRANE WITH RESPECT TO TENSILE FAILURE

REQUIRED TENSILE FORCE IN GEOMEMBRANE (kN/M)


COVER SOIL
$\delta_u = 34°$
$\delta_L = 20°$
GEONET COMPOSITE
GEOMEMBRANE
CLAY LINER

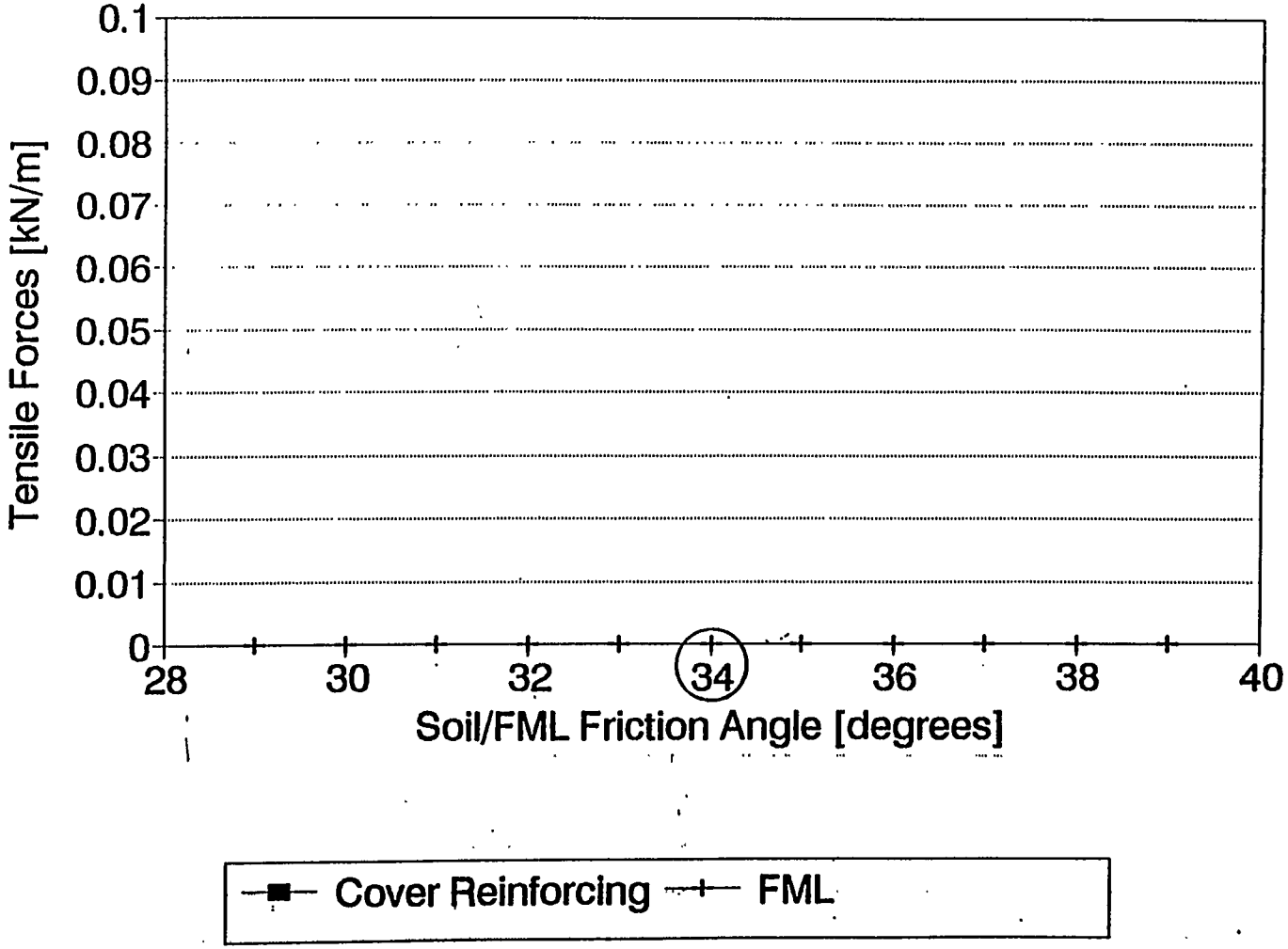
COVER SOIL/ GEONET COMPOSITE INTERFACE

STABILITY OF COVER SOIL



COVER SOIL/ GEONET COMPOSITE INTERFACE

REQUIRED TENSILE FORCES



STABILITY O NDFILL SLOPES P.L.Bourdeau Purdue University

after: Koerner, R.M. and Hwu, B.-L. (1991),
"Stability and Tension Considerations Regarding Cover Soils on
Geomembrane Lined Slopes", Geotextiles & Geomembranes, Vol.10, 335-355.

Version: LINERB

Created: June 28, 1991

Latest modification to program: July 17, 91
Corrected computation of FS3 to account for the passive wedge, now the mobilized strength at upper interface is (ultimate strength)/FS1

INPUT DATA: GENERAL

Slope Height (m)= 36.6

L[m]= 148

H[m]= 0.46

Omega[ ] 15.9 = 0.277507 [radians]

INPUT OF PARAMETERS AND COMPUTATION

Model 1: Stability of cover soil above a geomembrane

	gamma [kN/m3]	delta(u) [=>rad]	Ca(u) [kPa]	phi [=>rad]	C [kPa]
		34		14.4	
	19	0.593412	0	0.251327	24
Increments		1			
		0.017453			

gamma	delta(u)	Ca(u)	phi	C	a	b	c	FS1	(FS)	delta(u)	phi
19	0.593412	0	0.251327	24	179.5939	-460.66	31.10285	2.495612	0.069396	34	14.4
19	0.610865	0	0.251327	24	179.5939	-476.862	32.28788	2.585695	0.06953	35	14.4
19	0.628319	0	0.251327	24	179.5939	-493.466	33.50223	2.678017	0.069658	36	14.4
19	0.645772	0	0.251327	24	179.5939	-510.495	34.74779	2.772719	0.06978	37	14.4
19	0.663225	0	0.251327	24	179.5939	-527.979	36.02654	2.869955	0.069897	38	14.4
19	0.680678	0	0.251327	24	179.5939	-545.947	37.34066	2.969888	0.070008	39	14.4
19	0.698132	0	0.251327	24	179.5939	-564.429	38.69245	3.072694	0.070116	40	14.4
19	0.715585	0	0.251327	24	179.5939	-583.461	40.08444	3.178563	0.070219	41	14.4
19	0.733038	0	0.251327	24	179.5939	-603.08	41.51931	3.287702	0.070318	42	14.4
					179.5939	-623.325	43.00001	3.400333	0.070413	43	14.4

Model 3: Geomembrane tension due to unbalanced friction

delta(l) [=>rad]	Ca(l) [kPa]	Tm(allow) [kN/m]
20		
0.349066	0	7.4

delta(l)	Ca(l)	Tm(allow)	Tm(FS1>	Tm(FS1<	Tm(reqd)	FS3	delta(l)
0.349066	0	7.4	-116.556	386.3194	0	UNDEFI	20
0.349066	0	7.4	-115.906	418.2898	0	UNDEFI	20
0.349066	0	7.4	-115.286	451.0514	0	UNDEFI	20
0.349066	0	7.4	-114.695	484.6546	0	UNDEFI	20
0.349066	0	7.4	-114.129	519.1535	0	UNDEFI	20
0.349066	0	7.4	-113.587	554.6065	0	UNDEFI	20
0.349066	0	7.4	-113.067	591.076	0	UNDEFI	20
0.349066	0	7.4	-112.568	628.6297	0	UNDEFI	20
0.349066	0	7.4	-112.087	667.3406	0	UNDEFI	20
0.349066	0	7.4	-111.624	707.2878	0	UNDEFI	20
0.349066	0	7.4	-111.178	748.5569	0	UNDEFI	20

D9

SPECIFICATION — Minimum Average Roll Values

Raw material	PN-3000 polyethylene	PN-3000CN* polyethylene
Weight (lbs/ft²) D-3776	0.162	0.130
Thickness (inches) D-751	0.200	0.200
Density of polymer (g/cm³) D-1505**	0.940	0.940
Tensile strength (lb/in) D-1682 (Modified)	42	23
Carbon black ASTM D-1603 (%)	2	2
Porosity (%), Nom.	80	76
Roll width (feet), Nom.	7.54 & 14.5	7.54
Standard roll length (feet), Nom.	300	300
Area per roll (ft²), Nom.	2262 & 4350	2262

42 lb/in
= 186.8 N/in
= 7355 N/M
= 7.4 kN/M

*Foamed
**Fully compounded resin without foam

The transmissivity results listed on the preceding pages were determined in compliance with ASTM D4716-87 test procedure. The transmissivity was measured using water @ 20°C (68°F) with a seat time of one hour. Values may vary, based on dimensions of the transmissivity specimen and specific laboratory.

CONVERSION FACTORS FOR TRANSMISSIVITY UNITS

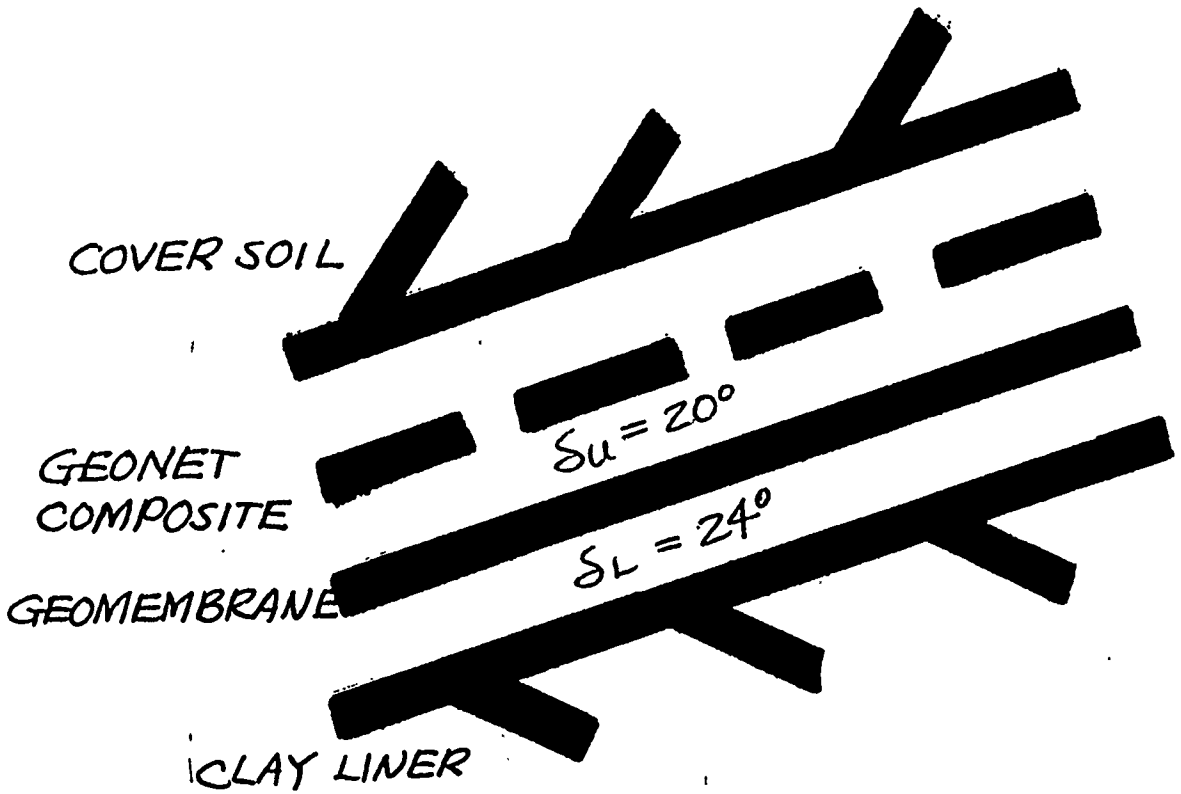
$1 m^2/s$ = 1 cubic meter/second/meter width/unit gradient
$1 m^2/s = 10^3$ liters/second/meter width/unit gradient
$1 m^2/s = 6 \times 10^4$ liters/minute/meter width/unit gradient
$1 m^2/s = 10.76$ ft²/second
$1 m^2/s = 646$ ft²/minute
$1 m^2/s = 4830$ gallons/minute/foot width/unit gradient

1 ft²/second = 1 cubic foot/second/foot width/unit gradient
1 ft²/second = $9.3 \times 10^{-2} m^2/s$
1 ft²/minute = 1 cubic foot/minute/foot width/unit gradient
1 ft²/minute = $1.55 \times 10^{-3} m^2/s$
1 gpm/foot width/unit gradient = $2.07 \times 10^{-4} m^2/s$
1 liter/minute/meter width/unit gradient = $1.66 \times 10^{-5} m^2/s$
100 liters/minute/meter width/unit gradient = 1.07 ft²/min.

The information contained herein has been compiled by Fluid Systems and is, to the best of our knowledge, true and accurate. All suggestions and recommendations are offered without guarantee. Final determination of suitability for use based on any information provided, is the sole responsibility of the user. There is no implied or expressed warranty of merchantability or fitness of the product for the contemplated use.

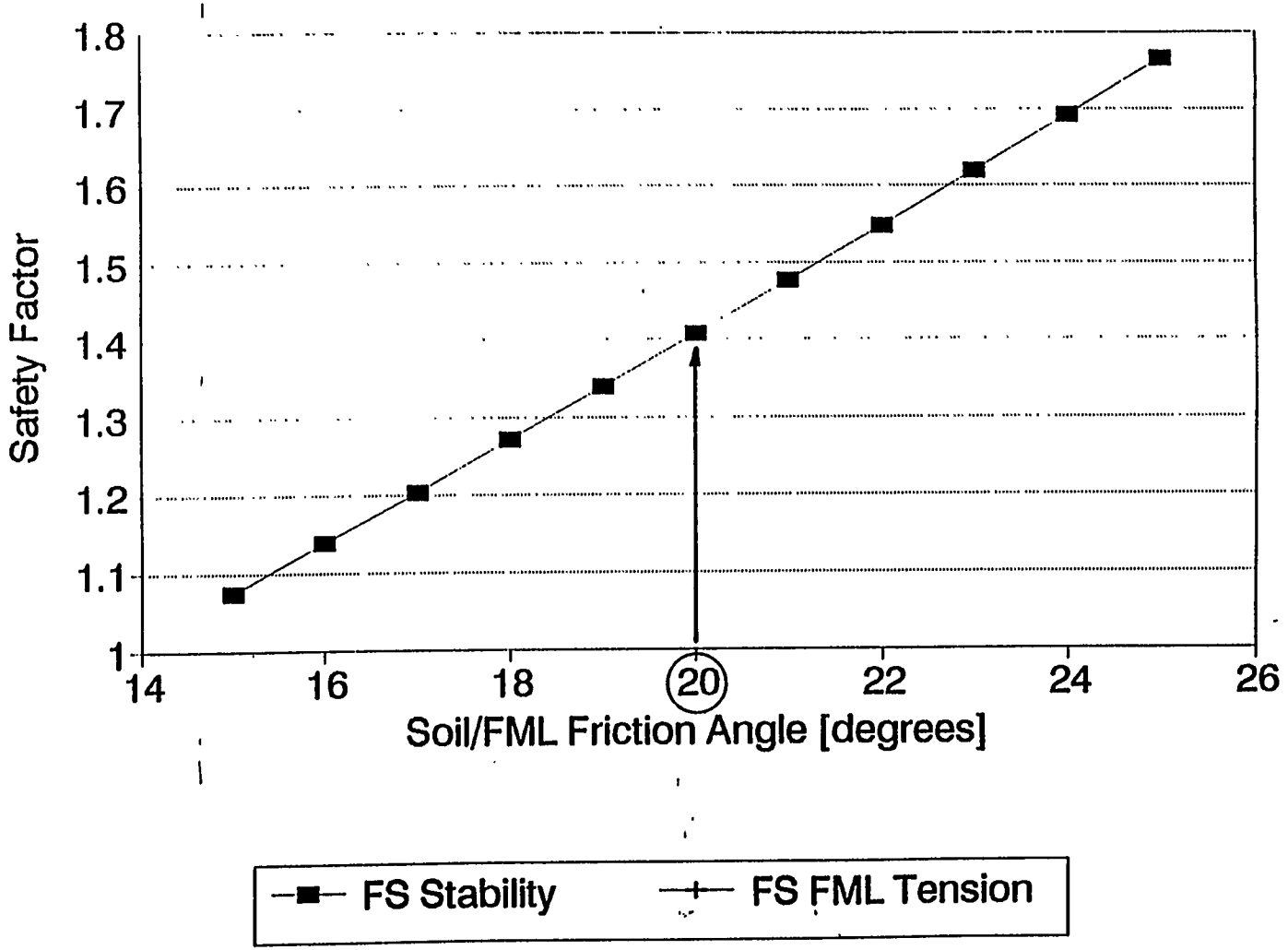
FSI
FLUID SYSTEMS
Farnsworth Center
1245 Corporate Blvd.
Suite 300
Aurora, Illinois 60504
800/346-9107
Fax: 708/898-1179

37-3/92-5M


COVER SOIL
GEONET
COMPOSITE
GEOMEMBRANE
CLAY LINER
$\delta_u = 20°$
$\delta_L = 24°$

GEONET COMPOSITE/ GEOMEMBRANE INTERFACE

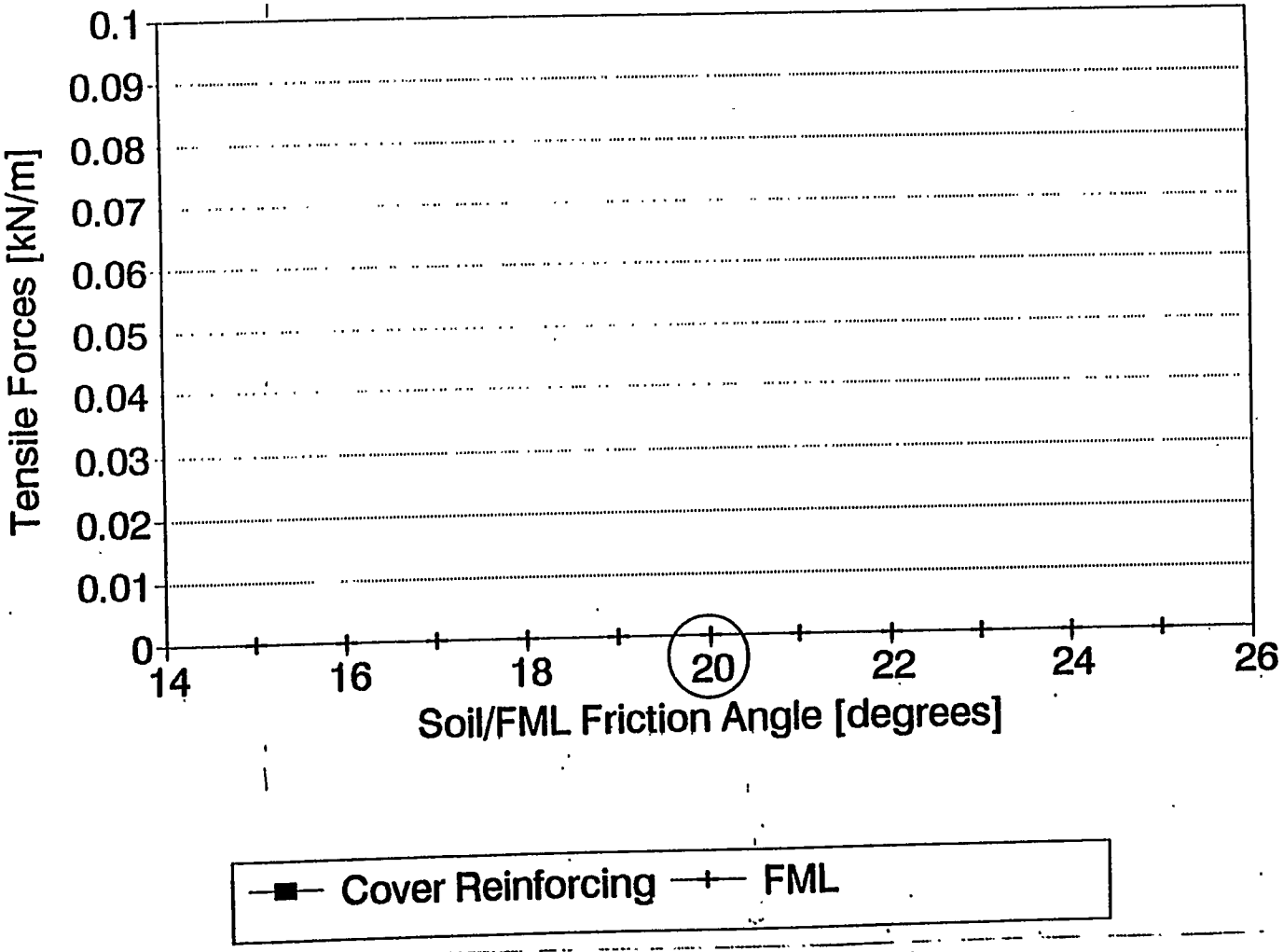
STABILITY OF COVER SOIL



D11

GEONET COMPOSITE/ GEOMEMBRANE INTERFACE

REQUIRED TENSILE FORCES



STABILITY O. ANDFILL SLOPES P.L.Bourdeau Purdue University

after: Koerner, R.M. and Hwu, B.-L. (1991),
"Stability and Tension Considerations Regarding Cover Soils on
Geomembrane Lined Slopes", Geotextiles & Geomembranes, Vol.10, 335-355.

Version: LINERB

Created: June 28, 1991

Latest modification to program: July 17, 91
Corrected computation of FS3 to account for the passive wedge, now the mobilized strength at upper interface is (ultimate strength)/FS1

INPUT DATA: GENERAL

Slope Height (m)= 36.6
L[m]= 148
H[m]= 0.46
Omega[ ] 15.9 = 0.277507 [radians]

INPUT OF PARAMETERS AND COMPUTATION

Model 1: Stability of cover soil above a geomembrane

	gamma [kN/m3]	delta(u) [=>rad]	Ca(u) [kPa]	phi [=>rad]	C [kPa]
		20		14.4	
	19	0.349066	0	0.251327	24
Increments		1			
		0.017453			

gamma	delta(u)	Ca(u)	phi	C
19	0.349066	0	0.251327	24
19	0.366519	0	0.251327	24
19	0.383972	0	0.251327	24
19	0.401426	0	0.251327	24
19	0.418879	0	0.251327	24
19	0.436332	0	0.251327	24
19	0.453786	0	0.251327	24
19	0.471239	0	0.251327	24
19	0.488692	0	0.251327	24

a	b	c	FS1	(FS)	delta(u)	phi
179.5939	-264.875	16.78335	1.408506	0.066348	20	14.4
179.5939	-277.417	17.70069	1.478008	0.066684	21	14.4
179.5939	-290.129	18.6304	1.54848	0.066992	22	14.4
179.5939	-303.021	19.57333	1.619981	0.067276	23	14.4
179.5939	-316.106	20.53033	1.692575	0.067539	24	14.4
179.5939	-329.395	21.50232	1.76633	0.067783	25	14.4
179.5939	-342.903	22.49026	1.841315	0.06801	26	14.4
179.5939	-356.643	23.49517	1.917608	0.068222	27	14.4
179.5939	-370.629	24.51812	1.995286	0.068421	28	14.4
179.5939	-384.878	25.56023	2.074436	0.068608	29	14.4

D13

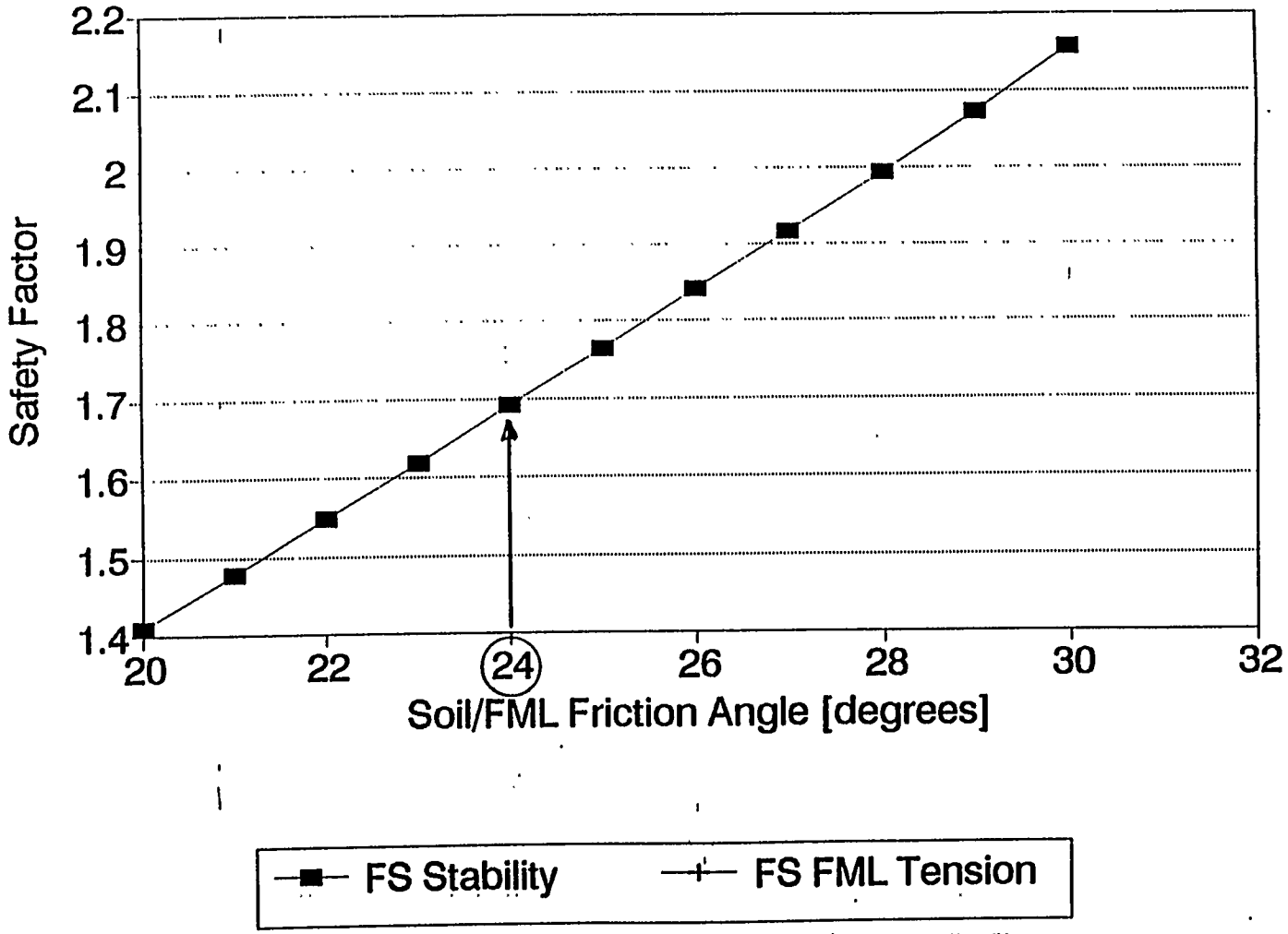
Model 3: Geomembrane tension due to unbalanced friction

delta(l) [=>rad]	Ca(l) [kPa]	Tm(allow) [kN/m]
24		
0.418879	0	15

delta(l)	Ca(l)	Tm(allow)	Tm(FS1>	Tm(FS1<	Tm(reqd)	FS3	delta(l)
0.418879	0	15	-232.41	-101.088	0	UNDEFI	24
0.418879	0	15	-230.782	-76.3396	0	UNDEFI	24
0.418879	0	15	-229.288	-51.2572	0	UNDEFI	24
0.418879	0	15	-227.912	-25.8185	0	UNDEFI	24
0.418879	0	15	-226.638	8.27E-14	0	UNDEFI	24
0.418879	0	15	-225.457	26.22291	0	UNDEFI	24
0.418879	0	15	-224.356	52.8762	0	UNDEFI	24
0.418879	0	15	-223.328	79.98721	0	UNDEFI	24
0.418879	0	15	-222.366	107.5848	0	UNDEFI	24
0.418879	0	15	-221.462	135.6994	0	UNDEFI	24
0.418879	0	15	-220.61	164.3634	0	UNDEFI	24

GEOMEMBRANE/ CLAY LINER INTERFACE

STABILITY OF COVER SOIL



D15

STABILITY INDFILL SLOPES P.L.Bourdeau Purdue University

after: Koerner, R.M. and Hwu, B.-L. (1991),
"Stability and Tension Considerations Regarding Cover Soils on
Geomembrane Lined Slopes", Geotextiles & Geomembranes, Vol.10, 335-355.
Version: LINERB
Created: June 28, 1991
Latest modification to program: July 17, 91
Corrected computation of FS3 to account for the passive wedge, now the mobilized strength at upper interface is (ultimate strength)/FS1

INPUT DATA: GENERAL

Slope Height (m)= 36.6
L[m]= 148
H[m]= 0.46
Omega[ ] 15.9 = 0.277507 [radians]

INPUT OF PARAMETERS AND COMPUTATION

Model 1: Stability of cover soil above a geomembrane

	gamma [kN/m3]	delta(u) [=>rad]	Ca(u) [kPa]	phi [=>rad]	C [kPa]
		24		14.4	
	19	0.418879	0	0.251327	24
Increments		1			
		0.017453			

	gamma	delta(u)	Ca(u)	phi	C	a	b	c	FS1	(FS)	delta(u)	phi
	19	0.418879	0	0.251327	24	179.5939	-316.106	20.53033	1.692575	0.067539	24	14.4
	19	0.436332	0	0.251327	24	179.5939	-329.395	21.50232	1.76633	0.067783	25	14.4
	19	0.453786	0	0.251327	24	179.5939	-342.903	22.49026	1.841315	0.06801	26	14.4
	19	0.471239	0	0.251327	24	179.5939	-356.643	23.49517	1.917608	0.068222	27	14.4
	19	0.488692	0	0.251327	24	179.5939	-370.629	24.51812	1.995286	0.068421	28	14.4
	19	0.506145	0	0.251327	24	179.5939	-384.878	25.56023	2.074436	0.068608	29	14.4
	19	0.523599	0	0.251327	24	179.5939	-399.404	26.6227	2.155148	0.068783	30	14.4
	19	0.541052	0	0.251327	24	179.5939	-414.227	27.70681	2.237516	0.068949	31	14.4
	19	0.558505	0	0.251327	24	179.5939	-429.364	28.81389	2.321642	0.069106	32	14.4
	19	0.575959	0	0.251327	24	179.5939	-444.834	29.9454	2.407636	0.069254	33	14.4

Product Specifications

Minimum Average Roll Values (MARV), Except When Designated Minimum Maximum or Range of Values

Gundline® FP

(Smooth Surfaced Flexible Polypropylene Liner)

Gundle Lining Systems Inc.

Gundle

	Property	Test Method	Unit	Gauge (Nominal) 30 mil (.75 mm)	40 mil (1.0 mm)	60 mil (1.5 mm)
Routine Gundle Tests	Density	ASTM D1505	g/cc	0.90	0.90	0.90
	Tensile Properties:	ASTM D638				
	Strength at Break	Type IV, 2 in. (50 mm) gauge length	[redacted] N/mm)*	63 (11)	84 (15)	120 (21)
	Elongation at Break	Dumb-bell @ 20 ipm (500 mmpm)	%	800	800	800
	Tear Resistance	ASTM D1004, Die C	Pounds (N)	12 (53)	15 (67)	21 (94)
	Puncture Resistance	FTMS 101B, Method 2065	Pounds (N)	40 (178)	50 (222)	70 (311)
Reference Properties Only	Seam Strengths:	ASTM D4437				
	Peel Strength	Type IV, 2 in. (50 mm) gauge length	PPI (N/cm)	21 (37)	26 (46)	36 (63)
	Shear Stregth	Dumb-bell @ 20 ipm (500 mmpm)	PPI (N/cm)	36 (63)	44 (77)	60 (106)
	Low Temperature Brittleness	ASTM D746, Procedure B	Degree F (°C)	-58 (-50) max.	-58 (-50) max.	-58 (-50) max.
	Coefficient of Linear Thermal Expansion	ASTM D696	x 10^{-4} cm/cm°C	1.4	1.4	1.4

15 N/mm = 15,000 N/m = 15 kN/m

*Approximate corresponding stress specifications are 2500 psi (17 N/mm²).

These descriptions are solely for use by engineers as general guidelines in formulating preliminary specifications, and should not be relied upon absent site-specific product testing and manufacturing information. Product designs and specifications are subject to change without advance notice. Any description of the materials contained in this document is for the sole purpose of identifying this material, and no description of the materials has created or amounted to an express warranty that the materials will conform to this description. The materials herein are subject to a printed special material warranty form issued at the time of purchase. This special material warranty supersedes all other warranties, express, implied and statutory, including any implied warranty of merchantability or fitness for a particular purpose.

Explanation for Not Including Certain Properties: There are many physical tests for extruded film but Gundle chooses to include those which are relevant to the application of geomembranes and/or those which truly evaluate manufactured quality of the material.

017

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT	Landfill V, Y-12	SUBJECT	Stability Analysis
REV #	0	SHEET	E1 OF E7
BY & DTT	6/23/95	OFS NO.	
CHKD & DATE	WPT 6/27/95	CALC NO.	CIV-ERWM-182

ATTACHMENT E

7 sheets

Design Reference Figures and Tables

Figure	Subject	Ref.
1	Shear Modulus and Damping Characteristics	B
2	Normalized Acceleration Response Spectra	B
3	Maximum Acceleration Ratio	B
4	Average Normalized Displacement	B
5	Peak Ground Acceleration	*

Table	Subject	Ref.
1	Seismic Hazard Levels for ORO	*
2	Comparison of Seismic Hazard Levels	*

* Figure 5, Table 1, and Table 2 were obtained from Lockheed Martin Energy Systems, Inc., Center for Natural Phenomena Engineering in May 1995.

E2

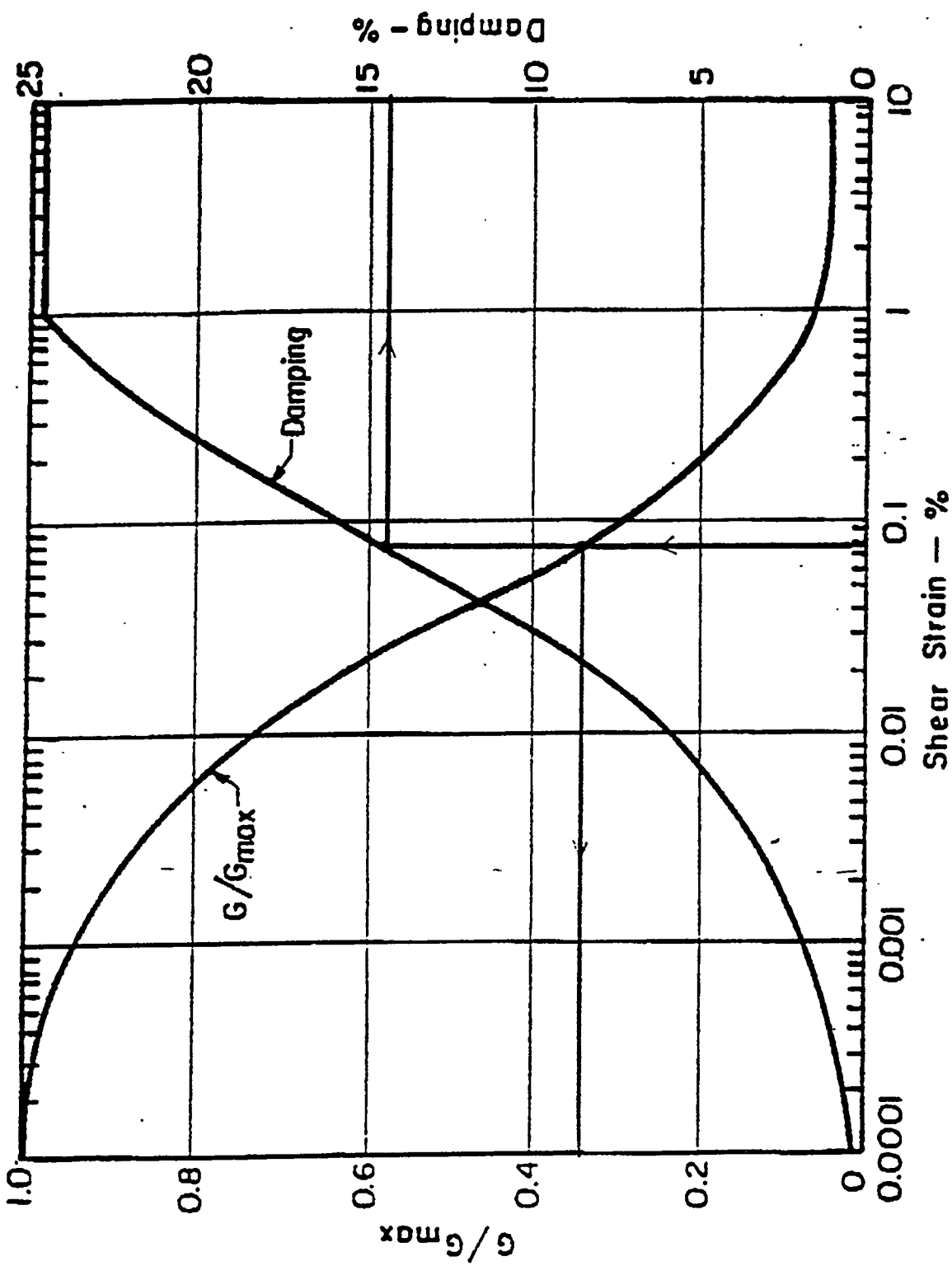


FIGURE 1: SHEAR MODULUS AND DAMPING CHARACTERISTICS USED IN RESPONSE CALCULATIONS

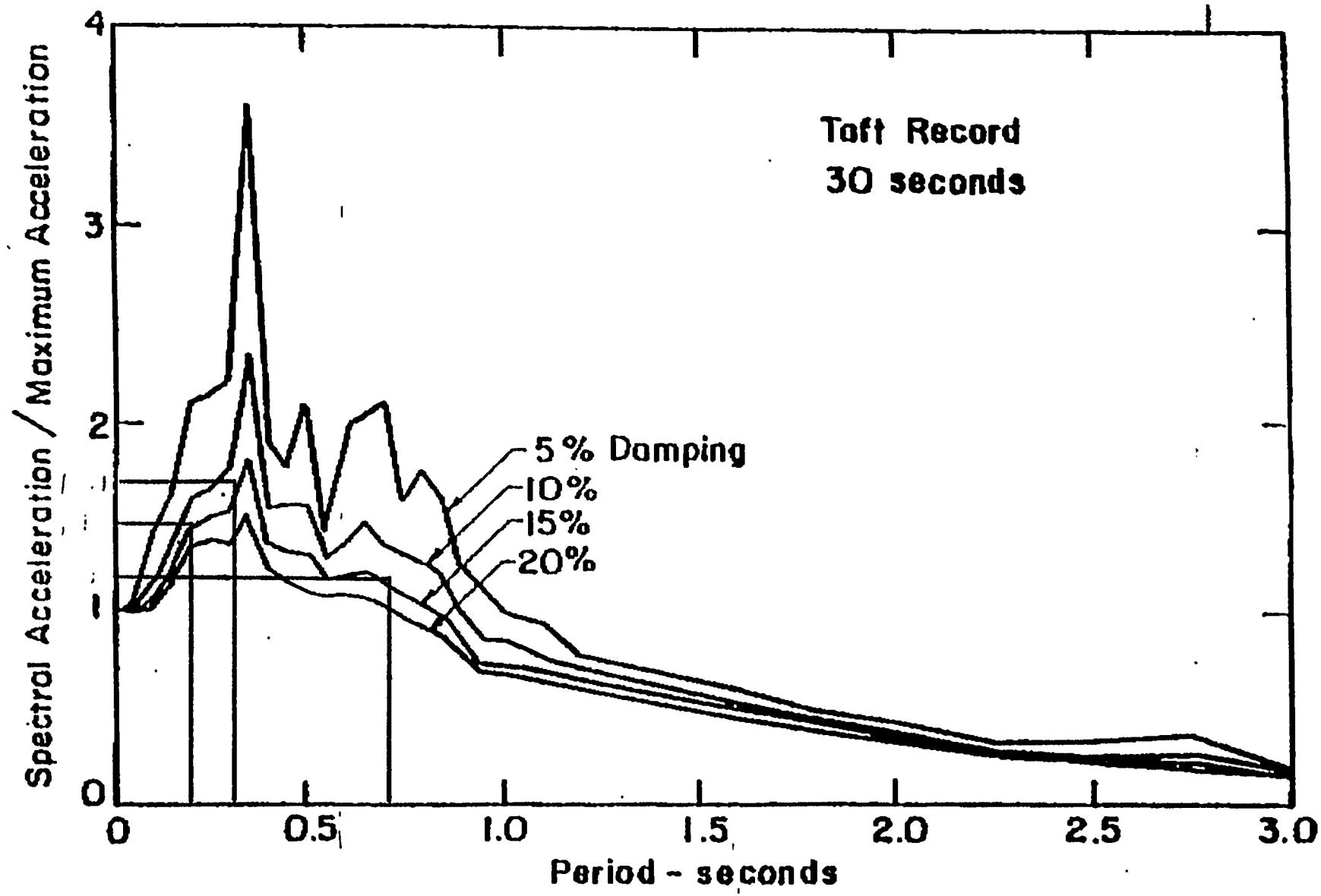


FIGURE 2: NORMALIZED ACCELERATION RESPONSE SPECTRA - TAFT RECORD (NORTH - SOUTH COMPONENT)

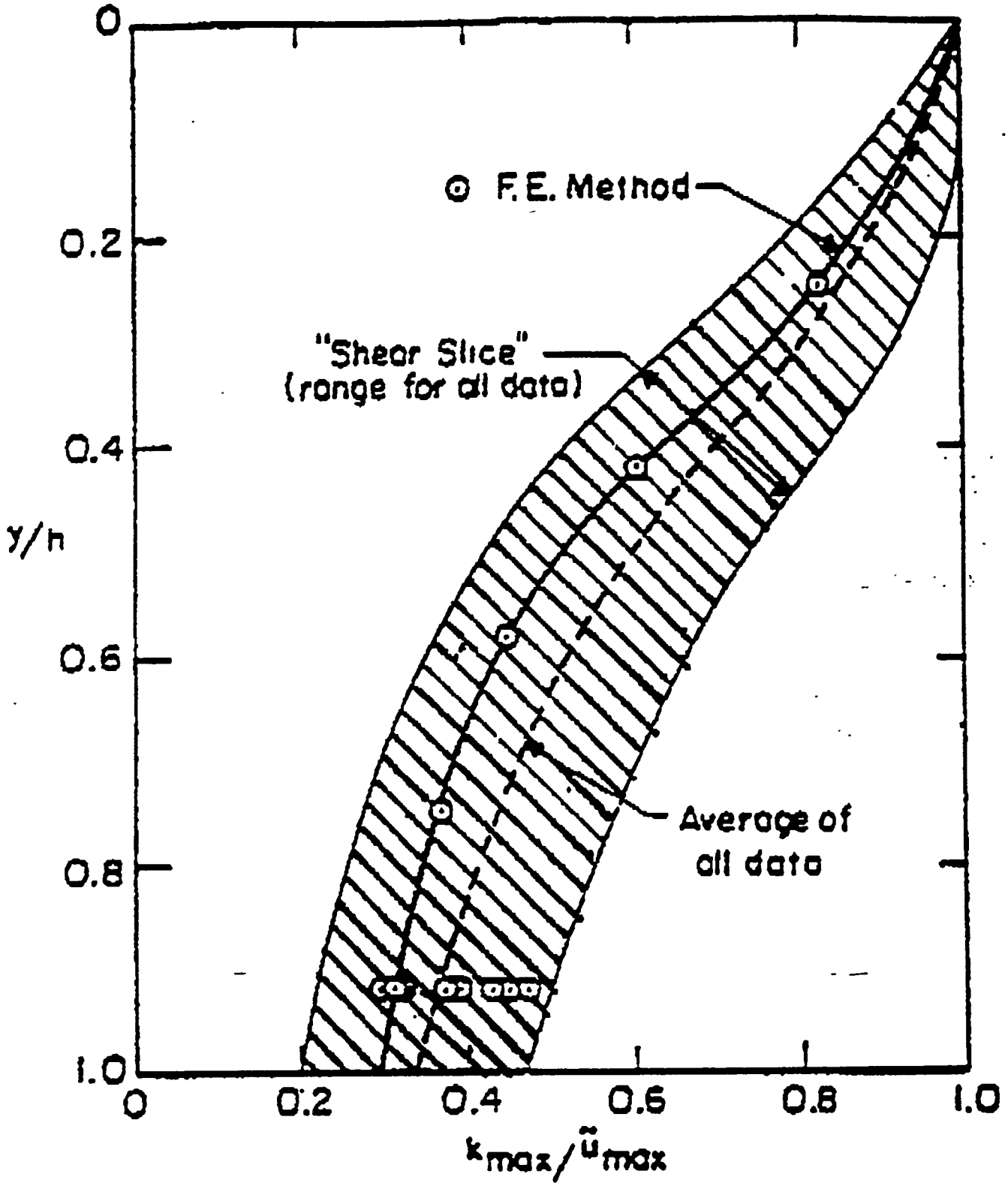


FIGURE 3: VARIATION OF " MAXIMUM ACCELERATION RATIO WITH DEPTH OF SLIDING MASS

BY DTT 8/4/95
CHK WPT 8/19/95

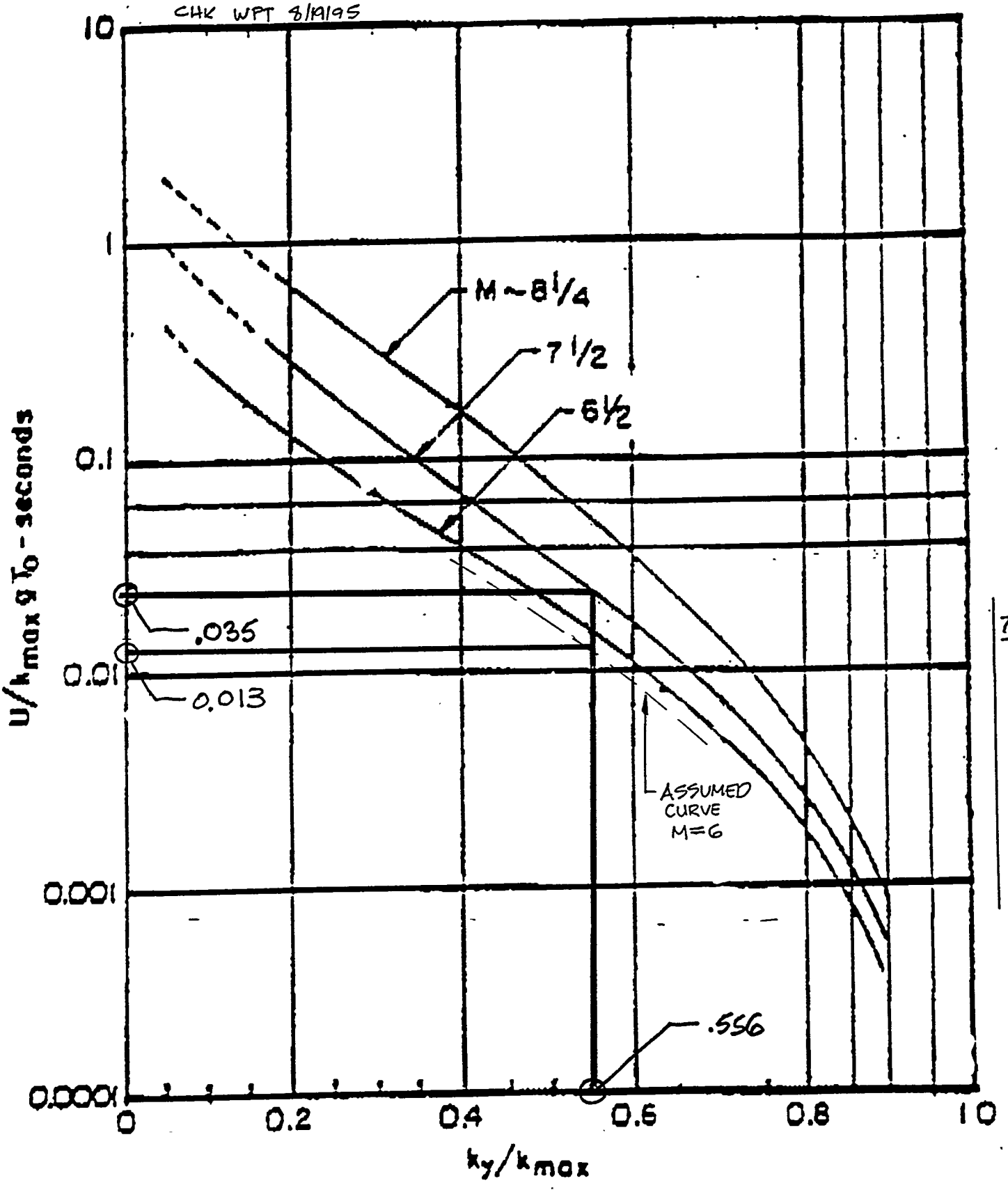


FIGURE 4: VARIATION OF AVERAGE NORMALIZED DISPLACEMENT WITH YIELD ACCELERATION

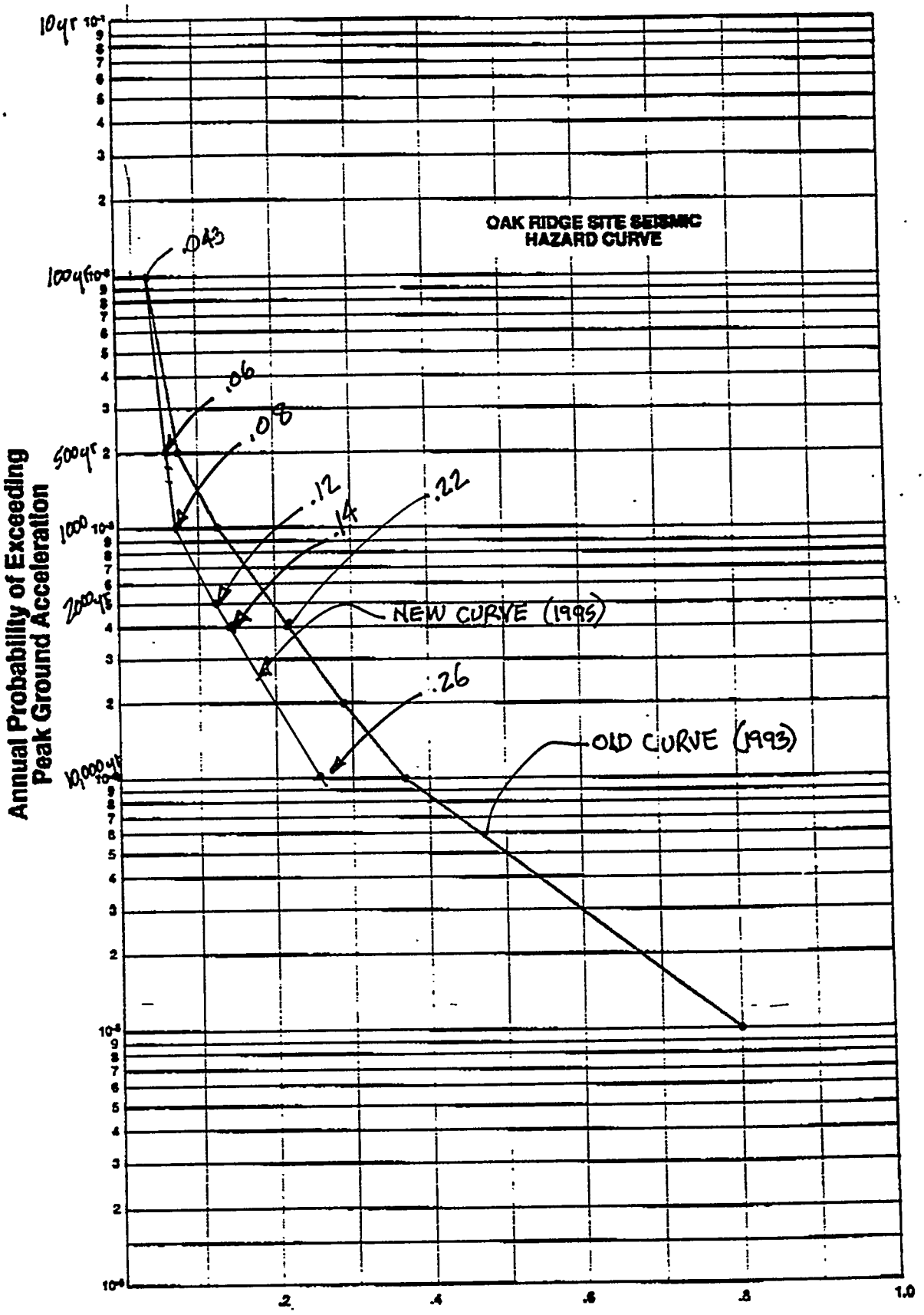


FIGURE 5 – Peak Ground Acceleration (g)

TABLE 1.

SEISMIC HAZARD LEVELS FOR ORO

PERFORMANCE CATEGORY	RETURN PERIOD YEARS	MEAN PEAK ROCK ACCELERATION (G)	
		HORIZONTAL	VERTICAL
PC 0	0	0.00	0.00
PC 1	500	0.06	0.04
PC 2	1000	0.08	0.05
PC3	2000	0.12	0.08
PC 4	10000	0.26	0.17

TABLE 2.

COMPARISON OF SEISMIC HAZARD LEVELS TO THE SEPTEMBER 1, 1993 LEVELS

1995 SEISMIC HAZARD LEVELS				SEPTEMBER 1, 1993 SEISMIC HAZARD LEVELS			
PERFORMANCE CATEGORY DOE-STD-1020-94	RETURN PERIOD, YEARS	MEAN PEAK ROCK ACCELERATION (G)		FACILITY USAGE CATEGORY UCRL-15910	RETURN PERIOD, YEARS	MEAN PEAK ROCK ACCELERATION (G)	
		HORIZONTAL	VERTICAL			HORIZONTAL	VERTICAL
PC 0	0	0.00	0.00	—	—	—	—
PC 1	500	0.06	0.04	GENERAL	500	0.08	0.05
PC 2	1000	0.08	0.05	LOW	1000	0.13	0.09
PC 3	2000	0.12	0.08	MODERATE	1000	0.13	0.09
PC 4	10000	0.26	0.17	HIGH	5000	0.29	0.19

Y-12 INDUSTRIAL LANDFILL V HELP MODEL RESULTS FOR COMPOSITE LINER AND CAP

```
**********************************************************************
**********************************************************************
**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**               HELP MODEL VERSION 3.03  (31 DECEMBER 1994)        **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**                    USAE WATERWAYS EXPERIMENT STATION             **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY       **
**                                                                  **
**                                                                  **
**********************************************************************
**********************************************************************

PRECIPITATION DATA FILE:     C:\HELP3\AVG30.D4
TEMPERATURE DATA FILE:       C:\HELP3\AVG30.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\AVG30.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\AVG30.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\ATTACHI.D10
OUTPUT DATA FILE:            C:\HELP3\ATTACHI.OUT

TIME:  11:15     DATE:   3/22/1995

**********************************************************************

     TITLE:  Landfill V, Y-12   Oak Ridge, Tennessee

**********************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   9
          THICKNESS                    =     18.00   INCHES
          POROSITY                     =      0.5010 VOL/VOL
          FIELD CAPACITY               =      0.2840 VOL/VOL
          WILTING POINT                =      0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2591 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.190000006000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0132	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	28.00	PERCENT
DRAINAGE LENGTH	=	500.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 41

THICKNESS	=	0.05	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999999000E-11	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	5.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	300.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 23

THICKNESS	=	12.00	INCHES

POROSITY	=	0.4610	VOL/VOL
FIELD CAPACITY	=	0.3600	VOL/VOL
WILTING POINT	=	0.2030	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3600	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.900000032000E-05	CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	12.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	5.60	PERCENT
DRAINAGE LENGTH	=	150.0	FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 41

THICKNESS	=	0.05	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999999000E-11	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	5.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 28.% AND A SLOPE LENGTH OF 500. FEET.

SCS RUNOFF CURVE NUMBER	=	87.80	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	15.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.732	INCHES

UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.515	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.025	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	117.467	INCHES
TOTAL INITIAL WATER	=	117.467	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
KNOXVILLE TENNESSEE

MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	85
END OF GROWING SEASON (JULIAN DATE)	=	307
AVERAGE ANNUAL WIND SPEED	=	7.10 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR KNOXVILLE TENNESSEE

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.57	4.34	5.68	4.08	4.68	4.34
5.45	3.70	3.86	3.18	4.59	5.30

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR KNOXVILLE TENNESSEE

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
35.00	38.80	47.90	56.80	64.90	72.40
75.80	75.20	69.10	57.40	47.30	38.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR KNOXVILLE TENNESSEE

STATION LATITUDE = 35.95 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	51.55	187126.531	100.00
RUNOFF	3.588	13025.009	6.96
EVAPOTRANSPIRATION	34.035	123547.133	66.02
DRAINAGE COLLECTED FROM LAYER 2	13.9206	50531.656	27.00

PERC./LEAKAGE THROUGH LAYER 4	0.000018	0.064	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0013		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.011	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000015	0.053	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.006	22.654	0.01
SOIL WATER AT START OF YEAR	117.467	426405.937	
SOIL WATER AT END OF YEAR	117.473	426428.594	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	63.06	228907.875	100.00
RUNOFF	10.758	39050.059	17.06
EVAPOTRANSPIRATION	31.760	115289.125	50.36
DRAINAGE COLLECTED FROM LAYER 2	18.6017	67524.336	29.50
PERC./LEAKAGE THROUGH LAYER 4	0.000017	0.061	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0017		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.013	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000013	0.048	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	1.941	7044.175	3.08
SOIL WATER AT START OF YEAR	117.473	426428.594	
SOIL WATER AT END OF YEAR	119.414	433472.781	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.115	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	56.17	203897.078	100.00
RUNOFF	6.323	22952.951	11.26
EVAPOTRANSPIRATION	36.152	131230.437	64.36
DRAINAGE COLLECTED FROM LAYER 2	14.6754	53271.746	26.13
PERC./LEAKAGE THROUGH LAYER 4	0.000018	0.067	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0014		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.011	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000015	0.056	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.980	-3558.077	-1.75
SOIL WATER AT START OF YEAR	119.414	433472.781	
SOIL WATER AT END OF YEAR	118.434	429914.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.039	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	53.97	195911.141	100.00
RUNOFF	6.327	22968.129	11.72
EVAPOTRANSPIRATION	30.180	109555.031	55.92
DRAINAGE COLLECTED FROM LAYER 2	16.8801	61274.785	31.28
PERC./LEAKAGE THROUGH LAYER 4	0.000017	0.063	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0016		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.012	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000014	0.051	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.582	2113.106	1.08
SOIL WATER AT START OF YEAR	118.434	429914.687	
SOIL WATER AT END OF YEAR	119.016	432027.812	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE	0.0000	0.035	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	50.72	184113.625	100.00
RUNOFF	2.800	10163.612	5.52
EVAPOTRANSPIRATION	34.233	124264.672	67.49
DRAINAGE COLLECTED FROM LAYER 2	13.7421	49883.801	27.09
PERC./LEAKAGE THROUGH LAYER 4	0.000016	0.057	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0013		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.011	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000013	0.047	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.055	-198.516	-0.11
SOIL WATER AT START OF YEAR	119.016	432027.812	
SOIL WATER AT END OF YEAR	118.961	431829.281	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.011	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	53.83	195402.922	100.00
RUNOFF	8.058	29248.777	14.97
EVAPOTRANSPIRATION	33.200	120515.930	61.68
DRAINAGE COLLECTED FROM LAYER 2	12.3902	44976.289	23.02
PERC./LEAKAGE THROUGH LAYER 4	0.000016	0.058	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0011		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.010	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000013	0.048	0.00

AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.182	661.793	0.34
SOIL WATER AT START OF YEAR	118.961	431829.281	
SOIL WATER AT END OF YEAR	119.144	432491.062	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.070	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.80	177144.000	100.00
RUNOFF	4.820	17495.170	9.88
EVAPOTRANSPIRATION	33.513	121652.250	68.67
DRAINAGE COLLECTED FROM LAYER 2	10.6524	38668.102	21.83
PERC./LEAKAGE THROUGH LAYER 4	0.000016	0.059	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0010		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.009	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000014	0.050	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.185	-671.597	-0.38
SOIL WATER AT START OF YEAR	119.144	432491.062	
SOIL WATER AT END OF YEAR	118.959	431819.469	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	54.73	198669.906	100.00
RUNOFF	6.422	23311.627	11.73
EVAPOTRANSPIRATION	31.522	114424.781	57.60

DRAINAGE COLLECTED FROM LAYER 2	16.5705	60151.094	30.28
PERC./LEAKAGE THROUGH LAYER 4	0.000019	0.068	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0015		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.012	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000015	0.056	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.216	782.320	0.39
SOIL WATER AT START OF YEAR	118.959	431819.469	
SOIL WATER AT END OF YEAR	119.174	432601.812	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	62.08	225350.406	100.00
RUNOFF	6.909	25078.369	11.13
EVAPOTRANSPIRATION	32.281	117180.383	52.00
DRAINAGE COLLECTED FROM LAYER 2	22.6278	82138.977	36.45
PERC./LEAKAGE THROUGH LAYER 4	0.000020	0.071	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0021		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.016	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000015	0.055	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.262	952.614	0.42
SOIL WATER AT START OF YEAR	119.174	432601.812	
SOIL WATER AT END OF YEAR	119.237	432831.875	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.199	722.527	0.32
ANNUAL WATER BUDGET BALANCE	0.0000	-0.008	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	54.55	198016.469	100.00
RUNOFF	6.067	22022.441	11.12
EVAPOTRANSPIRATION	30.932	112281.453	56.70
DRAINAGE COLLECTED FROM LAYER 2	17.5745	63795.410	32.22
PERC./LEAKAGE THROUGH LAYER 4	0.000015	0.056	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0016		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.013	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000012	0.043	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.023	-82.862	-0.04
SOIL WATER AT START OF YEAR	119.237	432831.875	
SOIL WATER AT END OF YEAR	119.414	433471.562	
SNOW WATER AT START OF YEAR	0.199	722.527	0.36
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.030	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.54	168940.234	100.00
RUNOFF	3.135	11379.421	6.74
EVAPOTRANSPIRATION	33.435	121370.078	71.84
DRAINAGE COLLECTED FROM LAYER 2	11.0658	40168.988	23.78
PERC./LEAKAGE THROUGH LAYER 4	0.000018	0.064	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0010		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.009	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000015	0.055	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-1.096	-3978.341	-2.35
SOIL WATER AT START OF YEAR	119.414	433471.562	
SOIL WATER AT END OF YEAR	118.228	429167.375	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.090	325.831	0.19
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.70	162260.969	100.00
RUNOFF	6.740	24465.811	15.08
EVAPOTRANSPIRATION	29.890	108500.500	66.87
DRAINAGE COLLECTED FROM LAYER 2	8.1562	29606.936	18.25
PERC./LEAKAGE THROUGH LAYER 4	0.000011	0.042	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0008		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.006	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000010	0.035	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.086	-312.263	-0.19
SOIL WATER AT START OF YEAR	118.228	429167.375	
SOIL WATER AT END OF YEAR	118.144	428863.187	
SNOW WATER AT START OF YEAR	0.090	325.831	0.20
SNOW WATER AT END OF YEAR	0.088	317.767	0.20
ANNUAL WATER BUDGET BALANCE	0.0000	-0.045	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.76	169738.812	100.00
RUNOFF	3.622	13147.859	7.75
EVAPOTRANSPIRATION	32.090	116485.773	68.63
DRAINAGE COLLECTED FROM LAYER 2	10.3956	37736.121	22.23
PERC./LEAKAGE THROUGH LAYER 4	0.000015	0.054	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0010		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.009	0.00

PERC./LEAKAGE THROUGH LAYER 9	0.000012	0.045	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.653	2368.952	1.40
SOIL WATER AT START OF YEAR	118.144	428863.187	
SOIL WATER AT END OF YEAR	118.884	431549.906	
SNOW WATER AT START OF YEAR	0.088	317.767	0.19
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.051	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	56.26	204223.797	100.00
RUNOFF	10.321	37466.160	18.35
EVAPOTRANSPIRATION	28.301	102733.758	50.30
DRAINAGE COLLECTED FROM LAYER 2	18.1864	66016.516	32.33
PERC./LEAKAGE THROUGH LAYER 4	0.000018	0.066	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0017		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.013	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000014	0.052	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.549	-1992.718	-0.98
SOIL WATER AT START OF YEAR	118.884	431549.906	
SOIL WATER AT END OF YEAR	117.866	427852.062	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.470	1705.134	0.83
ANNUAL WATER BUDGET BALANCE	0.0000	0.012	0.00

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.38	146579.406	100.00

RUNOFF	3.802	13800.390	9.41
EVAPOTRANSPIRATION	29.916	108595.836	74.09
DRAINAGE COLLECTED FROM LAYER 2	7.2716	26395.861	18.01
PERC./LEAKAGE THROUGH LAYER 4	0.000012	0.044	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0007		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.007	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000010	0.037	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.610	-2212.750	-1.51
SOIL WATER AT START OF YEAR	117.866	427852.062	
SOIL WATER AT END OF YEAR	117.726	427344.437	
SNOW WATER AT START OF YEAR	0.470	1705.134	1.16
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.024	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	60.60	219977.953	100.00
RUNOFF	8.254	29960.918	13.62
EVAPOTRANSPIRATION	32.394	117588.812	53.45
DRAINAGE COLLECTED FROM LAYER 2	18.9709	68864.383	31.31
PERC./LEAKAGE THROUGH LAYER 4	0.000019	0.069	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0018		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.014	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000015	0.056	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.982	3563.837	1.62
SOIL WATER AT START OF YEAR	117.726	427344.437	
SOIL WATER AT END OF YEAR	118.708	430908.281	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.063	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	60.94	221212.187	100.00
RUNOFF	7.889	28636.096	12.95
EVAPOTRANSPIRATION	33.590	121932.141	55.12
DRAINAGE COLLECTED FROM LAYER 2	20.2301	73435.273	33.20
PERC./LEAKAGE THROUGH LAYER 4	0.000021	0.076	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0019		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.014	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000017	0.062	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.769	-2791.432	-1.26
SOIL WATER AT START OF YEAR	118.708	430908.281	
SOIL WATER AT END OF YEAR	117.939	428116.844	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.026	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	51.75	187852.516	100.00
RUNOFF	5.111	18551.996	9.88
EVAPOTRANSPIRATION	29.071	105527.539	56.18
DRAINAGE COLLECTED FROM LAYER 2	16.9610	61568.527	32.77
PERC./LEAKAGE THROUGH LAYER 4	0.000017	0.063	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0016		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.012	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000014	0.051	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.607	2204.387	1.17
SOIL WATER AT START OF YEAR	117.939	428116.844	

SOIL WATER AT END OF YEAR	118.546	430321.219	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	59.11	214569.328	100.00
RUNOFF	5.403	19613.127	9.14
EVAPOTRANSPIRATION	33.077	120067.789	55.96
DRAINAGE COLLECTED FROM LAYER 2	20.6026	74787.555	34.85
PERC./LEAKAGE THROUGH LAYER 4	0.000022	0.081	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0019		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.015	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000018	0.066	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.028	100.753	0.05
SOIL WATER AT START OF YEAR	118.546	430321.219	
SOIL WATER AT END OF YEAR	118.574	430421.969	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	54.17	196637.109	100.00
RUNOFF	5.245	19041.125	9.68
EVAPOTRANSPIRATION	34.877	126605.320	64.39
DRAINAGE COLLECTED FROM LAYER 2	14.7900	53687.520	27.30
PERC./LEAKAGE THROUGH LAYER 4	0.000018	0.065	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0014		

DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.011	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000015	0.054	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.743	-2696.882	-1.37
SOIL WATER AT START OF YEAR	118.574	430421.969	
SOIL WATER AT END OF YEAR	117.831	427725.094	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.040	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	4.56	4.56	5.41	4.22	4.73	4.36
	5.04	3.93	3.78	2.61	4.63	5.72
STD. DEVIATIONS	2.23	2.32	2.90	1.77	2.35	1.47
	2.28	1.25	2.01	2.19	2.04	2.99
RUNOFF						
TOTALS	0.861	0.822	0.777	0.239	0.442	0.279
	0.481	0.194	0.348	0.160	0.434	1.042
STD. DEVIATIONS	0.826	0.920	1.095	0.334	0.717	0.407
	0.631	0.235	0.495	0.293	0.414	0.954
EVAPOTRANSPIRATION						
TOTALS	1.203	1.497	2.941	3.519	3.847	4.145
	4.181	3.355	2.851	2.285	1.393	1.005
STD. DEVIATIONS	0.187	0.263	0.213	0.740	1.340	1.207
	1.472	0.928	0.751	0.817	0.217	0.163
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	2.6767	2.0190	2.4102	1.2715	0.7498	0.3310
	0.1988	0.1753	0.4337	0.4527	1.2016	3.2929
STD. DEVIATIONS	1.8664	1.4740	1.4083	1.0056	0.8627	0.4005
	0.2664	0.2565	0.6575	0.4627	1.3671	1.9520
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 7						

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4

AVERAGES	0.0029	0.0024	0.0026	0.0014	0.0008	0.0004
	0.0002	0.0002	0.0005	0.0005	0.0014	0.0036
STD. DEVIATIONS	0.0020	0.0018	0.0015	0.0011	0.0009	0.0005
	0.0003	0.0003	0.0007	0.0005	0.0015	0.0021

DAILY AVERAGE HEAD ACROSS LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	53.53	(6.072)	194326.6	100.00
RUNOFF	6.080	(2.2206)	22068.96	11.357
EVAPOTRANSPIRATION-	32.222	(2.0412)	116967.44	60.191
LATERAL DRAINAGE COLLECTED FROM LAYER 2	15.21328	(4.25033)	55224.195	28.41823
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00002	(0.00000)	0.062	0.00003
AVERAGE HEAD ACROSS TOP OF LAYER 4	0.001	(0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.00000	(0.00000)	0.011	0.00001
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00001	(0.00000)	0.051	0.00003
AVERAGE HEAD ACROSS TOP OF LAYER 9	0.000	(0.000)		

CHANGE IN WATER STORAGE	0.018	(0.7265)	65.96	0.034

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	4.23	15354.900
RUNOFF	2.760	10019.3398
DRAINAGE COLLECTED FROM LAYER 2	1.16486	4228.44873
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00089
AVERAGE HEAD ACROSS LAYER 4	0.040	
DRAINAGE COLLECTED FROM LAYER 7	0.00000	0.00047
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00025
AVERAGE HEAD ACROSS LAYER 9	0.000	
SNOW WATER	4.17	15145.5801

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4354

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1195

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	5.0286	0.2794
2	0.0020	0.0100
3	0.0000	0.0000
4	10.2480	0.4270
5	87.6000	0.2920
6	4.3200	0.3600
7	0.3840	0.0320
8	0.0000	0.0000
9	10.2480	0.4270
SNOW WATER	0.000	

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UNITED STATES DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS

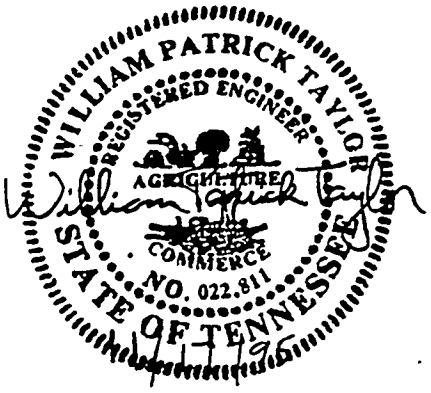
PROJECT ORDER NO. 940046.01

SPECIFICATIONS
DIVISION 2—SITE WORK

FOR
AREA 2, Y-12 INDUSTRIAL LANDFILL V

THIS DOCUMENT IS THE PROPERTY OF THE DEPARTMENT OF ENERGY, PREPARED BY FOSTER WHEELER ENVIRONMENTAL CORPORATION UNDER CONTRACT NO. DE-AC05-91OR21928 FOR EXECUTION OR REVIEW OF THE ENGINEERING AND CONSTRUCTION OF THE SUBJECT PROJECT. SPECIFICATIONS MADE AVAILABLE FOR INFORMATION TO THE BIDDER ARE NOT TO BE USED FOR OTHER PURPOSES AND ARE TO BE RETURNED UPON REQUEST TO THE FORWARDING CONTRACTOR.

Prepared under the supervision of William P. Taylor
Tennessee PE Number 22811



Revision	Prepared by	Reviewed by	Approved by	Date	Pages Affected
0	D. R. Smith	T. J. Brown	W. P. Taylor	8/19/95	All
1			WP Taylor	11/17/95	SECTION 022 11 All DOR

DIVISION 2

SITE WORK INDEX

Section	Title	Revision
02210	SITE CLEARING	0
02211	ROUGH GRADING	1 R1
02225	TRENCHING	0
02270	SLOPE PROTECTION AND EROSION CONTROL	0
02271	RIP-RAP	0
02276	GEOSYNTHETICS	0
02280	GEOMEMBRANE	0
02505	MINERAL AGGREGATE BASE COURSE	0
02700	LEACHATE PIPING AND STORM DRAINS	0
02936	SEEDING	0

LOCKHEED MARTIN ENERGY SYSTEMS, INC., ENGINEERING STANDARDS

ES-7.16-1, 10-3-88, TEMPORARY SILT FENCE, PAGE 1 OF 1
ES-7.16-2, 10-3-88, STRAW BALE BARRIERS, PAGE 1 OF 1

ATTACHMENT A	MOISTURE-DENSITY-PERMEABILITY ACCEPTABLE ZONE	0
ATTACHMENT B	SILTATION POND SILT REMOVAL	0
ATTACHMENT C	CONSTRUCTION PROJECT REQUIREMENTS SUMMARIES (CPRS), INSPECTIONS	0
ATTACHMENT D	CPRS, TEST	0
ATTACHMENT E	CPRS, SUBMITTALS	0

SECTION 02210

SITE CLEARING

PART 1: GENERAL

1.01 DESCRIPTION

Section includes: Clearing site of plant life including removal of trees and shrubs and their root systems.

1.02 RELATED SECTIONS

Division 1.

1.03 PROJECT CONDITIONS

A. All vegetative debris from clearing operations shall be burned on site by the Contractor.

B. The Contractor shall obtain all necessary burning permits from the Facilities Manager prior to beginning any burning.

PART 2: PRODUCTS

Not used.

PART 3: EXECUTION

3.01 INSPECTION

Tag or otherwise identify existing plant life and features designated to remain after site clearing.

3.02 PROTECTION

A. Protect utilities that are to remain in service from damage.

B. Protect trees, plant growth, and features designated to remain as final landscaping. As a minimum, protection shall consist of physical barriers to prevent damage to trees, plant growth, and associated root systems.

C. Protect survey control monuments, benchmarks and existing structures from damage or displacement.

D. Protect living trees located more than 5 ft outside the construction lines of the project. Treat cut or scarred surfaces of trees or shrubs with a paint prepared especially for tree surgery.

E. Maintain designated site access for vehicular and pedestrian traffic.

3.03 INSTALLATION/APPLICATION/ERECTION

A. Clearing

1) Clear areas required for access to site and execution of work.

2) Remove trees, shrubs, surface rock, and other objectional material within earthwork areas. Remove stumps, and root systems larger than 3 in. in diameter to a depth of 18 in. below existing grade elevation.

3) Clear undergrowth and deadwood.

4) Do not destroy, remove or disturb preconstruction ground cover more than 16 days prior to grading.

5) Apply a temporary mulch material or other approved ground cover within 7 days on area that will remain unfinished for more than 30 days.

B. Removal

Remove rock and other debris not suitable for burning from site and transport to the disposal area(s) identified in Division 1.

END OF SECTION

SECTION 02211

ROUGH GRADING

PART 1: GENERAL

1.01 DESCRIPTION

Section includes: Removal and stockpiling of topsoil, excavation and compaction of fill and backfill for the subgrade; placement and compaction of the compacted clay soil liner, leachate collection layer, protective soil cover; and the excavation and compaction of fill and backfill to the grade or subgrade for drainage structures and roadways located outside the landfill boundary.

1.02 RELATED SECTIONS

A. Division 1

B. Section 02270, Slope Protection and Erosion Control.

C. Section 02276, Geosynthetics.

D. Section 02280, Geomembrane.

E. Section 02505, Mineral Aggregate Base Course.

F. Section 02700, Leachate Piping and Storm Drains.

G. Section 02936, Seeding.

1.03 DEFINITION OF TERMS

A. Earth Excavation: Removal of material to lines, elevations, and dimensions shown on Construction Drawings and disposition of materials encountered in grading and excavation work except that classified as rock.

B. Rock Excavation: Removal of materials classified as rock and disposal of excavated material as specified herein and in conformity with lines, grades, and dimensions shown on drawings. To be classified as rock, material must be boulders of 9 ft^3 or more in volume, solid or ledgerock, or other hard material in place that cannot be excavated by heavy construction equipment, such as a Caterpillar 215C power excavator equipped with a short tip radius rock bucket, or a Caterpillar D9 bulldozer equipped with a single tooth hydraulic ripper. Material classified as rock shall be removed by drilling and feathering, bull point wedging, or other suitable means. Use of explosives is not allowed.

C. Unauthorized Excavation: Excavation not required by specifications or drawings or not authorized in writing by Construction Manager.

D. Fill: Earth or other material as specified, used to bring an existing grade to a specified grade. Do not use any concrete or masonry product as fill material.

E. Backfill: Earth, crushed stone, or other materials as specified used to replace material excavated during construction. Spread and compact backfill in same manner as fill.

F. Subgrade: Compacted fill or backfill of embankments or undisturbed soil of cut sections which supports gravel, wearing surface, compacted soil clay liner, or topsoil.

G. Undercutting: Removal of soft or undesirable materials determined by Construction Manager, encountered in undisturbed subgrade below grades specified for excavation.

H. Shoring: A structure, such as a metal, hydraulic, mechanical, or timber shoring system that supports sides of an excavation and which is designed to prevent cave-ins.

I. Landfill Boundary: the outermost perimeter of the compacted clay soil liner (projected in the horizontal plane), as it would exist at completion of construction. The location of the landfill boundary is defined on the Construction Drawings.

J. Desiccation: The process of drying due to evaporation to the extent that cracks are formed.

K. Landfill Liner: The compacted clay soil liner, geomembrane, geotextile fabrics, leachate collection layer, and the protective soil cover.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM), Annual Book of Standards.

1) ASTM D 422-63, Standard Test Method for Particle-Size Analysis of Soils.

2) ASTM D 698-91, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).

3) ASTM D 1556-90, Standard Test Material for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

4) ASTM D 2216-92, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

5) ASTM D 2434-68, Standard Test Method for Permeability of Granular Soils (Constant Head).

6) ASTM D 2487-93, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

7) ASTM D 2922-91, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

8) ASTM D 3017-88, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

9) ASTM D 5084-90, Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

B. Occupational Safety and Health Administration (OSHA), Code of Federal Regulations 29 CFR 1926, Subpart P-Excavations, latest revision.

1.05 PROJECT/SITE CONDITIONS

A. Existing utility lines and existing monitoring well locations shown represent approximate conditions only. The Contractor shall field verify all existing utility lines prior to beginning grading operations. Any deviations from the locations shown on the Construction Drawings shall be reported in writing to the Construction Manager prior to beginning grading operations.

B. A Construction Quality Assurance Plan for the construction of the compacted clay soil liner, geomembrane, leachate collection layer, and protective soil cover, has been prepared and submitted to Tennessee Department of Environment and Conservation (TDEC) for approval.

C. A soil investigation report for this site, as well as a report documenting direct shear testing of site soils, geosynthetics, and geomembrane materials is available at the Construction Manager's office for review by the Contractor. This information is provided for information only.

D. Topographic surveying of individual components of the landfill liner shall be in accordance with Division 1.

1.06 QUALITY ASSURANCE

Tests

The Construction Manager will be responsible for quality control testing of borrow source material and for quality assurance testing during construction of the landfill liner. The Construction Manager will be responsible for identifying soils, checking densities, and classifying soil materials during construction activities outside the landfill boundary.

1.07 SUBMITTALS

A. Submit prompt written notification to the Construction Manager after each completion of the compacted clay soil liner subgrade, compacted clay soil liner, and leachate collection layer.

B. Prior to delivery and installation of any crushed aggregate material supplied by the Contractor, the Contractor shall submit test data attesting that the crushed aggregate material used to construct the leachate collection layer conforms to the physical requirements outlined in Article 2.01.

C. Submit proposed machinery to be used to till clay materials. Include the physical and operating information for the machinery proposed.

D. Submit to the Construction Manager proposed methods for prevention of stormwater ponding in Area 1 of the landfill.

PART 2: PRODUCTS

2.01 MATERIALS

A. Compacted Clay Soil Liner

1) Soil used in constructing the compacted clay soil liner shall be obtained from on-site sources and shall consist of clay soil free of refuse, vegetation, and clods of earth in excess of 1/2 of the lift thickness.

2) Upon placing a loose lift, all exposed rock fragments in excess of 2 in. in largest dimension shall be removed.

3) The clay soil shall consist of material that has been tested and prequalified. The soil shall be classified as "Type A" as described below.

Type A soil is visually characterized as a reddish tan soil that is a mixture of bright red, sandy soils and light tan, highly plastic silty clay materials that achieves a low dry unit weight upon compaction; ASTM D 2487 classification as CL or CH. The soil generally contains significant amounts of rock fragments (chert) ranging up to several inches in size.

B. Materials used for subgrade fill or backfill inside of the landfill boundary and for the protective soil cover shall be obtained from on-site excavation. Materials shall be those classified by ASTM D 2487 as ML, CL, CH, MH, SC, or SM.

C. Satisfactory materials used for fill or backfill outside of the landfill boundary shall be those classified by ASTM D 2487 as GW, GP, SW, GM, GC, CL, SP, SM, SC, CH, ML, or MH, and are free of organic matter and fragments of rock or gravel exceeding 6 in. in any dimension.

D. Mineral Aggregate Base: In accordance with Section 02505, Mineral Aggregate Base Course.

E. Topsoil: Natural friable, fertile, fine sandy loam soil reasonably free from subsoil, noxious weeds, stones larger than 1 inch in diameter, lime, cement, ashes or other deleterious matter which will prevent the formation of a suitable seed bed.

F. The crushed aggregate material used in the leachate collection layer shall be a stone produced with the following gradation as determined by ASTM D 422. The coefficient of permeability value for the aggregate shall be 1×10^{-2} cm/sec, minimum, as determined by ASTM D 2434.

Sieve Size	Total Percent Passing, By Weight
2 in.	100%
1 1/2 in.	90–100%
1 in.	20–55%
3/4 in.	0–10%
No. 4	0–5%

G. Bentonite shall be Volclay SG-40, Baroid Aquaguard Grout, or equal as a minimum.

H. Geotextile Fabric: In accordance with Section 02276, Geosynthetics

2.02 CONSTRUCTION EQUIPMENT

A. A tandem axle truck loaded with soil, or other pneumatic-tire construction equipment with similar axle loads shall be used to proofroll the subgrade within the landfill boundary.

B. A smooth steel-drum roller shall be used to roll the final lift of the compacted clay soil liner prior to installing the geomembrane; seal the lifts of the compacted clay soil liner; compact the first lift of the protective cover; and compact the leachate collection layer. The roller shall have vibratory capability which shall be used in rolling the final lift of the compacted clay soil liner.

C. The compacted clay soil liner shall be compacted using a non-vibratory, footed compactor. The foot length of the compactor shall be a minimum of 6 in.. The compactor shall have a minimum static weight of 30,000 pounds.

D. Fill material for the compacted clay soil liner shall be worked as specified after placement using a tiller capable of tilling 10 in. deep. The Contractor shall submit physical and operating information for the proposed tiller machinery in accordance with Article 1.07.

E. Except as specified above, the choice of equipment to perform the required operations in conformity with these specifications will be the responsibility of the Contractor. However, any equipment that results in waste or damage of material, inaccurate work, or is otherwise objectionable is to be promptly replaced as directed by the Construction Manager at the Contractor's expense.

PART 3: EXECUTION

3.01 INSPECTION

A. Verify that subgrade is not soft, spongy, or composed of otherwise unstable materials. If unstable materials are encountered, notify Construction Manager immediately.

B. Verify that areas to be filled or backfilled are free of debris, snow, ice, or water and that surfaces are not frozen.

3.02 PREPARATION

A. Strip topsoil in manner to prevent intermingling with underlying subsoil or other objectionable material. Stockpile topsoil in storage areas as directed by the Construction Manager. Stockpile topsoil shall be seeded in accordance with Section 02936, Seeding.

B. Excavation

1) Materials to be stockpiled as fill or backfill materials shall be transported to and placed within the landfill site at areas designated by the Construction Manager. Soil stockpiles that remain shall be seeded in accordance with Section 02936, Seeding.

2) The Contractor shall grade clay soil stockpile(s) to provide positive drainage after each day's operation to minimize infiltration of water. Clay soil stockpile areas shall also be sealed with a smooth steel-drum roller at the end of each work period.

C. Subgrade within the Landfill Boundary

After subgrade preparation has been completed (including proofrolling) the subgrade shall be surveyed. The Contractor shall not begin placement of the compacted clay soil liner until authorized by the Construction Manager.

D. Compacted Clay Soil Liner

The compacted clay soil liner shall not be placed when weather conditions preclude obtaining required compaction. The compacted clay soil liner shall not be placed on frozen subgrade or when placed material can be damaged by freezing weather. After placement of the compacted clay soil liner within the landfill boundary, the areas occupied by the compacted clay soil liner shall be surveyed. The Contractor shall not begin installation of the geomembrane and protective geotextile until authorized by the Construction Manager.

E. Leachate Collection Layer

After placement of the leachate collection piping and crushed aggregate material, the area occupied by the leachate collection layer shall be surveyed. The Contractor shall not proceed with installation of the separator geotextile until authorized by the Construction Manager.

F. Operational Cover

After placement of the operational cover, the area occupied by the operational cover shall be surveyed.

G. Subgrade Preparation Outside of Waste Boundary

Ensure that the subgrade is not soft, spongy, or composed of otherwise unstable materials. If unstable materials are encountered, immediately notify the Construction Manager.

3.03 INSTALLATION/APPLICATION/ERECTION

A. Excavation-General

1) Carry excavation through whatever materials are encountered to depths shown on Construction Drawings. Remove all existing fill and other unsatisfactory materials within limits of excavation as indicated on Construction Drawings.

2) Remove excavated material not required or not suitable for backfill from site to disposal area specified by Construction Manager.

3) Backfill unauthorized excavation at Contractor's expense with subgrade fill materials specified under Part 2, Products, as directed by Construction Manager.

4) Maintain excavations free from water, and dispose of excess water by methods approved by Construction Manager. Report spring or seepage water encountered in excavation to Construction Manager.

5) Construction of the landfill liner shall be conducted in a manner which prevents stormwater from ponding in Area 1 of the landfill in accordance with approved methods.

6) Construction of the landfill liner shall not disrupt landfilling operations being conducted in active disposal areas.

7) Provide temporary shoring and bracing as necessary to safely support excavation. Remove shoring and bracing from excavation as backfilling progresses. Shoring shall be in accordance with OSHA 29 CFR 1926, Subpart P-Excavations, latest revision.

B. Fill, Backfill-General

The following general items shall apply in placement of fill materials specified in Article 2.01, B and C. Additional requirements for each landfill liner component are listed within this section.

1) Material used for fill shall be in accordance with Paragraph 2.01.

2) Maintain moisture condition of materials to be compacted in stockpiles or borrow sources.

3) All areas receiving fill shall be cleared, scarified to a depth of 6 in., brought to within ±2% of optimum moisture content, and compacted to a minimum of 95% of maximum dry density as determined by ASTM D 698.

4) When existing ground surface has a density less than the density specified, break up the ground surface, pulverize, adjust moisture content to specified limits, and compact to specified density.

5) Unless otherwise specified spread material to be compacted in layers that will not exceed 6 in. after compaction.

6) After placement of loose material, adjust moisture content to bring material within required moisture content limits.

7) Fill or backfill material of unacceptable moisture content shall either be conditioned to adjust the moisture content to within the range specified to achieve the required density or removed. Any material having an unacceptable moisture content shall be conditioned or removed at the expense of the Contractor.

8) Compact all fill not accessible to self-propelled or towed compactors by hand-operated power tampers or other approved means to the specified density.

9) Do not place fill material when weather conditions, condition of the subgrade, or condition of the fill material precludes obtaining the specified compaction. Do not use frozen material for fill, and do not place fill material on or against frozen surfaces.

C. Compacted Clay Soil Liner

1) Proofrolling

a. After the compacted clay soil liner subgrade has been constructed to the lines and grades shown on the Construction Drawings, the surface of the subgrade shall be proofrolled to identify soft zones, irregularities, and loose earth. Areas in excess of 5:1 slopes shall not be proofrolled. Equipment used in proofrolling activities shall be in accordance with Article 2.02, Paragraph A. Do not begin proofrolling activities until authorized by the Construction Manager. Proofrolling shall be witnessed by the Facilities Manager and Construction Manager.

b. Any portion of subgrade which is determined by the Construction Manager to be unacceptable shall be conditioned as necessary to achieve the required moisture, density, and proofrolling requirements. Subgrade material which cannot be conditioned shall be removed and replaced with acceptable material.

2) Method of Construction

a. The compacted clay soil liner shall not be placed during the months of November through March unless otherwise directed by the Construction Manager. Placement of the compacted clay soil liner shall be sequenced so that the leachate collection layer and protective soil cover are placed to provide protection of the compacted clay soil liner from frost penetration.

b. The clay soil shall be placed and spread. After spreading, the soil shall be tilled as necessary to promote blending, adjust the moisture content, and attain a nominal clod size of 2 in. or less. During tilling, the soil shall be visually checked to ensure that it does not contain rock fragments or gravel larger than 2 in. nominal size. Rock fragments or gravel larger than 2 in. nominal size shall be removed and placed on-site in areas designated by the Construction Manager.

c. The clay soil shall be compacted using a footed compactor as specified in Article 2.02 of this section. A minimum of six (6) one-way passes are required per lift.

d. Compaction requirements for clay soil placed for the compacted soil clay liner shall be governed by the moisture-density-permeability relationship of the soils as shown in Attachment A. Acceptance of a lift requires that results meet the moisture-density requirements as shown in the cross-hatched "acceptable zone" area except that the moisture content of the compacted clay soil shall not exceed 32.5%.

e. The compacted clay soil liner shall be compacted to a minimum total thickness of 2 ft except as noted on the Construction Drawings.

3) First lift: The first lift of fill material shall be maximum 6 in. thick after compaction. Grade checkers or another type of grade control system shall be utilized to maintain the 6-in.-thick lifts.

a. The fill material shall be tilled as necessary to reduce clods, with moisture added or deleted and gravel or rock fragments larger than specified shall be removed.

b. The fill material shall be compacted and in-place density and moisture tests performed.

c. If the moisture content is less than required, the area shall be reworked; water shall be added; and a tiller, disc, or other approved means shall be used to evenly moisturize the soil. After moisture addition, recompact the soil with six one-way passes and retest.

d. If the moisture content is greater than required, the area shall be reworked using a tiller, disc, or other approved device to reduce the moisture content of the soil. After the moisture reduction is achieved, compact the soil with a minimum of six one-way passes and retest.

e. If the density does not meet the minimum requirements, compact the lift with additional one-way coverages and retest.

f. Repeat items c, d, and e, as required until the in-place moisture content is within the specified moisture range.

g. After achieving the required moisture content and density, repair all voids left by test equipment. All voids shall be filled with bentonite and hand tamped.

h. Seal off accepted areas with a smooth steel-drum roller at end of shift or when weather turns inclement. If necessary, spray water periodically onto the completed lift to prevent excessive drying.

i. If water cannot be sprayed on a consistent basis to prevent drying, the completed lift shall be covered temporarily with plastic sheeting. Sandbags shall be used to prevent wind uplift of the sheeting.

4) Remaining Lifts

a. Scarify existing surface to a depth of 1–2 in. to ensure adequate bond between the previous lift and the lift being installed.

b. Install lift in accordance with the procedures and requirements outlined for the first lift.

c. The final lift shall be thoroughly raked in mutually perpendicular directions with tractor drawn equipment. This shall be followed by rock picking prior to compaction rolling. After compaction is completed the surface shall be carefully examined for rocks, to be removed by hand raking. Place rocks in areas designated by the Construction Manager.

d. For final surface preparation, the clay liner shall be rolled with a smooth steel-drum vibratory roller so as to be free of irregularities, loose earth, and abrupt changes in grade. All exposed rock fragments larger than 2 in. largest dimension shall be picked from the surface. The vibratory mechanism shall be activated when rolling to aid in the pulverizing of any small protrusions. The surface shall be maintained so as to prevent any noticeable drying.

5) Damaged Lifts

All damaged portions of the compacted clay soil liner shall be repaired with the same methods and equipment as specified in Subparagraphs 3.03C, 2 & 4 above.

D. Geomembrane Anchor Trench

The anchor trench for the geomembrane shall be excavated after construction of the compacted clay soil liner has been completed. The inside edges of the anchor trench shall be rounded to avoid sharp bends in the geomembrane. After placement of the geomembrane and protective geotextile along the inside face of the anchor trench, the trench shall be backfilled in 6-in. compacted lifts with the same clay soil (Type A) that was used to construct the compacted clay soil liner. Compaction requirements for the clay soil backfill shall be governed by the moisture-density-permeability relationship of the soils as shown in Attachment A. Acceptance of a lift requires that results meet the moisture-density requirements as shown in the cross-hatched "acceptable zone" area.

E. Geomembrane

Install geomembrane in accordance with Section 02280, Geomembrane.

F. Protective Geotextile Fabric

Install protective geotextile on top of the geomembrane in accordance with Section 02276, Geosynthetics.

G. Leachate Collection Layer Construction

1) Install leachate collection pipe in accordance with Section 02700, Leachate Piping and Storm Drains.

2) Aggregate material shall be placed evenly around the leachate collection piping to ensure the integrity of the leachate collection piping during construction.

3) Over the geomembrane and protective geotextile, provide a layer of crushed aggregate material having a completed thickness as shown on the Construction Drawings. The aggregate material shall be spread in the direction that minimizes wrinkles of and precludes damage to the geomembrane or protective geotextile.

4) Low ground pressure, wide track-type equipment shall be used to distribute the aggregate material in a manner which will minimize stress on the underlying protective geotextile and geomembrane. Do not crowd or shove the aggregate material or use the blade to cut into the aggregate material. Aggregate material placed on slopes shall be placed from the bottom of the slope and worked upslope. In areas inaccessible to a dozer, the aggregate material shall be placed with a small backhoe, rubber-tire loader, or other equipment approved by the Construction Manager to haul aggregate material.

5) Equipment used to haul aggregate material shall not drive on top of, nor dump directly onto the protective geotextile and geomembrane. Fill material shall be placed in a manner to maintain a minimum of 12 in. of aggregate material between the equipment tracks or tires and the protective geotextile and geomembrane.

6) A minimum of 24 in. of fill shall be placed on top of the geomembrane prior to dump trucks being allowed onto areas occupied by the geomembrane. The 24 in. of fill material can consist of the following: 12 in. of leachate collection layer aggregate plus an additional 12 in. of leachate collection layer aggregate (total of 24 in.); or 12 in. of leachate collection layer aggregate, separator geotextile, and 12 in. of protective soil cover, as discussed in the following sections paragraphs.

H. Install separator geotextile over the leachate collection layer in accordance with Section 02276, Geosynthetics.

I. Protective Soil Cover

1) After the separator geotextile has been installed over the leachate collection layer, provide protective soil cover having a completed thickness as shown on the Construction Drawings. The protective soil cover material shall be spread in the direction that minimizes wrinkles and precludes damage to the separator geotextile. Fill material to construct the protective soil cover shall come from areas on-site.

2) The first lift shall be placed with a loose measure thickness of approximately 12 in. Construction equipment shall not come in contact with or damage the separator geotextile. Fill material shall be placed in a manner to maintain a minimum of 8 in. of fill between the construction equipment and the separator geotextile. The initial lift shall not be compacted. The next lift shall be placed with a loose measure thickness of between 6 and 10 in., and compacted with a steel drum roller. Although compaction and moisture content testing is not required for the first two lifts, the moisture content of the material shall be controlled within a range suitable to allow the material to achieve compaction, and to permit construction equipment movement within the area where material is being placed. The last lift shall be 6-8 in. compacted thickness and compacted with a footed roller to a minimum of 95% of the maximum dry density at not less than 3% below nor more than 3% above the optimum moisture content as determined by ASTM D 698, to achieve the grades and thicknesses shown on the construction drawings. R1

3) No fill material shall be placed when weather conditions, conditions of subgrade or condition of the fill material precludes obtaining the specified compaction. Frozen material shall not be used for fill, and fill materials shall not be placed on or against frozen surfaces.

J. Provide erosion and sediment control to minimize erosion and transport of sediment beyond limits of Contractor's work area. Methods of control shall conform to Section 02270, Slope Protection and Erosion Control.

3.04 FIELD QUALITY CONTROL

A. Existing Ground Surface

Prepare in accordance with Article 3.03B.

B. Subgrade Within the Compacted Clay Soil Liner Boundary

Proofrolling activities shall be conducted in accordance with Article 3.03.C.

C. Fill Material for Compacted Clay Soil Liner

1) Testing of Clay Materials

a. The Construction Manager shall visually inspect clay soil being placed during construction in accordance with Article 3.03.C.

b. Field testing of the compacted clay soil liner shall be performed to assure that construction is meeting the established requirements found in Appendix A.

c. Compaction to the specified moisture-density relationship shall be verified by in-place density tests using ASTM D 2922. Every fifth density test taken will be verified by sand cone method in accordance with ASTM D 1556. Maximum density determination and in-place density tests will be performed by the Construction Manager.

d. Testing for moisture content of clay soils shall be in accordance with ASTM D 3017. Every fifth moisture content test taken will be verified by the direct oven drying in accordance with ASTM D 2216. Testing will be performed by the Construction Manager.

e. In-place moisture and density testing shall be conducted after each lift is placed at a frequency of 5 tests per acre per lift. The location of the density tests shall be selected randomly by the Construction Manager.

f. Laboratory permeability testing shall be performed on Shelby tube samples taken from the constructed liner at a rate of 1 test per 3 acres per lift. Permeability testing shall be in accordance with ASTM D 5084. Testing will be performed by the Construction Manager.

g. All voids left by test equipment shall be filled with bentonite by the Contractor and hand tamped. Contractor shall carefully examine the final lift, both prior to compaction rolling and after completion of compaction for presence of rock fragments larger than 2 in. in largest dimension and direct further rock picking as necessary.

2) Additional tests may be performed by the Construction Manager based on the following conditions:

a. The clay soil or fill material appears to be at an improper moisture content or the moisture content is not uniform.

b. Fill materials appear to differ substantially from those specified or previously tested.

c. The degree of compaction is questionable or does not appear uniform.

D. Leachate Collection Layer

During the installation of the leachate collection layer, gradation shall be tested in accordance with ASTM D 422 at a frequency of one test per 2,500 cubic yards. Gradation testing will be performed by the Construction Manager.

E. Protective Soil Cover

1) Compaction of the protective soil cover to the specified moisture-density relationship for the final lift shall be verified by in-place density tests using ASTM D 2922. Maximum density determination and in-place density tests will be performed by the Construction Manager. R1

2) Testing for moisture content of soils shall be in accordance with ASTM D 3017. Testing will be performed by the Construction Manager.

3) In-place moisture and density testing shall be conducted after the final lift is placed at a frequency of 5 tests per acre. The location of the density tests shall be selected randomly by the Construction Manager. R1

F. Areas Outside the Compacted Clay Soil Liner Boundary

1) Compaction of fill and backfill to the specified moisture-density relationship of soils shall be verified by in-place density tests using ASTM D 2922 or other ASTM in-place density tests approved by the Construction Manager. In-place density tests will be performed by the Construction Manager.

2) Testing for moisture content of soils shall be in accordance with ASTM D 3017. Testing will be performed by the Construction Manager.

3) In-place moisture and density testing shall be conducted after each lift is placed at a frequency of one test per 5,000 ft^2 of surface area of a compacted lift, with a minimum of two tests performed on each lift. The location of the density tests shall be selected randomly by the Construction Manager.

G. Grading Construction Tolerances

1) The top of the subgrade and protective cover shall not be more than 0.20 ft. below the specified grades.

2) The top of the compacted clay soil liner and leachate collection layer shall be within +0.20 ft. of specified grades, using the finished as-built elevation of the preceding layer to establish the adjusted new specified grades for each layer.

3) In areas outside the compacted clay soil liner boundary the top of subgrade shall be a uniformly smooth grade surface without high or low points and shall not be more than 0.10 ft above or below specified grades.

3.05 PROTECTION

A. Protect existing utility lines and structures in work area and existing roadway structures, seeded areas, and other features adjacent to work area during construction activities. Provide adequate shoring and bracing as required to protect and maintain the stability of previously constructed structures and facilities.

B. Maintain newly graded areas by Contractor until final acceptance by Construction Manager. Restore areas showing settlement or washes to specified grades at the Contractor's expense prior to final acceptance.

END OF SECTION

SECTION 02225

TRENCHING

PART 1: GENERAL

1.01 DESCRIPTION

Section includes: Excavation of trenches for utilities and compaction of bedding and backfill over utilities to subgrade elevation.

1.02 RELATED SECTIONS

A. Section 02211, Rough Grading

B. Section 02505, Mineral Aggregate Base Course

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM), Annual Book of Standards

1) ASTM D 698-91, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).

2) ASTM D 2216-92, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

3) ASTM D 2922-91, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4) ASTM D 3017-88, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

B. Occupational Safety and Health Administration (OSHA), Code of Federal Regulations 29 CFR 1926, Subpart P-Excavation, latest revision.

C. Tennessee Department of Transportation (TDOT), Standard Specifications for Road and Bridge Construction, 1981 edition.

1.04 PROJECT/SITE CONDITIONS

The existing leachate piping system and appurtenances have been located using information provided by Lockheed Martin Energy Systems Inc., and are shown for the purpose of assisting the Contractor in identifying utilities during construction. The Contractor should be aware that the actual location may vary from the location shown on the Construction Drawings. The Contractor shall use extreme caution when excavating in the vicinity of the existing leachate piping system and appurtenances. Damage to the existing leachate piping system or appurtenances shall be repaired at the Contractor's expense.

PART 2: PRODUCTS

2.01 MATERIALS

A. Backfill Material

1) Unless otherwise specified, materials for backfill shall be earth, free of clods, boulders, broken rock, or concrete exceeding 3 in. in largest dimension or organic or vegetable matter, rubbish, or other unsuitable material.

2) Backfill materials under roads or structures shall conform to Section 02505, Mineral Aggregate Base Course.

B. Bedding materials for storm drain pipes and leachate sewer pipe installed outside of the landfill boundary shall be mineral aggregate base course material in accordance with Section 02505, Mineral Aggregate Base Course.

C. Bentonite: In accordance with Section 02211, Rough Grading.

PART 3: EXECUTION

3.01 INSPECTION

A. Verify backfill materials to be reused are acceptable. Do not use frozen material.

B. Verify areas to be backfilled are free of debris, snow, ice, or water and that surfaces are not frozen.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stockpile excavated materials to be used in areas on-site as designated by the Construction Manager. Remove excess materials not being used from site and dispose in areas designated by the Construction Manager.

C. Grade excavation top perimeter to prevent surface water run-off into excavation. Keep trench bottom free of standing water. Provide side drainage ditches along the trench bottom or dewatering pumps as required. Direct discharge of water collected in trench to surface drainage channels with approval of the Construction Manager.

D. Notify Construction Manager immediately of unexpected subsurface conditions.

3.03 INSTALLATION/APPLICATION/ERECTION

A. Excavation

1) Excavate trenches to a width necessary for proper installation of pipe or other utility to be accommodated. Clearance between pipe and trench walls shall be as indicated on the Construction Drawings.

2) Grade bottom of trench to provide uniform bearing and support for utility either on undisturbed soil or properly compacted backfill throughout the length of the utility except where necessary to hand excavate for bell or coupling for proper sealing of pipe joints.

3) Hand excavate for bell and spigot after trench has been fine graded to ensure uniform bearing is provided for pipe.

4) Remove soft, spongy, or otherwise unstable materials encountered at elevation of pipe which will not provide a firm foundation for the pipe. Extend bedding depth as necessary to reach firm materials.

5) Backfill unauthorized excavation at the Contractor's expense with compacted earth, sand, crushed stone, or concrete as directed by Construction Manager.

B. Bedding/Backfill

1) Promptly backfill utility trenches and around utility structures after as-built surveying has been completed.

2) Deposit bedding material in 6-in. layers, and carefully ram or tamp until the depth is as shown on the Construction Drawings. The remainder of the backfill shall be placed in horizontal layers 6 in. (max) in depth under roads and structures and 12 in. (max) in depth in other areas. Hand-maneuvered power compaction tools shall be utilized to compact the backfill to the required density.

3) Compact soil backfill to a minimum of 95% of maximum dry density at not less than 2% below nor more than 2% above the optimum moisture content as determined by ASTM D 698.

4) Remove temporary blocking or cribbing material used to support utility before backfilling.

5) Where trenching occurs through the clay soil liner, bentonite shall be used for bedding material and shall be installed around the periphery of the pipe as shown on the Construction Drawings.

C. General

1) Employ a placement method that does not disturb or damage utility, or trench. Protect or replace existing structures and piping.

2) Support pipe during placement and compaction of bedding fill.

3.04 FIELD QUALITY CONTROL

A. Testing

1) Compaction of fill and backfill to the specified moisture-density relationship of soils shall be verified by in-place density tests using ASTM D 2922 or other ASTM in-place density tests approved by the Construction Manager. Maximum density determination and in-place density tests shall be performed by the Construction Manager.

2) Testing for moisture content of soils and aggregate shall be in accordance with ASTM D 2216 or D 3017. Testing will be performed by the Construction Manager.

3) A minimum of one in-place density/moisture test shall be conducted per 250 linear ft of trench. Layer to be tested shall be selected randomly by the Construction Manager.

4) Laboratory tests shall be completed for each type of soil to be used for fill. A sample shall be obtained by the Construction Manager each time a change in appearance of the material is noted.

B. Top of subgrade shall be a uniformly smooth grade surface without high or low points and shall not be more than 0.10 ft above or below specified grades. Bind thin layers of added materials to material in place by scarifying and recompacting.

3.05 PROTECTION

Protect excavation by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in of loose soil into excavation. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P-Excavations, latest revision.

A. Trenches 5 ft or greater in height shall be shored, laid back to a stable slope, or provided with some other equivalent means of protection.

B. Refer to OSHA 29 CFR 1926, Subpart P-Excavations, Appendices A and B, as a guide to minimum requirements for slopes that are laid back.

C. Refer to OSHA 29 CFR 1926, Subpart P-Excavations, Appendices C–E, as a guide to minimum requirements for shoring or bracing.

D. Trenches less than 5 ft in depth shall also be effectively protected when examination of the ground indicates hazardous ground movement may be expected.

E. Employees required to be in trenches 4 ft deep or more shall have an adequate means of exit, so as to require no more than 25 ft of lateral travel.

END OF SECTION

SECTION 02270

SLOPE PROTECTION AND EROSION CONTROL

PART 1: GENERAL

1.01 DESCRIPTION

Section includes: Temporary control measures for slope protection and controls to reduce erosion, sedimentation, and water pollution through the use of erosion control devices.

1.02 RELATED SECTIONS

A. Section 02210, Site Clearing.

B. Section 02936, Seeding.

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO). AASHTO M 288-92, Interim Geotextile Specification for Highway Applications.

B. Tennessee Department of Transportation (TDOT), Standard Specifications for Road and Bridge Construction, 1981 edition.

1.04 SUBMITTALS

Submit manufacturer's data for information.

1.05 PROJECT/SITE CONDITIONS

Coordinate temporary pollution control provisions with existing permanent erosion control features to assure economical, effective, and continuous erosion control throughout construction and postconstruction periods.

PART 2: PRODUCTS

2.01 MATERIALS

A. Silt Fences

1) Geotextile Filter Cloth material shall be pervious sheets of strong rot-proof plastic fabric meeting the requirements of AASHTO M 288 for sediment control applications.

2) Reinforcement Backing: Minimum 14 gage steel wire, and maximum mesh spacing of 6 in. or approved synthetic netting. Use reinforcement backing with the specified geotextile filter cloth.

Reinforcement backing can be eliminated if post spacing is a maximum of 6 ft and geotextile tensile strength is increased to a minimum of 200 lb.

3) Posts: Wood or steel and a minimum 4 ft long. Wood posts shall be at least 2 in. × 2 in. of oak or similar hardwood. Steel posts shall be round or "U," "T," or "C" shaped with a minimum weight of 1.33 lb/ft and projections for fastening reinforcement backing to fence.

4) Wire Staples: 9 gage and minimum 1 in. long.

5) A preassembled silt fence meeting the material requirements may be used instead of a field constructed silt fence.

B. Mulching Material

Straw Mulch, in accordance with Section 02936, Seeding.

C. Straw Bale Barriers

Baled hay or straw containing 5 ft^3 or more of material. Securely bind bales with wire or nylon.

D. Excelsior Matting

In accordance with TDOT Specification, Subsection 918.28, and TDOT Section 918B (Special Provision), Type II.

PART 3: EXECUTION

3.01 PREPARATION

A. Coordinate general preparation with requirements of Section 02210, Site Clearing.

B. Site Preparation: Prepare site in accordance with good engineering practices for installation of surface erosion control features. Compact surface and remove and replace pockets of soft soil with compacted earth material to provide a consistently uniform and stable surface in accordance with Section 02211, Rough Grading.

C. Silt fences, straw bale barriers, and other erosion and sediment control devices shall be installed as a first step in clearing and earthwork and maintained throughout the construction period. New vegetative areas shall be seeded and mulched within 14 days following completion of grading. Temporary measures may be removed at the beginning of the workday but must be replaced at the end of the workday. Silt fences and other erosion control measures shall be left in place and maintained until such time as permanent erosion control is fully developed.

3.02 INSTALLATION/APPLICATION/ERECTION

A. General

1) Control surface water runoff on-site and provide temporary soil stabilization measures as required to prevent removal of soil by action of either water or wind, more commonly known as erosion. Protect land areas adjacent to work site from sedimentation by installation of erosion and sediment control measures.

2) Seed and mulch within 14 days of completion of grading activities. Seed and mulch areas where grading has not been completed and has temporarily ceased, and grading activities are not anticipated to resume within 14 days, unless approval is obtained from the Construction Manager. Seed and mulch shall be in accordance with Section 02936, Seeding.

B. Silt Fences

1) Install silt fence as indicated on plans to reduce the quantity of sediment and flow velocities to downstream areas.

2) Space posts at a maximum spacing of 6 ft apart for silt fences constructed without reinforcement backing and 10 ft apart for silt fences constructed with reinforcement backing. Securely install with at least 2 ft of post in ground. Excavate trench approximately 6 in. wide and 6 in. deep along line of posts and upslope from the barrier. Securely fasten reinforcement backing fence to upslope side of posts using wire staples, tie wires, or hog rings. Extend backing into trench a minimum of 6 in. Attach geotextile filter cloth directly to posts and reinforcement backing as required using wire, staples, or other means accepted by the Construction Manager. Install filter fabric in a manner such that fabric height above grade is 2 to 3 ft and that 12 to 18 in. of fabric is extended along the sides and bottom of the trench. Do not staple fabric to trees. Do not use fabric with defects, rips, holes, flaws, deterioration, or other damage. Backfill trench and compact soil over the fabric as installed. A detail of the above installation is shown on the attached Energy Systems Engineering Standard ES-7.16-1.

C. Straw Bale Barriers

1) Install straw bale barriers in a row of entrenched and anchored hay or straw bales as indicated on the Construction Drawings.

2) Wire bind or string tie bales. Install bales so that bindings are oriented around the sides rather than along tops and bottoms of bales in order to prevent deterioration of bindings. Excavate a trench the width of bale and a length of proposed barrier to a minimum depth of 4 in. Place bales in the trench and fill the gaps with loose straw to prevent water from escaping between the bales. Anchor bales with at least two stakes or re-bars driven through bales to a depth of 1.5 to 2 ft in ground. Drive first stake in each bale toward previously laid bale to force the bales together. After bales are staked and chinked, backfill excavated soil against barrier. Backfill soil shall conform to ground level on downhill side and shall be built up to 4 in. against uphill side of the barrier. A detail of the above installation is shown on the attached Energy Systems Engineering Standard ES-7.16-2.

a. Channel Flow: Place bales at locations indicated, in a single row, lengthwise, oriented perpendicular to channel, with ends of adjacent bales tightly abutting one another. Extend

barrier to such a length that bottoms of end bales are higher in elevation than top of lowest middle bale to assure that sediment-laden runoff will flow either through or over barrier but not around it.

b. Sheet Flow: Place bales at locations indicated, in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another.

D. Excelsior Matting

1) Install excelsior matting on all permanent slopes outside of the Area 2 boundary.

2) Install excelsior matting on the bottom and side slopes of the 3 ft flat bottom ditch located south of Area 2.

3) Shape area to be protected to required shape and grade and thoroughly compact after seedbed preparation. Remove rocks or clods over 1 1/2-in. in diameter and sticks and other material that will prevent contract of excelsior matting with soil surface. Complete seeding and fertilizing activities in accordance with Section 02936, Seeding, prior to installing excelsior matting.

4) Unroll excelsior matting in the direction of the flow of water with edges and ends butted snugly against each other. When unrolled, the netting shall be on top and the fibers in contact with the soil. The mats shall be anchored firmly to the soil with 3 rows of staples spaced 2 1/2 to 3 ft apart driven vertically into the ground and flush with the surface of the mats. At all joints and ends, staples shall be spaced not more than 6 in. apart. The spacing of staples may be modified to fit conditions as directed by the Construction Manager.

3.03 MAINTENANCE

A. Silt Fences

The Contractor shall inspect to ensure silt fence installation complies with the specification weekly during dry periods, immediately after each rainfall, and at least daily during prolonged rainfall. Provide required repairs immediately. Should fabric decompose or become ineffective and still be necessary, replace fabric promptly. Remove sediment deposits after each storm event. As a minimum, remove sediment when deposits reach approximately one-third the height of barrier. Dispose of sediment in Construction/Demolition Landfill VII. Maintain fabric silt fence until final acceptance of the work by the Construction Manager, upon which all silt fence shall be removed, and all areas disturbed due to silt fence removal shall be seeded.

B. Straw Bale Barriers

Inspect straw bale barriers immediately after each rainfall, at least daily during prolonged rainfall and weekly during dry periods. Repair damaged bales, end runs, and undercutting beneath bales. Accomplish necessary repairs to barriers or replacement of bales promptly. Remove sediment deposits after each rainfall. Remove sediment when level of deposition reaches approximately one-half the height of lowest point of barrier. Dispose of sediment in Construction/Demolition Landfill VII. Maintain barrier until final acceptance of the work by the Construction Manager, upon which all barriers shall be removed, and all areas disturbed due to barrier removal shall be seeded.

C. Diversion Swales

Provide periodic inspection and maintenance for diversion swales. Remove channel obstructions.

D. Siltation Ponds

Contractor shall remove accumulated silt from Siltation Ponds 1 & 2 to the elevations shown on Attachment B, Siltation Pond Silt Removal, when accumulated silt reaches elevation 991 for Pond 1, and elevation 986 for Pond 2, and at the completion of the construction activities prior to acceptance by the Construction Manager. Dispose of sediment in Construction/Demolition Landfill VII. Regrade all areas disturbed during this process and stabilize against erosion in accordance with Section 02936, Seeding.

END OF SECTION

SECTION 02271

RIP-RAP

PART 1: GENERAL

1.01 DESCRIPTION

Section includes: Placement of permanent stone rip-rap.

1.02 RELATED WORK

A. Section 02276, Geosynthetics.

B. Section 02936, Seeding.

1.03 REFERENCES

Tennessee Department of Transportation (TDOT), Standard Specifications for Road and Bridge Construction, 1981 edition.

PART 2: PRODUCTS

2.01 MATERIALS

A. Rip-Rap: Rip-rap shall be machined clean shot rock containing no sand, dust, or organic material meeting the requirements of TDOT Section 709 (special provision). The rip-rap shall be classified as Class A-1, defined by stone varying in size from 2 in. to 1.25 ft with no more than 20% by weight being less than 4 in. The thickness of the stone layer shall be 1.5 ft with a tolerance of 3 in.

B. Existing rip-rap shown on the Construction Drawings may be reused in lieu of new rip-rap if approved by the Construction Manager.

PART 3: EXECUTION

3.01 PREPARATION

A. Preparation of Foundation: Immediately prior to the placement of rip-rap, trim slopes or ground surface within reasonably close conformity to lines and grades indicated on Construction Drawings. Overexcavate ground surface by a depth equal to specified thickness of stone layer. Thoroughly compact surface by use of hand or mechanical tamps.

B. Place geotextile fabric on smooth, uniform surface or slope in accordance with Section 02276, Geosynthetics. Place the fabric loosely enough to conform to minor irregularities.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Place rip-rap by use of appropriate power equipment in a manner that will produce a surface that is uniform in appearance without concentration of fines and small pieces at any location. Hand work may be required to correct irregularities. Place rip-rap to the final grade lines shown on the Construction Drawings. Place rip-rap so that the top surface matches the required invert of ditches and culverts with no reduction in the design waterway. Minimize drop height when placing rip-rap.

B. During placement, visual inspections shall reveal that approximately 50% of the surface area consists of stones no smaller than 1/2 of the maximum size specified.

C. Any previously seeded or grassed area which has been disturbed during the placement of rip-rap shall be reseeded in accordance with Section 02936, Seeding.

END OF SECTION

SECTION 02276

GEOSYNTHETICS

PART 1: GENERAL

1.01 DESCRIPTION

Section includes: Use of geosynthetics in drainage applications in which material serves as a subsurface filter/separator or as a surface water barrier. Geotextile fabric shall provide a permeable barrier between gravel and clay soils allowing water to pass while retaining soil. Geotextile fabric shall be used in the construction of graveled roadways, the leachate collection layer, the protective soil cover layer, and in the maintenance of the siltation ponds 1 & 2. The temporary synthetic cover shall provide an impermeable barrier preventing the saturation of underlying soil and drainage media. The temporary synthetic cover specified in this section shall be used to cover the protective soil cover within the limits of waste placement. The geomembrane specified to be installed on the compacted clay soil liner shall be in accordance with Section 02280, Geomembrane.

1.02 RELATED WORK

A. Section 02211, Rough Grading.

B. Section 02270, Slope Protection and Erosion Control.

C. Section 02280, Geomembrane.

1.03 DEFINITION OF TERMS

A. Geotextile Separation: Fabric barrier placed between dissimilar materials so that the integrity of both materials can remain intact or be improved.

B. Geotextile Filtration: Movement of liquid through fabric while retaining drainage material on the upstream side of the fabric.

C. Polypropylene: Polymeric compound used to make various geotextile fabrics.

D. Polyester: Polymeric compound used to make various geotextile fabrics.

E. Nonwoven Fabric: Fabrics made by extruding and spraying fibers onto a moving conveyor belt to form a continuous web. Fabrics are then bonded by melt-bonding, resin-bonding, or needle punching.

F. Separator Geotextile: Used in the construction of the landfill bottom liner between the protective soil cover and the leachate collection layer.

G. Protective Geotextile: Used in the construction of the landfill bottom liner between the geomembrane and the leachate collection layer.

H. Access Road Geotextile: Used as a separator fabric between the soil subgrade and the mineral aggregate base course.

1.04 QUALITY ASSURANCE

Manufacturer's Material Certification

Maintain a competent laboratory by producer of fabric at point of manufacture to ensure quality control in accordance with the specified physical properties ASTM testing procedures. That laboratory shall maintain records of its quality control results and provide, prior to shipment, a manufacturer's certificate. The certificate shall include the name of manufacturer, chemical composition, product description, statement of compliance to specification requirements, and signature of authorized official attesting to the information required.

1.05 REFERENCES

American Society for Testing and Materials (ASTM), Annual Book of Standards Properties of Plastics.

A. ASTM D 638-91, Standard Test Method for Tensile Properties of Plastics.

B. ASTM D 3776-90, Standard Test Methods for Mass Per Unit Area (Weight) of Woven Fabric (R-1990).

C. ASTM D 3786-87, Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics-Diaphragm Bursting Strength Tester Method.

D. ASTM D 4491-92, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

E. ASTM D 4533-91, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

F. ASTM D 4632-91, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

G. ASTM D 4751-90, Standard Test Method for Determining Apparent Opening Size of a Geotextile.

H. ASTM D 4833-88, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

1.06 SUBMITTALS

A. Submit Manufacturer's Material Certification for approval as described in Article 1.04.

B. Submit shop drawing for approval for installation of the temporary synthetic cover. The shop drawing shall include panel dimensions and layout, the location of field and shop seams, and dimensions of the cover.

1.07 PROJECT/SITE CONDITIONS

The protective geotextile shall not be approved for use until the results of the direct shear friction testing as specified in Section 02280, Geomembrane are accepted.

PART 2: PRODUCTS

2.01 MATERIALS

A. Geosynthetics-General

1) Provide geosynthetics in rolls wrapped with protective covering to protect fabric from mud, dirt, dust, and debris. The geosynthetic shall be free of defects or flaws which significantly affect their physical properties.

2) Number rolls of geosynthetics in shipments with a number or symbol to identify that production run.

3) At the discretion of the Facilities Manager, additional or confirming tests may be conducted on the proposed geosynthetic materials prior to acceptance. Additional or confirming tests will be conducted by the Facilities Manager.

B. Geotextile Fabric

1) Geotextile fabrics shall be inert to commonly encountered chemicals and hydrocarbons, mildew and rot resistant, insect and rodent resistant.

2) Protective Geotextile Fabric

a. Material for the protective geotextile fabric shall be a nonwoven geotextile consisting of needle-punched polyester, continuous filament or cut staple fabrics. Pre-approved manufacturers for the protective geotextile are as follows: Hoechst Celanese Corp. (Trevira); Wellman, Inc.; or Geocomposites, Inc.

b. The protective geotextile fabric shall be manufactured so that a 20 ft. minimum continuous width (without seams) can be installed.

c. Minimum average roll values for strength properties of individual rolls tested from manufacturing lot or lots of a particular shipment shall be in excess of the minimum average roll values stipulated in Table 1:

Table 1
Physical Requirements for Protective Geotextile Fabric

Property	Physical Properties	Test Method
Unit Weight (oz/yd^2)	16	ASTM D 3776
Tensile (Grab) Strength (lb)	350 minimum	ASTM D 4632
Elongation (%)	60 minimum	ASTM D 4632
Burst Strength (psi)	500 minimum	ASTM D 3786
Trapezoidal Tear (lb)	115 minimum	ASTM D 4533

3) Separator Geotextile Fabric/Access Road Geotextile Fabric

a. Material for the separator geotextile fabric and access road geotextile fabric shall be a nonwoven geotextile fabric consisting of polypropylene or polyester filaments or fibers.

b. The separator geotextile fabric shall be manufactured so that a 20 ft. minimum continuous width (without seaming) can be installed.

c. Minimum average roll values for strength properties of individual rolls tested from manufacturing lot or lots of a particular shipment shall be in excess of the minimum average roll values stipulated in Table 2:

Table 2
Physical Requirements for Separator Geotextile Fabric and Access Road Geotextile Fabric

Property	Physical Properties	Test Method
Unit Weight (oz/yd^2)	8	ASTM D 3776
Tensile (Grab) Strength (lb)	165 minimum	ASTM D 4632
Elongation (%)	50 minimum	ASTM D 4632
Puncture (lb)	85 minimum	ASTM D 4833
Burst Strength (psi)	300 minimum	ASTM D 3786
Trapezoidal Tear (lb)	75 minimum	ASTM D 4533

4) The geotextile fabric used in the maintenance of siltation pond spillways shall be geotextile filter cloth as specified in Section 02270, Slope Protection and Erosion Control.

C. Temporary Synthetic Cover

1) The material used to temporarily cover the protective soil cover until waste placement begins shall be Gundguard or equal as a minimum. The cover shall be provided with a white surface on one side.

2) All roll materials shall be continuously inspected during fabrication for uniformity, damage, imperfections, holes, cracks, thin spots, foreign materials, tears, punctures, and blisters. Any imperfections shall be repaired and reinspected prior to shipping to site.

3) Temporary synthetic cover shall be fabricated in panels to minimize field seaming.

Table 3
Physical Requirements for Temporary Synthetic Cover

Property	Physical Properties	Test Method
Thickness, (mils)	12	ASTM D 751
Tensile Strength at Break	35 lbs/in width	ASTM D 638 Type IV
Elongation of Break	700%	Per Manufacturer

D. Stainless steel bands shall be a minimum of 1 1/4 in. wide with a minimum thickness of 0.048 in. See Article 3.03B for application.

E. Sand bags shall weigh a minimum of 50 lbs.

PART 3: EXECUTION

3.01 INSPECTION

A. Verify that grades and elevations are correct.

B. Verify that subgrade does not contain unsuitable, unstable, or soft material. Free subgrade from mud or soft soil materials which would clog fabric openings. Subgrade preparation shall be in accordance with Section 02211, Rough Grading. If unstable materials are encountered, notify Construction Manager immediately.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Install geotextile fabric to limits and grades indicated on the Construction Drawings.

B. The geotextile fabric used in the construction of the separator and protective geotextiles shall be field joined by sewing with nylon thread at a stitch density of at least 5 stitches per inch and two rows of single-thread stitches or one row of double-thread stitches. The geotextile fabric used in the construction of roadways shall be field joined by a minimum of 18 in. overlap.

C. Temporary synthetic cover shall be field joined using hot wedge welding. Overlaps shall be "shingled" with the upper overlapped face edge pointing down slope. Install cover with white surface facing up.

D. Temporary synthetic cover shall be weighted with sandbags using an equally spaced pattern so that an approximate holding pressure of 0.25 lb/ft^2 is achieved. Sandbags shall be fabricated from the same material as the temporary synthetic cover. Seam bags per manufacturer's recommendations.

E. Backfill material placed directly on geotextile fabric shall be free from mud or soft soil material which would clog fabric openings. Place backfill material on geotextile fabric carefully to avoid damage to fabric by heavy equipment blades, buckets, or tracks.

F. Initial lift of aggregate upon geotextile fabric used in road construction shall be a minimum of 8 in. uncompacted and shall be compacted with equipment which will not penetrate soil layer and damage fabric.

G. Lift thicknesses of material upon the separator and protective geotextiles shall be in accordance with Section 02211, Rough Grading.

H. Exposure of geotextiles to elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

I. Place geotextile patch over damaged areas and extend 3 ft beyond perimeter of tear or damage.

J. Patching of synthetic cover shall be in accordance with the manufacturer's instructions.

3.03 MAINTENANCE

A. Upon stabilization of the areas disturbed during the construction activities, the existing geotextile fabric on Siltation Ponds 1 & 2 principal spillway shall be replaced with new fabric.

B. If existing metal bands are not reusable, new stainless steel bands shall be utilized to secure the geotextile fabric at maximum spacing of 2 ft-0 in. c/c.

END OF SECTION

SECTION 02280

GEOMEMBRANE

PART 1: GENERAL

1.01 DESCRIPTION

This section includes the manufacture, fabrication, and installation of the geomembrane to be installed on the compacted clay soil liner.

1.02 RELATED SECTIONS

A. Division 1.

B. Section 02211, Rough Grading

1.03 DEFINITIONS OF TERMS

A. Polypropylene: a polymeric, thermoplastic material used in the manufacture of geomembrane.

B. Manufacturer

The manufacturer is the firm or corporation responsible for production of the geomembrane material to be used in the project. The manufacturer is responsible for the condition of the geomembrane until the material is accepted by the Construction Manager or his/her field representative upon delivery. The manufacturer shall produce a consistent product meeting the project specifications and shall provide quality control documentation for the product specified herein.

C. Installer

The installer is the firm responsible for installation of the geomembrane. The installer shall be the manufacturer or an approved installer trained and certified to install the manufacturer's geomembrane. The installer shall provide an Installation Supervisor responsible for the installer's field crew.

D. Film Tear Bond (FTB): A failure in the ductile mode of one of the bonded sheets by tearing prior to complete separation to the bonded area as depicted in EPA Technical Guidance Document EPA/600/2-88/052. A seam shall be classified as a FTB if no greater than 10% of the seam width peels (separates) at any point.

E. Geomembrane: A synthetic lining material, also referred to as a flexible membrane liner (FML), placed in direct contact with the compacted clay soil liner.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM), Annual Book of Standards

1) ASTM D 638-91, Standard Test Method for Tensile Properties of Plastics.

2) ASTM D 751-89, Standard Test Methods for Coated Fabrics.

3) ASTM D 1238-90b, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.

4) ASTM D 4437-84, Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

5) ASTM D 5321-92, Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

B. United States Environmental Protection Agency (EPA).

1) Technical Guidance Document, EPA/600/2-88/052, Lining of Waste Containment and Other Impoundment Facilities, 1988.

2) Technical Guidance Document, EPA/530/SW-91/051, Inspection Techniques for the Fabrication of Geomembrane Field Seams, May 1991.

C. Geosynthetics Research Institute (GRI)

1) GRI Test Method GM3, Standard Test Method for Large Scale Hydrostatic Test, latest revision.

2) GRI Test Method GM4, Standard Test Method for Three Dimensional Geomembrane Tension Test, latest revision.

3) GRI Test Method GM6, Standard Practice for Pressurized Air Channel Test for Dual Seamed Geomembranes, latest revision.

D. National Sanitation Foundation (NSF), Standard Number 54, Flexible Membrane Liners, November 1993.

1.05 QUALITY ASSURANCE

A. A laboratory shall be maintained by the manufacturer of the geomembrane materials at the point of manufacture to ensure quality control in accordance with the American Society for Testing and Materials (ASTM) testing procedures. That laboratory shall maintain records of its quality control results and provide, prior to shipment, a Certificate of Compliance stating that all rolls of geomembrane materials supplied are in compliance with specification physical properties requirements.

B. The certificate shall include the name of the manufacturer, chemical composition, product description, statement of compliance to specification physical properties requirements, and signature of authorized official attesting to the information required.

C. Testing of factory fabricated seams for geomembrane shall be performed by the manufacturer. The manufacturer shall inspect and test 100% of factory fabricated seams in accordance with these specifications.

D. Testing of geosynthetic and geomembrane materials during construction will be performed by the Construction Manager.

E. Geomembrane shall be randomly sampled and tested in accordance with the manufacturer's approved QC manual. Samples not meeting the minimum requirements specified shall result in the rejection of the applicable sheets.

F. The Installation Supervisor shall be the manufacturer or manufacturer approved installer trained and certified to install the manufacturer's geomembrane liner material. The Installation Supervisor shall have demonstrated experience in installing and seaming of a minimum of 2 million ft^2 of geomembrane liner systems for similar applications. The Installation Supervisor shall remain on-site and be in responsible charge for the liner layout, seaming, patching, repairs, testing coordination with the Construction Manager, and all other activities associated with installation of the geomembrane.

1.06 SUBMITTALS

A. The Contractor will be required to submit a sample of the proposed geomembrane and protective geotextile materials.

B. Submit a Certificate of Compliance from the manufacturer in accordance with Article 1.05, Paragraphs A and B, for the geomembrane material.

C. Submit quality control certificates issued by the producer of the raw materials used to manufacturer the geomembrane. These certificates shall include the following:

1) Origin, identification, and production plant location of the resin used to manufacture the geomembrane.

2) Reports of testing conducted to verify the quality of the resin including the stabilization compounds used to manufacture the geomembrane, with signature of authorized official. Properties testing typically performed by the resin manufacturer shall be included in the reports.

D. Shop drawings: Submit shop drawings showing proposed geomembrane panel layout, panel size, shop and field seams, and location of test coupons. The drawings shall include number or letter of panels and cross-reference surrounding panels, details of seaming the geomembrane, connections, penetrations, pipe boot fabrication, and other construction related details. Shop drawings shall be prepared in accordance with Division 1.

E. The Contractor shall submit evidence of experience and competence to install the specified geomembrane in accordance with Article 1.05, Paragraph F. A resume of the Installation Supervisor to be assigned to the project shall be submitted.

F. Submit as-built drawings showing geomembrane panel layout, panel size, seam type and location, location of test coupons, and areas where repairs were made. Drawings shall be prepared in accordance with Division 1.

G. Submit inspection and testing data for factory fabricated seams in accordance with Article 1.05, Paragraph C, and Article 2.02, Paragraphs F & G.

H. Submit an Installation Schedule as required by the Construction Manager prior to start of construction.

I. Submit geomembrane manufacturer's quality control manual including description of laboratory facilities.

J. Submit a workmanship guarantee in accordance with Article 1.07.

K. Submit results of the manufacturer's physical properties testing in accordance with the approved QA Manual. Testing shall include but not be limited to the typical properties outlined in Table 1.

L. Submit evidence of accreditation and qualifications for the laboratory selected for friction testing in accordance with Article 1.08.

1.07 GUARANTY

The Contractor shall guarantee the geomembrane against defects in installation and workmanship for a period of 2 yr commencing with the date of final acceptance. The guarantee shall include the services of qualified technicians and all materials required for the repairs at no expense to the Government.

1.08 PROJECT/SITE CONDITIONS

The Contractor shall conduct direct shear friction tests to determine the friction angle of the interface between the proposed geomembrane and protective geotextile materials. Testing will be conducted under "wet" conditions. All interface friction tests shall be "3-point" tests with confining pressures of 1,000 pounds per square foot (psf), 3,000 psf, and 5,000 psf, in accordance with ASTM D 5321. The minimum acceptable residual friction angle produced from the tests of the proposed materials is 11 degrees. The laboratory shall hold current accreditation by the Geosynthetics Research Institute.

1.09 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane shall be marked to show the following minimum information:

1) Name of manufacturer.

2) Product type.

3) Physical dimensions (length and width)

4) Roll identification number.

B. Handling

1) Palleted geomembrane panels shall be accordion folded width-wise and length-wise without causing damage to the geomembrane.

2) Banding straps around the geomembrane and pallet should be properly cushioned so as not to cause damage to any part of the geomembrane panel.

3) The stacking of palleted geomembrane panels on top of one another is not permitted.

4) When the geomembrane materials are delivered to the construction site, the Construction Manager shall inspect to confirm that the material is the material that was specified and that the material is not damaged. Inspection activities shall prevent, detect, and correct the following:

   a. Puncture from nails or splinters.

   b. Tears from operation of equipment or inadequate packaging.

   c. Blocking: the bonding together of adjacent membrane layers, which may be caused by excessive heat.

   d. Crumpling or tearing from inadequate packaging support.

5) The above types of damage shall be avoided by careful handling of the geomembrane material during preparation for shipment and of the packaged crates and rolls of material.

6) When damage to a crate or roll cover has occurred, careful examination of the underlying material is required. If damage is found, the Contractor and the Construction Manager should carefully examine the entire shipment for damage.

C. Storage

On-site storage of the geomembrane material shall be in a secure area with provisions for shelter from adverse weather if on-site storage will exceed 90 days.

D. The Contractor shall be responsible for unloading, storage, and care of the geomembrane material until such material has been incorporated into the work. Materials shall be stored in a manner that prevents damage and shall be kept out of direct sunlight. The materials shall be stored on a prepared surface (excluding wooden pallets) and shall not be stacked more than two rolls high.

E. Unload materials at the work site, near the location of installation. Materials shall be placed so as to least interfere with normal operations.

F. The Contractor shall be responsible for replacing any damaged or unacceptable material at his expense.

PART 2: PRODUCTS

2.01 MATERIALS

A. Geomembrane Resin

The resin used in the manufacturing of the geomembrane shall be Astryn resin CA721G as manufactured by Montell, North America, Inc.

B. Geomembrane

1) The material used for the geomembrane shall be unreinforced, smooth polypropylene. Pre-approved manufacturers for the geomembrane are as follows: Serrot Corporation; Gundle Lining Systems, Inc.; SLT North America, Inc.; or National Seal Company. The geomembrane shall be manufactured from the resin specified in Paragraph A. No additional additive or fillers shall be allowed without prior approval by the Construction Manager. The geomembrane shall conform to the typical sheet properties outlined in Table 1.

Table 1

Typical Property Requirements for Geomembrane

Property	Typical Value	Test Method
Thickness, (mils)	40	ASTM D 751
Density, (g/cc)	0.9	ASTM D 1238
Tensile Strength at Yield (psi)	900 (Machine Direction) 700 (Cross Direction)	ASTM D 638
Tensile Strength at Break (psi)	2,400 (Machine Direction) 2,300 (Cross Direction)	ASTM D 638
Elongation Break (%)	800 (Machine Direction) 900 (Cross Direction)	ASTM D 638
Critical Cone Height (cm)	>10	GRI/GM3
Multiaxial Burst Extension (%)	>150	GRI/GM4

2) The geomembrane fabric shall be manufactured so that a 20 ft minimum continuous width (without seams) can be installed.

C. Other Materials

1) Boots for pipe penetrations shall be prefabricated and designed to fit site specific conditions for the intended slope and size of pipe. Boots shall be of the same material as the geomembrane.

2) Clamps shall be a Fernco, 1056 Series, with stainless steel clamps, or equal as a minimum.

2.02 FACTORY FABRICATION

A. Factory fabrication of pipe boots or other specialized fabrications shall be performed by the geomembrane manufacturer. Factory fabrication of geomembrane blankets or panels is prohibited.

B. Factory fabrication shall be performed under environmental conditions as recommended by the manufacturer.

C. The geomembrane material shall be continuously inspected for uniformity, damage, imperfections, holes, cracks, thin spots, foreign materials, tears, punctures, and blisters. Any imperfections shall be immediately repaired and reinspected.

D. Extrusion or solvent welding is prohibited.

E. All seams shall be visually inspected and results documented.

F. Nondestructive seam testing shall be performed on all fabricated seams over their full length in accordance with ASTM D 4437, and the manufacturer's quality control manual. Test methods shall be the air lance or vacuum box.

G. All inspection and testing of factory seams shall be performed by the manufacturer's laboratory in accordance with Article 1.05.

H. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the geomembrane material and/or seams as appropriate.

I. In addition to visual inspection and nondestructive testing, a 48 in. sample shall be taken from each factory seam welding unit used in this work at the beginning of every work shift and every four hours of production thereafter. Samples shall be from the same production lot as the field panels, i.e., will not require patching of fabricated panels. Test specimens shall be cut at quarter points from each 48 in. seam sample (a total of three places) and tested for factory seam strength and peel adhesion. The seam strength shall be tested in accordance with ASTM D 4437, as modified in Annex A of NSF 54, and shall have a tensile strength of at least 35 lbs per inch. Failure of seam shall be classified as "film tear bond" (FTB). The peel adhesion shall be tested in accordance with ASTM D 4437, as modified in Annex A of NSF 54, and shall provide a value of 25 lbs per inch. Failure of seam shall be classified as FTB.

PART 3: EXECUTION

3.01 PREPARATION

A. Ensure that the grades and elevations are correct before installation of geomembrane material.

B. Ensure that the finish grade does not contain rocks, roots, vegetation, or other debris. Foreign materials and protrusions shall be removed to the maximum extent practicable; and all cracks and voids shall be filled in accordance with Section 02211, Rough Grading.

C. The surface over which the geomembrane is to be installed shall be rolled with a steel drum roller prior to installation.

D. During the actual placing and seaming of the geomembrane, the subgrade shall be kept free of all standing water.

3.02 INSTALLATION

A. Deployment

1) The geomembrane shall be deployed following the manufacturer's recommendations so that at the time of installation it will contain a minimum of wrinkles and be under minimum stress.

2) Each panel/roll of the geomembrane shall be rolled out and installed in accordance with the approved shop drawings. The layout shall be designed to keep field joining of the geomembrane to a minimum and to be consistent with proper methods of geomembrane installation.

3) The geomembrane shall be unfolded or unrolled so as to prevent damage to the underlying or prepared subgrade.

4) Direct vehicular contact with the geomembrane shall not be allowed. The Contractor shall use procedures recommended by the manufacturer to prevent damage from equipment, tools, and traffic.

5) Should punctures, rips, or tears be encountered in the geomembrane material, the Contractor shall immediately notify the Construction Manager.

B. Seaming Weather Conditions

1) Normal Weather Conditions

a. The normal required weather conditions for seaming are as follows:

(1) Ambient temperature higher than 40°F and lower than 104°F.

(2) No precipitation or other excessive moisture, such as fog, dew, or ponded water.

(3) No excessive winds.

b. These weather conditions shall be fulfilled during seaming process.

2) Cold Weather Conditions

a. If the ambient temperature is below 40°F, no seaming of geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Construction Manager that geomembrane seam quality is not adversely impacted. The following conditions shall also be met to ensure quality seaming process:

(1) Preheating the surface of the geomembrane to achieve normal temperature range.

(2) Preheating may be waived by the Construction Manager if the Installer demonstrates that satisfactory welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

(3) Preheating devices shall be approved by the manufacturer.

(4) Care shall be taken to assure that surface temperatures are not lowered below the minimum required surface temperature for welding due to winds.

(5) Additional destructive test samples shall be taken at the discretion of the Construction Manager.

(6) Trial seams, as described in Article 3.03, shall be performed under the same ambient temperature conditions as the actual seams.

3) Warm Weather Conditions

a. If the ambient temperature is above 104°F, no seaming of geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Construction Manager that geomembrane seam quality is not adversely impacted.

b. Test seams shall be performed under the same ambient temperature conditions as the actual seams.

c. Additional destructive tests shall be taken at the discretion of the Construction Manager.

C. Field Seaming

1) Panel field seaming shall be performed utilizing the hot wedge welding techniques as outlined in Section 7 of the EPA Technical Guidance Document: "Inspection Techniques for the Fabrication of Geomembrane Field Seams." Welding equipment and seaming temperatures shall be in accordance with the manufacturer's recommendations.

2) Field seams shall be oriented parallel to the line of maximum slope.

3) Unless directed otherwise by the Construction Manager, minimum overlap for field seams shall be in accordance with the manufacturer's recommendations.

4) The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the lining material in order to ensure that changes in environmental conditions will not affect the integrity of the weld.

5) Welding of field seams with a hand held hot air gun is only acceptable for repairing holes in the liner, repairing failed seams revealed by non-destructive testing, repairing areas where destructive testing is performed, at pipe/liner penetration boots, and other areas where the hot wedge welding machines cannot be used due to space restrictions. Welding with a hand held hot air gun shall be performed utilizing the techniques as outlined in Section 8 of the EPA Technical Guidance Document: "Inspection Techniques for the Fabrication of Geomembrane Field Seam." Welding equipment and seaming temperatures shall be in accordance with the manufacturer's recommendations.

D. The liner shall be placed over the prepared surface in such a manner as to assure minimum handling. The geomembrane shall not be dragged over rough subgrade surfaces. Any damage to the base surface resulting from liner installation or liner handling equipment shall be repaired by the Contractor at its own expense prior to placement of the liner. Vehicular traffic across the geomembrane shall not be allowed. The panels shall be of such lengths and widths and shall be placed in such a manner as to minimize field seaming.

E. In areas where wind is prevalent, liner installation shall be started at the upwind side of the project and proceed downwind. The leading edge of the liner shall be secured at all times with sandbags or other means sufficient to hold it down during high winds.

F. Sandbags shall be used as required to hold the liner in position during installation. Materials, equipment, or other items shall not be dragged across the surface of the liner nor be allowed to slide down slopes on the liner.

G. Liner panels shall be closely fit and sealed around inlets, outlets, and other projections through the liner. All piping, structures, and other projections through the liner shall be sealed as shown on the Construction Drawings.

H. All joints shall be tightly bonded on completion of the work. Any liner surface showing injury resulting from scuffing, penetration by foreign objects, or distress from rough subgrade shall be repaired or replaced as approved by the Construction Manager.

I. Each suspect location shall be nondestructively tested using methods described in Article 3.03 as appropriate. The Contractor shall not proceed with any materials which will cover locations that have been repaired until satisfactory test results have been obtained.

J. Pipe/Liner Penetration Boots

1) The geomembrane boots shall be furnished and installed where indicated on the Construction Drawings.

2) The geomembrane end of the boots shall terminate in a skirt section suitable for welding to the geomembrane.

3) Boots and skirts shall fit snugly around the pipe. Prefabricated material shall be designed to fit site specific conditions for the intended size and slope of pipe.

4) The geomembrane shall be secured to the pipe with clamps as shown on the Construction Drawings after pipe/liner penetration boots have been tested.

K. After installation of the geomembrane, the Contractor shall not proceed with installation of the protective geotextile, until authorized by the Construction Manager.

L. Any wrinkles that can fold over shall be repaired either by cutting out excess material or, if possible, allowing the liner to contract due to temperature reduction prior to placing the overlying material. In no case shall material be placed over the geomembrane which could result in the geomembrane folding.

3.03 FIELD QUALITY CONTROL

A. Testing and inspection activities required during placement of the geomembrane will be conducted by the Construction Manager or Facilities Manager as indicated in Attachments C, D and E.

B. During installation the geomembrane shall be inspected for uniformity, damage, imperfections, tears, punctures, or blisters. Any imperfections shall be immediately repaired and reinspected.

C. Trial seams shall be made on fragment pieces of geomembrane to verify adequacy of seaming conditions and equipment. Trial seams shall be made for each seaming apparatus used at the beginning of each seaming period, at the Construction Manager's inspection personnel's discretion, and at least once every four hours during continuous operation. Trial seams shall be made under the same conditions as field seams.

D. The trial seam shall be approximately 3 ft × 1 ft with the seam centered lengthwise. Two adjoining coupons shall be cut from the trial seam sample. The Construction Manager shall test the coupons in shear and peel using a field tensiometer. Minimum acceptable test value shall be in accordance with Paragraph 2.02 I. Should failure of the seam occur, another trial seam shall be prepared and tested. If the additional sample fails, the seaming apparatus and seamer shall not be accepted until deficiencies are corrected.

E. All field seams shall be nondestructively tested using vacuum-box testing procedures in accordance with ASTM D 4437, or the pressurized air channel test in accordance with GRI GM-6. The Construction Manager will conduct nondestructive testing of seams.

F. Destructive Seam Testing

1) Two types of samples shall be taken at each location, one for field tests and one for laboratory tests.

2) For the field tests, two seam samples, 1 inch wide by 12 in. long with the seam centered across the length shall be taken 42 in. apart. These sample coupons shall be removed by the Contractor's Installer for every 500 feet of seam length unless more frequent testing is required by the Construction Manager. Additional tests shall be taken at locations specified by the Construction Manager. The seams shall not be covered by another material before they have been tested by the Construction Manager and accepted by the Construction Manager.

3) Upon obtaining each sample, assign a number to the sample and mark it accordingly. Record sample location on the layout drawing. Record the purpose of the sample, statistical routine, or suspicious weld area.

4) These samples shall be tested in the field using a tensiometer capable of quantitatively measuring shear and peel strengths. Minimum acceptable test values for field geomembrane seams shall in accordance with paragraph 2.02 I.

5) Once the field tests have passed, a sample shall be recovered from between previously passing field sample locations for laboratory testing. The Construction Manager may adjust the size of the sample coupon based on field conditions. The sample coupon shall be divided into 3 equal parts: one part for laboratory testing, one part to the Construction Manager for archive storage, and one part to the Contractor. The sample coupon shall be tested in the testing laboratory for shear strength and peel adhesion. Minimum acceptable test values and testing methods for field geomembrane seams shall be in accordance with Paragraph 2.02 I.

G. Repair Procedures

1) Any portion of the geomembrane failing a destructive test, non-destructive test, or any damaged portion shall be repaired in accordance with this section and the manufacturer's recommendations.

2) All surfaces must be clean and dry at the time of the repair.

3) The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the Construction Manager. Approved methods from which the selected repair shall be chosen are as follows:

   a. Patching-used to repair large holes, tears, large panel defects, and destructive sample locations.

   b. Capping-used to repair failed welds or to cover seams where welds cannot be nondestructively tested.

   c. Removal-used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles) from the installed geomembrane.

4) If a sample fails one of the destructive tests the seam shall be reconstructed using one of the following methods:

   a. The seam shall be reconstructed between the location of the sample which failed and the location of the next acceptable sample.

   b. The welding path is retraced to an intermediate location at least ten (10) feet from the location of the failed sample and a second sample is taken for additional testing. If the second test sample passes, the seam shall then be reconstructed between the location of the second test and the original sampled location. If the second test fails, this process shall be repeated.

5) All acceptable seams shall lie between two (2) locations where samples passed the required test procedures and include one (1) test location along the reconstructed seam.

6) Each major repair requiring a patch or cap shall be identified on the "as-built" drawing.

7) Each repair shall be numbered and logged by the Installer. Each repair shall be nondestructively tested using methods described in this section. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 ft long may be sufficient to require destructive test sampling, at the discretion of the Construction Manager. Failed tests indicate that the repair shall be redone and retested until passing test results are achieved. The Construction Manager shall observe all nondestructive testing of repairs. The Installer shall record the number of each repair, the test location, date, and test outcome.

END OF SECTION

SECTION 02505

MINERAL AGGREGATE BASE COURSE

PART 1: GENERAL

1.01 DESCRIPTION

Section includes: Compaction and installation requirements of mineral aggregate base course for roads as a wearing surface, and #57 stone underneath leachate manholes.

1.02 RELATED WORK

Section 02211, Rough Grading.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM), Annual Book of Standards

1) ASTM D 698-91, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).

2) ASTM D 2216-92, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

3) ASTM D 2922-91, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4) ASTM D 3017-88, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

B. Tennessee Department of Transportation (TDOT), Standard Specifications for Road and Bridge Construction, 1981 edition.

C. American Association of State Highway and Transportation Officials (AASHTO). AASHTO M 43-88, Standard Specifications for Sizes of Aggregate for Road and Bridge Construction.

PART 2: PRODUCTS

2.01 MATERIALS

1) Mineral aggregate base course shall be used as a wearing surface for gravel roads. The mineral aggregate base course shall conform to Class "A", Grading "D", in accordance with TDOT, Subsection 903.05.

2) No. 57 stone used underneath leachate manholes shall be in accordance with AASHTO M 43, aggregate shall be Class "A" aggregate material in accordance with TDOT Subsection 903.05.

PART 3: EXECUTION

3.01 INSPECTION

A. Verify that grades and elevations are correct.

B. Verify that subgrade is not soft, spongy, or composed of otherwise unstable materials. If unstable materials are encountered, stop work and notify Construction Manager.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Method of construction and workmanship shall be in accordance with TDOT, Section 303.

B. Prepare subgrade according to Section 02211, Rough Grading.

C. Compact mineral aggregate base course to a minimum of 95% of maximum dry density at not less than 3% below nor more than 3% above the optimum moisture content as determined by ASTM D 698.

D. When additional base material is to be added to existing mineral aggregate base, scarify existing base to a depth of 3 in. Add new mineral aggregate base material and thoroughly mix with old material by blading and compaction continued as for new aggregate base.

3.03 FIELD QUALITY CONTROL

A. Testing

1) Compaction of mineral aggregate base to the specified moisture-density relationship of soils shall be verified by in-place density tests using ASTM D 2922 or other ASTM in-place density tests approved by the Construction Manager. Maximum density determination and in-place density tests shall be performed by the Construction Manager.

2) Testing for moisture content of mineral aggregate base shall be in accordance with ASTM D 2216 or D 3017. Testing will be performed by the Construction Manager.

3) In-place density/moisture testing shall be conducted after each layer is placed at a frequency of one test per 5,000 ft^2 of surface area of a compacted layer, with a minimum of two tests performed on each layer. The location of the density/moisture tests shall be selected randomly by the Construction Manager.

B. The top of the aggregate surface shall be a uniformly smooth grade surface without high or low points and shall not be more than 0.10 ft above or below specified grades. Bind thin layers of added materials to the material in place by scarifying and recompacting.

END OF SECTION

SECTION 02700

LEACHATE PIPING AND STORM DRAINS

PART 1: GENERAL

1.01 DESCRIPTION

Section includes: Materials for and installation of leachate piping system and culvert storm drains. Furnish all materials, perform all necessary excavation, and properly install at the location(s) indicated on the Construction Drawings, or as directed by the Construction Manager, all piping and drains for the proper completion of the work included.

1.02 RELATED WORK

A. Division 1.

B. Section 02225, Trenching.

1.03 DEFINITIONS OF TERMS

A. Leachate collection: The sections of the leachate piping system that are located within the leachate collection layer and terminate at the leachate manholes; consisting of both perforated and solid piping.

B. Leachate sewer: The section of the leachate piping system that connects the series of leachate manholes; consists of only solid piping.

1.04 QUALITY ASSURANCE

A. Furnish materials of quality required by American Society for Testing and Materials (ASTM) standards or other approved standards and specifications.

B. All pipes will be subject to inspection and approval by the Construction Manager after delivery. Any pipe that has been broken, cracked, or otherwise damaged before or after delivery or that has failed to meet required tests shall be removed from the work site and shall not be used therein.

1.05 REFERENCES

A. American Society for Testing and Materials (ASTM), Annual Book of Standards

1) ASTM C 32-93, Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale) (AASHTO-M 91.)

2) ASTM C 270-94, Standard Specification for Mortar for Unit Masonry.

3) ASTM C 478-94, Standard Specification for Precast Reinforced Concrete Manhole Sections.

4) ASTM C 990-92, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

5) ASTM D 2241-93, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

6) ASTM D 2729-93, Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

7) ASTM F 477-93, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

B. American Association of State Highways and Transportation Officials (AASHTO)

AASHTO M 36-90, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.

C. Tennessee Department of Transportation (TDOT), Standard Specifications for Road and Bridge Construction, 1981 edition.

D. American Water Works Association (AWWA):

ANSI/AWWA C500-93, AWWA Standard for Metal-Seated Gate Valves for Water Supply Service.

1.06 SUBMITTALS

Submit survey data in accordance with Article 1.08.

1.07 DELIVERY, STORAGE, AND HANDLING

Deliver piping and fittings to site in a clean and protected condition. Maintain end seals of pipe and remove only as necessary for cleaning, fabrication, erection, or inspection. Exercise care in handling and storage of piping materials and prefabrication so that contamination by moisture, grease, dirt, or injurious foreign matter does not occur.

1.08 PROJECT/SITE CONDITIONS

Survey leachate collection and leachate sewer piping before backfilling. Submit survey data in accordance with Division 1.

PART 2: PRODUCTS

2.01 MATERIALS

Pipe and fittings shall be new materials that have not been previously used.

A. Corrugated Metal Pipe

1) Culvert storm drains used in roadway construction shall be corrugated metal pipe in accordance with AASHTO M 36, and TDOT Subsections 607 and 915.02. Corrugated metal storm drain pipe shall

be galvanized, 14 gage thickness, of the size and type specified on the Construction Drawings, with rerolled "annular" ends.

2) Coupling bands shall be corrugated, galvanized steel bands in accordance with AASHTO M 36. Pipe sections shall be joined with annular corrugated connecting bands. The coupling bands shall be supplied with "o-ring" type gaskets in accordance with AASHTO M36.

B. PVC Pipe

1) Leachate collection, piping, leachate sewer piping, cleanouts, and temporary stormwater drain piping shall be PVC with integral wall bell and spigot joints. Pipe and fittings shall conform to ASTM D 2241, SDR 13.5. Joints shall be by means of a rubber ring within a coupling or bell, with provisions for expansion or contraction of each joint. Joints shall use rubber gaskets conforming to ASTM F 477.

2) The leachate collection pipe located within the landfill boundary shall be perforated in accordance with applicable sections of ASTM D 2927. Perforations shall consist of two (2) rows of equally spaced, 1/2 in. diameter holes on 5-in. centers. Rows and spaces shall be parallel to the axis of the pipe and shall be 120±5° apart. The spigot end, and bell of belled-end pipe may be unperforated for a length equal to the depth of the socket or shoulder, or both.

C. Field touch up coating for galvanized items shall be Z.R.C. cold galvanizing compound as manufactured by Z.R.C. Products Co., Quincy, MA; or equal as a minimum.

D. Leachate Manholes

1) Leachate manholes shall consist of precast reinforced concrete sections, and a base section conforming with the typical manhole details as shown on the Construction Drawings.

2) Precast manhole sections shall be manufactured, tested, and marked in accordance with ASTM C 478.

3) Ends of each reinforced concrete manhole riser section and bottom end of manhole top section shall be so formed that when manhole risers and top are assembled, they will make a continuous and uniform manhole.

4) Joints of manhole sections shall be of tongue and groove type. Sections shall be jointed by applying a preformed butyl joint sealant in accordance with ASTM C 990.

5) Each section of the precast manhole shall have not more than two holes for the purpose of handling and laying. These holes shall be tapered and shall be plugged with rubber stoppers or mortar after installation.

6) Brick used in manhole construction shall be either solid or cored, medium hard or better, Grade SM brick conforming to requirements of ASTM C 32 for sewer and manhole brick.

7) Mortar used in manhole construction shall conform to the requirements of ASTM C 270, Type M.

8) Bedding for manholes shall be No. 57 crushed stone in accordance with Section 02505, Mineral Aggregate Base Course.

E. Frames, Lids

1) Manhole frames and lids shall be of the size, type, and location as shown on the Construction Drawings.

F. Temporary, Stormwater Drain Pipe Plugs

Pipe plugs shall be mechanical-type manufactured for use with PVC pipe, and rated for 20 ft. minimum backpressure. Pipe plugs shall be Cherne Industries, Inc., or equal as a minimum.

G. Non-Shrink Grout

Grout used to plug stub-outs at existing leachate manholes shall be Masterflow 928 Grout, manufactured by Master Builders, Inc., or equal as a minimum.

H. Valves

Nonrising Stem (NRS) Gate Valves: ANSI/AWWA C500, 6 in. size, cast-iron double disc, bronze disc rings and seat rings, bronze stem, cast-iron or ductile-iron body and bonnet, cast-iron stuffing box, 2 in. square wrench nut, 150 psig working pressure, for use with iron pipe size (IPS) PVC plastic pipe. NRS gate valves to be Mueller Co. Catalog Number A-2380-37 or equal as a minimum.

F. Valve Boxes

1) Cast-iron box having top section and cover with lettering "SEWER", bottom section with base of size to fit over valve, barrel approximately 8 in. in diameter, and adjustable cast-iron extension of length required for depth of bury of valve. Boxes shall be rated for HS 20-44 traffic loading.

2) All gate valves shall be equipped with valve boxes.

PART 3: EXECUTION

3.01 INSPECTION

Before backfilling, inspect to make sure that the pipe lies evenly on the bottom of the trench, that no debris is present, and that as-built surveying is complete where required.

3.02 INSTALLATION/APPLICATION/ERECTION

A. General

1) Detailed requirements for trenching and backfilling shall be in accordance with Section 02225, Trenching.

2) Each piece of pipe shall be carefully inspected before it is placed and no defective pipe shall be laid in trench. Trench bottoms found to be unsuitable for foundations after pipe laying operations have started shall be corrected and brought to exact line and grade with approved bedding materials.

3) Pipe shall be furnished in the sizes and types and at the location specified on the Construction Drawings.

4) Any pipe that is not in true alignment or that shows any settlement after being laid shall be taken up and relaid at the Contractor's expense.

5) Water shall not be allowed to run or stand in trench while pipe laying is in progress, before the joints are completely set, or before trench has been backfilled. Where pipelines are located in or across stream beds or drainage ditches, the Contractor shall divert stream flow and dewater each section as work progresses.

6) As work progresses, the interior of all pipe shall be kept clean. After each length of pipe has been laid, all earth, trash, rags, and other foreign matter shall be removed from the interior.

7) Backfilling of trenches shall be started immediately after the pipe in place has been inspected and approved by the Construction Manager. Backfill shall be deposited and compacted as provided under Section 02225, Trenching.

B. Corrugated Metal Pipe

1) Jointing of corrugated metal pipes shall be with coupling bands installed according to the pipe manufacturer's recommendation.

2) Prior to laying corrugated metal pipe, coat areas where the galvanizing finish has been removed or damaged with a zinc-enriched paint.

C. Leachate Collection Piping, Leachate Sewer Piping, Cleanouts, and Temporary Stormwater Drain Piping

1) Bell holes shall be of sufficient size to allow ample room for properly making pipe joints. Bell holes shall not be cut out more than ten joints ahead of pipe laying. The bottom of the trench between bell holes shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length as shown on the Construction Drawings. All adjustments to line and grade must be made by scraping away or filling in under the barrel of the pipe and not by wedging or blocking up any portion of the pipe. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe in order to avoid sudden offsets or inequalities in flow line.

2) The transition between perforated and solid leachate collection pipes are located as shown on the Construction Drawings.

3) Bending of leachate piping shall be in accordance, with the manufacturer's recommendations. Pipe shall be bent to the minimum radius recommended by the manufacturer for the kind, type, grade, wall thickness, and diameter of pipe. Otherwise, changes in direction shall be made using suitable fittings.

4) Perforated leachate collection pipe shall be installed so that the two rows of perforations are oriented at the bottom of pipe.

5) Install temporary storm drain pipe plugs at locations shown on the Construction Drawings, and in accordance with the manufacturer's installation instructions.

D. Leachate Manholes

After installation of pipe to proper grade and alignment, grout around annular space between pipe and manhole to prevent leakage and form a neat connection.

E. Existing Stub-outs

1) Plug existing stub-outs at locations shown on the Construction Drawings.

2) The stub-outs shall be plugged by pumping non-shrink grout into the stub-outs from inside of existing manholes. The grout shall completely fill the stub-outs to prevent infiltration into, or exfiltration out of the manhole.

3) Grout shall be mixed in accordance with the manufacturer's recommendations for the designated application.

4) Health and safety requirements for access into existing manholes shall be in accordance with Division 1.

F. Existing area inlet 3, and existing leachate manhole (MH4) shall be modified to accept the new leachate pipe at the locations and elevations shown on the Construction Drawings. Carefully remove backfill from the side of the area inlets and manhole to expose the area of work. Penetrate the side wall by coring or carefully chipping. The size of the opening shall be kept to the minimum required to accept pipe. Insert pipe such that the end of the pipe is approximately 2 in. beyond the inside face of wall. Fill annular space between wall and pipe with grout to provide watertight seal. Replace backfill as specified for new manholes and restore area to previously existing grades.

G. Installation of Valves

1) Install buried valves with stem pointing up and with cast-iron valve box as shown on the Construction Drawings. Valves shall be set plumb with operating nut aligned with top centerline of pipe. The valve box shall be centered over the operating nut. Backfill around valves shall be carefully tamped in 6-inch layers for full depth of trench with valve box in place.

2) Valve boxes shall be adjusted so that hub and cover are flush with finish grade.

3.04 FIELD QUALITY CONTROL

A. The alignment of each run of leachate piping and storm drain piping shall be visually inspected.

B. Prior to erection, the inside of all pipe shall be cleaned of dirt and foreign materials. After installation but prior to backfilling, all storm lines shall be cleaned free of foreign deposits and inspected for broken or cracked pipe and fittings. All defective pipes or workmanship shall be replaced.

END OF SECTION

SECTION 02936

SEEDING

PART 1: GENERAL

1.01 DESCRIPTION

Section includes: Seeding, mulching, fertilizing, and liming.

1.02 RELATED SECTIONS

Section 02270, Slope Protection and Erosion Control.

1.03 DEFINITION OF TERMS

A. Dry Seeding: Dry broadcast seeding by spreader or seeding machine.

B. Hydroseeding: Wet hydraulic spraying of seed, fertilizer, and mulch, if applicable, in a one-step process.

1.04 QUALITY ASSURANCE

Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.05 REFERENCES

Tennessee Department of Transportation (TDOT), Standard Specifications for Road and Bridge Construction, 1981 edition.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2: PRODUCTS

2.01 MATERIALS

A. Seed Mixture

1) Seed Mixture: Percentages forming group shall be as set out below.

Seed	Quantity% by Weight	Seeding Dates
Group A		
Kentucky 31 Fescue	85	Feb. 1–July 1
English Rye	15	
Group B		
Kentucky 31 Fescue	75	June 1–Aug. 15
English Rye	25	
Group C		
Kentucky 31 Fescue	70	Aug 1–Dec. 1
English Rye	20	
White Clover	10	

B. Straw Mulch: Dry oat or wheat straw, free from weeds, foreign matter detrimental to plant life. Hay or chopped cornstalks are not acceptable. All straw mulch materials shall be air dried and reasonably free of noxious weeds and weed seeds or other materials detrimental to plant growth. Straw shall be suitable for spreading with standard mulch blower equipment.

C. Fiber mulch: Mulch for hydroseeding shall be a specially processed 100% virgin wood fiber mulch containing no growth or germination-inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the wood fiber shall be marked by the manufacturer to show the air dry weight content and not contain in excess of 10% moisture.

D. Fertilizer: Standard commercial fertilizer conforming to requirements of TDOT Specification, Subsection 918.15 with guarantee of analysis conforming to a 6-12-12 formula. Fertilizer shall be uniform in composition, free flowing, and suitable for application with approved equipment.

E. Water: Clean, fresh, and free of substances or matter which could inhibit vigorous growth of grass.

F. Excelsior Matting: Shall be in accordance with Section 02270, Slope Protection and Erosion Control.

PART 3: EXECUTION

3.01 INSPECTION

Verify that earth surface is ready to receive work of this section and that final dressing is within reasonably close conformity to lines, grades, and cross-sections.

3.02 INSTALLATION/APPLICATION/ERECTION

A. All areas not within the limits of the landfill boundary, including the temporary cut slopes between the phased construction, shall be stabilized by an application of fertilizer, seed, and mulch.

B. Fertilizing

1) Apply commercial Grade 6-12-12 fertilizer at a rate of not less than 20 lb/1000 ft^2.

2) Apply after smooth raking of earth surface.

3) Uniformly incorporate into soil for a depth of approximately 1/2 in.

4) Lightly water to aid the dissipation of fertilizer.

C. Seeding and Mulching

1) General

a. Seeding mixture shall be based upon the seeding date in accordance with Paragraph 2.01A, as determined by the weather and as accepted by the Construction Manager.

b. Seeding shall not occur from December 1 through February 1.

c. Seeding shall be done within 10 days following soil preparation. Seed may be applied hydraulically or by dry broadcasting.

d. Do not sow or mulch immediately following rain, or during windy periods.

e. Mulch is not required on areas to receive excelsior matting.

2) Dry Seeding

a. Apply seed at a rate of 3 lb/1000 ft^2 evenly in two intersecting directions. Rake in lightly. Do not seed area in excess of that which can be mulched on same day.

b. Immediately following seeding, apply straw mulch at a rate of 100 lb/1000 ft^2. Maintain clear of shrubs and trees.

c. Apply water with a fine spray immediately after each area has received straw mulch. Saturate to 2 in. of soil.

3) Hydroseeding

a. Apply seeded slurry at a rate of 3 lb/1000 ft^2 evenly in two intersecting directions with a hydraulic seeder. If straw mulch or excelsior matting is used, do not hydroseed area in excess of that which can be mulched or matted on same day.

b. Fiber mulch shall be applied hydraulically at a rate of 35 lb/1000 ft^2 with the seed and fertilizer.

c. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed and fiber mulch shall be equal in quantity to the specified rates.

D. Excelsior Matting

Place and secure excelsior matting in accordance with requirements of Section 02270, Slope Protection and Erosion Control.

3.03 MAINTENANCE

A. Maintain newly graded and seeded areas until final acceptance. Restore areas showing settlement or washes to specified grades at Contractor's expense. Newly seeded areas shall be watered as necessary at the Contractor's expense to prevent grass and soil from drying out.

B. Protect seeded areas with warning signs during maintenance period.

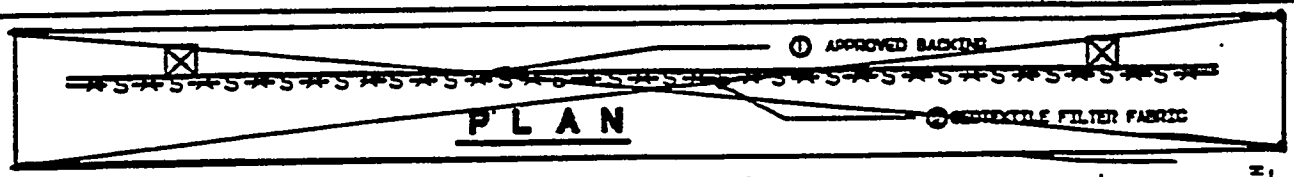
END OF SECTION

ENGINEERING STANDARD

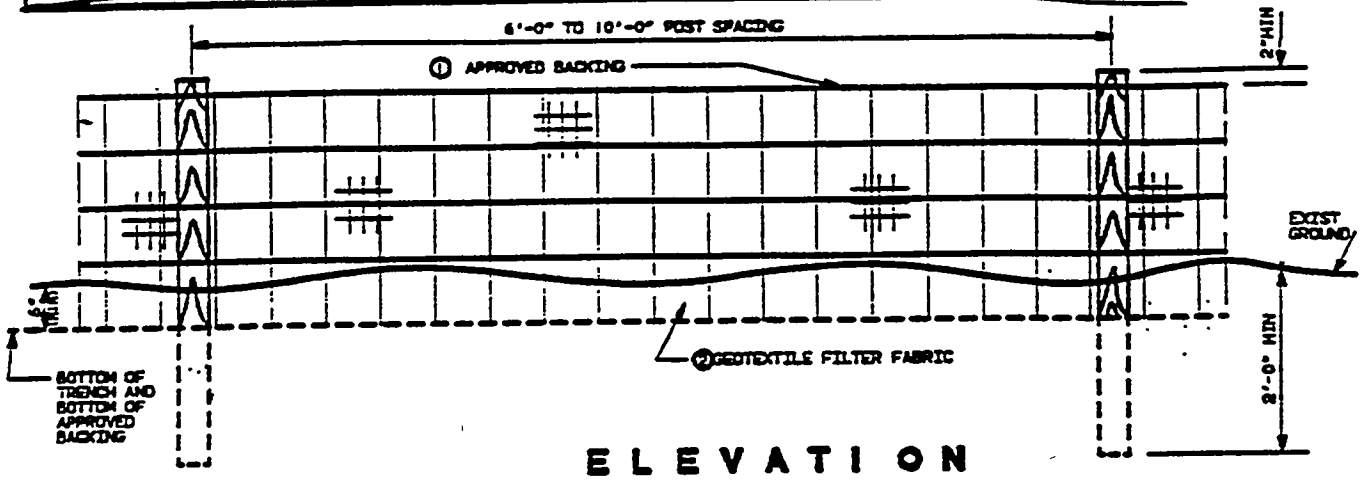
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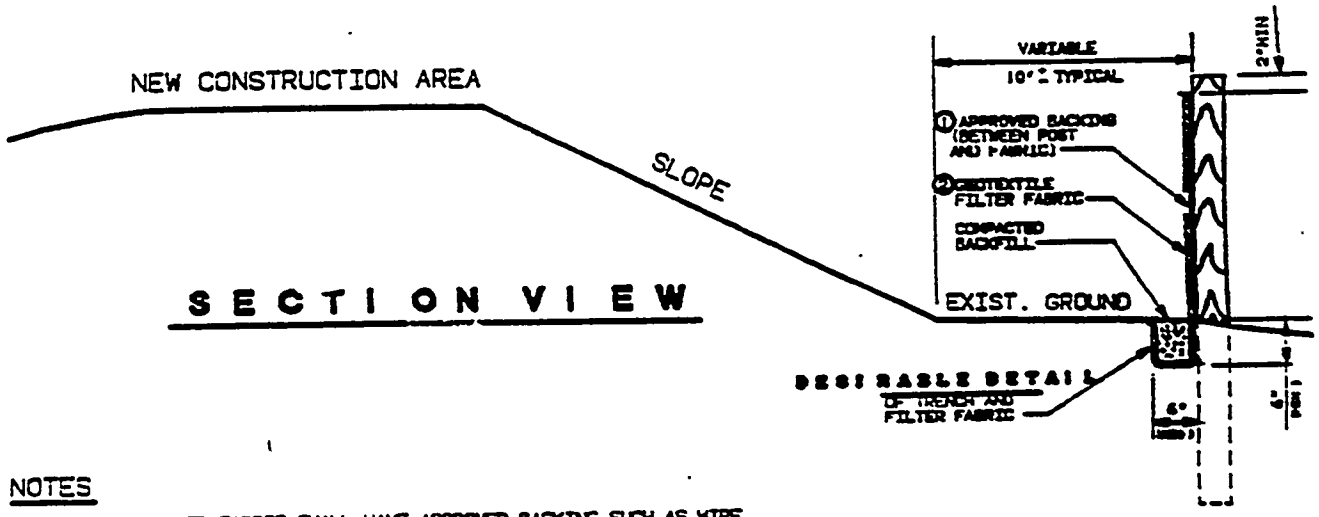
TEMPORARY SILT FENCE



PLAN

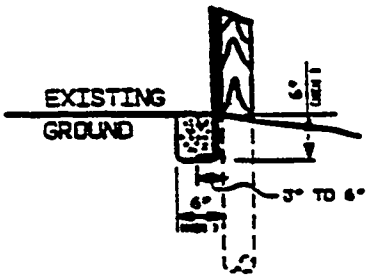


ELEVATION



SECTION VIEW

DESIRABLE DETAIL OF TRENCH AND FILTER FABRIC



ALTERNATE DETAIL OF TRENCH AND FILTER FABRIC

NOTES

① GEOTEXTILE FILTER FABRIC SHALL HAVE APPROVED BACKING SUCH AS WIRE MESH FENCE, OR A REINFORCED STRUCTURE AS RECOMMENDED BY THE MANUFACTURER TO SUPPORT THE FILTER FABRIC. WIRE FENCE SHALL BE LIVESTOCK TYPE WIRE, AT LEAST 14-GAGE, ~~A MINIMUM OF 30 INCHES IN HEIGHT~~, AND HAVE A MAXIMUM SPACING OF 6 INCHES.

② GEOTEXTILE FILTER FABRIC SHALL MEET THE REQUIREMENTS OF FABRIC MANUFACTURED FOR THE SPECIFIC PURPOSE OF SILT CONTROL.

~~③ ACCEPTABLE SILT FENCE FABRICS INCLUDE MIRAFI 100X AND~~

④ A PREASSEMBLED SILT FENCE MEETING THE REQUIREMENTS OF THIS DRAWING IS ACCEPTABLE IN LIEU OF A FIELD CONSTRUCTED SILT FENCE.

⑤ SILT FENCE SHALL BE MAINTAINED IN A SATISFACTORY CONDITION FOR THE DURATION OF THE PROJECT.

APPROVED BY

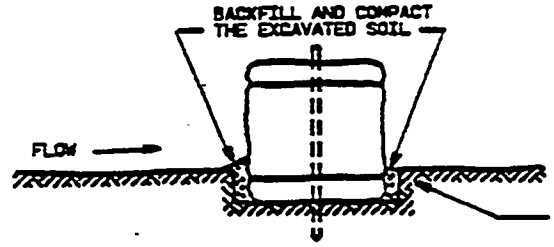
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ENGINEERING STANDARD

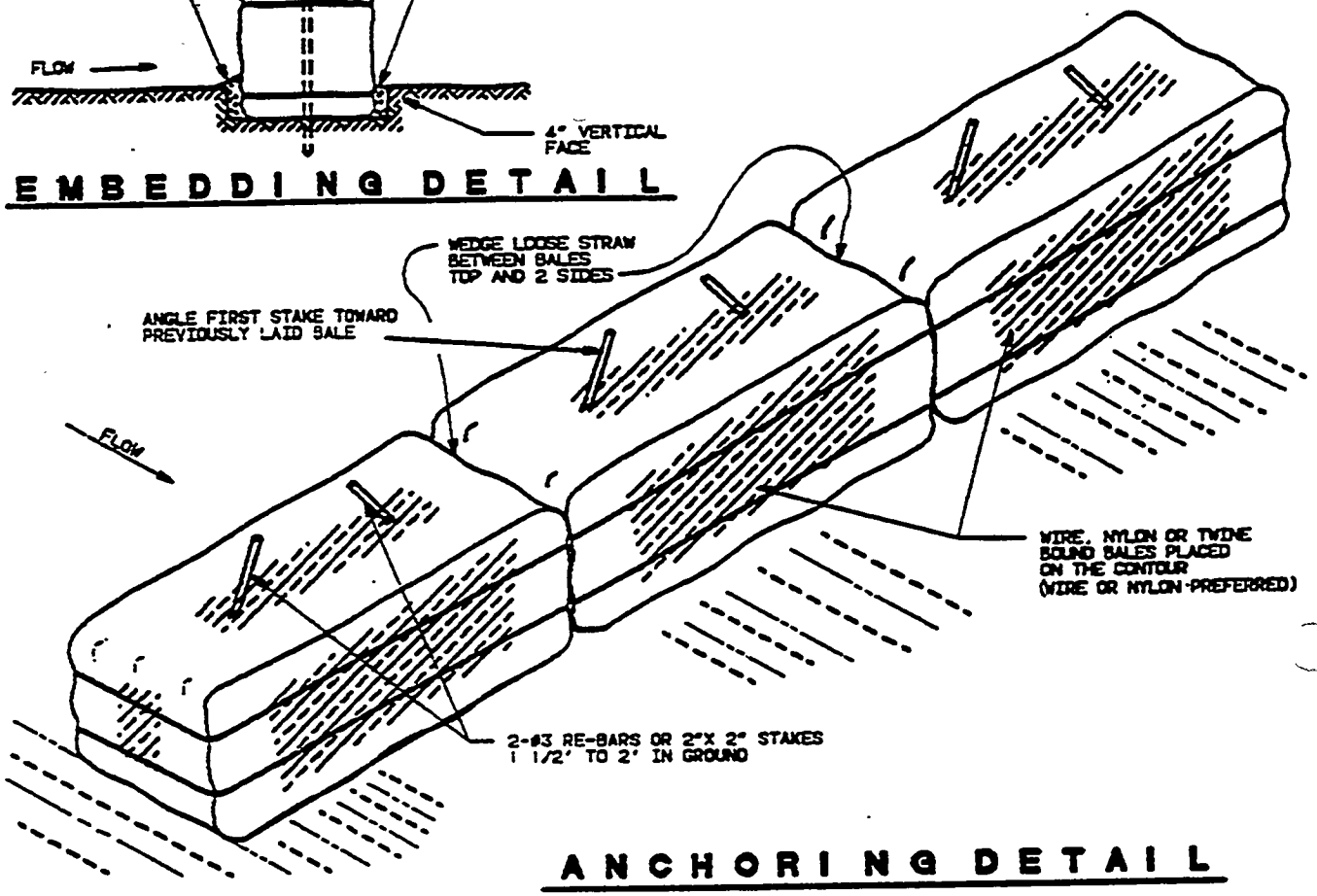
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STRAW BALE BARRIERS



EMBEDDING DETAIL



ANCHORING DETAIL

CONSTRUCTION SPECIFICATIONS

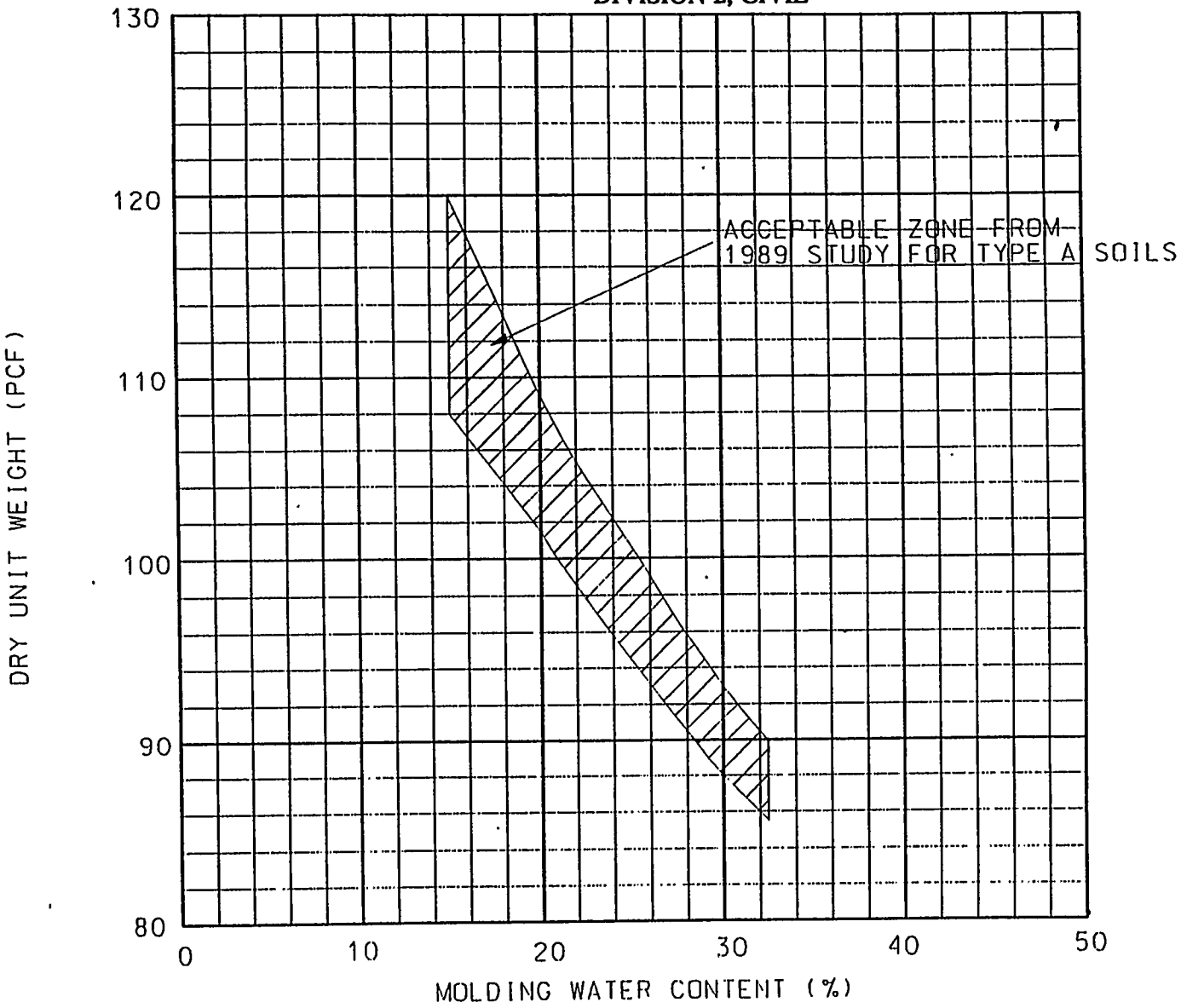
1. BALES SHALL BE PLACED IN A ROW WITH ENDS TIGHTLY ABUTTING ADJACENT BALES.
2. EACH BALE SHALL BE EMBEDDED IN THE SOIL A MINIMUM OF 4".
3. BALES SHALL BE SECURELY ANCHORED IN PLACE BY STAKES OR RE-BARS DRIVEN THROUGH THE BALES, THE FIRST STAKE IN EACH BALE SHALL BE ANGLED TOWARD PREVIOUSLY LAID BALE TO FORCE BALES TOGETHER.
4. TRENCH ON EACH SIDE OF BALES SHALL BE BACKFILLED AND COMPACTED WITH THE EXCAVATED SOIL TO PREVENT PIPING.
5. INSPECTION SHALL BE FREQUENT AND REPAIR OR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
6. BALES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFULNESS SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.

~~STANDARD SYMBOL~~ ~~SBB~~

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ATTACHMENT A: MOISTURE-DENSIT -ERMEABILITY ACCEPTABLE ZONE

DIVISION 2, CIVIL



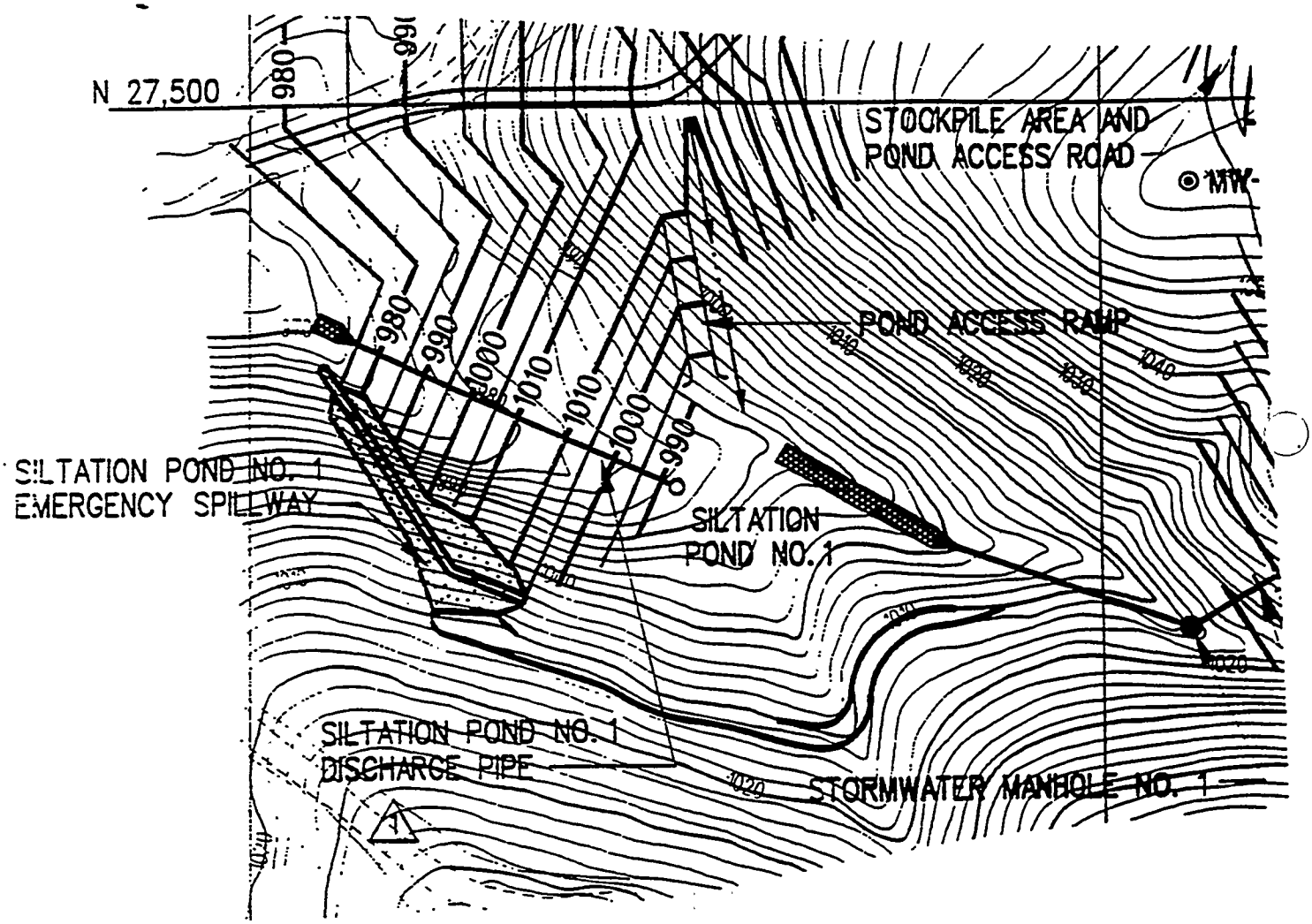
WATER CONTENT- DRY UNIT WEIGHTS THAT PRODUCED RANGES OF HYDRAULIC CONDUCTIVITY

REFERENCE - RESULTS OF HYDRAULIC CONDUCTIVITY TESTS AND RECOMMENDED WATER CONTENT-DRY DENSITY CRITERIA FOR POTENTIAL BORROW SOILS.

PREPARED BY- DAVID E. DANIEL ,OCTOBER 12, 1992

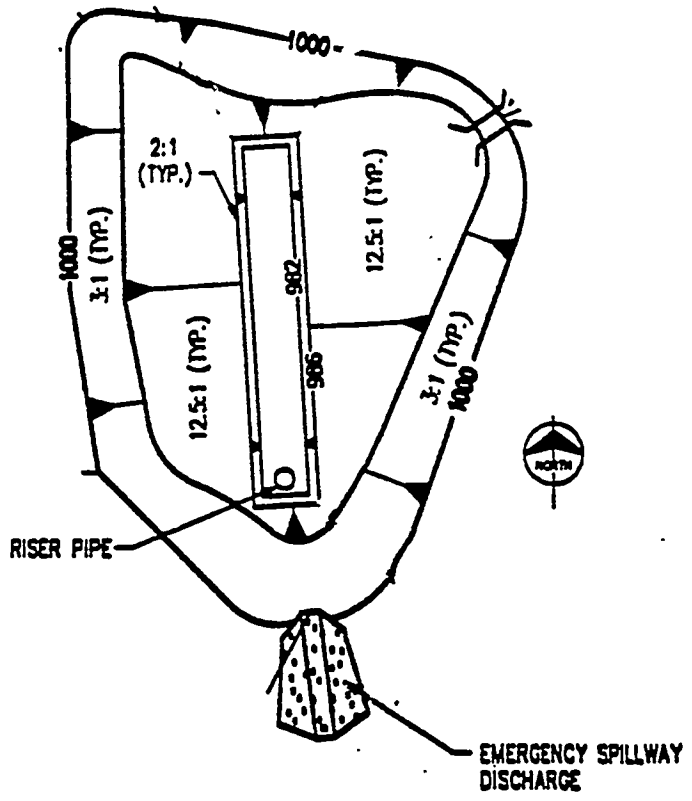
APPENDIX B

SILTATION POND SILT REMOVAL



APPENDIX B

SILTATION POND SILT REMOVAL



SILT POND NO. 2
NOT TO SCALE

ATTACHMENT C: CPRS, INSPECTIONS

DIVISION 2, CIVIL

DESCRIPTION OF ITEM TO BE INSPECTED	REQUIRED INSPECTION	CONSTRUCTION SPECIFICATION SECTION	INSPECTION TO BE PERFORMED BY	WITNESS(es) OF INSPECTION	RED	SEPARATE DOC REC'D	
						YES	NO
Plant life & features to remain	Tag and/or identify	02210	Contractor and Construction Manager	Title III	N/A		X
Subgrade	Stability	02211	Contractor	Title III	N/A		X
Fill area	Free of debris	02211	Contractor	Title III	N/A		X
Subgrade, Prot. cover, clay liner, drainage layer	Surface tolerance	02211	Contractor	Title III	N/A		X
Clay soil liner	Soil placement	02211	Construction Manager	Title III	N/A		X
Backfill materials	Acceptable	02225	Contractor	Title III	N/A		X
Backfill areas	Free of debris	02225	Contractor	Title III	N/A		X
Subgrade	Surface Tolerance	02225	Contractor	Title III	N/A		X
Silt fence	Maintenance	02270	Contractor	Title III	N/A		X
Straw Bale Barriers	Maintenance	02270	Contractor	Title III	N/A		X
Diversion swales	Maintenance	02270	Contractor	Title III	N/A		X
Subgrade	Grades/elevations	02276	Contractor	Title III	N/A		X
Subgrade	Stability	02276	Contractor	Title III	N/A		X
Geomembrane	Damage and delivery	02280	Construction Manager	Title III	N/A		X
Geomembrane	Imperfections	02280	Construction Manager	Title III	N/A		X
CPRS, INSPECTIONS AND INDIVIDUAL INSPECTIONS ACCEPTED:				DISTRIBUTION		RC, No RC	
TITLE III REP:		DATE:					
RED:		DATE:					

ATTACHMENT C: CPRS, INSPECTIONS

DIVISION 2, CIVIL

DESCRIPTION OF ITEM TO BE INSPECTED	REQUIRED INSPECTION	CONSTRUCTION SPECIFICATION SECTION	INSPECTION TO BE PERFORMED BY	WITNESS(es) OF INSPECTION	RED	SEPARATE DOC REC'D	
						YES	NO
Geomembrane	Seams	02280	Construction and Facilities Manager	Title III	N/A	X	
Geomembrane	Material inspection factory seams	02280	Manufacturer	N/A	N/A	X	
Subgrade	Grades/elevations	02505	Contractor	Title III	N/A		X
Subgrade	Stability	02505	Contractor	Title III	N/A		X
Subgrade	Surface Tolerance	02505	Contractor	Title III	N/A		X
Piping	Damaged material	02700	Construction Manager	Title III	N/A		X
In-place piping	Lies evenly, no debris	02700	Contractor	Title III	N/A		X
In-place piping	Alignment	02700	Contractor	Title III	N/A		X
In-place piping	Damaged material	02700	Contractor	Title III	N/A		X
Earth Surface	To grade	02936	Contractor	Title III	N/A		X

CPRS, INSPECTIONS AND INDIVIDUAL INSPECTIONS ACCEPTED:		DISTRIBUTION	RC, No RC
TITLE III REP:	DATE:		
RED:	DATE:		

ATTACHMENT D: CPRS, TESTS

DIVISION 2, CIVIL

DESCRIPTION OF ITEM TO BE TESTED	CAT. OF TEST	TYPE OF TEST	CONSTRUCTION SPECIFICATION SECTION	TEST NO.	TEST TO BE PERFORMED BY	WITNESS(es) OF TEST
Clay soil liner subgrade	CA	Proofroll	02211	N/A	Contractor	Title III
Fill and backfill inside landfill boundary	Construction Acceptance (CA)	Compaction	02211	N/A	Construction Manager	Title III
		Moisture	02211			
Fill and backfill outside of landfill boundary	CA	Compaction	02211	N/A	Construction Manager	Title III
		Moisture	02211			
Clay soil liner	CA	Permeability	02211	N/A	Construction Manager	Title III
Leachate collection layer	CA	Gradation	02211	N/A	Contractor	N/A
		Permeability	02211			
Leachate collection layer	CA	Gradation	02211	N/A	Construction Manager	Title III
Fill and backfill	CA	Compaction	02225	N/A	Construction Manager	Title III
		Moisture	02225			
Geomembrane	Technical Performance (TP)	Shear Test	02280	N/A	Contractor	—
Geomembrane	CA	Nondestructive	02280	N/A	Construction Manager	Title III
Geomembrane	CA	Destructive	02280	N/A	Construction Manager	Title III
Geomembrane	CA	Field Tensiometer	02280	N/A	Contractor	Title III
Mineral aggregate base	CA	Compaction	02505	N/A	Construction Manager	Title III
		Moisture	02505			

CPRS, TESTS AND INDIVIDUAL TESTS ACCEPTED:		DISTRIBUTION	RC, No RC
RED:	DATE:		
PE IF REQUIRED:	DATE:		

ATTACHMENT E: CPRS, SUBMITTALS

DIVISION 2, CIVIL

DESCRIPTION OF ITEM REQUIRING SUBMITTAL	TYPE AND/OR NATURE OF SUBMITTAL	CONSTRUCTION SPECIFICATION SECTION	SUBMITTAL TO BE PERFORMED BY	REQUIRED DISPOSITION	RECORD COPY	
					YES	NO
Compacted clay soil liner subgrade	Completion Notification	02211	Contractor	Monitor		X
Compacted clay soil liner	Completion Notification	02211	Contractor	Monitor		X
Granular drainage layer	Completion Notification	02211	Contractor	Monitor		X
Crushed aggregate material	Material certification	02211	Contractor	Approval	X	
Machinery for tilling	Physical/Operation info	02211	Contractor	Review		X
Plan for Prevention of Water Ponding	Written Plan	02211	Contractor	Approval	X	
Silt fence	Manufacturer's data	02270	Contractor	Approval		X
Geosynthetics	Material certification	02276	Contractor	Approval	X	
Geosynthetics	Shop Drawing	02276	Contractor	Approval	X	
Piping	Location survey	02700	Contractor	Review	X	
Geomembrane & Protection Geotextile	Material Sample	02280	Contractor	Approval	X	
Geomembrane & Protection Geotextile	Friction Test Results	02280	Contractor	Approval	X	
Geomembrane & Protection Geotextile	Lab Accreditation/ Qualifications	02280	Contractor	Approval	X	

CPRS, SUBMITTALS AND INDIVIDUAL SUBMITTALS ACCEPTED:		DISTRIBUTION
TITLE III REP:	DATE:	
RED:	DATE:	

ATTACHMENT E: CPRS, SUBMITTALS

DIVISION 2, CIVIL

DESCRIPTION OF ITEM REQUIRING SUBMITTAL	TYPE AND/OR NATURE OF SUBMITTAL	CONSTRUCTION SPECIFICATION SECTION	SUBMITTAL TO BE PERFORMED BY	REQUIRED DISPOSITION	RECORD COPY	
					YES	NO
Geomembrane	Material certification	02280	Contractor	Approval	X	
Geomembrane resin	Material certification	02280	Contractor	Approval	X	
Geomembrane	Shop drawings	02280	Contractor	Approval	X	
Geomembrane installer	Experience	02280	Contractor	Approval	X	
Geomembrane placement	As-built drawings	02280	Contractor	Review	X	
Geomembrane seams	Inspection/testing data	02280	Contractor	Approval	X	
Geomembrane	Installation schedule	02280	Contractor	Approval		X
Geomembrane	Guarantee	02280	Contractor	Review	X	
Geomembrane	Manufacturer's testing results	02280	Contractor	Approval	X	
Leachate collection piping	Survey data	02700	Contractor	Approval	X	

CPRS, SUBMITTALS AND INDIVIDUAL SUBMITTALS ACCEPTED:		DISTRIBUTION
TITLE III REP:	DATE:	
RED:	DATE:	
RED:	DATE:	
RED:	DATE:	

Y/WM-089/R3

DESIGN AND OPERATING PROCEDURE

FOR THE

OAK RIDGE Y-12 PLANT
INDUSTRIAL LANDFILL V

November 1995

Prepared for

U.S. Department of Energy
Oak Ridge Operations

Prepared by

Foster Wheeler Environmental Corporation
111 Union Valley Road
Oak Ridge, Tennessee 37830

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ACRONYMS

ASTM	American Society for Testing Materials
AVLIS	Atomic Vapor Laser Isotope Separation
BGS	below ground surface
BMP	Best Management Practices
CDL-VII	Y-12 Construction/Demolition Landfill VII
C/D waste	construction/demolition waste and spoil
CFR	Code of Federal Regulations
CQA	Construction Quality Assurance
CYRTF	Coal Yard Runoff Treatment Facility
CY	calendar year
DOE	U.S. Department of Energy
DSWM	Division of Solid Waste Management[1]
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency
HELP	Hydrogeologic Evaluation of Landfill Performance
HSEA	Y-12 Health, Safety, Environment, and Accountability
ILF-V	Y-12 Industrial Landfill V
K-25	Oak Ridge K-25 Site (formerly Oak Ridge Gaseous Diffusion Plant)
MSL	mean sea level
MSW	municipal solid waste
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NMOC	nonmethane organic compound
NOEC	No Observed Effect Concentration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
ORGDP	Oak Ridge Gaseous Diffusion Plant (now referred to as the K-25 Site)
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
SPWTF	Steam Plant Wastewater Treatment Facility
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation (formerly TDHE)
TDHE	Tennessee Department of Health and Environment
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
USCS	Unified Soil Classification System
VOCs	volatile organic compounds
WDS	waste disposal site

ACRONYMS

WMD	Waste Management Division
WTLO	Waste Transportation and Landfill Operations
Y-12	Oak Ridge Y-12 Plant

1.0 BACKGROUND

The U.S Department of Energy (DOE) has three major operating facilities on the DOE Oak Ridge Reservation (ORR) at Oak Ridge, Tennessee: the Y-12 Plant, the K-25 Site, and the Oak Ridge National Laboratory (ORNL). All facilities are managed by Lockheed Martin Energy Systems, Inc. for DOE. Operations associated with the DOE energy research and production facilities at Oak Ridge result in the production of several types of waste materials. Disposal of solid waste (as defined in the Solid Waste Processing and Disposal Rules for Tennessee) in disposal facilities operated by the Y-12 Plant is the responsibility of the Y-12 Waste Management Division (WMD).

This manual describes the site conditions, design, physical operation, administrative operation, and closure/post closure for the industrial solid waste disposal unit. This disposal unit is referred to as the Y-12 Industrial Landfill V (ILF-V) and is currently being operated by the Y-12 Plant for DOE. The drawings referred to in this manual are listed in Appendix A. This is a Class II Landfill permitted by the Tennessee Department of Environment and Conservation/Division of Solid Waste Management (TDEC/DSWM[1]). This Design and Operation Procedure is being revised to incorporate proposed modifications to the type of liner to be constructed for this facility, as well as modifications to the final cover. These modifications are required by TDEC regulations.

The WMD is proposing to develop ILF-V to encompass future waste disposal activities in accordance with the approved permit. The approved permit was issued on April 26, 1993, and was modified by TDEC/DSWM on September 28, 1993. The permit was approved for a total area of approximately 25.9 acres. DOE has developed Area 1 of this landfill, which encompasses approximately 5 acres. Area 1 was permitted as a Class II landfill by TDEC/DSWM and is constructed with a 3-ft-thick compacted low permeable clay liner, overlain with a 1-ft-thick granular drainage layer, which is overlain by a 1-ft-thick protective soil cover. A geotextile was placed above and below the granular drainage layer.

Development of Areas 2 through 5 will proceed in accordance with the approved permit. Due to regulatory changes enacted since the permit was approved, future landfill development will require that the liner be constructed with a composite liner consisting of 2 ft of compacted low permeable clay and a geomembrane (flexible membrane liner). This design modification for future liner construction will necessitate that the cap design utilized for Area 1 (a 2-ft-thick low permeable clay layer, geonet drainage layer, and vegetative layer with a variable thickness) be modified for future development as well. The landfill cap design for Areas 2 through 5 will consist of the following layers (from bottom to top): a composite geonet gas vent layer; a 6-in. sacrificial soil layer (to protect the gas vent layer from damage from clay layer compaction); a 2-ft-thick low permeable clay layer with a geomembrane; a composite geonet drainage layer; and a 1.5-ft-thick vegetative layer.

[1] DSWM was formerly under the Tennessee Department of Health and Environment (TDHE). It is now under TDEC.

1.1 Location

The DOE ORR is located in Anderson and Roane Counties, approximately 24 miles west of the city of Knoxville. The Tennessee Valley Authority's Melton Hill and Watts Bar Reservoirs on the Clinch River form the southern and western boundaries of the reservation, and the city of Oak Ridge forms the northern boundary. The ILF-V site is located on Clear Spring Road, which is approximately 1.8 miles west of the intersection of New Bethel Valley Road and State Highway 62.

The ILF-V site is located in the Lovell Quadrangle (138-NW) at approximate latitude 35°58′54″ and approximate longitude 84°14′51″. This location is in Anderson County on East Chestnut Ridge, approximately ½ mile south of the Y-12 Plant. The site is bounded on the east by the Y-12 Construction/Demolition Landfill VII (CDL-VII) and on the north, west, and south by a forested watershed that is a tributary to the Melton Hill Reservoir.

1.2 Facilities Served

The facilities to be served by ILF-V include the Y-12 Plant, the K-25 Site, and ORNL. In addition, the landfill will serve other prime contractors for DOE, as well as DOE subcontractors, in Oak Ridge.

The Y-12 Plant serves as a key manufacturing technology center for the development and demonstration of unique materials, components, and services of importance to DOE and the nation. This is accomplished through the reclamation and storage of nuclear materials, manufacture of nuclear materials, manufacture of components for the nation's defense capabilities, support to national security programs, and services provided to other customers as approved by DOE.

The original mission of the K-25 Site was the production of uranium hexafluoride enriched in the uranium-235 isotope in support of the U.S. Nuclear Power and Weapons Program. The gaseous diffusion activities were placed on standby in 1985 and were shut down in 1987. The present mission is multipurpose with major programmatic mission areas as follows:

- environmental restoration programs, including remedial actions of solid waste management units, surveillance and maintenance of the shutdown facilities, and hazardous materials management and disposal of the regulated materials still residing in the shutdown facilities;
- waste management programs, which include the development and demonstration of waste treatment technologies and the construction and operation of low-level waste treatment and disposal facilities for the ORR;
- development activities associated with design and construction of the new low-level waste disposal facilities for the ORR;
- applied technology program, which includes the application of research and development capabilities, technologies, expertise, and facilities to solve problems of national importance for DOE and other federal agencies; and

- technical support for uranium enrichment, which includes development and demonstration support for the Atomic Vapor Laser Isotope Separation (AVLIS) program and the protection and transfer of surplus equipment to the operating gaseous diffusion plants.

ORNL is a large, multipurpose research laboratory, whose basic mission is the discovery of new knowledge, both basic and applied, in all areas related to energy. To accomplish this mission, the laboratory conducts research in all fields of modern science and technology. ORNL's facilities consist of nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities.

Some work at the DOE ORR is accomplished by contractors other than the operating contractor, Energy Systems. These contractors perform work at various locations on the ORR under the cognizance of Energy Systems; DOE; and/or MK-Ferguson of Oak Ridge Company, the DOE prime construction management contractor. Contractors are made aware of waste disposal requirements as part of the project specifications or bid package. When a contractor begins a project, MK-Ferguson works with the contractor in understanding the waste/spoil disposal requirements for the respective site/plant. The contractor works to the same disposal and random inspection procedures as those pertaining to normal site facilities.

2.0 GENERAL GEOLOGY

The ORR is in the Valley and Ridge Physiographic Province of the Southern Appalachians. The region is characterized by many elongated ridges and intervening valleys trending in a general northeast-southwest direction. The ridges and valleys were formed as a result of folding and faulting caused by the Allegheny Orogeny some 230–300 million years ago during the late Paleozoic Era. Ridges within the Province range in elevation from 1495 ft elevation above mean sea level (MSL) at White Oak Mountain near Chattanooga to 3097 ft MSL at Bays Mountain near Kingsport. The elevation of the valley floors in the region range from approximately 750 ft MSL to 1000 ft MSL.

Stream courses in the Valley and Ridge Province are closely related to the structure and composition of the bedrock. Generally, resistant sandstone and/or dolomite beds form the tops of the ridges, while less resistant strata, such as weaker dolomites or shale formations, are found beneath the side slopes of these ridges or the valley floors. Weathered and solutioned carbonate rocks ("karst" terrain) generally form the valleys in the Province and contain most of the smaller streams that are in these northeast-southwest trending valleys. Variations from the general descriptions given above occur. Less resistant carbonate units may underlie the dip slopes of ridges in the vicinity of the Y-12 Plant. In addition, karst units do not always form valleys.

The facility site is underlain by Cambro-Ordovician age rocks (deposited 475–525 million years ago) of the Knox Group. Specifically, these rock units include the Copper Ridge Dolomite of the Upper Cambrian System and the Chepultepec Dolomite, the Longview Dolomite, and the Newala Formation of the Lower Ordovician System. The Chepultepec, Longview, and Newala units are described in the published geologic literature as light gray to gray, fine-grained, well-bedded, cherty dolomite. The Copper Ridge

is described as coarse, dark gray dolomite with abundant chert. Along Chestnut Ridge, these bedrock units generally dip between 20° to 50° toward the southeast.

Differential weathering of the bedrock surface has occurred due to the soluble nature of the carbonate fraction of the bedrock units. In extreme cases, this differential weathering may create a highly irregular or "pinnacled" bedrock surface. Soils derived from weathering of the Knox Group typically consist of thick residual clays and silts with moderate to high chert content. Residual overburden soils are commonly over 100 ft thick in this region.

Soils on the facility site are silty clays of the Fullerton Series. These soils are developed on uplands from the weathering of the Knox Group, and they tend to be thick and uniform. Observation of these soils at road cuts, pits, and drill holes in adjacent areas on Chestnut Ridge indicate they are thick (up to 100 ft) uniform soils with occasional cherty zones.

Additional information on the soils, geology, and hydrogeology is provided in the next section of this manual. For a complete discussion, refer to the document, *Industrial Landfill V Permit Application Part I and II* (June 1992, Y/TS-835).

3.0 LANDFILL DESIGN

3.1 Site Selection

The geographic area that was considered for site selection is located near the Y-12 Plant to permit the utilization of existing equipment and personnel in the development and operation of the facility. Boundaries of the geographic area considered are the DOE ORR boundary to the north and east, State Route 95 to the west, and New Bethel Valley Road to the south. Within those approximately 10 square miles of the DOE ORR, unsuitable areas for site development include dedicated lands, buffer zones, ORNL study sites, a national environmental park, and areas with severe slopes. These areas were mapped and eliminated. Geologic units in the remaining area include the Rome Formation, Conasauga Group, Knox Group, and Chickamauga Limestone. An evaluation of the topography, soil characteristics, and hydrology of these units indicated that the Knox Group is the most suitable for landfill development. Favorable characteristics of the Knox Group include moderate to gentle slopes; thick, uniform, clayey soil; deep water table; and separation from floodplains.

The area selected for the facility is an approximately 210-acre tract of land located south of the Y-12 Plant. ILF-V is located on the western side of the facility, with the disposal unit covering 25.9 acres. The CDL-VII, the Landfill Facilities Building, siltation ponds, roads, and an additional buffer area comprise the remaining acreage. A detailed investigation of the facility site by plant personnel found no rock outcrops or springs present. Topography is moderate with approximately 90% of the area having slopes less than 20%. On the basis of all preceding evaluations, the site was recommended for review by TDEC/DSWM personnel. The site was reviewed and was approved as a potential landfill site in a letter dated March 13, 1990, by Herman A. Sain, DSWM. Subsequently, more detailed investigations were conducted to determine site suitability for both the industrial landfill and a construction/demolition landfill.

The facility is located well within the DOE ORR boundary. As such, there are no property boundaries within 100 ft, nor are there any residences within 500 ft of the facility. There are no wells that are used as a source of drinking water for humans or livestock located within 500 ft of the facility. A minimum of 200 ft of buffer area will be maintained between the fill area and the normal boundaries of streams or springs. The nearest airport is located more than 10,000 ft from the facility.

The facility will be accessed from New Bethel Valley Road. The main facility access road (Clear Spring Road) is located on the north side of New Bethel Valley Road, approximately 1.4 miles southwest of the intersection of State Highway 62 and New Bethel Valley Road. An additional access road (Chestnut Ridge Access Road) connects ILF-V and CDL-VII to the south side of the Y-12 Plant. Appropriate access gates have been installed on all facility access roads.

ILF-V is located at elevations ranging from approximately 1000 ft MSL to 1090 ft MSL. Flooding from the Clinch River is not a concern since flood elevations on Melton Hill Lake at the mouth of McCoy Branch are 796.6 ft MSL and 796.9 ft MSL, respectively, for the 100-yr and 500-yr floods. Small, intermittent streams are located to the east and south of ILF-V.

As part of the National Environmental Policy Act (NEPA) documentation required by federal law for the project, a survey of the area has been done for endangered or threatened species of plant, fish, and wildlife or their habitats. The results of the survey are reported in *Environmental Assessment for Steam Plant Ash Disposal Facility and Industrial Landfill at the Y-12 Plant, Anderson County, Tennessee* (ORNL 1991). The environmental assessment resulted in a finding of no significant impact. No plant or terrestrial mammals listed by the U.S. Fish and Wildlife Service as endangered or threatened are known to occur on the East Chestnut Ridge site. No threatened or endangered fishes or invertebrates listed by either the State of Tennessee or the U.S. Fish and Wildlife have been found or are known to occur on the ORR.

One species of fish, the Tennessee dace (*Phoxinus tennesseensis*), listed by the State of Tennessee as a species in need of management, resides in several streams on the ORR; but there is no record of its occurrence in either of the streams located adjacent to the East Chestnut Ridge site, and it has not been found in any stream draining the south side of Chestnut Ridge that has been recently sampled (M. G. Ryon, Environmental Sciences Division, ORNL, August 1989). All areas slated for development contain habitat that might be used for nesting or foraging by the Cooper's hawk, a species listed by the state as threatened. This species is believed to be scarce on the ORR and has not been seen on the site (R. L. Kroodsma, Environmental Sciences Division, ORNL, personal communication to J. W. Webb, ORNL, August 1989). The site also provides foraging and nesting habitat for species listed by the state as in need of management, specifically, the black vulture and the red-shouldered hawk, the latter of which has been sighted over the East Chestnut Ridge site.

3.2 Soil Borings

Two sets of soil test borings were drilled at or in the vicinity of ILF-V as part of this hydrogeologic investigation. Five soil test borings were drilled in Spring 1989 by Geologic Associates (Knoxville, Tennessee) under the direction of Golder Associates (Atlanta, Georgia). Three of these test borings were completed as piezometers. Another thirteen soil test borings with four piezometers were installed by

Geotek Engineering Company (Knoxville, Tennessee) in January 1991. Additional borings were drilled in 1988 and 1989 under the direction of Energy Systems.

Overburden materials encountered at the ILF-V site consist primarily of thick deposits of residual silts and clays overlain by a thin mantle of topsoil. The average residuum thickness encountered in the 25 borings drilled for this site is approximately 65 ft. However, due to the differential weathering of the bedrock surface, overburden thicknesses ranging from approximately 47 ft to over 150 ft were logged. The residual soils have a high chert (flint) content occurring in erratic zones or lenses. Auger refusal at depths shallower than expected based on regional elevations of the top of the bedrock are apparently a result of chert boulders embedded in residual soil above the deeper bedrock surface. Visual descriptions of the residual soil encountered in test borings include reddish-brown silty clay to clay and alternating layers of moist orange, yellow-to-red silty clay and clayey silts with varying amounts of chert gravel. The chert gravel dispersed throughout the residual soil is estimated to comprise up to 5% of the mass of the soil. The soils, as classified by the Unified Soil Classification System (USCS), are high- and low-plasticity clays (CH and CL), clean silts (ML), plastic silts (MH), and some clayey and silty sand (SC and SM). The grain sizes of the chert grains, fragments, and nodules were seen to range from fine sand size to cobbles; but boulder-size masses of chert are not uncommon in the area and are to be expected at this site.

Results of the drilling indicate that the thick, silty, plastic clays should provide a suitable setting for development of an industrial landfill. Large masses of chert may have to be removed individually if encountered in the excavation; however, large quantities of rock removal are not anticipated.

3.3 Core Borings

As part of the first phase of work at the ILF-V site, one bedrock core boring (GW-556) was drilled by Golder Associates in November 1988. The core boring was drilled to a total depth of 356.5 ft below ground surface. Data from this core boring are supplemented by the rock core taken from the adjacent CDL-VII site investigation.

The drilling logs for the core borings describe the bedrock as gray, hard, dense, fine- to medium-grained dolomite of the Knox Group. Nodular, brecciated, and oolitic chert were common throughout the core retrieved. The core was broken and had many joints perpendicular to the bedding plane.

Two distinctive joint sets were noted, and approximately the same number of joints were observed in each joint dip direction. The first joint set direction was approximately parallel to the true bedding dip direction, at a dip angle of 35° to the southeast. Most dip angles for the first set ranged from 45° to 55°. The second joint set was nearly orthogonal to the primary, or a dip angle of northwest 55°. The joints in the core samples were either clay-filled, calcite-filled, or mineralized.

3.4 Hydrogeology

The geology underlying Chestnut Ridge is considered to be a karst terrain and is characterized by features such as sinks and springs. A large number of rivers and streams within the ORR and surrounding area

are springfed. Although no springs occur within the proposed landfill area, numerous springs have been mapped within a 1-mile radius of the site.

Groundwater beneath the ILF-V site primarily occurs within the dolomite bedrock of the Knox Group aquifer and locally within the overlying residual soils near the soil/bedrock interface zone at elevations between 960 ft MSL and 1010 ft MSL. Groundwater flow in the uppermost (Knox Group) aquifer is generally eastward beneath ILF-V. In the westernmost portion of the site, groundwater flow is generally westward. The groundwater gradient varies between 0.05 and 0.09 ft per foot, with the steeper gradient of 0.09 ft per foot occurring in the northeast corner of the site. Groundwater also occurs under confined artesian conditions in some zones within the bedrock, where the regional piezometric surface is locally above the ground surface elevation. Depths to the regional piezometric surface range from 20 to 50 ft below the proposed landfill bottom.

Minor amounts of groundwater also occur in chert zones perched well above the soil/bedrock interface. Groundwater encountered in soil boring SB-12 at a depth of approximately 15 ft below ground surface (elevation 1008) is a good example of perched water occurring almost 50 ft above the regional groundwater table. Perched water was also encountered during drilling in soil test borings SB-52a, SB-62, and PZ-22 at elevations of approximately 986 ft MSL, 1001 ft MSL, and 1041 ft MSL, respectively. Perched water was also encountered in the following piezometers: GW-565, GW-571, PZ-12, PZ-32, and SB-12. These perched water zones will be eliminated during landfill construction by the excavation of the soil materials in which they occur. The opening of the excavation will allow the perched water zones to be drained.

The Knox Group aquifer is recharged by infiltration of rainfall through the residuum. The amount of infiltration is low due to the extremely low permeability of the residual soils and due to the steep terrain, which promotes runoff. The deep clay residual soils overlying the Knox Group yield low quantities of water to domestic, dug wells. Water may be stored as perched water in cherty zones in the residuum, and with few exceptions the greatest yield can be expected along structural or bedrock lows. Wells in the residuum typically go dry in summer months, due to the low storage capacity of the fine-grained soils. The residual soils of the Knox Group have a lower permeability than the shallow fractured and solutioned bedrock and act as a leaky aquitard to the deeper bedrock aquifer.

3.5 Solid Waste Composition

ILF-V is used for the disposal of industrial and institutional solid waste. A general description of those materials typically allowed to be disposed of at ILF-V is given in Appendix B. Waste may be accepted in either loose or baled form. Baled waste will only be accepted in accordance with conditions outlined in "Procedures and Guidelines for the Disposal of Special and Other Wastes at the Y-12 Industrial Landfill V," located in Appendix C. Appendix C includes provisions for acceptance of special wastes, such as asbestos and beryllium oxide. Disposal of other special waste streams are addressed individually by submittal of a "Special Waste Request" to TDEC/DSWM for approval. Established in-plant controls are used to segregate nonpermitted materials from the flow of plant solid waste to be disposed of in the industrial landfill. In addition, administrative operations that will be used at the landfill to prevent the disposal of nonpermitted materials are discussed in Section 5.0.

3.6 Design Loading

Based on existing practices and workloads at the time that Area 1 was constructed, the compacted, in-place industrial waste loading at the landfill (including daily and intermediate cover) was estimated to be approximately 200 yd^3/workday (51,875 yd^3/yr). The 1994 Class II volume usage rate for the ORR was 2,648 yd^3/mo (31,776 yd^3/yr). This waste stream will fluctuate with workloads, funding availability, weather, and project schedules.

3.7 Site Capacity

Due to changes resulting from the addition of a geomembrane to the landfill liner and cover, the total volume in the landfill available for waste disposal has decreased slightly. The interior side slopes for the liner in Areas 2–5 have been changed from 3:1 to 3.5:1, and upper and lower terraces have been incorporated into the design of the final cover. The following table lists the original and revised capacities of the landfill.

Table 1. Original and Revised Landfill Volumes

Item	Original Design (yd^3)	Revised Design (yd^3)
Total airspace*	2,571,000	2,520,404
Waste volume	1,489,310	1,429,550
Bottom liner†	208,930	208,930
Daily and intermediate cover	744,660	714,780
Final cover‡	128,100	167,140

* The airspace volume is the volume between the excavation contours shown on the excavation plan (Drawing C2E900000A627) and the proposed final contours shown on the final closure plan (Drawing C2E900000A630).

† The bottom liner includes a composite clay layer, granular drainage layer, and protective soil cover layer.

‡ Final cover volume computed assumes a 4-ft-thick final cover over an area of 25.9 acres.

Based upon the original estimated design loading of 51,875 yd^3/yr, the original estimated life of ILF-V is 43 yrs. Based upon the 1994 volume usage rate of 2648 yd^3/mo, the revised estimated life of ILF-V is 67.5 yrs. The usage rate will be frequently monitored, and the projected life of ILF-V will be revised annually.

3.8 Initial Site Preparation

The following activities were performed prior to initially placing the landfill in operation.

- Installed groundwater Monitoring Wells GW-746, GW-797, and GW-799 as shown on Drawing C2E900000A628, to allow background characterization of the groundwater in those wells at least 180 days prior to disposal of waste in ILF-V.
- Performed background characterization of the site groundwater at least 180 days prior to disposal of waste in ILF-V. Background characterization activities are described in Appendix D.
- Constructed the main facility access road (Clear Spring Road) and access control gates.
- Constructed the maintenance road and stormwater control channels into initial construction area (Drawing C2E900000A628 or C2E900000A629).
- Cleared and removed trees and stumps from all the initial construction areas shown on Drawing C2E900000A628 or C2E900000A629.
- Installed three horizontal and vertical control points, one of which will be the permanent, on-site bench mark. A permanent bench mark is located to the north of the facility, on the north side of Chestnut Ridge, as shown of Drawing C2E900000A705.
- Drilled out or pulled casing and plugged all existing groundwater piezometers that are located within 100 ft of the disposal area. Plugging was performed using an approved cement-bentonite slurry placed to an elevation 10 ft above the lowest elevation of excavation for the disposal area.
- Stripped topsoil from the initial excavation area and the maintenance road and placed in stockpile.
- Constructed Siltation Ponds 1 and 2.
- Excavated the initial excavation area to the elevations shown on Drawing C2E900000A628 or C2E900000A629. Initial excavation involved cuts up to 35 ft. Used the soil from the initial excavation to supply any additional soil necessary to construct the maintenance road. Filled the west soil stockpile area as required.
- Constructed the landfill liner (compacted soil layer, granular drainage layer, and protective soil cover layer) in landfill Area 1 as shown on Drawing C2E900000A628 or C2E900000A629.
- Constructed a temporary access road from the maintenance road into Area 1.

- Constructed leachate collection pipe in Area 1, lift station, and holding tanks as shown on Drawing C2E900000A628 or C2E900000A629.

3.9 Proposed Landfill Development

Further development of Areas 2 and 3 of ILF-V will be sequenced as shown on Drawing C2E900000A925 and -A926, respectively; and the total site excavation plan is shown on Drawing C2E900000A627. The following paragraphs discuss future landfill development.

Landfill development is planned so that each area is developed as needed. Due to regulatory changes enacted since the permit was approved, future landfill development will require that the liner be constructed as a composite liner consisting of 2 ft of compacted low permeable clay and a geomembrane. A granular drainage layer will be constructed above the composite liner, and geotextile will be placed above and below the granular drainage layer. A 2-ft-thick protective soil cover will be constructed above the granular drainage layer to provide frost protection for the composite liner. The protective soil cover will also serve to function as a barrier to the infiltration of stormwater during the period when the cover is exposed prior to placement of the initial lift of waste.

The development of each disposal area will occur so as to promote drainage of runoff away from the working face. Temporary roads will be built as each area is developed and will be located so that at least one road is available for access to the working face during all weather conditions. Interior slopes of partially completed areas receiving intermediate cover will have a maximum slope of approximately 3:1.

The proposed final contours, shown on Drawing C2E900000A630, create a small, relatively flat area with a 5% slope and a maximum elevation of approximately 1153 ft MSL. The closed landfill will slope downward from this flat area with approximately 3½:1 side slopes, beginning at elevation 1150 ft MSL. The final cover is to be constructed with two terraces which are designed to improve the slope stability of the final cover and to facilitate constructing the final cover in stages, if necessary, by providing an anchorage for the geomembrane. Upon achieving the developed waste grade, the final cover will be placed. Closures will be performed in approximately 2–5-acre areas in order to establish a manageably sized area for efficient closure. The final cover will be applied to minimize infiltration of precipitation into the waste, to provide a pleasing appearance, and to provide a growing surface for vegetation. The final cover will be placed on the landfill as shown on Drawing C2E900000A930 and is described in the following two paragraphs.

As shown on Drawing C2E900000A630, a clay soil final cover will be placed on the side slopes of Area 1 only and will consist of 36 in. of soil that includes a 24-in. compacted, low-permeability layer (1×10^{-7} cm/s), overlain by a 12-in. layer that will support vegetative growth. Placement of the final cover will be in accordance with procedures outlined in the Construction Quality Assurance (CQA) Plan.

The remaining portion of ILF-V will have a composite clay soil final cover consisting of a composite geonet gas vent layer, overlain by a 6-in.-thick sacrificial layer. The sacrificial layer will serve as protection for the composite geonet from the footed compactor used to construct the low-permeability clay layer. The compacted soil clay layer will be placed next. This layer will be 2 ft thick and placed in

multiple lifts with each lift being compacted to the required moisture and density range as described in the CQA Plan. Gas vent pipes will be constructed to tie in to the gas vent layer, in order to facilitate the release of any gas that is generated within the landfill, as shown on Drawing C2E900000A930. Next, a geomembrane will be placed in direct contact with the low-permeable clay layer. The drainage layer consists of a composite geonet and will be placed on top of the geomembrane. A vegetative layer 1½ ft thick will be placed above the composite geonet drainage layer. The Closure Plan provides additional detail concerning the landfill closure.

Calculations were included in the original permit application and established the infiltration rate for the clay soil final cover. According to results obtained using the U.S. Environmental Protection Agency (EPA) Hydrogeologic Evaluation of Landfill Performance (HELP) Model, the clay soil final cover (placed over a portion of Area 1) will allow an infiltration rate of 5219 ft^3/acre/yr. This infiltration rate is less than the maximum infiltration rate (6000 ft^3/acre/yr) allowed by the provisions outlined in the TDEC/DSWM regulations that were in effect at the time the permit was issued. The regulations required that the infiltration rate through the final cover be less than the infiltration through a 3-ft bottom liner with a permeability of 1×10^{-7} cm/s and 1 ft of hydraulic head. Since future landfill development is governed by amended rules, the allowable infiltration for the composite final cover has been calculated, and it is provided in a separate document containing calculations to support revision to he landfill design. The infiltration rates for the composite final cover and the composite landfill liner are both less than 0.1 ft^3/acre/yr.

3.10 Landfill Stability Analysis

Stability analyses have been performed for the landfill and the results are contained in a separate document. The stability analyses were performed in accordance with the TDEC guidance document, *Earthquake Evaluation Guidance Document.* Analyses were performed for both global and slope veneer stability and for both static and seismic loadings. Seismic analyses for global stability included both pseudostatic and landfill deformation. The slope veneer seismic assessment was by pseudostatic analysis. Global analyses considered both the circular and sliding block modes of potential failure. The potential for soil liquefaction was also assessed. Since the soils are predominantly clayey, there is no potential for liquefaction. The expected global deformation under seismic loads is less than 6 in. which is the allowable value published in the guidance document. Factors of safety obtained were adequate in all cases except for veneer stability, where the obtained factor of safety was less than the desired 1.0. This suggests that the vegetative cover on the final cover slopes will most likely be displaced during a very large seismic event such as the design basis earthquake (e.g., 2500-yr), but the structural stability of the landfill will not be impacted. Furthermore, the vegetative cover should be stable under large seismic shocks such as a 100-yr to 500-yr event. No waste or leachate will be released to the environment. Displaced vegetative cover will be recognized during routine inspections and can be repaired as a maintenance activity. The landfill design, as modified by the revised drawings, meet the TDEC seismic criteria.

3.11 Soil Balance and Cover Material

All soil cover material to be used for ILF-V is available at the ILF-V and CDL VII. The total soil requirement for the ILF-V cover is estimated to be 872,760 yd^3 (includes daily, intermediate, and final soil cover). The soil available from the excavation of ILF-V is estimated to be 1,175,170 yd^3. The excess excavated soil (302,410 yd^3) will be used for additional site construction, including the landfill liner, or will be used as needed by the Y-12 Waste Transportation and Landfill Operations (WTLO) Department. Earthwork calculations were provided in the original permit application. Uses for excess soil are detailed in Appendix E.

Excavated soils will be stored in various stockpiles located near the facility. Some stockpile locations are shown on Drawing C2E900000A627. Other stockpiles will be located over undeveloped future phases portions of the landfill. Side slopes on the stockpiled soil will be approximately 3:1. The stockpile areas that are not on the landfill may remain permanently. Therefore, side slopes and the completed top elevations of these stockpiles will be seeded with grass at the time they are established.

Filter fabric fences, riprap, and other erosion controls will be used along sides of open areas to minimize sediment runoff. Vegetation enhances evapotranspiration and reduces erosion, thus playing an important part in surface water control. The final cover will be prepared for seeding after it is applied. Mulch will be applied after seeding. Areas will be reseeded as necessary to establish and maintain vegetative cover at all times. Hydroseeding and hydromulching may be used.

3.12 Surface Water and Sediment Control

The surface water drainage system is designed to intercept surface run-on from areas adjacent to the landfill; to intercept surface runoff from ILF-V both during and after the operation of the landfill; to control the rate of runoff from exceeding the existing discharge rate; to collect silt and limit deposition in adjacent drainage ditches; and to control erosion. All surface water calculations were provided in the original permit application.

Potential run-on from the wooded area to the north of ILF-V will be diverted to the east by an open channel located on the north side of the maintenance road and then through a stormwater sewer to an open channel discharge.

During operation of the landfill, runoff from inside the area enclosed by the maintenance road will be collected in a perimeter channel inside the road and will be carried to the siltation ponds.

Runoff from the completed landfill will be carried in berm channels which will be placed at approximately 35-ft elevation intervals, and will discharge either into letdown channels or to a riprap perimeter drainage channel. The channels will carry the runoff to siltation ponds located on the east and west sides of the landfill. The berm channels and letdown channels will be riprapped. All channels and culverts utilized as permanent features are sized for the 25-yr, 24-hr storm.

The siltation ponds are designed to detain the water volume resulting from the 10-yr, 24-hr storm; to divert the water volume resulting from the 25-yr, 24-hr storm through the principal spillway; and to discharge the peak flow from the 100-yr, 24-hr storm through the emergency spillway. In normal operations, the water volume below the principal spillway will be drained within 24 hrs through the orifice holes located in the riser pipe, resulting in a dry pond from which the sediment can be removed. In normal operations, discharge from the siltation ponds will not exceed the discharge resulting from a 25-yr, 24-hr storm under the predeveloped conditions. Discharges will be governed by the Y-12 Plant National Pollutant Discharge Elimination System (NPDES) General Permit (No. TN0002968) issued by the TDEC Division of Water Quality Control. Surface water monitoring requirements established in the general permit will be carried out through the operating life of ILF-V.

Every effort will be made to keep disturbed areas to a minimum. Existing natural drainage will be maintained where possible to avoid disturbing areas with vegetation. The disturbed area in front of the working face will be kept to a minimum to help control sediment runoff. Sediment runoff from undisturbed areas, revegetated areas, stockpiled earth, or other disturbed areas not draining into a siltation pond will be controlled with filter fabric fences or other erosion control measures as operationally necessary. Fences will be constructed of material specifically designed to decrease the velocity of runoff and cause retention of silt by settlement and filtration.

When Area 2 is developed, the temporary access road for Area 1 will be removed. Runoff from Area 1 will flow across the extreme eastern end of Area 2 via temporary pipe culverts placed underneath the Area 2 temporary access road to a temporary ditch located south of Area 2, as shown on Drawing C2E900000A925. From there runoff will flow to the perimeter ditch and siltation pond. As Area 1 continues to receive waste, the height of the waste/cover will reach a point where runoff will be conveyed directly to the perimeter channel. As Area 3 is developed, the same basic steps described for Areas 1 and 2 will apply to Areas 2 and 3.

Another design feature for Areas 2 and 3 will minimize stormwater runoff into the leachate tanks until such a time these areas will be receiving waste. Manholes 2A and 3A (Drawing C2E900000A925) will be constructed during Area 2 development to allow for diversion of stormwater from the leachate collection tanks prior to waste placement.

Prior to landfill operation for Area 2, the leachate collection pipe will connected to Manhole 2A. A temporary stormwater drain pipe will be added to allow Manhole 2A stormwater to be diverted to Siltation Pond 2 during construction activities and prior to waste placement. Valves 2-1 and 2-2 will be added to the leachate sewer leading to Manhole 3A and the temporary stormwater drain pipe to provide flow control for generated stormwater or leachate between the siltation pond and leachate storage tanks as appropriate. Just prior to waste being placed in Area 2, valving will be set to divert generated leachate to the leachate storage tanks. The stormwater drain to the siltation pond will be plugged to prevent Area 2 leachate from entering the siltation pond. The stormwater drain pipe may be utilized in the future by rerouting it to an additional storage tank to allow segregation of Area 2 leachate. The two valves will then serve as flow control for leachate between the existing and future storage tanks. If the future construction of additional leachate storage tank becomes necessary, a request will be submitted to TDEC for approval.

For Area 3, Manhole 3A will be constructed with a pipe stub for future connection to Area 3. The stubbed pipe will allow stormwater collected in Area 3 to pass uninterrupted through Manhole 3A and lead to Area Inlet 2 to be conveyed to the siltation pond. Prior to waste placement in Area 3, the section of stormwater pipe inside Manhole 3A will removed and the invert leading to Area Inlet 2 plugged or grouted to divert leachate to the leachate storage tanks.

3.13 Groundwater Protection and Monitoring

ILF-V will have a liner, a leachate collection system, and a geologic buffer to provide protection of groundwater resources.

The landfill liner will be designed, constructed, and installed as discussed earlier to control migration of waste or waste constituents out of the landfill into the adjacent subsurface soil, groundwater, or surface water at any time during the active life of the landfill and the post closure care period. The design layer will allow leachate to readily flow into the leachate collection lines.

The on-site soils, discussed in detail in the hydrogeologic report, are silty clays of the Fullerton Series and are well suited for use as a compacted clay soil liner. It is anticipated that residual clay material removed from the landfill excavation will be used for construction of the compacted clay soil liner. A previous study entitled, *Permeability of Compacted Soils from the East and West Borrow Areas, Y-12 Plant*, dated March 27, 1989, prepared by Dr. David E. Daniel, as well as a subsequent study by Dr. Daniel, *Results of Hydraulic Conductivity Tests and Recommended Water Content-Dry Density Criteria for Potential Borrow Soils*, dated October 12, 1992, have confirmed that material from the ILF-V Borrow Areas at the Y-12 Plant can be recompacted to achieve the required permeability of 1×10^{-7} cm/s or less. Remolded permeabilities at 95% Standard Proctor compaction and at 3%–5% above optimum moisture content ranged from 2.6×10^{-8} cm/s to 6.5×10^{-8} cm/s for the ILF-V borings.

As discussed earlier, Area 1 has a 3-ft compacted clay soil liner. Areas 2–5 will be constructed with a 2-ft-thick composite clay soil liner (clay soil liner overlain with a geomembrane). The clay soil liner will be placed in uniform, loose lifts not exceeding 9 in. in uncompacted thickness. These lifts will be compacted to a maximum thickness of 6 in. using a footed roller that has feet a minimum of 6 in. long and a minimum static weight of 30,000 lbs. A minimum of six passes of the equipment is required over each lift. The particular compaction procedures to achieve the required liner permeability are presented in the CQA Plan.

The type of geomembrane to be used in the liner for ILF-V for future development is a 40-mil polypropylene geomembrane. Polypropylene was selected for the following reasons:

- It possesses superior multiaxial strain capability and is thus better able to conform to sharp objects without being penetrated.
- It is not prone to stress cracking.
- It can be thermally seamed over a wide temperature range.

- It is relatively easy to repair.
- It exhibits a relatively low coefficient of thermal expansion, resulting in reduced thermal growth and shrinkage during installation.
- It is available in smooth or textured sheets, and it provides an adequate interface friction coefficient when layered with a variety of materials on various slopes.
- It is available from a number of vendors.

A separate calculation package provides justification for the use of a 40-mil-thick polypropylene geomembrane, as well as results of the slope stability analyses. Recommendations are also presented for use of both smooth and textured sheets, based on varying slope conditions.

A geotextile will be placed over the composite clay soil liner, followed by a 1-ft-thick granular drainage layer. The 6-in., perforated polyvinyl chloride (PVC) leachate collection line will be embedded in the granular drainage layer. The drainage layer will be covered with another layer of geotextile, and a protective soil cover will protect the composite clay soil liner and the granular drainage layer.

The landfill design and operation will minimize potential leachate generation. Off-site surface water will be diverted away from the landfill so that the only water potentially becoming leachate will be the precipitation falling directly on the waste disposal area.

The leachate collection and removal system is designed for the removal of leachate and for the prevention of the buildup of any significant hydraulic head at the site (see engineering calculations document attached to the original permit application). The leachate generated by the landfill will be removed by the granular drainage layer and the leachate collection lines. The leachate collection line for each area will discharge into a corresponding manhole located on the east side of the landfill. Originally five leachate collection lines were constructed that discharged into five manholes. As discussed earlier, an additional manhole is being added to both Areas 2 and 3. Since the composite clay liner is only required to be 2 ft thick, the additional manholes will be installed to provide improved slopes in the leachate sewer pipes for gravity drainage to the lift station.

The TDEC/DSWM regulations require that the leachate holding tanks must have the capacity to store the volume of leachate expected to be generated within a 30-day period. As contained in the permit application, the maximum monthly leachate generation was calculated to be 223,200 gallons using the HELP model. The quantity of leachate was calculated for an assumed worst-case scenario. The assumptions used are detailed in the original engineering calculations document.

In addition, leachate movement will be minimized by a geologic buffer, an in situ clay layer extending from the bottom of the landfill liner to the seasonal high groundwater table. This in situ clay layer is required by TDEC/DSWM regulation to be a minimum of 10 ft thick, with a maximum saturated hydraulic conductivity of 1×10^{-5} cm/s, or to be a minimum of 5 ft thick, with a maximum saturated hydraulic conductivity of 1×10^{-6} cm/s. Under all of ILF-V, the soil samples analyzed within the 10-ft geologic

buffer had a saturated hydraulic conductivity ranging from 1.0×10^{-7} cm/s to 6.6×10^{-8} cm/s. In the soil testing program for ILF-V, the single hydraulic conductivity value that exceeded 1×10^{-6} cm/s (e.g., 1×10^{-5} cm/s) was from a sample above the bottom of the landfill excavation; soil from this elevation will be excavated prior to landfill construction. Therefore, the soils in the geologic buffer exceed the minimum required standard of 5-ft thickness with a maximum hydraulic conductivity of 1×10^{-6} cm/s.

Groundwater monitoring is required by the TDEC/DSWM rules for a Class II disposal facility. The groundwater compliance monitoring boundary for ILF-V is considered to be the waste management boundary of the unit (Drawing C2E900000A705). The waste management boundary is the vertical surface located at the hydraulically downgradient limit of the unit, and it extends down into the uppermost aquifer.

The approach to the detection groundwater monitoring program at ILF-V is a conventional program of monitoring one upgradient well and four downgradient wells and a supplemental program that compares any groundwater contamination detected by the conventional monitoring program to the chemical analysis of the actual ILF-V leachate (leachate fingerprinting). The primary reason for supplementing the conventional (upgradient versus downgradient) monitoring program with the background well and leachate fingerprinting program is that the latter program would potentially provide documentation that the source of downgradient contamination (if it occurs) is or is not from ILF-V. This documentation is important both because of the groundwater flow regime in the area of the facility and because of the presence of other disposal sites in the area, including the CDL-VII.

The conventional groundwater monitoring system, as required by the TDEC/DSWM, will consist of one upgradient (GW-796) and four downgradient (GW-797, GW-799, GW-557, and GW-801) monitoring wells. The locations of the five monitoring wells (shown on Drawing C2E900000A627) have been selected based upon the piezometric surface contour map (Figure 4-10 in the hydrogeologic report, attached to the original permit application). Monitoring Well GW-557 was used in the initial hydrological investigation of the facility. Monitoring Wells GW-796, GW-797, GW-799 and GW-801 are new installations that have been monitored since 1993. All wells at the ILF-V are constructed of 4-in. No. 304 stainless steel casing and screen.

The downgradient wells will yield groundwater samples that are representative of the groundwater passing the compliance monitoring boundary as it flows downgradient away from ILF-V. Monitoring Well GW-801 is a special case, in that it is not currently downgradient from ILF-V. The elevation of the piezometric surface in this vicinity is expected to drop due to the reduced amount of infiltration that will pass through the landfill liner and the leachate collection system, and eventually the final cover. Monitoring Well GW-801 would thus become a downgradient well. It will be monitored regularly in order to evaluate the water levels during and after landfill construction. If water levels in the well do not drop, Monitoring Well GW-801 may eventually be dropped from the groundwater monitoring system.

As described above, the conventional groundwater monitoring system will be supplemented by use of leachate fingerprinting. Leachate is routinely obtained from the leachate collection system to determine the components of the leachate. The dual system has been proposed to determine if other activities within the ORR have an impact upon the groundwater beneath ILF-V. If contamination appears in the downgradient wells, the downgradient chemical data will be compared first with the upgradient chemical

data and then with the chemical data from the leachate analyses. If these comparisons show that the contamination is from ILF-V, then a groundwater quality assessment monitoring plan may be developed and implemented.

Monitoring well data are as follows:

New Monitoring Well No.	Previous No.	Surface Elev.	Total Depth (BGS*)	Depth to Bedrock (BGS)	Bedrock Elev.	Screened Interval (BGS)
GW-557	QW-557	1078.60	139.0	134.0	944.63	115.75–135.75
GW-801	1134	1093.82	188.9	112.5	981.32	178.10–188.10
GW-796	MW-11	1048.80	139.7	102.0	946.80	126.50–136.50
GW-797	MW-13	1056.10	134.1	67.1	989.00	123.50–133.50
GW-799	MW-14	978.10	92.0	60.8	917.30	81.00–91.00

* BGS = below ground surface.

Groundwater background characterization was performed, and a detection monitoring program was implemented when ILF-V became operational. The background groundwater characterization and detection monitoring parameters have been selected using the TDEC/DSWM rules as a guideline and are included in Appendix D. The background data were determined from samples collected from the wells beginning a minimum of 180 days prior to disposal of waste in ILF-V. Subsequent to beginning operation of the landfill, groundwater monitoring of these wells was performed and reported in accordance with the document, *Y-12 Industrial Landfill V and Construction/Demolition Landfill VII Groundwater Sampling and Analysis Plan*, attached to the permit application. This document delineates sample collection techniques, sample preservation and shipment methods, analytical procedures, and chain-of-custody control procedures. Records of monitoring activities and results will be maintained by the Y-12 Health, Safety, Environment, and Accountability (HSEA) Division and the WMD. The detection monitoring program will be performed, and the records will be maintained through the post closure care period of the landfill.

3.14 Gas Migration Control System

The gas migration control system designed for ILF-V is designed as a passive system to collect and vent decomposition gases so that the following conditions are met.

- There is no buildup of gas pressure under the final cover that would compromise the functions of the final cover.

- The concentration of explosive gases in structures on-site (excluding gas control or recovery system components) does not exceed 25% of the lower explosive limit for the gases.

- The concentration of explosive gases at the site boundary does not exceed the lower explosive limit for the gases.

A perimeter gas migration control system was installed during construction of Area 1 that will allow gases within the compacted waste to be collected and vented to the atmosphere. Gas vents (Drawing C2E900000A630) are placed approximately every 100 ft around the perimeter of the landfill in Area 1 only. The vents consist of 14-ft-wide strips of geonet surrounded by geotextile placed along the side slope of the landfill bottom. The geonet vent extends up the side slope and is wrapped around a perforated PVC header pipe. The header pipe will vent gas through a 4-in. stainless steel riser pipe, extending above the landfill surface. For Areas 2–5, the gas vent system described above for Area 1 will be modified since the liner and cover system for Areas 2–5 are different than that of Area 1. The perimeter gas vent system for Area 1 will terminate at the Area 1/Area 2 boundary. The final cover to be placed over the remainder of the landfill has a geomembrane. The geomembrane will serve to enhance the ability of the cover to retard the formation of leachate, and it will also reduce the ability of the gas to diffuse through the cover. Therefore, gas vents will be located in the cover (Drawing C2E900000A630) to prevent the buildup of gas underneath the composite cover to be constructed over the remaining portion of the landfill.

Furthermore, the landfill is more than 1 mile away from any property boundaries, so any explosive gases that are generated in ILF-V are expected to diffuse prior to reaching the property boundary. The Landfill Facilities Building is of slab-on-grade construction, so no basement will be available for concentration of explosive gases. In addition, the building is more than 250 ft north of the landfill boundary, and the existing soils are not conducive to gas migration.

EPA has proposed new source performance standards to regulate and control municipal solid waste (MSW) landfills (*Federal Register*, Vol. 56, No. 104, pp. 24468–24528). The pollutant to be regulated by the proposed standards is "MSW landfill emissions." MSW landfill emissions are composed of a collection of air pollutants, including methane and nonmethane organic compounds (NMOCs), some of which are toxic. To reduce the burden and complexity of measuring and monitoring the various constituents of MSW landfill emissions, NMOCs are specified in the proposed regulation as a surrogate for measurement purposes and to define regulated quantities.

MSW landfill emissions change over time due to the volume of refuse in place, the age of the refuse, whether or not the landfill is still accepting waste, and other factors. Thus, the format selected by EPA for the proposed regulation was to establish a baseline of 100,000 Mg (111,000 tons) of design disposal capacity. Those new landfills having a design disposal capacity greater than or equal to the baseline must calculate an estimated annual NMOC emissions rate and report periodically.

Since this landfill design capacity (approximately 744,000 tons) exceeds the threshold value established in the proposed rule, the estimated NMOC annual emissions rates have been calculated using the average annual rate of waste acceptance and the empirical values proposed in the regulation. The calculations are

contained in the engineering calculations document (attached to the permit application). Based on the assumptions and calculations, the highest estimated annual NMOC emissions rate was 116 Mg/yr. This is below the proposed regulatory rate of 150 Mg/yr for NMOC emissions requiring design and installation of gas destruction systems.

3.15 Facility Roads

The main access road, designated Clear Spring Road, is a paved, two-lane, "Official Use Only" roadway located inside the Y-12 Plant Perimeter Buffer Zone. Bar-type gates are used across the main access road, both at the Old Bethel Valley Road and at the leachate holding tanks for ILF-V, in order to control vehicular access to the facility during offshift hours. Vehicular access around the bar gates will also be prevented. The facility and the main access road are located well within the "Official Use Only" portion of the ORR and away from public roads. These details are shown on Drawing C2E900000A705.

An additional access road, designated as the Chestnut Ridge Access Road, has been completed to provide access to both ILF-V and CDL-VII from the Y-12 facility located north of the landfills. This road is a two-lane asphalt-paved road with the same vehicular access controls as those described for Clear Spring Road.

A new gravel maintenance road is provided around the perimeter of ILF-V. This road is 24 ft wide and consists of 24 in. of stabilized aggregate base rock. Temporary roads provide access to the landfill working face. Rock will be used as needed on the temporary roads to maintain access to the working face.

3.16 Personnel Services and Safety

Necessary utilities (heating, air conditioning, potable water, sanitary facilities, and telephone), kitchen facilities, and a records area are supplied at the Landfill Facilities Building. Minimal lighting has been installed outside of the Landfill Facilities Building.

Open burning of wastes will not be permitted at ILF-V. A burning permit will be acquired for the clearing and grubbing of the trees and vegetative growth. Good compaction of the solid waste and the application of daily cover material will reduce the potential for accidental fire occurrence and should minimize the spread of any fires that may occur. In the event that a fire occurs, the Y-12 Plant Fire Department will be notified. In the meantime, the on-site personnel will attempt to extinguish the fire by covering the area with soil or by using fire extinguishers located at the site or on the equipment if this can be performed safely. In the event the fire cannot by controlled by on-site personnel, the Y-12 Plant Fire Department will assist in extinguishing the flames.

3.17 Final Use of Landfill

Upon completion of the proposed landfill and after the final cover has been applied, grass will be planted on the remaining unvegetated area to control erosion and create a grassed area. There are no plans for future development of the closed site.

4.0 OPERATIONS

4.1 Facility Access and Operating Hours

The facility is located well within the "Official Use Only" area of the ORR and away from public roads. The entrances to the facility are from New Bethel Valley Road, as well as the Y-12 Plant. Bar gates are located to control access to the facility. This area of the ORR is routinely patrolled by plant security forces.

The facility is open for operation on regularly scheduled workdays, Monday through Friday. Hours of operation are in accordance with scheduled plant activities. Delivery of waste to the facility at times other than normal plant operating hours requires scheduling through the WTLO Department to include necessary operating personnel. Operating expenses incurred as a result of such activities are charged to the requestor. Access gates at the facility are opened and closed at the beginning and end of each workday by the on-site landfill technician or an authorized WTLO person.

During operating hours, the landfill technician is at the office located in the Landfill Facilities Building. All vehicles entering the facility will pass this office. Also, operations personnel will have visual contact over the facility during operating hours.

4.2 Sign

A sign is located at the facility entrance on New Bethel Valley Road and provides the following information:

- facility name,
- emergency phone numbers,
- TDEC/DSWM class of facility, and
- authorized users.

Since the facility is not open to the public, it is not necessary to post the hours of operation or list the acceptable materials; however, hours are posted for receiving wastes which pose a respiratory hazard during disposal. A listing of those materials permitted for disposal at each landfill at the facility will be available for the user at the facility office. A copy of the listing is given in Appendix B. Additionally, copies of the TDEC/DSWM rules and the TDEC/DSWM operating permit will be available at the facility office.

4.3 Mobile Equipment

The principal pieces of mobile equipment to be used at the facility include the following:

- motorized bulldozer/compactor for performing compaction and cover application,
- motorized scraper for providing and spreading cover material, and
- motorized end loader for using as a backup to the compactor.

Other support equipment available for use at the facility includes graders, dump trucks, end loaders, a backhoe, and a bulldozer. Replacements for equipment are scheduled and procured with capital funds as approved by DOE.

4.4 Placement of Waste Material

The proposed landfill bottom contours prior to construction of the liner are shown on Drawing C2E900000A627. The landfill will be developed by areas shown in sequence in the inset on Drawing C2E900000A627. The initial construction for Area 1 is shown on Drawing C2E900000A628. Drawings C2E900000A925 and -A926 provide partial grading plan views of the completed liner for Areas 2 and 3, respectively.

The volume of in-place compacted solid waste and soil cover as constructed each day constitutes a cell, the basic building unit of the landfill. A line of cells along the slope is a row. The general progression of cell and row construction within each area is shown in the inset on Drawing C2E900000A627. As the rows form lifts over each area, the top of each landfill lift should continue to slope toward the east drainage channel. Small berms will be placed as needed to direct runoff away from the working face.

The compacted solid waste in ILF-V will be covered at the end of each operating day with daily cover. This daily cover will consist of a minimum of 6 in. of compacted soil; the sloped working face may be covered with 8-mil sheet plastic or an approved alternate daily cover. All surfaces of the landfill that will be left exposed for more than 30 days will be covered by either an intermediate cover or the final cover. Intermediate cover will consist of at least a 1-ft-thick layer of compacted soil. All intermediate cover depths will be maintained until either additional wastes are placed in the area or the final cover is applied.

When a new lift is placed over an existing lift, it is desirable to create a path for leachate to percolate through the cells into the granular drainage layer. Prior to daily placement of solid waste, the previously placed daily or intermediate cover will be removed in the area where waste will be placed that day, creating a "window" for leachate percolation. This window will be at least 4 ft by 10 ft. On lifts over layers with respiratory hazards (e.g., asbestos, fiberglass) no windows will be constructed. A marker layer will be placed over the soil cover in these areas for identification and to warn operators of these respiratory hazards. During construction of the first lift, the protective soil cover over the granular drainage layer will also be removed from an area at least 4 ft by 10 ft under each day's cell. Windows will be constructed by one of the following two methods, depending on the characteristics of the waste being placed.

- Cut geotextile into strips 4–6 in. and fill with waste that has no fines contained.
- Remove geotextile and install a ½-in. stone layer followed by waste with or without fines.

The basic fill progression within the landfill areas will begin at the western (uppermost) portion of the opened area and move east (parallel to the slope). Each area will be filled as shown on Drawings C2E900000A631 through C2E900000A634. As indicated on these drawings, when intermediate fill elevations for the lower and/or upper terraces are reached, the terrace will be created by shifting waste placement operations inward approximately 10 ft.

Delivery vehicles will enter the facility and will be directed to the appropriate disposal unit by the landfill technician. Waste will be unloaded and incorporated into the working face, maintaining the width of the working face as small as practicable. The working face is a sloped surface upon which the waste is spread in layers less than 2 ft thick, and it is compacted by the landfill bulldozer/compactor as the waste is spread over the cell. Baled waste will be placed at the bottom of the working face and will be covered with additional waste. The slope of the working face will be approximately 3 ft horizontal to 1 ft vertical (3:1). Plastic covered bales may be stacked vertically at the working face (provided that adequate stability is maintained) so that cover soil use is minimized. The height of the cells will be approximately 10 ft. The other cell dimensions will be selected to minimize cover material, to maximize operating flexibility, and to dispose of the waste received during any given day. Laborers will pick up litter scattered around the site on an as-needed basis.

4.5 Cover Material

Soil obtained during the disposal area excavation will be used as daily, intermediate, and final cover for the compacted solid waste. Soil from the initial excavation area may be used in the construction of the main facility access road or placed in stockpiles and shaped according to the contours shown on Drawing C2E900000A627. As the soil is stockpiled, it will be spread in 8–12-in. loose lifts and uniformly compacted with heavy equipment. A silt fence will be placed at the base of stockpiles to control erosion. Upon completion of the soil stockpile areas, the surface soil will be roughened and planted with vegetative cover. Excavated materials may also be stockpiled on top of the partially completed portions of the landfill in order to minimize haul distances.

The compacted solid waste in ILF-V will be covered at the end of each operating day with daily cover to minimize water infiltration in the event of precipitation, to minimize waste from becoming airborne due to wind, and to minimize insect and vector problems. As a primary means of daily cover, soil and a minimum 8-mil plastic sheeting will be utilized in the following manner.

At the end of the working day, 6 in. of compacted soil cover will be placed on the top surface of each cell. The plastic sheeting will be spread daily over the sloped working face and will be anchored in place with heavy objects (e.g., blocks, sandbags, or earthen piles) to prevent wind removal. The plastic sheeting will be left in place as a disposable item when filling operations begin the following day. The width of the daily waste cells will be sized in order to keep seams in the plastic to a minimum. On the last working day of each week (Friday or Saturday), 6 in. of compacted soil cover will replace the plastic sheeting as the sloped working face cover, in order to isolate the waste cells and to help prevent the spread of fires that might occur.

If weather conditions (e.g., high winds, high rainfall) or operational considerations make the use of the plastic sheeting impractical, the equipment operator will use a minimum of 6 in. of compacted soil over the waste as daily cover. A bulldozer/compactor will be used to spread and compact the cover materials.

4.6 Leachate Holding Tank Area

The operation of the leachate holding tank area is semiautomatic and does not require full-time personnel presence. Initial startup of the leachate holding tank area includes the following two steps.

1. Select one holding tank to receive leachate by setting the leachate lift station pump discharge valving so that leachate will flow to the desired tank.

2. Energize lift station pumps 1 and 2.

The lift station control system then will automatically turn the pumps on and off by level controls. The system has alternate lead and lag pumps to equalize pump use.

Leachate will drain by gravity from each manhole to the lift station, from where it will be pumped into one of two 125,000-gallon aboveground, steel leachate holding tanks. The leachate will be mixed with diffused air in the leachate holding tank, after which it will either be pumped into a tank truck for appropriate disposal or pretreatment or be pumped through a pipeline directly to the sanitary sewer system for treatment by the City of Oak Ridge sewage treatment plant. Leachate monitoring will be performed as required in order to comply with the pretreatment requirements for the wastewater treatment facility receiving the leachate.

As leachate accumulates in a holding tank, landfill personnel will set the valves in the blower discharge line to introduce air into the filling tank and will manually energize the blower. The criteria and schedule for blower operation will be determined by leachate tank levels and by leachate removal requirements.

Normal operation of the leachate facility allows transfer of leachate from the holding tanks into the sanitary sewer system. Discharge pumps will be manually controlled by setting the tank removal selector switch to the appropriate tank, arranging the tank discharge line valving to provide suction to the desired pump, and energizing the desired leachate discharge pump. The operating criteria and schedule for this operation are determined by leachate quantity as well as by whether or not the leachate quality meets the acceptance criteria established by the wastewater treatment system.

If leachate is unacceptable for discharge into the sanitary sewer, the leachate is removed from the holding tank by tanker truck for alternative disposal. This is accomplished by setting the tank removal selector switch to the appropriate tank and energizing the loading and transfer pump. The loading and transfer pump can also be used to transfer leachate from one tank to the other. All operations are performed by trained personnel.

In normal operations, the leachate holding system will be monitored periodically to review system operation. Items to be monitored include the following at a minimum:

- alarm lights,
- lift sump operation,
- freeze protection (seasonal),

- tank levels,
- blower operation,
- visual inspection for leakage of leachate, and
- rainwater accumulation in the dike.

Records of observations are maintained by the WTLO.

4.7 Maintenance

The Y-12 Plant employs and provides training for mechanics and equipment service personnel for maintaining the vehicles and equipment used in the plant. Programmed maintenance and minor repairs of equipment are performed in the field. For major repair work, the equipment will be transported to the Y-12 Garage or to a commercial repair facility.

Required maintenance will be performed on leachate pumps, motors, valves, etc. Any parts necessary to maintain operation will be acquired and installed. If necessary, the entire component will be replaced. The leachate collection lines will be inspected semiannually for blockage and will be cleaned as necessary.

Grounds maintenance, including seeding, mowing, road grading, and trash pickup, will be provided by the Y-12 WTLO Department. Drainage channels will be maintained to minimize run-on onto the landfill area, to prevent erosion of earthen cover, and to drain surface runoff from the landfill. The sediment in the siltation ponds will be removed as required.

Grass cover will be established on completed and unused earthen surfaces around the open landfill area(s) to minimize erosion and the generation of dust. Gravel roads will be graded periodically and/or sprayed with water as necessary to control dust.

Utilization of proper landfill operating procedures, including daily cover and compaction of waste, should minimize any problems with vectors. However, if a vector problem should arise, an assessment will be made of the operating conditions to see what conditions are being maintained that are favorable for the existence of the vectors, and the necessary corrective actions will be taken.

5.0 ADMINISTRATIVE OPERATIONS

5.1 Organization

ILF-V is owned by DOE and managed by the Y-12 Plant WMD. The landfill will serve the three DOE plants managed by Energy Systems in Oak Ridge (Y-12 Plant, K-25 Site, and ORNL) and certain other prime contractors to DOE in Oak Ridge. Waste generated as part of DOE operations in the Oak Ridge area, but external to the three plants, may be disposed of at the facility within the TDEC/DSWM guidelines and/or special waste approvals. Solid waste from the private sector of Oak Ridge and surrounding areas will not be accepted at the facility, unless approval is obtained from TDEC/DSWM.

As owners of the facility, DOE interfaces with the regulatory agency (TDEC/DSWM) and the facility managers (Y-12 Plant). Appropriate construction and operating permits will be obtained for the facility, required reports will be submitted to TDEC/DSWM, and any corrective actions required by TDEC/DSWM will be initiated and performed.

The WTLO Department of the WMD will allocate equipment and personnel needed for the operation, including disposal area excavation and the maintenance of areas adjacent to the landfill. The WTLO Department will oversee and be responsible for the landfill operation, which includes site maintenance, daily operations, excavation, and necessary actions to correct problems detected by monitoring activities. Additional responsibilities will include working with Engineering to maintain drawings and obtain grade information. A WTLO Department supervisor will be responsible for directing work activities at the facility.

The HSEA Division will oversee the groundwater background characterization and monitoring activities at the facility. The monitoring activities are developed using requirements established by the TDEC/DSWM as guidelines. Five groundwater monitoring wells will be used for ILF-V as shown on Drawing C2E900000A627. HSEA Division personnel will ensure collection and laboratory analyses of the groundwater samples. A copy of the analyses will be forwarded to TDEC/DSWM.

The Plant Emergency Response personnel will respond to calls for incidents involving personnel injury, fire, and requests for assistance for site security control.

5.2 Training

Plant employees participate in regularly scheduled and planned safety meetings designed to encourage safe work habits. Specific operating procedures for facility operations and equipment are reviewed with the employees. In addition, facility personnel are requested to report needed equipment repairs, unusual incidents, and site entry by unauthorized personnel.

Operating personnel are trained in the proper operation of the facility prior to its operation. Assistance in the startup of ILF-V, including the initial disposal area, was provided by a licensed Professional Engineer. Remaining Areas 2–5 differ from the initial area by utilizing a composite liner with a geomembrane and 24-in. protective soil cover. Upon initiating operation of Area 2, assistance will be provided by a Professional Engineer during preparation for waste and initial disposals during the first week of operation. This assistance will provide verification that operating personnel are adequately trained to properly cut windows in the protective soil cover without damaging the geomembrane in the composite liner system utilized in the remaining areas. Initiating operation of Areas 3–5 will not require additional Professional Engineering assistance since this requirement will have been satisfied during startup of Areas 1 and 2. R3

5.3 Inspection and Evaluation

Inspections and evaluations of landfill operations will be performed periodically by personnel from TDEC/DSWM. A notice of any deficiencies and any recommended corrective actions will be sent to DOE and/or Energy Systems.

In addition to the TDEC/DSWM inspections, the WTLO Department will conduct a random inspection program as follows.

1. Inspection will be made of a minimum of 5% of the daily incoming loads. In addition, inspection will be made of all suspicious loads.

2. Records of all inspections will be kept.

3. If regulated hazardous or unpermitted wastes are encountered, the wastes will be returned to the generation source for proper disposal (see below).

4. Facility personnel will be trained to recognize regulated hazardous and unpermitted wastes.

One out of every 20 loads of unbaled waste will be inspected as it is deposited at the working face. In addition, 1 out of every 20 loads of waste delivered to the baler will be inspected. The driver will be directed to a location where inspection of the load can easily be accomplished. Facility personnel will first check the load on the truck when possible. If the waste appears to be of acceptable composition, the driver will then be directed to dump the load while spreading it out somewhat. Facility personnel will then further inspect the waste and record its general composition while being alert for special or regulated hazardous wastes. Inspection will include radiation detection monitoring equipment. In addition, any load of solid wastes delivered to the facility deemed suspicious by facility personnel will also be inspected for conformance with TDEC/DSWM regulations.

Respiratory Hazardous Waste Handling Procedures require the containment packaging not to be breeched. Radiation surveys are performed by Health Physics before delivery to the landfill for disposal. Therefore, these wastes are not included in the 1 out of 20 inspection count.

The inspector will keep a record of each inspection by recording the composition of the waste, information suitable to identify the hauler and the source, date and time of delivery, and other comments relative to the particular load.

If upon inspection of any load of refuse a regulated hazardous waste is identified, facility personnel will immediately notify the WTLO Department supervisor. The supervisor will then inspect the load to verify that the waste may be regulated hazardous waste. If the supervisor determines that all or a portion of the load may be regulated hazardous waste, the generator of the waste will be contacted and directed to remove the waste, if the generator can be identified. Every attempt will be made to identify the generator and to hold them responsible for any costs involved in handling the waste. The WMD will assume

responsibility for handling these wastes only as a last resort. Under no circumstances will such wastes be disposed of in ILF-V unless specifically authorized by TDEC/DSWM.

Facility personnel have been trained to properly operate the facility and to recognize hazardous wastes and follow the proper procedures.

5.4 Records and Reports

Records of the source, weight, and/or volume of waste received at the landfill each day will be maintained by the WTLO Department. Records will be maintained for the random inspection of daily incoming loads. Additional records will be kept of the operating costs, including labor, materials, and equipment maintenance. This information will be maintained for future planning and reports. A report will be filed annually with TDEC/DSWM to provide an estimate of the remaining useful life at the landfill site.

Records of the groundwater monitoring activities and analyses results will be maintained by the Y-12 Plant HSEA Division and the WMD through the post closure care period of the landfill.

6.0 FINAL CLOSURE OF LANDFILL

TDEC/DSWM will be notified in writing of the intent to close the landfill at least 60 days prior to the date final closure is expected to begin. Upon achieving final waste fill elevations, the final cover will be placed over the completed landfill. This will be accomplished in the shortest time practicable, not to exceed 90 days after completion of waste filling operations. The cover will be placed as described in the Closure/Post Closure Plan for Landfill V. In the shortest time practicable, not to exceed 180 days after the disposal area has achieved final waste fill elevations, closure activities (including final grading, surface drainage and road construction, and establishing vegetative cover) will be complete. Closure will be in accordance with the Closure Plan as approved by TDEC/DSWM and as shown on Drawing C2E900000A630. The closure design implements measures to minimize run-on, optimize drainage, prevent pooling, and minimize erosion. The design does not adversely affect drainage of adjacent lands.

If at any point in time during the life of the landfill it becomes necessary to partially close the landfill before maximum utilization of the fill area is achieved, an engineering assessment of the current state of ILF-V with respect to the TDEC/DSWM-approved plan will be performed. Required changes to the Closure/Post Closure Plan will be accomplished and submitted to TDEC/DSWM for approval. Partial closure then will proceed in accordance with the approved, revised Closure/Post Closure Plan.

Upon completion of closure activities for ILF-V, TDEC/DSWM will be notified in writing of the completion of closure. The notification will include certification as required by TDEC/DSWM that the closure has been accomplished in accordance with the approved Closure Plan. An inspection of the closure will be made by TDEC/DSWM to verify that the closure has been performed in accordance with the approved plan. Closure will not be considered final and complete until approved in writing by TDEC/DSWM.

Within 90 days of completion of final closure, a notation will be recorded on the deed to the property or some other instrument which is normally examined during a title search that will in perpetuity notify any person conducting a title search that the land has been used as a disposal facility.

In addition, in accordance with state law, within 60 days of ILF-V becoming inactive (i.e., final closure), a notation will be recorded on the deed to the facility property and on any other instrument that would normally be examined during a title search. The notation will in perpetuity notify any potential purchaser of the property of the following.

- The land has been used for the disposal of asbestos-containing waste material.
- The survey plot and record of the location and quantity of asbestos-containing waste disposed of within the disposal site have been filed with the Administrator or Commissioner.
- The site is subject to Code of Federal Regulations (CFR) 40 CFR 61, Subpart M.

The anticipated life of ILF-V is approximately 67.5 yrs, based on current waste disposal projections. Therefore, it is estimated the landfill will close in the year 2061. Many closure activities, such as placement of final cover and establishment of vegetation, may occur during the landfill operating life as the final elevation is reached. The terraces, letdown channel, and road also may be constructed as the appropriate landfill elevations are reached to allow their construction and proper function.

The complete Closure Plan has been revised to incorporate design changes commensurate with recent regulatory changes and is being submitted to TDEC/DSWM for review and approval.

7.0 POST CLOSURE CARE OF LANDFILL

The closed landfill will be afforded post closure care for a period of 30 yrs after the date of the final completion of closure of the landfill. The WTLO Department will be responsible for all post closure care activities except for the groundwater monitoring. Post closure groundwater monitoring will be the responsibility of the HSEA Division.

Post closure care will include, as a minimum, the following activities.

- Maintain the final contours to assure the proper functioning of the drainage system of the site.
- Ensure that a healthy vegetative cover is established and maintained, including mowing as required.
- Maintain drainage facilities, siltation ponds, and erosion control measures until vegetative cover is established sufficiently to render such maintenance unnecessary.
- Repair any cracked, eroded, and uneven areas that occur in the final cover.

- Maintain groundwater monitoring in accordance with the approved plan.
- Maintain leachate collection, disposal, and monitoring in accordance with the approved plan.
- Maintain gas venting system.

The completed site will be owned and maintained by DOE for an indefinite period. The intended use for the site is as a grassed area. There are no plans for future development of the closed site.

The TDEC/DSWM rules have a provision for landfill operators to provide financial assurance for closure and post closure care of landfills. However, this requirement is waived for facilities operated by the federal government.

The complete Post Closure Plan is provided as a separate document.

APPENDIX A

DRAWING INDEX FOR Y-12 INDUSTRIAL LANDFILL V

TABLE 1

LIST OF ORIGINAL DRAWINGS FOR PERMIT APPLICATION

C2E900000A703	Cover Sheet
C2E900000A704	Index Sheet
C2E900000A705	Overall Site Plan
C2E900000A627	Total Site Development and Excavation Plan
C2E900000A628	Initial Construction Plan
C2E900000A629	Initial Construction Plan (Bid Alternate A)
C2E900000A630	Final Closure Plan
C2E900000A631	Landfill Cross Sections - I
C2E900000A632	Landfill Cross Sections - II
C2E900000A633	Landfill Cross Sections - III
C2E900000A634	Landfill Cross Sections - IV
C2E900000A635	Landfill Details - I
C2E900000A636	Landfill Details - II
C2E900000A637	Landfill Details - III
C2E900000A638	Landfill Details - IV
C2E900000A639	Leachate Sewer Profiles
C2E900000A641	Leachate Holding Tank Area - Site Plan
P2E900000A027	Leachate Holding Tank Area - Tank Piping Details
P2E900000A028	Leachate Holding Tank Area - Details
P2E900000A029	Leachate Holding Tank Area - Pump & Blower Details
P2E900000A030	Leachate Holding Tank Area - Pipe Supports & Misc. Details
S2E900000A001	Leachate Holding Tank Area - Foundation Plan
S2E900000A002	Leachate Holding Tank Area - Structural Sections
S2E900000A004	Miscellaneous Structural Details I

TABLE 2

LIST OF NEW AND REVISED DRAWINGS FOR REVISED PERMIT

C2E900000A703	Permit Package Access Plan and Drawing Index
C2E900000A627	Total Site Development and Excavation Plan
C2E900000A925	Area 2 Partial Plan Protective Soil Cover
C2E900000A926	Area 3 Partial Plan Protective Soil Cover
C2E900000A630	Final Closure Plan
C2E900000A631	Landfill Cross Sections - I
C2E900000A632	Landfill Cross Sections - II
C2E900000A633	Landfill Cross Sections - III
C2E900000A634	Landfill Cross Sections - IV
C2E900000A927	Leachate Sewer Profiles Areas 2 & 3
C2E900000A635	Landfill Details - I
C2E900000A636	Landfill Details - II
C2E900000A928	Landfill Details - V
C2E900000A929	Landfill Details - VI
C2E900000A930	Landfill Details - VII
C2E900000A931	Landfill Details - VIII

APPENDIX B

COMPOSITION OF WASTE DELIVERED TO THE Y-12 INDUSTRIAL LANDFILL V

The disposal of the following at the landfill is permissible.[1,2,3,4]

Primary Waste Stream

Paper and cardboard	Noninfectious institutional waste
Plastic and rubber	Treated medical waste
Animal bedding	Miscellaneous metals
Organic garbage	Food and cafeteria waste
Textile products	
Empty containers	(not otherwise listed as special wastes)
Glass	(not otherwise listed as other waste)
Special wastes	[Categories of special wastes will be subject to approval by TDEC/DSWM prior to acceptance at the Y-12 Industrial Landfill V (ILF-V).]

Secondary Waste Stream

Brick	Soil
Concrete	Rock
Masonry materials	Gravel
Lumber	Road spoil
Paving materials	PVC pipe
Sheetrock/gypsum	Paneling
Roofing materials	Flooring
Polyethylene sheeting	

Rebar (embedded in concrete)
Vitrified clay materials (tile, pipe, block, etc.)
Insulation materials (fiberglass, rockwool, styrofoam)
Building siding materials
Miscellaneous metals associated with building demolition
Window and door glass associated with building demolition
Miscellaneous building demolition materials
Miscellaneous dewatered debris from the cleanout and maintenance of sanitary and storm sewers on the Oak Ridge Reservation

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1 The WTLO Department manager may limit the quantity of debris accepted from any source delivered to ILF-V. Also, the WTLO Department manager may impose conditions on acceptance as required to meet Plant Safety Department requirements.

2 Exclusion of waste categories from this list does not preclude acceptance at ILF-V. Acceptance is based on requirements of the TDEC/DSWM rules.

3 The follow wastes will not be acceptable for disposal: Resource Conservation and Recovery Act (RCRA) wastes, polychlorinated biphenyl (PCB) wastes, radioactive wastes, wastes containing free liquids, and lead acid batteries.

4 Masonry materials must be cured for 60 days or more.

APPENDIX C

PROCEDURES AND GUIDELINES FOR THE DISPOSAL OF SPECIAL AND OTHER WASTES AT THE Y-12 INDUSTRIAL LANDFILL V

These special and other solid wastes are approved for disposal in the Y-12 Industrial Landfill V (ILF-V), subject to the procedures and guidelines discussed in this section.

Special Waste:	Asbestos Waste	C-3
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Special Waste:	Beryllium Oxide Wastes	C-9
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Special Waste:	Fly Ash, Oak Ridge National Laboratory	C-27
Special Waste:	Fly Ash, Y-12 Plant	C-29
Special Waste:	Petroleum Product Contaminated Soil	C-31
Special Waste:	Steam Plant Wastewater Treatment Facility Sludge, Y-12 Plant	C-32
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Other special solid wastes will be deposited in the landfill as approved by TDEC/DSWM.

SPECIAL WASTE: ASBESTOS WASTE

General: Asbestos waste from the DOE facilities in Oak Ridge includes insulation, piping, metal, equipment, and clothing that contains or is contaminated with asbestos. The asbestos is generated principally through maintenance and demolition activities at the facilities. Strict procedures are followed for handling the asbestos materials. Asbestos-bearing materials are wet down prior to removal activities to eliminate concentrations of airborne fibers for the protection of employees. All such wastes are packaged and sealed in double-thickness plastic bags. The bags are then labeled as containing asbestos. Guidelines for the handling and disposal of asbestos waste at ILF-V are given in the following sections. The Tennessee Division of Air Pollution Control and DSWM will be notified 10 days prior to the initial disposal of asbestos waste to allow an inspection of the procedures and facilities by representatives from the respective organizations.

Packaging: Asbestos wastes will be packaged and sealed tightly in double-bagged, 6-mil-thick plastic bags; double-wrapped, 6-mil-thick plastic sheets (piping and equipment); fiber drums; metal drums; or plywood boxes. A label or tag describing the container's contents will be attached to each container.

Transport Vehicles: The packaged wastes will be placed in a fully enclosed space or be fully covered by a secured tarpaulin on the vehicles transporting the wastes to the landfill.

Handling and Unloading: All handling and unloading will be carefully performed to avoid the rupturing of containers. Lightweight, plastic-wrapped, or bagged waste containing highly friable asbestos (i.e., ductwork or boiler insulation) shall be carefully unloaded manually and stacked in the asbestos waste cell being operated that day. If necessary, heavy, highly friable waste wrapped in plastic may be unloaded with forklifts, cranes, or other suitable equipment, provided that rupturing of containment packaging does not occur. Low-friable asbestos material (i.e., roofing, siding, floor, or ceiling tiles) may be dumped, provided the material is wrapped in a plastic sheath and is covered carefully, avoiding contact with equipment blades or treads. Determination of the unloading method will be based on the friability classification. Durable containers, such as sturdy drums, may be unloaded by slowly raising trucks beds and allowing the containers to slide to the ground. Plastic-wrapped and bagged wastes are not to be moved with heavy equipment blades. Packaging, handling, and loading methods shall be chosen to maintain container integrity.

Waste Cell Operation: As previously stated, asbestos waste will be disposed of in ILF-V. These wastes will be buried in the regular landfill areas in specific cells separated from cells used for other industrial wastes. A specific area for asbestos waste will be selected and prepared for each disposal operation on the working face of the landfill area. The same area or cell may also be used for the disposal of any beryllium oxide waste transported the same day.

The packaged wastes will be carefully unloaded from the trucks and placed in the proper waste cell area as designated by the landfill technician. Back-to-back unloading of several trucks will be considered one unloading operation. After continuous unloading operations are completed, or at any major time lag before unloading will be continued, the waste will be covered with at least 12 in. of cover material. After all asbestos waste is delivered, unloaded, and covered at the end of the day's operation, the landfill

equipment will compact the covered waste. Extra cover material will be added as necessary to maintain a minimum cover thickness of 12 in., to fill in depressions, and to provide proper drainage. Only suitable soil will be used as cover material.

Protection: During all disposal operations of the asbestos waste, all nonessential personnel will be required to stay at least 100 ft from the disposal activities. All personnel within 100 ft of the disposal operation will be required to wear respirators.

Portable warning signs, prepared in accordance with Tennessee Air Quality Regulations, Chapter 1200-3-11-.02, will be set adjacent to the asbestos waste cell on the days of disposal of the subject material.

Records: The entire ILF-V site will be used for asbestos disposal; therefore, the entire site will be designated as an asbestos landfill. The designation *asbestos landfill* eliminates the need for identifying and surveying the location of individual asbestos cells.

A representative of the organization generating the asbestos wastes will be required to complete the generator section of the Asbestos Waste Shipment Record for each truckload of waste. This completed form will be sent to the landfill technician via the waste transport vehicle. The transporter(s) is(are) required to complete the transporter section of the Asbestos Waste Shipment Record. This form is shown on page C-4.

The landfill technician will complete the disposal site section of the Waste Shipment Record and compare the amount of waste shipped versus amounts received for burial. This form is shown on page C-4, and the instructions are on pages C-5 and C-6.

These logs will be kept on file by the Y-12 WTLO Department. Copies of the logs will be sent each month to TDEC/DSWM.

Scheduling: A routine schedule will be established for the disposal of the asbestos wastes. It is anticipated that disposal of these wastes will be conducted on the same day each week. This schedule will allow the waste generators, transporters, and landfill operators to plan and prepare for the necessary activities. Varying waste generation rates, which may result from large demolition projects or holiday seasons, may require an additional day for disposal or deletion of a regularly scheduled day for disposal. In either case, all parties will be given sufficient notice to adjust their schedules.

ASBESTOS WASTE SHIPMENT RECORD

Generator	1. Work site name and mailing address	Owner's name	Owner's telephone no.
	2. Operator's name and address		Owner's telephone no.
	3. Waste disposal site (WDS) name, mailing address, and physical site location		WDS telephone no.
	4. Name and address of responsible agency		
	5. Description of materials	6. Containers No. Type	7. Total qty. m^3 (yd^3)
	8. Special handling instructions and additional information		
	9. OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and government regulations.		
	Printed/typed name & title	Signature	Month Day Year
Transporter	10. Transporter 1 (Acknowledgment of receipt of materials)		
	Printed/typed name & title Address and telephone no.	Signature	Month Day Year
	11. Transporter 2 (Acknowledgment of receipt of materials)		
	Printed/typed name & title Address and telephone no.	Signature	Month Day Year
Disposal Site	12. Discrepancy indication space		
	13. Waste disposal site owner or operator: Certification of receipt of asbestos materials covered by this manifest except as noted in item 12.		
	Printed/typed name & title	Signature	Month Day Year

INSTRUCTIONS

Waste Generator Section (Items 1–9)

1. Enter the name of the facility at which asbestos waste is generated and the address where the facility is located. In the appropriate spaces, also enter the name of the owner of the facility and the owner's phone number.

2. If a demolition or renovation is involved, enter the name and address of the company and authorized agent responsible for performing the asbestos removal. In the appropriate spaces, also enter the phone number of the operator.

3. Enter the name, address, and physical site location of the waste disposal site (WDS) that will be receiving the asbestos materials. In the appropriate spaces, also enter the phone number of the WDS. Enter "on-site" if the waste will be disposed of on the generator's property.

4. Provide the name and address of the local, state, or EPA Regional office responsible for administering the asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP) program.

5. Indicate the types of asbestos waste materials generated. If from a demolition or renovation, indicate the amount of asbestos that is

   - friable asbestos material
   - nonfriable asbestos material

6. Enter the number of containers used to transport the asbestos materials listed in item 5. Also enter one of the following container codes used in transporting each type of asbestos material (specify any other type of container used, if not listed below):

   DM—metal drums, barrels
   DP—plastic drums, barrels
   BA—6-mil plastic bags or wrapping

7. Enter the quantities of each type of asbestos material removed in units of cubic meters (cubic yards).

8. Use this space to indicate special transportation; treatment, storage or disposal; or Bill of Lading information. If an alternate waste disposal site is designated, note it here. Emergency response telephone numbers or similar information may be included here.

9. The authorized agent of the waste generator must read and then sign and date this certification. The date is the date of receipt by transporter.

NOTE: The waste generator must retain a copy of this form.

Transporter Section (Items 10 and 11)

10/11. Enter the name, address, and telephone number of each transporter used, if applicable. Print or type the full name and title of person accepting responsibility and acknowledging receipt of materials as listed on this waste shipment record for transport. Enter date of receipt and signature.

NOTE: The transporter must retain a copy of this form.

Disposal Site Section (Items 12 and 13)

12. The authorized representative of the WDS must note in this space any discrepancy between waste described on this manifest and waste actually received, as well as any improperly enclosed or contained waste. Any rejected materials should be listed and the destination of those materials provided. A site that converts asbestos-containing waste material to nonasbestos material is considered a WDS.

13. The handwritten signature of the authorized WDS agent indicates acceptance and agreement with statements on this manifest except as noted in item 12. The date is the date of the signature and receipt of shipment.

NOTE: The WDS must retain a completed copy of this form. The WDS must also send a completed copy to the operator listed in item 2.

SPECIAL WASTE: BALED WASTE

The Y-12 Plant, the K-25 Site, and/or ORNL may send their waste to ILF-V in loose form; or they may develop and implement plans to bale wastes at the individual plant sites prior to disposal of the baled waste in ILF-V. Since Energy Systems operates all three sites for DOE, such baling and processing of solid waste is not required to have a permit (Rule 1200-1-7-.02). The baling of the waste will be controlled to allow only wastes as defined in Appendix B to be baled. Excluded wastes will not be allowed in the baling operation. Prior to baling the solid waste, random inspections will be performed on the unbaled waste for the presence of excluded wastes. The baled waste from the Y-12 Plant, the K-25 Site, and ORNL may be disposed of with unbaled waste at ILF-V. Plastic wrapped bales will be stacked at the working face, provided a stable working face can be obtained. The waste will be compacted in a manner that minimizes subsidence around the bales.

As part of the administration of the baled waste operation, the generators of the baled waste will be required, on an annual basis, to complete Y-12 Form 2109 (Request for Transfer, Storage, or Disposal of Wastes). This will document that their baled waste stream meets the requirements of Appendix B and does not contain excluded wastes. The completed Form 2109 will be submitted annually to the Y-12 WTLO Department before baled waste will be accepted at ILF-V from the respective generator.

SPECIAL WASTE: BERYLLIUM OXIDE WASTES

General: Beryllium oxide (BeO) wastes are generated at the DOE facilities in Oak Ridge. The waste composition includes metals, piping, equipment, clothing, plastic bags, paper, wood, and demolition materials contaminated with BeO. Variable quantities of BeO solids and filter cake may be included in the waste stream. The BeO wastes are generated principally through maintenance, demolition, and fabrication activities at the facilities. Strict procedures are followed for handling BeO materials. During fabrication, BeO materials are worked in controlled areas in enclosed machines and facilities. Mineral oil is used as a coolant and lubricant during machining operations. The used mineral oil is continuously filtered using a filter press. The resulting filter cake and papers may constitute a portion of the waste stream. Solid wastes from BeO process areas are checked for surface contamination before removal from the process areas. Those wastes that have been identified as containing BeO contamination are packaged prior to removal from the process areas and labeled as containing BeO. Guidelines for handling and disposal of BeO waste at the Y-12 ILF-V are given in the following sections. The Tennessee Division of Air Pollution Control and DSWM will be notified 10 days prior to the initial disposal of BeO waste to allow an inspection of the procedures and facilities by representatives from the respective organizations.

Packaging: BeO wastes will be packaged and sealed tightly in double-bagged, 6-mil-thick plastic bags; double-wrapped, 6-mil-thick plastic sheets (piping and equipment); fiber drums; metal drums; or plywood boxes. A label or tag describing the container's contents will be attached to each container.

Transport Vehicles: The bagged wastes will be placed in a fully enclosed space or be fully covered by a secured tarpaulin on the vehicles transporting the wastes to the landfill. The wastes in drums and boxes will be transported to the landfill using standard transport vehicles only.

Handling and Unloading: All handling and unloading will be carefully performed to avoid rupturing the containers. Lightweight, plastic-wrapped or -bagged waste will be carefully unloaded manually and stacked in the BeO waste cell being operated that day. If necessary, heavy waste wrapped in plastic will be unloaded with forklifts, cranes, or other suitable equipment. The sturdy drums and boxes will be unloaded by slowly raising the truckbeds and allowing the containers to slide out of the truckbeds. Plastic-wrapped and -bagged waste will not be moved with heavy equipment blades. Packaging, handling, and unloading methods will be chosen to maintain container integrity.

Waste Cell Operation: As previously stated, BeO waste will be disposed of in ILF-V. These wastes will be buried in the regular landfill areas in specific cells separated from cells used for the industrial wastes. A specific area for BeO waste will be selected and prepared for each disposal operation on the working face of the landfill area. The same area or cell may also be used for the disposal of any asbestos waste transported the same day.

The packaged wastes will be carefully unloaded from the trucks and placed in the proper waste cell area as designated by the landfill technician. Back-to-back unloading of several trucks will be considered one unloading operation. After continuous unloading operations are completed, or at any major time lag before unloading will be continued, the waste will be covered with at least 12 in. of cover material. After all BeO waste is delivered, unloaded, and covered at the end of the day's operation, the landfill equipment

will compact the covered waste. Extra cover material will be added as necessary to maintain a minimum cover thickness of 12 in., to fill in depressions, and to provide proper drainage. Only suitable soil will be used as cover material.

Protection: During all disposal operations of the BeO waste, all nonessential personnel will be required to stay at least 100 ft from the disposal activities. All personnel within 100 ft of the disposal operation will be required to wear respirators.

Portable warning signs, similar to those for asbestos and described in Tennessee Air Quality Regulations, Chapter 1200-3-11-.02, will be set adjacent to the BeO waste cell on the days of disposal of the subject material.

Records: The entire ILF-V will be used for BeO disposal; therefore, the entire site will be designated as a BeO landfill. The designation "*BeO landfill*" eliminates the need for identifying and surveying the location of individual BeO cells.

A representative of the organization generating the BeO wastes will be required to complete a Generator's/Shipper's Log for Beryllium/Beryllium Oxide Removal and Disposal for each truckload of waste. This completed form will be sent to the landfill technician via the waste transport vehicle. This form is shown on page C-9.

The landfill technician will complete a Landfill Technician's Log for Beryllium/ Beryllium Oxide Disposal and compare the amount of waste shipped versus amounts received for burial. This form is shown on page C-11.

These logs will be kept on file by the Y-12 WTLO Department. Copies of the logs will be sent each month to TDEC/DSWM.

Scheduling: A routine schedule will be established for the disposal of the BeO wastes. It is anticipated that disposal of these wastes will be conducted on the same day each week. This schedule will allow the waste generators, transporters, and landfill operators to plan and prepare for the necessary activities. Varying waste generation rates, which may result from large demolition projects or holiday seasons, may require an additional day for disposal or deletion of a regularly scheduled day for disposal. In either case, all parties will be given sufficient notice to adjust their schedules.

GENERATOR'S/SHIPPER'S LOG FOR BERYLLIUM/BERYLLIUM OXIDE REMOVAL AND DISPOSAL

1. Description of Be/BeO-Containing Wastes

Load Number	Date Loaded	Number of Cntrs	Type of Cntrs	Description

Total Weight (lbs): _____ Total Volume (yd^3): _____

2. Name/Address of Site from Which Removed

Plant Site: _____, Oak Ridge, TN

Building(s) or Area(s): _____

3. Name/Address of Landfill to Which Sent for Disposal

_____ Y-12 ILF-V, Oak Ridge, TN

4. Transporter (Check One)

_____ Lockheed Martin _____ MK-Ferguson
_____ Other (specify) _____

5. Charge Account

Blanket No. _____ Job or Charge No. _____

6. Waste Delivery (To Be Completed by Transporter)

Delivery No. _____ Date Delivered _____ Truck Tag No. _____

7. Certification by Person Responsible for Removal Operations

I hereby certify that the above record of waste shipped is complete and accurate and that the waste was packaged and transported as specified in the approval letter.

Generator:	Transporter:
Name _____	Name _____
Badge _____	Badge _____
Affiliation _____	Affiliation _____
Date _____	Date _____

LANDFILL TECHNICIAN'S LOG FOR BERYLLIUM/BERYLLIUM OXIDE DISPOSAL

1. Description of Beryllium/Beryllium Oxide-Containing Wastes

Delivery Number	Truck Tag No.	Date Received	Approx. No. & Type of Cntrs	Description

Total Weight (lbs) _____ Total Volume (yd^3) _____

2. Name/Address of Receiving Landfill

_____ Y-12 ILF-V, Oak Ridge, TN

3. Name/Address of Site from Which Removed

Plant Site: _____, Oak Ridge, TN

5. Charge Account

Blanket No. _____

Job or Charge No. _____

6. Certification by Landfill Technician

I hereby certify that the above record of waste received is complete and accurate, and that the waste was handled and disposed of as specified in the approval letter.

Name _____

Badge _____

Affiliation _____

Date _____

SPECIAL WASTE: BOTTOM ASH—Y-12 PLANT

Pulverized coal is burned in the Y-12 Steam Plant's four industrial boilers to generate steam for process and heating purposes. Bottom ash from the operation is sluiced into dewatering bins where it is dewatered and then hauled by truck to ILF-V. Moisture content of the ash is controlled to a range that prevents fugitive dust and allows good handling properties but does not contain free liquids. Bottom ash from this process will be disposed of with normal waste (not in a special cell). Characteristics of the bottom ash are as follows:

1. Physical Characteristics

State:	Sludge
Color:	Black
Moisture Content:	No free liquids

2. Chemical Characteristics

   See page C-13 for analyses results.

3. Quantity

   280 tons per month maximum

4. Additional Characteristics

   - Sludge will not contain any free liquids.
   - Sludge will be suitable for handling, unloading, and landfill operations.
   - Operators will operate the ash handling facility to minimize moisture content while maintaining dust control.

Bottom Ash: Y-12 Plant

CAS NO.	COMPOUND	REGULATORY LIMIT	11/23/94 SAMPLE
	METALS	--mg/l--	--mg/l--
7440-38-2	Arsenic	5.0	< 0.50
7440-49-3	Barium	100.0	< 10
7440-43-9	Cadmium	1.0	< 0.10
7440-47-3	Chromium	5.0	< 0.50
7439-92-1	Lead	5.0	< 0.50
7439-97-6	Mercury	0.2	< 0.02
7782-49-2	Selenium	1.0	< 0.1
7440-22-4	Silver	5.0	< 0.50
	HERBICIDES & PESTICIDES		
93-72-1	2,4,5-TP (Silvex)	1.0	< 0.1
94-75-7	2,4-D	10.0	< 1.0
57-74-9	Chlordane	0.03	< 0.003
72-20-8	Endrin	0.02	< 0.002
76-44-8	Heptachlor	0.008	< 0.0008
1024-57-3	Heptachlor epoxide	0.008	< 0.0008
72-43-5	Methoxychlor	10.0	< 1.0
8001-35-2	Toxaphene	0.5	< 0.05
58-89-9	gamma-BHC (Lindane)	0.4	< 0.04
	VOLATILE ORGANICS		
75-35-4	1,1-Dichloroethene	0.7	0.07 U
107-06-2	1,2-Dichloroethane	0.5	0.05 U
106-46-7	1,4-Dichlorobenzene	7.5	0.75 U
78-93-3	2-Butanone	200.0	20. U
71-43-2	Benzene	0.5	0.05 U
56-23-5	Carbon tetrachloride	0.5	0.05 U
108-90-7	Chlorobenzene	100.0	10. U
67-66-3	Chloroform	6.0	0.6 U
127-18-4	Tetrachloroethene	0.7	0.07 U
79-01-6	Trichloroethene	0.5	0.05 U
75-01-4	Vinyl chloride	0.2	0.02 U
	BASE NEUTRAL/ACID EXTRACTABLE		
95-95-4	2,4,5-Trichlorophenol	400.0	40. U
88-06-2	2,4,6-Trichlorophenol	2.0	0.2 U
121-14-2	2,4-Dinitrotoluene	0.13	0.013 U
95-48-7	2-Methylphenol	200.0	20. U
108-39-4	3-Methylphenol	200.0	20. U
106-44-5	4-Methylphenol	200.0	20. U
118-74-1	Hexachlorobenzene	0.13	0.013 U
87-68-3	Hexachlorobutadiene	0.5	0.05 U
67-72-1	Hexachloroethane	3.0	0.3 U
98-95-3	Nitrobenzene	2.0	0.2 U
87-86-5	Pentachlorophenol	100.0	0.06 U
110-86-1	Pyridine	5.0	0.5 U

SYMBOL	INTERPRETATION
<	Denotes that compound was detected, but at estimated concentration less than the indicated lower reporting limit, generally established as one-tenth of the regulatory limit.
U	Denotes that compound was undetected; number shown is the lower reporting limit.

OTHER COMMONLY USED NAMES FOR COMPOUNDS

1,1-Dichloroethene = 1,1-Dichloroethylene
2-Butanone = Methyl ethyl ketone = MEK
Tetrachloroethene = Tetrachloroethylene
Trichloroethene = Trichloroethylene
2-Methylphenol = o-Cresol
3-Methylphenol = m-Cresol
4-Methylphenol = p-Cresol

SPECIAL WASTE: COAL PILE RUNOFF SLUDGE—K-25 SITE

The K-25 Site generates approximately 200,000 gallons of coal pile runoff sludge per year. The coal pile runoff flows to a neutralization facility where it is neutralized with lime. The resulting precipitate is then discharged to one of two retention basins, which will be dredged about four times per year. The dredged sludge will be dewatered and disposed of in ILF-V by incorporation with the normal waste (not in a special cell). The K-25 Steam Plant is being converted from coal to natural gas as a fuel. As a result of this conversion, the need for the K-25 Coal Yard will diminish. In addition, the resulting Coal Yard runoff sludge will diminish. Eventually, the K-25 Coal Yard runoff sludge waste stream will be eliminated.

1. Physical Characteristics

State:	Sludge
Color:	Orange
Moisture Content:	75%
Density:	0.65 g/ml (dry weight)

2. Chemical Characteristics

pH:	6.5–8.5

See page C-15 for Toxic Characteristic Leaching Procedure (TCLP) analyses results.

Coal Pile Runoff Sludge: K-25 Site

CAS NO.	COMPOUND	REGULATORY LIMIT	9/12/91 SAMPLE 1	9/12/91 SAMPLE 2
	METALS	--mg/l--	--mg/l--	--mg/l--
7440-38-2	Arsenic	5.0	0.023	0.019
7440-49-3	Barium	100.0	0.23	0.28
7440-43-9	Cadmium	1.0	0.016	0.025
7440-47-3	Chromium	5.0	< 0.01	< 0.01
7439-92-1	Lead	5.0	0.0051	< 0.004
7439-97-6	Mercury	0.2	< 0.0004	< 0.0008
7782-49-2	Selenium	1.0	< 0.005	< 0.005
7440-22-4	Silver	5.0	< 0.006	< 0.006
	HERBICIDES & PESTICIDES	--mg/l--	--µg/l--	--µg/l--
93-72-1	2,4,5-TP (Silvex)	1.0	2.0 U	2.0 U
94-75-7	2,4-D	10.0	20. U	20. U
57-74-9	Chlordane	0.03	*	*
72-20-8	Endrin	0.02	2. U	2. U
76-44-8	Heptachlor	0.008	1. U	1. U
1024-57-3	Heptachlor epoxide	0.008	1. U	1. U
72-43-5	Methoxychlor	10.0	10. U	10. U
8001-35-2	Toxaphene	0.5	20. U	20. U
58-89-9	gamma-BHC (Lindane)	0.4	1. U	1. U
	VOLATILE ORGANICS			
75-35-4	1,1-Dichloroethane	0.7	5. U	5. U
107-06-2	1,2-Dichloroethane	0.5	5. U	5. U
106-46-7	1,4-Dichlorobenzene	7.5	5. U	5. U
78-93-3	2-Butanone	200.0	85	100
71-43-2	Benzene	0.5	5. U	5. U
56-23-5	Carbon tetrachloride	0.5	5. U	5. U
108-90-7	Chlorobenzene	100.0	5. U	5. U
67-66-3	Chloroform	6.0	1. J	1. J
127-18-4	Tetrachloroethene	0.7	5. U	5. U
79-01-6	Trichloroethene	0.5	5. U	5. U
75-01-4	Vinyl chloride	0.2	5. U	5. U
	BASE NEUTRAL/ACID EXTRACTABLE			
95-95-4	2,4,5-Trichlorophenol	400.0	170. U	210. U
88-06-2	2,4,6-Trichlorophenol	2.0	34. U	42. U
121-14-2	2,4-Dinitrotoluene	0.13	34. U	42. U
95-48-7	2-Methylphenol	200.0	34. U	42. U
108-39-4	3-Methylphenol	200.0		
106-44-5	4-Methylphenol	200.0	34. U	42. U
118-74-1	Hexachlorobenzene	0.13	34. U	42. U
87-68-3	Hexachlorobutadiene	0.5	34. U	42. U
67-72-1	Hexachloroethane	3.0	5. U	5. U
98-95-3	Nitrobenzene	2.0	34. U	42. U
87-86-5	Pentachlorophenol	100.0	170. U	210. U
110-86-1	Pyridine	5.0		

* Chlordane was analyzed as alpha-Chlordane and gamma-Chlordane. Results were 10 U (µg/l) for each compound.

SYMBOL INTERPRETATION

U Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.

B Analyte was found in the reagent blank as well as the sample.

J Indicates an estimated value.

OTHER COMMONLY USED NAMES FOR COMPOUNDS

1,1-Dichloroethane = 1,1-Dichloroethylene
2-Butanone = Methyl ethyl ketone = MEK
Tetrachloroethene = Tetrachloroethylene
Trichloroethene = Trichloroethylene
2-Methylphenol = o-Cresol
3-Methylphenol = m-Cresol
4-Methylphenol = p-Cresol

SPECIAL WASTE: COAL YARD RUNOFF BASIN SLUDGE— OAK RIDGE NATIONAL LABORATORY

ORNL generates approximately 60,000 gallons of coal yard runoff sludge per year. This sludge is captured in a collection pond where it is stored until periodic removal. The sludge is neutralized with lime and dewatered to at least 55% solids. The sludge will then be disposed of in ILF-V by incorporation with the normal waste (not in a special cell).

The characteristics given below are from samples taken February 8, 1991.

1. Physical Characteristics

State:	Sludge
Color:	Brown
Moisture Content:	66.8%
Density:	1.2277 g/ml

2. Chemical Characteristics

See page C-17 for TCLP analyses results.

3. Additional Waste Stream Characterization

See page C-18.

Coal Yard Runoff Basin Sludge: Oak Ridge National Laboratory

CAS NO.	COMPOUND	REGULATORY LIMIT (mg/l)	2/8/91 SAMPLE 1 (mg/l)	2/8/91 SAMPLE 2 (mg/l)
	METALS			
7440-38-2	Arsenic	5.0	< 0.55	< 0.55
7440-39-3	Barium	100.0	0.86	0.87
7440-43-9	Cadmium	1.0	< 0.055	< 0.005
7440-47-3	Chromium	5.0	0.065	0.017
7439-92-1	Lead	5.0	< 0.55	< 0.05
7439-97-6	Mercury	0.2	< 0.01	< 0.01
7782-49-2	Selenium	1.0	< 0.55	< 0.05
7440-22-4	Silver	5.0	< 0.055	< 0.005
	HERBICIDES & PESTICIDES			
93-72-1	2,4,5-TP (Silvex)	1.0	P	
94-75-7	2,4-D	10.0	P	
57-74-9	Chlordane	0.03	P	
72-20-8	Endrin	0.02	P	
76-44-8	Heptachlor	0.008	P	
1024-57-3	Heptachlor epoxide	0.008	P	
72-43-5	Methoxychlor	10.0	P	
8001-35-2	Toxaphene	0.5	P	
58-89-9	gamma-BHC (Lindane)	0.4	P	
	VOLATILE ORGANICS			
75-35-4	1,1-Dichloroethene	0.7	P	
107-06-2	1,2-Dichloroethane	0.5	P	
106-46-7	1,4-Dichlorobenzene	7.5	P	
78-93-3	2-Butanone	200.0	P	
71-43-2	Benzene	0.5	P	
56-23-5	Carbon tetrachloride	0.5	P	
108-90-7	Chlorobenzene	100.0	P	
67-66-3	Chloroform	6.0	P	
127-18-4	Tetrachloroethene	0.7	P	
79-01-6	Trichloroethene	0.5	P	
75-01-4	Vinyl chloride	0.2	P	
	BASE NEUTRAL/ACID EXTRACTABLE			
95-95-4	2,4,5-Trichlorophenol	400.0	P	
88-06-2	2,4,6-Trichlorophenol	2.0	P	
121-14-2	2,4-Dinitrotoluene	0.13	P	
95-48-7	2-Methylphenol	200.0	P	
108-39-4	3-Methylphenol	200.0	P	
106-44-5	4-Methylphenol	200.0	P	
118-74-1	Hexachlorobenzene	0.13	P	
87-68-3	Hexachlorobutadiene	0.5	P	
67-72-1	Hexachloroethane	3.0	P	
98-95-3	Nitrobenzene	2.0	P	
87-86-5	Pentachlorophenol	100.0	P	
110-86-1	Pyridine	5.0	P	

SYMBOL	INTERPRETATION
<	Denotes that compound was detected but at estimated concentration less than the indicated reporting limit.
P	Denotes that compound passed TCLP with respect to the regulatory limit.

OTHER COMMONLY USED NAMES FOR COMPOUNDS

1,1-Dichloroethene = 1,1-Dichloroethylene
2-Butanone = Methyl ethyl ketone = MEK
Tetrachloroethene = Tetrachloroethylene
Trichloroethene = Trichloroethylene
2-Methylphenol = o-Cresol
3-Methylphenol = m-Cresol
4-Methylphenol = p-Cresol

ADDITIONAL INFORMATION FOR THE OAK RIDGE NATIONAL LABORATORY COAL YARD PRECIPITATION RUNOFF, BOILER BLOWDOWN, AND WATER SOFTENER REGENERANT SLUDGE

1. Boiler Blowdown Water from ORNL Steam Plant and 7600 Fuel Recycle Area

a. The boiler water additive is disodium phosphate, to encourage precipitation of solids.

b. Boiler water analysis is

Phosphate (PO_4):	35 to 100 ppm
Sulfite (NA_2SO_3):	20 to 50 ppm
Silica (SiO_2):	40 to 100 ppm
Total Solids:	900 to 2200 ppm

c. Additional characterization data on the boiler blowdown water are presented in Table I.

2. Water Softener Regenerant

Salt (NaCl) and sulfuric acid (93% H_2SO_4) are used to regenerate the water softener ion exchange columns (which are used to soften water before it goes into the boilers). A total of approximately 10,000 gallons of regenerant wastewater is produced each day. Characterization of the water softener regenerant is presented in Table I.

3. Coal Yard Runoff Treatment Facility (CYRTF)

The treatment steps are (a) clarifier and drum filter (solid/sludge removal) and (b) pH neutralization.

Note: During the time these waste streams were treated at CYRTF, some benefits were noted. Because the CYRTF influent pH was more neutral, less CaOH had to be used to neutralize the liquid; therefore, less sludge was generated. [Also, CYRTF effluent toxicity No Observed Effect Concentration (NOEC) for the combined wastewaters was around 50%, whereas during treatment of only coal yard runoff, the NOEC runs around 6%–12%.] The first two waste streams (i.e., precipitation runoff and boiler blowdown) are a very small fraction of the total waste stream compared to the water softener regenerant.

4. Water Softener Regenerant from 6000 Area

The water softener process in the 6000 Area is used to treat influent potable water in order to remove dissolved ions. The resultant deionized water is used in cooling systems for research

equipment. Periodically (approximately four to five times per year) the deionizer columns are regenerated using hydrochloric acid and sodium hydroxide.

Wastewater generated from this practice is collected and transported to the CYRTF for treatment.

Table I
CHARACTERIZATION OF BOILER BLOWDOWN WATER
AND WATER SOFTENER REGENERANT

Parameter	Boiler Blowdown (mg/l)	IX Sodium Regeneration (mg/l)	IX Acid Regeneration (mg/l)
Ag	< 0.015	< 0.075	< 0.014
Al	0.18	< 0.30	0.68
As	0.007	< 0.002	< 0.002
B	0.15	< 0.12	< 0.023
Ba	0.027	0.79	0.15
Be	< 0.00060	0.0086	0.001
Ca	0.47	1,100	180
Cd	0.001	0.003	0.001
Co	< 0.0030	< 0.015	< 0.0029
Cr	0.002	< 0.002	0.025
Cu	1.2	0.067	0.028
Fe	0.20	0.17	0.38
Hg	< 0.0001	0.0001	0.0002
Li	0.28	0.38	0.067
Mg	0.16	> 28	> 5.4
Mn	0.0034	0.026	0.017
Mo	< 0.012	< 0.060	< 0.012
Na	600	2,200	25
Ni	< 0.018	< 0.090	0.018
P	12	< 0.45	1.8
Pb	0.004	0.012	0.011
Sb	0.079	0.026	0.004
Se	< 0.002	< 0.002	< 0.002
Si	2.3	1.5	1.5
Sn	< 0.015	< 0.075	< 0.014
Sr	< 0.0015	3.1	0.60
Ti	0.060	0.048	0.072
U	< 0.0030	0.026	0.0063
Zn	0.61	2.7	0.45
Zr	< 0.0060	< 0.030	< 0.0058
SO_4	630	98	3,600
SO_3	64	< 25	< 25
F	26	< 10	< 10
Cl	200	7,100	10
Br	11	< 25	< 25
PO_4	30	< 25	< 25
TOC	32.2	7.7	13.4
CN	0.002	< 0.002	0.002
Oil & Grease	< 2	< 2	< 2
TSS	52.7	36.7	29.7
TDS	2,094	13,681	3,854
pH	12.3	7.5	1.5

SPECIAL WASTE: DEAD ANIMALS

Occasionally, there is a need to dispose of dead animals from the ORR. These animals may result from incidents such as highway accidents, discovery of dead animals on a plant site, or extermination projects. Consequently, the following guidance is provided for disposal of nonhazardous, nonradioactive dead animals. Dead animals disposed of in the Class II landfill will be managed as follows.

1. Dead animals must be covered upon receipt with a minimum of 2 ft of cover and placed in an area that will receive additional waste and cover within 48 hrs; or covered with 3 ft of compacted cover soil if placed in an area that will not receive additional waste and cover within 48 hrs.

2. Dead animals must not be disposed of in an area of the landfill that will not accommodate a minimum of 5 ft of depth from the finished landfill surface elevation when final cover has been put in place.

3. Dead animals must be distributed for disposal over the landfill area in such a manner as to minimize the occurrences of future sinks and depressions in the final landfill cover caused by carcass decay.

The following animals are prohibited from disposal in ILF-V:

1. Animals containing and/or contaminated with hazardous materials as defined in 40 CFR Part 261 or Tennessee Hazardous Waste Management Regulations.

2. Animals containing and/or contaminated with radioactive materials as defined by the Atomic Energy Act of 1954, amended.

3. Animals containing and/or contaminated with carcinogens or suspected carcinogens.

4. Animals containing and/or contaminated with polychlorinated biphenyls (PCBs).

SPECIAL WASTE:. EMPTY AEROSOL CANS AND PRESSURIZED GAS CYLINDERS

Empty aerosol cans and nonreturnable, nonreusable pressurized gas cylinders (reference Bureau of Explosives Specification Number 39) will be delivered to the landfill in sealed fiber drums, metal drums, or 6-mil-thick plastic bags. The containers of cans and cylinders will not be placed on the working face, but they will be placed on the side of the daily cell away from the working face. After all containers of cans and cylinders are delivered on a given day, the containers will be covered with 12–18 in. of dirt and then compacted. An effort will be made to concentrate disposal of the pressurized containers on a specified day each week to minimize the landfill volume required by the cover and compaction procedure.

SPECIAL WASTE: EMPTY HAZARDOUS MATERIAL CONTAINERS

Containers that have contained hazardous materials and that meet the requirements for empty containers in Rule 1200-1-11-.02(1)(g) of *Rules Governing Hazardous Waste Management in Tennessee* will be disposed of in ILF-V. Glass and plastic laboratory chemical containers meeting the definition of *empty* in the regulations referenced above may be crushed prior to disposal in ILF-V as discussed in Appendix C, Other Waste: Glass.

SPECIAL WASTE: EMPTY PAINT CANS

As a result of ongoing construction and maintenance programs, empty paint cans are generated by the DOE construction manager contractor; the operating contractor of the Y-12 Plant, the K-25 Site and ORNL; and other DOE contractors in Oak Ridge Operations. Most waste paint cans have a capacity of 5 gallons or less. Empty paint cans containing small amounts of dry paint residue will be disposed of in the industrial landfill. Waste paint cans containing large amounts of dry paint residue will be disposed of as hazardous waste per *Rules Governing Hazardous Waste Management in Tennessee* and/or screened by TCLP and ignitability tests in the subject hazardous waste management rules. If these tests are conducted, the test results will be considered representative for later disposal of paint residue of the same brand and generic type. Liquid paint will not be allowed in the landfill.

SPECIAL WASTE: EMPTY PESTICIDE CONTAINERS

The following procedure will be used for the disposal of empty pesticide containers in ILF-V. This procedure generally follows the guidelines found in 40 CFR 165.9, Recommended Procedures for the Disposal of Pesticide Containers and Residues. The entire ILF-V site may be used for empty pesticide container disposal.

If the container is made of paper, cardboard, or other material that would deteriorate upon rinsing with water, the container shall be shaken vigorously to remove all residue. The residue will be collected and used along with the bulk of the pesticide. All cardboard boxes will be crushed. The containers will be sealed in plastic bags, which will be placed in a dumpster for disposal in ILF-V.

If the container is metal, fiber, or other wettable material, it will be rinsed three times. The rinse liquid will be added to the spray mixture. Each rinsing will be done with a volume of water (or other normal diluent) equal to approximately one-fourth of the container volume. After the final rinse, the container will be punctured to facilitate drainage prior to disposal and will be placed in a dumpster for disposal in ILF-V.

In the event that the contents of the container included a listed acute hazardous waste (40 CFR 261.33) and if the container is made of paper, cardboard, or other material that would be deteriorated by rinsing with water, this container shall be disposed of as a hazardous waste and may not be disposed of in ILF-V. If the container can be triple rinsed without deteriorating, the procedure given above for wettable material containers may be used, and the container may be disposed of in ILF-V.

The following is a list of substances that are used in pesticides and that are classified as acute hazardous wastes upon disposal:

SUBSTANCE	CHEMICAL ABSTRACTS SERVICE NUMBER
Acetic Acid, fluoro-, sodium salt	62-74-8
Acrolein	107-02-8
Aldicarb	116-06-3
Aldrin	309-00-2
Allyll alcohol	107-18-6
Aluminum phosphide	20859-73-8
4-Aminopyridine	504-24-5
Arsenic acid H_3AsO_4	7778-39-4
Arsenic oxide As_2O_3	1327-53-3
Arsenic trioxide	1327-53-3
Calcium cyanide	592-01-8
Calcium cyanide $Ca(CN)_2$	592-01-8
Carbon disulfide	75-15-0
Copper cyanide	544-92-3
Copper cyanide Cu(CN)	544-92-3
Cyanogen chloride	506-77-4
Cyanogen chloride (CN)Cl	506-77-4
2-Cyclohexyl-4,6-dinitrophenol	131-89-5
Dieldrin	60-57-1
O,O-Diethyl O-pyrazinyl phosphorothioate[1]	297-97-2
Dimethoate	60-51-5

SUBSTANCE	CHEMICAL ABSTRACTS SERVICE NUMBER
4,6-Dinitro-o-cresol	534-52-1
4,6-Dinitro-o-cresol and salts	534-52-1
Dinoseb	88-85-7
Disulfoton	298-04-4
Endosulfan	115-29-7
Endothall	145-73-3
Endrin	72-20-8
Endrin, & metabolites	72-20-8
Famphur	52-85-7
Fluoroacetamide	640-19-7
Heptachlor	76-44-8
Hydrocyanic acid	74-90-8
Hydrogen cyanide	74-90-8
Hydrogen phosphide	7803-51-2
Isodrin	465-73-6
Methomyl	16752-77-5
Methyl parathion	298-00-0
alpha-Napthylthiourea	86-88-4
Nicotine, & salts	54-11-5
Parathion	56-38-2
Phenylmercury acetate[1]	62-38-4
Phorate	298-02-2
Phosphine	7803-51-2
2-Propenal	107-02-8
Sodium azide	26628-22-8
Sodium cyanide	143-33-9
Sodium cyanide Na(CN)	143-33-9
Strychnine, & salts	57-24-9
Tetraethyl pyrophosphate[1]	107-49-3
Thallium(I) sulfate	7446-18-6
Thiofanox	39196-18-4
Thiourea, 1-naphthalenyl	86-88-4
Toxaphene[1]	8001-35-2
Warfarin, & salts when present at concentrations greater than 0.3%	81-81-2
Zinc phosphide Zn_3P_2 when present at concentrations greater than 10%	1314-84-7

[1] These compounds have other names commonly used and included as such in the EPA's *Title III List of Lists*. They are listed below along with their Chemical Abstracts Number.

Camphechlor	8001-35-2
PMA	62-38-4
TEPP	107-49-3
Thionazin	297-97-2

SPECIAL WASTE: FLY ASH—OAK RIDGE NATIONAL LABORATORY

Pulverized coal is burned in the ORNL industrial boilers to generate steam for process and heating purposes. Fly ash is collected in the high furnace hoppers and baghouses and is pneumatically conveyed to the Dry Ash Handling System for transfer to trucks. Prior to being loaded into trucks, the dry ash will be conditioned with process water to control fugitive dust. Fly ash from this process will be disposed of in ILF-V on a daily basis by incorporation with the normal landfill waste (not in a special cell).

The characteristics given below are from samples taken February 8, 1991.

1. Physical Characteristics

State:	Powder
Color:	Black
Moisture Content:	0.8%
Density:	2.3419 g/ml

2. Chemical Characteristics

See page C-27 for TCLP analyses results.

3. Quantity

Approximately 3650 yd^3/yr.

Fly Ash: Oak Ridge National Laboratory

CAS NO.	COMPOUND	REGULATORY LIMIT (mg/l)	2/8/91 SAMPLE 1 (mg/l)	2/8/91 SAMPLE 2 (mg/l)
	METALS			
7440-38-2	Arsenic	5.0	2.3	3.0
7440-49-3	Barium	100.0	3.1	3.2
7440-43-9	Cadmium	1.0	< 0.055	< 0.055
7440-47-3	Chromium	5.0	< 0.044	< 0.044
7439-92-1	Lead	5.0	< 0.55	< 0.55
7439-97-6	Mercury	0.2	< 0.01	< 0.01
7782-49-2	Selenium	1.0	< 0.55	< 0.55
7440-22-4	Silver	5.0	< 0.055	< 0.055
	HERBICIDES & PESTICIDES			
93-72-1	2,4,5-TP (Silvex)	1.0	P	
94-75-7	2,4-D	10.0	P	
57-74-9	Chlordane	0.03	P	
72-20-8	Endrin	0.02	P	
76-44-8	Heptachlor	0.008	P	
1024-57-3	Heptachlor epoxide	0.008	P	
72-43-5	Methoxychlor	10.0	P	
8001-35-2	Toxaphene	0.5	P	
58-89-9	gamma-BHC (Lindane)	0.4	P	
	VOLATILE ORGANICS			
75-35-4	1,1-Dichloroethene	0.7	P	
107-06-2	1,2-Dichloroethane	0.5	P	
106-46-7	1,4-Dichlorobenzene	7.5	P	
78-93-3	2-Butanone	200.0	P	
71-43-2	Benzene	0.5	P	
56-23-5	Carbon tetrachloride	0.5	P	
108-90-7	Chlorobenzene	100.0	P	
67-66-3	Chloroform	6.0	P	
127-18-4	Tetrachloroethene	0.7	P	
79-01-6	Trichloroethene	0.5	P	
75-01-4	Vinyl chloride	0.2	P	
	BASE NEUTRAL/ACID EXTRACTABLE			
95-95-4	2,4,5-Trichlorophenol	400.0	P	
88-06-2	2,4,6-Trichlorophenol	2.0	P	
121-14-2	2,4-Dinitrotoluene	0.13	P	
95-48-7	2-Methylphenol	200.0	P	
108-39-4	3-Methylphenol	200.0	P	
106-44-5	4-Methylphenol	200.0	P	
118-74-1	Hexachlorobenzene	0.13	P	
87-68-3	Hexachlorobutadiene	0.5	P	
67-72-1	Hexachloroethane	3.0	P	
98-95-3	Nitrobenzene	2.0	P	
87-86-5	Pentachlorophenol	100.0	P	
110-86-1	Pyridine	5.0	P	

SYMBOL	INTERPRETATION
<	Denotes that compound was detected but at estimated concentration less than the indicated reporting limit.
P	Denotes that compound passed TCLP with respect to the regulatory limit. At the time these analyses were done, the ORNL Analytical Chemistry Division set their reporting limit at the regulatory limit and did not provide actual data.

OTHER COMMONLY USED NAMES FOR COMPOUNDS

1,1-Dichloroethene = 1,1-Dichloroethylene
2-Butanone = Methyl ethyl ketone = MEK
Tetrachloroethene = Tetrachloroethylene
Trichloroethene = Trichloroethylene
2-Methylphenol = o-Cresol
3-Methylphenol = m-Cresol
4-Methylphenol = p-Cresol

SPECIAL WASTE: FLY ASH—Y-12 PLANT

Pulverized coal is burned in the Y-12 Steam Plant's four industrial boilers to generate steam for process and heating purposes. Fly ash is collected in the high furnace hoppers and baghouses and is pneumatically conveyed to the Dry Ash Handling System for transfer to trucks. Prior to being loaded into trucks, the dry ash will be conditioned with process water to control fugitive dust. Fly ash from this process will be disposed of in ILF-V on a daily basis by incorporation with the normal landfill waste (not in a special cell).

1. Physical Characteristics

State:	Solid
Color:	Gray
Moisture Content:	0 (Moisture may vary somewhat due to the use of water to control dusting.)
Density:	1.36 g/ml

2. Chemical Characteristics

See page C-29 for TCLP analyses results.

3. Quantity

Approximately 1600 tons of fly ash may have been generated through the year 1993. After 1993, the volume will increase by a factor of 5.

Fly Ash: Y-12 Plant

CAS NO.	COMPOUND	REGULATORY LIMIT	10/22/91 SAMPLE
	METALS	--mg/l--	--mg/l--
7440-38-2	Arsenic	5.0	< 0.50
7440-49-3	Barium	100.0	< 10
7440-43-9	Cadmium	1.0	< 0.10
7440-47-3	Chromium	5.0	< 0.50
7439-92-1	Lead	5.0	< 0.50
7439-97-6	Mercury	0.2	< 0.02
7782-49-2	Selenium	1.0	< 0.1
7440-22-4	Silver	5.0	< 0.50
	HERBICIDES & PESTICIDES		
93-72-1	2,4,5-TP (Silvex)	1.0	< 0.1
94-75-7	2,4-D	10.0	< 1.0
57-74-9	Chlordane	0.03	< 0.003
72-20-8	Endrin	0.02	< 0.002
76-44-8	Heptachlor	0.008	< 0.0008
1024-57-3	Heptachlor epoxide	0.008	< 0.0008
72-43-5	Methoxychlor	10.0	< 1.0
8001-35-2	Toxaphene	0.5	< 0.05
58-89-9	gamma-BHC (Lindane)	0.4	< 0.04
	VOLATILE ORGANICS		
75-35-4	1,1-Dichloroethene	0.7	0.07 U
107-06-2	1,2-Dichloroethane	0.5	0.05 U
106-46-7	1,4-Dichlorobenzene	7.5	0.75 U
78-93-3	2-Butanone	200.0	20. U
71-43-2	Benzene	0.5	0.05 U
56-23-5	Carbon tetrachloride	0.5	0.05 U
108-90-7	Chlorobenzene	100.0	10. U
67-66-3	Chloroform	6.0	0.6 U
127-18-4	Tetrachloroethene	0.7	0.07 U
79-01-6	Trichloroethene	0.5	0.05 U
75-01-4	Vinyl chloride	0.2	0.02 U
	BASE NEUTRAL/ACID EXTRACTABLE		
95-95-4	2,4,5-Trichlorophenol	400.0	< 40.
88-06-2	2,4,6-Trichlorophenol	2.0	< 0.2
121-14-2	2,4-Dinitrotoluene	0.13	< 0.065
95-48-7	2-Methylphenol	200.0	< 20.
108-39-4	3-Methylphenol	200.0	< 20.
106-44-5	4-Methylphenol	200.0	< 20.
118-74-1	Hexachlorobenzene	0.13	< 0.065
87-68-3	Hexachlorobutadiene	0.5	< 0.05
67-72-1	Hexachloroethane	3.0	< 0.3
98-95-3	Nitrobenzene	2.0	< 0.2
87-86-5	Pentachlorophenol	100.0	< 10.
110-86-1	Pyridine	5.0	< 0.5

SYMBOL	INTERPRETATION
<	Denotes that compound was detected but at estimated concentration less than the indicated lower reporting limit, generally established as one-tenth of the regulatory limit.
U	Denotes that compound was undetected; number shown is the lower reporting limit.

OTHER COMMONLY USED NAMES FOR COMPOUNDS

1,1-Dichloroethene = 1,1-Dichloroethylene
2-Butanone = Methyl ethyl ketone = MEK
Tetrachloroethene = Tetrachloroethylene
Trichloroethene = Trichloroethylene
2-Methylphenol = o-Cresol
3-Methylphenol = m-Cresol
4-Methylphenol = p-Cresol

SPECIAL WASTE: PETROLEUM PRODUCT CONTAMINATED SOIL

Occasionally, soil contaminated with petroleum product or spill cleanup residues may be disposed of in ILF-V. In order to safely dispose of the waste, the following procedures will be followed.

1. All free liquid gasoline or other petroleum products must be removed from the soil or spill cleanup residues before they are taken to the landfill. As much of the petroleum product will be removed from the material as can practically be removed and will be recycled or disposed of in an appropriate manner.

2. The contaminated soil or spill cleanup residues will be tested and must be found to contain less than 0.5-ppm benzene and 10.0-ppm total petroleum hydrocarbons in the TCLP extract before they are taken to the landfill.

3. The landfill technician and the equipment operator will be aware that the contaminated soils and residues could present a fire hazard and will act accordingly. There will be no smoking around the waste and minimum contact with sources of heat or sparks from the equipment. Clean soil or cool fly ash will be pushed over the contaminated soil or cleanup residues before it is graded and compacted. Fire extinguishers will be readily available during the disposal operation.

4. Only soil from petroleum product spill cleanups in locations that are not known or believed to be contaminated with hazardous or radioactive constituents will be accepted.

5. A report will be made to TDEC/DSWM following each petroleum product spill cleanup incident in which the soil or residues are placed in ILF-V in accordance with this approval. This report will contain the following information:

   - the location and nature of the spill;
   - a laboratory analysis of the contaminated soils and residues showing that the TCLP extract does not exceed acceptance limits of 0.5-ppm benzene and 10.0-ppm total petroleum hydrocarbons; and
   - the date of each disposal, with the estimated quantity disposed of.

6. All portions of the petroleum product spill residue or contaminated soil will be covered with at least 6 in. of clean, compacted soil by the end of the same operating day in which it is received.

SPECIAL WASTE: STEAM PLANT WASTEWATER TREATMENT FACILITY SLUDGE (SPWTF)—Y-12 PLANT

The SPWTF treats approximately 55 million gallons of steam plant wastewater each year. The wastewater fed to the facility consists of a regular baseload and periodic coal yard runoff during precipitation periods. The baseload consists of boiler drain, boiler blowdown, deaerator drain, hydrogen-ion regeneration, sodium-ion regeneration, carbon filter backwash, and steam plant floor drain water. On a yearly average, the coal yard runoff is estimated to be 10% of the total flow to the facility. Through treatment of these wastes with lime slurry, a sludge is formed. This sludge is dewatered for disposal. In addition to sludge from the lime treatment process, sludge is periodically removed from the coal pile runoff collection basin and dewatered. The dewatered basin sludge is similar to the sludge from the treatment process. The dewatered sludge is disposed of by incorporation with the normal waste (not in a special cell). The sludge has been tested under the TCLP and was determined to be nonhazardous.

1. Physical Characteristics

State:	Sludge
Color:	Whitish (variable)
Moisture Content:	No free liquids
Density:	0.7 g/ml (dry weight)

2. Chemical Characteristics

See page C-32 for TCLP analyses results and page C-33 for results of the total metals analysis.

3. Quantity

40,000 ft^3/yr

4. Additional Characteristics

- Sludge will not contain any free liquids.
- Sludge will be suitable for handling, unloading, and landfill operations.
- SPWTF operators will operate sludge processes to minimize moisture content.

Steam Plant Wastewater Treatment Facility Sludge: Y-12 Plant

CAS NO.	COMPOUND	REGULATORY LIMIT	8/5/91 SAMPLE
	METALS	--mg/l--	--mg/l--
7440-38-2	Arsenic	5.0	< 0.50
7440-49-3	Barium	100.00	< 10
7440-43-9	Cadmium	1.0	< 0.10
7440-47-3	Chromium	5.0	< 0.50
7439-92-1	Lead	5.0	< 0.50
7439-97-6	Mercury	0.2	< 0.02
7782-49-2	Selenium	1.0	< 0.1
7440-22-4	Silver	5.0	< 0.50
	HERBICIDES & PESTICIDES		
93-72-1	2,4,5-TP (Silvex)	1.0	< 0.1
94-75-7	2,4-D	10.0	1.0
57-74-9	Chlordane	0.03	< 0.003
72-20-8	Endrin	0.02	< 0.002
76-44-8	Heptachlor	0.008	< 0.0008
1024-57-3	Heptachlor epoxide	0.008	< 0.0008
72-43-5	Methoxychlor	10.0	< 1.0
8001-35-2	Toxaphene	0.5	< 0.05
58-89-9	gamma-BHC (Lindane)	0.4	< 0.04
	VOLATILE ORGANICS		
75-35-4	1,1-Dichloroethene	0.7	0.07 U
107-06-2	1,2-Dichloroethane	0.5	0.05 U
106-46-7	1,4-Dichlorobenzene	7.5	0.75 U
78-93-3	2-Butanone	200.0	< 20. BJ
71-43-2	Benzene	0.5	0.05 U
56-23-5	Carbon tetrachloride	0.5	0.05 U
108-90-7	Chlorobenzene	100.0	10. U
67-66-3	Chloroform	6.00	0.6 U
127-18-4	Tetrachloroethene	0.7	0.07 U
79-01-6	Trichloroethene	0.5	0.05 U
75-01-4	Vinyl chloride	0.2	0.02 U
	BASE NEUTRAL/ACID EXTRACTABLE		
95-95-4	2,4,5-Trichlorophenol	400.0	< 40.
88-06-2	2,4,6-Trichlorophenol	2.0	< 0.2
121-14-2	2,4-Dinitrotoluene	0.13	< 0.065
95-48-7	2-Methylphenol	200.0	< 20.
108-39-4	3-Methylphenol	200.0	< 20.
106-44-5	4-Methylphenol	200.0	< 20.
118-74-1	Hexachlorobenzene	0.13	< 0.065
87-68-3	Hexachlorobutadiene	0.5	< 0.05
67-72-1	Hexachloroethane	3.00	< 0.3
98-95-3	Nitrobenzene	2.0	< 0.2
87-86-5	Pentachlorophenol	100.0	< 10.
110-86-1	Pyridine	5.00	< 0.5

SYMBOL	INTERPRETATION
<	Denotes that compound was detected but at estimated concentration less than the indicated lower reporting limit, generally established as one-tenth of the regulatory limit.
U	Denotes that compound was undetected; number shown is the lower reporting limit.

OTHER COMMONLY USED NAMES FOR COMPOUNDS

1,1-Dichloroethene = 1,1-Dichloroethylene
2-Butanone = Methyl ethyl ketone = MEK
Tetrachloroethene = Tetrachloroethylene
Trichloroethene = Trichloroethylene
2-Methylphenol = o-Cresol
3-Methylphenol = m-Cresol
4-Methylphenol = p-Cresol

Steam Plant Wastewater Treatment Facility Sludge: Y-12 Plant

COMPOUND	8/5/86 SAMPLE
	--mg/kg--
Aluminum	1,200
Arsenic	< 34
Barium	14.7
Beryllium	< 0.3
Boron	6
Cadmium	< 3.4
Calcium	21,600
Cerium	< 13
Chromium	< 5.1
Cobalt	4
Copper	9
Gallium	< 15
Iron	1,390
Lead	< 17
Lithium	< 13
Magnesium	9,980
Manganese	71
Molybdenum	< 5.1
Nickel	14
Niobium	< 8.4
Phosphorous	1,120
Potassium	< 420
Scandium	< 0.3
Silver	< 5.1
Sodium	540
Strontium	16.8
Thorium	< 8.4
Titanium	20
Vanadium	4
Yttrium	161
Zinc	90
Zirconium	< 3.4

OTHER WASTE: GLASS

In general, glass will be crushed by in-plant facilities prior to delivery and disposal at ILF-V. As circumstances arise, disposal of uncrushed glass at the landfill may be allowed at the discretion of the WTLO Department manager. All glass chemical containers to be disposed of in the landfill shall be empty as defined in Rule 1200-1-11-.02(1)(g) of *Rules Governing Hazardous Waste Management in Tennessee*. In all cases, the condition of the glass and method of handling the glass will be selected on the basis of ensuring the safety of the equipment operators and other site operating personnel. The glass will be placed on the working face of the refuse cell and compacted along with other daily refuse. If operating experience at the facility dictates, the glass may be spread and covered with 6 in. of compacted soil immediately following each such disposal to promote safe operating conditions for personnel and to minimize damage to delivery vehicles.

APPENDIX D

GROUNDWATER BACKGROUND CHARACTERIZATION AND MONITORING PARAMETERS AND FREQUENCIES

I. Groundwater Background Characterization

1. Sample collection and analyses will be accomplished in accordance with the document, *Y-12 Industrial Landfill V and Construction/Demolition Landfill VII Groundwater Sampling and Analysis Plan*, attached to the permit application.

2. Background characterization sampling for four quarters was completed in April 1994 prior to placement of industrial waste in the landfill.

3. The elevation of the groundwater surface will be determined and recorded at each monitoring well each time a sample is obtained, but prior to any pumping or bailing of the well.

4. Samples will be analyzed for the parameters identified in Sections III, IV, V, and VI of this appendix.

5. Groundwater sample analysis results and associated recordings of groundwater surface elevations will be submitted to TDEC/DSWM within 60 days after completing the well sampling as proposed and verbally agreed upon by Energy Systems and TDEC/DSWM.

6. Background characterization sampling will be terminated upon initiation of operation of ILF-V.

II. Groundwater Monitoring

1. Sample collection and analyses will be accomplished in accordance with the document, *Y-12 Industrial Landfill V and Construction/Demolition Landfill VII Groundwater Sampling and Analysis Plan*, attached to the permit application.

2. Groundwater monitoring began in June of calendar year 1993 (CY93), with the initiation of background characterization. Sampling was performed on a quarterly basis through CY94. Semiannual sampling began in January of CY95.

3. The elevation of the groundwater surface will be determined and recorded at each monitoring well each time a sample is obtained but prior to any pumping or bailing of the well.

4. Samples will be analyzed for the parameters identified in Sections III, IV, and V of this appendix.

5. Groundwater sample analysis results and associated recordings of groundwater surface elevations will be submitted to TDEC/DSWM within 60 days after completing the well sampling as proposed and verbally agreed upon by Energy Systems and TDEC/DSWM.

6. Quarterly sampling was completed in the fourth quarter of CY94 (corresponds to the TDEC/DSWM requirement for background characterization).

7. Semiannual sampling began in CY95.

8. Monitoring will be continued through the post closure care period for the landfill.

III. Radionuclides

Alpha activity
Beta activity
Total uranium
Uranium alpha activity
Gamma activity (to be accomplished one time per year)

IV. Groundwater Chemistry

Ammonia (as N)
Calcium
Chloride
Iron
Magnesium
Manganese, dissolved
Nitrate (as N)
Potassium
Sodium
Sulfate
Chemical Oxygen Demand (COD)
Total Dissolved Solids (TDS)
Total Organic Carbon (TOC)
pH

V. Groundwater Quality

Arsenic
Barium
Cadmium
Chromium
Cyanide
Lead
Mercury
Selenium
Silver

VI. Groundwater Volatile Organic Constituents (VOCs)[1]

Acetone
trans-1,2-Dichloroethene

[1] The TDEC/DSWM requirements for groundwater monitoring at Class II disposal facilities do not require VOC monitoring. Rule 1200-1-7-.04(7)(b)1 states, "Class II disposal facilities are not required to perform the analysis for the volatile organic compounds in Appendix I unless specifically required by the Commissioner." Rule 1200-1-7-.04(7)(b)2 states, "Class II disposal facilities are not required to perform the analysis for the Appendix II parameters unless specifically required by the Commissioner."

Acrolein
Acrylonitrile
Benzene
Bromodichloromethane
Bromoform
Bromomethane
2-Butanone (Methyl ethyl ketone)
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
2-Chloroethyl vinyl ether
Chloroform
Chloromethane
Dibromomethane
1,4-Dichloro-2-butene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethene (total)
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Ethanol
Ethylbenzene
Ethyl methacrylate
2-Hexanone
Iodomethane
Methylene chloride
4-Methyl-2-pentanone
Styrene
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Toluene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
1,2,3-Trichloropropane
Vinyl acetate
Vinyl chloride
Xylene

The *Y-12 Plant Comprehensive Groundwater Monitoring Plan* (September 1990, Y-SUB/90-00206C/5, Martin Marietta Energy Systems, Oak Ridge, Tennessee) provides an overall monitoring strategy necessary to collect the variety of data needed to address the multiple, and often overlapping, regulatory requirements for groundwater monitoring at the Y-12 Plant. Currently, the Y-12 Plant standard program for VOC monitoring is an abbreviated list of constituents defined by the EPA as target compounds for monitoring at National Priority List (NPL) sites (the ORR has been placed on the NPL). However, the annual monitoring and reporting of the listed VOCs will be undertaken to maintain a general consistency with the overall detection monitoring program at the Y-12 Plant and to fulfill the TDEC Commissioner's requirements.

The proposed list of VOCs, as outlined in this section, differs from the TDEC/DSWM Appendix I list as follows:

1. Bromochloromethane, 4-bromofluorobenzene, and 1,4-difluorobenzene are internal and/or surrogate standards used by laboratories, per EPA procedures, to quantitate VOCs on the EPA target compound list. A review of the analytical methodology failed to identify approved methods for analyzing these constituents in groundwater. Therefore, these compounds are not suitable parameters for analysis and are not included in the groundwater monitoring program.

2. The following typographical errors were corrected:

   Ethyl mechacrylate to Ethyl methacrylate
   1,4-Dichloro-2-butane to 1,4-Dichloro-2-butene

APPENDIX E

USES FOR EXCESS SOIL RESULTING FROM THE CONSTRUCTION OF THE INDUSTRIAL LANDFILL V AND THE CONSTRUCTION/DEMOLITION LANDFILL VII

The construction of the Y-12 Industrial Landfill V (ILF-V) and the Y-12 Construction/Demolition Landfill VII (CDL-VII) will result in excavated quantities of soil and residuum materials in excess of those necessary to perform daily operations and closure of ILF-V and CDL-VII. These excess materials will be managed in an appropriate manner to control erosion and mitigate insult to the environment. Satellite soil stockpile areas may be established and maintained off the facility site as needed. The excess soil material may be utilized by the Y-12 Waste Management Division (WMD) for operations and/or closure at the Spoil Area I, Y-12 Centralized Sanitary Landfill II, Industrial Landfill IV, Construction/Demolition Landfill VI, and/or other WMD facilities as needed for routine operation or closure activities.

The WMD may consider requests for use of the excess soil material by other Energy Systems Oak Ridge Operations organizations. However, this excess soil may only be removed from the landfill sites with written approval of the WMD and under the direction of the WTLO Department.

Y-12 INDUSTRIAL LANDFILL V
AND
CONSTRUCTION/DEMOLITION LANDFILL VII

GROUNDWATER SAMPLING AND ANALYSIS PLAN

1.0 GROUNDWATER LEVELS

The groundwater level in each well shall be determined prior to each sampling for calculation of the appropriate purge volumes. In addition, water levels are collected annually from selected well independently of sampling events to preclude the possibility of purging activities influencing water level measurements used for construction of water-table elevation maps. The following procedure shall be used to determine ground-water levels (any variations on this procedure will be reported to the Division of Solid Waste Management in detail):

Scope/Applications

This procedure outlines the use of a conducting probe to obtain water level measurements in completed wells.

Summary of Method

The electronic water level indicator is an instrument with a conducting probe. The probe is lowered by means of an electrical cord from the top of the well casing to the water level. When the probe intersects the water a circuit is completed, activating the meter. The depth to water level is determined by reading the measured and marked increments on the cord.

Procedure

Starting with the background well:

A. Unlock and open well; note condition of well and don clean gloves.

B. Record sampling station number, date, time, weather conditions, and any other well-specific pertinent information in field log.

C. Locate reference mark at top of well casing and record.

   1. If reference mark is not present, alert management.

Collect water level measurements with electronic water level indicator.

D. Check battery on cleaned electronic water level indicator.

E. Lower electronic water level indicator probe into well making sure the cord on the probe does not scrape the sides of the well casing.

F. When the meter needle moves or alarm sounds, stop lowering the probe.

G. Pull up on the probe until the meter needle no longer registers or alarm is no longer audible.

H. Lower probe again slowly. Stop at the instant the needle moves forward or alarm sounds and remains activated.

I. Hold cord to side of casing at the location of the reference mark.

J. Mark cord with thumb where it touches reference mark.

K. For water level indicators with the cord marked in increments of 0.01 ft., read the measurement directly from the cord. Otherwise, use a measuring device to determine distance from last marked increment to marked point on cord. The total depth is the distance from top of casing to the water level.

L. Record measurement to 0.01 ft. as Depth to Water (DTW) in field log.

M. Repeat steps E-L, two to three times for consistency. Measurement should remain consistent.

N. Average the depth to water measurements and record the average value in the field log.

O. Pull water level indicator from well.

P. Close and lock well cap.

Q. After each well, as a minimum, rinse the probe with ASTM Type II distilled deionized reagent grade water.

2.0 WELL DEPTH MEASUREMENT PROCEDURES

The depth to the bottom of the well is measured during annual routine well inspections of monitoring wells. The following procedures shall be used to determine these measurements:

A. Lower a weighted measurement probe until refusal;

B. Measure and record the distance from the well bottom to the top of the well casing;

C. All measurements should be taken to a 0.1 foot;

D. After each well, as a minimum, rinse the probe with ASTM Type II distilled Deionized reagent grade water.

The rinse water from both measurement procedures shall be collected and properly disposed of within the wastewater treatment system at the facility, if required.

3.0 WELL PURGING PROCEDURES

Scope and Application

The procedure covers the purging of water from a well prior to sampling so that the sample is representative of the formation groundwater. The device used (bailer or pump) depends upon aquifer properties, individual well construction and data quality objectives.

Summary of Method

Well construction information is gathered prior to beginning purging. Water level is measured to calculate the volume of water present in the well. Purging is completed using a calculated number of volumes and/or field measurements to determine the end point.

Comments

Rate of purging should be regulated to minimize agitation of the groundwater. If using a bailer to purge the well, lower and raise it slowly so as not to agitate the water in the well. Water will be removed from top of water column.

Required Equipment and Apparatus

A. Bailer or pump as necessary

B. Water level measurement equipment

C. Measuring tape

D. Instrumentation for measuring pH, conductivity, temperature, Eh, and dissolved oxygen.

Procedures

A. Obtain the following information about well to be sampled.

- Well location
- Diameter(s) of well
- Depth of well
- Screen interval or open interval

B. Determine method to be used to purge well (i.e., pump or bailer).

C. Calibrate instruments according to manufacture's instrument calibration and maintenance manual.

D. Locate well and record well number, site, date, and well condition in log.

E. Unlock and open well after placing plastic sheeting on ground.

F. Collect water level measurements as described previously in Section 1.0.

G. Use known well depth information to determine the height of water column in well. Subtract distance to water level from depth of well to get the length of the water column. Record all information in field log.

(Depth of well) - (distance to water level)= (length of water column)

H. Measure initial pH, specific conductance, temperature, Eh, and dissolved oxygen to evaluate water quality.

I. Purge well of required volumes after calculating volume of water in well.

1. The formula for calculating the volume in gallons of water in the well casing or sections of telescoping well casing is as follows:

   $(\pi r^2 h)\ 7.481$ = gallons: where π=3.142

   r=radius of the well pipe in feet

   h=linear feet of water in well

   7.481=gallons per cubic foot of water

2. Calculation of the volume of water in typical well castings may be done as follows:

   a. 2" dia. well:
   0.1632 gal/ft x ____(linear ft of water) =gal.

   b. 4" dia. well:
   0.6528 gal/ft x ____(linear ft of water) =gal.

   c. 6" dia. well:
   1.4688 gal/ft x_____(linear ft of water) =gal.

J. Collect intermittent field measurements of pH, specific conductance, temperature, Eh, and dissolved oxygen during the purging process.

1. Purge one well volume, then begin measuring field parameters once during each well volume.

2. Purge a minimum of 3 well volumes.

K. Purge the required well volumes or to dryness if insufficient water is present to yield the required purge volumes.

L. Record all purge times and rates of well evacuation in field log.

M. When all necessary procedures are complete lock well, clean are and dispose of refuse, in accordance with guidelines.

All purged water from downgradient wells will be collected for processing through the wastewater treatment system as required. After each well is sampled the bailer or pump will be cleaned in accordance with the procedures described in Section 7.0. Samples will be taken as soon as practical, i.e., sufficient recovery after purging.

4.0 SAMPLE COLLECTION PROCEDURES

All monitoring wells shall be sampled in accordance with the guidelines set forth in the EPA RCRA GroundWater Monitoring Technical Enforcement Guidance Document. Samples shall be collected by the facility.

Order of Collection

The following order will be observed for collection of analytical samples from each monitoring well. Collect samples that may be affected by the loss of volatile components first, i.e., volatile organic analysis (VOA). These samples will be collected with zero headspace. Collect the balance of the required samples for the particular site in the following order:

Anions
Metals, total and dissolved
Radiochemistry Parameters

Exceptions to this would include deep wells purged using a gas-driven piston pump. In these situations the piston pump can be used to sample all nonvolatile sample fractions listed above, after which the pump shall be removed to collect the volatile fractions with a bailer. Any exceptions to this order shall be noted on the field data sheet.

4.1 Sampling with a Bailer

Scope and Applications

This procedure describes the use of a bailer (hollow, cylindrical tube) for collecting groundwater samples. Groundwater samples may be used to obtain physical, chemical, or radiological data.

Summary of Method

A bailer is lowered by cord into the groundwater where it fills. The bailer is withdrawn, and it contents are drained into the appropriate containers.

Comments

A. Only bottom loading stainless steel or Teflon bailer will be used.

B. Only new, clean cord will be used.

C. A reel upon which the cord may be wound is helpful in lowering and raising the bailer. It also reduces chance of contamination.

D. Bailer constructed with adhesive joints will not be used.

E. Each days sampling event will begin with cleanest well.

Procedures

A. Record sampling station number, sample I.D., date, time, weather conditions, and any other well specific, pertinent information (i.e., water level, presence of product, etc. in field log).

B. Place plastic sheeting around well and work area as necessary.

C. Unlock and remove well cap.

D. Collect water level measurements as described in Section 1.0 and calculate required purge volume as described in Section 3.0.

E. After purging is compete and recovery is sufficient, remove clean bailer from protective covering; attach cord allowing enough length for bailer to reach bottom of well.

F. Lower bailer slowly to the interval from which the sample is to be collected.

G. Allow bailer to fill with a minimum of surface disturbance in order to prevent sample water aeration.

H. Raise bailer to surface, feeding cord into a container or reel. Do not allow bailer cord to contact ground.

I. Remove the cap from the sample bottle, and tilt the bottle slightly.

J. Pour the sample slowly down the inside of the sample bottle. Avoid splashing of the sample. Assure that any suspended matter in the sample is transferred quantitatively to the sample bottle. Properly dispose of all excess water collected in bailer in wastewater treatment system, as required.

K. Leave adequate air space in the bottle to allow for expansion, except for VOA vials which must be filled to overflowing.

L. Label the bottle carefully, and clearly. Enter all information accurately, and check to be sure it is legible.

M. Samples will be placed in containers defined according to the needs, and then, when appropriate, packed in a cooled ice chest as soon as practical. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in Sections 8.0 and 10.0.

N. Complete field log and chain-of-custody forms in accordance with Section 10.0.

O. Replace well cap and lock.

Control of Deviations

When feasible, and departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

4.2 Sampling with a Gas Driven Piston Pump

Scope and Applications

This procedure discusses collection of groundwater samples using a single stage, positive displacement, double action, gas driven, reciprocating piston type pump (such as the Bennett pump). The water samples may be used to obtain physical, chemical, or radiological data.

Summary of Method

A piston pump can be either dedicated to a well or cleaned/decontaminated before use. The pump is placed in the well prior to sample collection. A compressed air source drives a piston which is connected to another piston that forces water into the discharge line of the pump.

Comments

The piston pump will not be used to collect sample for volatile organic analysis. If outgasing is of concern, this method may not be appropriate.

Procedures

A. Locate well and record well number, site, date, and well condition in field log.

B. Use plastic sheeting as necessary to prevent equipment from coming in contact with potentially contaminated surfaces.

C. Unlock and open well.

D. Collect water level measurements as described in Section 1.0 and calculate purge volume as described in Section 3.0.

E. Lower pump in well to desired level, if pump is not dedicated.

F. Connect air lines from regulated compressed air source to pump.

G. Start air flow.

H. Adjust flow rate with throttle knob found on pump regulator.

I. When a piston pump is used for purging, measure the amount of water discharged with a container of know volume and calculate purge time for the required purge volume.

J. Obtain and record required intermittent field measurements of the well water, (i.e., pH, conductivity, temperature, Eh, and dissolved oxygen) during purging and prior to sampling.

K. Remove the cap from the sample bottle, and tilt the bottle slightly.

L. Pour the sample slowly down the inside of the sample bottle. Avoid splashing of the sample. Assure that any suspended matter in the sample is transferred quantitatively to the sample bottle.

M. Leave adequate air space in the bottle to allow for expansion.

N. Use a 0.45 μm filter and add the appropriate preservatives, as required.

O. Label the bottle carefully, and clearly. Enter all information accurately, and check to be sure it is legible.

P. Samples will be placed in containers defined according to the needs, and then, when appropriate, packed in cooled ice chest coolers as soon as practical. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in Section 8.0 and 10.0.

Q. Complete field log and Chain-of-Custody form in accordance with Section 10.0.

R. If not dedicated, remove pump, close well cap and lock.

S. Decontaminate pump as described in Section 7.0.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently document to allow repetition of the activity as actually performed.

4.3 Sampling with a Bladder Pump

Scope and Applications

This procedure discusses collection of groundwater samples using the bladder pump. The water samples may be used to obtain physical, chemical, or radiological data.

Summary of Method

A bladder pump is either dedicated to a well or cleaned before each use.. The pump is placed in the well prior to sample collection. A compressed air source forces air through a control box which regulates timed intervals of air discharges into, and air escapes from, the bladder pump, along with air intake pressure. The bladder expands and contracts with air intake and escape, and thereby forces water to the head of the well where it is collected.

Comments

Because there is letter aeration or agitation of the water, the bladder pump can be used to collect samples for volatile organic analysis.

Procedures

A. Locate well and record well number, site, date and well condition in log.

B. Use plastic sheeting as necessary to prevent equipment from coming in contact with potentially contaminated surfaces.

C. Unlock and open well.

D. Collect water level measurements as described in Section 1.0 and calculate purge volume as described in Section 3.0.

E. Attach air lines, samples lines, and lifting lines to pump. Lifting lines should bear the weight of the pump with air and sample lines attached to lifting lines approximately every 10 feet with appropriate inert devices.

F. Lower pump in well to desired level, if pump is not dedicated.

G. Connect air lines from regulated compressed gas sources to control box.

H. Connect battery, if required.

I. Start air flow.

J. Adjust flow rate with throttle knob found on control box.

K. To control discharge and refill cycle rate of the bladder, use the discharge and refill control knobs located on control box.

L. Equal length discharge and refill cycles are generally desirable, but individual well conditions may dictate otherwise.

M. When a bladder pump is used for purging, measure the amount of water discharged with a container of known volume, and calculate purge time for the required purge volume.

N. Obtain and record required measurements of the well water, (i.e., pH, conductivity, temperature, Eh, and dissolved oxygen).

O. Remove the cap from the sample bottle, and tilt the bottle slightly.

P. Pour the sample slowly down the inside of the sample bottle. Avoid splashing the sample. Assure that any suspended matter in the sample is transferred quantitatively to the sample bottle.

Q. Leave adequate air space in the bottle to allow for expansion, except for VOA vials which are filled to overflowing and capped.

R. Label the bottle carefully, and clearly. Enter all information accurately, and check to be sure it is legible.

S. Use a 0.45 μm filter and add the appropriate preservatives, as required.

T. Samples will be placed in containers defined according to the needs, and then, when appropriate, packed in a cooled ice chest as soon as practical. Packaging, labeling, and preparation of shipment procedures will follow procedures as specified in Section 8.0 and 10.0.

U. Complete field log and Chain-of-Custody forms in accordance with Section 10.0.

V. If pump not dedicated, remove from well and decontaminate as described in Section 7.0.

W. Replace well cap and lock.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

5.0 FIELD MEASUREMENT PROCEDURES

5.1 Temperature

Scope and Application

This procedure is applicable to groundwater from monitoring wells.

Summary of Method

Temperature measurements may be made with any calibrated high quality mercury-filled thermometer or thermistor with analog or digital read-out device.

Comments

For field operations using a glass thermometer, the thermometer will be transported in a protective case to prevent breakage. Thermometers or thermistors used with this procedure require calibration with a certified NBS thermometer.

Procedure

A. Use only mercury-filled thermometer or thermistor that is in calibration.

B. Inspect thermometer before each field trip to ensure that there are neither cracks in the glass, nor air spaces or bubbles in the mercury.

C. Allow thermometer or thermistor enough time to equilibrate to outside temperature when removed from a field vehicle.

D. Insert thermometer or thermistor in-situ when possible, or in a grab sample. Swirl the thermometer or thermistor in the sample, and take the temperature reading when the mercury column or digital readout stabilized; record temperature in field log to the nearest 0.5°C or 1.0°C, depending on need. Collect all contaminated water in a container for later disposal in the wastewater treatment system, as required.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

Calibration

Each temperature measurement device will be initially calibrated at three temperatures covering the range of the device against a National Bureau of Standards (NBS) certified thermometer, and then cross-checked against a calibrated NBS certified thermometer at least semiannually.

5.2 pH (Hydrogen Ion Concentration)

Scope and Application

This procedure is applicable to groundwater from monitoring wells.

Summary of Methods

The pH of a sample is determined electronically using a combination electrode and a pH meter.

Comments

Coatings of oily material or particulate matter can impair electrode response. Remove these coatings by gently wiping with a clean tissue followed by a distilled water rinse. Temperature effects on the electrometric measurement of pH are controlled by using instruments having temperature compensation or by calibrating the electrode meter system at the temperature of the sample.

Poorly buffered solutions with low specific conductance values (less than 200 umhos) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in sample before taking pH measurements.

Procedure

A. Prior to field activity check meter for mechanical and electrical failures, weak batteries, and cracked or fouled electrodes. Check pH recorders for recording and time scale accuracy.

B. Following instructions provided with each type of meter, test the meter against standard buffer solutions before using. Thereafter, the meter can be checked periodically against two buffers that bracket the expected value of the sample. Use a fresh aliquot of buffer solution for each measurement. Multi-range pH paper may be used to determine expected value.

C. For pH meter without automatic temperature compensation, bring the sample and buffer to same temperate, if possible. If the sample temperature differs more than 2°C from the buffer solutions, adjust for temperature difference.

D. Thoroughly rinse the electrode with distilled water and remove excess water between immersion in each buffer solution and sample.

E. Immerse the electrode in-situ when possible. If it is necessary to measure pH on a portion of the sample swirl the electrode at a constant rate until the meter reading reaches equilibrium. The rate of stirring used should minimize the air transfer rate at the air-water interface of the sample.

F. Note and record sample pH to the nearest 0.1 pH unit; repeat measurement on successive volumes of sample or in-situ until values differ by no less than 0.1 pH unit. Two or three volumes are usually sufficient.

G. For samples of high ionic strength, condition electrodes after cleaning by dipping them into sample for one minute, immerse in fresh portion of the same sample, and read pH.

H. For dilute, poorly buffered solutions, equilibrate electrodes immersing in three or four successive portions of sample. Take a fresh sample to measure pH.

I. Turn off meter at last reading.

J. Rinse electrodes thoroughly with ASTM Type II distilled deionized reagent grade water and store in appropriate storage solution as described in operating instructions for the specific meter or electrode.

K. Record data in field log and complete Chain-of-Custody forms.

L. Collect all contaminated water in container for later disposal in the wastewater treatment system, as required.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

5.3 Conductivity

Scope and Application

This procedure is applicable to groundwater form monitoring wells.

Summary of Method

The conductivity of the sample is determined by measuring the conductance of the sample using a digital or analog conductivity meter.

Comments

Temperature effects on the measurement of conductivity are controlled by using an instrument having temperature compensation or by calibrating the electrode meter system at the temperature of the same.

Procedure

A. Prior to field activity check meter for mechanical and electrical failures, weak batteries, and cracked or fouled electrode(s).

B. Following instructions provided with the meter, test the meter for accuracy.

C. Thoroughly rinse the electrode with distilled water and remove excess water between each sample.

D. Immerse the probe into the sample and gently swirl until reading stabilizes. Record values of conductivity and temperature to nearest 1.0 unit, as appropriate.

E. Turn off meter at last reading.

F. Rinse electrode thoroughly with distilled water and store according to operating instructions.

G. Record data in field log and complete Chain-of-Custody form.

H. Collect all contaminated water in a container for later disposal in the wastewater treatment system, as required.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

6.0 SAMPLING QA/QC PROGRAM

A. Trip Blank - Fill one VOA vial with ASTM Type II distilled deionized reagent grade water, transport to the site, handle like a sample, and return to the laboratory for analysis. One trip blank per cooler is recommended. Pack VOC samples collected at well site with trip blank.

B. Field Duplicate - One per well grouping of 20 wells or less. For more than 20 wells per group there shall be one per 20 wells or fraction thereof.

C. Rinsate Blank - One per well grouping.

D. Field Blank - Fill one VOA vial with ASTM Type II distilled deionized reagent grade water at the well site prior to collecting VOC samples, handle like a sample, and return to the laboratory for analysis. One field blank per cooler is recommended. Pack VOC samples collected at well site with field blank.

7.0 CLEANING AND DECONTAMINATING SAMPLE CONTAINERS AND SAMPLING DEVICES

Scope and Application

This procedure establishes methodologies for cleaning and decontaminating sample containers and sampling devices.

Summary of Method

Sampling devices will be cleaned prior to being used in the field to prevent potential contamination of a sample. Sampling devices will be cleaned and decontaminated to prevent cross-contamination and will be decontaminated at the close of the sampling event prior to being taken off-site.

An acceptable alternative to cleaning and decontaminating sampling containers is the use of items cleaned or sterilized by the manufacturer that are discarded after use. Care must be exercised to ensure such previously cleaned or sterilized items do not retain residues of chemical or radioactive sterilizing agents that might interfere with analytical techniques.

Definitions

A. Sample containers include, but are not limited to, the following:

Jars
Vials
Jugs

B. The laboratory detergent must be a standard brand of phosphate-free laboratory detergent.

C. The nitric acid solution (10 percent) is made from reagent-grade nitric acid and deionized or organic-free water.

D. The standard cleaning solvent will be pesticide-grade isopropanol. The use of any solvent other than pesticide-grade isopropanol for equipment cleaning purposes must be justified and approved by the responsible project personnel and will be documented in the log. The laboratory must be informed as well.

E. Tap water may be used from an approved municipal water treatment system. The use of an untreated portable water supply is not an acceptable substitute for tap water.

F. Deionized water is defined as tap water that has been treated by passing through a standard deionizing resin column. The deionized water should contain no heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard Inductively Coupled Arc Plasma Spectroscopy scan.

General

During cleaning operations, the substitution of a higher grade water (i.e., deionized) is permitted and need not be noted as a variation.

The brushes used to clean equipment as outlined in the various sections of this procedure must not be of the wire-wrapped type.

The solvents, nitric acid solution, laboratory detergent, and rinse waters used to clean equipment must not be reused, except as specifically permitted.

Procedure

A. Select appropriate cleaning procedure Section 7.1 or 7.2.

B. Segregation of Used Field Equipment

Field equipment or reusable sample containers needing cleaning must not be stored with clean equipment, or sample containers. Field equipment, reusable sample containers, and disposable sample containers that have not been used may not be replaced in storage without being recleaned if these materials have been transported to a facility or study site where contamination or suspected contamination is present.

C. Storage of Cleaned Field Equipment and Sample Containers

Previously cleaned sample containers and field equipment are stored in a contaminant-free environment. Sample containers and field equipment are stored separately from all other equipment and supplies and from each other.

D. Transporting Used Sample Containers Off-Site

Sampling containers that contain a sample, regardless of the assumed or known level of hazard associated with that sample, must have all exterior surfaces decontaminated. For sample containers used in areas other than a controlled access area, a wipedown with disposable rags or toweling, or rinse with deionized water followed by drying with disposable rags or toweling will suffice. Any visible dirt, water droplets, stains, or other extraneous materials must be removed.

E. Sample Equipment Cleaning Procedures (From Testing Laboratory Sampling Container Decontamination Procedures)

Containers are purchased with regard to materials of construction, volume, and cleanliness. Depending upon the project, varying degrees of detail in these three areas are assessed. EPA's 40 CFR Part 136, Table II (Table 5.6.2), and SW-846's Table 11-1 (Table 5.6.1) are consulted for appropriate container type and preservation rules.

Contamination Control

The solvent used to implement the cleaning procedures outlined in this method will be collected and disposed of properly. Similarly, spent acids will be collected and disposed of properly. There procedures apply whether cleaning procedures take place in the laboratory or in the field.

7.1 Cleaning Procedures for PVC, Teflon, or Glass Field Sampling Equipment Used for the Collection of Samples for Trace Organic Compounds and/or Metals Analyses

A. Equipment will be washed thoroughly with laboratory detergent and hot water using a brush to remove any particulate matter or surface film.

B. The equipment will be rinsed thoroughly with hot tap water.

C. Rinse equipment with at least 10 percent nitric acid solution.

D. Rinse equipment thoroughly with tap water.

E. Rinse equipment thoroughly with deionized water.

F. Rinse equipment twice with solvent and allow to air dry for at least 24 hours.

G. Wrap equipment with aluminum foil to prevent contamination during storage and/or transport to the field.

7.2 Clean Procedures for Bailers

A. Thoroughly wash the bailer interior and exterior with a non-phosphate detergent.

B. Rinse the bailer interior and exterior with ASTM Type II distilled deionized reagent grade water.

C. Repeat B.

D. Rinse the bailer interior and exterior with isopropyl alcohol and allow to air dry.

E. Wrap bailer in aluminum foil when dry.

7.3 Miscellaneous Equipment Cleaning Procedures

A. Well Sounders Used to Measure Groundwater Levels

1. Wash with laboratory detergent and tap water.
2. Rinse with tap water.
3. Rinse with deionized water, as appropriate.
4. Equipment will be wrapped to prevent contamination during storage or transit.

B. Submersible Pumps and Hoses Used to Purge Wells

1. Cleaning procedures before and after all wells are sampled.
   a. Steam clean the pump head and entire length of tubing.
   b. In lab, run one tubing volume of a rinse solution of 10% nitric acid and water through the tubing bundle. Collect the nitric acid waste and dispose as required.
   c. Rinse inside and outside of pump and tubing for 30 minutes with tap water.
   d. Flush tubing and pump with two tubing volumes of ASTM Type II distilled deionized reagent grade water.
   e. Wipe down pump head and wrap in aluminum foil for future use.
2. Cleaning procedures between wells
   a. Rinse entire length of pump head with water, then flush the system with one to two gallons of water with non-phosphate detergent.
   b. Flush system twice with one to two gallons of ASTM Type II distilled deionized reagent grade water.
   c. Seal pump head in a clean bag to prevent contamination.

C. Ice Chests and Shipping Containers

All ice chests and reusable containers will be washed with laboratory detergent (interior and exterior) and rinsed with tap water and air dried before storage. In the event that an ice chest becomes severely contaminated, in the opinion of the field investigator, with concentrated waste or other toxic material, it shall be cleaned as thoroughly as possible, rendered unusable, and disposed of properly.

8.0 PACKAGING ENVIRONMENTAL SAMPLES FOR TRANSPORTATION

Scope of Application

This method describes the minimum procedures required to properly package containers of environmental samples for transport to analysis at testing laboratory. It outlines the general requirements to be followed for laboratory samples collected in the course of field investigations and monitoring activities.

Summary of Method

Individual sample containers will be checked against accompanying Chain-of-Custody form(s) prior to signing the receipt for the sample collection. Site samples will be placed in strong exterior shipping packages and surrounded with compatible cushioning absorbent material if necessary.

The Chain-of-Custody must accompany the package. The package will be closed and sealed as appropriate.

Procedures for Sample Container Packaging

1. The sample container will be determined based on the analytical requirements as defined in the individual sampling and analysis plan.

2. The sample container will be cleaned in the field to remove sampled material from its exterior prior to packing for shipment.

3. Samples will be packed to insure physical integrity during the normal rigors of transportation. These requirements will include, but not be limited to:

   a) Strong, light outer containers as appropriate for sample;

   b) The outer container will provide secondary containment for the sample provided the primary container is breached;

   c) Absorbent material will be used, as required, to contain liquid samples and will be compatible with the sample;

   d) Cushioning materials may be appropriate to reduce shock to samples and breakage of sample containers.

5. The outer container will be closed and secured as appropriate to maintain Chain-of-Custody.

6. Prepare Chain-of-Custody as described in Section 10.0.

9.0 CHEMICAL ANALYSIS PROCEDURES

For most of the analytical parameters to be measured, there is usually more than one analytical method that may be applied. Selecting the appropriate method involves assessing the characteristics of each sample, the intended use of the data obtained from the analysis, and the limitations imposed by the analytical facility.

To select the most appropriate method for the analysis, the following factors should be considered:

a) Physical state of sample

b) Anticipated concentration of analytes

c) Required detection limit

d) Data quality objectives (DQO)

e) Regulatory requirements

f) Set up and equipment available at the analytical facility

g) Cost of analysis

After all of the above has been taken into consideration, the analytical method used can be found in Table 1.

10.0 CHAIN OF CUSTODY CONTROL

Procedure

A. Samples Under Custody

Chain-of-Custody requirements are necessary whenever a sample leaves the sampling team's custody. A sample is considered to be under a persons custody if any of the following conditions are met:

1. The sample is in the persons physical possession;
2. The sample is in line of sight of the person after he/she has taken possession;
3. The sample is secured by that person so any tampering can be detected;
4. The sample is secured by the person in possession, in an area which only authorized personnel can enter.

B. Sample Labels or Tags

Sample labels (Figure D-1) will be affixed to all sample containers prior to or at the time of sampling. Sample labels will be waterproof paper or plastic with gummed backs or waterproof tags, as appropriate. Labels will be completed with black indelible ink and will include the following information:

1. Unique field study or sampling activity name and/or number;
2. Unique sample number;
3. Sample locations or appropriate identification as identified in the sampling program;
4. Sampling date;

5. Sample preservation used;
6. Media sample or sample type;

7. Analyses required;

8. Comments and special precautions as needed.

Included is an example copy of sample labels (Figure D-1).

C. Sample Seals

Sample seals (Figure D-1) are used to detect tampering of samples, following sample collection prior to the time of analysis. The seal will be attached in such a way that is necessary to break the seal in order to open the sample container. Here, "sample containers" may refer to either individual sample containers or a shipping container such as an ice chest. Seals will be affixed to the containers before they leave the custody of the sampling personnel.

Sample seals will be waterproof paper or plastic. All samples designated for shipment which leaves the sampler's custody will have a sample seal affixed which includes the following information:

1. Name(s) of collector(s) or initials;

2. Date of sampling.

Included is a example of a Sample Seal (Figure D-1).

D. Field Log (Field Data Sheet)

A field log entry (Figure D-2) will be completed at the time the sample is taken. The field log entry will include, but not be limited to, the following information:

1. Unique field study or sampling activity name and number and sample number;

2. Volume of sample taken;

3. Name(s) of collector(s);

4. Date and time of sample collection;

5. Analytical parameter(s) to be measured;

6. Preservative;

7. Location of sampling point (i.e., well number);

8. Designation of QC samples (e.g., blanks, splits, or duplicates);

9. Sampling methodology;

10. Observations during sampling (e.g., odors and colors);

11. Field observations and measurements.

E. Chain-of-Custody Records

The Chain-of-Custody record (Figure D-2) will be completed by the sampling personnel at the time of the sampling event. The record(s) will be signed as relinquished or received each time the sample changes possession, from collection to final deposition. The Chain-of-Custody record will include the following information. This information may be integrated into the field log sheet.

1. Unique sample number(s);
2. Unique field study of sampling activity name and/or number;
3. Date and time of sample collection;
4. Place and address of collection;
5. Name(s) of sample team member(s);
6. Signature(s) of the collector(s) or field sample custodian;
7. Laboratory destination, if known;
8. Container type;
9. Condition of sample on receipt;
10. Chain-of-Custody control number (Does not apply to on-site analyses);
11. Signature and date blocks for personnel relinquishing or receiving sample custody.

Included is an example copy of the Chain-of-Custody form/field sheet (Figure D-2).

F. Sample Request for Analysis

Sample request for analysis will be pre-arranged with the laboratory.

G. Laboratory Chain-of-Custody Sheet

The laboratory Chain-of-Custody sheet will be completed by the laboratory personnel receiving custody of the field samples.

The laboratory personnel will verify the information on the appropriate form is complete and accurate. He/she will verify that the sample received is with all pertinent information and that the integrity of the sample(s) has been maintained.

Y-12 GROUNDWATER PROTECTIO[N] ROGRAM

DESTINATION: K-25 ACD

WELL NO.	LOCATION
DATE	ANALYSIS NO.
CAL. SHEET NO.	COC NO. (WET CHEM LAB SAMPLES ONLY)
COOLER NO.	TRIP BLANK NO.
	BLANK PREP. LOCATION

WELL MEASUREMENTS: *

Depth to well bottom (from annual measurements): _____ ft.

Depth to water (measured): _____ ft.

Height of water column (calculated): _____ ft.

* From top of Casing

- ☐ 2" well: 0.1632 gal./ft.
- ☐ 4" well: 0.6528 gal./ft.
- ☐ 6" well: 1.4688 gal./ft.
- ☐ 10" well: 4.0800 gal./ft.

x _____ = _____ gal.
(water column)

Purge Volume = 3 x vol. of water column = _____

Purge Volume _____ /Purge Rate _____ = Purge Time _____

WELL PURGING METHOD:

- ☐ Bailed
- ☐ Bennett Pump No. _____ APV: _____
- ☐ Well Wizard (use volume below "Mizer") Air Temperature _____

RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME

CONDITION ON RECEIPT: ☐ Acceptable ☐ Unacceptable

LOGIN REMARKS

COMMENTS

SUPERVISORY REVIEW	DATE	FORM APPROVED BY	DATE
		K. JAGO	03/09/94

UCN-16990 (1 4-94)

SHEET NO. _____

☐ FILTER AND FIX IN LABORA.

PUMP	BAIL	NO.	TYPE	PRES.	ANALYSIS
			500 ml Poly	HNO_3	Total Metals
			500 ml Poly	Filter/HNO_3	Dissolved Metals
			500 ml Poly	HNO_3	Radiochemistry
			500 ml Poly	Filter/HNO_3	Radiochemistry
			500 ml Poly		
			500 ml Poly		
			500 ml Poly		
			1-Liter Poly	HNO_3	Radiochemistry
			1-Liter Poly	HNO_3	ICP Scan
			1-Liter Poly	NaOH	Cyanide
			1-Liter Poly	HNO_3	Iodine
			1-Liter Poly	HNO_3	Radium
			1-Liter Poly		
			1-Liter Poly		
			1-Liter Poly		
			250 ml Poly		Gamma Spectrum
			250 ml Poly	H_2SO_4	COD
			250 ml Poly		Anions
			250 ml Poly		Carbonate/Bicarbonate
			250 ml Poly		Turidity,pH & Conduct.
			250 ml Poly		Total Suspended Solids
			250 ml Poly		Total Dissolved Solids
			250 ml Poly	HNO_3	ICP Scan
			250 ml Poly	HNO_3	Total Uranium Fluorometric
			250 ml Poly	Filter/HNO_3	Uranium Fluorometric
			250 ml Poly		Nitrate Nitrogen
			250 ml Poly	H_2SO_4	Ammonia Nitrogen
			250 ml Poly		
			250 ml Poly		
			250 ml Poly		
			1-80 oz Glass		BNA Extractables
			1-Liter Glass		BNA Extractables
			1-Liter Glass	H_2SO_4	Phenols
			1-Liter Glass		TPH
			1-Liter Glass		TPH Matrix Spike
			1-Liter Glass		
			250 ml Glass		Tritium
			250 ml Glass	H_2SO_4	Tox Blank
			250 ml Glass	H_2SO_4	Tox
			250 ml Glass		
			250 ml Glass		
			40 ml Glass		VOA
			40 ml Glass		VOA Blank
			40 ml Glass	HCL	VOA
			40 ml Glass	HCL	VOA Blank
			40 ml Glass	H_2SO_4	TOC
			40 ml Glass	HCL	TPH
			40 ml Glass		
			40 ml Glass		

☐ pH <2 LITMUS CHECK HNO_3
☐ pH <2 LITMUS CHECK H_2SO_4
☐ pH <2 LITMUS CHECK HCL
☐ pH >10 LIT[MUS CHECK] NAOH

FIELD MEASUREMENTS:

WELL NO. _____

			COND. UMHO/CM	D. O. PPM	TEMP. °C	pH SU	REDOX MV	TIME	DATE
ARRIVAL DATE (1)	_____	METER SERIAL NO.	_____	_____	_____	_____			
ARRIVAL TIME (1)	_____	INITIAL	_____	_____	_____	_____	_____	_____	_____
DEPARTURE TIME (1)	_____	1 ST	_____	_____	_____	_____	_____	_____	_____
PURGE START TIME (1)	_____	2 ND	_____	_____	_____	_____	_____	_____	_____
PURGE STOP TIME (1)	_____	FINAL PURGE	_____	_____	_____	_____	_____	_____	_____

SAMPLED ON

TECHNICIAN _____ TECHNICIAN _____

			COND. UMHO/CM	D. O. PPM	TEMP. °C	pH SU	REDOX MV	TIME	DATE
ARRIVAL DATE (2)	_____	3 RD	_____	_____	_____	_____	_____	_____	_____
ARRIVAL TIME (2)	_____	4 TH	_____	_____	_____	_____	_____	_____	_____
DEPARTURE TIME (2)	_____	5 TH	_____	_____	_____	_____	_____	_____	_____
PURGE START TIME (2)	_____	6 TH	_____	_____	_____	_____	_____	_____	_____
PURGE STOP TIME (2)	_____	7 TH	_____	_____	_____	_____	_____	_____	_____

TECHNICIAN _____ TECHNICIAN _____

			COND. UMHO/CM	D. O. PPM	TEMP. °C	pH SU	REDOX MV	TIME	DATE
ARRIVAL DATE (3)	_____	8 TH	_____	_____	_____	_____	_____	_____	_____
ARRIVAL TIME (3)	_____	9 TH	_____	_____	_____	_____	_____	_____	_____
DEPARTURE TIME (3)	_____	10 TH	_____	_____	_____	_____	_____	_____	_____
PURGE START TIME (3)	_____	11 TH	_____	_____	_____	_____	_____	_____	_____
PURGE STOP TIME (3)	_____	12 TH	_____	_____	_____	_____	_____	_____	_____

TECHNICIAN _____ TECHNICIAN _____

COMMENTS:

_____

_____

_____

_____

CLOSURE/POSTCLOSURE PLAN

FOR THE

OAK RIDGE Y-12 PLANT
INDUSTRIAL LANDFILL V

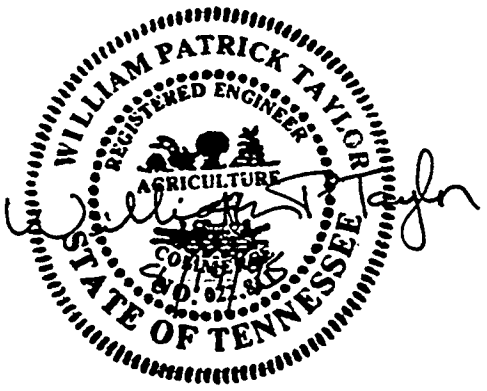
August 1995

Prepared for

U.S. Department of Energy
Oak Ridge Operations

Prepared by

Foster Wheeler Environmental Corporation
111 Union Valley Road
Oak Ridge, Tennessee 37830



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ACRONYMS

CFR	Code of Federal Regulations
CQA	Construction Quality Assurance
DOE	U.S. Department of Energy
DSWM	Division of Solid Waste Management
ILF-V	Y-12 Industrial Landfill V
MSL	mean sea level
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
TDEC	Tennessee Department of Environment and Conservation
WMD	Y-12 Waste Management Division
WTLO	Waste Transportation and Landfill Operations

1.0 INTRODUCTION

1.1 Facility Description

The U.S. Department of Energy (DOE) has three major operating facilities on the DOE Oak Ridge Reservation (ORR) at Oak Ridge, Tennessee: the Y-12 Plant, the K-25 Site, and the Oak Ridge National Laboratory (ORNL). All facilities are managed by Lockheed Martin Energy Systems, Inc. (Energy Systems) for DOE. Operations associated with the DOE energy research and production facilities at Oak Ridge result in the production of several types of waste materials. Disposal of solid waste (as defined in the *Solid Waste Processing and Disposal Rules for Tennessee*) in disposal facilities operated by the Y-12 Plant for DOE is the responsibility of the Y-12 Waste Management Division (WMD), which currently is operating Area 1 of the Y-12 Industrial Landfill V (ILF-V) (permit number IDL-01-103-0083).

WMD is proposing to develop ILF-V to encompass future waste disposal activities in accordance with the issued permit. The permit was issued on April 26, 1993, for a total area of approximately 25.9 acres. DOE has developed Area 1 of this landfill, which encompasses approximately 5.1 acres. ILF-V was permitted as a Class II landfill by the Tennessee Department of Environment and Conservation/Division of Solid Waste Management (TDEC/DSWM). Area 1 was constructed with a 3-ft-thick compacted low permeable clay liner, overlain with a 1-ft-thick granular drainage layer, which is overlain by a 1-ft-thick protective soil cover. A geotextile was placed above and below the granular drainage layer.

Landfill development will proceed in accordance with the permit. Due to regulatory changes enacted since the permit was issued, future landfill development will require that the liner be constructed with a composite liner consisting of 2 ft of compacted low permeable clay and a geomembrane. This design modification for future liner construction will necessitate that the cover design utilized for Area 1 (a 2-ft-thick compacted clay soil layer and a 1-ft vegetative layer) be modified for Areas 2–5. The composite cover will be 4 ft in overall thickness and will incorporate a passive gas vent system, a geomembrane (placed in contact on top of the compacted clay soil layer), a drainage layer, and a vegetative cover. This document describes the closure and postclosure plans for ILF-V.

1.2 Expected Year of Closure

Based on existing practices and workloads, ILF-V will have a compacted waste loading of approximately 200 yd^3/workday, or 51,875 yd^3/yr. The available airspace is the volume between the excavation contours shown on the excavation plan (Drawing C2E900000A627) and the proposed final contours (Drawing C2E900000A630). The airspace includes the volume of waste; daily, intermediate and final cover; and bottom liner (includes compacted clay layer, granular drainage layer, and protective soil cover layer). Landfill operation began in April 1994. Based on the original projected waste loading and on the estimated airspace volume, the anticipated life of the ILF-V was approximately 43 yrs. ILF-V volume usage rate will be frequently monitored and the projected life will be revised annually. Based upon the 1994 volume usage rate of 2648 yd^3/mo, (31,776 yd^3/yr), the revised estimated life of ILF-V is 67.5 years. The expected year of closure is 2061.

1.3 Facility Contact

ILF-V is owned by DOE and managed by the Y-12 Plant WMD. The address and phone number of the facility contact are as follows:

Waste Transportation and Landfill Operations (WTLO) Department Manager
Lockheed Martin Energy Systems, Inc.
Y-12 Plant
P.O. Box 2009
Oak Ridge, Tennessee 37831-8060

(615) 576-4965

2.0 FACILITY CLOSURE

2.1 Partial Closure Steps

If at any point in time during the life of the landfill, it becomes necessary to close the landfill before maximum utilization of the fill area is achieved, an engineering assessment of the current state of the ILF-V with respect to the TDEC/DSWM-approved plan will be performed. TDEC/DSWM will be notified in writing of the intent to close the landfill at least 60 days prior to the date partial closure is expected to begin. Required changes to the closure/postclosure plan and accompanying engineering drawings will be accomplished and submitted to TDEC/DSWM for approval. The plan and drawings will be submitted showing the necessary modifications of the final contours and the drainage system. The modifications will take into account permanent closure elements already constructed and temporary landfill operations elements such as berms and drainage ditches.

The proposed final contours, shown on Drawing C2E900000A630, create a small, relatively flat area with a 5% slope and a maximum elevation of approximately 1153 ft mean sea level (MSL). The closed landfill will slope downward from this flat area with approximately 3½:1 side slopes, beginning at elevation 1150 ft MSL. The final cover is to be constructed with two terraces which are designed to improve the slope stability of the final cover. Upon achieving the developed waste grade, the final cover will be placed. Closures will be performed in approximate two to five acre areas in order to establish a manageable size area. The final cover will be applied to minimize infiltration of precipitation into the waste, to provide a pleasing appearance, and to provide a growing surface for vegetation. The final cover will be placed on the landfill as shown on Drawing C2E900000A630 and is described in the following two paragraphs.

As shown on Drawing C2E900000A930, a clay soil final cover will be placed on the side slopes of Area 1 only (to approximately elevation 1080 ft MSL) and will consist of 36 in. of soil that includes a 24-in. compacted, low-permeability layer (1×10^{-7} cm/s) overlain by a 12-in. layer that will support vegetative growth. Placement of the final cover will be in accordance with procedures outlined in the Construction Quality Assurance (CQA) Plan.

The remaining portion of ILF-V will have a composite clay soil final cover consisting of a composite geonet gas vent layer overlain by a 6-in.-thick sacrificial layer. The sacrificial layer will serve as protection for the composite geonet from the footed compactor used to construct the compacted clay soil layer. The compacted soil clay layer will be placed next. This layer will be 2 ft thick and will be placed in multiple lifts with each lift being compacted to the required moisture and density range as described in the CQA Plan. Gas vent pipes will be constructed to tie in to the gas vent layer, in order to facilitate the release of any gas that is generated within the landfill, as shown on Drawing C2E900000A930. Next, a geomembrane will be placed in direct contact with the compacted clay soil layer. The drainage layer will consist of a composite geonet and will be placed on top of the geomembrane. A vegetative layer 1½ ft thick will be placed above the composite geonet drainage layer.

Upon achieving the appropriate elevation for compacted waste below the new final contours of the side slopes and the landfill top of the disposal area, final cover will be placed over the completed disposal area. This will be accomplished in the shortest time practicable, not to exceed 90 days after completion of waste filling operations. Closure activities (including grading, surface drainage and cap access road construction, and establishing vegetative cover) will be completed in the shortest time practicable, not to exceed 180 days after completion of waste filling operations. Partial closure will be in accordance with this manual as revised and approved by TDEC/DSWM and as shown on the final contour drawing. This design will minimize run-on, optimize drainage, prevent pooling, and minimize erosion. The design will not adversely affect drainage of adjacent lands.

The final cover for Area 1 will be as described above for the side slopes. The final cover for Area 2, as well as for subsequent Areas developed for waste disposal in accordance with the permit, will be as described above. The interface of final cover between Areas 1 and 2 will be constructed in accordance with details shown on Drawing C2E900000A930. The cover will be constructed in accordance with the CQA Plan (Y/WM-093 R1).

During final grading of each respective cover section, the berm channels, letdown channels, and maintenance road sections thereon will be constructed. Finally, the top and side slopes of the completed landfill will be fertilized, seeded, and mulched. The closed areas of the landfill will be seeded with Kentucky 31 Fescue (or a mixture of rye and fescue) at a rate of no less than 3.5 lbs of live seed per 1000 ft^2. Hydroseeding and hydromulching may be used. The side slopes of the completed landfill may instead be seeded with a mixture of perennial rye and crown vetch applied at a rate of 4 lbs/1000 ft^2 and 2 lbs/1000 ft^2, respectively. Seeding of the perennial rye and crown vetch will be done separately in order to assure even distribution of seed. The side slopes will be roughened before seed is applied to promote infiltration, which is necessary for vegetative growth. Roughening may be accomplished with the track loader or some type of harrowing device.

All stockpiles and other disturbed areas that are not part of the fill area will be stabilized (i.e., slopes will be a maximum of 3:1), graded to promote drainage, and seeded with Kentucky 31 Fescue at a rate of no less than 3.5 lbs of live seed per 1000 ft^2.

The landfill liner and leachate collection system will be constructed during ongoing landfill operations, as each respective area is opened. All of these facilities will be operated throughout the active landfill period, and no additional construction will be required at partial closure.

A passive gas migration control system will also be constructed in the cover during closure. The location of the gas vents is depicted on Drawing C2E900000A630, and the gas vent details are depicted on Drawing C2E900000A930. An analysis of proposed federal regulations requiring gas collection and destruction at landfills emitting above-threshold levels of gas indicated that the ILF-V will emit less than the threshold quantity and thus will not be subject to the regulation. Therefore, no additional gas control construction is anticipated to be required at partial closure.

The groundwater monitoring system utilizes existing wells and wells to be constructed prior to the ILF-V operation, and no modifications to this system are required at partial closure.

Upon completion of each partial closure activity, TDEC/DSWM will be notified in writing of the completion of closure. The notification will include certification as required by TDEC/DSWM that the closure has been accomplished in accordance with the approved closure plan. An inspection of the closure will be made by TDEC/DSWM to verify that the closure has been performed in accordance with the approved plan. Partial closure will not be considered final and complete until approved in writing by TDEC/DSWM. A final contour map with a vertical interval of no more than 2 ft will be made after final and complete closure of the entire ILF-V.

2.2 Complete Closure Steps

TDEC/DSWM will be notified in writing of the intent to close the landfill at least 60 days prior to the date final closure is expected to begin. Upon achieving the appropriate compacted final waste elevations, final cover will be placed over the remaining unclosed areas. This will be accomplished in the shortest time practicable, not to exceed 90 days after completion of waste filling operations. Closure activities (including grading, surface drainage and road construction, and establishing vegetative cover) will be complete in the shortest time practicable, not to exceed 180 days after the completion of waste filling operations. Closure will be in accordance with this manual as approved by TDEC/DSWM and as shown on Drawing C2E900000A630. This design will minimize run-on, optimize drainage, prevent pooling, and minimize erosion. The design will not adversely affect drainage of adjacent lands. The existing Siltation Ponds 1 and 2 will continue to function during closure activities and will remain functional beyond final closure in order to minimize sediment migration to surface waters while adequate vegetation is being established on the cover. After closure is complete, agreement will be obtained from TDEC on elimination of the siltation ponds.

The final cover will be constructed as described earlier. The cap will be constructed in accordance with the CQA Plan (Y/WM-093 R1) attached to the permit application.

During final grading, the berm channels, letdown channel, and maintenance road will be completed. Finally, the top and side slopes of the completed landfill will be fertilized, seeded, and mulched. The landfill will be seeded with Kentucky 31 Fescue (or a mixture of rye and fescue) at a rate of no less than

3.5 lbs of live seed per 1000 ft^2. Hydroseeding and hydromulching may be used. The side slopes of the completed landfill may instead be seeded with a mixture of perennial rye and crown vetch applied at a rate of 4 lbs/1000 ft^2 and 2 lbs/1000 ft^2, respectively. Seeding of the perennial rye and crown vetch will be done separately in order to assure even distribution of seed. The side slopes will be roughened before seed is applied to promote infiltration, which is necessary for vegetative growth. Roughening may be accomplished with the track loader or some type of harrowing device.

All stockpiles and other disturbed areas that are not part of the fill area will be stabilized (i.e., slopes will be a maximum of 3:1), graded to promote drainage, and seeded with Kentucky 31 Fescue (or a mixture of rye and fescue) at a rate of no less than 3.5 lbs of live seed per 1000 ft^2.

The landfill liner and leachate collection system will be constructed during ongoing landfill operations, as each respective area is opened. All of these facilities will be operated throughout the active landfill period, and no additional construction will be required at closure.

The groundwater monitoring system utilizes existing wells and wells to be constructed prior to the ILF-V operation, and no modifications to this system are required at closure.

Upon completion of closure activities for ILF-V, TDEC/DSWM will be notified in writing of the completion of closure. The notification will include certification as required by TDEC/DSWM that the closure has been accomplished in accordance with the approved closure plan. An inspection of the closure will be made by TDEC/DSWM to verify that the closure has been performed in accordance with the approved plan. Closure will not be considered final and complete until approved in writing by TDEC/DSWM. A final contour map with a vertical interval of no more than 2 ft will be made after final closure of the entire ILF-V is complete.

Within 90 days of final and complete closure, a notation will be recorded on the deed to the property or some other instrument which is normally examined during a title search that will in perpetuity notify any person conducting a title search that the land has been used as a disposal facility.

In addition, in accordance with state law, within 60 days of the ILF-V becoming inactive (i.e., final and complete closure), a notation will be recorded on the deed to the facility property and on any other instrument that would normally be examined during a title search. The notation will in perpetuity notify any potential purchaser of the property of the following.

- The land has been used for the disposal of asbestos-containing waste material.
- The survey plot and record of the location and quantity of asbestos-containing waste disposed of within the disposal site have been filed with the Administrator or Commissioner.
- The site is subject to Code of Federal Regulations (CFR) 40 CFR 61, Subpart M.

3.0 POSTCLOSURE CARE

The postclosure activities will be continued for at least 30 yrs after the date of final and complete landfill closure.

ILF-V will be inspected quarterly by walking the site and recording problems and their locations. Corrective action will be initiated to correct the problems as soon as reasonably possible. Any occurrences of the following problems will be recorded during the inspection and corrected:

- uneven settlement or cracks that prevent adequate runoff;
- drainage system erosion or other deterioration;
- inadequate vegetation;
- deterioration of drainage, gas migration control, and leachate collection and holding systems such that their functions are impaired.

During the site inspection, the ILF-V groundwater monitoring wells will also be inspected. The same semiannual monitoring and analysis program as that established during the landfill operations will be carried out throughout the postclosure period unless a program modification is approved by TDEC/DSWM. The surface water monitoring parameters as established by the Y-12 Plant storm water discharge general permit for postclosure care will be followed.

Leachate removal will continue throughout the postclosure period. As leachate quantities decrease after final closure, the frequency of leachate removal will be revised as necessary. Leachate sampling and analyses as required by the accepting wastewater treatment plant pretreatment program will also be continued.

As required, maintenance will be performed on leachate pumps, motors, valves, etc. Any parts necessary to maintain operation will be acquired and installed. If necessary, the entire component will be replaced. The leachate collection lines will be inspected semiannually for blockage and will be cleaned as necessary.

All documents and records generated during the postclosure period will be maintained by the WTLO Department through the postclosure period. HSEA will maintain the original groundwater monitoring records and WMD will keep a copy of the groundwater monitoring records.

The closed site will be maintained as a grassed area. There are no plans for future development of the closed site.

4.0 COST ESTIMATES

Itemized cost estimates for performing the closure and postclosure care activities are included on the following pages.

WORK SHEET A
CLOSURE ACTIVITIES

Cost categories that vary from the TDEC/DSWM form are shown in italics.

1. Establishing final cover

A. Vegetative Layer		
1.	Quantity needed (yd^3)	62,949
2.	Excavation unit cost ($/$yd^3$)	
3.	Excavation cost (1. x 2.)	
4.	Placement and spreading unit cost ($/$yd^3$)	
5.	Placement cost (1. x 4.)	
6.	*Excavation, placement, & spreading unit cost ($/$yd^3$)*	$12.60
7.	*Excavation, placement, & spreading cost (1. x 6.)*	$793,157
*TOTAL: Topsoil (3. + 5.) *or 6.*		$793,157
B. Landfill cap + *compacted layer*		
1.	On-site soil	
a.	Quantity needed (yd^3)	107,955
b.	Excavation unit cost ($/$yd^3$)	
c.	Excavation cost (a. x b.)	
d.	Placement and spreading unit cost ($/$yd^3$)	
e.	Placement cost (a. x d.)	
f.	Compaction unit cost ($/$yd^3$)	
g.	Compaction cost (a. x f.)	
h.	*Excavation, placement, spreading, & compaction unit cost ($/$yd^3$)*	$14.00
i.	*Excavation, placement, spreading, & compaction cost (a. x h.)*	$1,505,972
*TOTAL: On-site clay (c. + e. + g.) *or i.*		$1,505,972
2.	Off-site clay	
a.	Quantity needed (yd^3)	
b.	Purchase unit cost ($/$yd^3$)	
c.	Purchase cost (a. x b.)	
d.	Delivery unit cost ($/$yd^3$)	
e.	Delivery cost (a. x d.)	
f.	Placement/spreading unit cost ($/$yd^3$)	
g.	Placement cost (a. x f.)	

h. Compaction unit cost ($/yd^3)	
i. Compaction cost (a. x h.)	
*TOTAL: Off-site clay (c. + e. + g. + i.)	N/A
3. Quality control/testing of *compacted layer*	
a. Number of samples to be tested	
b. Clay testing unit cost ($/sample)	
c. Testing cost (a. x b.)	
*TOTAL: *Compacted layer* testing (c.)	$34,760
C. Synthetic membrane	
1. Quantity needed (yd^2)	118,604
2. Purchase unit cost ($/$yd^2$)	
3. Purchase cost (1. x 2.)	
4. Installation unit cost ($/$yd^2$)	
5. Installation cost (1. x 4.)	$7.10
6. Purchase & instllation unit cost ($/$yd^2$	
*TOTAL: Synthetic membrane (3. + 5.)	$842,088
D. *Geonet for 1.7-acre landfill top*	
1. Quantity needed (yd^2)	237,208
2. Purchase unit cost ($/$yd^2$)	
3. Purchase cost (1. x 2.)	
4. Installation unit cost ($/$yd^2$)	
5. Installation cost (1. x 4.)	
6. Purchase & installation unit cost ($/$yd^2$)	$12.62
*TOTAL: Geotextile filter fabric (3. + 5.) *Geonet (1. x 6.)*	$2,993,565
TOTAL for establishing final cover (*): (A. + B. + C. + D.)	$6,134,782

2. Establishing vegetation cover

A. Labor ($/acre)	
B. Seeding ($/acre)	
C. Fertilizing ($/acre)	
D. Mulching ($/acre)	
E. Number of acres	25.9
F. Labor, seeding, fertilizing, & mulching ($/acre)	$1,800

TOTAL for establishing vegetation cover:
E. x (A. + B. + C. + D.) *or (E. x F.)* $46,620

3. Establishing or completing a system to minimize and control erosion/sedimentation

A. Siltation ponds
1. Excavation/construction ($) _____
2. Materials (e.g., pipe, rip-rap) ($) _____

*TOTAL: Sediment pond (1. + 2.) N/A[1]

B. Diversion ditch
1. Construction ($) _____
2. Materials ($) _____

*TOTAL: Diversion ditch (1. + 2.) N/A

C. Temporary structures (e.g., silt fence, swales)
1. Construction ($) _____
2. Materials ($) _____

*TOTAL: Temporary structures (1. + 2.) N/A

D. Berm channels
1. Quantity needed (linear ft) 9,580
2. Construction unit cost ($/linear ft) $60

**TOTAL: Berm channels (1. x 2.)* $574,800

E. Letdown channels
1. Quantity needed (linear ft) 650
2. Construction unit cost ($/linear ft) $98

**TOTAL: Letdown channel (1. x 2.)* $63,375

[1] Completed in initial site development.

TOTAL for establishing or completing a system to minimize and control erosion and sedimentation (*):
(A. + B. + C.) *or (A. + B. + C. + D. + E.)* $638,175

4. Establishing or completing leachate collection, removal, and treatment system

A. Installation
1. Number of feet _____
2. Unit cost ($/ft) _____
3. Storage tanks ($) _____
4. Pumps ($) _____

TOTAL for establishing or completing leachate system:
(1. + 2. + 3. + 4.) N/A[1]

5. Establishing or completing a system to collect or vent gases

A. Installation
1. Materials (e.g., piping) $1000
2. Equipment (e.g., pumps) —
3. Labor (e.g., drilling) $1500

TOTAL for establishing or completing a system to collect or vent gases:
(1. + 2. + 3.) $2500

6. Establishing or completing groundwater/surface water monitoring system

A. Installation
1. Number of wells _____
2. Drilling cost (1. x 2.) _____
3. Materials (e.g., casing) (1. x 3.) _____
4. Equipment (e.g., pumps) _____
5. Labor _____

TOTAL for establishing or completing groundwater monitoring system:
(2. + 3. + 4. + 5.) N/A[2]

[1] Completed in initial site development.
[2] Already established.

TOTAL CLOSURE COSTS:

(Sum of TOTALS for Items 1. through 6.)	$6,822,077

WORK SHEET B
POSTCLOSURE ACTIVITIES

Cost categories that vary from the TDEC/DSWM form are shown in italics.

1.	**Surveying inspection to confirm final grade and drainage are maintained**	
	A. Transportation	$1,000
	B. Labor *(2 people, 10 hr/quarter @ $30/hr)*	$2,400
	TOTAL for surveying inspections: (A. + B.)	$3,400
2.	**Maintain healthy vegetation**	
	A. Transportation	$1,600
	B. Labor *(80 hrs @ $30/hr)*	$2,400
	C. Seeding	———
	D. Fertilizing	———
	E. Mulching	———
	F. Rodent control	N/A
	G. Mowing *(25.9 acres @ $30/acre, 3 times/yr)*	$2,330
	H. Number of acres	1.3
	I. Seeding, fertilizing, & mulching unit cost ($/acre)	$1,800
	J. Seeding, fertilizing, & mulching cost (H. x I.)	$2,340
	TOTAL for maintaining healthy vegetation: (A. + B. + C. + D. + E. + F. + G.) *or (A. + B. + F. + G. + J.)*	$8,670
3.	**Maintain the drainage facilities, sediment ponds and other erosion/sedimentation control measures** *and final cover*	
	A. Transportation	$1,000
	B. Labor *(40 hrs @ $30/hr)*	$1,200
	C. Cleaning out of systems	$1,000
	D. Repair of gullies or rills	
	1. Soil acquisition	
	a. Quantity (yd^3)	$500
	b. Purchase unit cost ($/$yd^3$)	N/A
	c. Purchase cost (a. x b.)	N/A
	d. Delivery unit cost ($/$yd^3$)	$5.00
	e. Delivery cost (a. x d.)	$2,500
	Total for soil acquisition: (c. + e.)	$2,500

2. Placement/spreading/compaction	$1,000
3. Revegetation	$1,500
Total for repair of gullies & rills: (1. + 2. + 3.)	$5,000
TOTAL for maintaining drainage: (A. + B. + C. + D.)	$8,200

4. Maintain and monitor leachate collection, removal, and treatment system

A. Treatment of leachate	
1. On-site	
a. Quantity (yd^3)	____
b. Treatment unit cost ($/$yd^3$)	____
c. Treatment cost (a. x b.)	____
d. Sewer discharge unit cost	____
e. Discharge cost (a. x d.)	____
Total for on-site: (c. + e.)	N/A
2. Off-site	
a. Quantity (gal)	195,217
b. Hauling unit cost ($/$yd^3$)	$0.28
c. Hauling cost (a. x b.)	$54,661
d. Treatment unit cost ($/gal	$0.01
e. Treatment cost (a. x d.)	$1,952
f. Leachate testing	$8,400
Total for off-site: (c. + e. + *f.*)	$65,013
*TOTAL: Treatment of leachate (1. or 2. Total)	$65,013
B. Maintenance of leachate collection system	
1. Transportation	____
2. Labor	____
3. Repairs/materials (see below)	
a. Pumps	$1,000
b. Cleaning out system	____
c. Leak detection	____
d. Other *(Electricity)*	$5,000
Total for repairs/materials: (a. + b. + c. + d.)	$6,000
4. Transportation and labor (40 hr/yr @ $50/hr)	$2,000
*TOTAL: Maintenance (1. + 2. + 3.) *or (3. + 4.)*	$8,000
TOTAL for monitoring and maintaining leachate system (*): (A. + B.)	$73,013

5. Maintain and monitor gas collection or venting system
(Passive venting system to be inspected quarterly)

A. Transportation	$100
B. Labor *(4 hr/quarter @ $30/hr)*	$480
C. Repairs/materials (see below)	
1. Cleaning	____
2. Caps	____
3. Other	____
Total for repairs/materials: (1. + 2. + 3.)	N/A
TOTAL for monitoring and maintaining gas control system: (A. + B. + C.)	$580

6. Maintain and monitor the groundwater and/or surface water monitoring system

A. Monitoring of groundwater system	
1. Number of wells/springs	5
2. Number of samples/well/*yr*[1]	3
3. Unit cost of analysis	$1,200
4. Cost of sampling and analysis (1. x 2. x 3.)	$18,000
5. Labor cost per well	$1,500
6. Labor costs (1. x 5.)	$7,500
*TOTAL: Monitoring (4. + 6.)	$25,500
B. Inspection and maintenance of system	
1. Transportation	$1,000
2. Labor	$2,000
3. Repairs/materials (see below)	
a. Caps	$50
b. Tubing	$100
c. Pumps	$500
d. Well replacement	N/A
e. Other	$500
Total for repairs/materials: (a. + b. + c. + d. + e.)	$1,150
*TOTAL: Inspection and maintenance (1. + 2. + 3.)	$4,150
C. Recordkeeping	
1. Labor (40 hr/yr @ $30/hr)	$1,200
**TOTAL: Recordkeeping (1.)*	$1,200

[1] Assumes semiannual sampling and analyses for groundwater contamination indicator parameters and annual analyses for volatile organic compounds.

TOTAL for maintaining and monitoring groundwater system (*) (A. + B.) *or (A. + B. + C.)*	$30,850

TOTAL POSTCLOSURE COSTS:

Annual Basis: (Sum of Items 1. through 6.)	$124,713
Inflation Rate Utilized	4%
30-year Basis: (Annual cost)(Inflation rate)(30 yrs)	$3,891,046

Construction QA Plan

CONSTRUCTION QUALITY ASSURANCE PLAN

FOR THE

OAK RIDGE Y-12 PLANT
INDUSTRIAL LANDFILL V

November 1995

Prepared for

U.S. Department of Energy
Oak Ridge Operations

Prepared by

Foster Wheeler Environmental Corporation
111 Union Valley Road
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ACRONYMS

ASTM	American Society for Testing and Materials
CQA	construction quality assurance
EPA	U.S. Environmental Protection Agency
FML	flexible membrane liner
FTB	film tear bond
ILF-V	Oak Ridge Y-12 Plant Industrial Landfill V
MARV	minimum average roll values
PI	plasticity index
QA	quality assurance
QC	quality control

1.0 INTRODUCTION

This Plan describes construction quality assurance (CQA) procedures for the successful construction and performance of the Oak Ridge Y-12 Plant Industrial Landfill V (ILF-V). The elements of construction which require field monitoring and documentation under the CQA procedures include the compacted clay soil liner for the bottom liner and closure cap; the crushed aggregate material layer for the leachate collection layer; the operational soil cover; the synthetic components of the landfill bottom liner; cap; the leachate collection system; and the cap final vegetative cover. Synthetic components include geomembranes, geonets, and geotextiles.

The overall goal of this CQA Plan is to outline procedures for verifying that proper materials, construction techniques, and installation procedures are used by the Contractor and that the design intent is met. In addition, this plan is intended to define problems that may occur during construction and to provide a mechanism for resolving these problems.

The program described by this CQA Plan is independent of the quality control (QC) program conducted by the Contractor. The CQA Plan is intended to provide verification that the Contractor has met its obligation in the supply and installation of the specified materials. This CQA Plan does not replace the contract specifications regarding the selection and placement of materials. Where there is a discrepancy, the project construction drawings and specifications will govern.

2.0 DEFINITIONS

This section provides definitions for terms used in this Quality Assurance (QA) Plan.

Construction Manager—the official representative of the Company responsible for overseeing construction of the project.

Contractor—the individual or firm responsible for landfill-related construction activities. This definition applies to any party performing work defined as geomembrane, geotextile, or composite geonet installation.

Earthwork—an activity involving the use of soil or rock materials as defined in the construction specifications.

Engineer-of-Record—the firm or individual appointed by the Facilities Manager who is responsible for preparing the postconstruction report certifying that the installation conforms to the closure plan and design documents.

Facilities Manager—the individual or firm responsible for the design and preparation of the project construction drawings and specifications, for the operation of the landfill for the Government, and for the planning of future development of the landfill within the permitted boundary.

Geomembrane—a synthetic lining material, also referred to as a flexible membrane liner (FML), placed in direct contact with the compacted soil clay layer.

Composite Geonet—a synthetic drainage material consisting of a layer of geotextile, a layer of geonet, and another layer of geotextile.

Geotextile—any permeable textile material used for separation and/or filtration with soil, rock, etc., in civil engineering construction. Also used in protective applications to aid in the prevention of punctures to geomembranes (i.e., protective geotextile).

Government—owner of ILF-V.

Panel—a unit area of the geomembrane that will be seamed in the field.

Project construction drawings and specifications—all project-related drawings and specifications, including design modifications and record drawings.

Project documents—include, but not limited to, Contractor submittals, construction drawings, record drawings, specifications, shop drawings, field inspection reports, and project schedule.

QA Officer—Individual appointed by the Facilities Manager who is responsible for performing tasks outlined in this CQA Plan. The QA Officer shall be a registered Professional Engineer in the state of Tennessee.

Quality Assurance/QA—provides verification that QC functions have been performed in substantial compliance with the project construction drawings and specifications.

Quality Control/QC—functions done by the Contractor and material supplier to verify that work performed conforms to project construction drawings and specifications.

Record drawings—drawings recording the locations, elevations and details of the facility after construction is completed.

Testing laboratory—a laboratory capable of conducting the tests required by this CQA Plan and the materials specifications. This laboratory will be retained by the Facilities Manager and shall not be affiliated with the Contractor.

3.0 QA OFFICER

Construction of compacted clay liners and/or caps, the leachate collection layer, and the various synthetic components within the Class II landfill will be closely monitored by the QA Officer, under contract to the Facilities Manager. The QA Officer will be a Professional Engineer licensed to practice in the state of

Tennessee, will be knowledgeable in the field of soil mechanics and geosynthetics, and will have a good working knowledge of the equipment and procedures generally used in the construction of landfills.

The QA Officer has the following duties.

- Provide written, certified documentation attesting to conformance to the design specifications and the CQA Plan with respect to construction of soil and synthetic liners, leachate collection systems, and caps within ILF-V.
- Be present during the construction of all compacted liners, caps, and embankments in order to determine the optimum mixture of materials, moisture contents, densities, etc., to be used in the construction of the facilities as specified in the contract documents.
- Use such soil analyses as deemed necessary to determine the optimum construction methods and procedures to be used in constructing liners and caps.
- Be present at appropriate intervals during construction of the liner sections, perform appropriate tests, and obtain samples for laboratory analyses.
- Inspect the leachate collection system components (and installation of these components) for conformance with the contract documents.
- Observe material delivery and unloading.
- Observe all placement and seaming operation of geosynthetics.
- Observe nondestructive seam testing.
- Recover and process seam samples for destructive testing.
- Observe and document repair operations.
- Use the results of tests and laboratory analyses to document conformance to performance requirements.
- Educate other CQA inspection personnel on the CQA requirements and procedure.
- Schedule and coordinate the CQA inspection activities.
- Reject defective work and verify that corrective measures have been implemented.

The QA Officer may utilize qualified field technicians to perform soil and geosynthetics testing described and to provide additional observational oversight during construction.

4.0 MEETINGS

To facilitate construction and clearly define construction goals and activities, close coordination between the Facilities Manager, Construction Manager, QA Officer, and Contractor is essential. To meet this objective, design review, preconstruction, progress, and deficiency meetings will be held.

4.1 Design Review Meeting (Optional)

Following completion of the design and after review and approval by the Facilities Manager and applicable state and federal agencies, a design review meeting will be held. The purpose of this meeting, which the Facilities Manager, Construction Manager, and QA Officer shall attend, is to accomplish the following activities.

- Identify key personnel.
- Provide all parties with relevant documents.
- Review the project construction drawings, specifications, and CQA Plan.
- Confirm responsibilities of each party.
- Review reporting and documenting procedures.
- Define lines of communication.
- Establish work area procedures.
- Review sampling and testing procedures for nondestructive and destructive testing.

The meeting will be documented by the QA Officer or person designated by the Construction Manager. Copies of the minutes and relevant documents will be provided to all parties.

4.2 Preconstruction Meeting

A preconstruction meeting, which may be held concurrently with the design review meeting, will be held at the site prior to the start of construction. The Facilities Manager, Construction Manager, QA Officer, Contractor, and others designated by the Government will attend this meeting. The purpose of the meeting is to accomplish the following activities.

- Review the construction drawings and specifications, CQA Plan, work area security, construction procedures, and related issues.
- Define the responsibilities of each party.
- Define lines of communication and authority.
- Review the project schedule.
- Review documentation procedures (i.e., testing and record drawings).

- Review testing procedures and procedures for correcting and documenting construction deficiencies.

- Conduct a site inspection to discuss work areas, work plans, stockpiling, equipment and material laydown areas, access roads, haul roads, and related items.

This meeting will be documented by the Construction Manager or authorized representative, and copies of the documentation will be distributed to all parties.

4.3 Progress Meetings

A progress meeting will be held daily before the start of work. At a minimum, this meeting will be attended by the QA Officer and the Contractor's on-site superintendent and QC manager. The purpose of this meeting is to accomplish the following activities.

- Review the previous days activities.
- Review scheduled work.
- Discuss problems.
- Review test data.

This meeting will be documented by the QA Officer, and copies of the documentation will be distributed to the Construction Manager, Facilities Manager, and Contractor.

4.4 Deficiency Meetings

As required, special meetings will be held to discuss problems or deficiencies. At a minimum, these meetings will be attended by the QA Officer and Contractor's on-site superintendent and QC manager. If the problem requires a design modification, the Contractor and Facilities Manager should also be present. The meeting will be documented by the QA Officer on a daily meeting report form.

5.0 CONSTRUCTION METHODS

Construction will be conducted in accordance with the project construction drawings and specifications. To monitor compliance, a QA program will be implemented that includes the following activities:

- Contractor's QC submittals review,
- material conformance testing,
- soil installation testing,
- geosynthetic installation testing (nondestructive and destructive), and
- construction observation.

Conformance testing refers to those activities that can take place prior to material installation. *Construction testing* includes those activities that occur during and following material installation.

All QA testing of materials shall be conducted in accordance with this CQA Plan and the project construction drawings and specifications. Where there is a discrepancy, the project construction drawings and specifications will govern. Documentation shall meet the requirements of this CQA Plan.

When minimum physical properties are listed for geosynthetics within this document, the values are minimum average roll values (MARV).

5.1 Compacted Clay Soil Liners and Covers

5.1.1 Materials Selection

One of the most important considerations in materials selection is the achievement of low hydraulic conductivity in compacted soil liners and covers. From the geotechnical investigations performed at this site, it appears that these soils contain a relatively high percentage of fines (silt and clay) and correspondingly low percentages of larger particles.

Experience and laboratory testing for the soil types available indicate that, in general, the soils can be compacted to achieve a hydraulic conductivity (k) less than or equal to 1×10^{-7} cm/s if

- the amount of fines (defined as dry-weight percentage passing the No. 200 sieve) is greater than or equal to 30%, or
- the plasticity index (PI) of the soil is greater than or equal to 10.

Stones or rocks present in the soil material can increase the hydraulic conductivity if too many are present or if they are too large. For this project, the amount of gravel (defined as dry-weight percentage retained on the No. 4 sieve) shall not be more than 20%. The largest particle size shall be no larger than 2 in. Dry or hard clods of material are difficult to compact and shall be pulverized prior to adding water.

Prequalification analyses have been conducted to determine the optimum soil properties of soils available on-site and the degree of compaction, water content, etc., that will be required to achieve the permeability specified. Samples were taken from excavation sites and sent to a laboratory for sieve analysis and hydraulic conductivity tests to determine the moisture content, density, and compaction effort required to obtain the required hydraulic conductivity. These samples were taken from different locations within the source to ensure that representative samples were being obtained. The results of the testing are presented in the report *Results of Hydraulic Conductivity Tests and Recommended Water Content-Dry Density Criteria for Potential Borrow Soils*[1] (see Appendix C.) This report showed that soils excavated on-site contain suitable clay material for construction of the low permeability layer, provided the soils are properly tested and compacted. Test methods that are described in the reports include the following.

- Excavated soil was prepared and compacted with Modified Proctor [American Society for Testing and Materials (ASTM) D 1557][2] and Standard Proctor (ASTM D 698) compaction procedures to develop compaction curves (dry unit weight vs molding water content.) Curves were plotted on same graph.

- The compacted specimens were permeated per ASTM D 5084. Care was taken to ensure that the permeation procedures were correct, with important details such as degree of saturation and effective confining stress carefully selected. The measured hydraulic conductivity was plotted as a function of molding water content.

- The dry unit weight/water content points were replotted with different symbols used to represent compacted specimens that had hydraulic conductivities greater than 1×10^{-7} cm/s and specimens with hydraulic conductivities less than or equal to 1×10^{-7} cm/s. An "Acceptable Zone" was drawn to encompass the data points representing test results meeting or exceeding the hydraulic conductivity criteria.

Additional testing of the source material shall be conducted during construction. The recommended tests and frequency of testing during construction are shown in Table 1. These tests shall be taken on material samples from the borrow or excavation areas.

5.1.2 Subgrade Preparation

Whether the clay soil is placed on a natural soil subgrade or on a constructed fill, the subgrade shall be adequately proofrolled to identify soft zones, irregularities, and loose earth. If large boulders are encountered during the landfill bottom excavation, they will be removed, and the resulting cavity will be filled to the landfill bottom elevation with soil placed in the same manner as the soil liner (discussed below).

Subsequent to the completion of the subgrade, the entire area proposed for clay liner construction will be surveyed in accordance with the construction specifications.

5.1.3 Placement of Compacted Clay Soil Liner

The loose lift thickness can be checked visually at the working face of placement. If uniform lift thickness is questionable, holes can be excavated at appropriate locations in the lift, and the loose lift thickness can be measured.

If the Contractor chooses to control fill levels with grade stakes, care must be taken to remove the grade stakes and to repair holes left by the grade stakes. The QA Officer should see that grade stakes are not buried in the liner. The holes left by grade stakes should be packed with soil liner material or bentonite that is tamped into the hole in layers with a rod.

5.1.3.1 Moisture Content

Low hydraulic conductivity cannot be obtained if the soil is too dry at the time it is compacted. Conversely, if the soil is too moist, it will be difficult to compact and will be susceptible to desiccation cracking. The soils must be within the proper acceptable ranges of moisture content as provided in the construction specifications. The moisture content of the clay soil should not exceed 32.5% to ensure that

the friction angle for the geomembrane/compacted clay soil liner interface will not be below the specified limit.

5.1.3.2 Soil Compaction

The soil shall be placed in lifts of proper thickness. Otherwise, the lower portion of the lift will not be well compacted, and lifts will not be effectively bonded. Loose lifts no more than 9 in. in thickness and compacted lifts no more than approximately 6 in. in thickness are required.

Compaction equipment to be used consists of heavy, footed compactors with minimum 6-in. foot length. The compactor must be heavy to ensure that adequate compactive energy is delivered to the soil. Fully penetrating feet knead the soil over the full depth of the lift and help to bond lifts. The compactor shall have a static weight of at least 30,000 lbs for compacting liners.

It is important that compaction equipment pass over a given area a sufficient number of times. Dry density alone is not always a good indicator of compactive energy, especially for soils compacted wetter than optimum. The minimum number of passes with footed compactors shall be six passes per lift regardless of whether or not the lift meets density requirements. A pass is defined as one pass of the compactor drum over an area, not one pass of an axle.

The tests and observations recommended for ensuring that the soil is properly compacted are listed in Table 2. Periodic calibration checks are required for tests performed with microwave ovens, nuclear devices, drive rings, or other apparatus that may introduce a small systematic bias in the test results. All test results must be documented.

No clay soil fill will be placed or compacted during a sustained period of temperatures below 30°F. Clay soil fill may be placed and compacted during periods of early morning and evening freezing temperatures with warming trends above freezing during the day. During construction, finished lifts or sections of compacted clay liner may be sprinkled with water as needed to prevent drying and desiccation. Should a prolonged cold spell occur and frost damage be suspected, the liner shall be evaluated by measuring the moisture content of the soil within and beneath the zone of suspected frost damage and by investigating the morphology of the soil by digging in the soil and examining its condition. To examine the soil a small test pit shall be excavated and small samples of the wall be peeled off. Because soil damaged by freezing usually contains hairline cracks, the soil will break apart in chunks along larger cracks caused by the freeze/thaw. Once the depth of damage is identified, the liner shall be repaired. If the damage is shallow (single lift), simply discing and recompacting should be sufficient. If the damage is extensive, removal of the affected layers and replacement will be required.

Thickness of the clay liner on the side slopes will be measured vertically. The as-built thickness of the compacted clay liner will be determined by survey methods as described below. An individual lift may be sampled upon completion (but prior to subsequent lift placement) with an approved sampler or other investigative tool, but the resulting penetration will be properly backfilled with hand-tamped clay fill or bentonite. Samples of the in-place compacted clay liner will be tested and evaluated prior to acceptance.

After completion of a segment of compacted clay liner, but before installation of the geomembrane liner, the top of the clay will be surveyed to ensure that (1) the specified thickness of compacted clay liner has been achieved and (2) the top of the clay liner slopes across the phase at the grades specified on the permitted plans. In addition, the final surface lift of the clay liner shall be inspected for all deleterious material such as rocks larger than 2 in., sticks or other sharp objects. All such material shall be removed and backfilled with clay material or bentonite prior to placement of the geomembrane.

5.1.3.3 Protection of Compacted Clay Soil Liner

Placed soil shall be protected from desiccation cracking and frost damage. A smooth-drum roller shall be used to seal the surface of a completed lift at the end of the work period in order to minimize desiccation. The resulting smooth surface also helps to shed on-site surface water.

When the soil is placed on a previously sealed lift, the surface should be scarified to a nominal depth of 1–2 in. prior to placing the soil for the next lift. In this manner, lifts are blended together and seepage is eliminated along lift interfaces, which is critical to liner and cap uniformity. In addition to smooth-rolling the surface, the soil may require that moisture be added periodically and/or that it be covered temporarily with plastic sheeting, determined by the QA Officer.

The type of inspection is best performed by visual observation to determine if adequate measures have been taken to protect each lift of soil from desiccation and freezing. Additional moisture content tests shall be performed at the request of the QA Officer in cases where desiccation is suspected.

5.1.4 Sampling Pattern

A common method of selecting sample locations is to establish a grid pattern. The grid pattern is simple and ensures a high probability of locating defective areas as long as the defective areas are of a size greater than or equal to the spacing between the sampling points. To prevent the repairs of the testing penetrations from overlying one another, it is important to stagger the grid patterns in successive lifts so that sampling points are not at the same location in each lift.

5.1.5 Erroneous Measurements

Occasionally, an error is made in a measurement. If, in the opinion of the QA Officer, an error has been made, the test shall be repeated immediately adjacent to the area where the test in question was performed. Three passing tests shall be required to invalidate a failing test.

5.1.6 Failed Tests

Density and moisture content test locations which fail to meet or exceed construction criteria will require reworking. The boundaries of the area to be reworked will be defined by the closest test locations which meet density and moisture content specifications. The nonconformance report will be prepared for areas which do not meet construction specifications after reworking and retesting.

Laboratory permeability test results which demonstrate above 1×10^{-7} cm/s will be immediately brought to the attention of the QA Officer. Nonconforming permeability test results may result in a review of previous test results, in retesting, and/or in a reevaluation of compaction criteria. After review and/or retesting, areas which do not meet the specified permeability will require reworking. To define the limits of the area that requires repair, additional tests are often needed. Alternatively, the area that extends from the failing test out to the boundaries defined by passing tests will be repaired.

All nonconformance reports will be brought to the attention of the Construction Manager by the QA Officer and will be documented in the QA files.

The QA Officer shall record the area of the failed test and actions taken to correct the deficiency.

5.1.7 Outliers

There are several reasons why a field water content or density test may produce a failing result, (i.e., value outside of the specified range). Possible causes for a variation include human error in measurement of water content or dry unit weight, natural variability of the soil or the compaction process leading to an anomaly at an isolated location, limitations in the sensitivity and repeatability of the test methods, or inadequate construction procedures that reflect broader-scale deficiencies.

If it is suspected that a test result is in error, the proper procedure for rectifying the error should be as follows. QA personnel should return to the point where the questionable measurement was obtained. Several additional tests should be performed in close proximity to the location of the questionable test. If all of the repeat tests provide satisfactory results, the questionable test result may be disregarded as an error. It is recommended that approximately three passing tests be required to negate the results of a questionable test.

One of the main reasons why soil liners are built of multiple lifts is a realization that the construction process and the materials themselves vary. With multiple lifts no one particular point in any one lift is especially significant even if that point consists of unsatisfactory material or improperly compacted material. It should be expected that occasional deviations from construction specifications will be encountered for any soil liner. In fact, if one were to take enough soil samples, one can rest assured that a failing point on some scale would be located.

It is unrealistic to expect that 100% of all QA tests will be in compliance with specifications. Occasional deviations should be anticipated. If there are only a few randomly located failures, the deviations in no way compromise the quality or integrity of a multiple-lift liner.

It is recommended that a certain percentage of test results be allowed to deviate from specifications, provided the failed tests are randomly distributed spatially and are not substantial deviations. For installation of this liner and cap, up to 2% outliers among all tests performed will be acceptable, and failing tests shall not be permitted to be concentrated in any one lift or in any one area.

5.2 Leachate Collection Layer

5.2.1 Material Selection and Testing

The crushed aggregate material used in the leachate collection layer shall conform to the physical properties as specified in the construction specifications. Grain size analysis testing results (ASTM D 422) and hydraulic conductivity testing results (ASTM D 2434) shall be provided for each aggregate source. During placement, one sample for every 2500 yd^3 of stone shall be tested in accordance with ASTM D 422. In the event that a change in the drainage material is observed or suspected, the QA Officer shall coordinate additional material testing.

5.2.2 Placement of Aggregate

Low ground pressure, wide track-type equipment will be used to distribute the aggregate material in a manner which will minimize stress on the underlying protective geotextile fabric and geomembrane. The QA Officer shall verify that the equipment operator does not crowd or shove the aggregate material nor use the blade to cut into the aggregate material. Aggregate material shall be placed on slopes from the bottom of the slope and worked upslope. In areas inaccessible to a dozer, the aggregate material shall be placed with a small backhoe, rubber-tire loader, or other equipment as approved by the QA Officer and the Construction Manager. Equipment used to haul aggregate material shall not drive on top of, nor dump directly onto, the geotextile fabric and geomembrane liner. A minimum of 12 in. of aggregate material shall be kept between the equipment tracks or tires and the geotextile fabric and geomembrane liner.

A minimum of 24 in. of fill shall be placed on top of the geomembrane prior to dump trucks being allowed onto areas occupied by the geomembrane. The 24 in. of fill material can consist of the following: 12 in. of leachate collection layer aggregate, plus on additional 12 in. of leachate collection layer aggregate (total of 24 in.); or 12 in. of leachate collection layer aggregate, separator geotextile, and 12 in. of protective soil cover, as discussed in the following section. R2

5.2.3 Protective Soil Cover

A layer of geotextile and the protective soil cover shall be placed on the granular drainage layer as soon as possible to prevent soil erosion from adjacent slope from reducing the effectiveness of the drainage system. Prior to installing these overlying components, the top of the granular drainage layer shall be surveyed to ensure that the specified thickness of stone has been achieved.

5.3 Leachate Collection Piping

5.3.1 Delivery

The QA Officer shall verify that the following actions are performed.

- Material was delivered to the site in a clean and protected condition.

- Equipment used to unload will not damage the piping.
- End seals are maintained and removed only as necessary for cleaning and installation.
- Care is exercised in handling, storage, and installation so that contamination by injurious foreign material does not occur.

5.3.2 Material Inspection

The QA Officer shall ensure the following.

- The correct ASTM insignia is printed on the sides of the piping.
- The pipe is of the proper material diameter and wall thickness. Perforated pipe shall be as specified.

5.3.3 Placement of Piping

Leachate collection sewer lines shall be checked for proper placement in the trenches with regard to grade and stone bedding. The geotextile fabric shall also be checked for proper placement. The grades and depth of pipe and bedding will be continuously checked for conformance with the drawings and specifications. Where the leachate collection line passes through the landfill liner, the pipe shall be bedded and surrounded with bentonite to ensure that the same permeability criteria is maintained as for the compacted landfill liner. The perforated collection pipe shall be installed so that perforations are oriented at the bottom of the pipe. The QA Officer shall verify that perforated collection piping is not installed outside of the waste boundary area. Prior to backfilling, the pipe installation shall be inspected for broken or cracked pipe and fittings.

5.4 Protective Soil Cover

5.4.1 Material Selection

Materials used for the protective soil cover shall conform to the physical properties as specified in the construction specifications.

5.4.2 Placement of Soil

The protective soil cover material shall be spread in the direction that minimizes wrinkles and precludes damage to the separator geotextile fabric. The first lift shall be placed with a loose measure thickness of approximately 12 in. Construction equipment shall not come in contact with or damage the separator geotextile fabric. Fill material shall be placed in a manner to maintain a minimum of 8 in. of fill between the construction equipment and the separator geotextile fabric.

R2

5.4.3 Soil Compaction

The initial lift shall not be compacted . The next lift shall be placed with a loose measure thickness of between 6 in. and 10 in. and compacted with a steel drum roller. Although compaction and moisture content testing is not required for the first two lifts, the moisture content of the first two lifts shall be controlled within a range suitable to allow the material to achieve compaction, and to permit construction equipment movement within the area where material is being placed. The last lift shall be 6-8 in. compacted thickness and compacted with a footed roller to a minimum of 95% of the maximum dry density at no less than 3% below nor more than 3% above the optimum moisture content as determined by ASTM D 698, to achieve the grades and thickness shown on the construction drawings. In-place moisture and density testing shall be conducted for the final lift, at a frequency of 5 tests per acre. The location of the density tests shall be selected randomly by the Facilities Manager. R2

5.5 Sacrificial Layer

5.5.1 Material Selection

Materials used for the sacrificial layer shall conform to the physical properties as specified in the construction specifications.

5.5.2 Placement of Soil

The sacrificial layer shall be spread in the direction that minimizes wrinkles and precludes damage to the composite geonet gas vent layer. The material shall be placed and compacted in a single lift that is 6 in. thick after compaction. A minimum of 6 in. of soil shall be kept between the roller and the composite geonet.

5.5.3 Soil Compaction

The material shall be compacted using a smooth-drum roller until the Construction Manager is satisfied that the density is not being increased by additional passes.

5.6 Vegetative Layer

5.6.1 Material Selection

The soil material used in the vegetation layer shall be sufficient to sustain vegetative growth. Acceptable soil types are SC, ML, CL, MH, or CH, as determined by ASTM D 2487.

5.6.2 Placement of Soil

Low ground pressure, wide track-type equipment will be used to distribute the soil material in a manner which will minimize stress on the underlying composite geonet and geomembrane. The QA Officer shall verify that the equipment operator does not crowd or shove the soil material nor use the blade to cut into

the soil material. Soil material shall be placed on slopes from the bottom of the slope and worked upslope. In areas inaccessible to a dozer, the soil material shall be placed with a small backhoe, rubber-tire loader, or other equipment as approved by the QA Officer and the Construction Manager. Equipment used to haul soil material shall not drive on top of, nor dump directly onto, the composite geonet and geomembrane liner. A minimum of 12 in. of soil material shall be kept between the equipment tracks or tires and the composite geonet and geomembrane liner.

5.6.3 Soil Compaction

The vegetative layer does not require additional compaction other than that which occurs during soil placement, except that berm drainage channels shall be compacted in the following manner. The initial lift shall be an approximately 12-in. loose lift and shall not be compacted. Succeeding lifts shall be compacted to a minimum of 90% of the maximum dry density at no less than 3% below nor more than 3% above the optimum moisture content as determined by ASTM D 698. In-place moisture and density testing shall be conducted after each lift is placed, at random locations determined by the QA Officer. R1

5.6.4 Seeding

The QA Officer will check to verify that the fertilizers and seeds are brought from an approved source. The QA Officer will inspect the fertilizing and hydroseeding operations to ensure the following.

- The material meets the requirements of the closure plan and the specifications.
- The manufacturer's certificate of compliance is received and approved for each seed type.
- Lime, fertilizer and seed mix are of specified grade; and the rate of application meets the rates specified.
- The seed, fertilizer, and mulch are installed in accordance with the requirements of the specification.

5.7 Geomembranes

5.7.1 Delivery

The QA Officer shall verify that the following activities are performed.

- Equipment used to unload the rolls will not damage the geomembrane.
- Care is used to unload the rolls.
- Manufacturer's QC documentation for each roll is received.

At the QA Officer's discretion, damaged rolls may be rejected. They shall be removed from the site or stored at a location, separate from accepted rolls, designated by the Construction Manager. All rolls that do not have proper manufacturer's documentation will be rejected.

A Material Received Log will be prepared by the QA Officer for all geosynthetic material delivered to the job site.

5.7.2 Conformance Testing

Geomembrane shall be randomly sampled and tested by the Facilities Manager in accordance with the manufacturer's approved QC manual. Test results shall include the following information:

- roll number,
- date of production,
- resin identification,
- thickness (ASTM D 751),
- density (ASTM D 1505),
- melt index (ASTM D 1238, Condition E), and
- tensile characteristics (ASTM D 638).

Shear tests shall be performed on the actual products used in the field, including the geomembrane and protective geotextile interface of the landfill liner and the geomembrane and the drainage layer geocomposite interface of the landfill cover. Unless otherwise allowed by the Engineer-of-Record, the following minimum accepted residual friction angles shall apply:

- for the landfill liner geomembrane and protective geotextile interface of Areas 2, 3 and 4—11°
- for the landfill liner geomembrane and protective geotextile interface of Area 5—20°, and
- for the landfill cover geomembrane and drainage layer composite geonet interface—20°.

The geomembrane installed in the landfill liner system for Areas 2 and 3 will have a smooth surface (nontextured) on both sides.

The geomembrane installed in the landfill liner system for Area 4 will have smooth surface (nontextured) on both sides on slopes less than 15 ft in height. For slopes 15 ft or more in height the geomembrane will be textured on the bottom surface, and either a textured surface on top or a smooth surface (nontextured) with a friction enhancement added to the protective geotextile.

The geomembrane installed in the landfill liner system for Area 5 will be textured on the bottom surface, and either a textured surface on top or a smooth surface (nontextured) with a friction enhancement added to the protective geotextile.

The geomembrane installed for the landfill cover will be textured on the bottom surface; the upper surface may be textured or smooth provided the minimum residual friction angles are maintained.

The QA Officer shall review all test results and report any nonconformance to the Construction Manager and the Contractor.

5.7.3 Geomembrane Installation

5.7.3.1 Surface Preparation

Prior to installation, the QA Officer shall verify that the following activities have been performed.

- All lines and grades have been verified by a surveyor registered in the state of Tennessee.
- The subgrade has been prepared in accordance with the earthwork specification.
- The surface has been rolled and compacted to be free of surface irregularities, loose soil, and protrusions.
- There is no desiccation cracking of the soil liner surface.
- The supporting surface does not contain stones or other material that could damage the liner.
- There are no excessively soft areas that could result in liner damage.
- The soil liner moisture content does not exceed specified values.
- All construction stakes and hubs have been removed.

5.7.3.2 Panel/Roll Placement

The Contractor shall give each panel/roll a permanent identification number. This number shall be used by the QA Officer, Contractor, and all other parties for documentation. The QA Officer shall establish a chart showing correspondence between roll numbers, certification reports, and panel numbers. The QA Officer shall record the panel number on the Geomembrane Placement Log and the Geomembrane Seaming Log forms (see Appendix B).

During panel placement, the QA Officer shall perform the following activities.

- Observe the sheet surface as it is deployed, and record all panel defects and disposition of the defects (e.g., panel rejected, patch installed). All repairs are to be made in accordance with the geomembrane specifications.
- Verify that equipment used does not damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or other means.
- Verify that the surface beneath the geomembrane has not deteriorated once liner preparation has been completed and has not been damaged by the deployment methods.
- Inspect the geomembrane for scratches if it has been pulled across an unprotected surface.

- Record weather conditions, including temperature, wind, and humidity. The geomembrane shall not be deployed in the presence of excess moisture (e.g., fog, dew, mist). The ambient temperature shall be within the specified range.

- Verify that construction personnel working on the geomembrane do not smoke, wear shoes that could damage the geomembrane, or engage in activities that could damage the geomembrane.

- Verify that the method used to deploy the sheet minimizes wrinkles and that the sheets are anchored to prevent movement by wind. The QA Officer shall not specify anchorage methods (the Contractor is responsible for any damage resulting to or from windblown geomembranes).

- Verify that only the amount that can be seamed during one work shift is deployed.

- Verify that each panel is being installed in accordance with the approved shop drawings.

- Verify that geomembrane is under minimum stress before and during seaming operations.

The QA Officer shall inform both the Contractor and Construction Manager if the above conditions are not met.

5.7.3.3 Field Seaming

The Contractor shall provide the Construction Manager and QA Officer with a seam and panel layout drawing. This drawing may be modified, with approval of the QA Officer, to meet job site conditions. The Contractor will maintain record drawings that will be updated by the Contractor on a daily basis.

A seam numbering system shall be agreed upon by the QA Officer and Contractor prior to the start of seaming operations. (One procedure is to identify the seam by adjacent panels. For example, the seam located between Panel 306 and 401 would be Seam No. 306/401.)

Prior to seaming, each operator and seaming apparatus (welder) shall be tested in accordance with the geomembrane specification to determine if the equipment and operator are functioning properly. The QA Officer shall observe all welding operations, observe the testing of each trial weld, and record the results on the Trial Weld Log form (see Appendix B). All trial welds are to be completed under conditions similar to those existing when the panels will be seamed. If at any time the QA Officer believes that an operator or seaming apparatus is not functioning properly, a weld test shall be performed. If there are large changes in temperature, humidity, or wind speed, the test weld is to be repeated.

During seaming operations, the QA Officer shall verify that the following activities are done.

- The Contractor has the number of seamers and spare parts agreed to in the preconstruction meeting.

- Equipment used for seaming does not damage the geomembrane.

- Seaming techniques will be as defined by the U.S. Environmental Protection Agency (EPA) Technical Guidance Document, *Inspection Techniques for the Fabrication of Geomembrane Field Seams.*[2]

- The ambient temperature measured within 6 in. of the geomembrane surface is between 40°F and 104°F unless approved otherwise by the QA Officer.

- The weld is free of dust, dirt, moisture, or other contaminants.

- The seams are overlapped in accordance with the manufacturer's recommendations.

- No solvents or adhesives are present in the seam area, unless approved otherwise by the QA Officer.

- The procedure used to temporarily hold the panels together does not damage the panels and does not preclude CQA testing.

- The panels are being seamed in accordance with the plans and specifications.

The QA Officer shall prepare a Geomembrane Seaming Log to document seaming CQA activities.

5.7.4 Anchor Trench Backfilling

The anchor trench will be backfilled and compacted by the Contractor to the same moisture-density requirements as the compacted clay soil liner. Care should be taken when backfilling the trench to prevent any damage to the geomembrane. Anchor trench spoil will be used as backfill material, wherever possible.

5.7.5 Protection of Leading Edges

Between construction of partial sections of the membrane liner, leading edges of the membrane may be exposed or buried for extended periods of time prior to their joining to adjacent, subsequent membrane sections. The combined action of abrasive soil and equipment impact stresses may "etch" unprotected membrane surfaces sufficiently to affect seam strengths. Therefore, it is necessary to protect leading edges in future seaming areas with sacrificial layers of geotextile and geomembrane sheets until they are ready for final seaming. As a minimum, each leading edge to be seamed that must be buried or that must be exposed for periods of 1 month or longer will be continuously covered by a layer of geotextile overlain by a layer of geomembrane sheet. The geotextile will be nonwoven and have a minimum weight of 16 oz/yd^2. The sacrificial geomembrane sheet will have a minimum thickness equal to that of the membrane liner to be protected. Both protective layers will have a minimum width of 4 ft. The edge of the sheet to be protected will be approximately centered beneath the overlying protective layers prior to burial. Leading edges located in areas expected to receive direct traffic from construction equipment will be buried under a minimum thickness of 1 1/2 ft of buffer soil.

5.7.6 Construction Testing

5.7.6.1 Trial Seam Testing

The Contractor will maintain and use equipment and personnel at the site to perform testing of trial seams. Trial seams will be made each day prior to commencing field seaming. These seams will be made on fragment pieces of the geomembrane liner, to verify that seaming conditions are adequate. Such a trial seam will be made at the beginning of each seaming period, at the CQA inspection personnel's discretion, and at least once every 4 hours during continuous operation of each welding machine. Also, each seamer will make at least one trial seam each day. Requirements for trial seams are as follows.

The trial seam sample will be at least 3 ft long by 1 ft wide with the seam centered lengthwise. Two adjoining specimens will be die cut from the trial seam sample. These specimens will be tested in the field with a tensiometer for both shear and peel. A passing machine or hand welded trial seam will be achieved when the criteria described in the following sections are met. If a trial seam fails, the entire operation will be repeated. If the additional trial seam fails, the seaming apparatus will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved. Trial seam failure is defined as failure of any one of the specimens tested in shear or peel.

5.7.6.2 Nondestructive Seam Testing

During nondestructive testing operations, the QA Officer shall perform the following activities.

- Record and observe all nondestructive testing.
- Record the location, date, test number, technician's name, and results of all nondestructive testing on the Geomembrane Seaming Log form (see Appendix B).
- Mark the location of any defects requiring repairs, and record on the Geomembrane Repair Log form.
- Mark the failed areas with a waterproof marker compatible with the liner (spray paint should not be used), and inform the Contractor of any required repairs.
- Verify that all testing is completed in accordance with the project specifications.
- Verify that all repairs are completed and tested in accordance with the project specifications.

5.7.6.3 Destructive Seam Testing

Destructive tests are performed to evaluate seam strength and estimate long-term performance. Destructive testing shall be performed concurrently with seaming operations, not at the completion of the installation. The types of destructive testing required during the liner installation are the peel and shear tests.

The QA Officer shall select locations where seam samples will be cut for laboratory testing. These locations shall be established in the following manner.

- A minimum of one test per 500 ft of seam length. This is the frequency for the entire installation; individual samples may be taken at smaller intervals.

- If the number of failed samples exceeds 3% of the tested samples, this frequency may be increased at the discretion of the QA Officer. Samples taken as the result of failed tests do not count toward the total number of tests.

- Test locations shall be determined by the QA Officer. Locations selected may be prompted by liner distortion due to overheating, weld contamination, or any potential cause of poor welds. The Contractor shall not be informed in advance of the destructive test sample locations.

Samples shall be removed by the Contractor at locations identified by the QA Officer. The QA Officer shall perform the following activities.

- Observe sample cutting.

- Mark each sample with an identifying number containing the seam number.

- Record the sample location and reason sample was taken (e.g., random sample, visual appearance, result of a previous failure) on the Damage and Failure Log (see Appendix B).

Two types of samples shall be taken at each location, one for field tests and one for laboratory tests. For the field tests, two seam samples, 1 in. wide by 12 in. long with the seam centered across the length, shall be taken 42 in. apart. These samples shall be tested in the field using a tensiometer capable of quantitatively measuring shear and peel strengths. If one or both of these samples fail, the Contractor has the following options.

- Reconstruct the seam between passing field test sample locations.

- Take another test sample 10 ft from the point of the failed field test in each direction and repeat this procedure. If the second test passes, the Contractor can either reconstruct or cap strip the seam between the two passing field test locations. If subsequent tests fail, the procedure is repeated until the length of the poor quality seam is established. Repeated failures indicate that the seaming equipment and/or operator is not performing properly, and appropriate action will be taken.

Once the field tests have passed, a sample shall be recovered from between previously passing field sample locations for Testing Laboratory testing. The sample shall be 42 in. long by 12 in. wide with the seam centered along the length. This recovered sample shall be divided into three equal parts: one section shall be given to the Contractor, one sample shall be given to the Facilities Manager for archival, and one

sample shall be sent to the Testing Laboratory for testing. Destructive samples shall be shipped by the QA Officer to the Testing Laboratory on the same day the sample is recovered.

Testing shall include the shear and peel test (ASTM D 4437). At least five specimens shall be tested in shear and five specimens in peel. At least four of the five specimens tested using each method must meet the minimum test values presented in the geomembrane specification. The Testing Laboratory shall provide test results in writing or by telephone conversation with the QA Officer within an agreed-upon time frame. Certified test results are to be provided in no later than 5 days. The QA Officer shall immediately notify the Contractor in the event of a failed test. Higher-than-normal failure rates (in excess of 3% of tested samples) shall be reported to the Facilities Manager. No areas, except as necessary to provide temporary wind protection or to temporarily prevent water from getting under the geomembrane, are to be covered prior to receiving the Testing Laboratory test results.

A passing seam will be achieved in peel when the following three conditions are met.

- Failure is by film tear bond (FTB).
- Peel strength for the seam is not less than specified.
- No greater than 10% of the seam width peels (separates) at any point.

A passing seam will be achieved in shear when the following conditions are met.

- Failure is by FTB.
- Bonded seam strength for the seam is not less than specified.
- No greater than 10% of the seam width peels (separates) at any point.

If the laboratory test fails in either peel or shear, the Contractor may either reconstruct the entire seam or additional samples may be recovered. If additional samples are to be recovered, samples must be taken on either side of the failed sample for laboratory testing. These samples must be taken at least 10 ft from the location of the failed sample or at the end of the seam if it is less than 10 ft from the failed sample. Sample size and disposition shall be as described previously. This process shall be repeated until sections that have passed tests bracket the failed seam section. All seams shall be bounded by locations where passing laboratory tests have been taken. In cases involving more than 50 ft of reconstructed or cap stripped seam, the reconstructed or cap stripped seam must also be tested. Laboratory testing governs seam acceptance. In no case shall field testing of installed seams be used for final acceptance.

5.7.6.4 Repairs

Any portion of the geomembrane with a flaw or that fails a nondestructive or destructive test shall be repaired in accordance with the specifications. The QA Officer shall locate and describe all damage on the Damage and Failure Log form (see Appendix B). Repairs shall be documented on the Geomembrane Seaming Log.

- Patching is used to repair large holes, tears, large panel defects, and destructive sample locations.

- Capping is used to repair failed welds or to cover seams where welds cannot be nondestructively tested.

- Removal is used to replace areas with large defects where the preceding methods are not appropriate. It is also used to remove excess material (wrinkles) from the installed geomembrane.

5.7.6.5 Wrinkles

Placing soil cover over the geomembrane, temperature changes, or creep may cause wrinkles to develop in the geomembrane. Any wrinkles that can fold over shall be repaired either by cutting out excess material or, if possible, allowing the liner to contract due to temperature reduction. In no case shall material be placed over the geomembrane which could result in the geomembrane folding.

5.7.6.6 Geomembrane Acceptance

The Contractor shall retain responsibility for the geomembrane until acceptance by the Construction Manager. In the event the Contractor is responsible for placing a protective cover over the geomembrane, the Contractor shall retain responsibility for the geomembrane until the protective cover is placed. The geomembrane shall be accepted by the QA Officer when the following activities have occurred.

- The installation is finished.

- All seams have been inspected and approved.

- All required laboratory tests have been completed and approved.

- One signed QC certificate for each roll of geomembrane has been supplied by the Contractor and approved by the QA Officer. Certificate shall include resin identification, roll number, date of production, and test results for density, melt index, thickness and tensile strength.

- All record drawings have been completed and approved.

5.8 Geotextile

5.8.1 Delivery

The QA Officer shall verify that the following conditions are met.

- Equipment used to unload the rolls will not damage the geotextile.
- Care is used to unload the rolls.
- All documentation required by the specification has been received.

At the QA Officer's discretion, damaged rolls may be rejected. They shall be removed from the site or stored at a location, separate from accepted rolls, designated by the Construction Manager. All rolls that do not have proper manufacturer's documentation will be rejected.

5.8.2 Conformance Testing

Testing shall be performed by a competent laboratory at point of manufacture in accordance with the specified ASTM testing procedures. The laboratory shall maintain records of its QC results and provide, prior to shipment, a manufacturer's certificate. The certificate shall include the name of manufacturer, chemical composition, product description, statement of compliance to specification requirements, and signature of authorized official attesting to the information required. The QA Officer shall review the certificate and report any nonconformance to the Construction Manager and the Contractor.

To aid the geomembrane to fully achieve its desirable elongation property, the protective geotextile installed over the geomembrane will have an elongation value of at least 60%. The protective geotextile will be a nonwoven geotextile consisting of needle-punched polyester continuous filament or cut stapled fabrics with a minimum weight of 16 oz/yd^2.

In order to achieve the required friction angle value as described in Section 5.7, Geomembranes, the protective geotextile may be treated with a friction surface on the side against the geomembrane. Friction surfaces approved for use include those consisting of micropelletized polyolefin copolymer thermoplastic that is scatter-coated onto the geotextile surface at various levels of addition. The heat-activated copolymer is heated and pressed onto the geotextile surface through rollers to not only attach the copolymer to the geotextile but also to increase the surface area of the copolymer.

The separator geotextile will be a nonwoven geotextile fabric consisting of polypropylene or polyester filaments, with a minimum weight of no less than 8 oz/yd^2. Geotextile used in the gas venting and cover drainage layer composite geonets shall have a weight of no less than 7 oz/yd^2, nor more than 9 oz/yd^2.

5.8.2.1 Geotextile Installation

Prior to geotextile installation, the QA Officer shall verify that the following activities have been performed.

- All lines and grades have been verified by a registered Surveyor in the state of Tennessee.
- The subgrade has been prepared in accordance with the construction specification.
- If the geotextile is to be placed over a geomembrane, the portion of the geomembrane installation to be covered by the geotextile, including all required documentation, has been completed.
- The supporting surface does not contain stones or other material that could damage the geotextile or, where applicable, an underlying geomembrane.

- There are no excessively soft areas that could result in damage to an overlying geomembrane.
- All construction stakes and hubs have been removed.

During panel placement, the QA Officer shall perform the following activities.

- Observe the geotextile as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications.
- Verify that equipment used does not damage the geotextile through handling, trafficking, leakage of hydrocarbons, or other means.
- Verify that people working on the geotextile do not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.
- Verify that the geotextile is anchored to prevent movement by the wind (the Contractor is responsible for any damage resulting from windblown geotextiles).

The QA Officer shall inform the Contractor and Construction Manager if any of the above conditions are not met.

During geotextile placement, the QA Officer shall verify that the following activities are done.

- Where overlapped seams are specified, the seams are overlapped a minimum of 18 in.
- Where sown seams are specified, any thread used to sew the panels of geotextile together meets specification requirements.
- The geotextile panels are being joined in accordance with all other requirements of the plans and specifications.

Repair procedures include the following activities.

- Patching is used to repair holes, tears, and defects.
- Removal is used to replace areas with large defects where the preceding method is not appropriate. Specific repair procedures are outlined in the specification.

5.9 Composite Geonet

5.9.1 Delivery

The QA Officer shall verify that the following conditions are met.

- Equipment used to unload the rolls will not damage the composite geonet.
- Care is used to unload the rolls.
- The label containing product identification, roll number, and roll dimensions has been supplied by the Contractor and approved by the QA Officer.

At the QA Officer's discretion, damaged rolls may be rejected. They shall be removed from the site or stored at a location, separate from accepted rolls, designated by the Construction Manager. All rolls that do not have proper manufacturer's documentation will be rejected.

5.9.2 Conformance Testing

Testing shall be performed by a competent laboratory at point of manufacture in accordance with the specified ASTM testing procedures. That laboratory shall maintain records of its QC results and provide, prior to shipment, a manufacturer's certificate. The certificate shall include the name of manufacturer, chemical composition, product description, statement of compliance to specification requirements, and signature of authorized official attesting to the information required.

The QA Officer shall review the certification and report any nonconformance to the Construction Manager and the Contractor.

5.9.3 Composite Geonet Installation

Prior to composite geonet installation, the QA Officer shall verify that the following conditions have been met.

- All lines and grades have been verified by a registered Surveyor in the state of Tennessee.
- The geomembrane installation, including all required documentation, has been completed.
- The geomembrane surface is clean.

During panel placement, the QA Officer shall perform the following activities.

- Observe the composite geonet as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications.
- Verify that equipment used does not damage the composite geonet or underlying geomembrane through handling, trafficking, leakage of hydrocarbons, or other means.
- Verify that people working on the composite geonet do not smoke, wear shoes that could damage the composite geonet, or engage in activities that could damage the composite geonet or underlying geomembrane.

- Verify that the composite geonet is anchored to prevent movement by the wind (the Contractor is responsible for any damage resulting to or from windblown composite geonet).

- Verify that the composite geonet remains free of contaminants such as soil, grease, fuel, etc.

The QA Officer shall inform the Contractor and Construction Manager if the above conditions are not met.

During composite geonet placement, the QA Officer shall verify that the following activities are performed.

- The seams are overlapped in accordance with the manufacturer's recommendations.

- Ties are placed at minimum intervals in accordance with the manufacturers recommendations.

- Only plastic ties that will not damage the underlying geomembrane are used; metal ties are not permitted.

- The panels are being joined in accordance with the plans and specifications.

Repair procedures include the following activities.

- Patching is used to repair holes, tears, and defects.
- Removal is used to replace areas with large defects where the patching is not appropriate.

6.0 REPORTING

6.1 Deficiencies

When deficiencies (items that do not meet specified values) are discovered, the QA Officer shall immediately determine the nature and extent of the problem, notify the Contractor, and complete required documentation. In all cases, the QA Officer will notify the Contractor within ½ hour of discovering the deficiency. If the deficiency will cause construction delays of more than 4 hours or will necessitate substantial rework, the QA Officer shall also notify the Construction Manager.

The Contractor shall correct the deficiency to the satisfaction of the QA Officer. If the Contractor is unable to correct the problem, the QA Officer will prepare a nonconformance report and will develop and present suggested solutions to the Construction Manager for approval. If the solution requires a design revision, the Facilities Manager shall also be contacted.

The corrected deficiency shall be retested before additional work is performed. All retests and the steps taken to correct the problem shall be documented by the QA Officer.

6.2 Documentation

The QA plan depends on thorough monitoring and documentation of all construction activities. Therefore, the QA Officer shall document that all QA requirements have been addressed and satisfied. Documentation shall consist of daily recordkeeping, construction problem resolutions, photographic records, design and specification revisions, weekly progress reports, and a certification and summary report.

6.2.1 Daily Recordkeeping

At a minimum, daily records shall consist of field notes, summaries of the daily meetings with the Contractor, observations and data sheets, and construction problem and resolution reports. This information shall be submitted regularly to the Construction Manager for review and approval.

A Daily Meeting Report will be prepared each day, summarizing discussions held with the Contractor. At a minimum, the report will include the following items:

- date, project name, and location;
- names of parties involved in discussions;
- data on weather conditions;
- unit processes and locations of construction underway during the time frame of the Daily Summary Report;
- equipment and personnel present on-site, including subcontractors;
- descriptions of areas and/or activities being inspected and/or tested, and related documentation;
- description of off-site materials received, including any QC certifications received;
- scheduled activities;
- items discussed; and
- signature of the QA Officer or the QA inspection personnel preparing the report.

6.2.2 Observation and Test Sheets

Observation and test data sheets shall include the following information:

- date, project name, and location;
- weather data;

- reduced-scale site plan showing work areas, including sample and test locations;
- description of ongoing construction;
- summary of test results identified as passing, failing, or in the event of a failed test, retest;
- test equipment calibrations, if applicable;
- summary of decisions regarding acceptance of the work and/or corrective actions taken; and
- signature of the QA Officer and appropriate QA inspection personnel.

6.2.3 Construction Problem Reports

This report identifies and documents construction problems and resolutions. It is intended to document problems involving significant rework and is not intended to document items easily corrected unless the problems are recurring. At a minimum, this report shall include the following items:

- detailed description of the problem,
- location and cause of the problem,
- how the problem was identified,
- how the problem was resolved,
- personnel involved, and
- signature of the QA Officer and Construction Manager.

6.2.4 Survey Control

The following procedures will be followed with respect to the survey of the completed landfill components.

- The clay liner subgrade, the completed clay liner surface, the leachate collection layer, the clay cap subgrade, the cap clay component, and the cap final grade will be surveyed to verify that grades are in accordance with the plans. A comparison of the pre- and postcomponent construction surveys will be conducted to verify construction to the permitted thickness.

- A minimum of one cross section for every 100 linear feet of phase length and width will be surveyed. At a minimum, survey points will be established at the top, midpoint, and bottom of each slope and at three points on the bottom of the phase. These survey points will be coincident with those of the previous cross section lines.

- The QA inspection personnel certifying the survey results will be either a registered Surveyor or a Professional Engineer.

- The QA Officer will certify that the components meet the requirements in the plans and specifications and will submit documentation to the Construction Manager.

6.2.5 Photographs

Construction activities will be photographed, including significant problems and remedial actions. The photographs will be identified by location, time, date, and photographer.

6.2.6 Design and Specification Changes

Design and specification changes may be required during construction. In such cases, the QA Officer shall notify the Construction Manager, who will notify the Facilities Manager. Design and specification changes shall only be made with written agreement of the Construction Manager and Facilities Manager.

6.2.7 Weekly Progress Reports

The QA Officer shall prepare weekly progress reports summarizing construction and QC activities. At a minimum this report, submitted to the Construction Manager, shall contain the following information:

- date, project name, and location;
- summary of work activities;
- summary of deficiencies and/or defects and resolutions; and
- signature of the QA Officer.

6.2.8 Certification Reports

At the completion of the project, the QA Officer shall submit a certification report to the Construction Manager. This report shall certify that the work has been performed in substantial compliance with the construction drawings and specifications. At a minimum, the report shall contain the following information:

- summary of all construction activities,
- testing laboratory test results,
- observation and test data sheets,
- sampling and testing location plans,
- description of significant construction problems and their resolution,
- list of changes from the construction drawings and specifications and the justification for these changes,
- record drawings, and
- certification statement signed and sealed by a registered Professional Engineer.

The record drawings shall show all construction items, including the piping, anchor trenches, sumps, etc. All surveying and base maps required for the development of the record drawings shall be prepared by a Surveyor registered in the state of Tennessee.

7.0 REFERENCES

1. Daniel. 1992. *Results of Hydraulic Conductivity Tests and Recommended Water Content-Dry Density Criteria for Potential Borrow Soils.*

2. Fazio, P. C., et al., eds. 1993. *Annual Book of Standards.* Section 8, Vols. 8.01–8.03, Plastics I–III. American Society for Testing and Materials. Philadelphia, Pennsylvania.

3. *Inspection Techniques for the Fabrication of Geomembrane Field Seams.* May 1991. EPA/530/SW-91/051. U.S. Environmental Protection Agency. Washington, D.C.

APPENDIX A

TABLES

TABLE 1

RECOMMENDED MATERIALS TESTS

Parameter	Test Method	Minimum Testing Frequency
Percent fines (Note 1)	ASTM D 1140 (Note 2)	1 per 1,000 yd^3
Percent gravel (Note 3)	ASTM D 422 (Note 2)	1 per 1,000 yd^3
Liquid & plastic limits	ASTM D 4318	1 per 1,000 yd^3
Water content (Note 4)	ASTM D 4643	1 per 200 yd^3
Water content (Noted 5)	ASTM D 2216	1 per 1,000 yd^3
Moisture/density	ASTM D 698	1 per 5,000 yd^3 or 1 per soil change

NOTES:

1. *Percent fines* is defined as the percent passing through the No. 200 sieve.
2. In addition, at least one test should be performed each day that soil is excavated or placed, and additional tests should be performed on any suspect material observed by QA personnel.
3. *Percent gravel* is defined as percent retained on the No. 4 sieve.
4. This is a microwave oven drying method. Other methods may be used, if more appropriate.
5. Microwave oven drying and other rapid measurement methods may involve systematic errors. Conventional oven drying (ASTM D 2216) is recommended on every fifth sample taken for rapid measurement. The intent is to document any systematic error in rapid moisture content measurement.

TABLE 2

RECOMMENDED TESTS AND OBSERVATIONS ON COMPACTED SOIL

Parameter	Test Method	Minimum Testing Frequency
Water content (Note 1)	ASTM D 3017 Nuclear Density or ASTM D 4643 microwave	5 per acre/lift (Note 2)
Water content (Note 3)	ASTM D 2216 Oven dry	1 per acre/lift (Note 3)
Density (Note 4)	ASTM D 2922 Nuclear Density ASTM D 2937 Drive Cylinder	5 per acre/lift (Note 2)
Density (Note 5)	ASTM D 1556	1 per acre/lift (Note 5)
Number of passes	Visual Observation	1 per acre/lift (Note 2)
Construction oversight	Visual Observation	Continuous

NOTES:

1. ASTM D 3017 is a nuclear method and ASTM D 4643 is microwave oven drying.

2. In addition, at least one test should be performed each day soil is compacted, and additional tests should be performed in areas for which CQA personnel have reason to suspect inadequate compaction.

3. Every fifth sample tested with ASTM D 3017 or ASTM D 4643 should also be tested by direct oven drying (ASTM D 2216) to aid in identifying any significant, systematic calibration errors with ASTM D 3017 or ASTM D 4643.

4. ASTM D 2922 is a nuclear method.

5. Every fifth sample tested with ASTM D 2922 or D 2937 should also be tested (as closely, as possible to the same test location) with the sand cone (ASTM D 1556) to aid in identifying any systematic calibration errors with D 2922 or D 2937. The sand cone method may be used in lieu of D 2922 and D 2937.

APPENDIX B

QA INSPECTION FORMS

Project Name _____
Project No. _____
Date _____

GEOMEMBRANE PLACEMENT LOG

Panel No.	Roll No.	Subgrade Condition	Length	Width	Visual Inspection Pass/Fail	QA Officer Initials	CM* Initials

Comments _____

* Construction Manager

Project Name _____
Project No. _____
Date _____

GEOMEMBRANE SEAMING LOG

Welder _____ Weld Type _____

Welding Machine No. _____ Liner Thickness _____

Seam ID	Original or Repair	Ambient Temp.	Weather Conditions	Non-Destructive Test Pass/Fail	On-Site Destructive Peel Test Pass/Fail	QA Officer Initials	CM Initials

Comments _____

Project Name _____
Project No. _____
Date _____

DAMAGE AND FAILURE LOG

Panel No.	Seam No.	Location of Repair or Damage	Type of Damage	Inspec. Date	QA Officer Initials	CM Initials

Comments _____

Project Name _____
Project No. _____
Date _____

TRIAL WELD LOG

Sample No.	Test	Test Method	Results	QA Officer	CM Initials

Comments _____

APPENDIX C

RESULTS OF HYDRAULIC CONDUCTIVITY TESTS AND RECOMMENDED WATER CONTENT-DRY DENSITY CRITERIA FOR POTENTIAL BORROW SOURCES

RESULTS OF HYDRAULIC CONDUCTIVITY TESTS

AND

RECOMMENDED WATER CONTENT-DRY DENSITY

CRITERIA FOR POTENTIAL BORROW SOILS

Prepared for

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RESULTS OF HYDRAULIC CONDUCTIVITY TESTS AND RECOMMENDED WATER CONTENT-DRY DENSITY CRITERIA FOR POTENTIAL BORROW SOILS

Purpose

This report summarizes the results of laboratory hydraulic conductivity tests performed on laboratory-compacted soil samples that were obtained from test pits excavated at several potential borrow areas at Oak Ridge National Laboratory (ORNL) and the Y-12 plant in Oak Ridge, Tennessee. The objective of the testing was to evaluate water content-density criteria necessary to ensure that compacted soils will have a hydraulic conductivity $\leq 1 \times 10^{-7}$ cm/s.

The testing program was developed to confirm that the compaction criteria for the soils tested are similar to the criteria developed in an earlier study described in the report, "Permeability of Compacted Soils from the East and West Borrow Sites, Y-12 Plant, Oak Ridge, Tennessee," prepared by the author of this report and dated March 6, 1989. In the 1989 study, more than 100 hydraulic conductivity tests were performed on three types of soils from two borrow areas. The soils tested in the 1989 study were compacted with 3 compactive energies over a wide range in molding water content. In addition, the 1989 study included an assessment of the effect of various laboratory testing variables upon hydraulic conductivity as well as an evaluation of the repeatability of test results.

The soils tested in the current study were obtained from sites that are geologically identical to the borrow areas tested in the 1989 study. Thus, the compaction criteria are expected to be nearly identical for the soils tested for this study and those tested for the 1989 study.

The specific objectives of this study were to:

1. Prepare compacted test specimens for hydraulic conductivity testing using a representative range in compactive energy and an appropriate molding water content for the particular compactive energy.
2. Perform hydraulic conductivity tests on the compacted soil specimens.
3. Compare the results of the compaction/hydraulic conductivity tests with those from the 1989 study to determine if the criteria developed in the 1989 study are valid for the soils tested in this investigation.
4. Based upon the results of the tests and analysis, provide recommendations concerning appropriate compaction criteria.

Soils Investigated

The soil samples that were tested in this study were obtained from shallow test pits excavated into soils from the following potential sites for borrow soils:

1. HPRR Borrow Site at ORNL.
2. Landfill V, Y-12 Plant.
3. Landfill VI, Y-12 Plant.
4. Landfill VII, Y-12 Plant.

Shallow test pits were excavated with a backhoe at selected locations. Locations of test pits, and information about the soils from the test pits, are presented in two reports:

1. "Backhoe Investigation of Proposed HPRR Borrow Site at ORNL, Oak Ridge Tennessee," by Ogden Environmental and Energy Services, August 12, 1992.
2. Backhoe Investigation of Proposed Industrial Landfill V, Construction-Demolition Landfill VII at Y-12 Plant, Oak Ridge, Tennessee," by Ogden Environmental and Energy Services, August 12, 1992.

The test pits were logged, and bulk samples were taken at several depths within each test pit. The samples were analyzed to determine the water content, grain-size distribution, and Atterberg limits. In addition, compaction tests were performed on 24 bulk samples to define the

compaction characteristics of the soils and to aid in selecting representative bulk samples for hydraulic conductivity testing. The author reviewed the trench locations, descriptions of soil samples, and test results. Based upon this review, 11 bulk soil samples were selected for hydraulic conductivity testing. The samples were selected to provide coverage of the full range of materials encountered at the site.

Data provided by Ogden for the 11 samples are summarized in Tables 1 (compaction and plasticity data) and Table 2 (grain-size and classification data). The range and average values (in parentheses) of various parameters may be summarized as follows:

- Percent Fines[1]: 35 - 99 (66)
- Percent Gravel[2]: 0 - 36 (17)
- Liquid Limit (%): 36 - 70 (55)
- Plasticity Index (%): 19 - 40 (30)
- Optimum Water Content (%)[3]: 18 - 33 (25)
- Max. Dry Unit Weight (pcf)[3]: 87 - 109 (96)

The results reported above are contrasted with similar test parameters from the 1989 study, where comparative data are available, as follows:

Test Parameter	Typical Value from 1989 Study for Type A Soil	Typical Value from This Investigation
Liquid Limit (%)	55	55
Plasticity Index (%)	24	30
Optimum Water Content (%)[3]	27	25
Max. Dry Unit Weight (pcf)[3]	94	96

[1] Defined as Percent by Dry Weight Passing the No. 200 Sieve (Opening Size = 0.075 mm).
[2] Defined as Percent by Dry Weight Retained on the No. 4 Sieve (Opening Size = 4.76 mm).
[3] Standard Compaction, ASTM D698.

Table 1. Data on Compaction Characteristics and Atterberg Limits for Eleven Soil Samples Tested.

Borrow Area	Test Pit	Sample Number	Depth (ft)	Standard Proctor Optimum Water Content (%)	Standard Proctor Maximum Dry Unit Weight (pcf)	Modified Proctor Optimum Water Content (%)	Standard Proctor Maximum Dry Unit Weight (pcf)	Liquid Limit (%)	Plasticity Index (%)
HPRR	A	2/2	8-10	30	90	25	99	63	32
HPRR	B	2/2	9-11	33	87	27	96	70	34
HPRR	C	2/2	7-9	18	106	16	115	45	19
HPRR	E	3/3	10-12	26	97	19	106	58	28
HPRR	H	1/2	2-4	25	98	18	110	57	32
Landfill V	A	2/2	9-11	16	109	13	119	36	20
Landfill V	B	2/2	7-9	25	93	19	106	52	29
Landfill VI	A	1/2	4-6	27	94	21	104	48	28
Landfill VI	C	2	8-10	24	90	19	106	64	40
Landfill VII	C	1	5-7	24	98	20	108	56	30
Landfill VII	D	1	3-5	24	99	18	110	54	35

Table 2. Data on Percent Gravel, Percent Fines, and Unified Soil Classification Symbol for Eleven Soils Tested.

Borrow Area	Test Pit	Sample Number	Depth (ft)	Percent Gravel	Percent Fines	Soil Classification Symbol
HPRR	A	2/2	8-10	7	63	CH
HPRR	B	2/2	9-11	0	99	MH
HPRR	C	2/2	7-9	13	76	CL
HPRR	E	3/3	10-12	36	46	GC
HPRR	H	1/2	2-4	21	67	CH
Landfill V	A	2/2	9-11	17	67	CL
Landfill V	B	2/2	7-9	18	63	CH
Landfill VI	A	1/2	4-6	5	75	CL
Landfill VI	C	2	8-10	26	64	CH
Landfill VII	C	1	5-7	34	35	GC
Landfill VII	D	1	3-5	6	73	CH

It can be seen from the comparative data presented at the bottom of page 3 that the soils tested in this investigation are practically identical to the Type A soils from the 1989 study. This finding was anticipated because the materials are all from the same geologic environment.

Test Procedures

Soils were collected from the field, placed in 5-gal buckets, sealed, and shipped to the University of Texas laboratories for testing. Any materials larger than 1/2 inch were removed by hand. The soil was processed without drying the material back, except when drying was necessary to produce the desired molding water content if that water content was less than the natural water content of the material as shipped.

Compaction curves for the 11 samples were provided by Ogden Environmental and Energy Sources. Two compaction curves were provided for each sample: (1) standard Proctor compactive energy, ASTM D698, and (2) modified Proctor compactive energy, ASTM D1557. From the curves, an estimate was made of the optimum water content for reduced compaction, which is compaction that is identical to standard Proctor compaction except that only 15 blows per lift are provided from the ram rather than the usual 25 blows.

The sample preparation procedure was as follows:

1. The desired, or "target," water content was identified for each sample for reduced, standard, and modified compaction, based on the compaction curves provided by Ogden. The target water content was about 3 percentage points wet of optimum.
2. Soil samples were mixed to the 3 target water contents for each of the 11 samples. The materials were sealed, stored for at least 48 hours, and tested to confirm that the water content was correct.
3. Compacted test specimens were prepared for each compactive energy and soil sample (3 compactive energies and 11 soil samples for a total of 33 test specimens). Appendix A contains plots of the compaction curves provided by Ogden and the actual water content-dry unit weight values of the test specimens

prepared for this study. In most cases, the water content-dry unit weight values that were obtained for the hydraulic conductivity test specimens were very close to the compaction curves defined by Ogden. Natural variation in soils is expected to lead to some variation in test results. In a few cases, the dry unit weight was not as close to the target value as desired, or the hydraulic conductivity seemed anomalous. In these cases, a replicate test specimen was prepared.

4. Test specimens were permeated in the same compaction mold in which the materials were compacted. Permeation was with tap water without application of any external confining stress. Permeation continued for each test specimen until hydraulic conductivity was steady. The head applied to the test specimens remained constant throughout the tests.

The test procedures employed for this investigation are identical to those used for the 1989 study. The testing procedures (fixed-wall cell with no vertical confining stress and no backpressure) are thought to be appropriate for final cover systems that will be subjected to low overburden stress.

Results

The results of hydraulic conductivity tests are summarized in Tables 3 (HPRR site), 4 (Landfill V), 5 (Landfill VI), and 6 (Landfill VII). Thirty seven hydraulic conductivity tests were performed, including replicate tests for questionable specimens. Of the 37 tests that were performed, 32 produced hydraulic conductivities $\leq 1 \times 10^{-7}$ cm/s. Hydraulic conductivity was $> 1 \times 10^{-7}$ cm/s in 5 tests. However, for 4 of the 5 tests that yielded hydraulic conductivities $> 1 \times 10^{-7}$ cm/s, new test specimens were prepared and the specimens were permeated in replicate tests -- all 4 replicate tests gave hydraulic conductivities $\leq 1 \times 10^{-7}$ cm/s in the retest. Occasional deviations from a hydraulic conductivity target are to be expected, particularly when low compactive energies (e.g., reduced compaction energy) are used.

Table 3. Summary of Results of Hydraulic Conductivity Tests on Soils from HPRR Site at ORNL.

Borrow Area	Test Pit	Sample Number	Depth (ft)	Compaction Method	Molding Water Content (%)	Dry Unit Weight (pcf)	Hydraulic Conductivity (cm/s)	Remarks
HPRR	A	2/2	8-10	Reduced	34	86	4×10^{-8}	
HPRR	A	2/2	8-10	Standard	33	88	4×10^{-8}	
HPRR	A	2/2	8-10	Modified	28	96	8×10^{-9}	
HPRR	B	2/2	9-11	Reduced	38	81	2×10^{-8}	
HPRR	B	2/2	9-11	Standard	35	84	3×10^{-8}	
HPRR	B	2/2	9-11	Modified	29	94	2×10^{-8}	
HPRR	C	2/2	7-9	Reduced	23	96	1×10^{-7}	
HPRR	C	2/2	7-9	Standard	20	102	5×10^{-7}	See Replicate on Next Line
HPRR	C	2/2	7-9	Standard	21	102	4×10^{-8}	Replicate Test
HPRR	C	2/2	7-9	Modified	19	108	1×10^{-8}	
HPRR	E	3/3	10-12	Reduced	31	90	3×10^{-7}	See Replicate on Next Line
HPRR	E	3/3	10-12	Reduced	31	91	1×10^{-7}	Replicate Test
HPRR	E	3/3	10-12	Standard	29	93	3×10^{-8}	
HPRR	E	3/3	10-12	Modified	21	104	1×10^{-8}	
HPRR	H	1/2	2-4	Reduced	29	91	7×10^{-8}	
HPRR	H	1/2	2-4	Standard	28	94	4×10^{-8}	
HPRR	H	1/2	2-4	Modified	20	103	2×10^{-8}	

Table 4. Summary of Results of Hydraulic Conductivity Tests on Soils from Landfill V at Y-12 Plant.

Borrow Area	Test Pit	Sample Number	Depth (ft)	Compaction Method	Molding Water Content (%)	Dry Unit Weight (pcf)	Hydraulic Conductivity (cm/s)	Remarks
Landfill V	A	2/2	8-10	Reduced	20	103	6×10^{-8}	
Landfill V	A	2/2	8-10	Standard	19	106	9×10^{-8}	
Landfill V	A	2/2	8-10	Modified	16	114	8×10^{-9}	
Landfill V	B	2/2	9-11	Reduced	29	91	3×10^{-8}	
Landfill V	B	2/2	9-11	Standard	27	94	2×10^{-8}	
Landfill V	B	2/2	9-11	Modified	20	103	1×10^{-8}	

Table 5. Summary of Results of Hydraulic Conductivity Tests on Soils from Landfill VI at Y-12 Plant.

Borrow Area	Test Pit	Sample Number	Depth (ft)	Compaction Method	Molding Water Content (%)	Dry Unit Weight (pcf)	Hydraulic Conductivity (cm/s)	Remarks
Landfill VI	A	1/2	4-6	Reduced	31	90	2×10^{-7}	See Replicate on Next Line
Landfill VI	A	1/2	4-6	Reduced	31	88	5×10^{-8}	Replicate Test
Landfill VI	A	1/2	4-6	Standard	29	92	1×10^{-7}	
Landfill VI	A	1/2	4-6	Modified	23	102	2×10^{-8}	
Landfill VI	C	2/2	8-10	Reduced	28	88	3×10^{-7}	
Landfill VI	C	2/2	8-10	Standard	26	89	6×10^{-8}	
Landfill VI	C	2/2	8-10	Modified	21	104	9×10^{-9}	

Table 6. Summary of Results of Hydraulic Conductivity Tests on Soils from Landfill VII at Y-12 Plant.

Borrow Area	Test Pit	Sample Number	Depth (ft)	Compaction Method	Molding Water Content (%)	Dry Unit Weight (pcf)	Hydraulic Conductivity (cm/s)	Remarks
Landfill VII	C	1/2	5-7	Reduced	29	92	1×10^{-7}	
Landfill VII	C	1/2	5-7	Standard	27	94	2×10^{-7}	See Replicate on Next Line
Landfill VII	C	1/2	5-7	Standard	26	95	3×10^{-8}	Replicate Test
Landfill VII	C	1/2	5-7	Modified	22	104	1×10^{-8}	
Landfill VII	D	1/2	3-5	Reduced	28	92	2×10^{-8}	
Landfill VII	D	1/2	3-5	Standard	27	94	5×10^{-8}	
Landfill VII	D	1/2	3-5	Modified	20	108	6×10^{-8}	

Overall, the hydraulic conductivity tests were successful in demonstrating that the soils can be compacted to produce a hydraulic conductivity $\leq 1 \times 10^{-7}$ cm/s.

Water Content-Dry Unit Weight Criterion

Water content-dry unit weight points are plotted in Figure 1. Open symbols are used for samples with hydraulic conductivities $> 1 \times 10^{-7}$ cm/s and solid symbols are used for samples with hydraulic conductivities $\leq 1 \times 10^{-7}$ cm/s. The Acceptable Zone defined from the 1989 study is also shown in Fig. 1. The data obtained from this study are consistent with the Acceptable Zone from the 1989 study. The data demonstrate that the same Acceptable Zone from the 1989 study is applicable to the soils tested in this investigation.

The Acceptable Zone shown in Fig. 1 is based upon hydraulic conductivity. Other considerations besides hydraulic conductivity are often important. For example, the soil should not be compacted at such a high water content that the shear strength is unacceptably low.

Conclusions and Recommendations

Based on the data presented in this report, the compaction criteria developed in a 1989 study of "Type A" soils are applicable to the potential borrow soils tested in this study. It is recommended that the same Acceptable Zone applied to Type A soils in 1989 be assumed to apply to the soils from the HPRR, Landfill V, Landfill VI, and Landfill VII sites. However, caution should be excercised during construction to ensure that soils are not so wet that the materials are too soft, even though low hydraulic conductivity is achieved.

There is no indication that soil from any one of the potential borrow sites is superior or inferior to soil from the other borrow sites, in terms of ability to produce a low-permeability compacted soil liner. Thus, selection of borrow sites should be based upon other criteria.

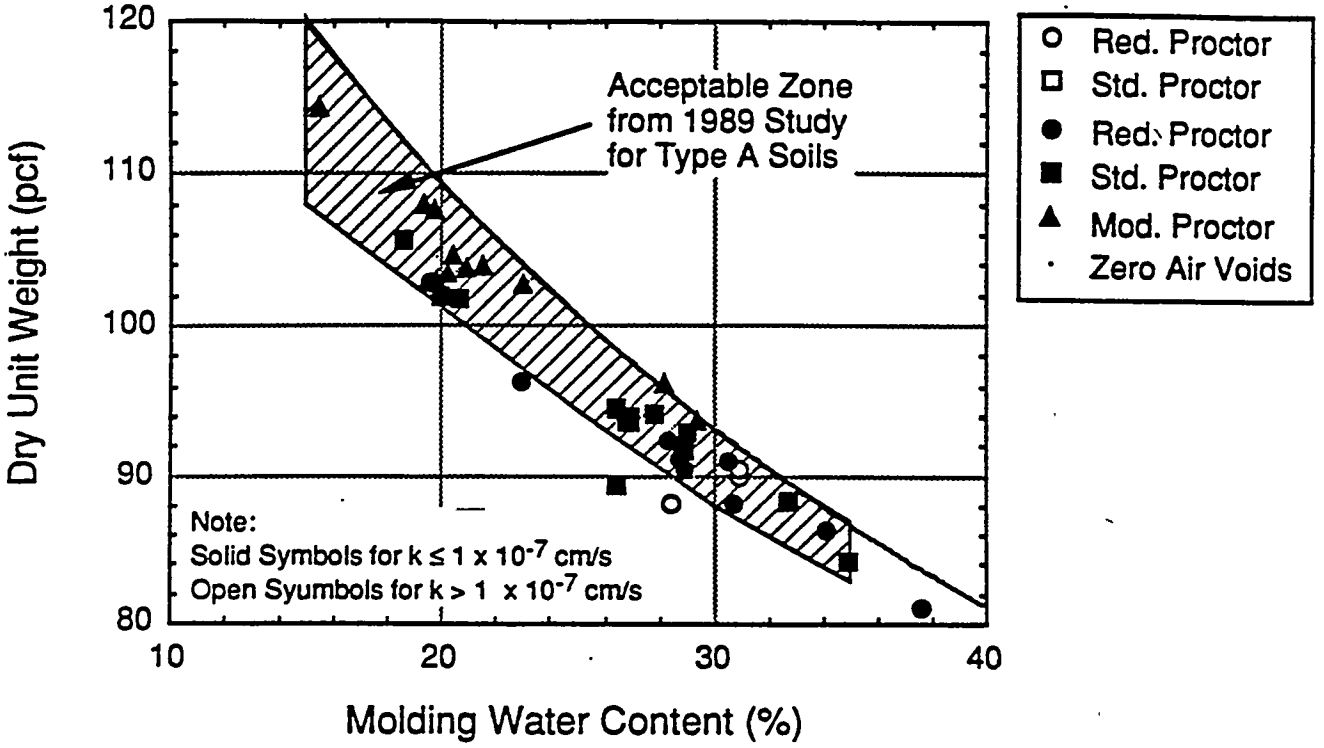
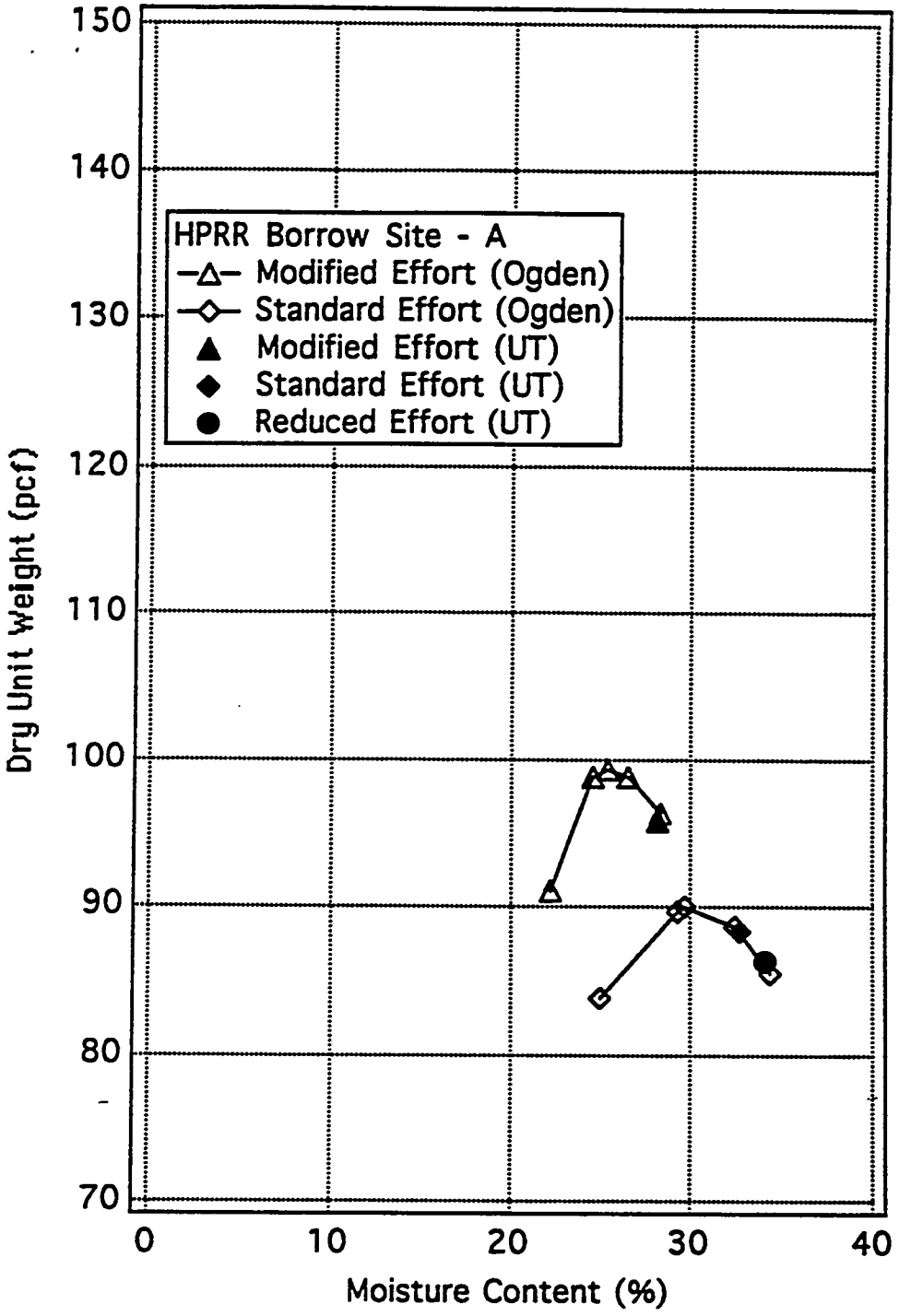
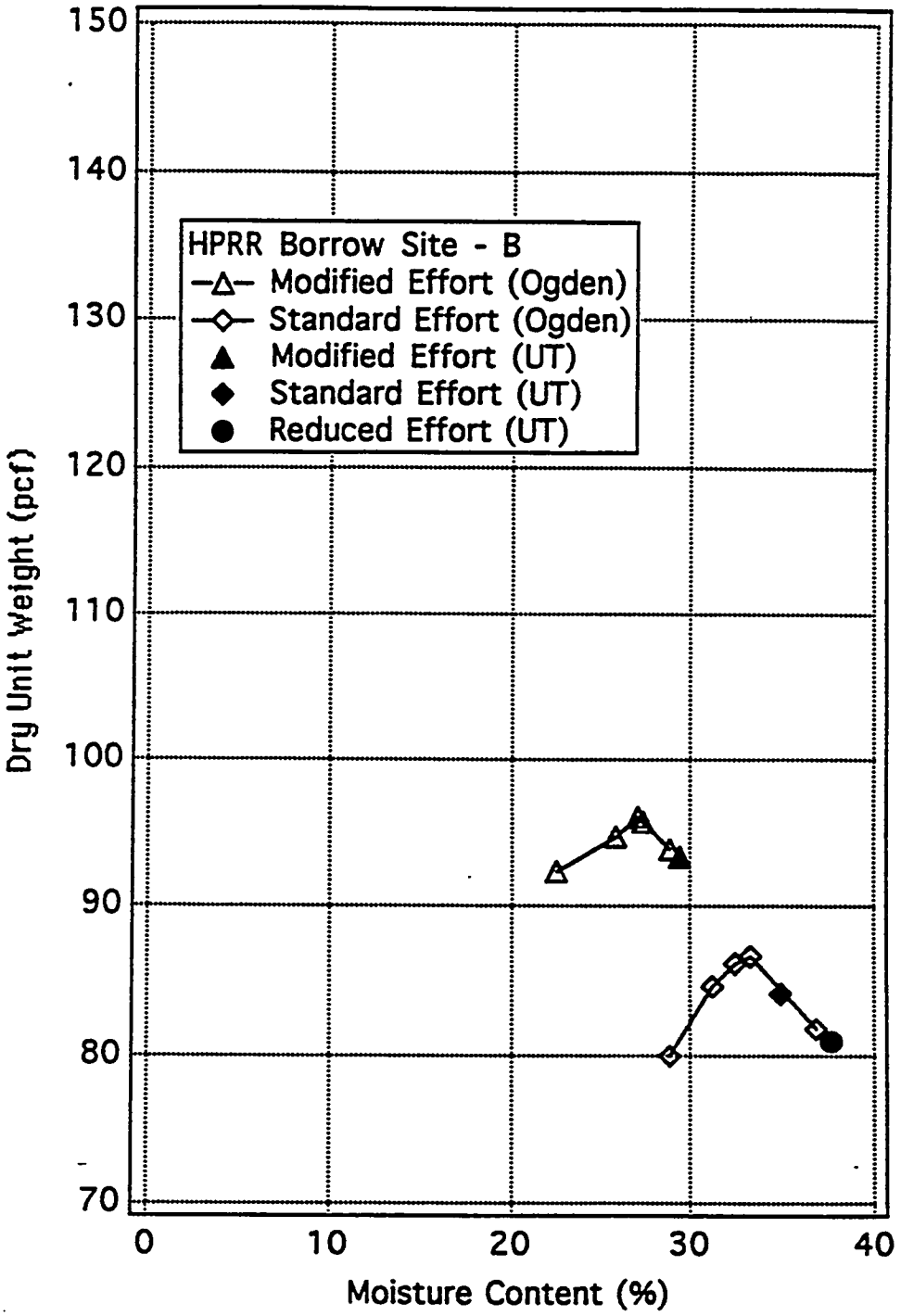


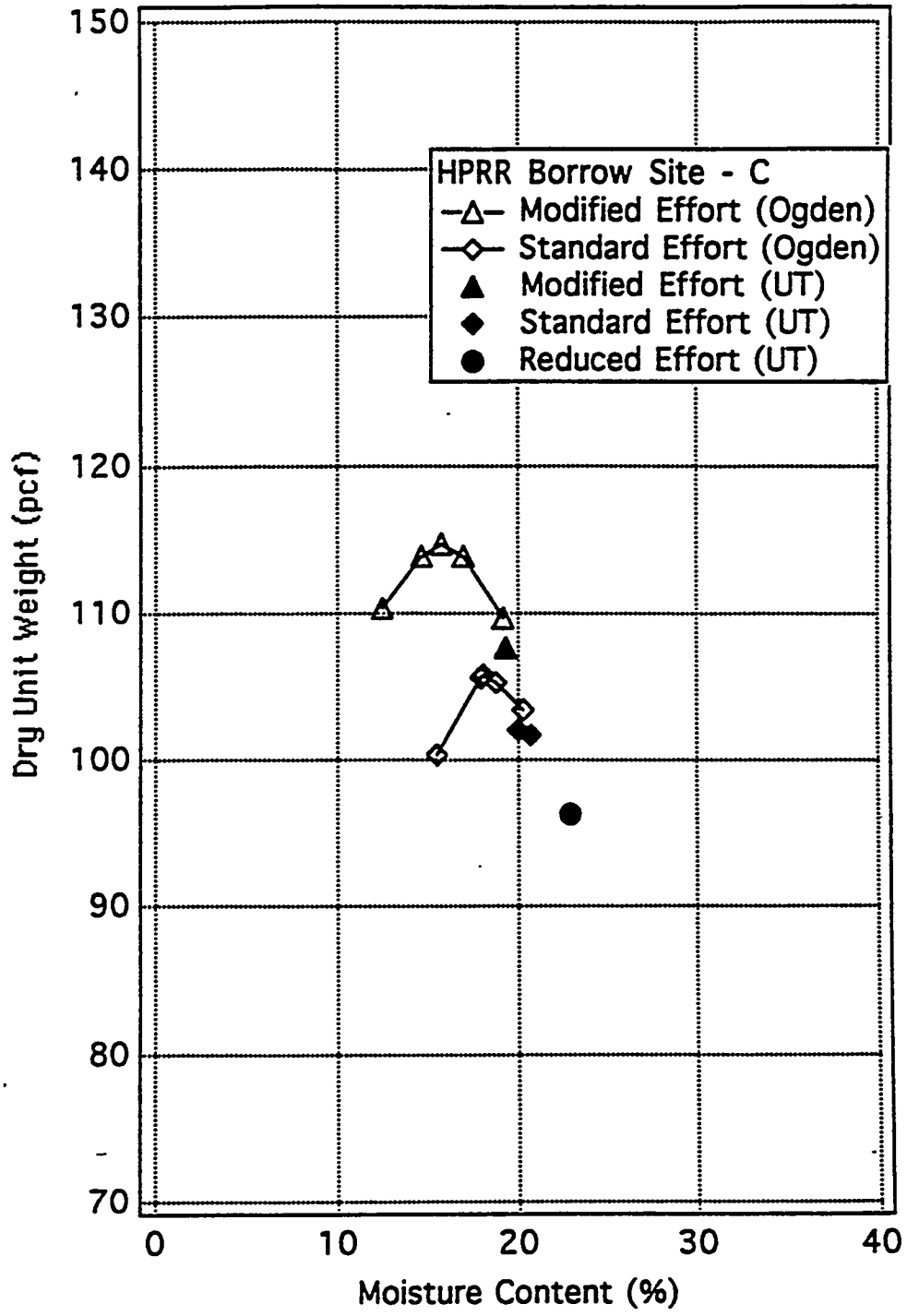
Figure 1. Water Content - Dry Unit Weights that Produced Ranges of Hydraulic Conductivity.

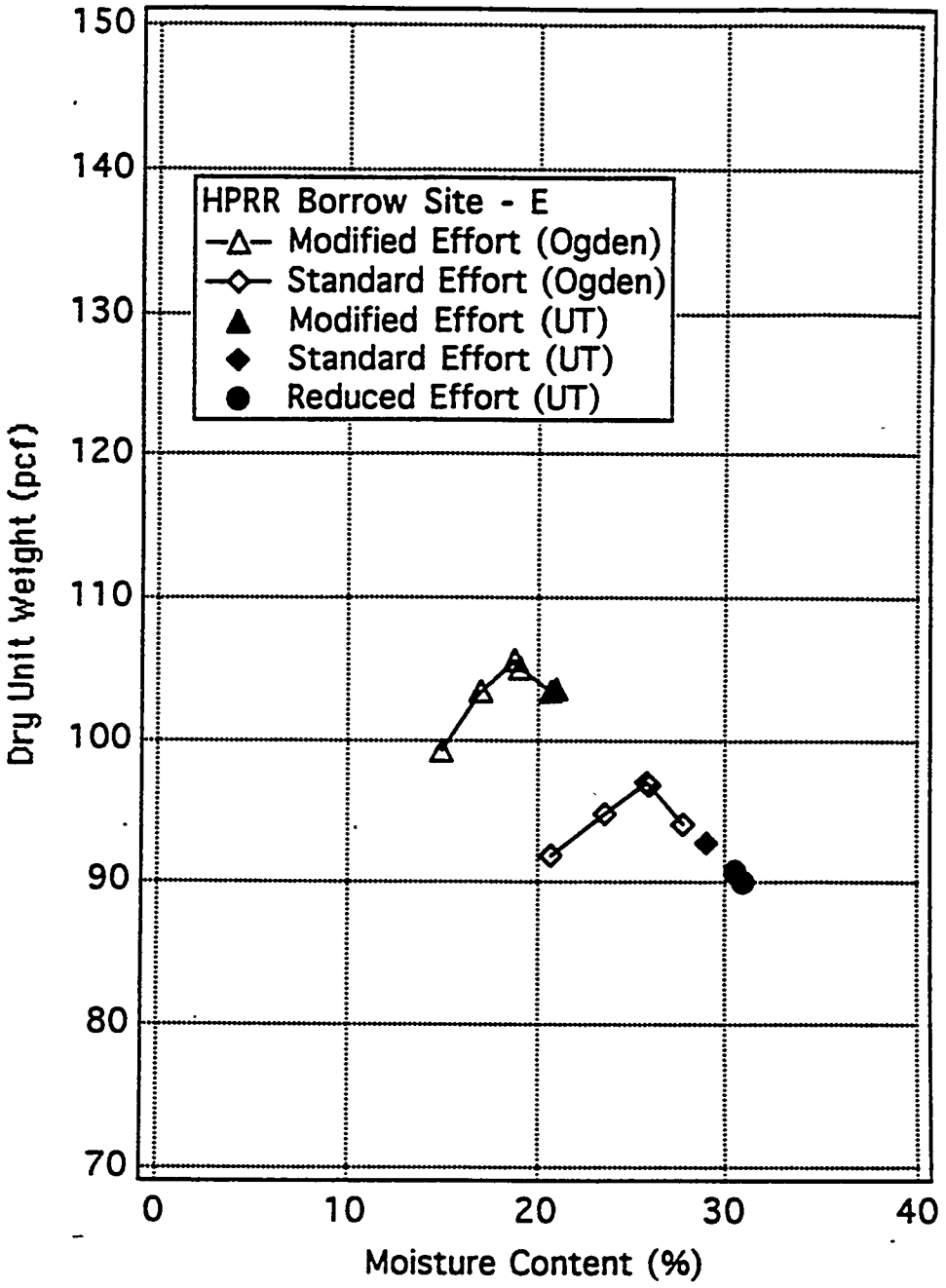
APPENDIX

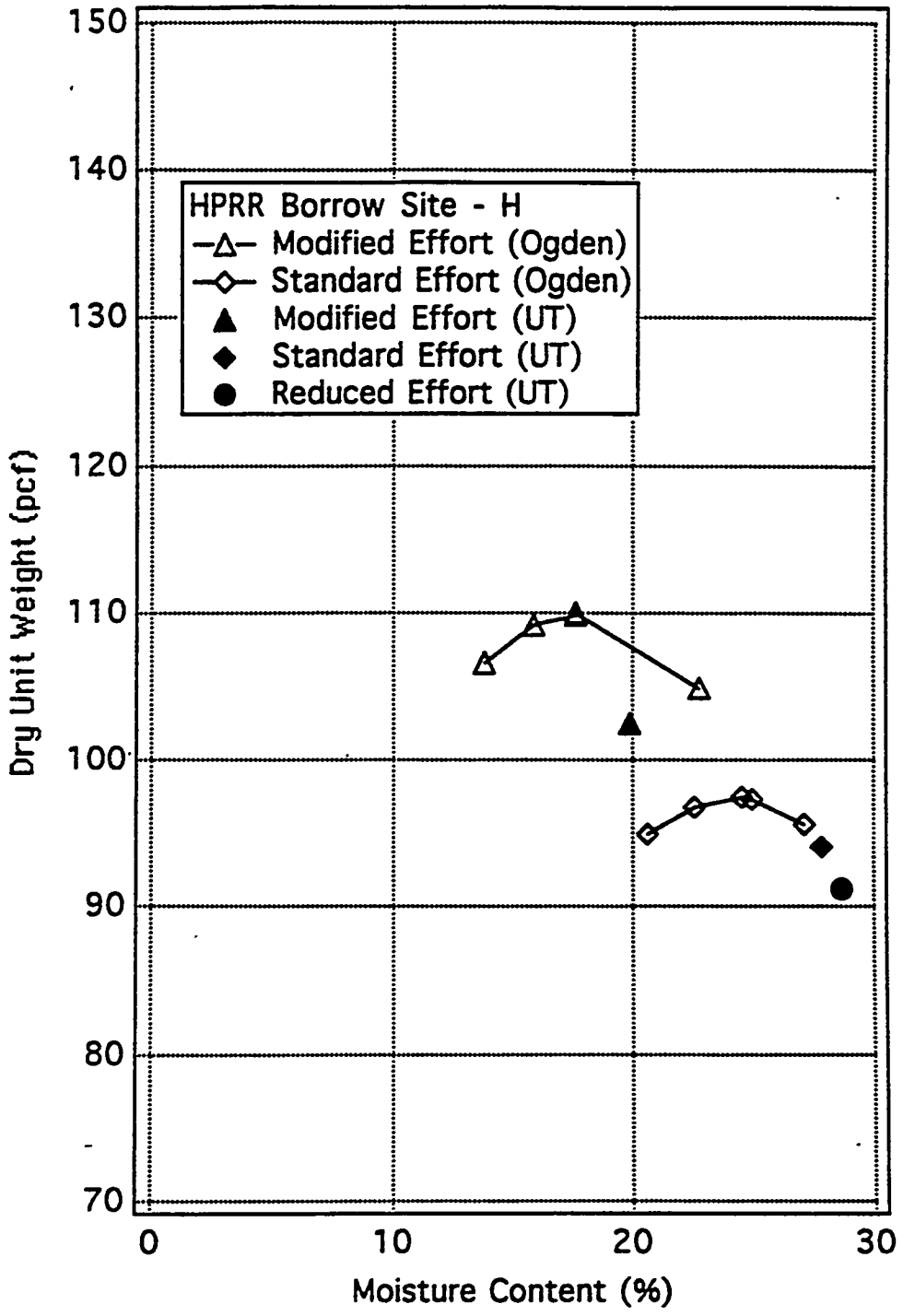
COMPACTION CURVES FROM OGDEN ENVIRONMENTAL AND ENERGY SERVICES AND COMPACTION TEST RESULTS FROM THIS STUDY

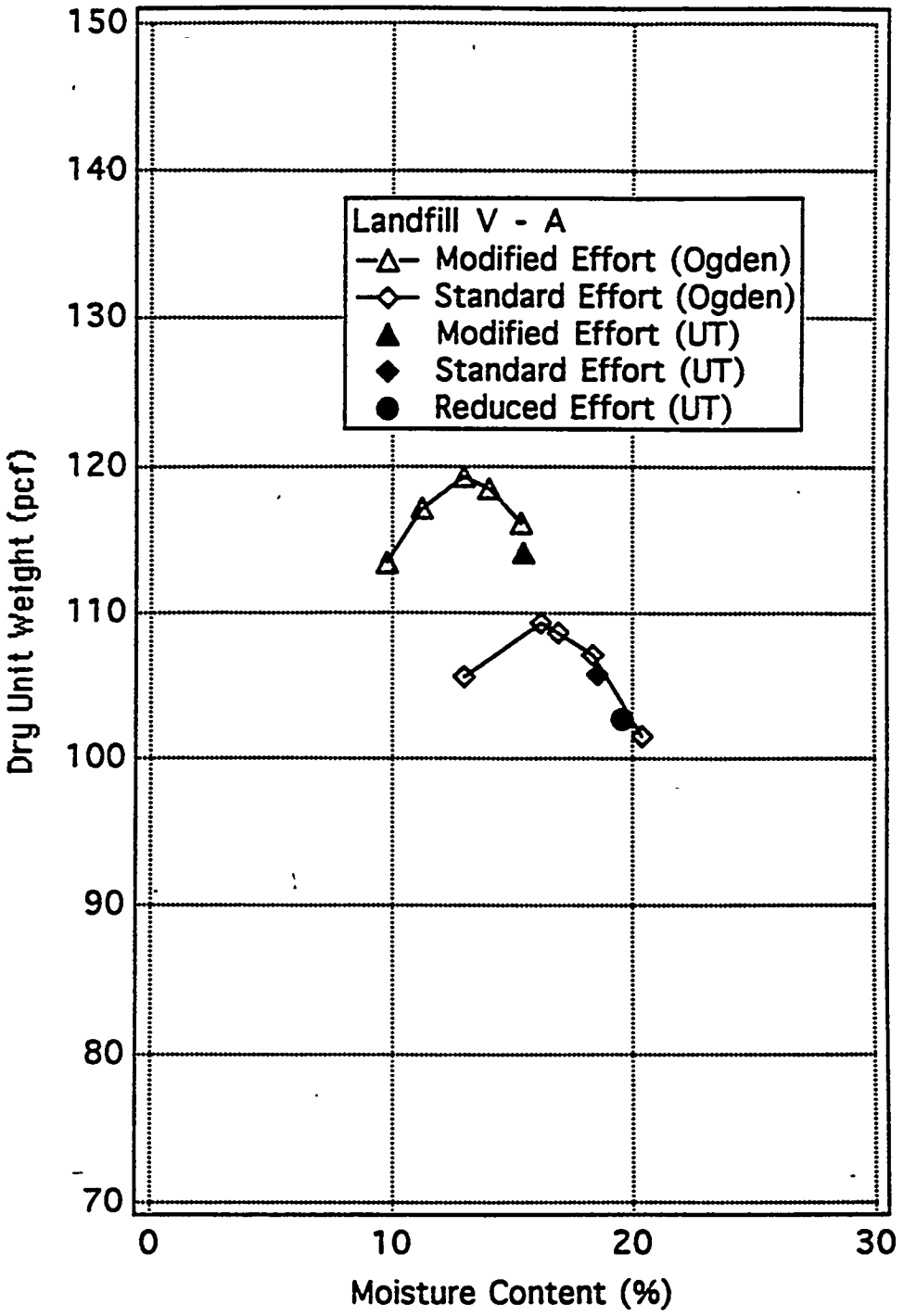

HPRR Borrow Site - A
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
40
Moisture Content (%)

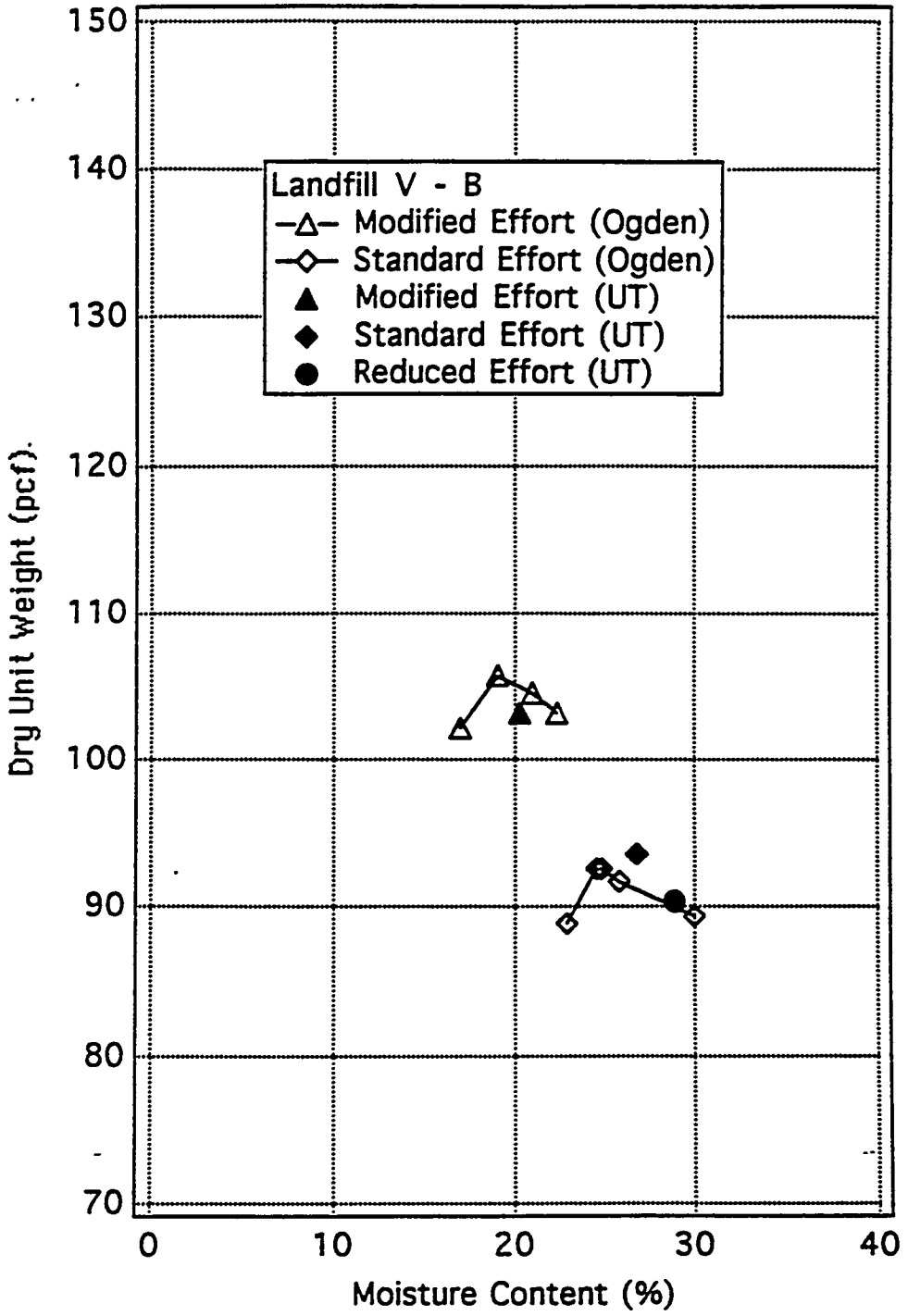

HPRR Borrow Site - B
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
40
Moisture Content (%)

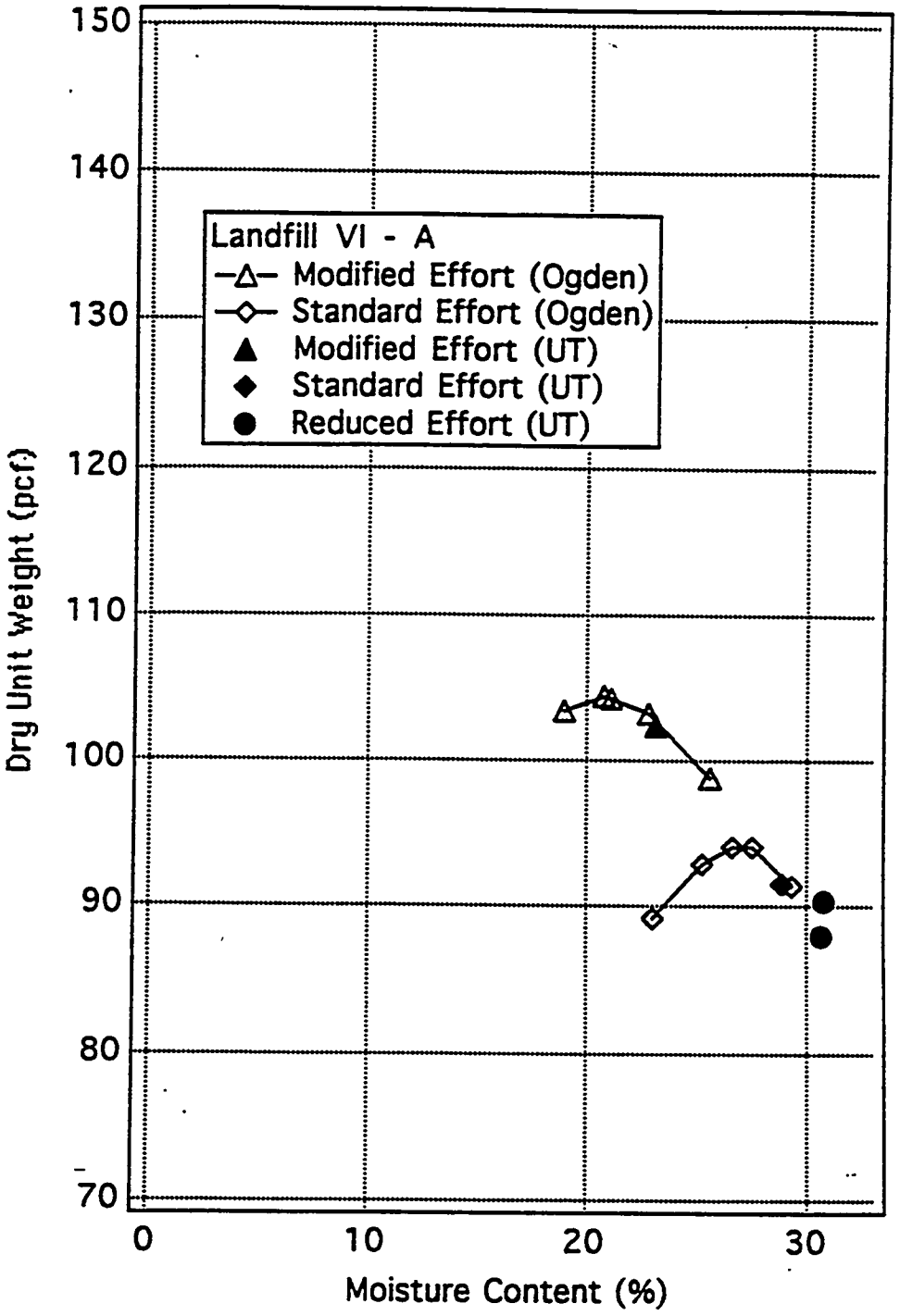

HPRR Borrow Site - C
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
40
Moisture Content (%)

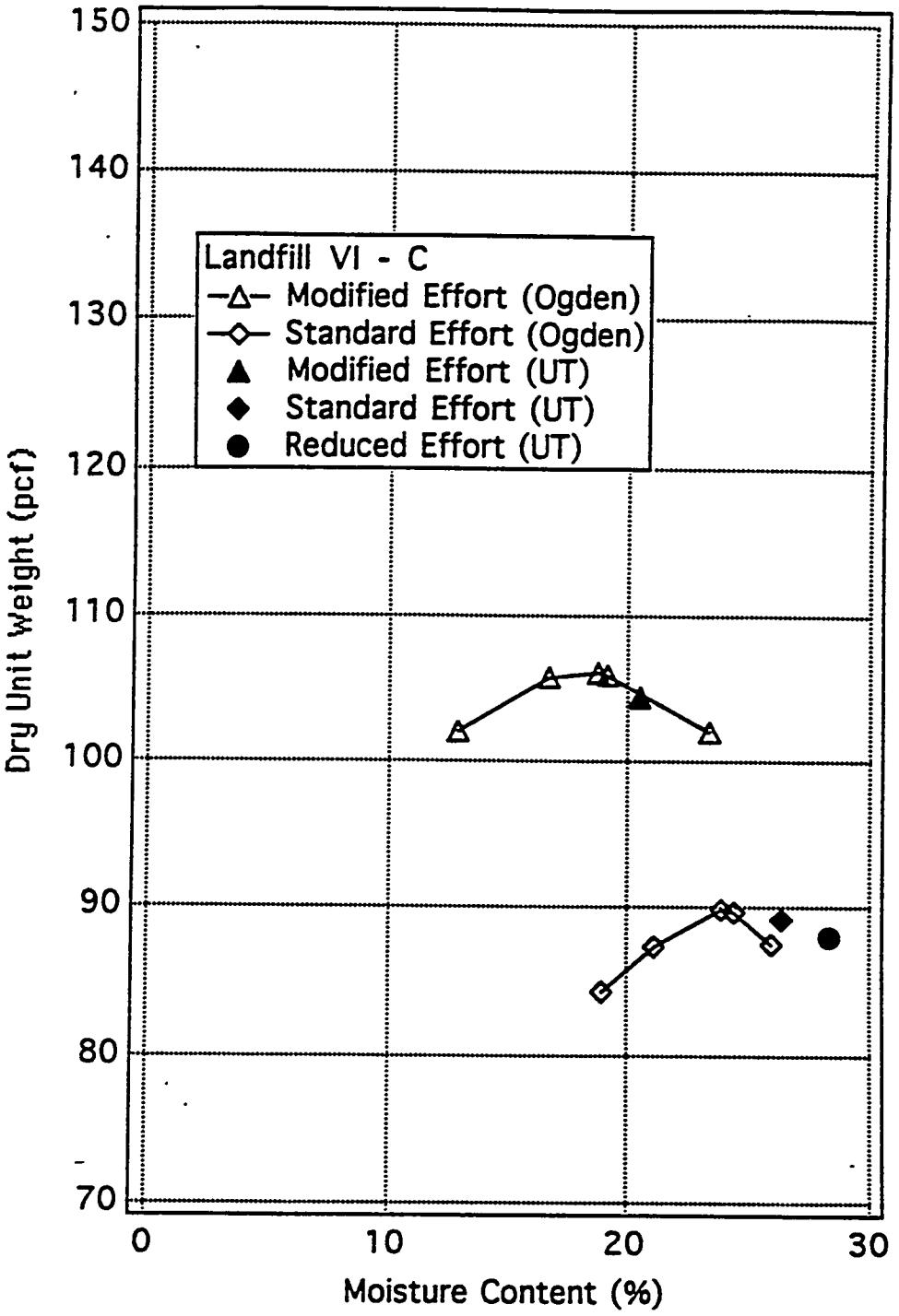

HPRR Borrow Site - E
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
40
Moisture Content (%)

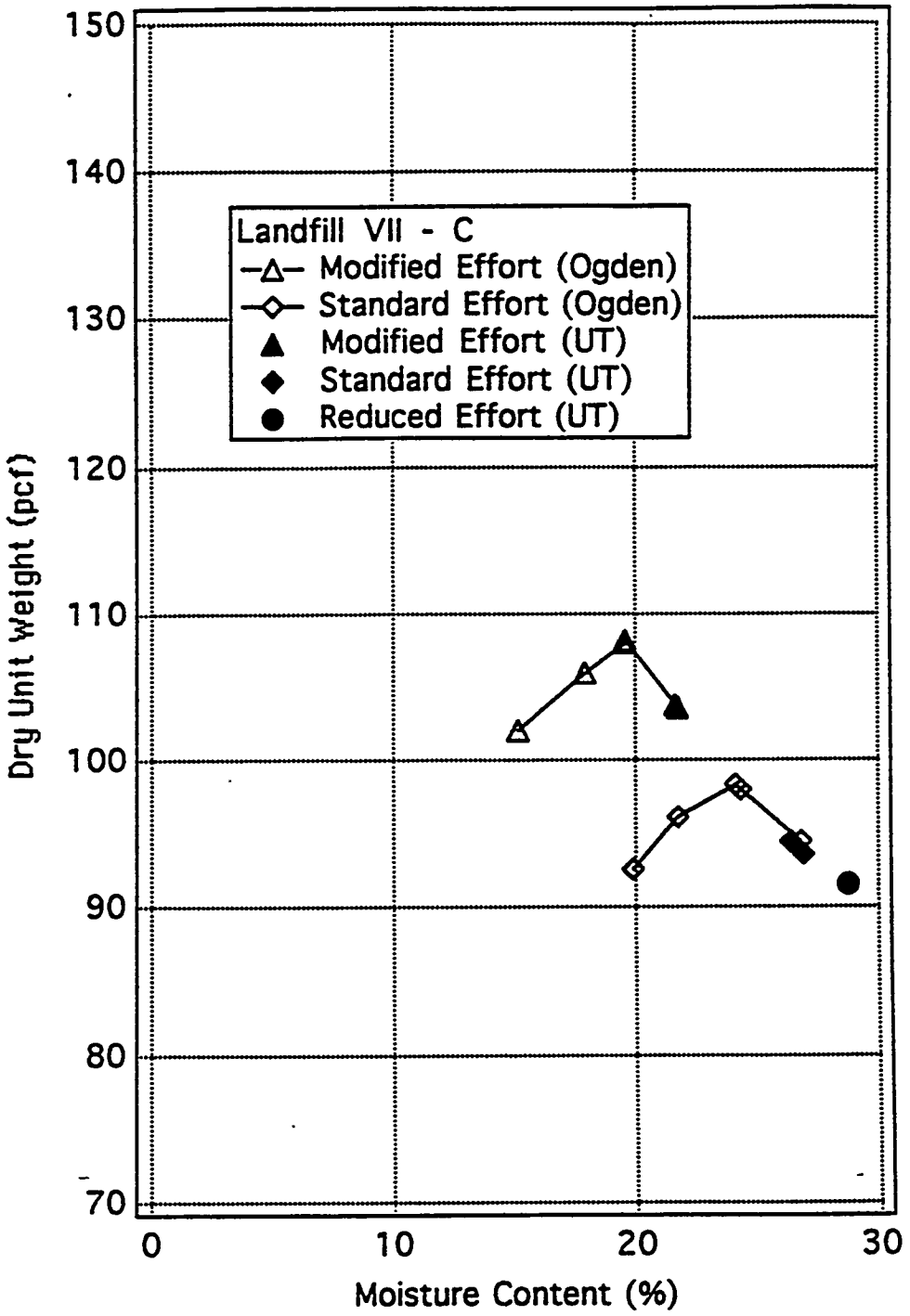

HPRR Borrow Site - H
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
Moisture Content (%)

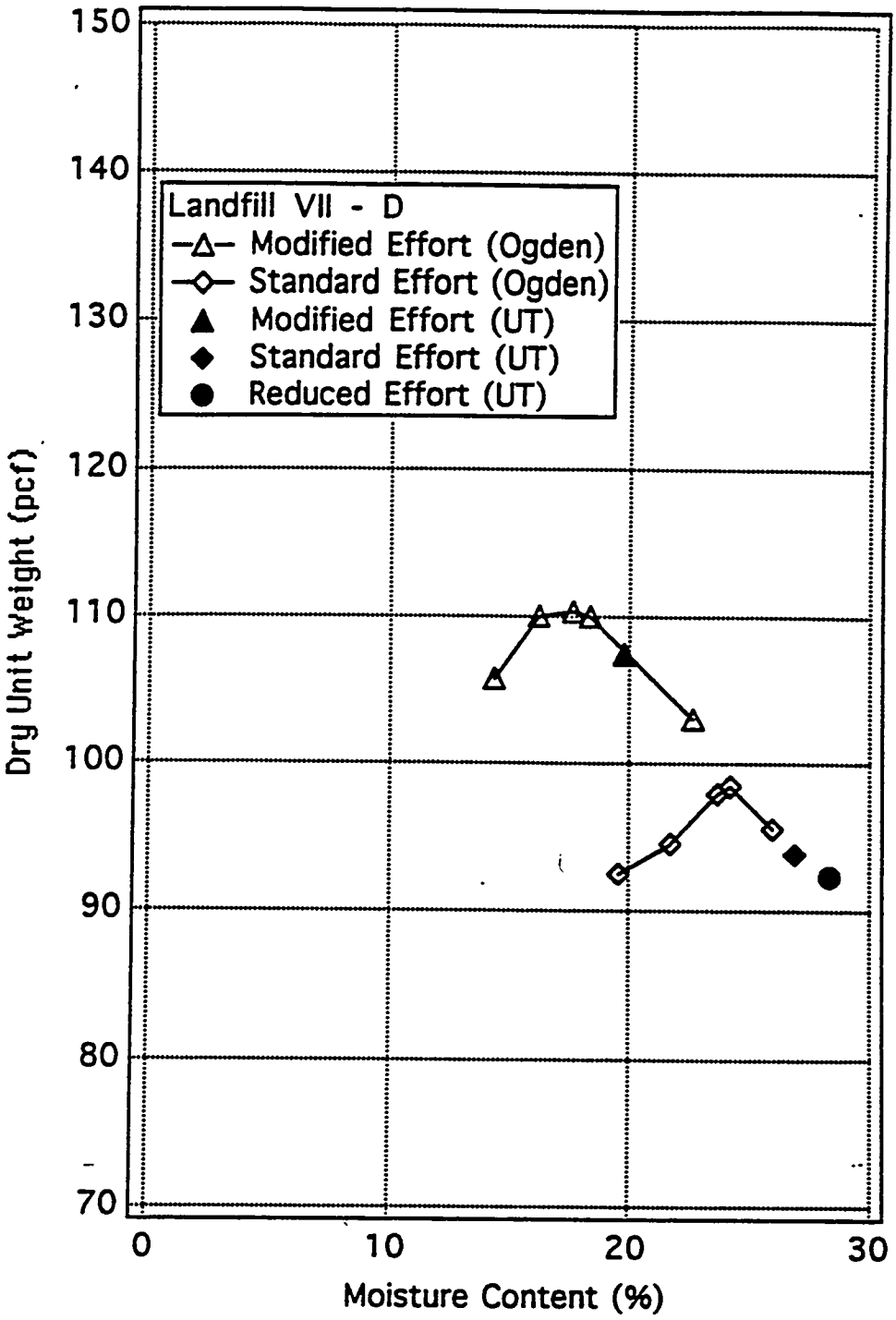

Landfill V - A
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
Moisture Content (%)

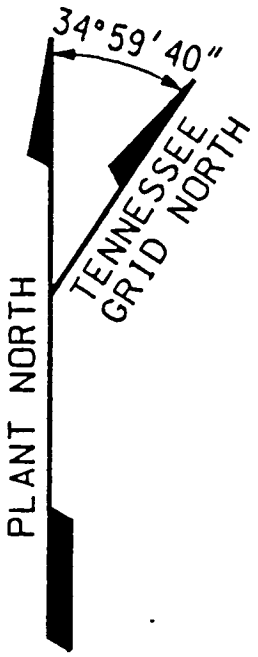

Landfill V - B
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
Moisture Content (%)
150
140
130
120
110
100
90
80
70
0
10
20
30
40

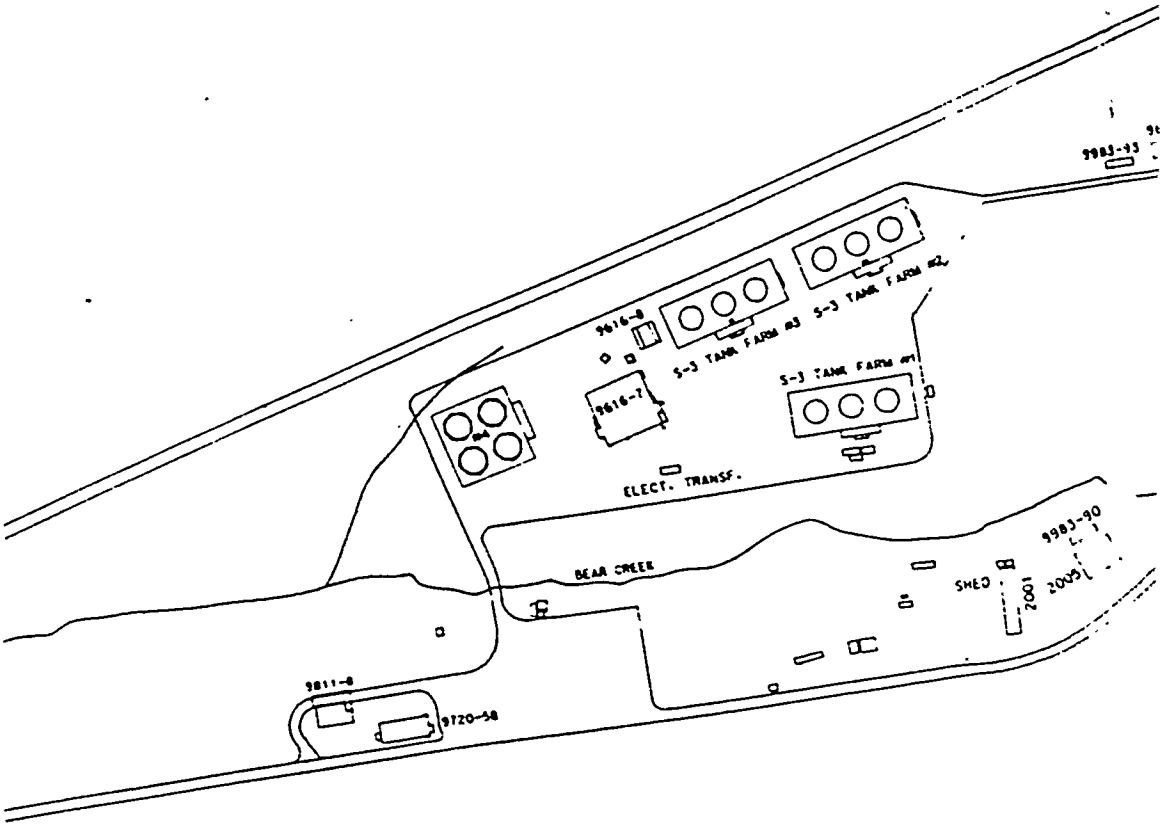

Landfill VI - A
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
Moisture Content (%)

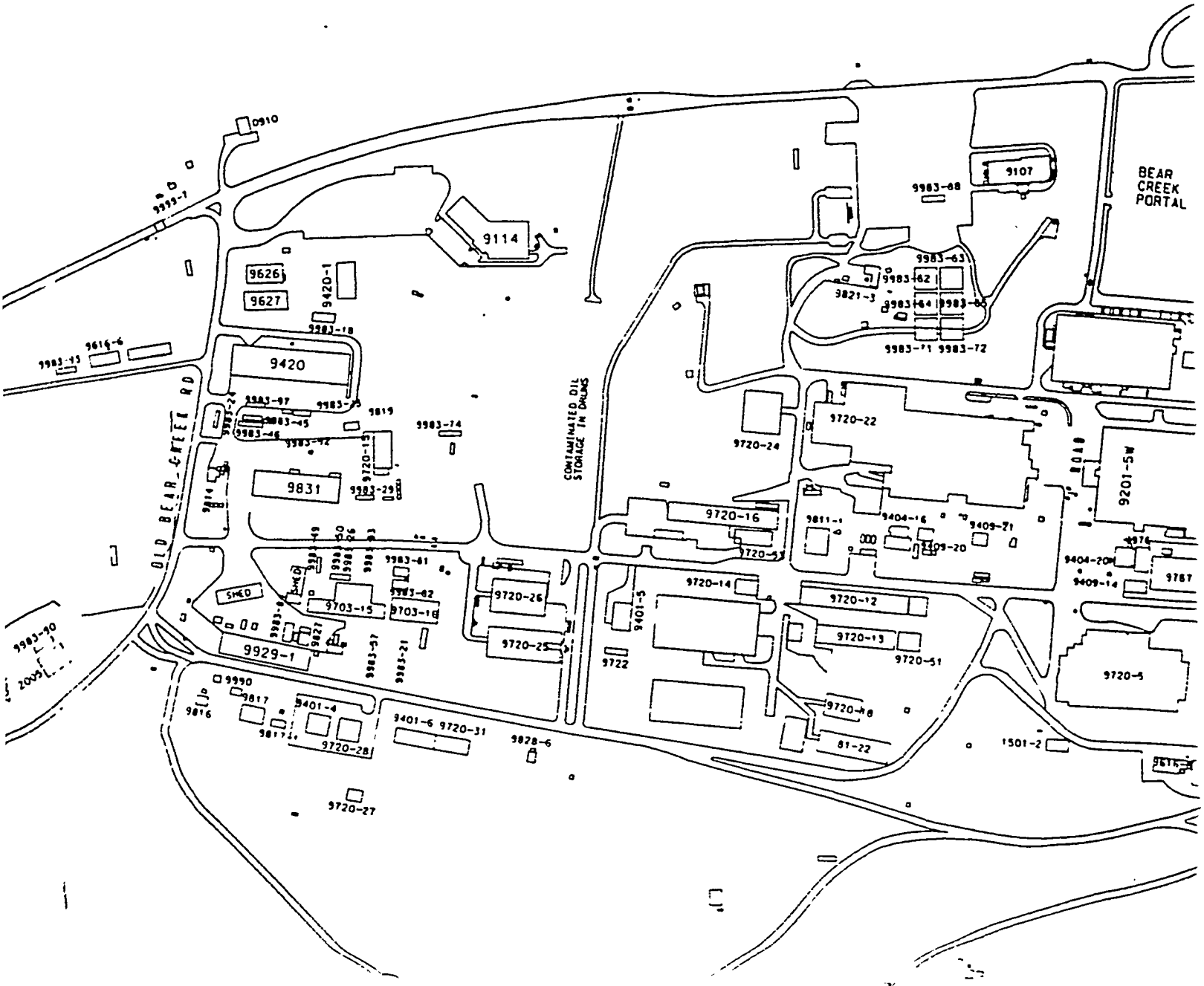

Landfill VI - C
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
Moisture Content (%)

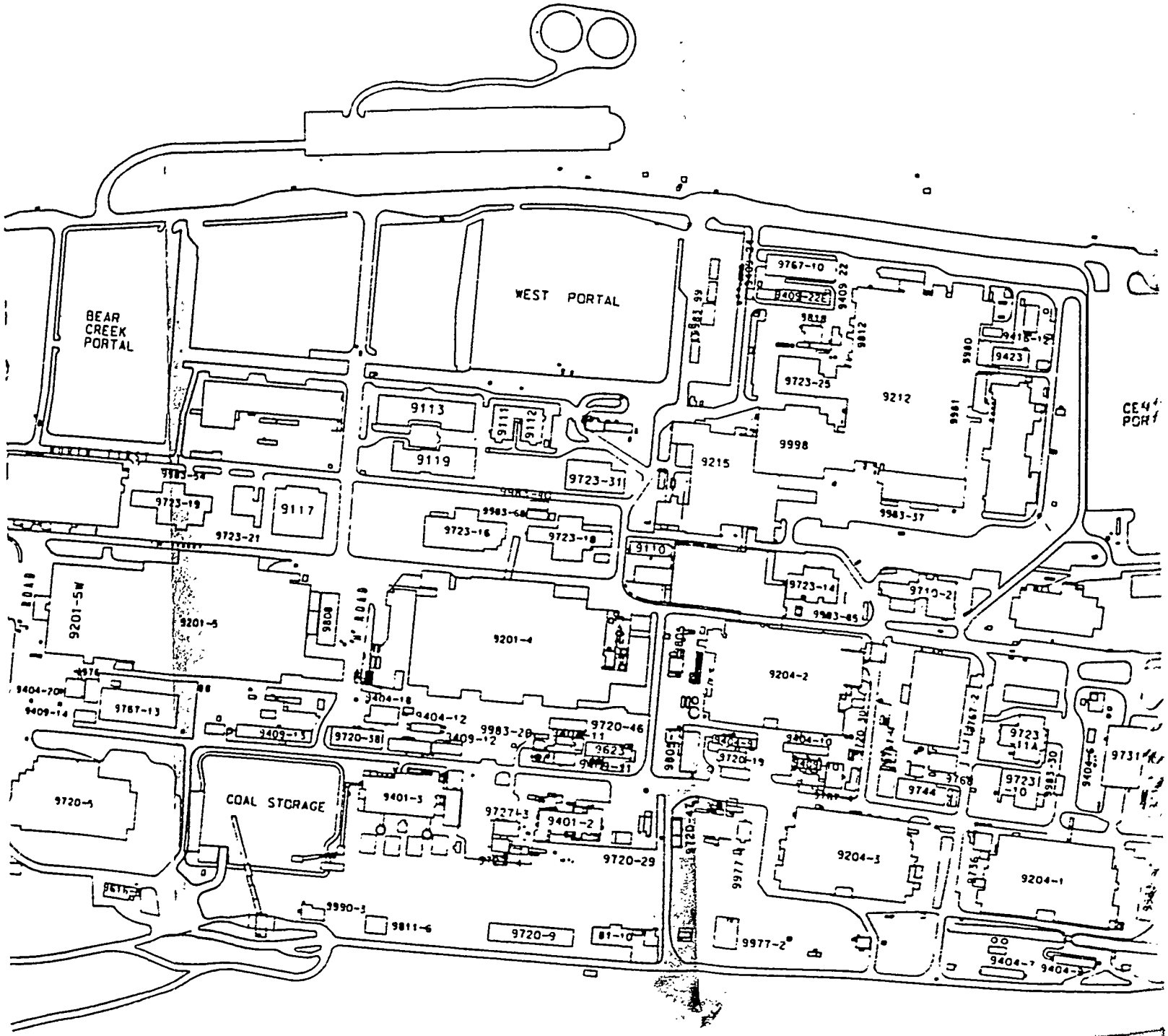

Landfill VII - C
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
Moisture Content (%)

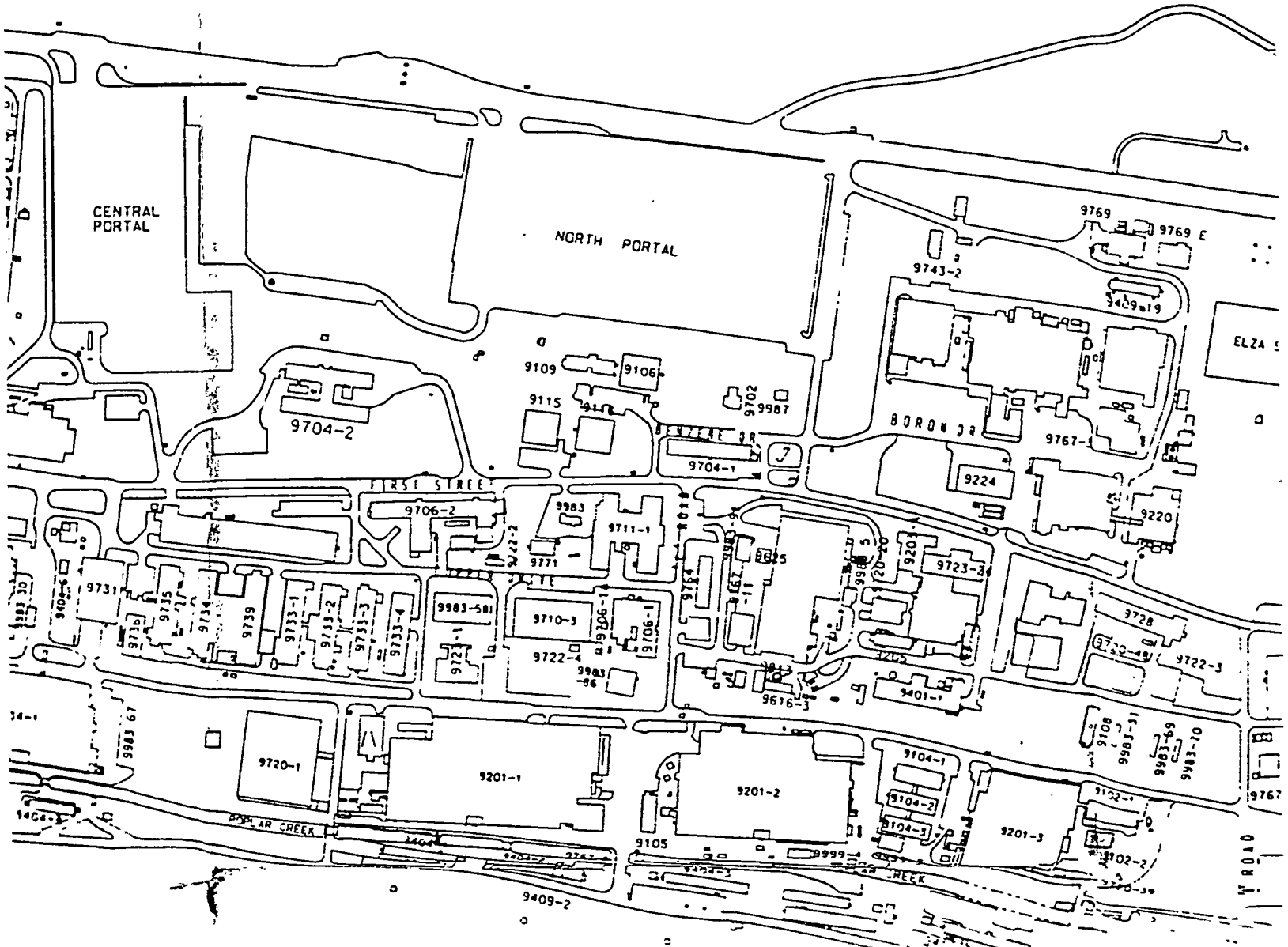

Landfill VII - D
Modified Effort (Ogden)
Standard Effort (Ogden)
Modified Effort (UT)
Standard Effort (UT)
Reduced Effort (UT)
Dry Unit Weight (pcf)
150
140
130
120
110
100
90
80
70
0
10
20
30
Moisture Content (%)

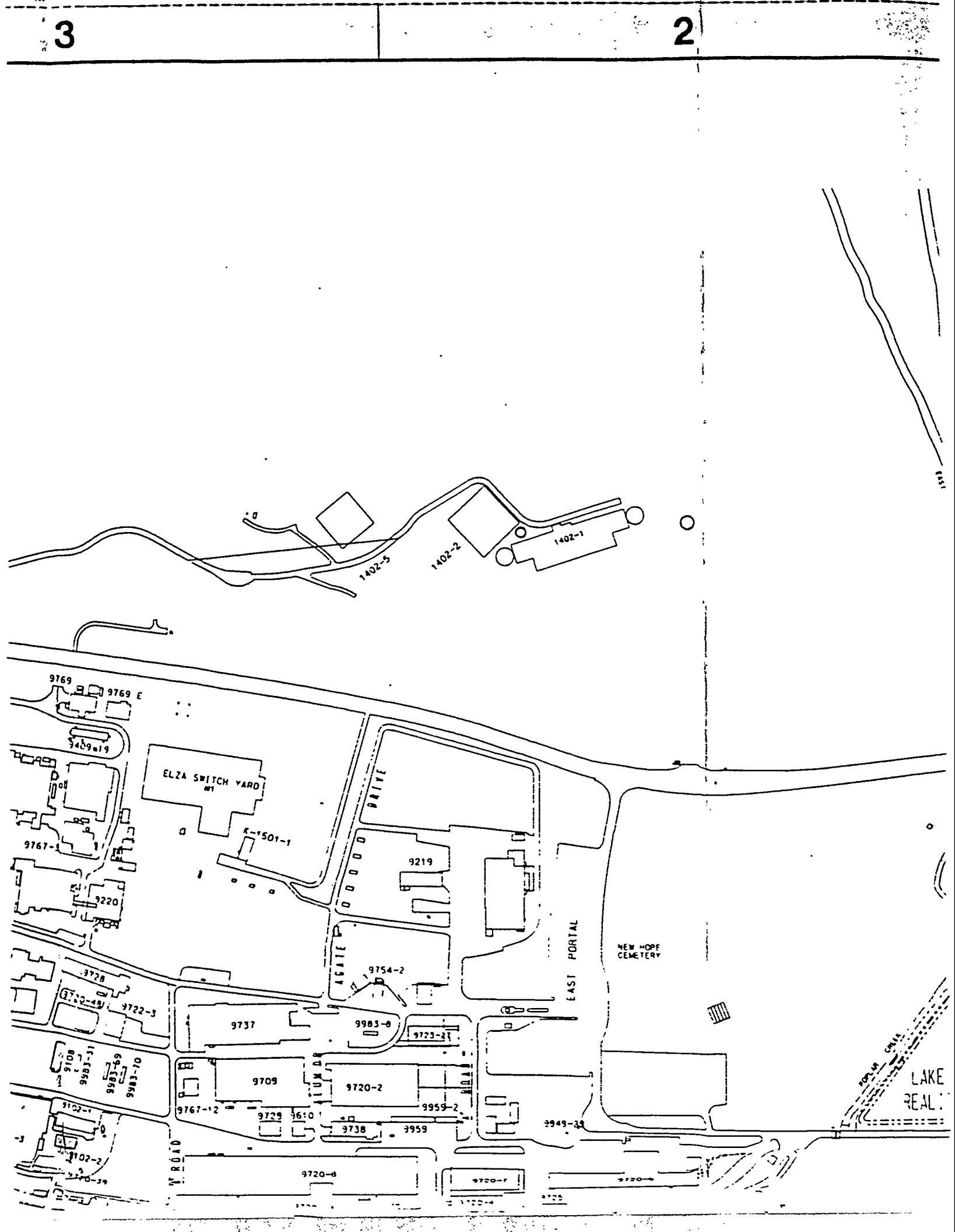

34°59'40"
TENNESSEE GRID NORTH
PLANT NORTH


9983-93
9616-8
S-3 TANK FARM #3
S-3 TANK FARM #2
S-3 TANK FARM #1
9616-7
ELECT. TRANSF.
BEAR CREEK
9983-90
SHED
2001
2005
9811-8
9720-58


BEAR CREEK PORTAL
OLD BEAR CREEK RD
CONTAMINATED OIL STORAGE IN DRUMS
9114
9420
9831
9929-1
9107
9720-16
9720-22
9720-24
9720-26
9720-25
9720-28
9720-27
9720-31
9720-12
9720-13
9720-51
9720-5
9720-14
9720-16
9626
9627
9420-1
9703-15
9703-16
9401-4
9401-5
9401-6
9722
9828-6
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9983-65
9983-71
9983-72
9983-18
9983-97
9983-45
9983-46
9983-42
9983-74
9983-29
9983-61
9983-82
9983-57
9983-21
9990
9817
9816
9819
9821-3
9811-1
9404-16
9409-21
9409-20
9404-20
9409-14
9787
1501-2
81-22
SHED
2005


BEAR CREEK PORTAL
WEST PORTAL
COAL STORAGE
9113
9119
9117
9112
9111
9723-31
9723-19
9723-21
9723-16
9723-18
9983-58
9983-59
9110
9215
9998
9212
9723-25
9423
9767-10
9409-22E
9983-57
9723-14
9983-65
9201-5W
9201-5
9201-4
9204-2
9204-3
9204-1
9720-5
9401-3
9401-2
9720-29
9720-9
9811-6
9990-3
9977-2
9404-7
9404-18
9404-12
9409-12
9983-28
9720-46
9720-58
9623
9744
9731
9723-10
9723-11A
9767-13
9409-15
9404-19
9720-19
9404-7
9404-8

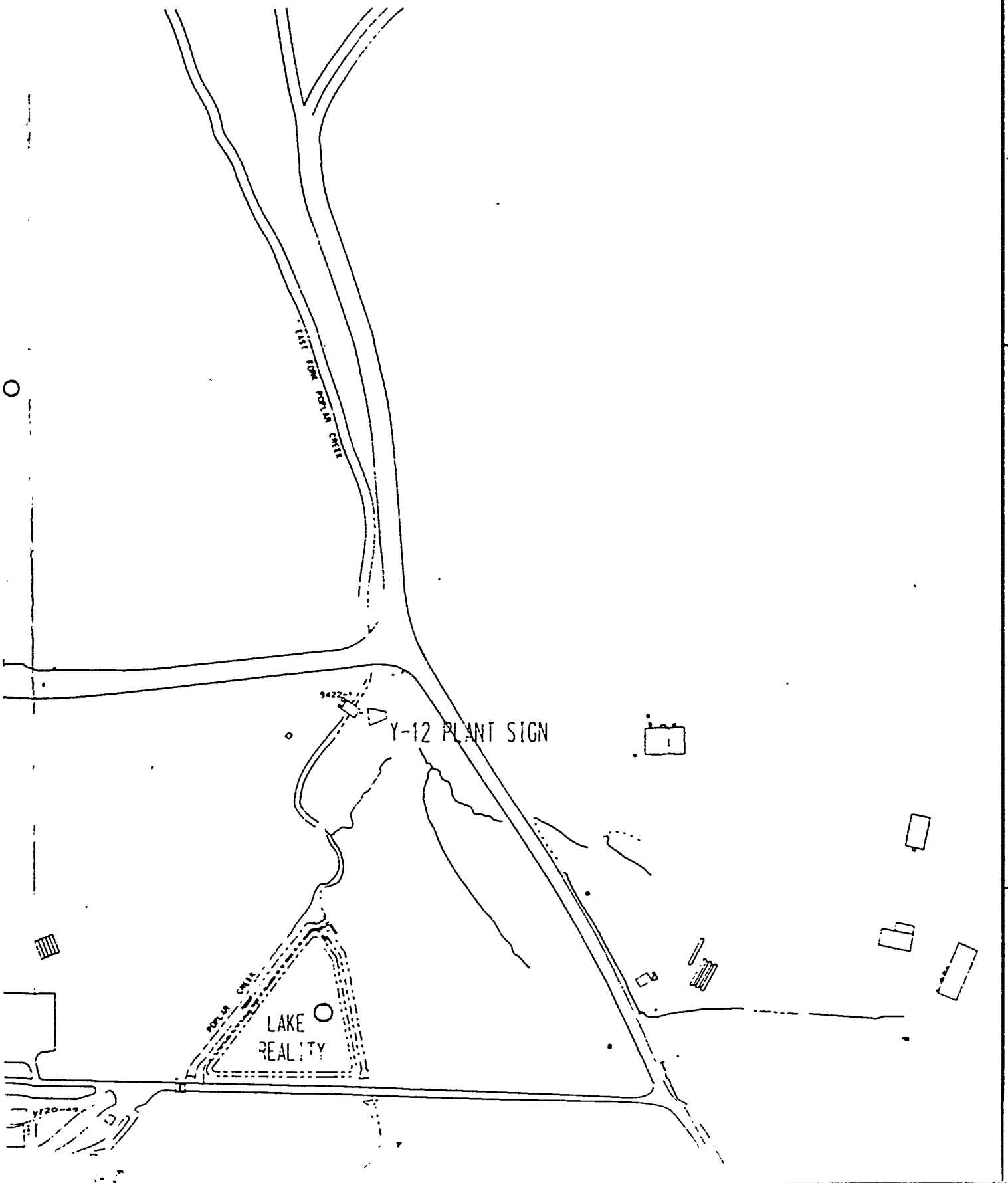

CENTRAL PORTAL
NORTH PORTAL
FIRST STREET
BORON DR
POPLAR CREEK
9704-2
9109
9106
9115
9702
9987
9704-1
9706-2
9983
9711-1
9771
9731
9739
9733-1
9733-2
9733-3
9733-4
9721-1
9983-68
9710-3
9722-4
9983-66
9106-1
9764
9825
9201-1
9723-3
9728
9722-3
9616-3
9401-1
9720-1
9201-2
9104-1
9104-2
9104-3
9201-3
9105
9999
9409-2
9743-2
9769
9769 E
9409-19
ELZA
9767-1
9224
9220
9102-1
9102-2
9767


3
2
1402-5
1402-2
1402-1
9769
9769 E
9769-19
ELZA SWITCH YARD
#1
R-1501-1
9767-1
9220
9219
DRIVE
AGATE
9754-2
EAST PORTAL
NEW HOPE
CEMETERY
9728
9722-3
9737
9983-8
9723-3
9108
9983-11
9983-9
9983-10
9709
9720-2
9767-12
9729
9610
9738
9959
9959-2
9949-39
9102-1
9102-2
9720-39
9720-8
9720-7
9720-6
9720-4
LAKE
REAL

2

NEXT ASS'Y:

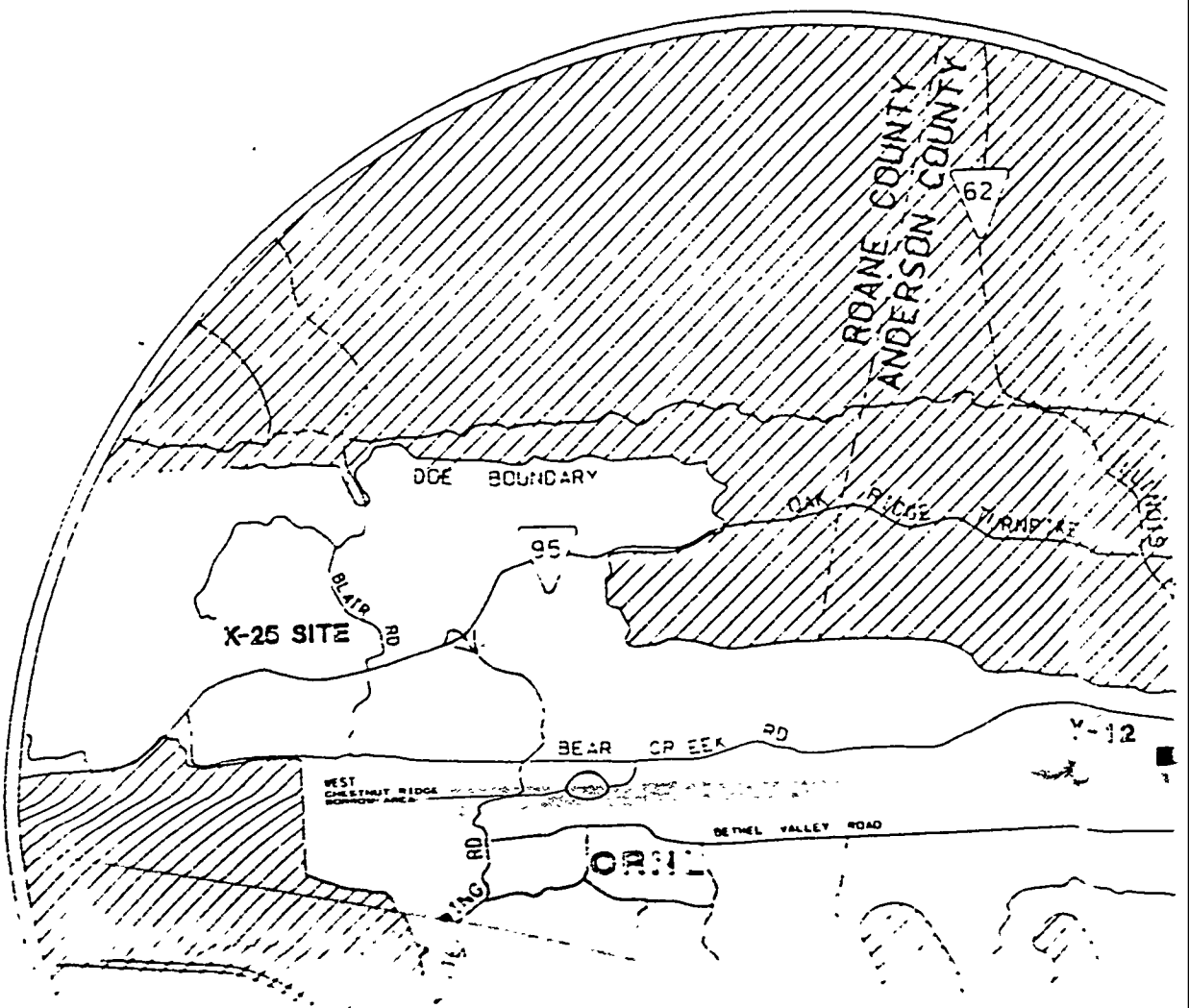
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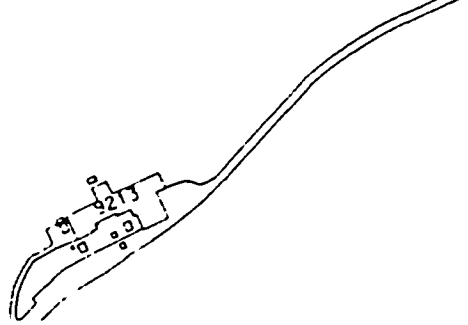


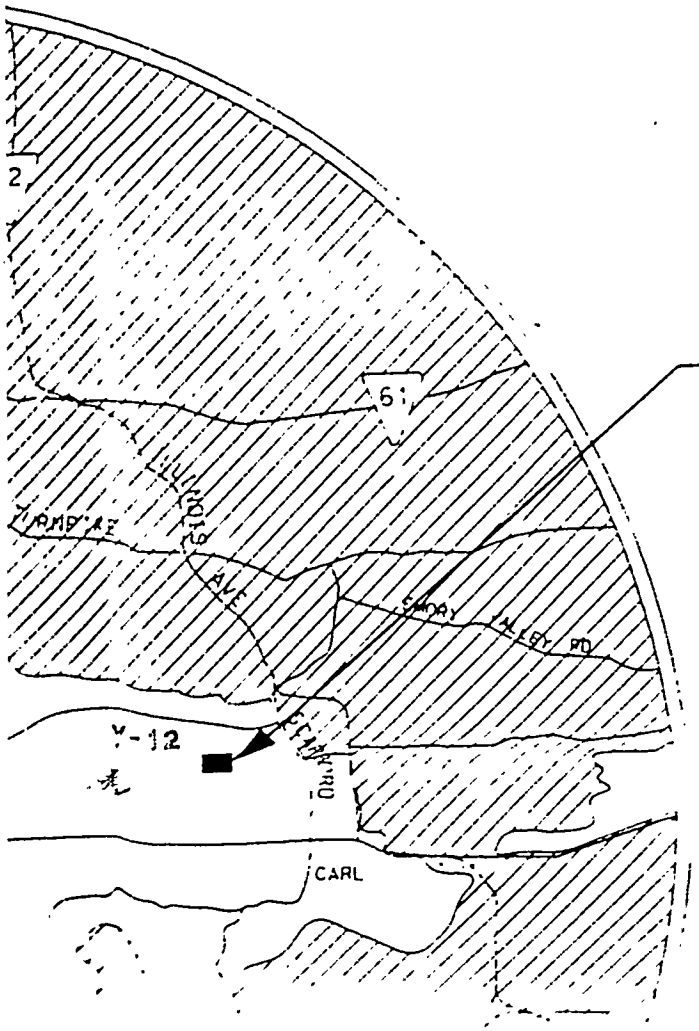
H

G

F


ROANE COUNTY
ANDERSON COUNTY
62
DOE BOUNDARY
OAK RIDGE TURNPIKE
95
BLAIR RD
X-25 SITE
BEAR CREEK RD
V-12
WEST CHESTNUT RIDGE
BETHEL VALLEY ROAD
RD
ORNL





PROJECT LOCATION

DRAWING

DRAWING NUMBER:

C2E900000A703
C2E900000A627
C2E900000A925

SITE ACCESS PL

NOT TO SCALE

DRAWING INDEX:

DRAWING NUMBER:	REV.	TITL
C2E900000A703	1	PERMI
C2E900000A627	2	TOTAL
C2E900000A925	0	AREA
[illegible]	3	[illegible]

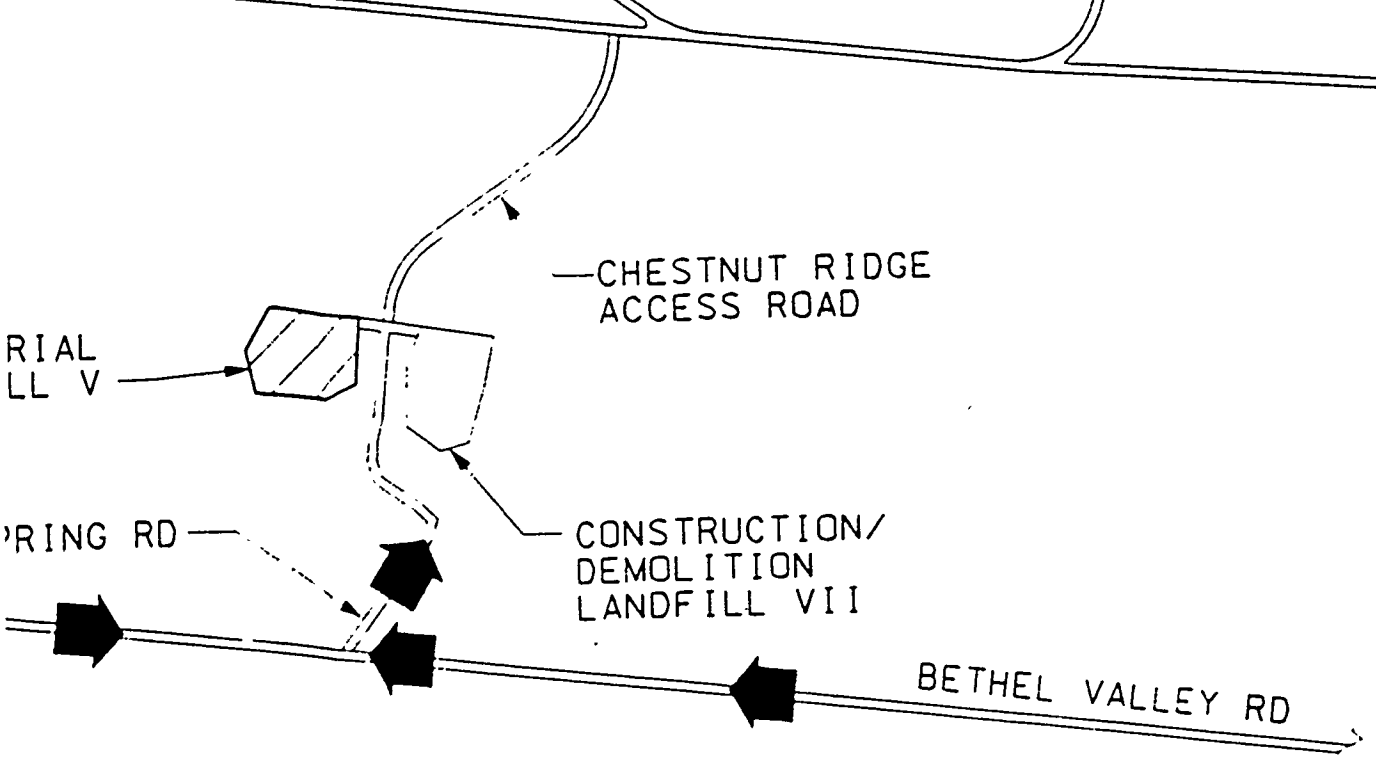
INDUSTRIAL
LANDFILL V

CLEAR SPRING RD

PLAN

TITLE

PERMIT PACKAGE ACCESS PLAN AND DRAWING INDEX
TOTAL SITE DEVELOPMENT AND EXCAVATION PLAN
AREA 2 PARTIAL PLAN PROTECTIVE SOIL COVER
AREA 3 PARTIAL PLAN PROTECTIVE SOIL COVER
FINAL CLOSURE PLAN



EXIST

1050

SD-1

LC-6

OE

SW-1

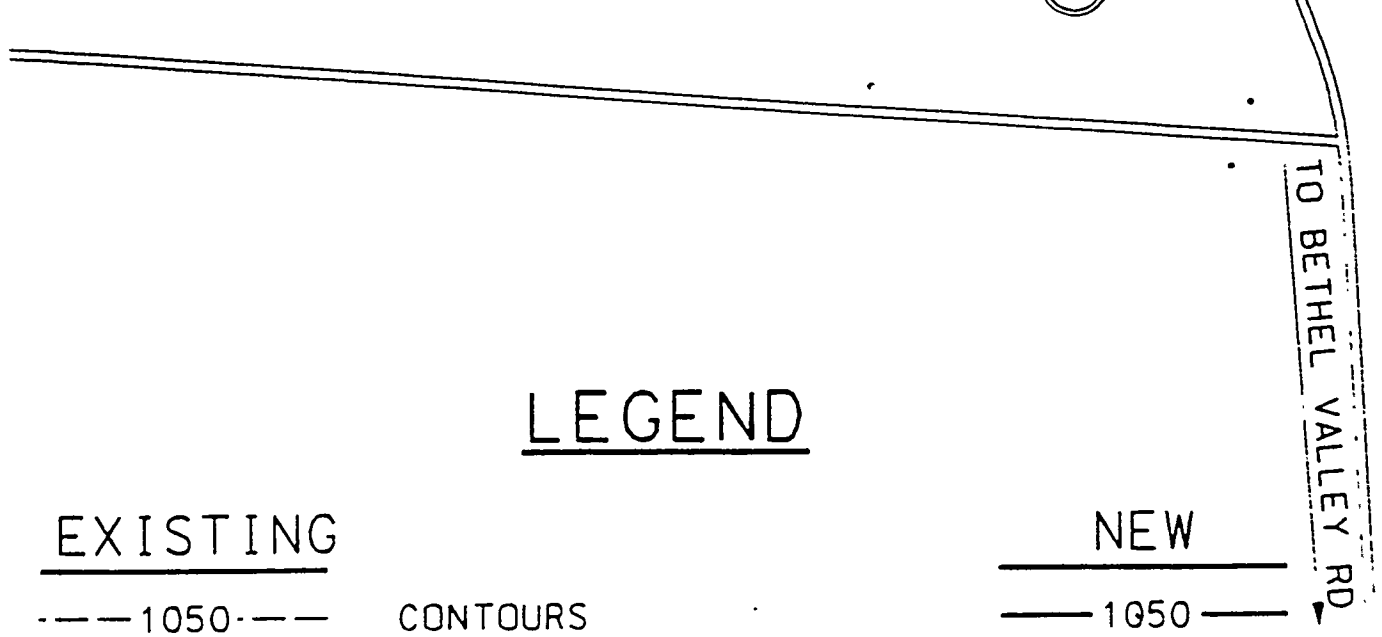
SS-3

NA

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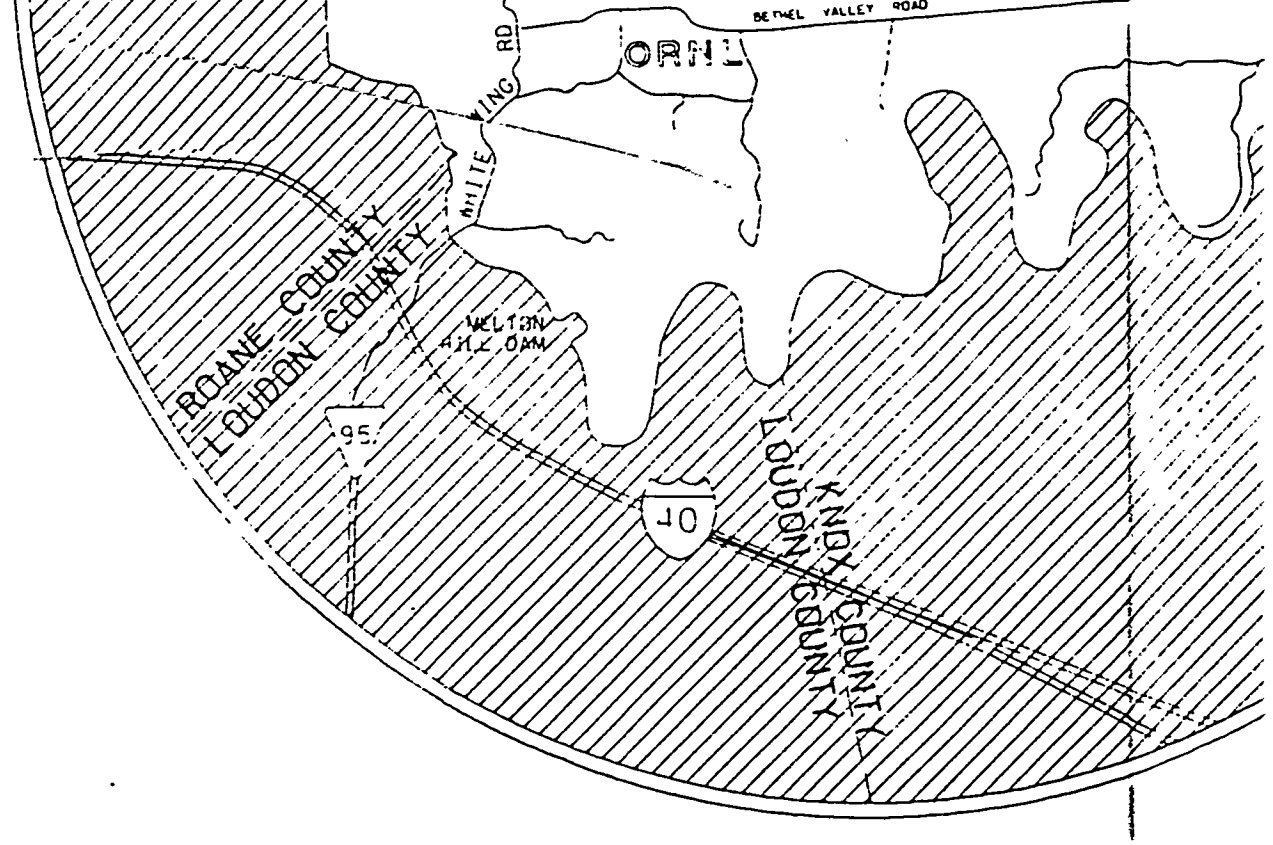
LEGEND

EXISTING		NEW
---1050---	CONTOURS	——1050——
- - - - - - - - - - - -	GRAVEL ROAD	- - - - - - - - - - - -
————	CULVERT WITHOUT HEADWALL	————
—SD-15"—	STORM SEWER	—— SD ——
—LC-6"—	LEACHATE COLLECTION PIPE	—LC-6"—
— OE —	OVERHEAD ELECTRIC	NA
— SW-12 —	SANITARY WATER	NA
— SS-3" —	SANITARY SEWER	NA
NA	CONTRACTOR'S ACCESS ROUTE	
	BUILDING	NA
— · —— —	DITCH CENTERLINE	
NA	BERM CHANNEL	
NA	PARKING AREA	
NA	CONTRACTOR'S WORK AND STORAGE AREA	
●	PERIMETER GAS VENT	NA
C	LEACHATE MANHOLE	●

E

D

C



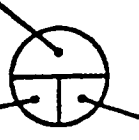
LOCATION PLAN

NOT TO SCALE

FOR PERMIT USE ONLY

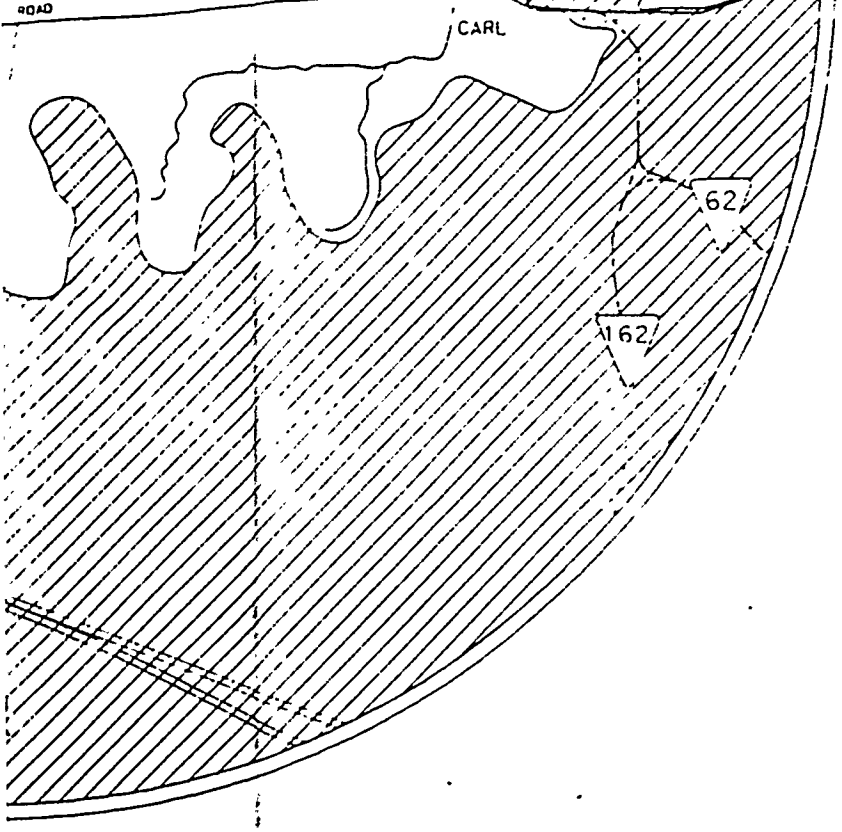
Document Rev. No.:
EG-C-37 Review By
Guideline Documer
UCN-19586 (12356

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SECTION AND DETAIL KEY

C
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C2E90000C
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N PLAN

SCALE

ocument Rev. No.: ___ Date: _____
G-C-37 Review By: _____
uideline Document: _____
CN-19586 (12356 4-93)

DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

DETAIL KEY

THIS DOCUMENT CONTROLLED BY

CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DES
1				ISSUE FOR PERM

REVISION OF

900000A703	1	PERMIT PA
900000A627	2	TOTAL SIT
900000A925	0	AREA 2 PA
900000A926	0	AREA 3 PA
900000A630	2	FINAL CLC
900000A631	2	LANDFILL
900000A632	2	LANDFILL
900000A633	2	LANDFILL
900000A634	2	LANDFILL
900000A927	0	LEACHATE
900000A635	3	DETAILS -
900000A636	3	DETAILS -
900000A928	0	DETAILS -
900000A929	0	DETAILS -
900000A930	0	DETAILS -
900000A931	0	DETAILS -

NOTE:

DRAWINGS C2E900000A637 (DETAILS III) AND C2E900000A638 (DETAILS
WERE ORIGINALLY ISSUED BY BURNS AND McDONNELL AND HAVE NOT BEEN

DESCRIPTION	BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE
PERMITTING	JLA	WPT	—	[illegible]	8/19/95				[illegible]	8/28/95

VISION OR ISSUE PURPOSE — REVISION APPROVALS

TITLE

PERMIT PACKAGE ACCESS PLAN AND DRAWING INDEX
TOTAL SITE DEVELOPMENT AND EXCAVATION PLAN
AREA 2 PARTIAL PLAN PROTECTIVE SOIL COVER
AREA 3 PARTIAL PLAN PROTECTIVE SOIL COVER
FINAL CLOSURE PLAN
LANDFILL CROSS SECTIONS - I
LANDFILL CROSS SECTIONS - II
LANDFILL CROSS SECTIONS - III
LANDFILL CROSS SECTIONS - IV
LEACHATE SEWER PROFILES AREAS 2 & 3
DETAILS - I
DETAILS - II
DETAILS - V
DETAILS - VI
DETAILS - VII
DETAILS - VIII

THIS DRAWING WAS ORIGINALLY ISSUED FOR
(REV. 0) BY BURNS AND McDONNELL, KANSA
DATED 1/25/92, AND WAS PART OF A LANDF
FOR THE Y-12 INDUSTRIAL LANDFILL V.
SUPERCEDES THE ORIGINAL DRAWING, AND R
MADE TO REFLECT ADDITIONAL LANDFILL DE
FOR COMPLIANCE WITH TDEC REGULATORY CH

(DETAILS IV)
NOT BEEN REVISED.

1 GENERAL REVISION
REVISED THE FOLLOWING:
SITE ACCESS PLAN
LEGEND
DRAWING INDEX

THE ORIG
THEREOF,
AND WITH
MAINTAIN

MMES	DATE	RPE	RPE NO	DATE			QA	DATE	ST	CV	EC	EE	EM	IE	M	PD
DRA	8/28/95	WPT	22511	9/19/95					—	DRL	—	—	—	—	—	—

NA

NA

NA

LY ISSUED FOR PERMITTING/CFC
)ONNELL, KANSAS CITY, MISSOURI.
(RT OF A LANDFILL PERMIT PACKAGE
,ANDFILL V. THIS DRAWING
)RAWING, AND REVISIONS ARE BEING
(L LANDFILL DEVELOPMENT, AND
REGULATORY CHANGES.

NA

1050.22

SB22

NA

WING:

NA

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, DATES AND WITH THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES.

GW-797

NA

							RPE		
							WILLIAM PATRICK TAYLOR REGISTERED ENGINEER AGRICULTURE STATE OF TENNESSEE	DSGN	8/19/95
								DRW	8/19/95
								CHKR WP Taylor	8/19/95
								SECT —	
								DEPT	8/17/95
								PE	
								PJ	8/29/95
								REQ	
—	—	—	—	—	—	—			
M	IE	M	PD	SE	ARC	VER	REV. 0 DATE 8/19/95	MMES	

SQUAD CHECK

NA	CONTRACTOR'S WORK AND STORAGE AREA	
●	PERIMETER GAS VENT	NA
○	LEACHATE MANHOLE	●
═	AREA INLET	▬
○	CLEANOUT	•
----------	ROAD ℄	NA
NA	AREA BOUNDARY/BREAKLINE	----------
NA	WASTE LIMIT	.....
	RIP-RAP	NA
×1050.22	SPOT ELEVATION	•1050.22
◎SB22	SOIL BORING	NA
NA	COVER GAS VENT	◉
NA	CLAY SOIL COVER	
NA	PIEZOMETER	◓PZ22
◎ GW-797	MONITORING WELL	NA
NA	VALVE	⋈

C2E900000A703

	8/19/95
	8/19/95
	8/19/95
	8/17/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

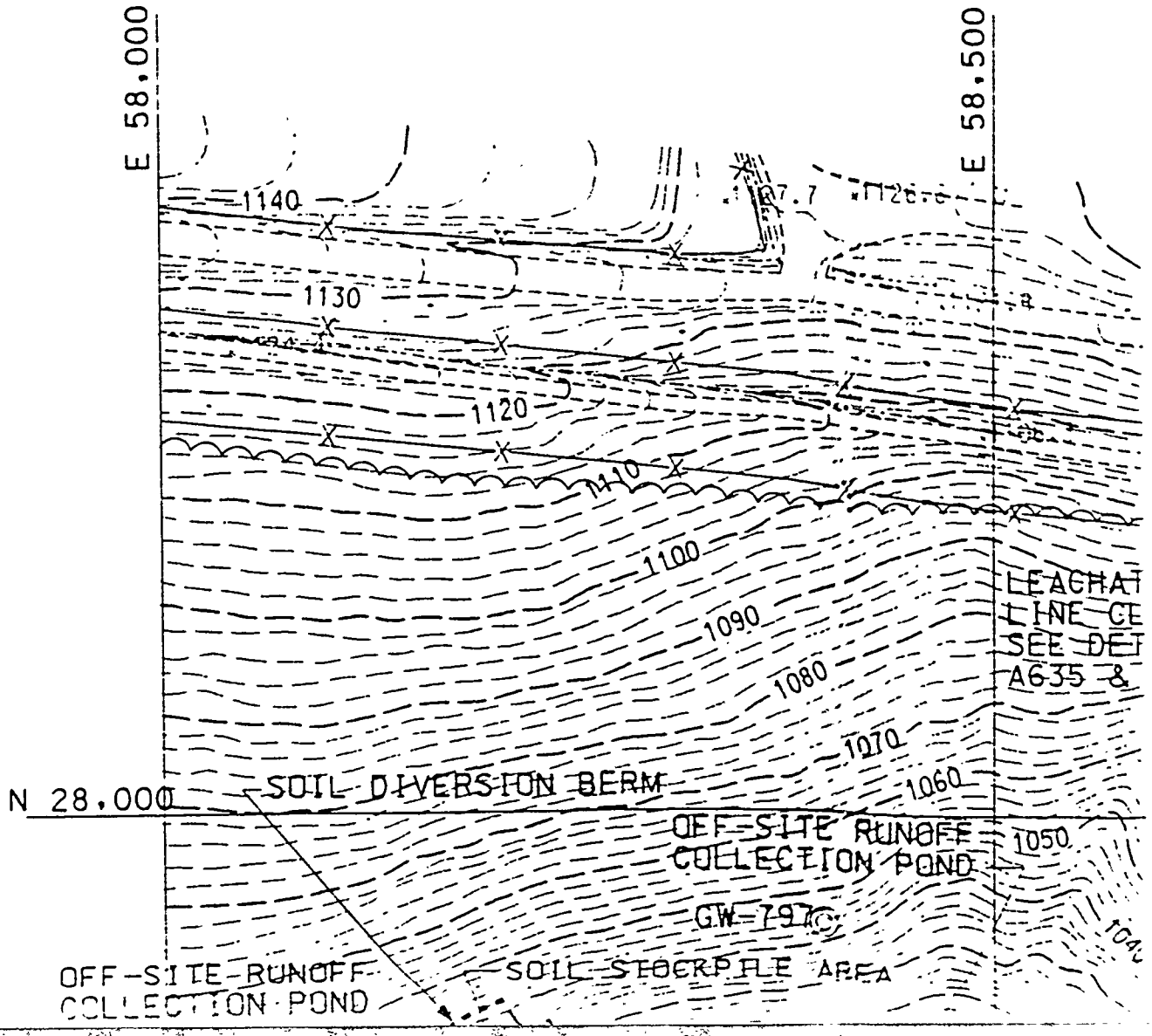
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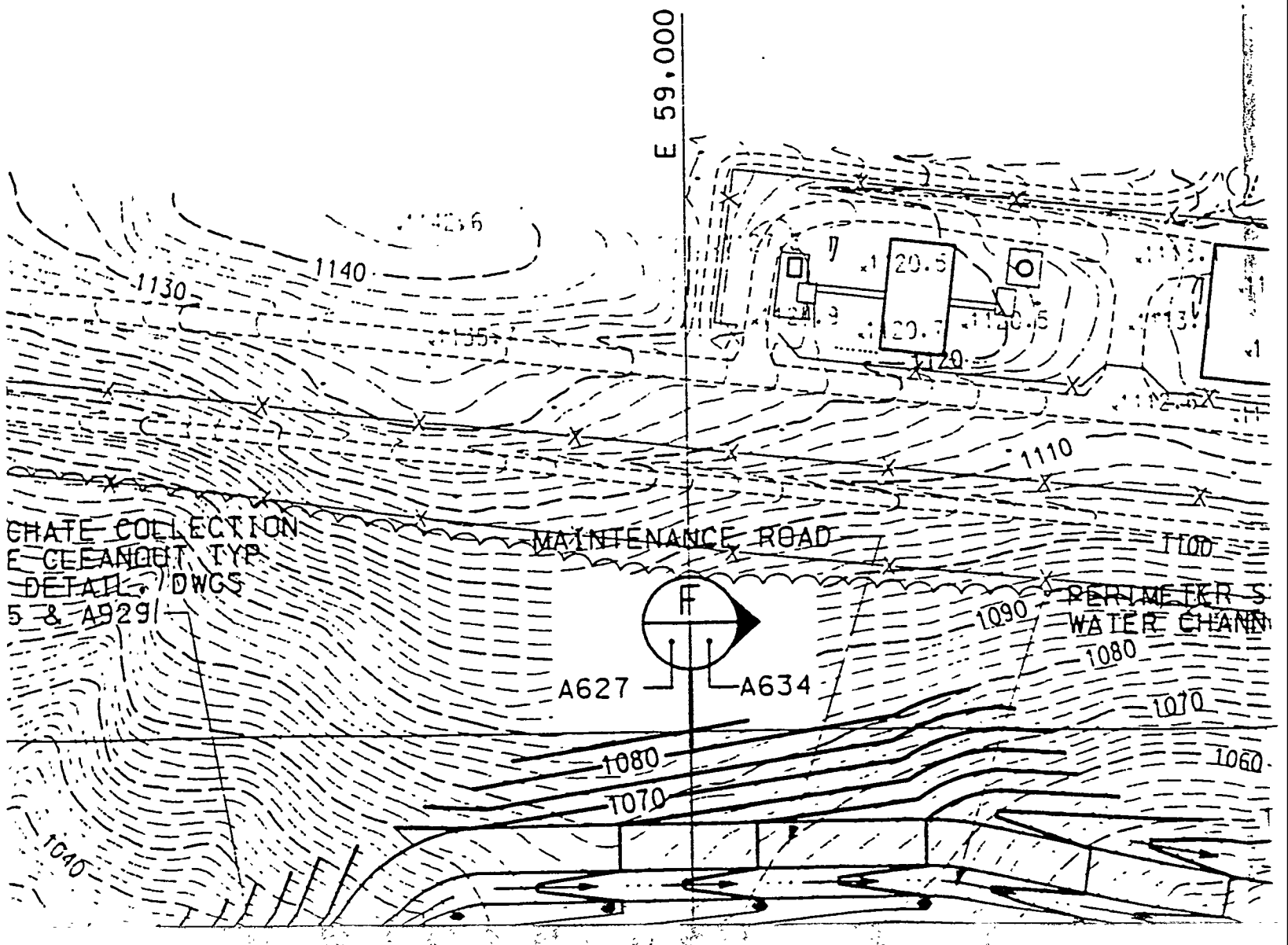
Y-12 INDUSTRIAL LANDFILL V

PERMIT PACKAGE ACCESS PLAN AND DRAWING INDEX

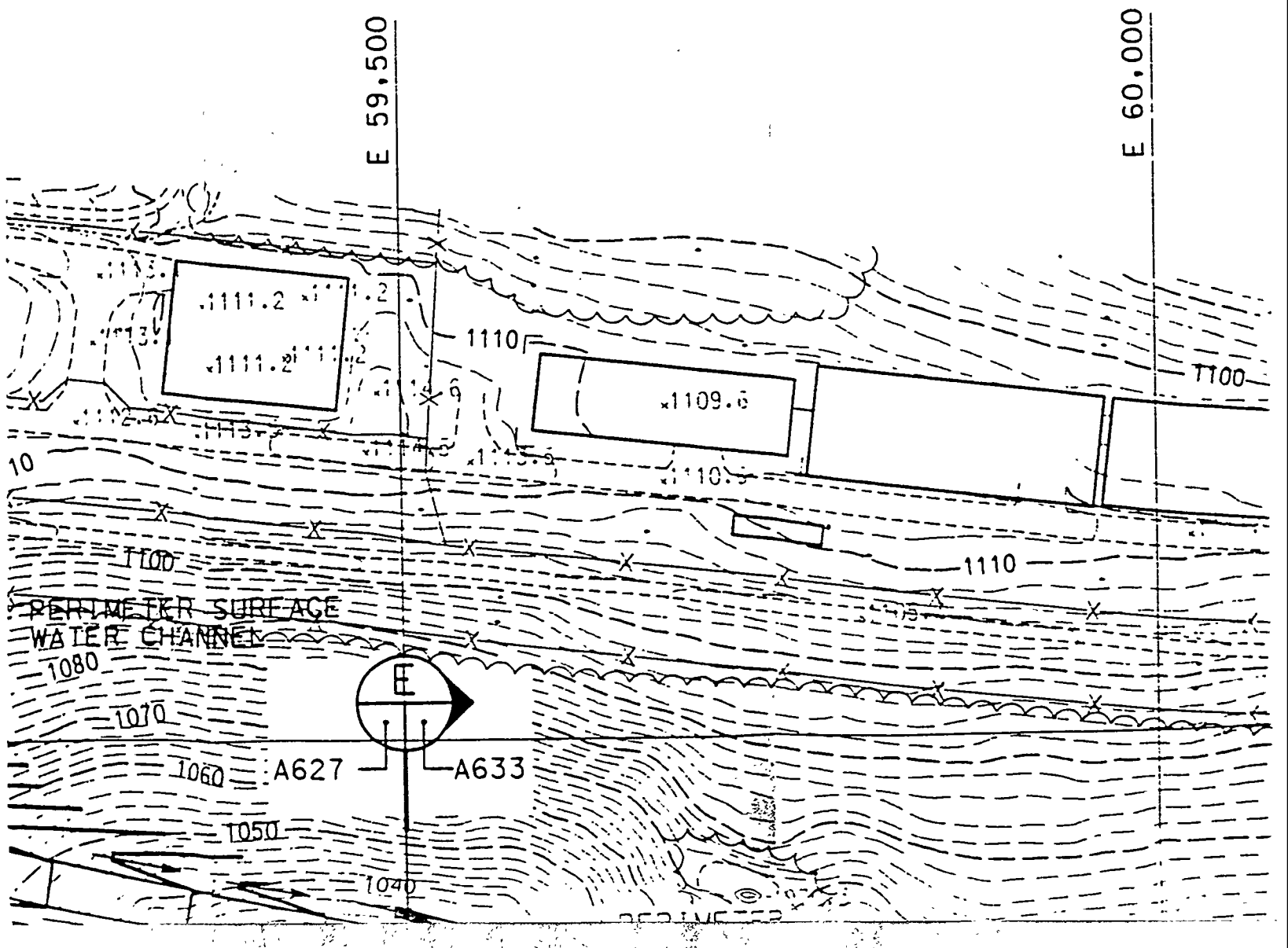
1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	A	Y-12	YAREA	A	1	1	P	U
51		52		53	C2E900000A703					REV

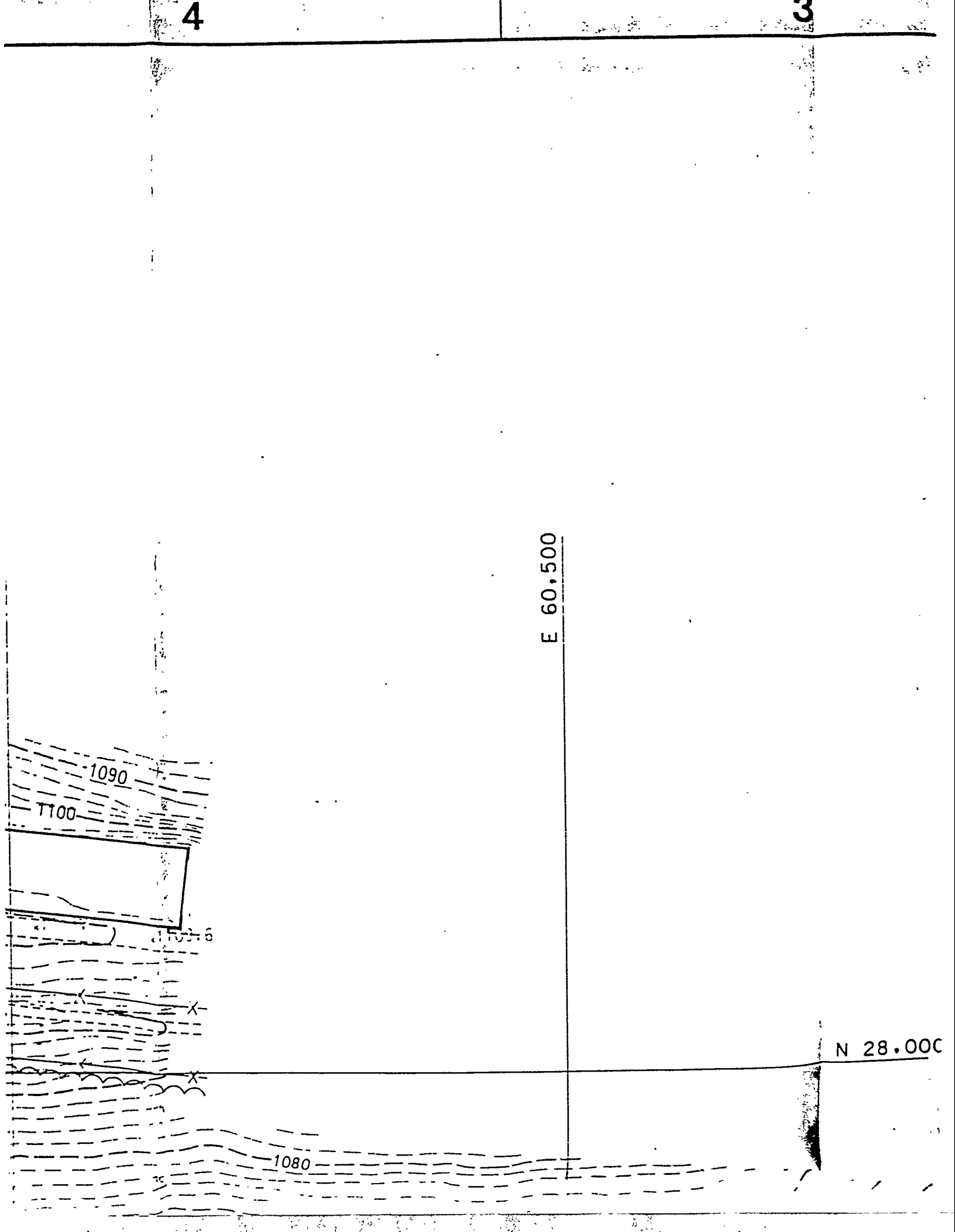

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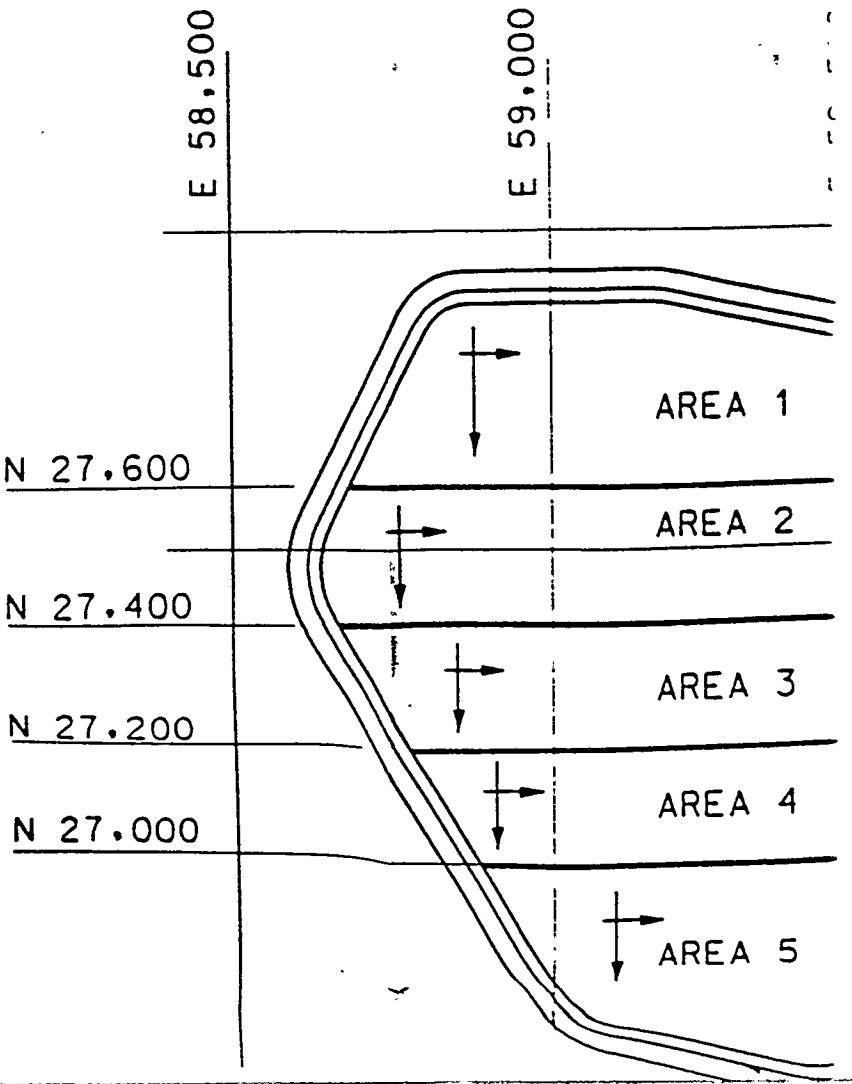

E 58,000
E 58,500
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
LEACHAT
LINE CE
SEE DET
A635 &
N 28,000
SOIL DIVERSION BERM
OFF-SITE RUNOFF
COLLECTION POND
GW-19
OFF-SITE RUNOFF
COLLECTION POND
SOIL STOCKPILE AREA


E 59,000
1140
1130
1110
1100
1090
1080
1070
1060
1040
MAINTENANCE ROAD
A627
A634
CHUTE COLLECTION
E CLEANOUT TYP
DETAIL, / DWGS
5 & A929
PERIMETER S
WATER CHANN

5


E 59,500
E 60,000
1110
1100
1109.6
1110
1100
PERIMETER SURFACE
WATER CHANNEL
1080
1070
1060
1050
1040
A627
A633


4
3
E 60,500
1090
1100
N 28.000
1080


E 58.500
E 59.000
AREA 1
AREA 2
AREA 3
AREA 4
AREA 5
N 27.600
N 27.400
N 27.200
N 27.000

N 28.000

NEXT ASS'Y:

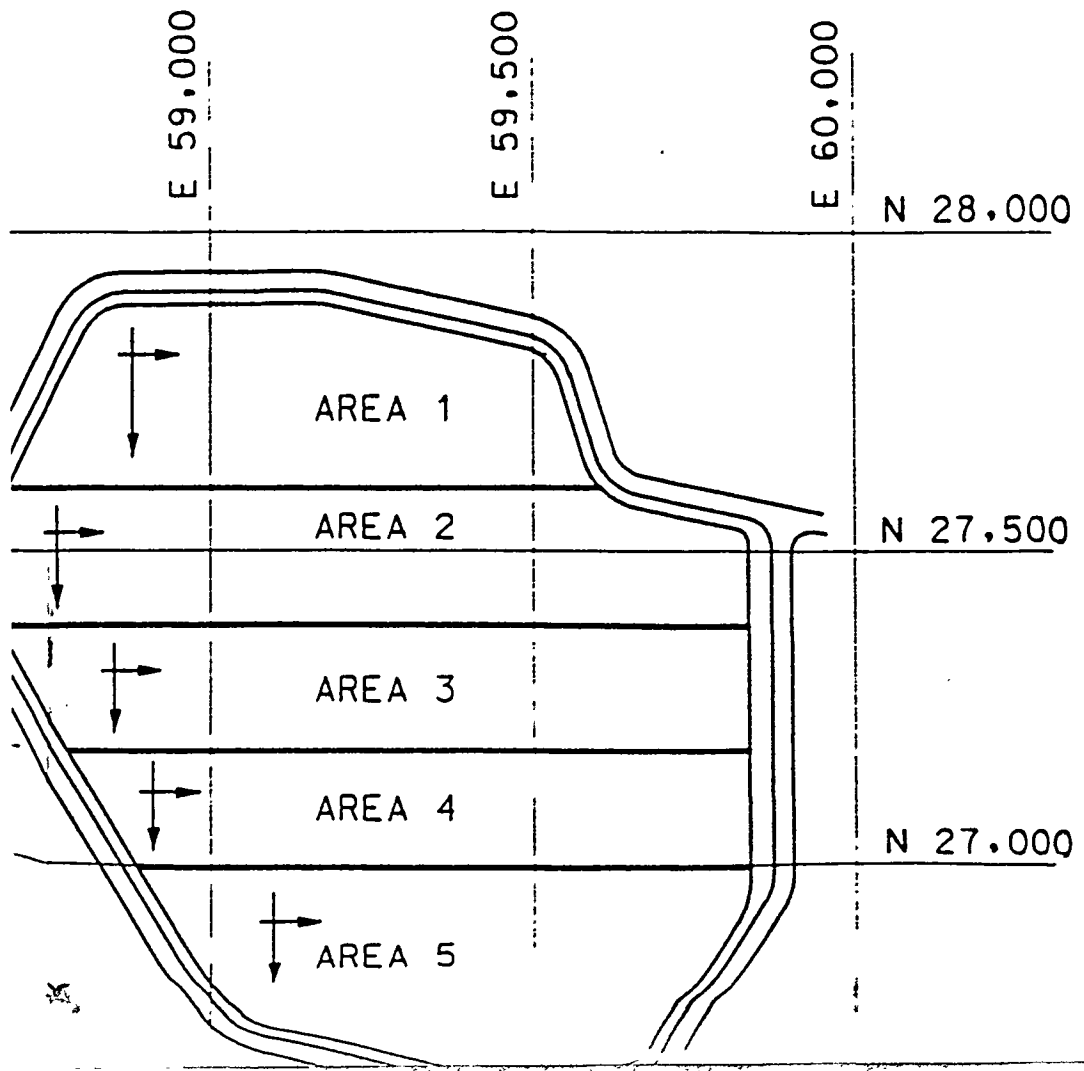
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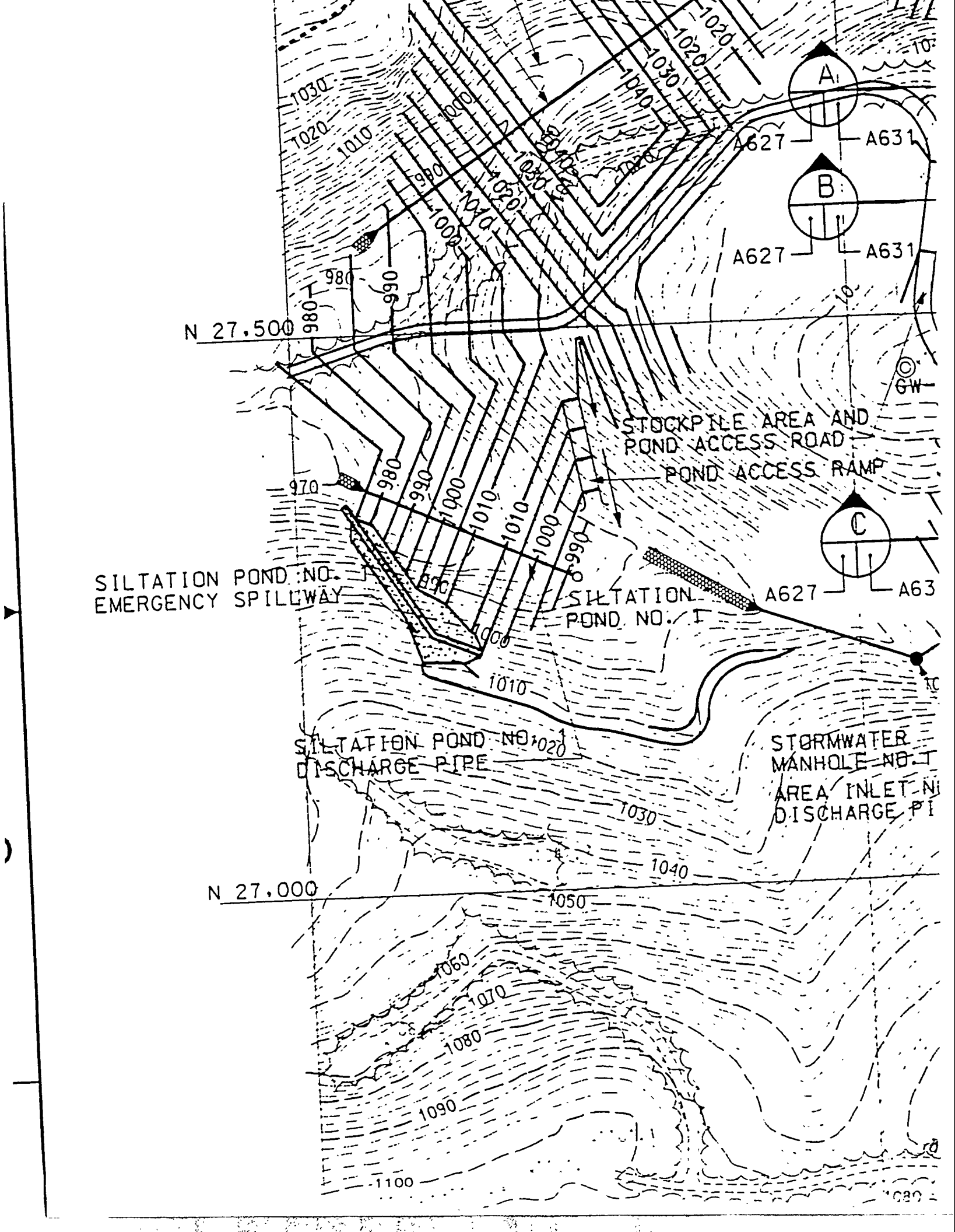
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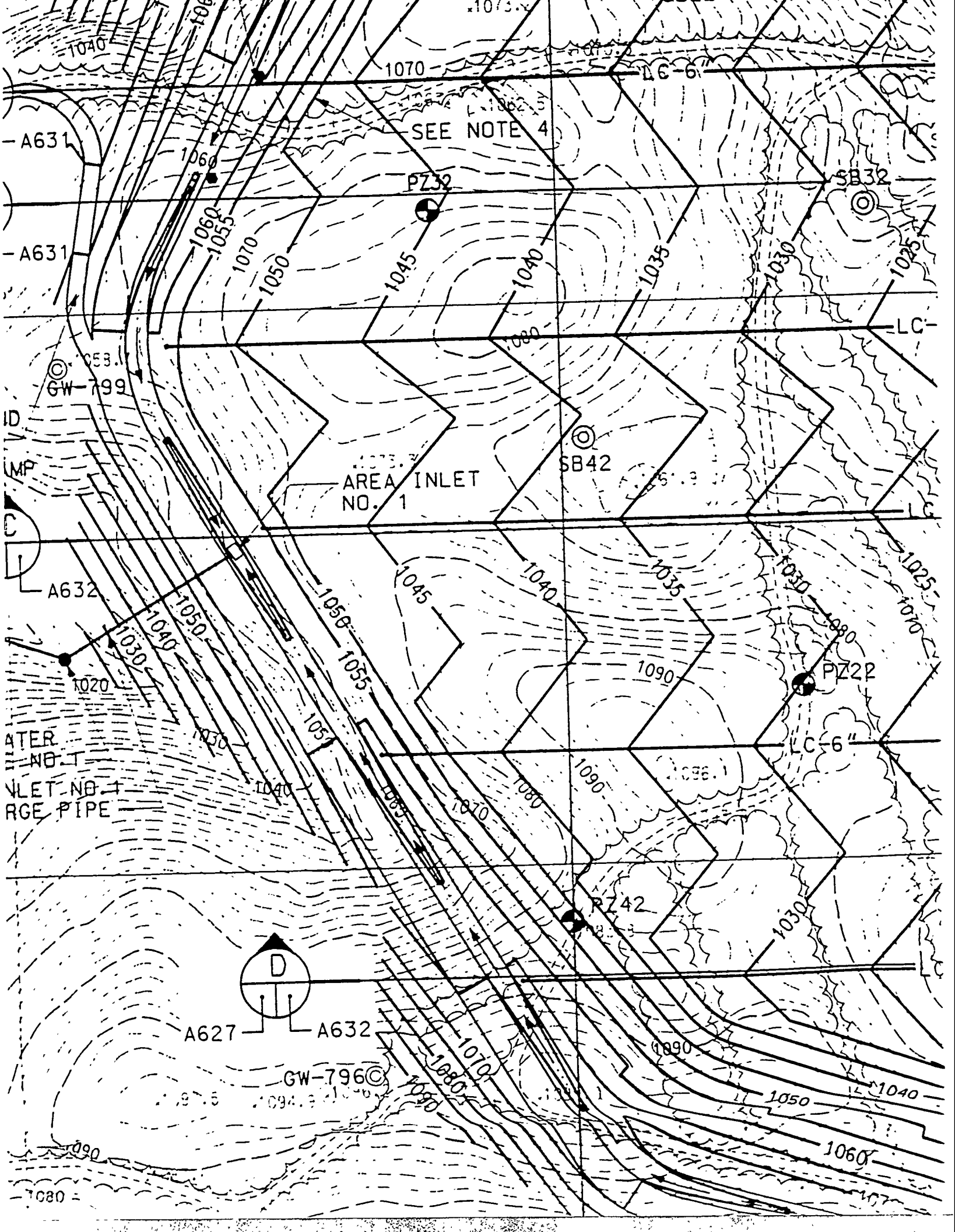
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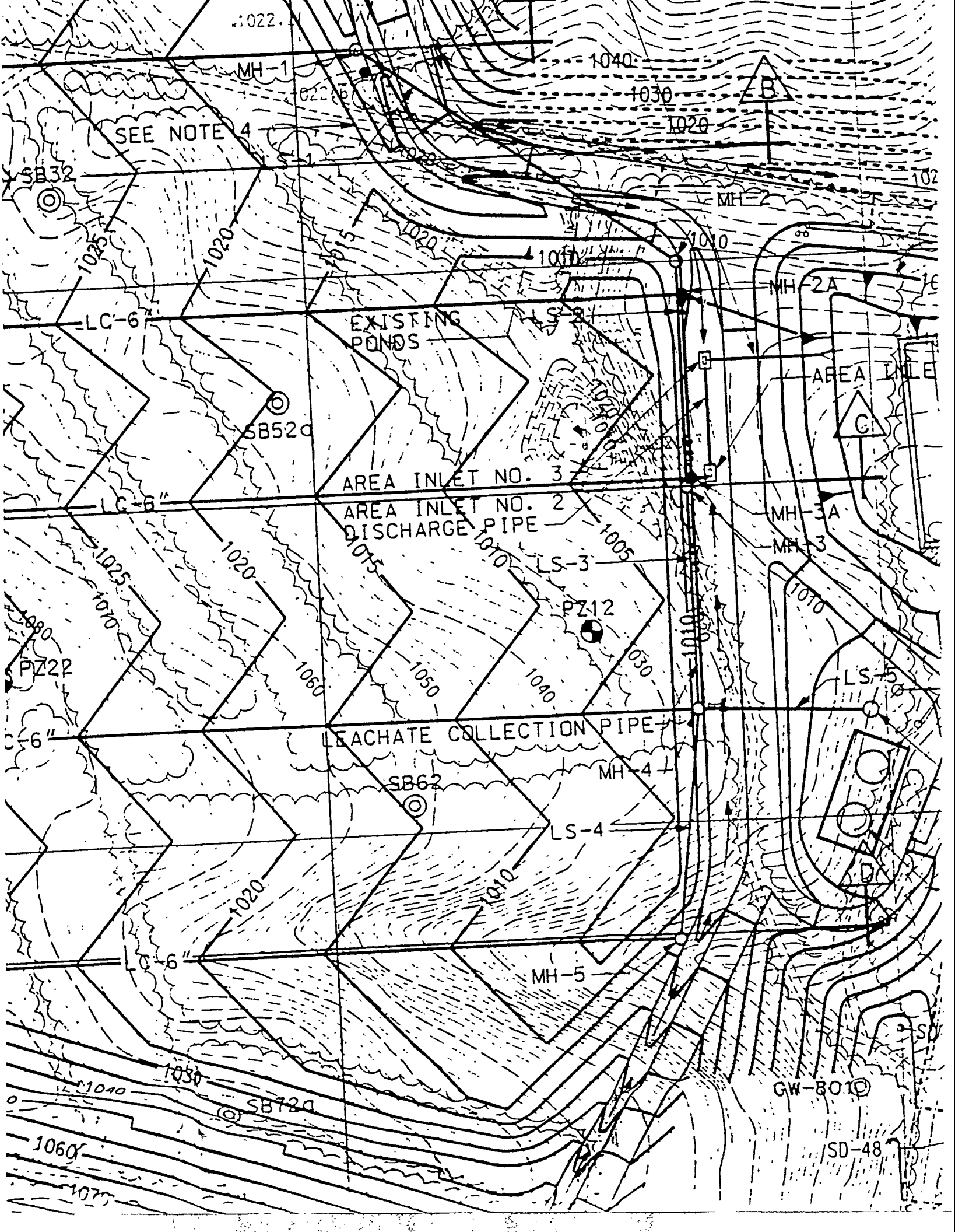
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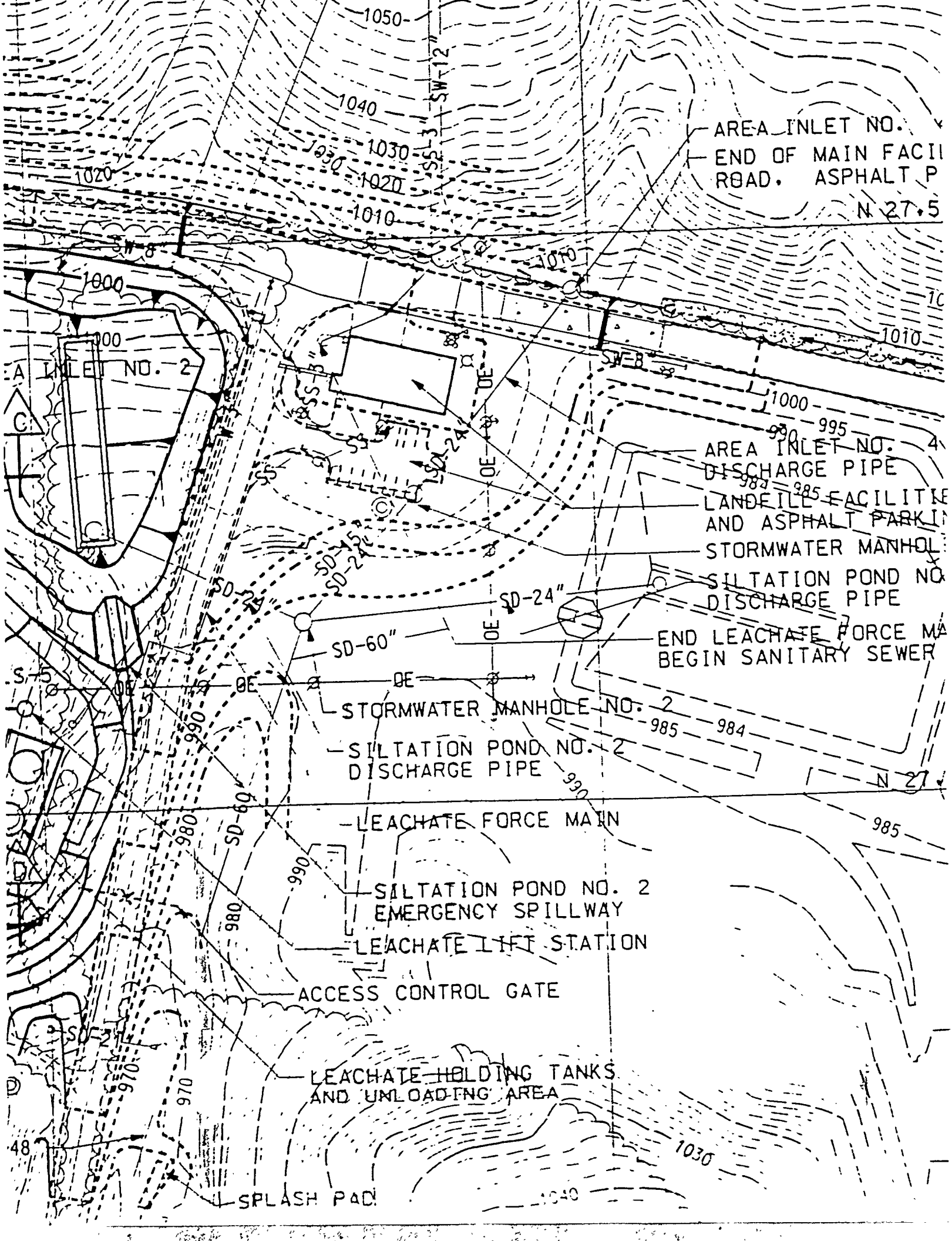
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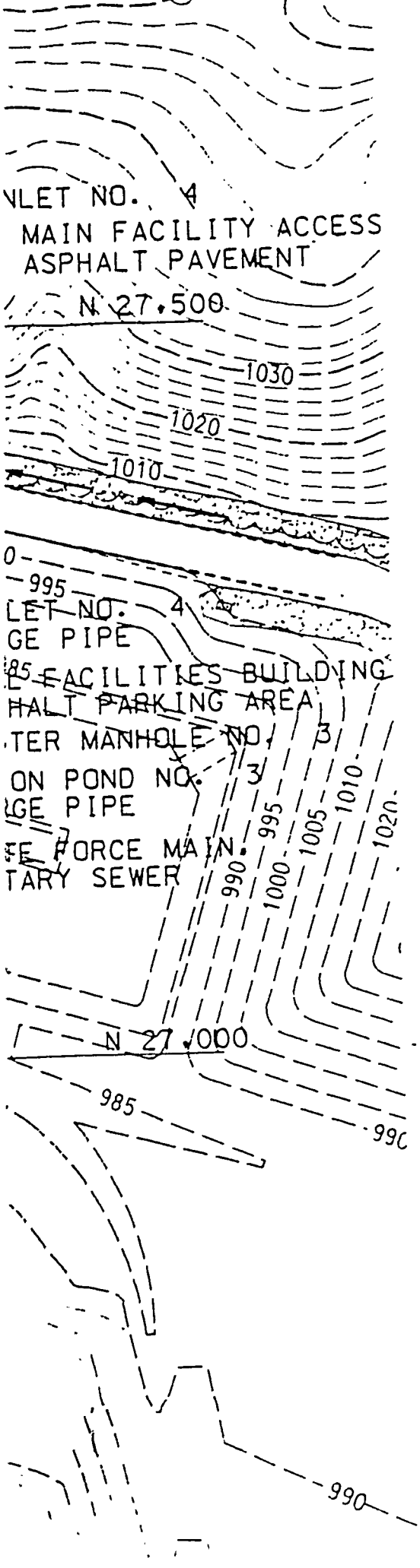



N 27,500
N 27,000
STOCKPILE AREA AND
POND ACCESS ROAD
POND ACCESS RAMP
SILTATION POND NO. 1
EMERGENCY SPILLWAY
SILTATION
POND NO. 1
SILTATION POND NO. 1
DISCHARGE PIPE
STORMWATER
MANHOLE NO. 1
AREA INLET NO
DISCHARGE PI
A627
A631
A63
GW
970
980
990
1000
1010
1020
1030
1040
1050
1060
1070
1080
1090
1100


SEE NOTE 4
PZ32
SB32
SB42
AREA INLET
NO. 1
PZ22
PZ42
GW-799
GW-796
A631
A631
A632
A632
A627
LC-6"
LC-6"
LC
1070
1060
1055
1050
1045
1040
1035
1030
1025
1080
1090
1020
D


MH-1
SEE NOTE 4
SB32
1040
1030
1020
B
MH-2
1010
MH-2A
LC-6"
EXISTING PONDS
LS-2
AREA INLE
C
SB52
AREA INLET NO. 3
AREA INLET NO. 2 DISCHARGE PIPE
MH-3A
MH-3
LS-3
PZ12
PZ22
LS-5
LEACHATE COLLECTION PIPE
MH-4
SB62
LS-4
D
MH-5
SB72
GW-801
SD-48
1025
1020
1015
1010
1005
1030
1040
1050
1060
1070
1080


AREA INLET NO.
END OF MAIN FACI
ROAD. ASPHALT P
N 27.5
AREA INLET NO. 2
AREA INLET NO.
DISCHARGE PIPE
LANDFILL FACILITIE
AND ASPHALT PARKI
STORMWATER MANHOL
SILTATION POND NO
DISCHARGE PIPE
END LEACHATE FORCE MA
BEGIN SANITARY SEWER
STORMWATER MANHOLE NO. 2
SILTATION POND NO. 2
DISCHARGE PIPE
LEACHATE FORCE MAIN
SILTATION POND NO. 2
EMERGENCY SPILLWAY
LEACHATE LIFT STATION
ACCESS CONTROL GATE
LEACHATE HOLDING TANKS
AND UNLOADING AREA
SPLASH PAD
SD-24"
SD-60"
SD-15"
SW-8
SW-12"
SS-3
OE
1050
1040
1030
1020
1010
1000
995
990
985
984
980
970



DEVELOPMEN

(FOR REFERI
NOT TO

RC

LIFT PROGRE

NOTES:

1. THIS DRAWING REPRESEN
ENTIRE LANDFILL OVER
AND IS TO BE USED FOF

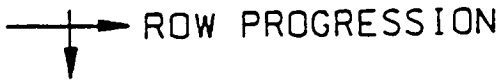
2. FOR WASTE PLACEMENT E
CROSS-SECTIONS. DWGS

3. CONTOURS SHOWN ON TH
OF EXCAVATION ELEVAT
AREAS. LINER AND LEA
WILL BE CONSTRUCTED

4. TRANSITION SLOPE FRO
3.5H:1V IN AREA 2.
WILL BE 3.5H:1V.

DEVELOPMENT SEQUENCE

(FOR REFERENCE ONLY)
NOT TO SCALE



LIFT PROGRESSION

S:

IIS DRAWING REPRESENTS DEVELOPMENT OF THE
ITIRE LANDFILL OVER THE LIFE OF THE FACILITY
ID IS TO BE USED FOR REFERENCE ONLY.

IR WASTE PLACEMENT ELEVATIONS AND SLOPES, SEE
IOSS-SECTIONS, DWGS C2E900000A631 - C2E900000A634.

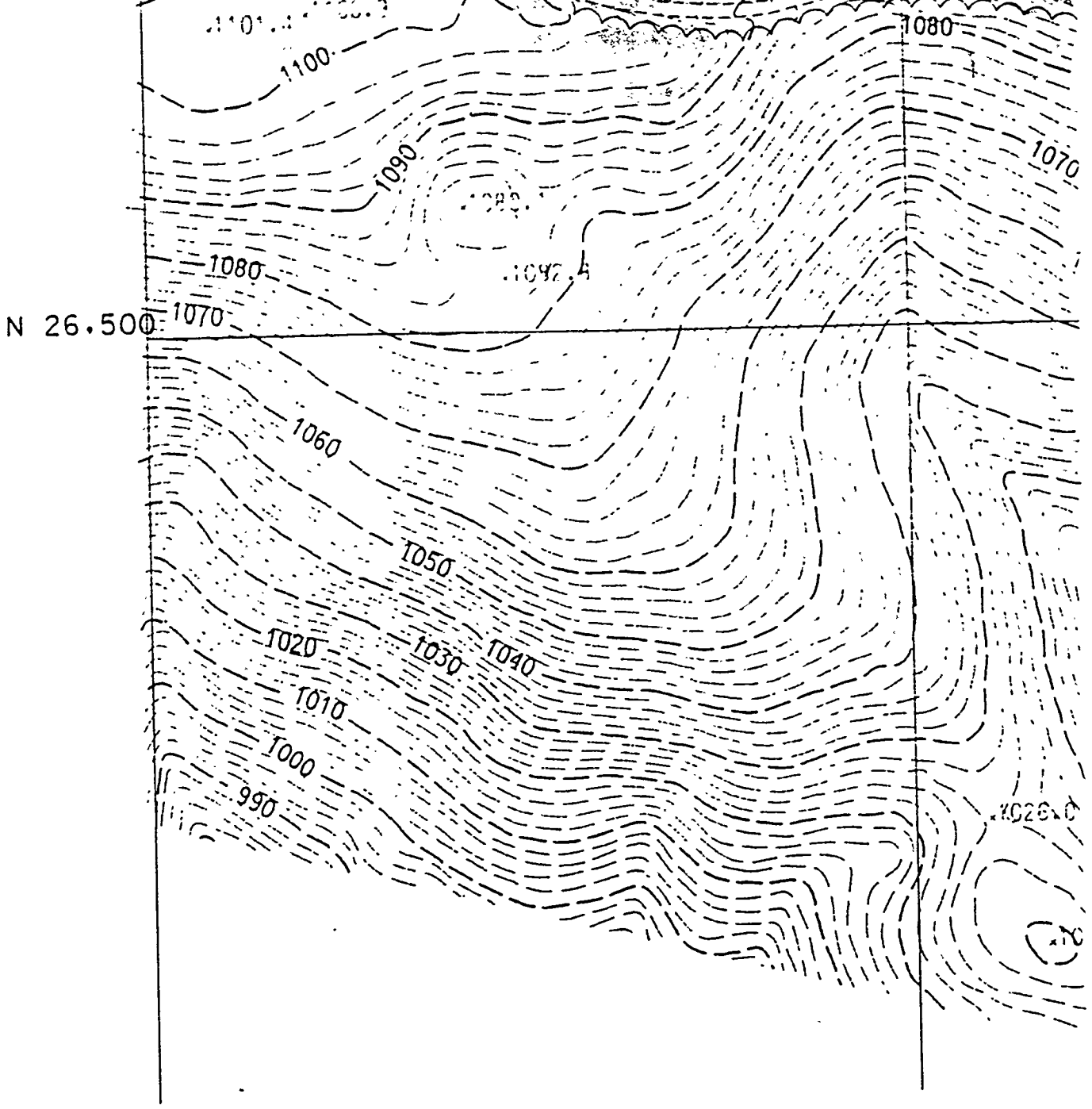
)NTOURS SHOWN ON THIS DRAWING ARE BOTTOM
' EXCAVATION ELEVATION. IN WASTE DISPOSAL
IEAS, LINER AND LEACHATE COLLECTION SYSTEM
'LL BE CONSTRUCTED ABOVE ELEVATIONS SHOWN.

IANSITION SLOPE FROM 3H:1V AT AREA 1 TO
5H:1V IN AREA 2. SIDE SLOPES IN AREAS 2-5
ILL BE 3.5H:1V.

E

D

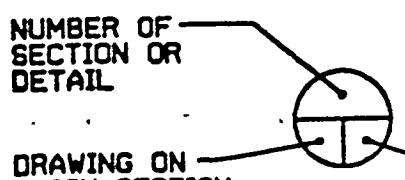
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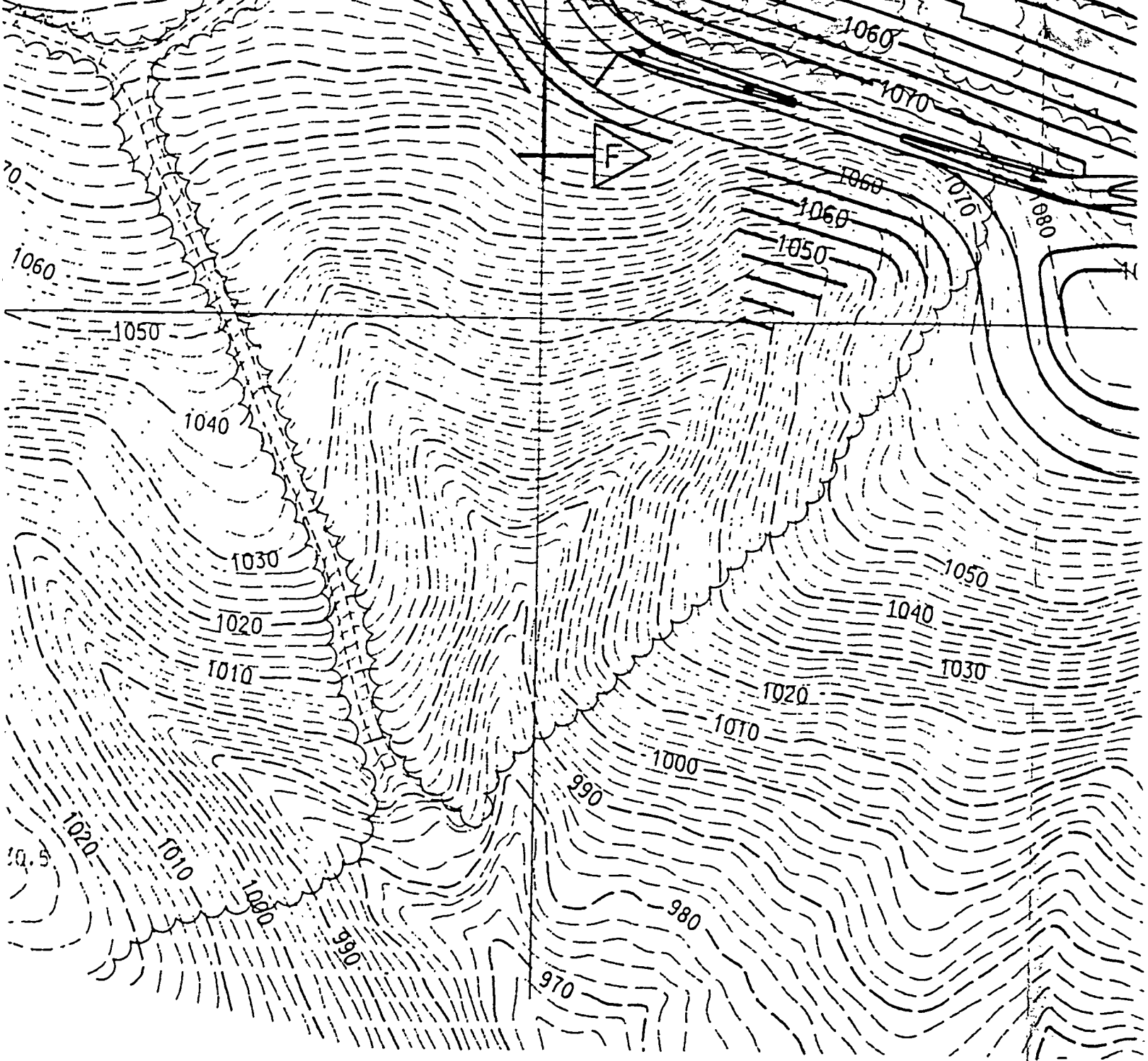
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EG-C-37 Review E
Guideline Docume
UCN-19586 (12356

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) BE USED FOR OTHER PURPOSES AND ARE TO BE RETURNED UPON
QUEST OF THE FORWARDING CONTRACTOR.



SECTION AND DETAIL KEY



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ıt: _____

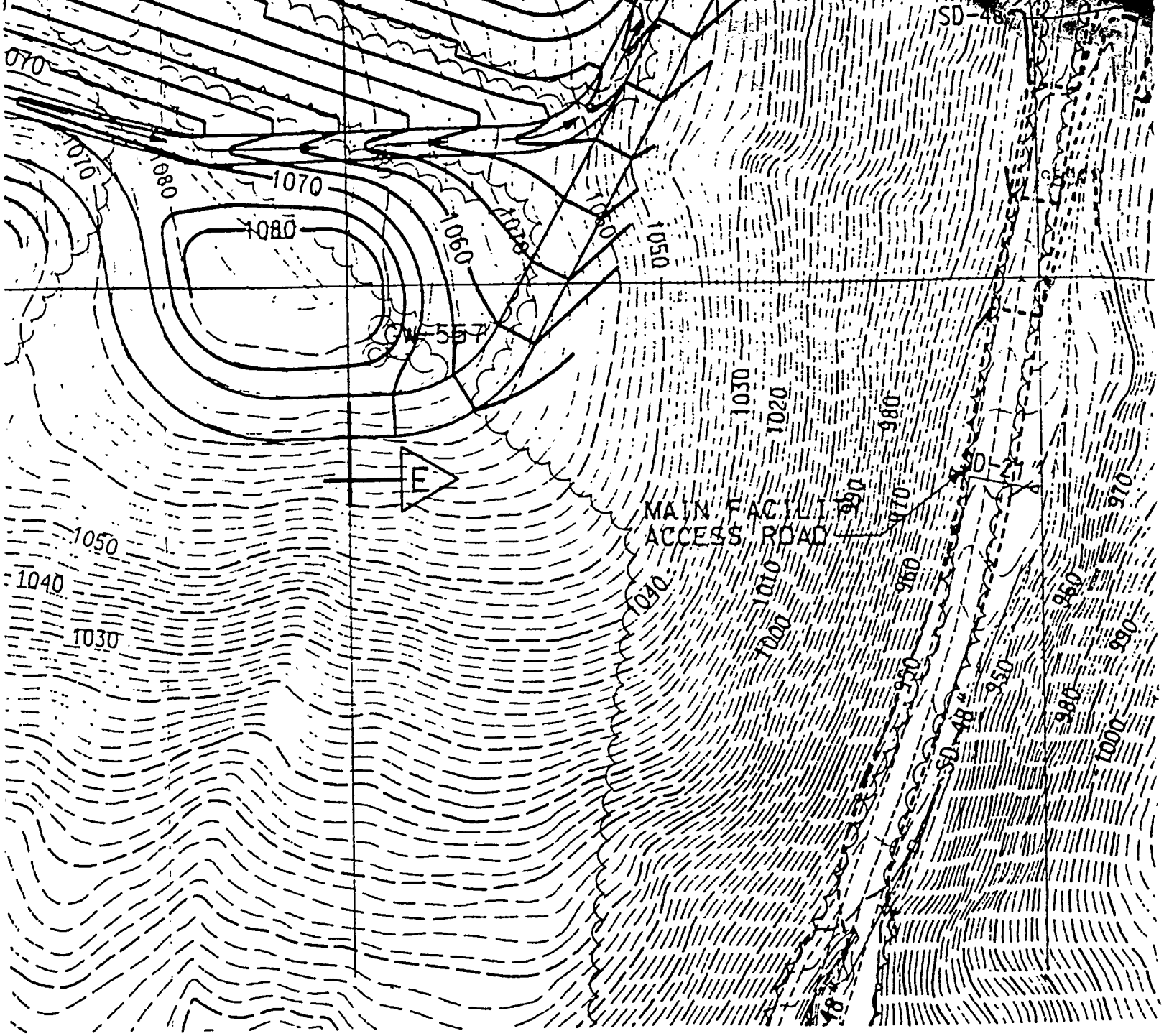
4-93)

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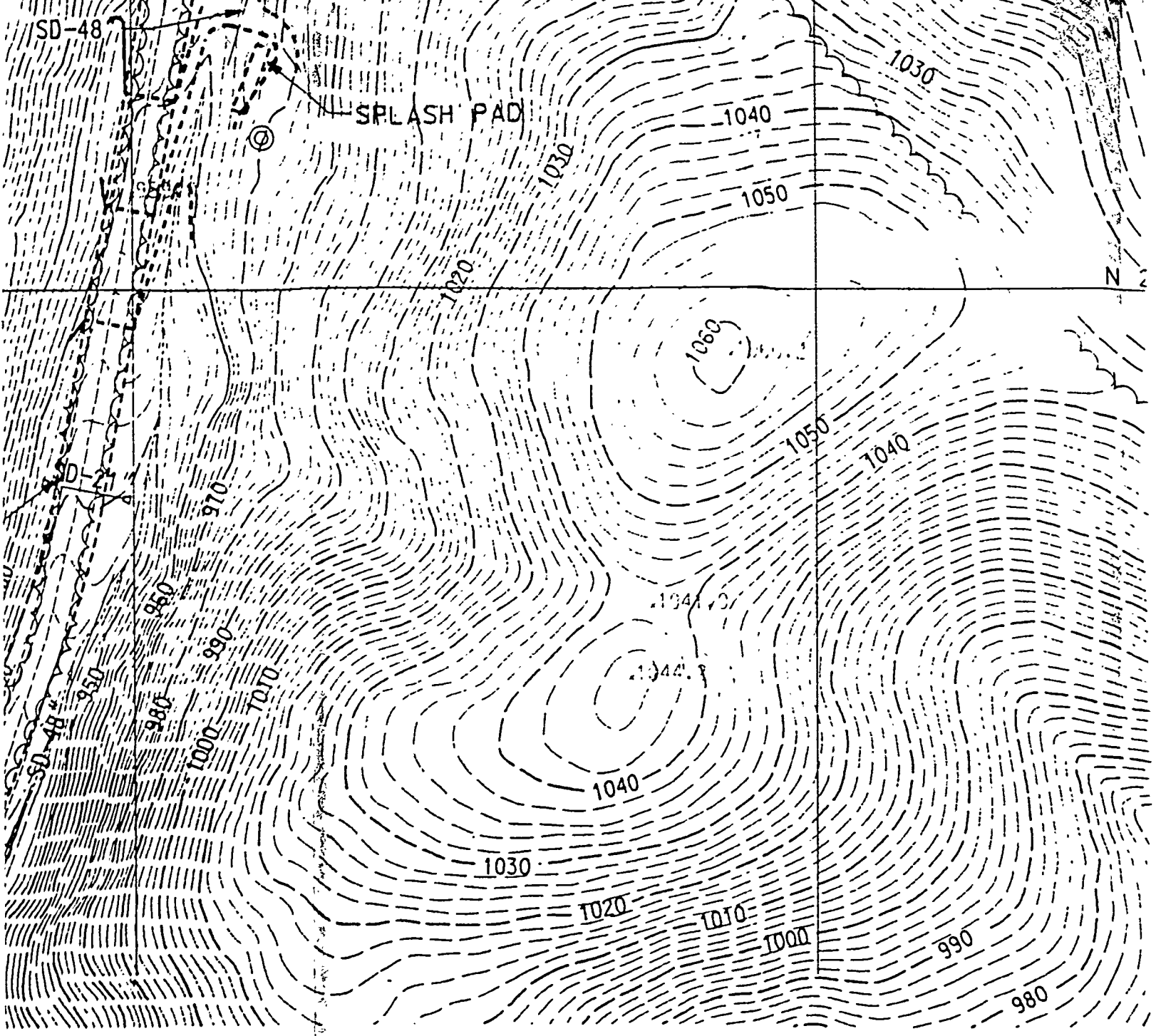
'HANGE CONTROL YSTEM 2

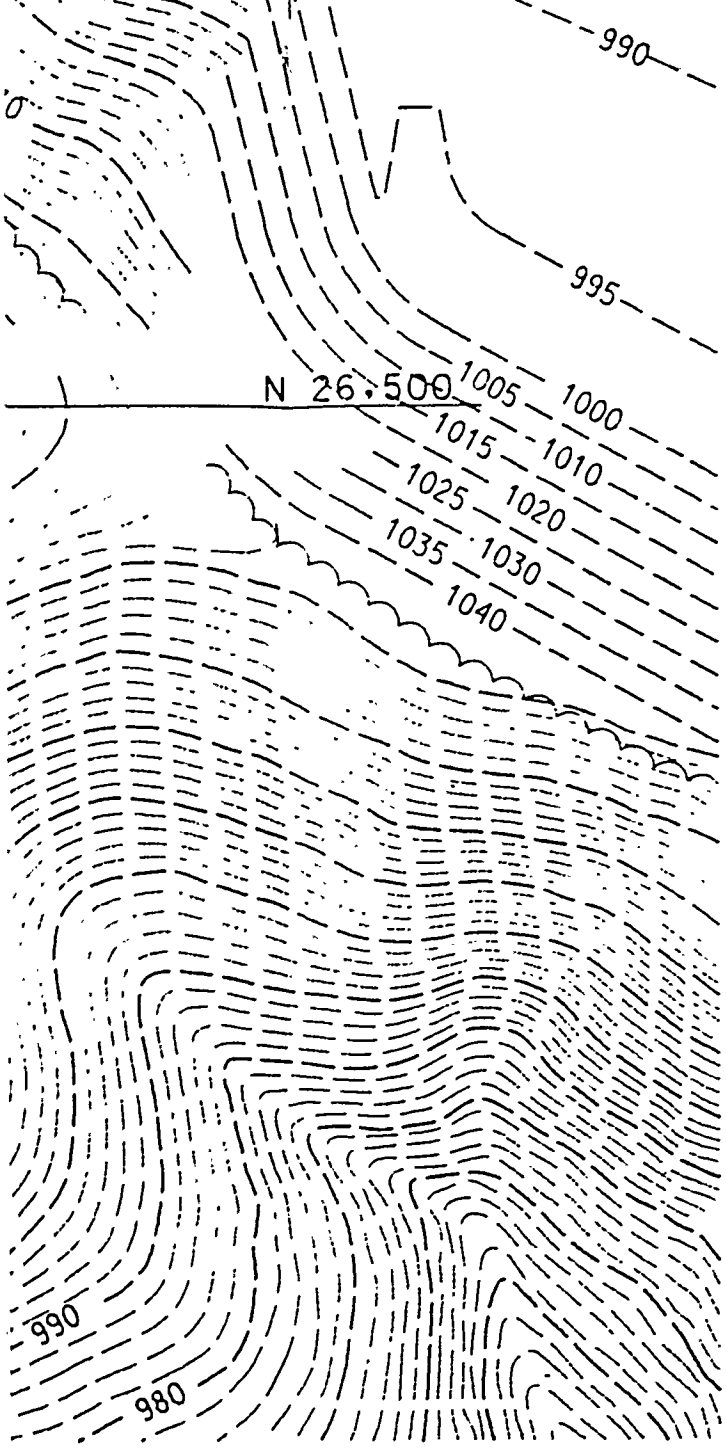
NGINEERING ROCEDURE EP-C-18

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION
2				ISSUE FOR PERMITTING



ITTING	JCA	WPT	WPT		8/19/95						
SCRIPTION	BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RPE
R ISSUE PURPOSE	REVISION APPROVALS										


SD-48
SPLASH PAD
1030
1040
1050
1020
1060
1050
1040
1030
1020
1010
1000
990
980
970
960
950
940
SD-48
SD-21
N



THIS DRAWING WAS ORI
(REV. 0) BY BURNS AN
DATED 1/25/92, AND W
FOR THE Y-12 INDUSTR
SUPERCEDES THE ORIGI
MADE TO REFLECT ADDI
FOR COMPLIANCE WITH

THE ORIGINAL DRAWING AND SUBSEQUENT R
THEREOF, WITH APPROVAL NAMES, INITIAL
AND WITH THE PE SEAL, IF APPLICABLE,
MAINTAINED IN THE FILES.

							RPE	DSGN 8/19/
							WILLIAM PATRICK TAYLOR REGISTERED ENGINEER AGRICULTURE No. 22,[illegible] STATE OF TENNESSEE	DRW B. G. Ashworth 8/19/9
								CHKR W P Taylor 8/19/9
								SECT —
								DEPT 8/19/9
								PE
								PJ 8/28/9
								REQ
—	—	—	—	—	—	—		
EM	IE	M	PD	SE	ARC	VER	REV. 0 DATE 8/19/95	MMES
SQUAD CHECK							DRAWING APPROVALS	

AWING WAS ORIGINALLY ISSUED FOR PERMITTING/CFC
) BY BURNS AND McDONNELL, KANSAS CITY, MISSOURI,
/25/92, AND WAS PART OF A LANDFILL PERMIT PACKAGE
Y-12 INDUSTRIAL LANDFILL V. THIS DRAWING
DES THE ORIGINAL DRAWING, AND REVISIONS ARE BEING
REFLECT ADDITIONAL LANDFILL DEVELOPMENT, AND
PLIANCE WITH TDEC REGULATORY CHANGES.

2 GENERAL REVISION
REVISED THE FOLLOWING:
GRADING WITHIN LANDFILL BOUNDARY
ADDED MANHOLES 2A & 3A
REMOVED PERIMETER GAS VENTS IN AREAS 2-5
REVISED MONITORING WELL NUMBERS

SUBSEQUENT REVISIONS
AMES, INITIALS, DATES
APPLICABLE, ARE

100 0 100 200 300 FT
SCALE: 1"=100'

	8/19/95
Asbmith	8/19/95
Taylor	8/19/95
Crank	8/19/95
	8/24/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

TOTAL SITE DEVELOPMENT AND EXCAVATION PLAN

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	T	Y-12	YAREA	A	1	1	P	U

51	52	53		REV
NC	NA	AR	C2E900000A627	2

C2E900000A627

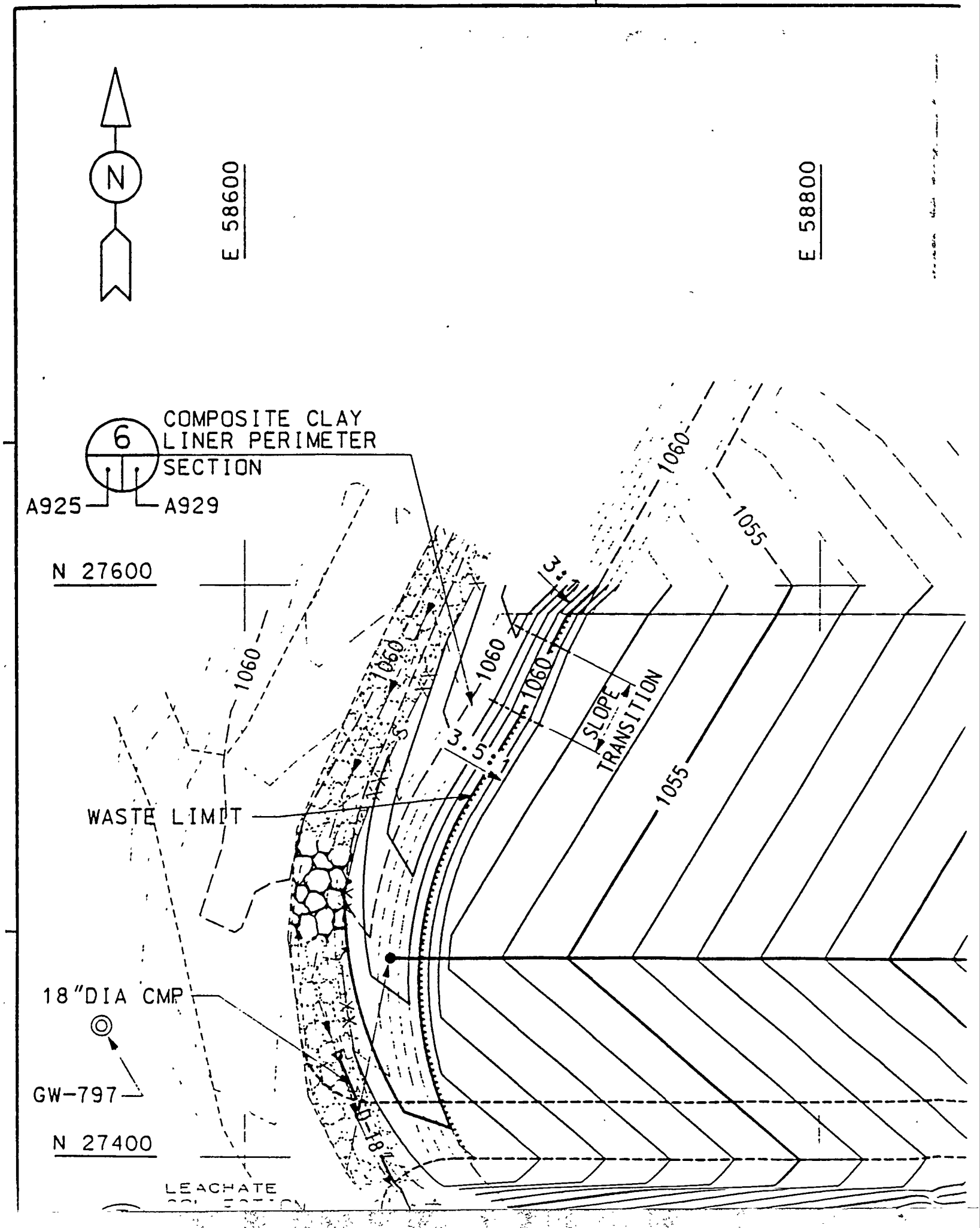
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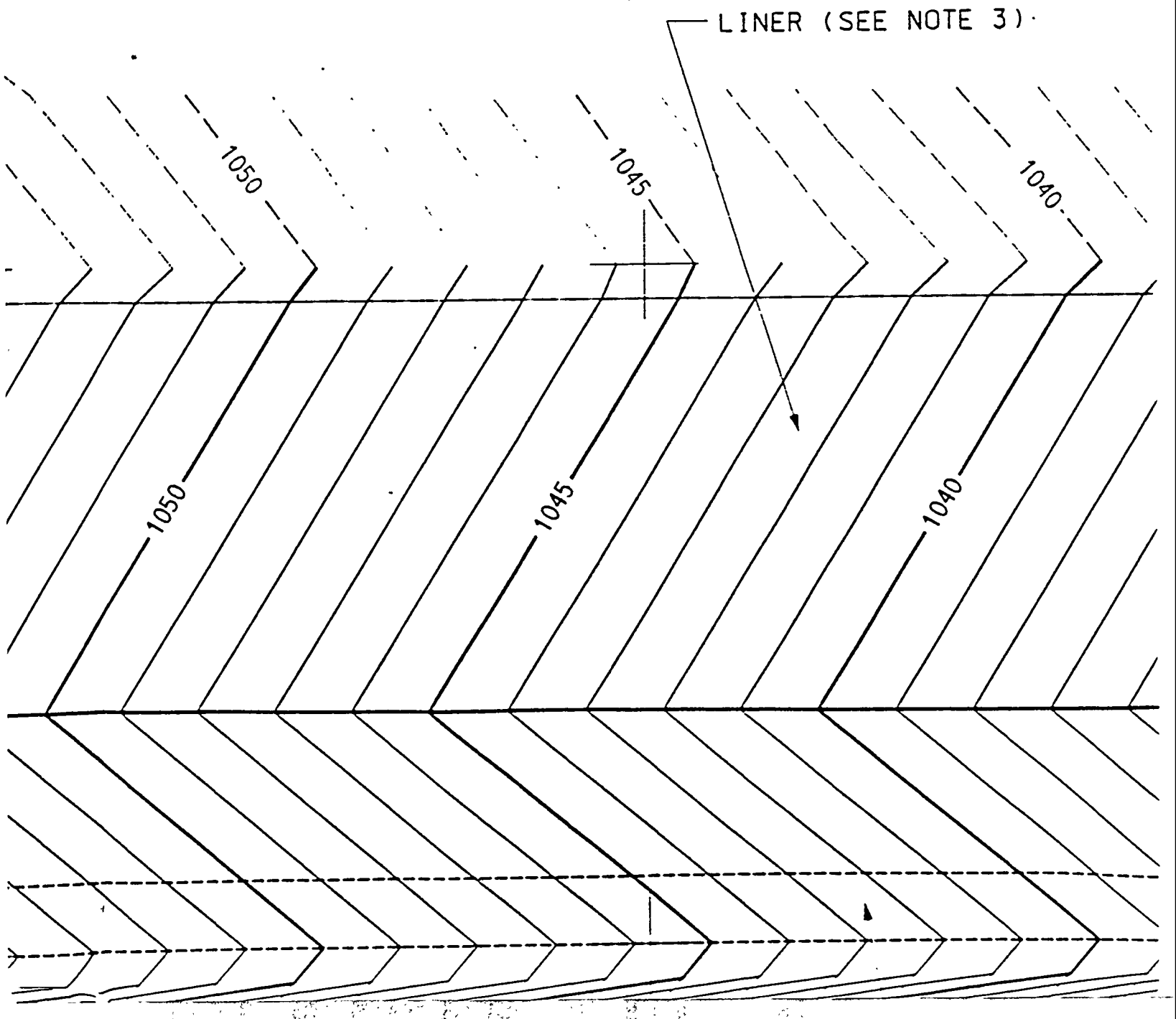
A

8

7


N
E 58600
E 58800
6
COMPOSITE CLAY
LINER PERIMETER
SECTION
A925
A929
N 27600
N 27400
1060
1055
3:1
3.5:1
SLOPE
TRANSITION
WASTE LIMIT
18"DIA CMP
GW-797
LEACHATE

E 59000

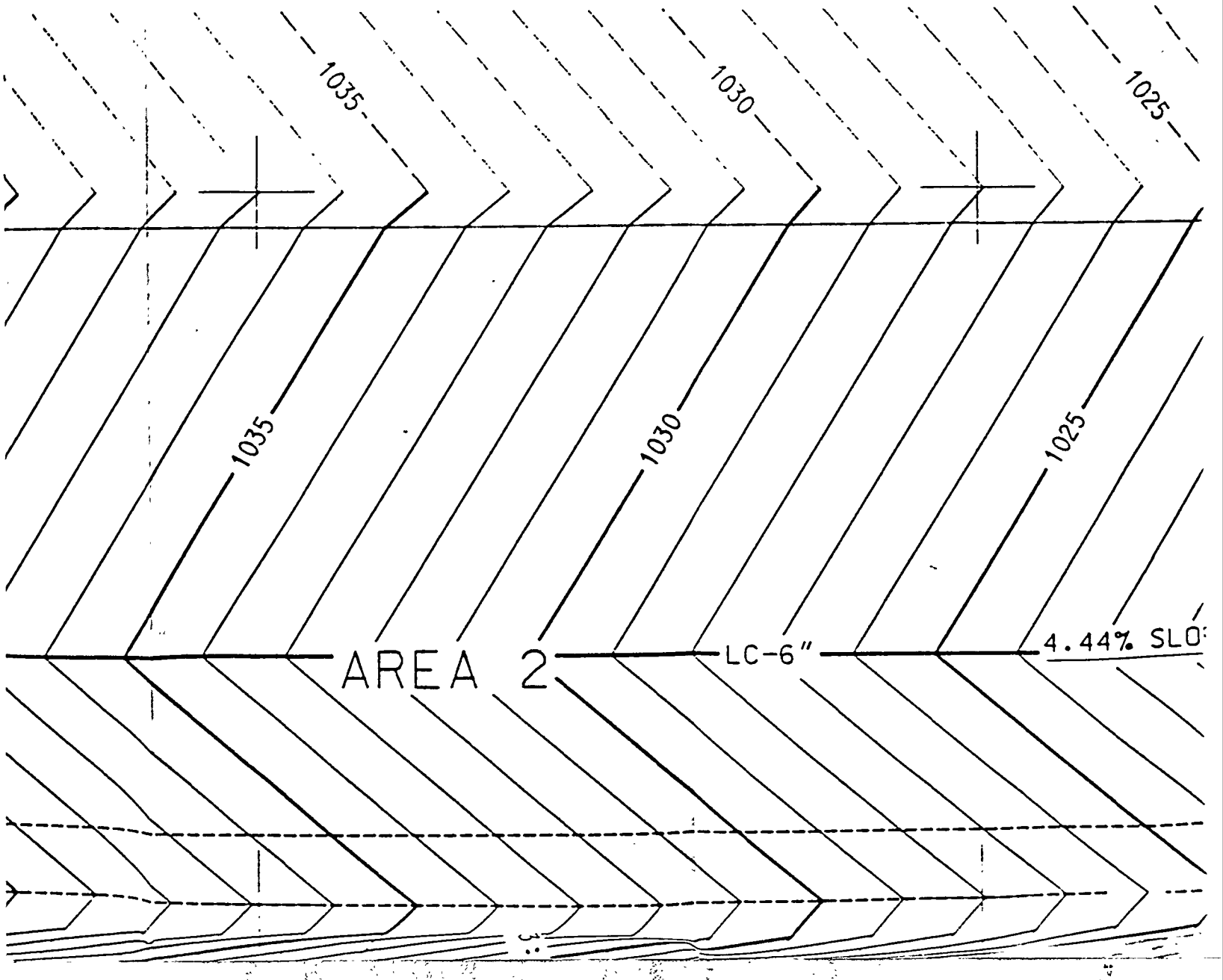


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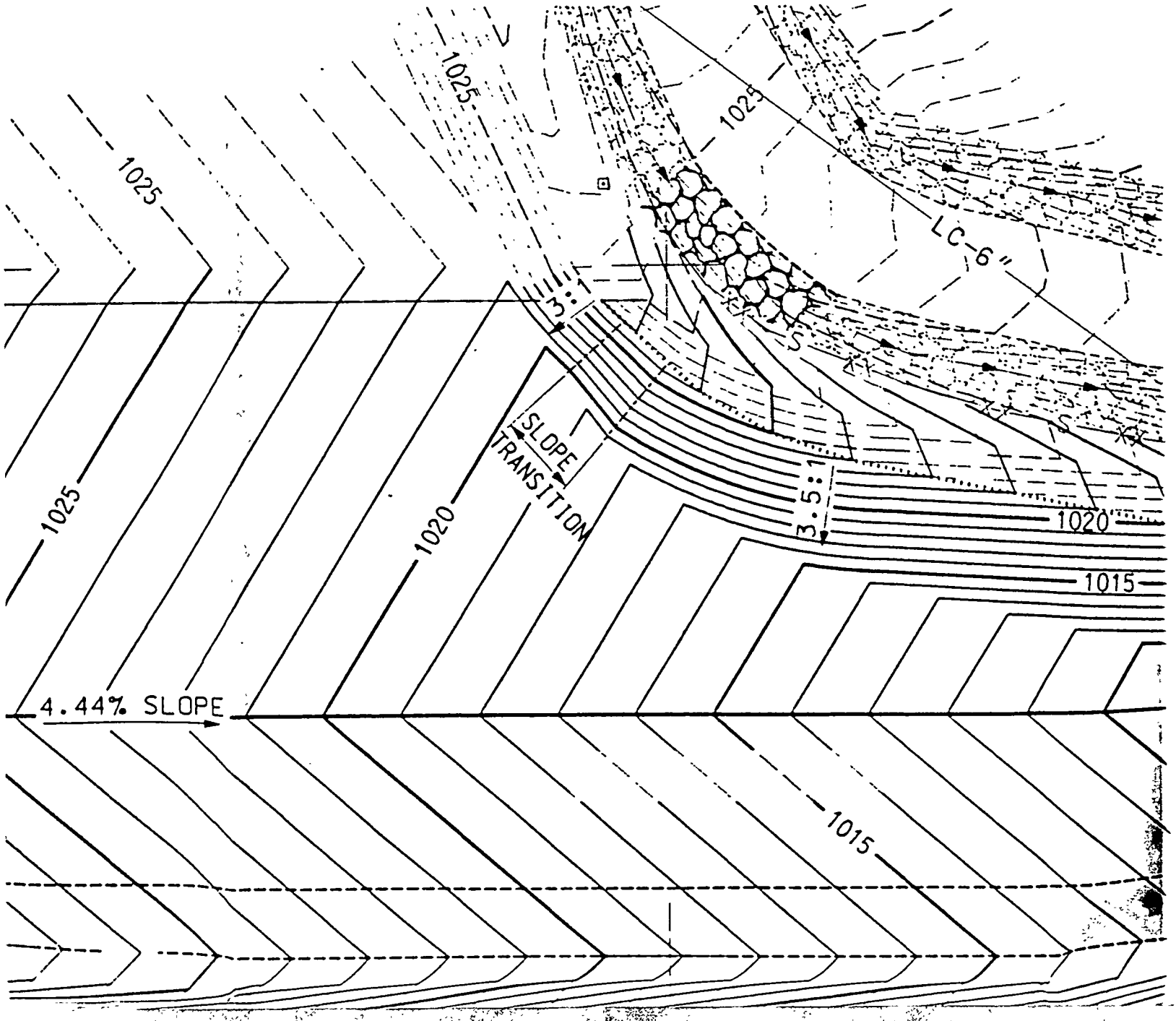
E 59200

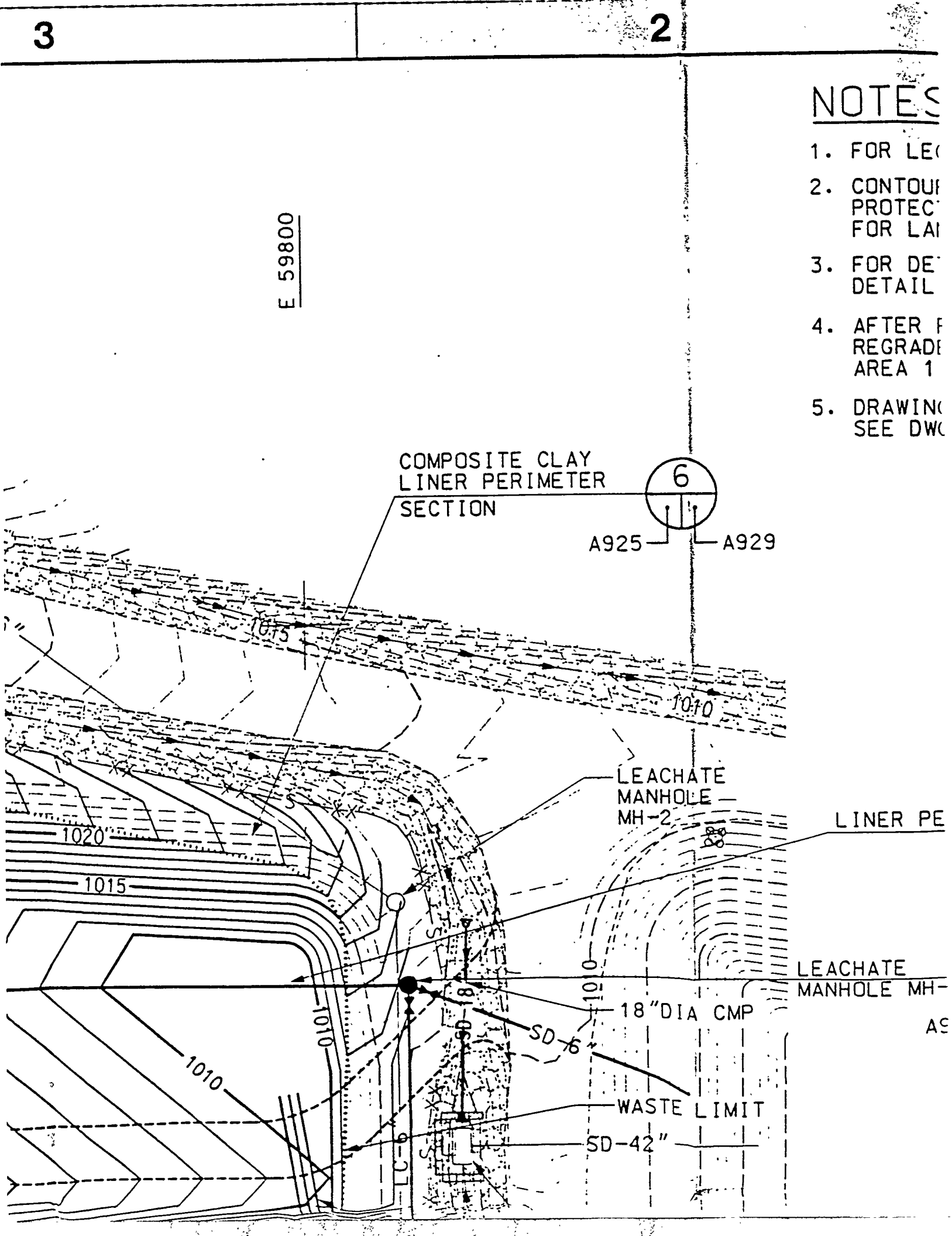
E 59400

AREA 1 (EXISTING)



E 59600


1025
1025
1025
1025
1020
1020
1015
1015
3:1
3.5:1
SLOPE TRANSITION
LC-6"
4.44% SLOPE



NOTES

1. FOR LE(
2. CONTOUI PROTEC FOR LAI
3. FOR DE DETAIL
4. AFTER F REGRADE AREA 1
5. DRAWIN(SEE DW(

2 NEXT ASS'Y: 1 FINAL ASS'Y:

NOTES:

1. FOR LEGEND SEE DWG C2E900000A703.
2. CONTOURS SHOWN ON THIS DRAWING ARE TOP OF PROTECTIVE SOIL COVER ELEVATION. CONTOURS FOR LANDFILL ACCESS ROAD ARE NOT SHOWN.
3. FOR DETAILS OF LINER PHASING FOR AREA 2 SEE DETAIL 2. DWG. C2E900000A928.
4. AFTER REMOVAL OF AREA 1 ACCESS ROAD AND CULVERT REGRADE AREA 1 TO PROVIDE POSITIVE DRAINAGE FROM AREA 1 TO AREA 2.
5. DRAWING DEPICTS GRADING WITHIN AREA 2 ONLY. SEE DWG C2E900000A926 FOR GRADING OF AREA 3.

H

6
A929

G

1010

CHATE
IOLE

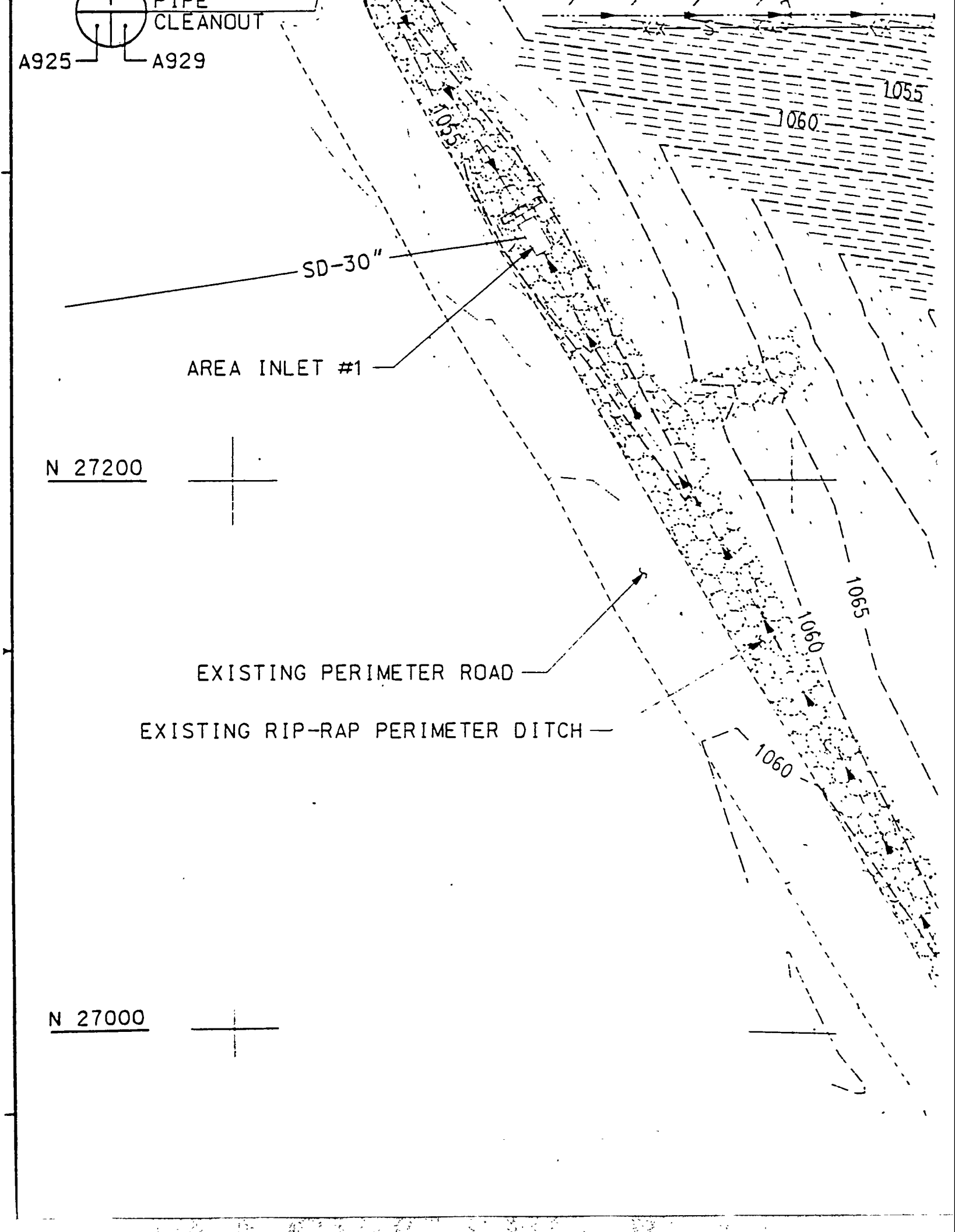
LINER PENETRATION 11
A925 A929

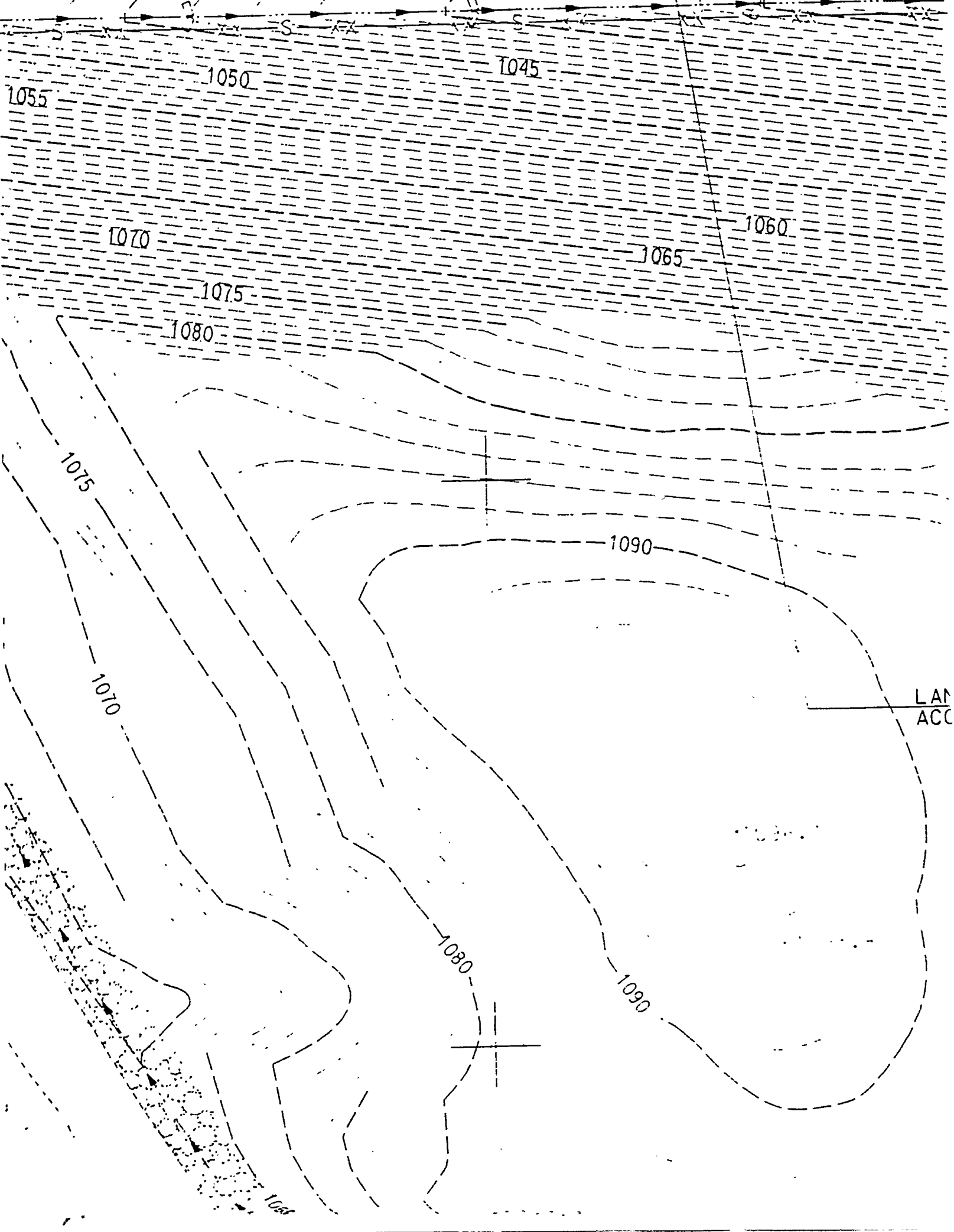
LEACHATE
MANHOLE MH-2A 12
A925 A929

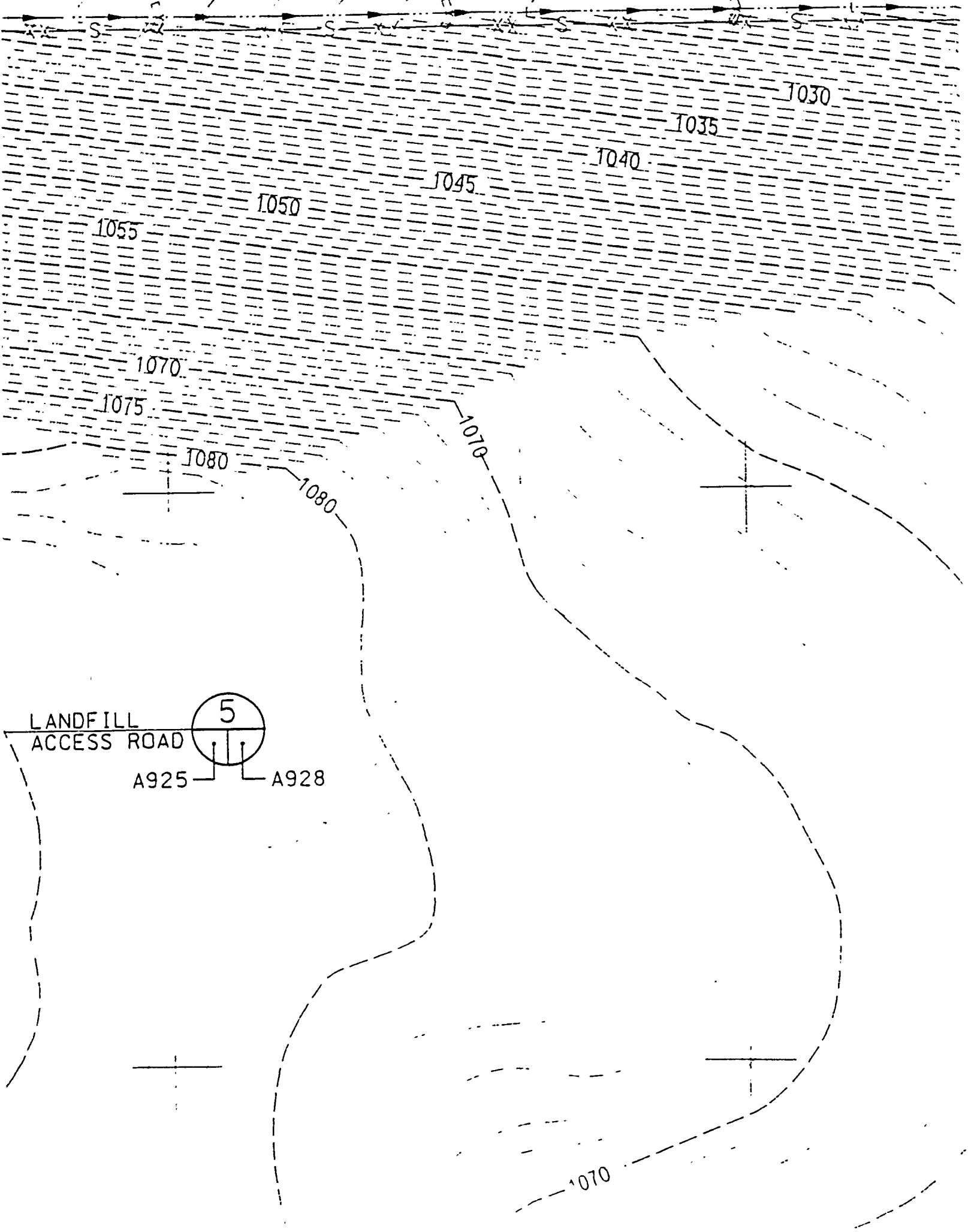
)IA CMP

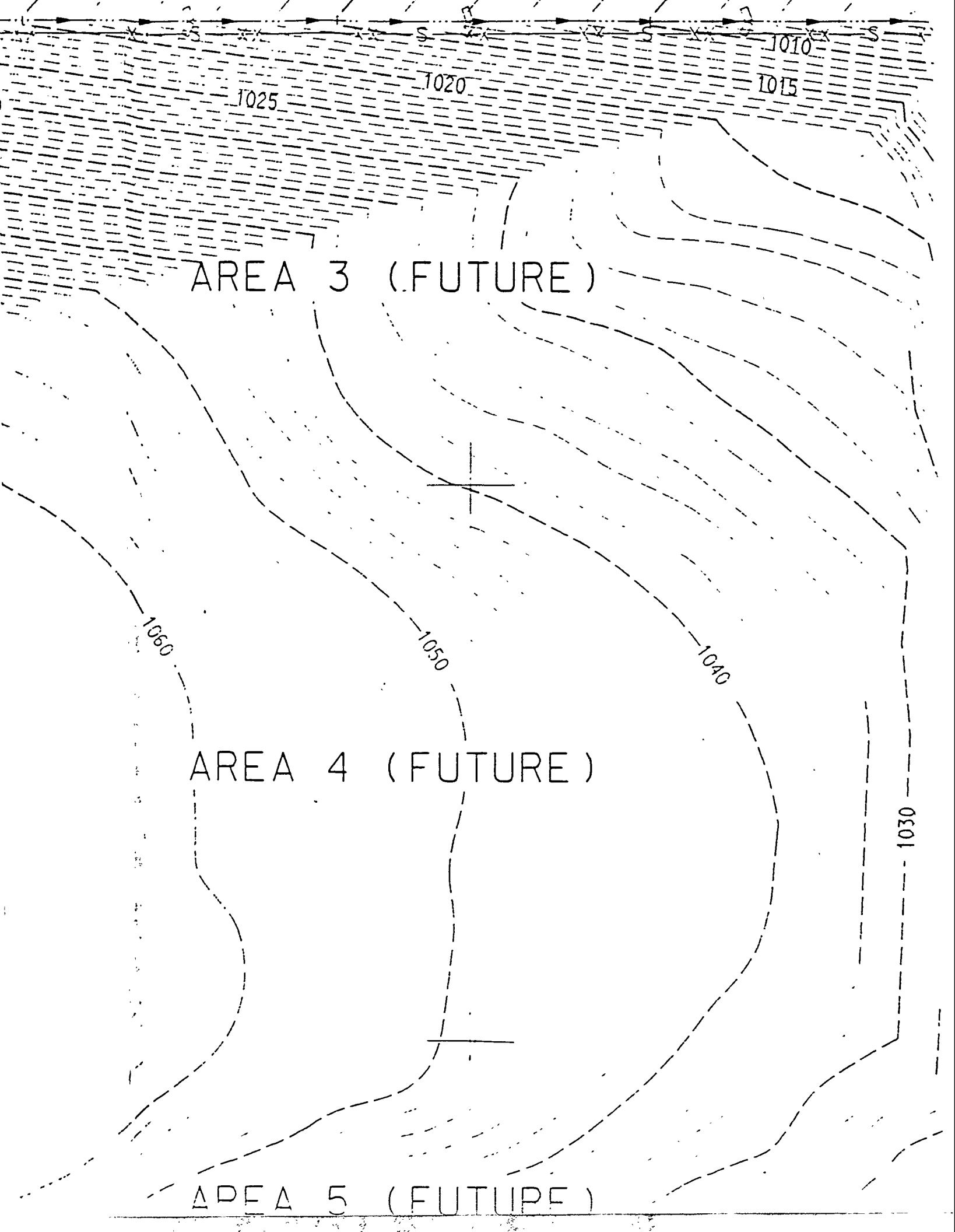
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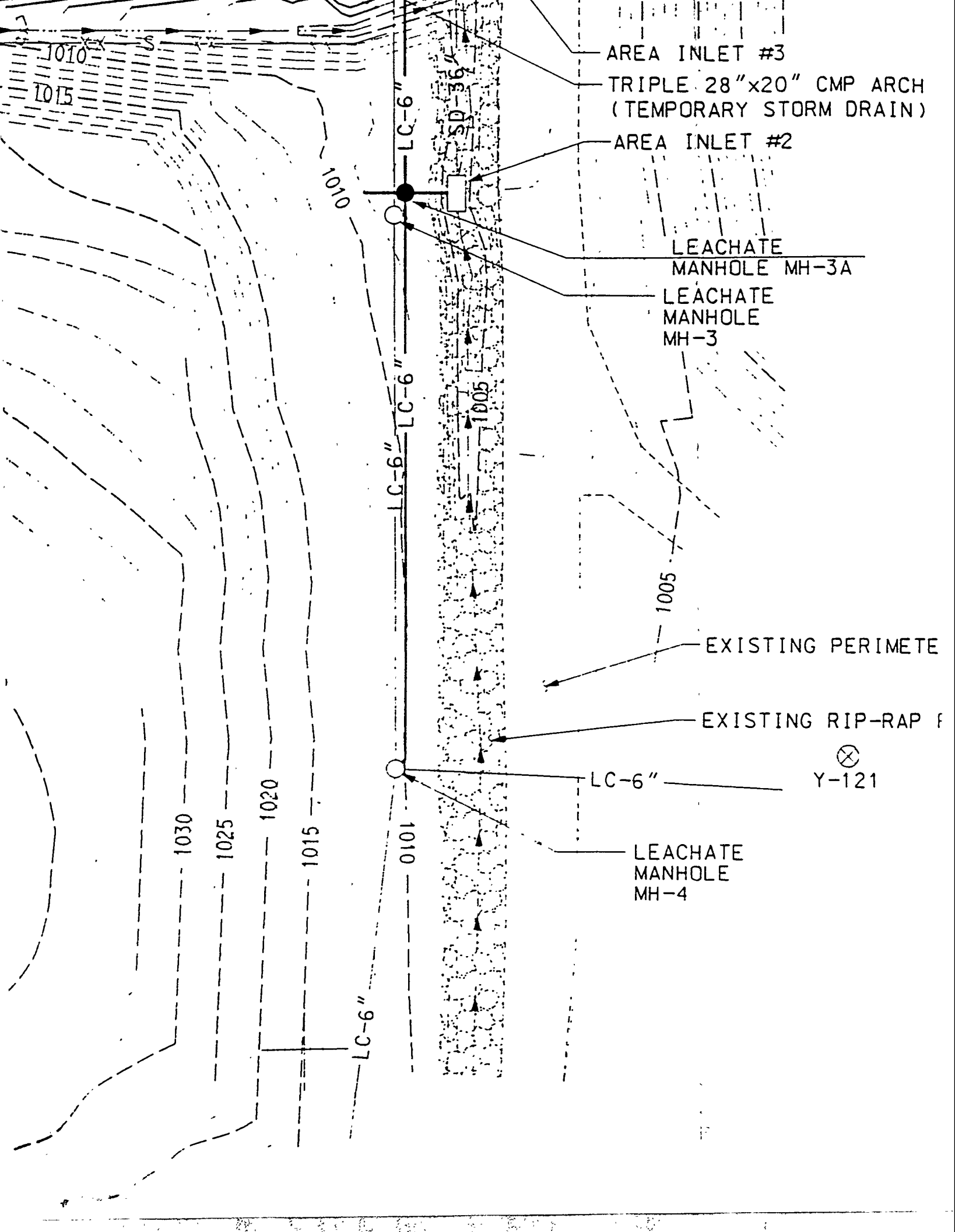
F


PIPE
CLEANOUT
A925
A929
1055
1060
1065
SD-30"
AREA INLET #1
N 27200
EXISTING PERIMETER ROAD
EXISTING RIP-RAP PERIMETER DITCH
1060
1065
1060
N 27000


1045
1050
1055
1060
1065
1070
1075
1080
1075
1090
1070
1080
1090
LAN
ACC


1030
1035
1040
1045
1050
1055
1070
1075
1080
1080
1070
1070
LANDFILL
ACCESS ROAD
5
A925
A928


1025
1020
1015
1010
AREA 3 (FUTURE)
1060
1050
1040
1030
AREA 4 (FUTURE)
AREA 5 (FUTURE)


AREA INLET #3
TRIPLE 28"x20" CMP ARCH
(TEMPORARY STORM DRAIN)
AREA INLET #2
LEACHATE
MANHOLE MH-3A
LEACHATE
MANHOLE
MH-3
EXISTING PERIMETE
EXISTING RIP-RAP F
LC-6"
Y-121
LEACHATE
MANHOLE
MH-4
SD-36"
LC-6"
1010
1015
1005
1030
1025
1020

INLET #3

E 28"x20" CMP ARCH
PORARY STORM DRAIN)

INLET #2

LEACHATE
MANHOLE MH-3A

.EACHATE
IANHOLE
IH-3

EXISTING PERIMETER ROAD

EXISTING RIP-RAP PERIMETER DITCH

Y-121

ACHATE
NHOLE
-4

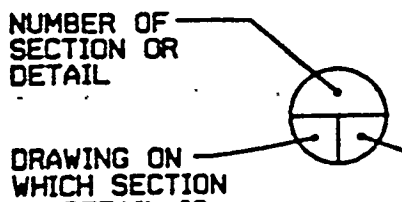
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SECTION AND DETAIL KEY



ev. No.: ___ Date: _____
view By: _____
ocument: _____
12356 4-93)

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CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

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IS

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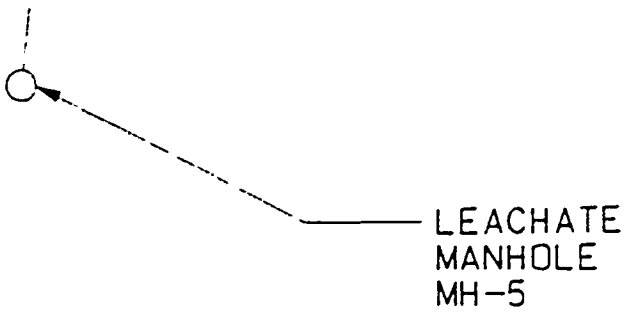
REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION
0				ISSUE FOR PERMITTING

REVISION OR ISSUE PURPOSE

TTING	SLA	WPT	—	WLL	8/9/95					8/28/95	WPT	7/9
RIPTION	BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RPE	RPE
ISSUE PURPOSE	REVISION APPROVALS											

2931	8/19/93					—		—	—	—	—	—	—	—	—	—
RPE NO	DATE			QA	DATE	ST	CV	EC	EE	EM	IE	M	PD	SE	ARC	VER

SQUAD CHECK



40 0 40

SCALE:

	RPE	DSGN	8/19/95	FOSTER WHEELER ENVIRONMENTAL CO OAK RIDGE, designed for the DEPARTMENT OF ENERGY managed for the DEPARTMENT OF ENER under U.S. GOVERNMENT contracts DE Oak Ridge, Tennessee • Pa
		DRW	8/19/95	
		CHKR	8/19/95	
		SECT		PROJE
		DEPT	8/19/95	Y-12 INDUSTR
		PE		
		PJ	8/28/95	ARI
		REQ		PARTI
				PROTECTIVE
				1 3 | 48 C | 49 P | 50 T | PLANT Y-12 | B. YAI
—				51 NC | 52 NA | 53 AR | C2
VER	REV. 0 DATE 8/19/95	MMES		
	DRAWING APPROVALS			

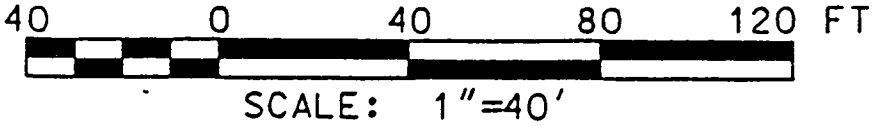
WILLIAM PATRICK TAYLOR
REGISTERED ENGINEER
AGRICULTURE
No. 22...
STATE OF TENNESSEE

C

B

A

C2E900000A925



2	8/19/95
[illegible]	8/19/95
[illegible]	8/19/95
[illegible]	8/19/95
	8/28/95

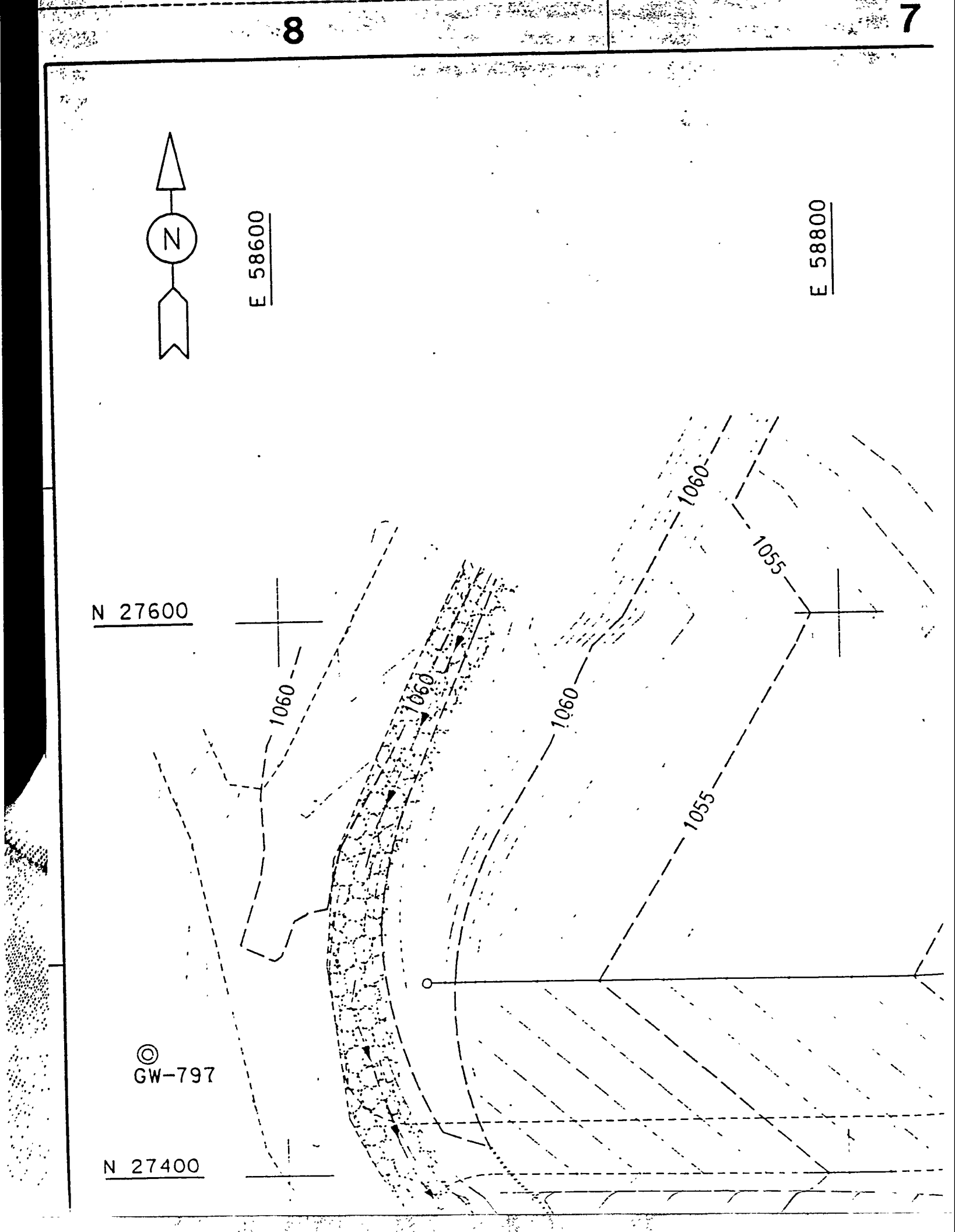
FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:
Y-12 INDUSTRIAL LANDFILL V

AREA 2
PARTIAL PLAN
PROTECTIVE SOIL COVER

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	T	Y-12	YAREA	A	1	1	P	U

51	52	53		REV
NC	NA	AR	C2E900000A925	0


N
E 58600
E 58800
N 27600
N 27400
1060
1060
1060
1055
1055
GW-797

7

6

E 59000

1050

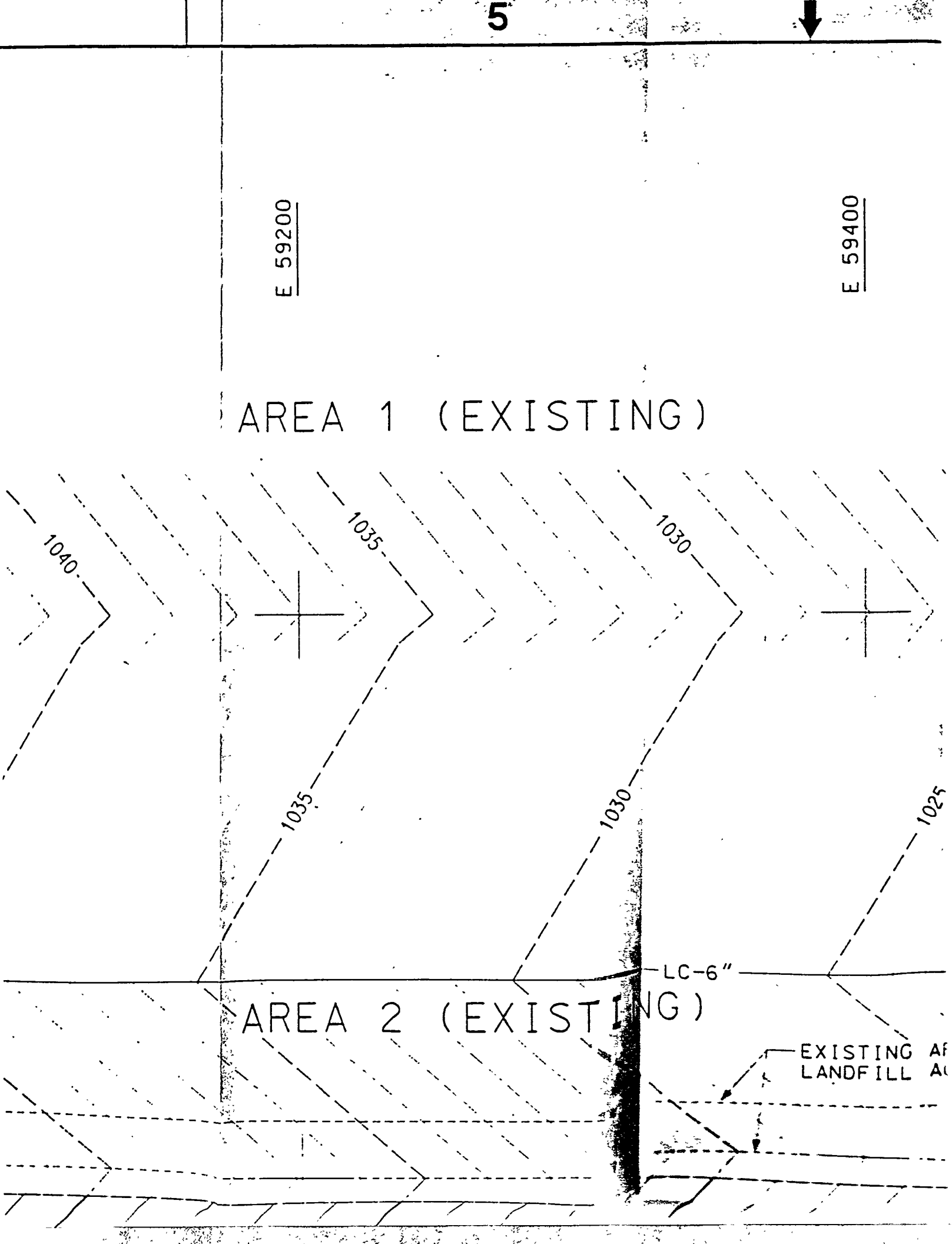
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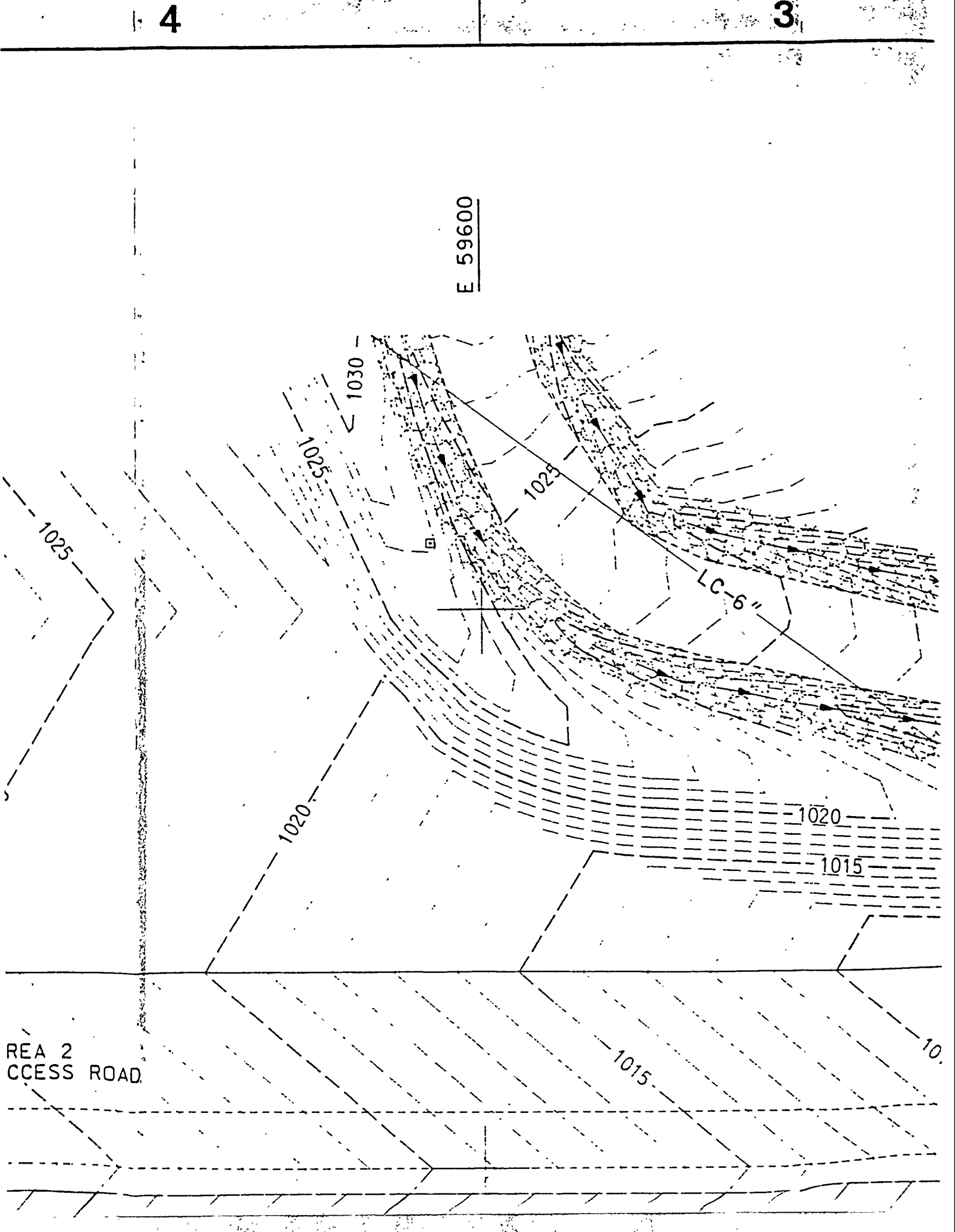
1040

1050

1045

1040


5
E 59200
E 59400
AREA 1 (EXISTING)
1040
1035
1030
1035
1030
1025
LC-6"
AREA 2 (EXISTING)
EXISTING
LANDFILL

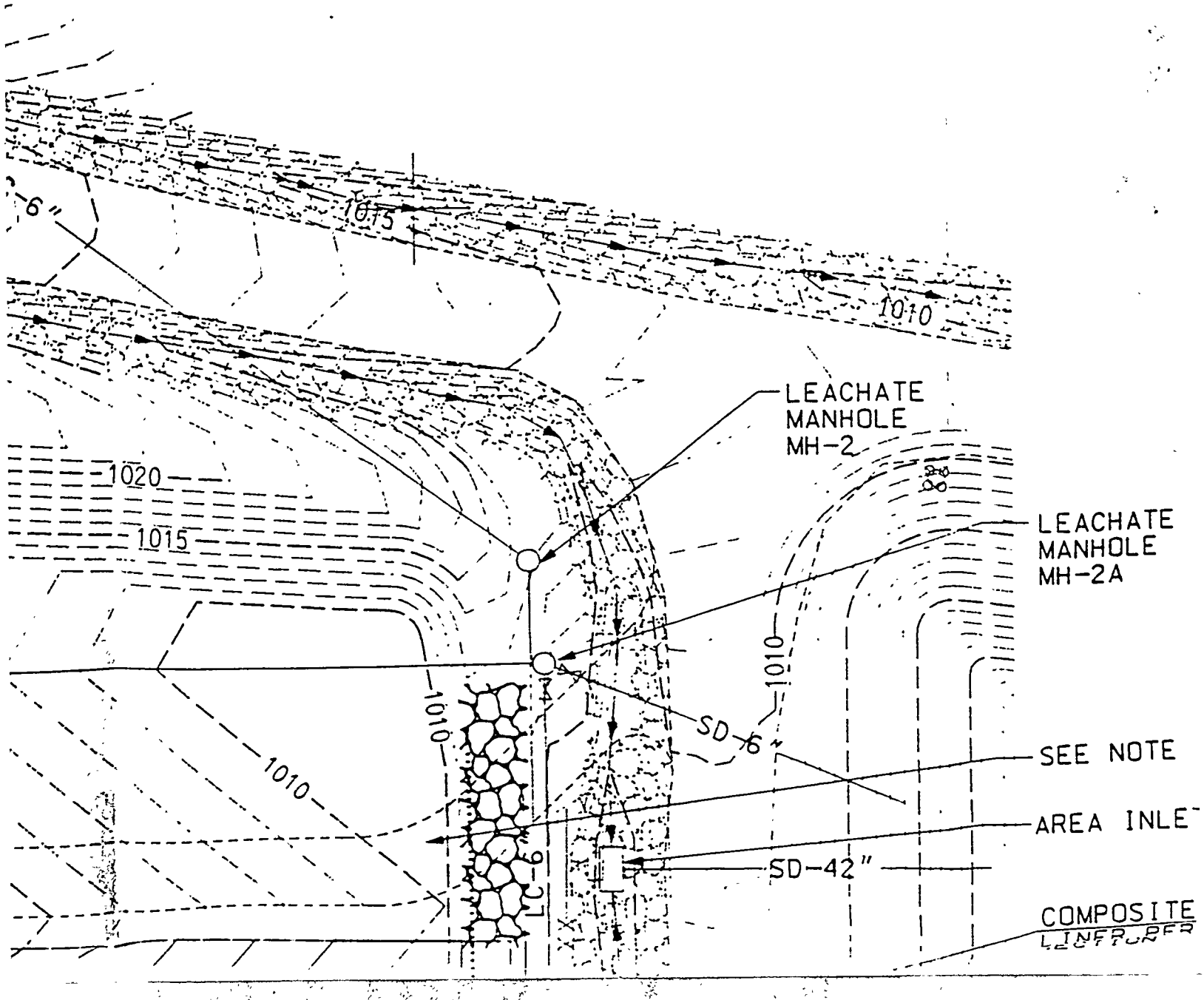

4
3
E 59600
1030
1025
1025
1020
1020
1015
1015
LC-6"
REA 2
CCESS ROAD

3 2

E 59800

NOTE

1. FOR L
2. CONTC PROTE FOR L
3. AFTER REGRA AREA
4. FOR D SEE D
5. DRAWI SEE D



NOTES:

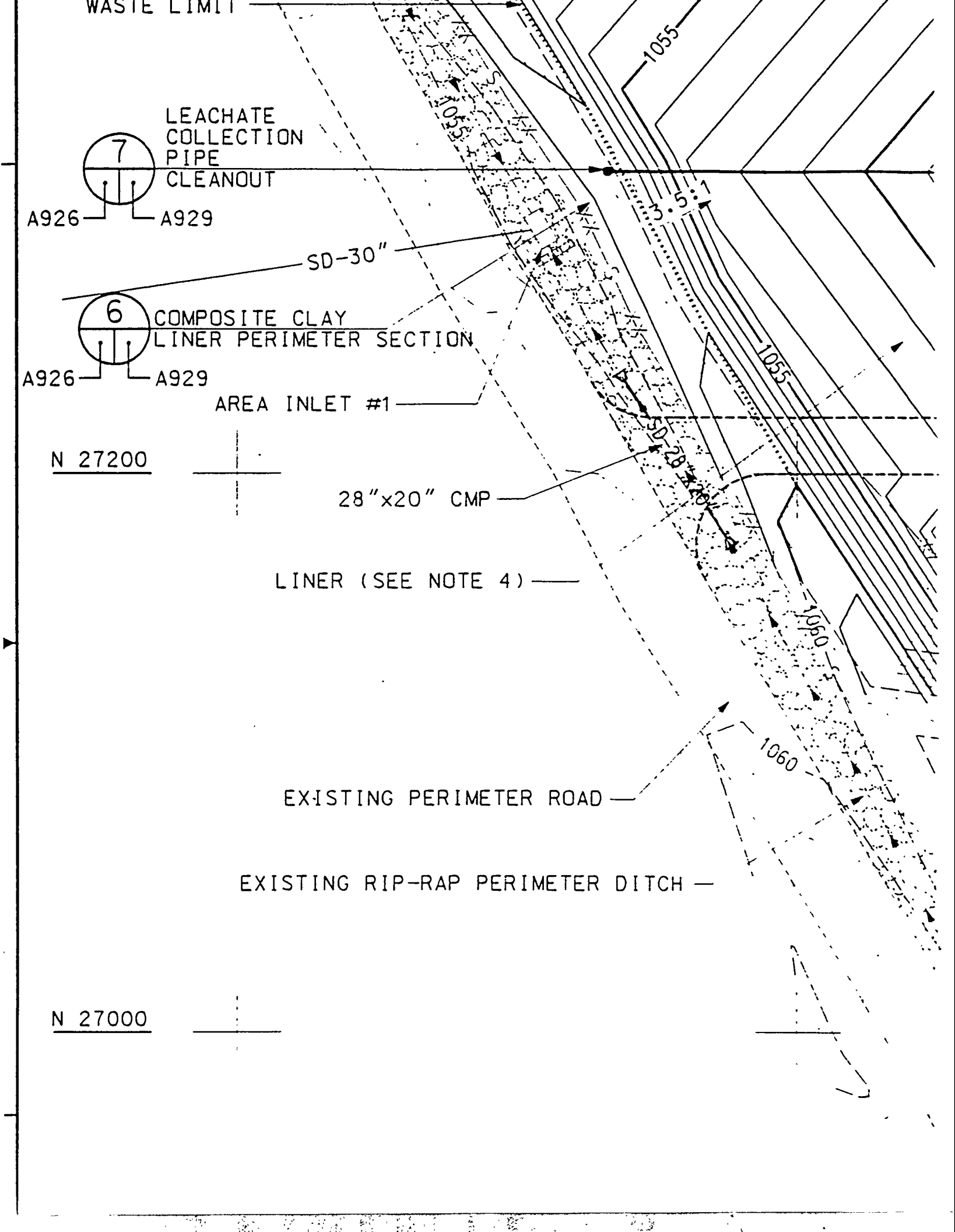
1. FOR LEGEND SEE DWG C2E900000A703.
2. CONTOURS SHOWN ON THIS DRAWING ARE TOP OF PROTECTIVE SOIL COVER ELEVATION. CONTOURS FOR LANDFILL ACCESS ROAD ARE NOT SHOWN.
3. AFTER REMOVAL OF AREA 2 ACCESS ROAD AND CULVERT, REGRADE AREA 2 TO PROVIDE POSITIVE DRAINAGE FROM AREA 2 TO AREA 3.
4. FOR DETAILS OF LINER PHASING FOR AREA 3, SEE DETAIL 2, DWG. C2E900000A928.
5. DRAWING DEPICTS GRADING WITHIN AREA 3 ONLY. SEE DWG C2E900000A925 FOR GRADING OF AREA 2.

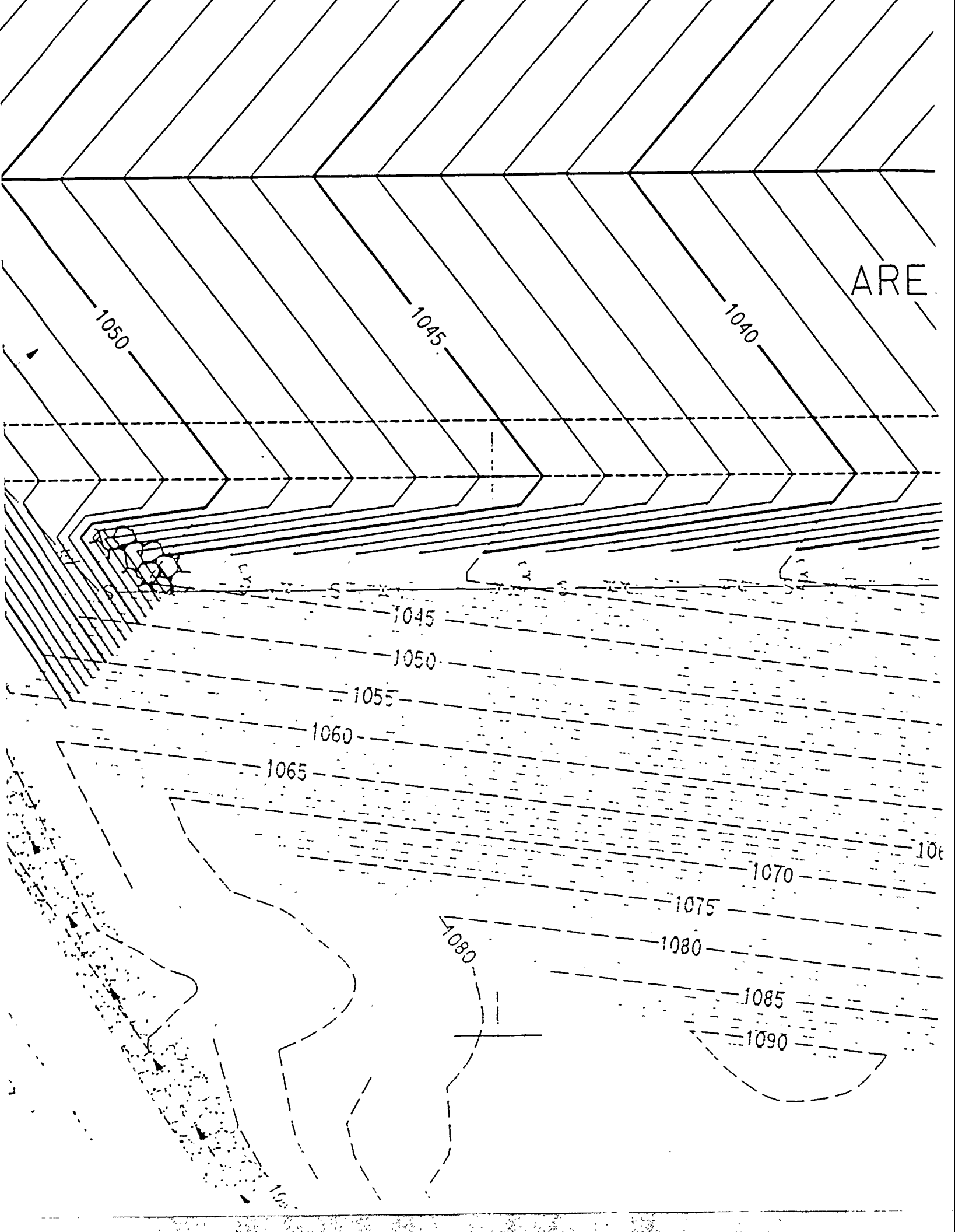


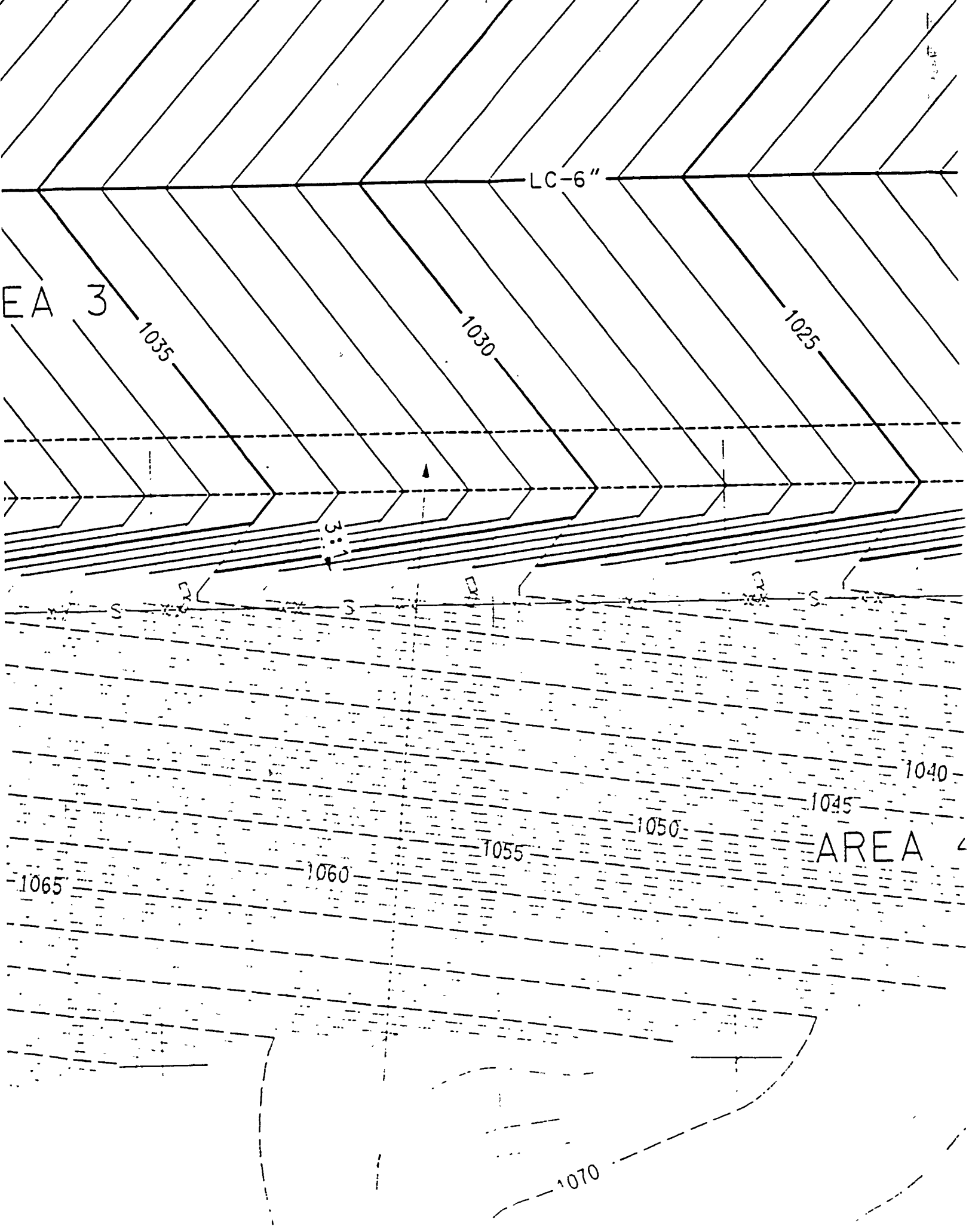
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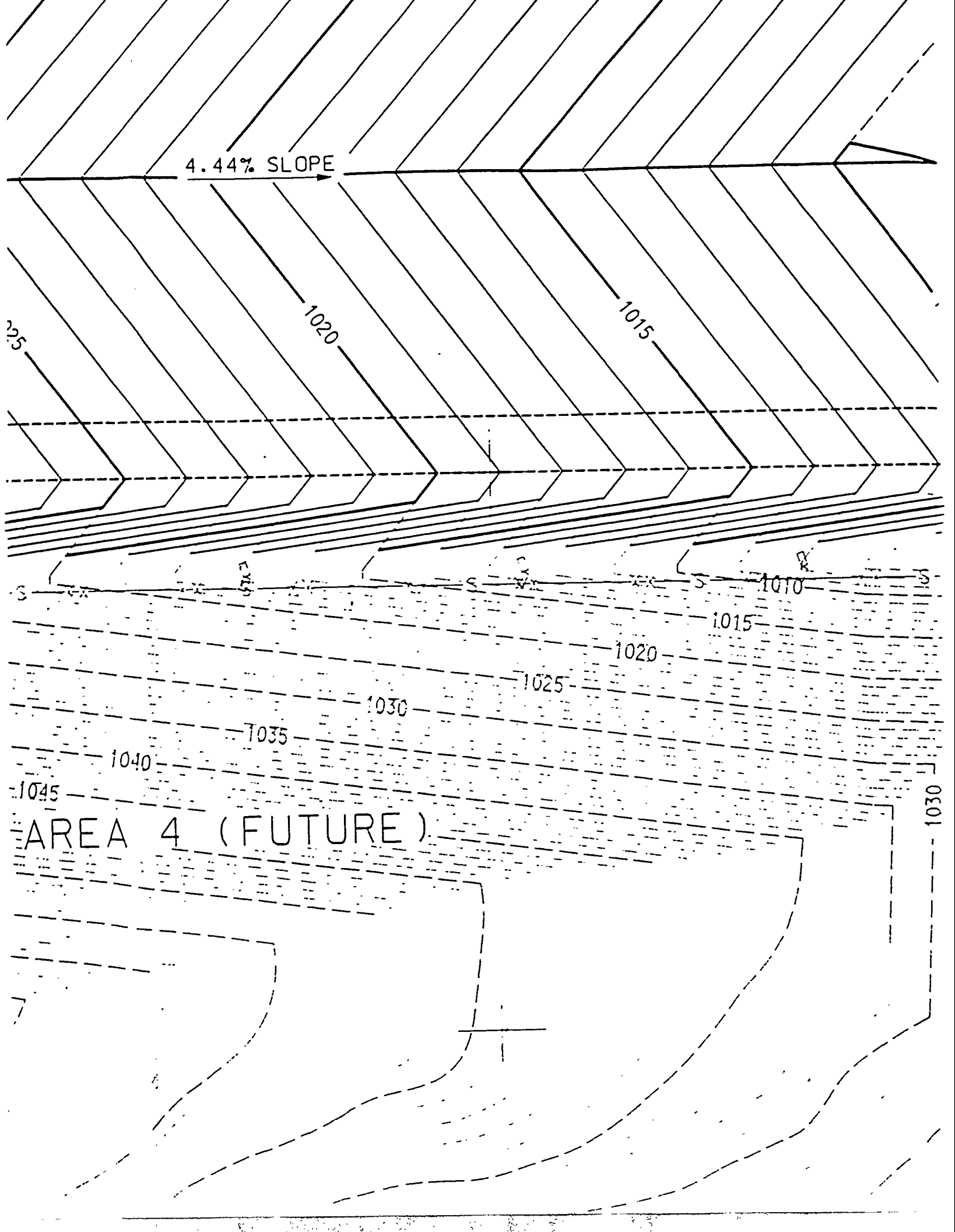
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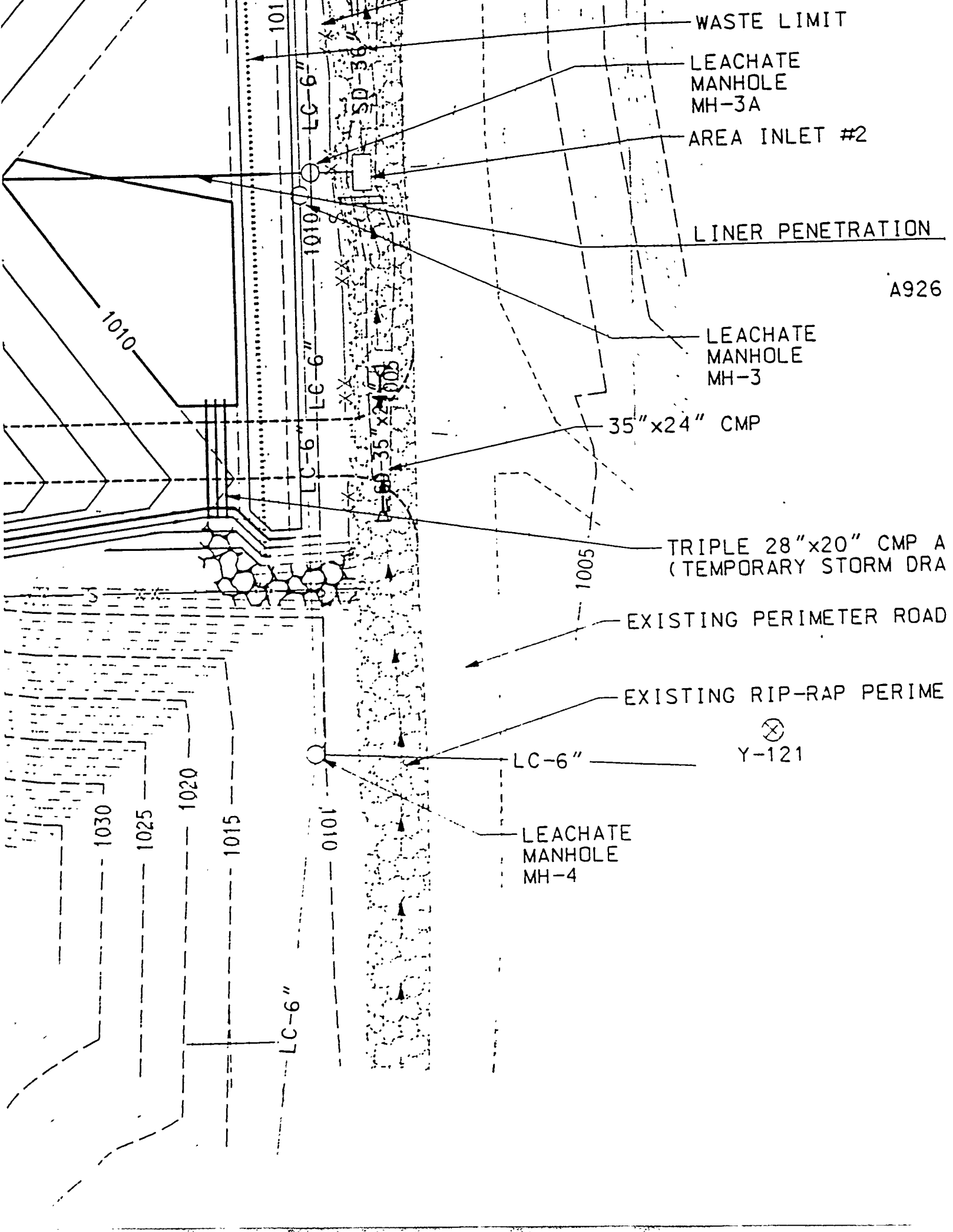
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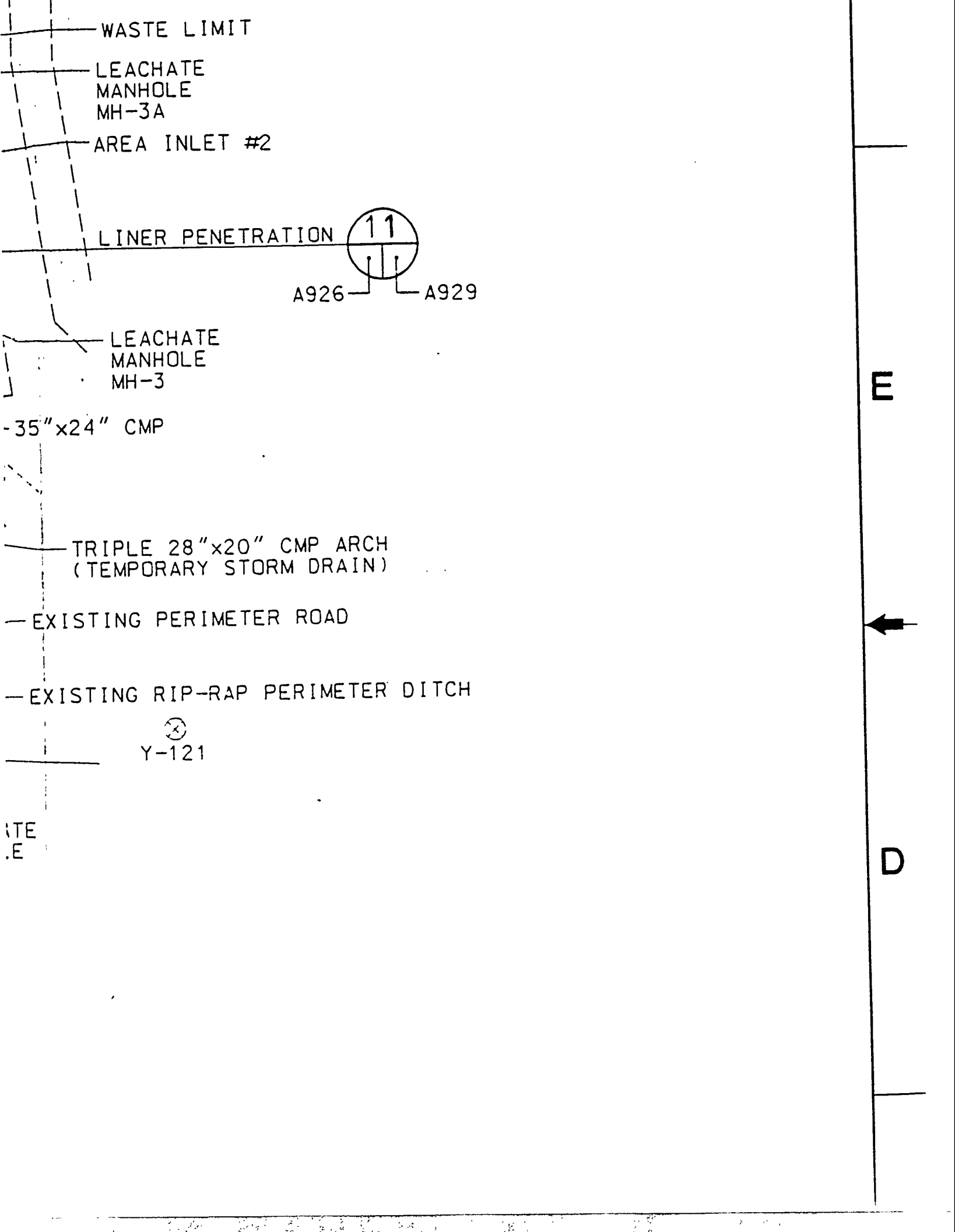

WASTE LIMIT
LEACHATE COLLECTION PIPE CLEANOUT
7
A926
A929
SD-30"
6
COMPOSITE CLAY LINER PERIMETER SECTION
A926
A929
AREA INLET #1
N 27200
28"x20" CMP
LINER (SEE NOTE 4)
EXISTING PERIMETER ROAD
EXISTING RIP-RAP PERIMETER DITCH
N 27000
1055
1060
3.5:1


ARE
1050
1045
1040
1045
1050
1055
1060
1065
1070
1075
1080
1085
1090


LC-6"
EA 3
1035
1030
1025
S
S
S
S
1040
1045
1050
1055
1060
1065
1070
AREA


4.44% SLOPE
1020
1015
1010
1015
1020
1025
1030
1035
1040
1045
1030
AREA 4 (FUTURE)

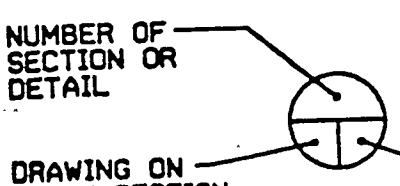

WASTE LIMIT
LEACHATE MANHOLE MH-3A
AREA INLET #2
LINER PENETRATION
A926
LEACHATE MANHOLE MH-3
35"x24" CMP
TRIPLE 28"x20" CMP A
(TEMPORARY STORM DRA
EXISTING PERIMETER ROAD
EXISTING RIP-RAP PERIME
Y-121
LC-6"
LEACHATE MANHOLE MH-4
LC-6"
SD-36"
LC-6"
LC-6"
LC-6"
1010
1010
1005
1005
1030
1025
1020
1015
1010
1010


WASTE LIMIT
LEACHATE MANHOLE MH-3A
AREA INLET #2
LINER PENETRATION
11
A926
A929
LEACHATE MANHOLE MH-3
-35"x24" CMP
TRIPLE 28"x20" CMP ARCH (TEMPORARY STORM DRAIN)
EXISTING PERIMETER ROAD
EXISTING RIP-RAP PERIMETER DITCH
Y-121
E
D

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INTERGRAPH



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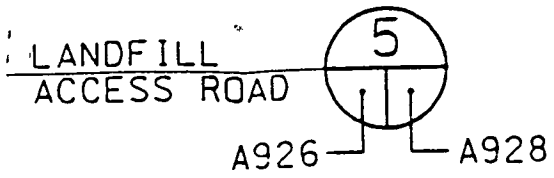
CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION
0				ISSUE FOR PERMITTING

REVISION OR ISSUE PURPOSE

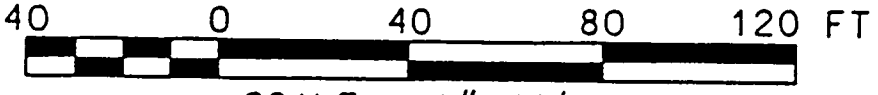
AR



RMITTING	JGA	WPT	—	WLL	8/19/95						
DESCRIPTION	BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RP

N OR ISSUE PURPOSE

REVISION APPROVALS



SCALE: 1"=40'

	8/19/95
	8/19/95
	8/19/95
	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:
Y-12 INDUSTRIAL LANDFILL V

AREA 3
PARTIAL PLAN
PROTECTIVE SOIL COVER

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	T	Y-12	YAREA	A	1	1	P	U

51	52	53		REV
NC	NA	AR	C2E900000A926	O

CAD FILE:C0001297.DGN

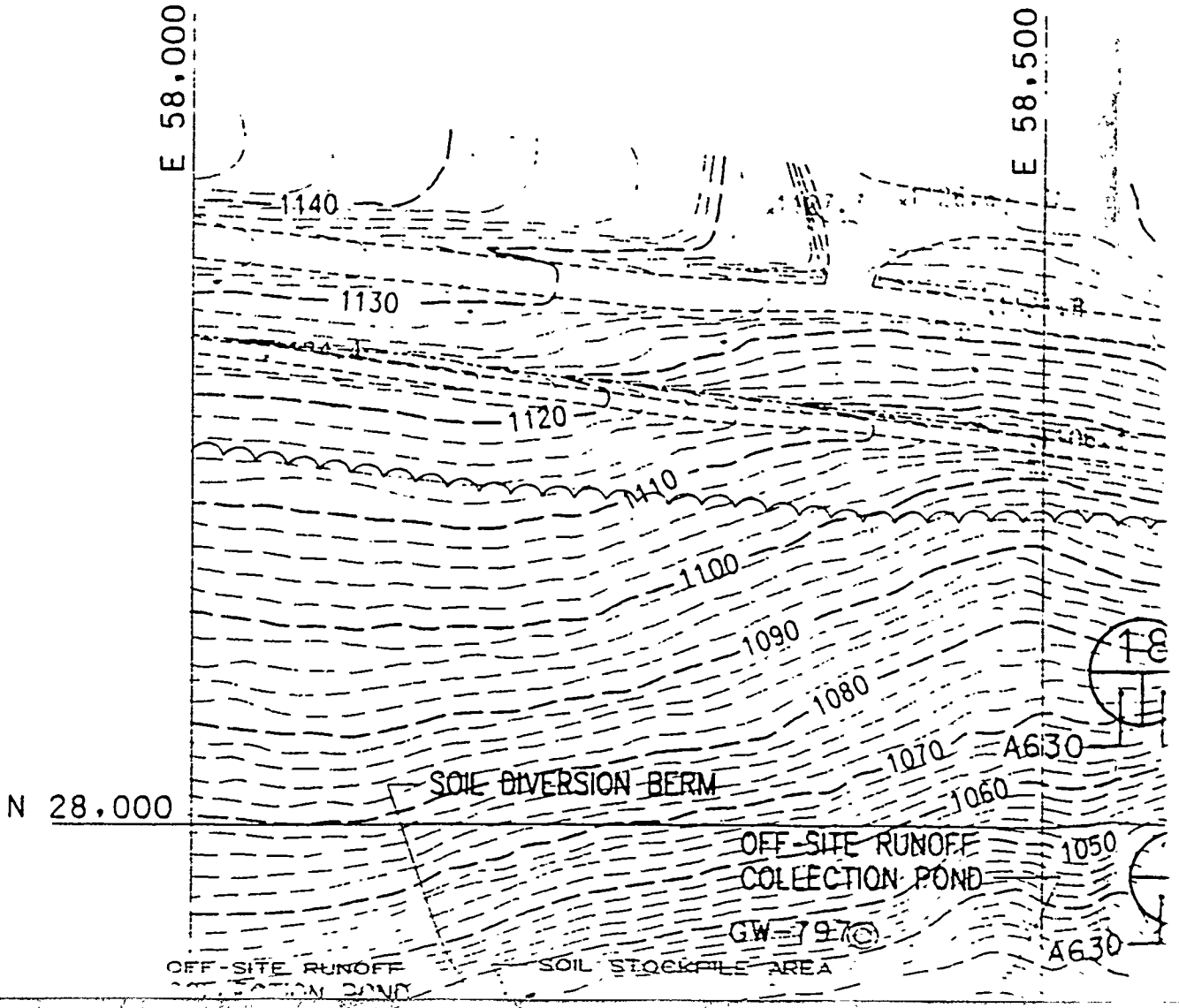
C2E900000A926

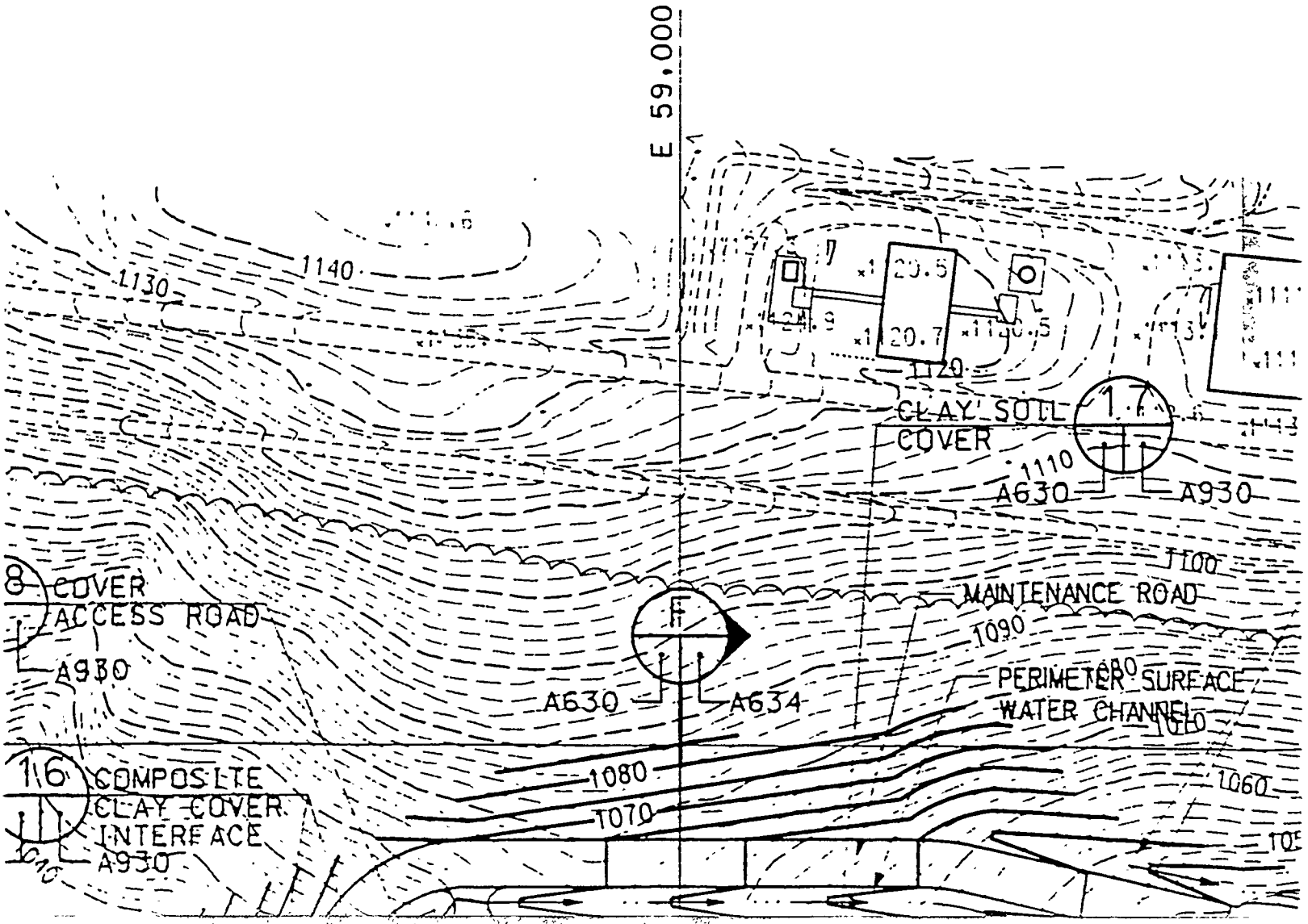
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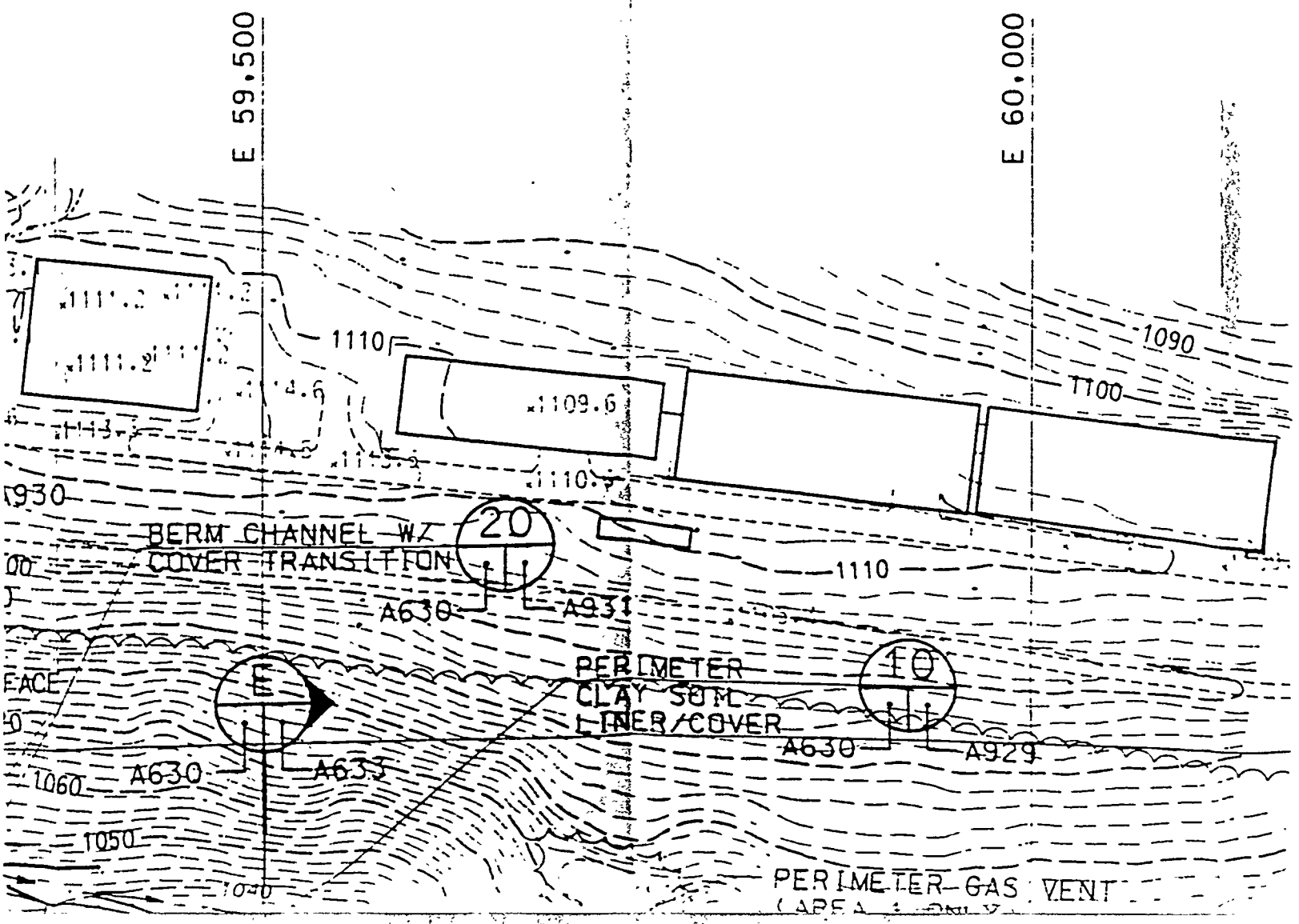
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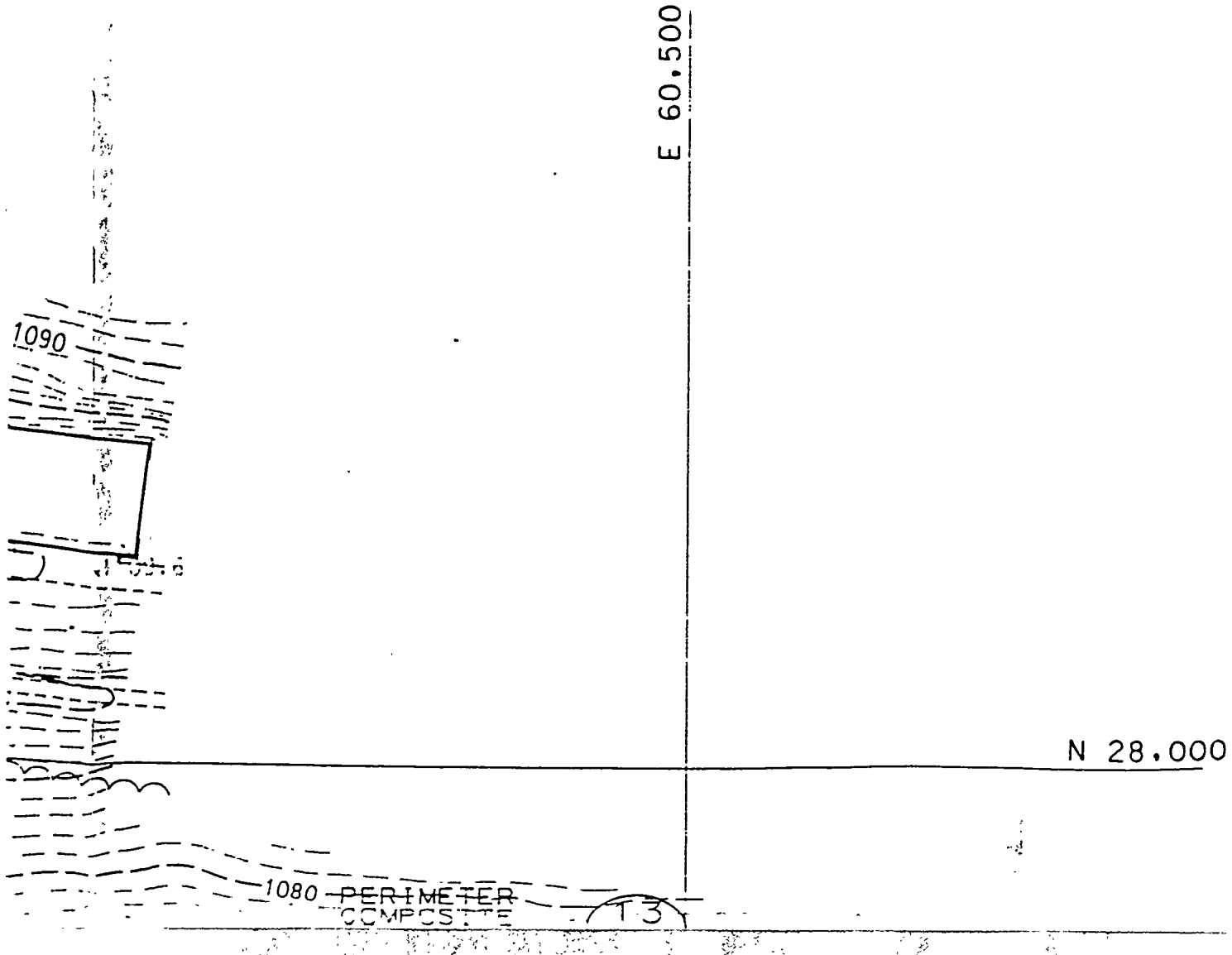
A


N


E 58,000
E 58,500
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
A630
A630
N 28,000
SOIL DIVERSION BERM
OFF-SITE RUNOFF
COLLECTION POND
GW-797
SOIL STOCKPILE AREA
OFF-SITE RUNOFF


E 59,000
1140
1130
1120
1110
1100
1090
1080
1070
1060
20.5
20.7
CLAY SOIL COVER
1.7
A630
A930
MAINTENANCE ROAD
8
COVER
ACCESS ROAD
A930
A630
A634
PERIMETER SURFACE WATER CHANNEL
16
COMPOSITE CLAY COVER INTERFACE
A930


E 59.500
E 60.000
1110
1090
1100
1109.6
1110
1110
1930
BERM CHANNEL W/
COVER TRANSITION
20
A630
A931
PERIMETER
CLAY SOIL
LINER/COVER
10
A630
A929
A630
A633
1060
1050
PERIMETER GAS VENT


E 60.500
1090
N 28.000
1080 PERIMETER COMPOSITE
T3

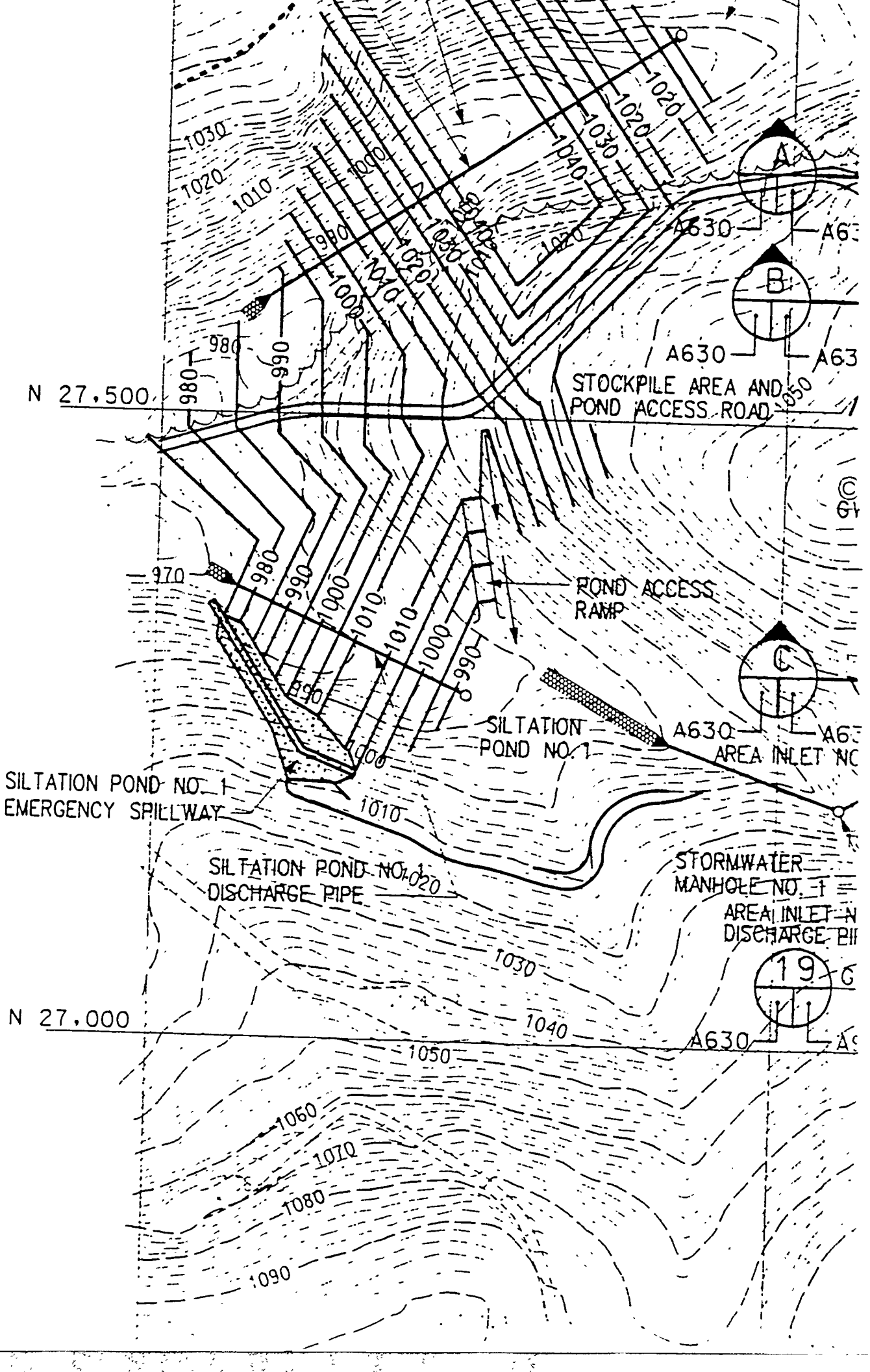
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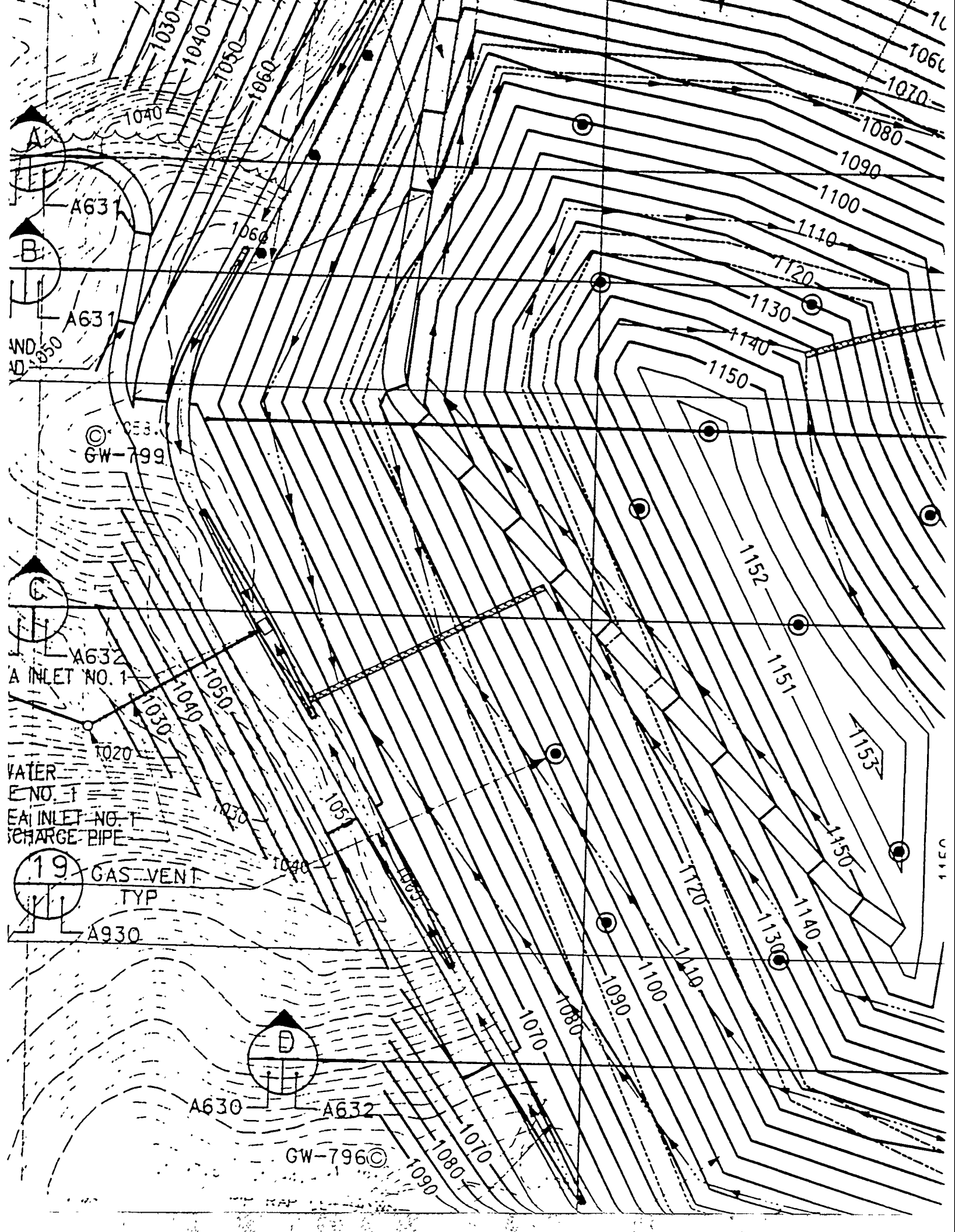
1. FOR LEGEND SEE DWG. C2
2. FINAL CLOSURE GRADE WI
   FEET PLUS OR MINUS OF
3. MAXIMUM SLOPE WILL BE
   VERTICAL).
4. FINAL GRADING SHALL PR
   OF WATER IN DEPRESSION
5. EXISTING TOPOGRAPHY PR
   CORPORATION. ST. LOUI
   PHOTOGRAPHY: 12-6-90.
6. ALL PROPOSED CONTOURS
   ELEVATIONS.

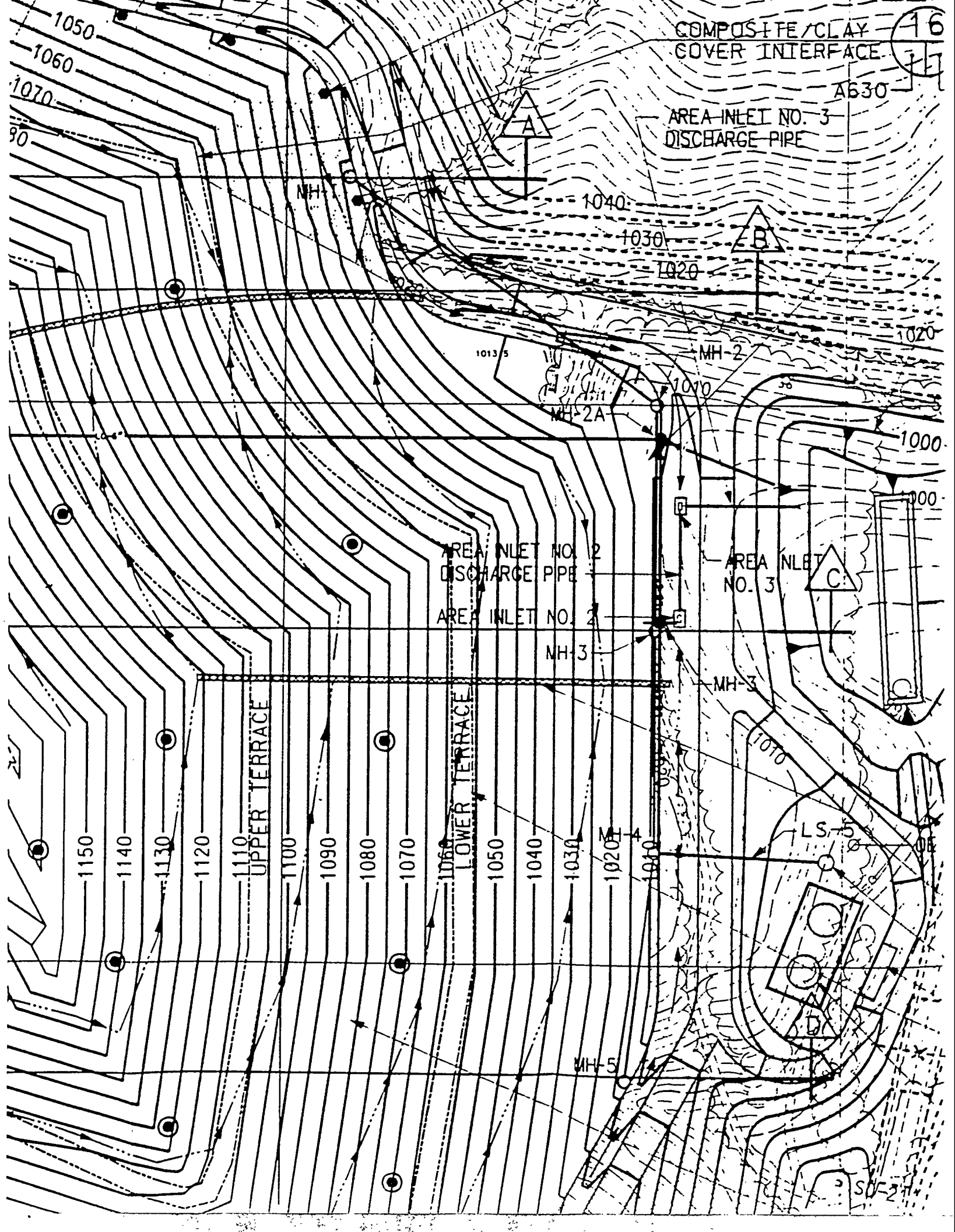
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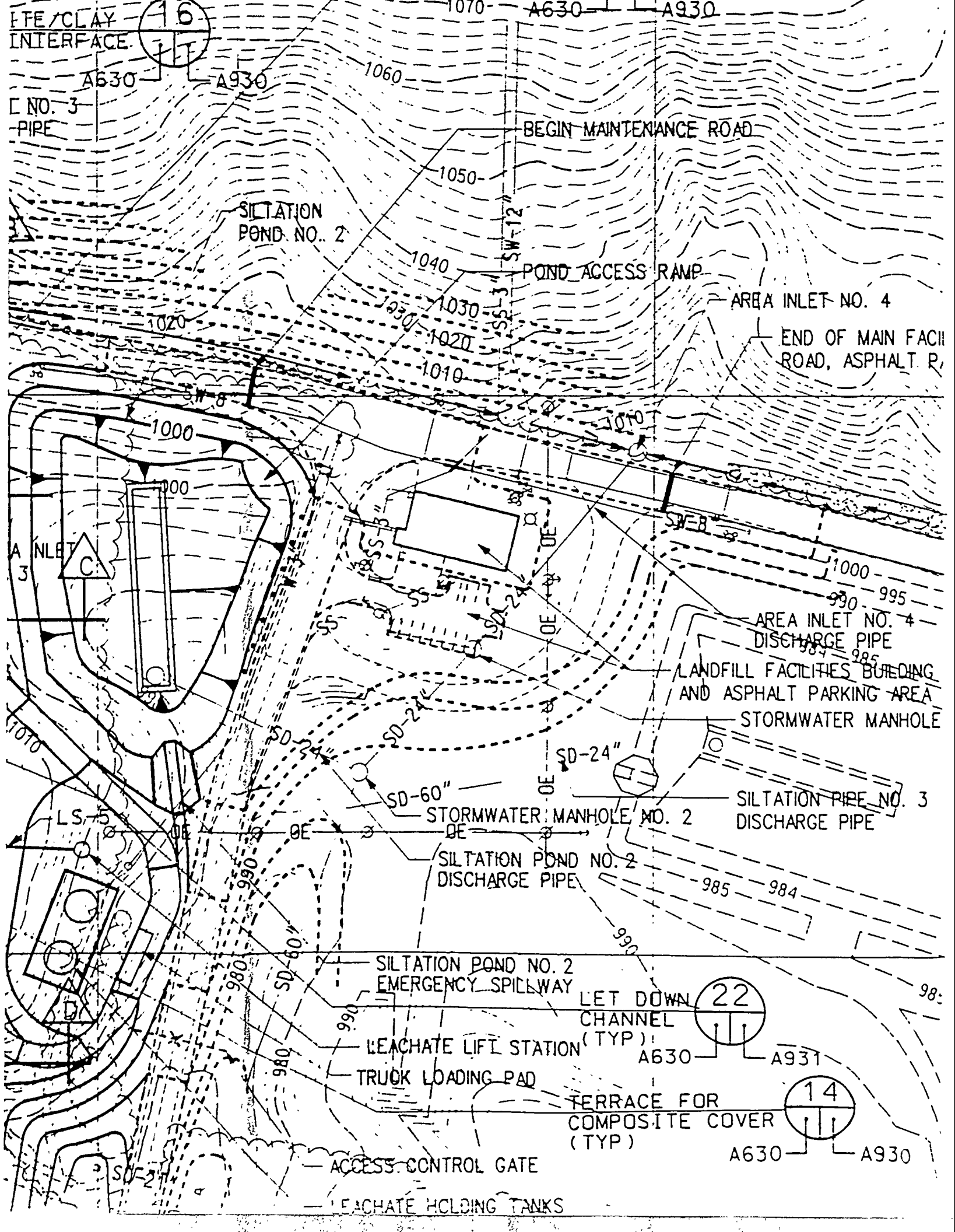
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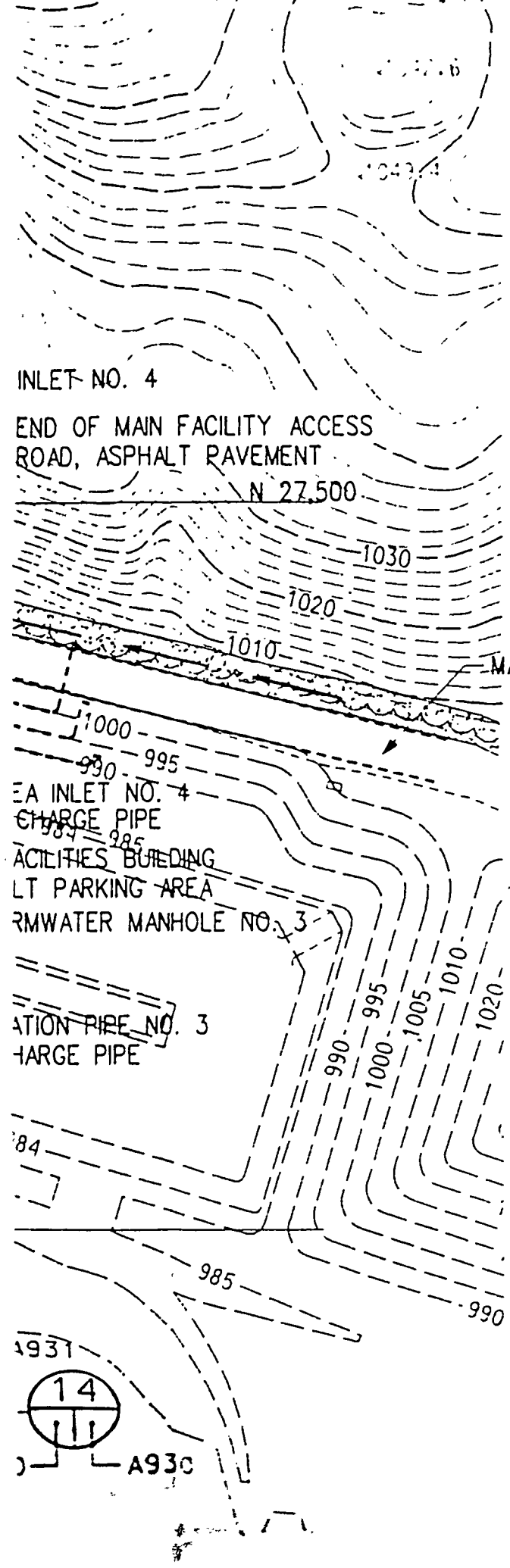
1. FOR LEGEND SEE DWG. C2E900000A703.
2. FINAL CLOSURE GRADE WILL BE PLACED AT TWO (2) FEET PLUS OR MINUS OF THE ACTUAL GRADE SHOWN.
3. MAXIMUM SLOPE WILL BE 3.5:1 (HORIZONTAL TO VERTICAL).
4. FINAL GRADING SHALL PREVENT THE ACCUMULATION OF WATER IN DEPRESSIONS ON DISPOSAL AREA.
5. EXISTING TOPOGRAPHY PROVIDED BY SURDEX CORPORATION. ST. LOUIS, MO. DATE OF PHOTOGRAPHY: 12-6-90.
6. ALL PROPOSED CONTOURS ARE FINISHED SURFACE ELEVATIONS.


N 27,500
N 27,000
STOCKPILE AREA AND POND ACCESS ROAD
POND ACCESS RAMP
SILTATION POND NO. 1
SILTATION POND NO. 1 EMERGENCY SPILLWAY
SILTATION POND NO. 1 DISCHARGE PIPE
STORMWATER MANHOLE NO. 1
A630
A
B
C
19
970
980
990
1000
1010
1020
1030
1040
1050
1060
1070
1080
1090


A
A631
B
A631
GW-799
C
A632
A INLET NO. 1
1020
WATER
E NO. 1
EAI INLET NO. 1
SCHARGE PIPE
19
GAS VENT
TYP
A930
D
A630
A632
GW-796
1030
1040
1050
1060
1070
1080
1090
1100
1110
1120
1130
1140
1150
1152
1151
1153

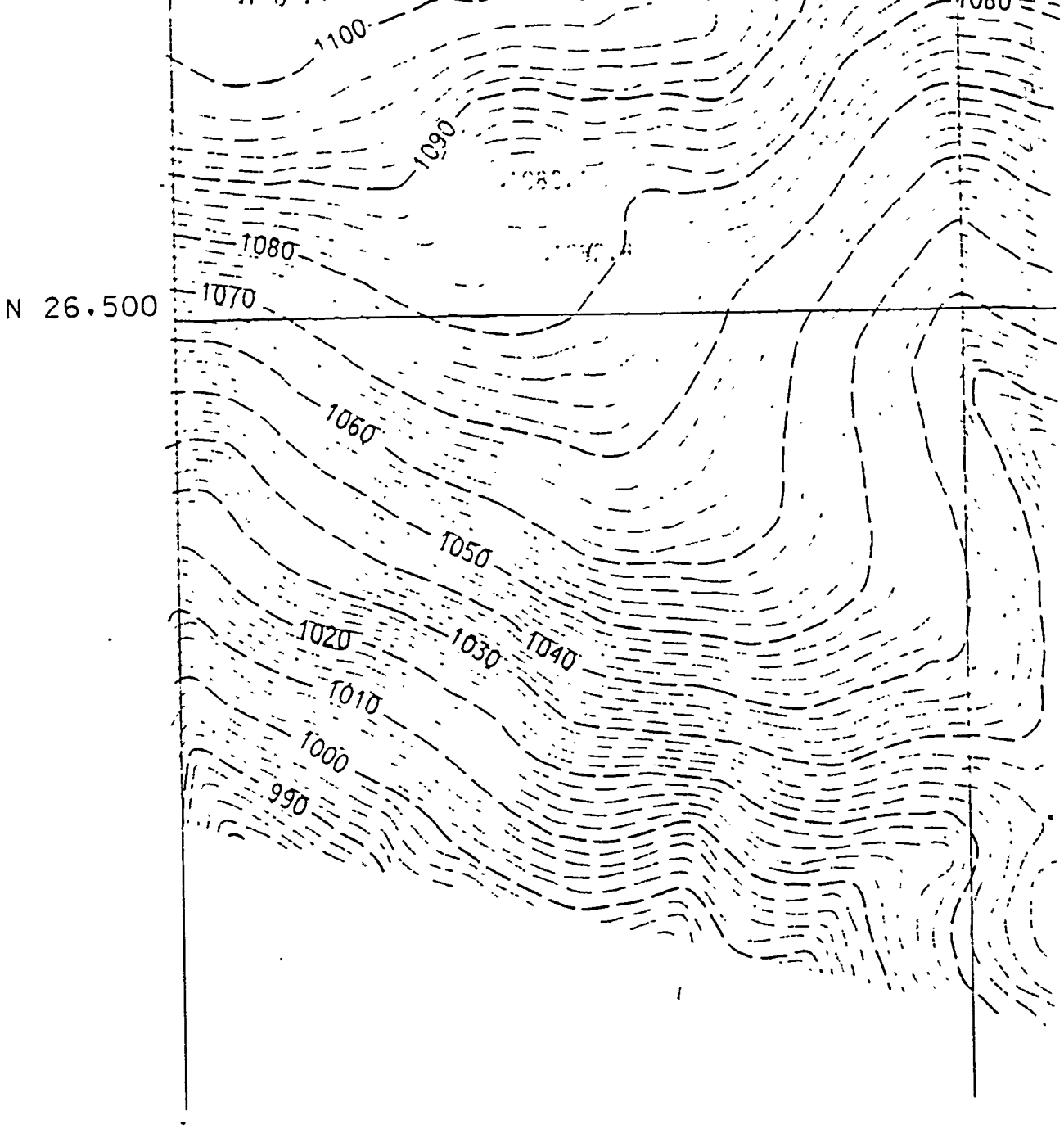

COMPOSITE/CLAY COVER INTERFACE
A630
AREA INLET NO. 3 DISCHARGE PIPE
AREA INLET NO. 2 DISCHARGE PIPE
AREA INLET NO. 2
AREA INLET NO. 3
MH-1
MH-2
MH-2A
MH-3
MH-4
MH-5
LS-1
UPPER TERRACE
LOWER TERRACE
A
B
C
D
1050
1060
1070
1040
1030
1020
1010
1000
1150
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010


FFE/CLAY INTERFACE
16
A630
A930
C NO. 3 PIPE
1070
A630
A930
1060
BEGIN MAINTENANCE ROAD
1050
SILTATION POND NO. 2
SW-12"
1040
POND ACCESS RAMP
1030
SS-3
1020
AREA INLET NO. 4
END OF MAIN FACI
ROAD, ASPHALT P
1010
SW-8"
1000
A INLET 3
C
SS
SD-24"
OE
995
990
985
AREA INLET NO. 4 DISCHARGE PIPE
LANDFILL FACILITIES BUILDING AND ASPHALT PARKING AREA
STORMWATER MANHOLE
SD-60"
STORMWATER MANHOLE NO. 2
SILTATION PIPE NO. 3 DISCHARGE PIPE
LS-5
SILTATION POND NO. 2 DISCHARGE PIPE
984
980
SILTATION POND NO. 2 EMERGENCY SPILLWAY
LET DOWN CHANNEL (TYP)
22
A630
A931
LEACHATE LIFT STATION
TRUCK LOADING PAD
TERRACE FOR COMPOSITE COVER (TYP)
14
A630
A930
ACCESS CONTROL GATE
LEACHATE HOLDING TANKS


INLET NO. 4
END OF MAIN FACILITY ACCESS ROAD, ASPHALT PAVEMENT
N 27.500
1030
1020
1010
MAINTENANCE ROAD
1000
995
990
EA INLET NO. 4
CHARGE PIPE
984
985
ACILITIES BUILDING
LT PARKING AREA
RMWATER MANHOLE NO. 3
ATION PIPE NO. 3
HARGE PIPE
990
995
1000
1005
1010
1020
84
N 27.000
985
990
931
14
A930

E

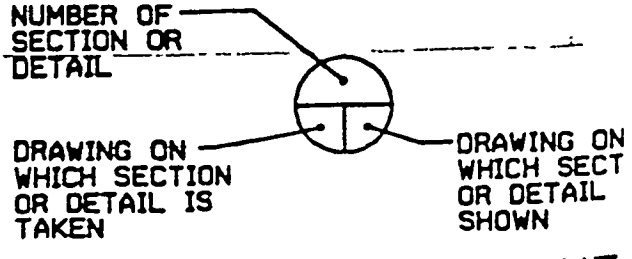
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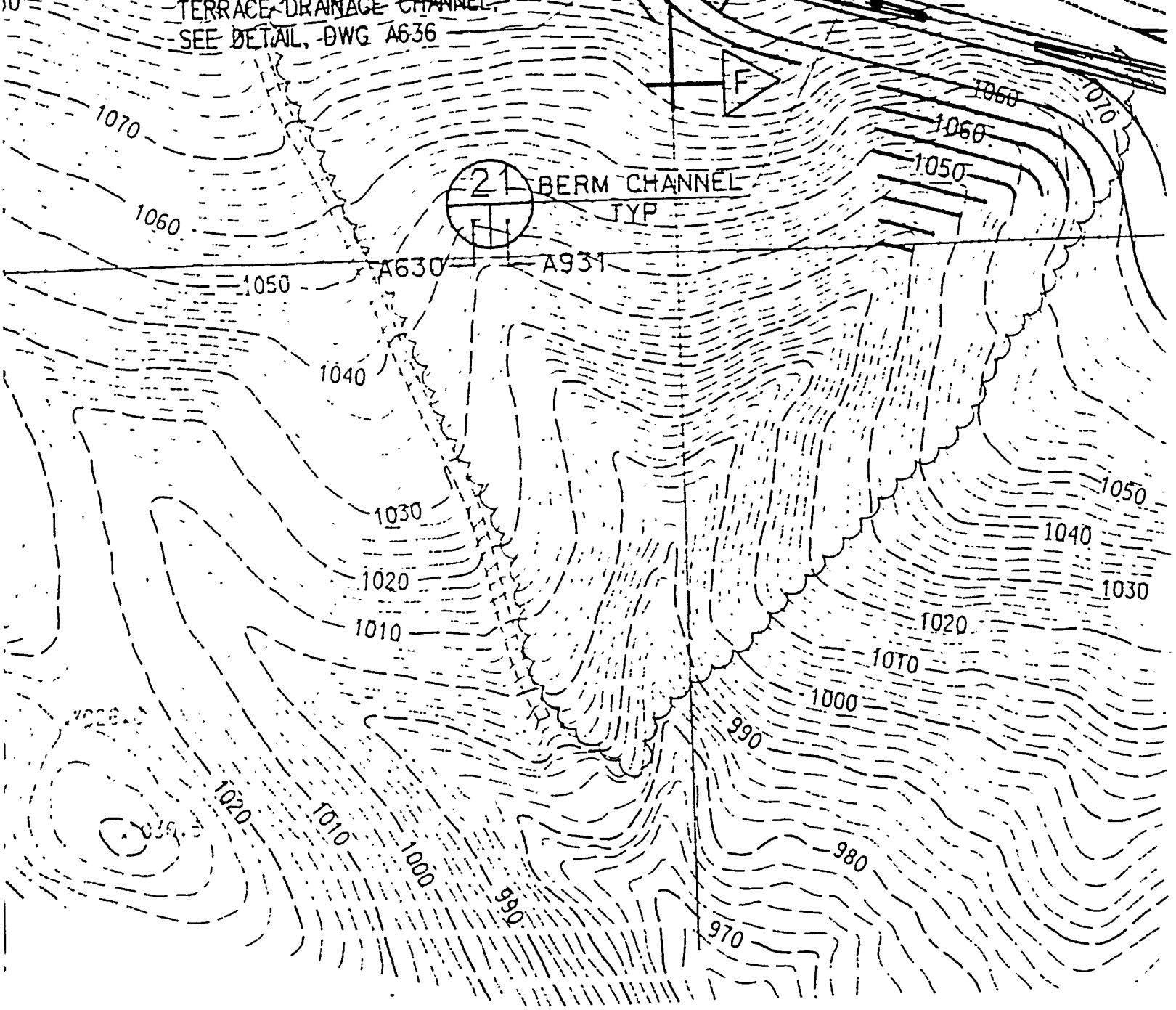
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Review By: _____
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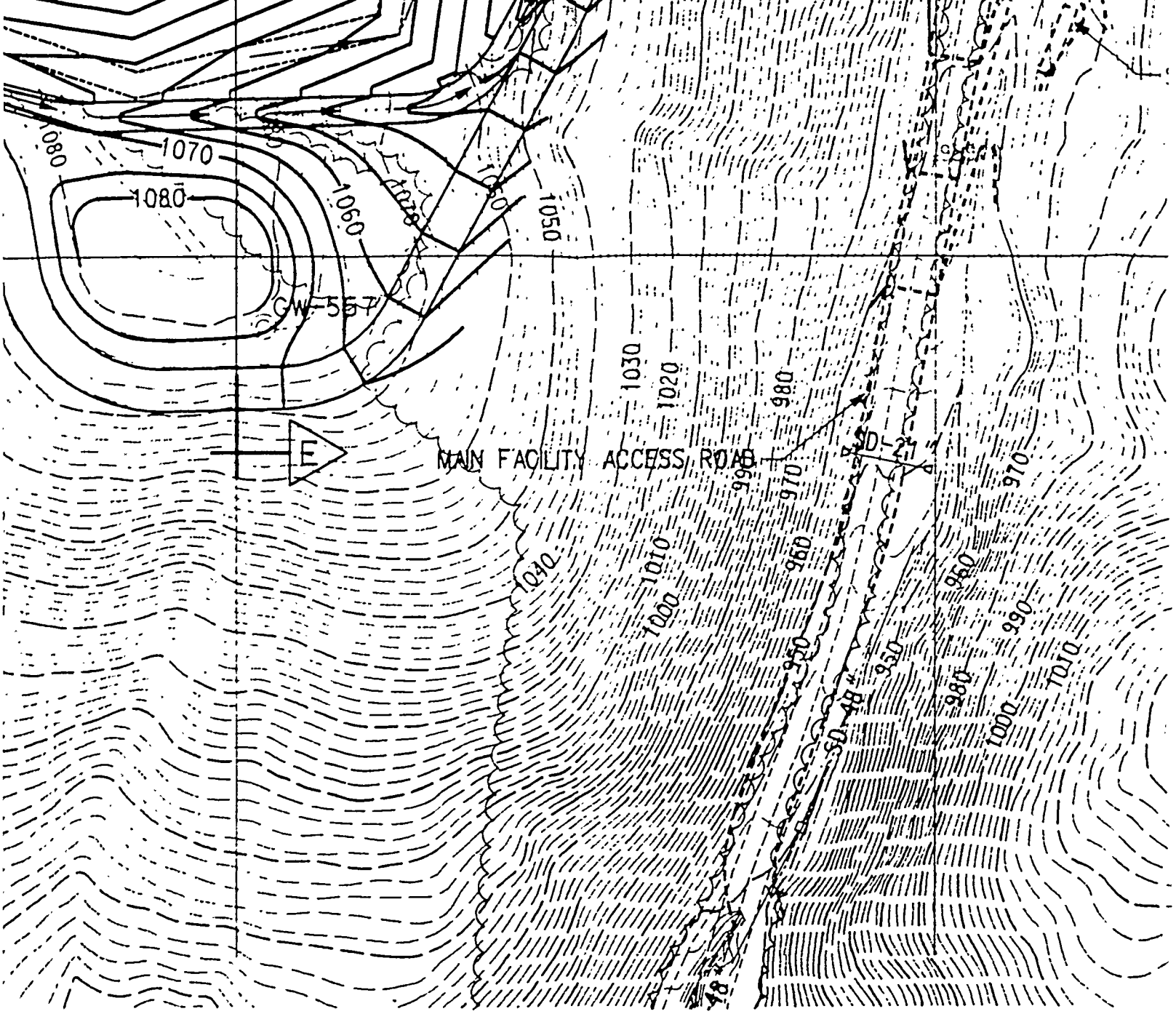
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CONTROLLED BY

CHANGE CONTROL
SYSTEM 2

ENGINEERING
PROCEDURE EP-C-18

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION
2				ISSUE FOR PERMITTING

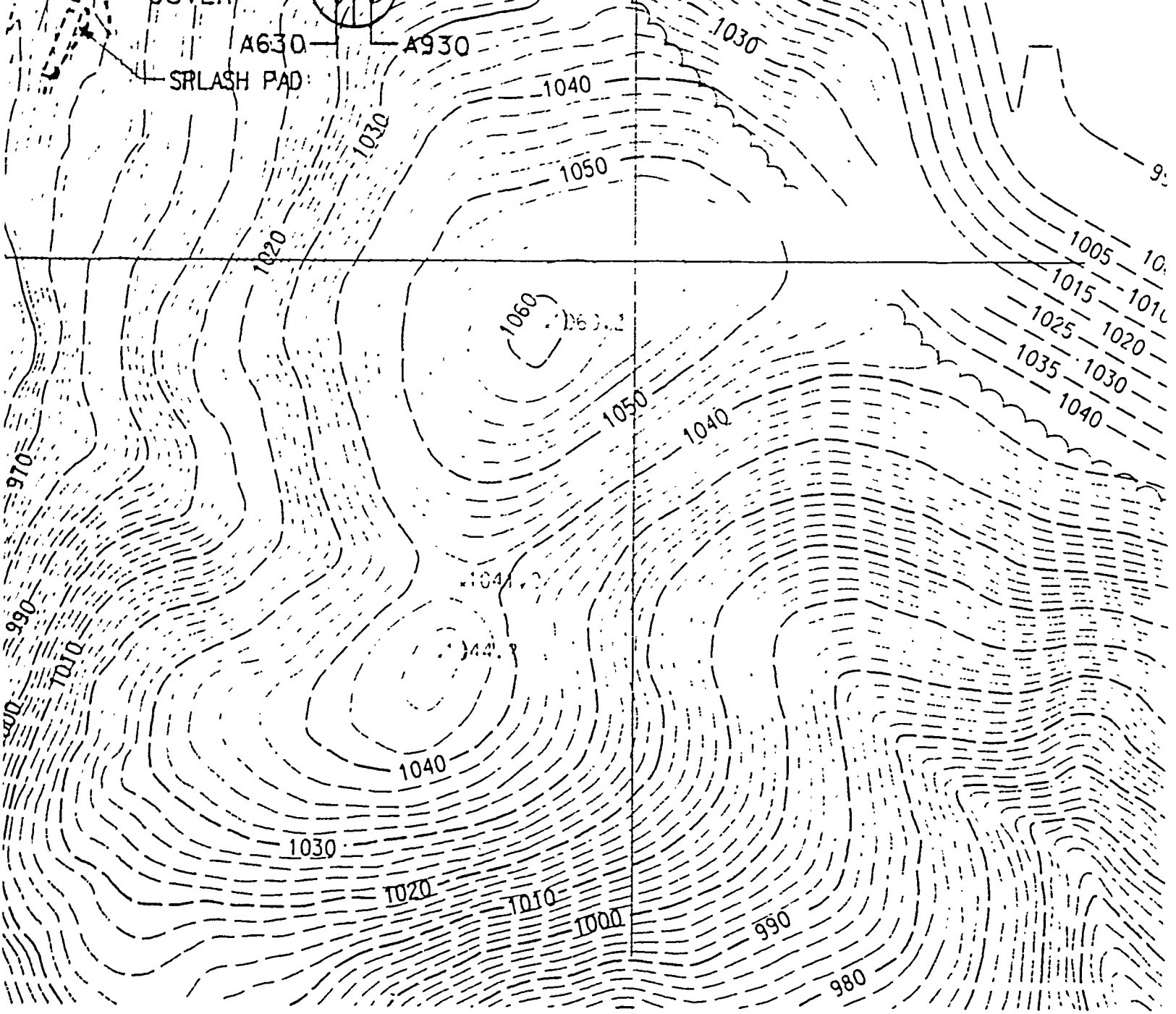
REVISION OR ISSUE PUR



	JGA	WPT	—	WW	8/9/95								
	BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RPE	RPE NO	DATE

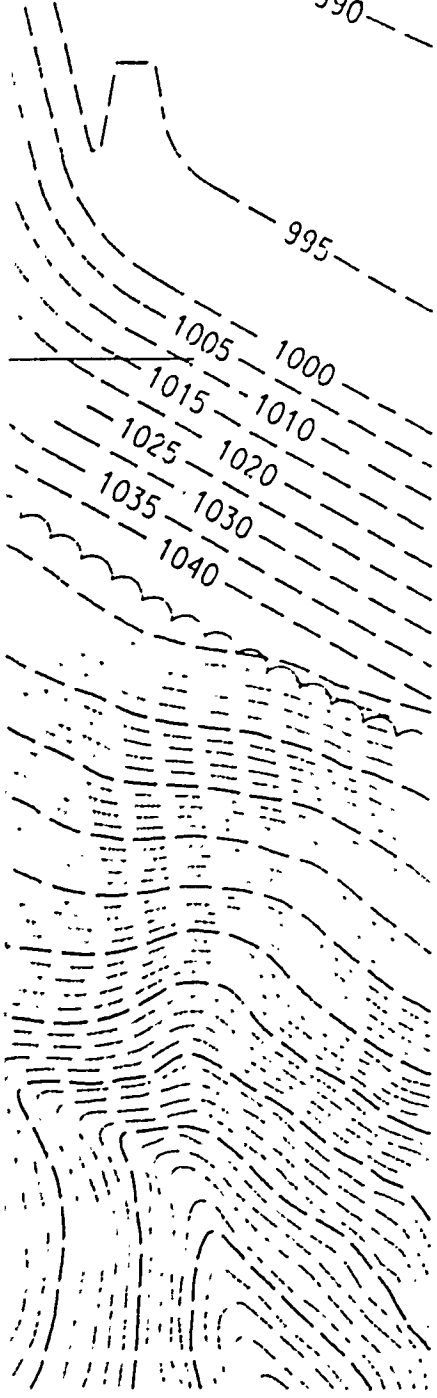
:POSE

REVISION APPROVALS



JPT	22811	8/19/99					—		—	—	—	—	—	—	—	—
RPE	RPE NO	DATE			QA	DATE	ST	CV	EC	EE	EM	IE	M	PD	SE	ARC

SQUAD CHECK



N 26,500

THIS DRAWING WAS O
CFC (REV. 0) BY BU
MISSOURI, DATED 1/
PERMIT PACKAGE FOR
THIS DRAWING SUPER
REVISIONS ARE BEIN
LANDFILL DEVELOPME
TDEC REGULATORY CH

2 GENERAL REVISION
REVISED THE FOLLC
FINAL CONTOUR ELE
ADDED COMPOSITE C
BERM CHANNEL LOCA
LET DOWN CHANNEL
REMOVED PERIMETEF
ADDED LEACHATE MA
REVISED MONITORIN

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, DATES AND WITH THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES.

—	—	—	—
PD	SE	ARC	VER

RPE

WILLIAM PATRICK TAYLOR
REGISTERED ENGINEER
AGRICULTURE
No. 022415
STATE OF TENNESSEE

DSGN		8/19/95
DRW	Brian G. Ashworth	8/19/95
CHKR	W P Taylor	8/19/95
SECT	—	
DEPT	William L. Crosh	8/19/95
PE		
PJ		8/28/95
REQ		

REV. 0 DATE 8/19/95 MMES

DRAWING APPROVALS

FOSTER WHEE
designed for th
managed fo
under U.S
Oak

Y-12

F

1	48	49	5
3	C	P	

51	52
NC	NA

THIS DRAWING WAS ORIGINALLY ISSUED FOR PERMITTING/ CFC (REV. 0) BY BURNS AND McDONNELL, KANSAS CITY, MISSOURI, DATED 1/25/92, AND WAS PART OF A LANDFILL PERMIT PACKAGE FOR THE Y-12 INDUSTRIAL LANDFILL V. THIS DRAWING SUPERCEDES THE ORIGINAL DRAWING, AND REVISIONS ARE BEING MADE TO REFLECT ADDITIONAL LANDFILL DEVELOPMENT, AND FOR COMPLIANCE WITH TDEC REGULATORY CHANGES.

GENERAL REVISION
REVISED THE FOLLOWING:
2 FINAL CONTOUR ELEVATIONS
ADDED COMPOSITE COVER WITH PASSIVE VENT SYSTEM
BERM CHANNEL LOCATIONS
LET DOWN CHANNEL LOCATIONS
REMOVED PERIMETER GAS VENTS IN AREAS 2-5
ADDED LEACHATE MANHOLES 2A & 3A
REVISED MONITORING WELL NUMBERS

SUBSEQUENT REVISIONS
MES, INITIALS, DATES
APPLICABLE, ARE

100 0 100 200 300 FT

SCALE: 1"=100'

	8/19/95
	8/19/95
	8/19/95
	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

FINAL CLOSURE PLAN

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	T	Y-12	YAREA	A	1	1	P	U

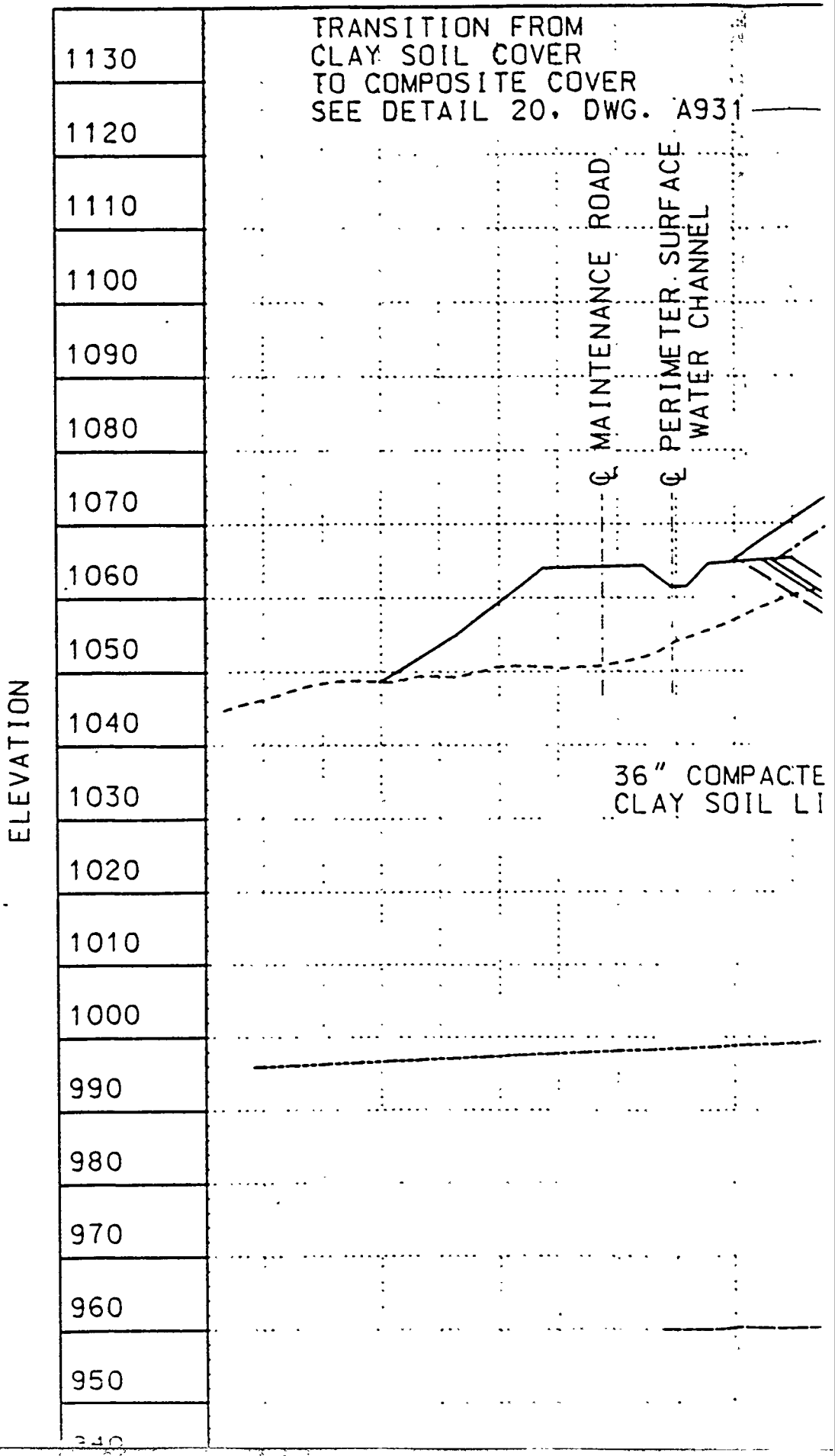
51	52	53		REV
NC	NA	AR	C2E900000A630	2

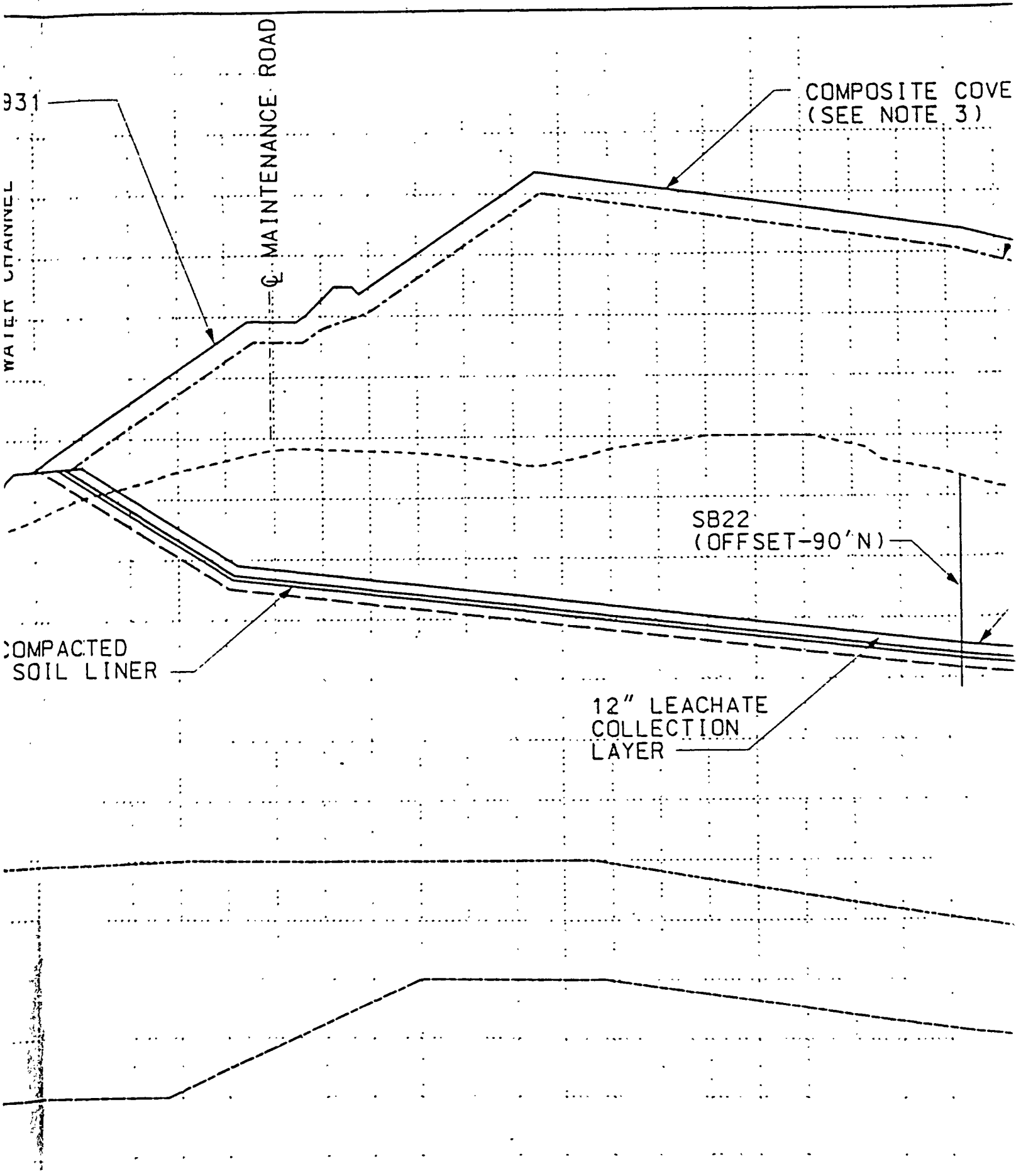
C2E900000A630

C

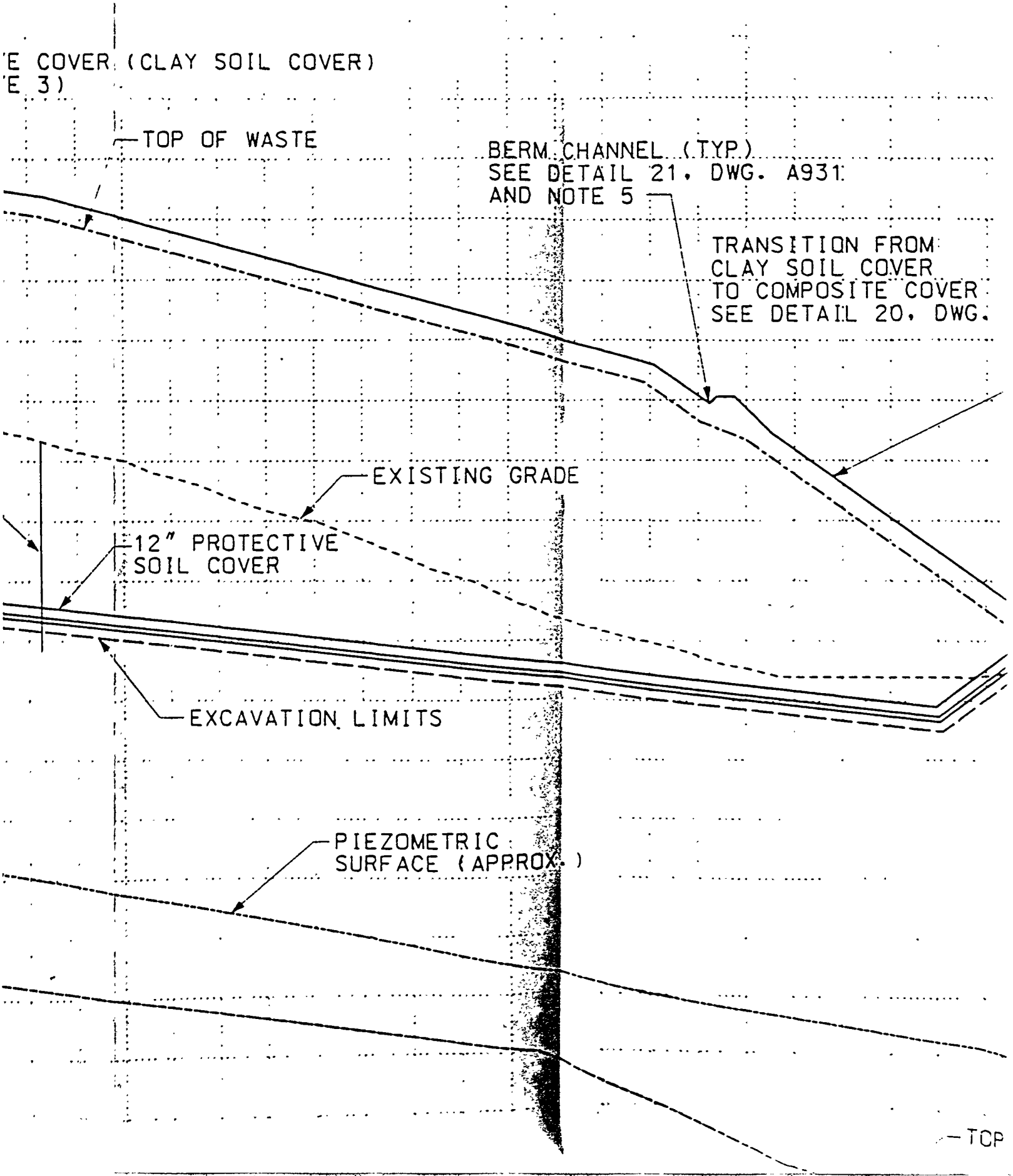
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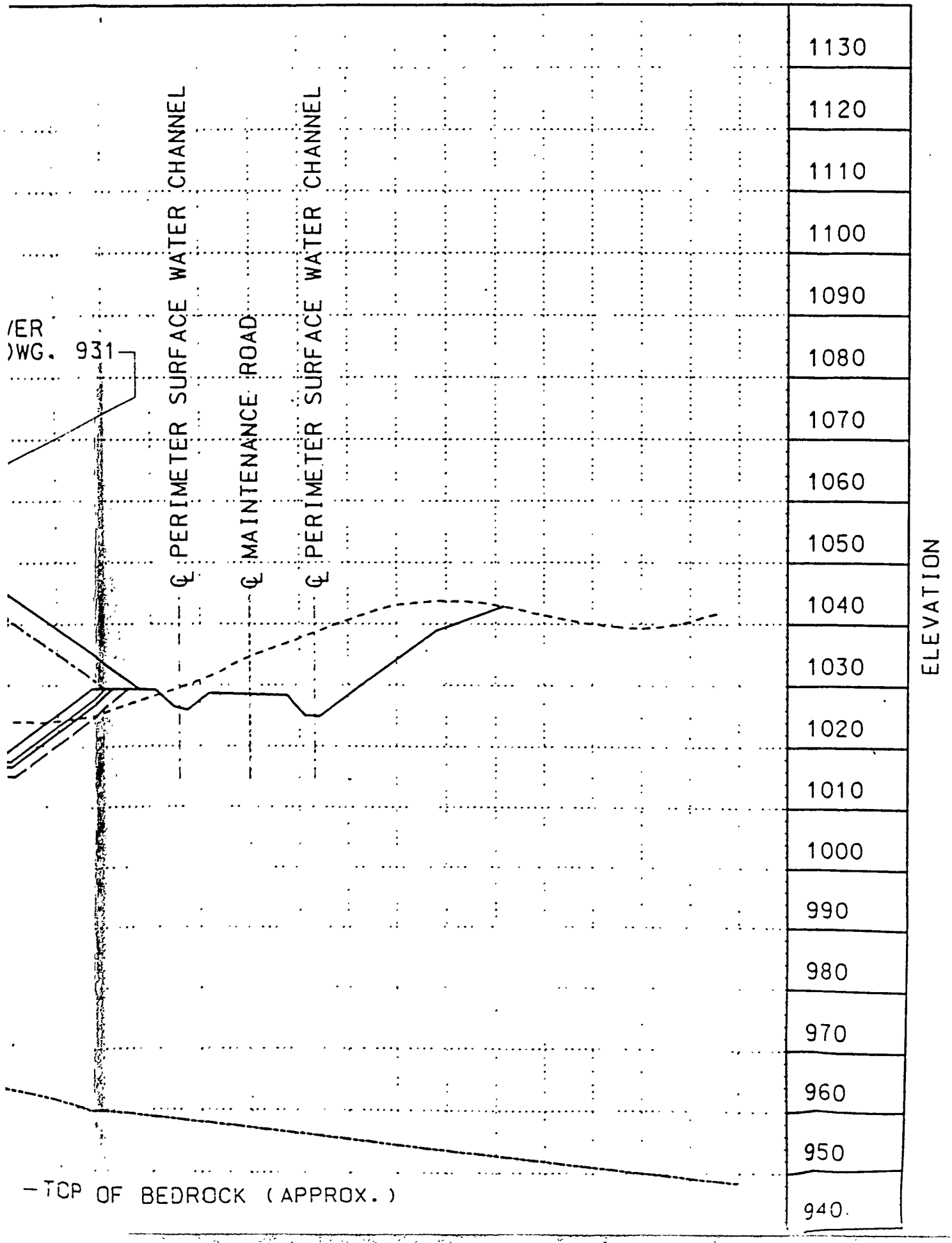
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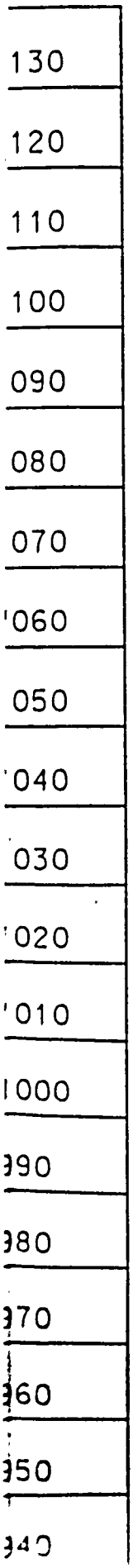

TRANSITION FROM
CLAY SOIL COVER
TO COMPOSITE COVER
SEE DETAIL 20, DWG. A931
℄ MAINTENANCE ROAD
℄ PERIMETER SURFACE
WATER CHANNEL
ELEVATION
1130
1120
1110
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010
1000
990
980
970
960
950
36" COMPACTE
CLAY SOIL LI


931
WATER CHANNEL
℄ MAINTENANCE ROAD
COMPOSITE COVE
(SEE NOTE 3)
SB22
(OFFSET-90'N)
COMPACTED
SOIL LINER
12" LEACHATE
COLLECTION
LAYER

5


'E COVER (CLAY SOIL COVER)
'E 3)
TOP OF WASTE
BERM CHANNEL (TYP.)
SEE DETAIL 21, DWG. A931
AND NOTE 5
TRANSITION FROM
CLAY SOIL COVER
TO COMPOSITE COVER
SEE DETAIL 20, DWG.
EXISTING GRADE
12" PROTECTIVE
SOIL COVER
EXCAVATION LIMITS
PIEZOMETRIC
SURFACE (APPROX.)
TOP


1130
1120
1110
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010
1000
990
980
970
960
950
940
ELEVATION
℄ PERIMETER SURFACE WATER CHANNEL
℄ MAINTENANCE ROAD
℄ PERIMETER SURFACE WATER CHANNEL
/ER
)WG. 931
TOP OF BEDROCK (APPROX.)



NOTES:

1. EXISTING AND PRO
   ARE SHOWN ON CRO
   VARY SLIGHTLY BA
   MAPPING AND CONS
2. THEORETICAL FINA
   SHOWN ON CROSS-S
   AND SLOPES WILL
3. MAXIMUM SLOPE OF
   (HORIZONTAL TO V
   ABOVE ELEV 1150
4. FINAL GRADING SH
   ACCUMULATION OF
5. ALL BERM CHANNEL
   BERM LOCATIONS S

NEXT ASS'Y:

FINAL ASS'Y:

NOTES:

1. EXISTING AND PROPOSED SITE PREPARATION ELEVATIONS ARE SHOWN ON CROSS-SECTIONS. ELEVATIONS MAY VARY SLIGHTLY BASED ON ACCURACY OF AERIAL MAPPING AND CONSTRUCTION TOLERANCES.

2. THEORETICAL FINAL CLOSURE ELEVATIONS ARE SHOWN ON CROSS-SECTIONS. ACTUAL ELEVATIONS AND SLOPES WILL VARY ±2 FT.

3. MAXIMUM SLOPE OF CLOSED FACILITY WILL BE 3.5:1 (HORIZONTAL TO VERTICAL), EXCEPT THAT THE SLOPE ABOVE ELEV 1150 IS APPROXIMATELY 5%.

4. FINAL GRADING SHALL BE PERFORMED TO PREVENT THE ACCUMULATION OF WATER IN DEPRESSIONS ON DISPOSAL AREA.

5. ALL BERM CHANNELS ARE NOT SHOWN. FOR APPROXIMATE BERM LOCATIONS SEE DWG C2E900000A630.

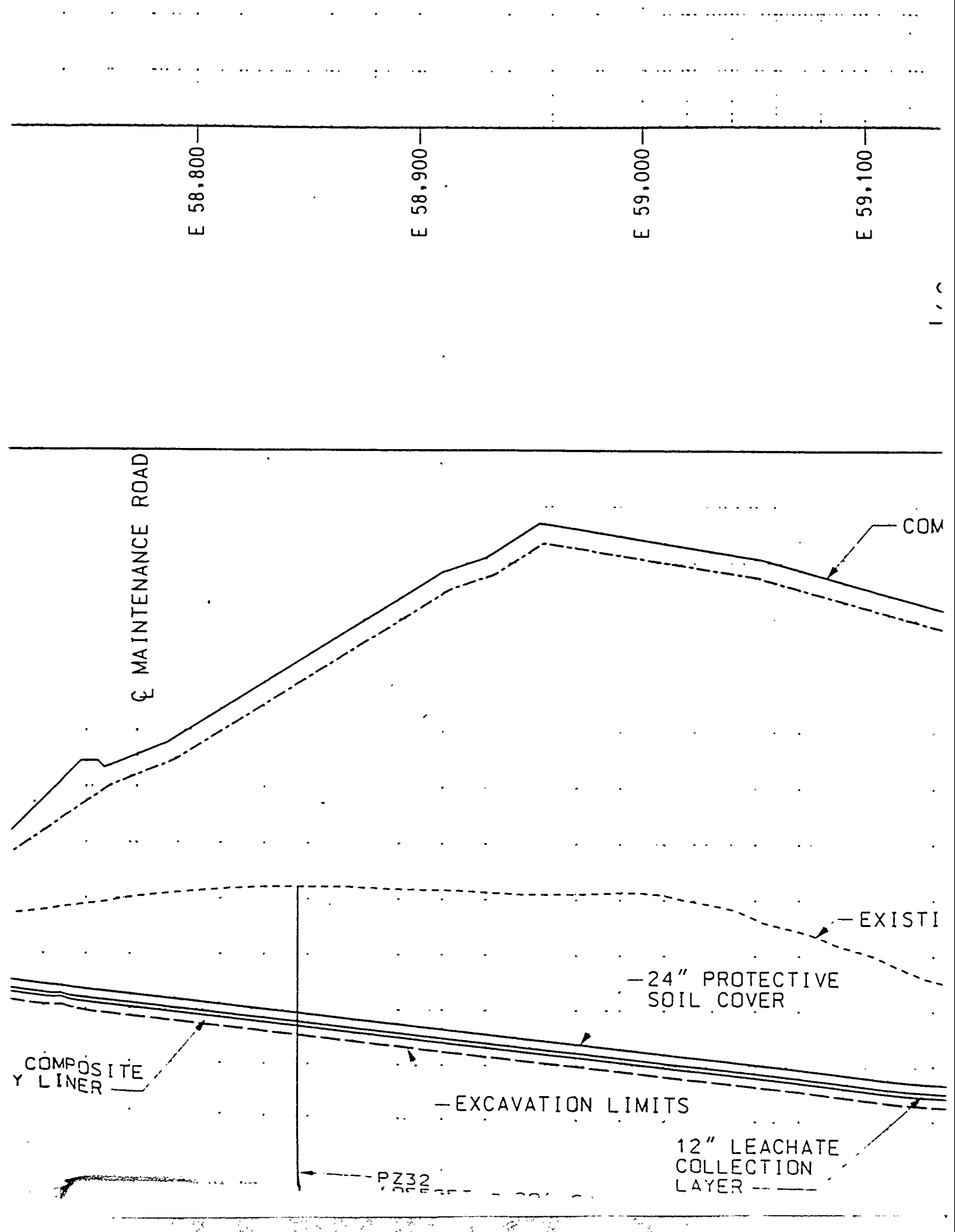
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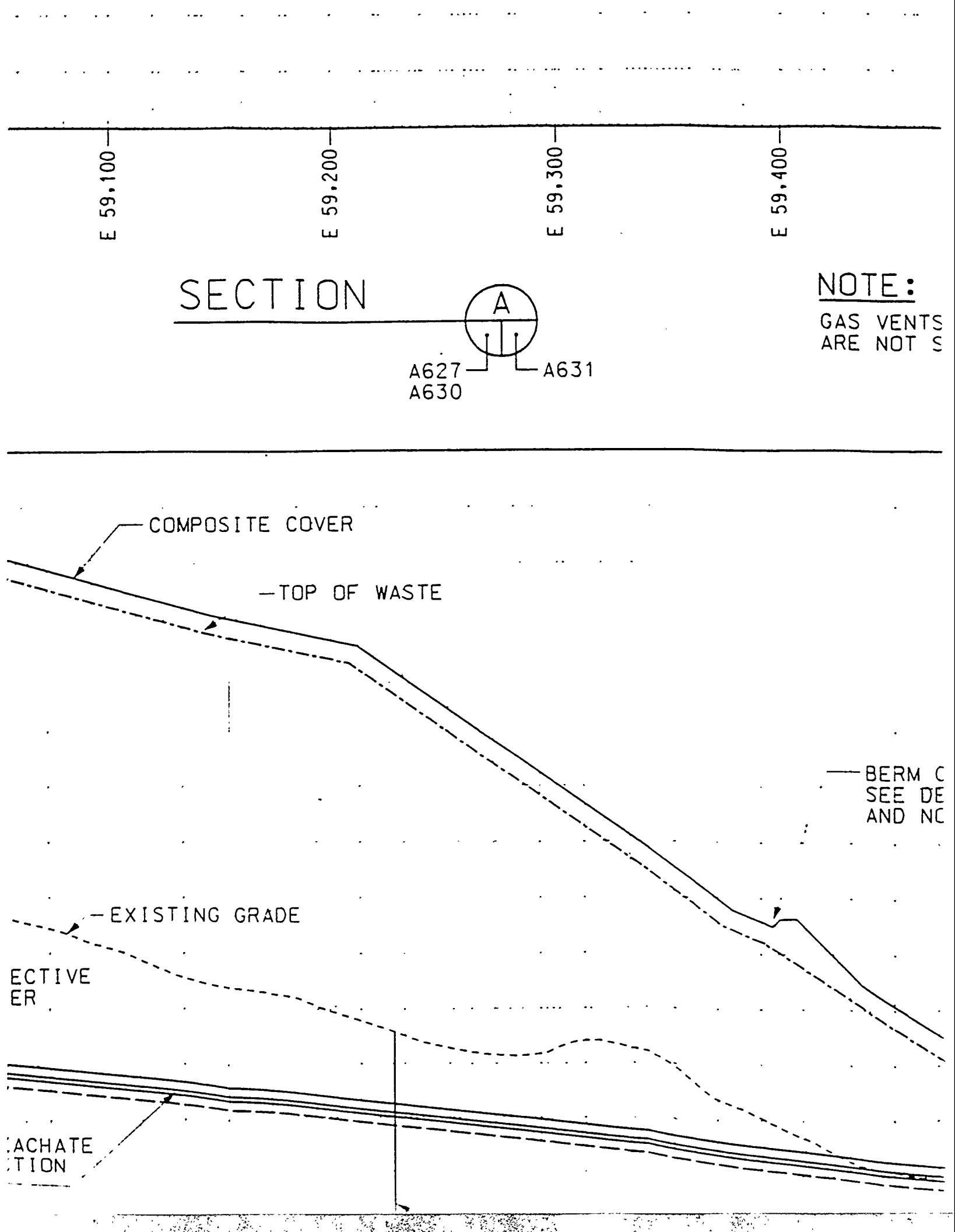
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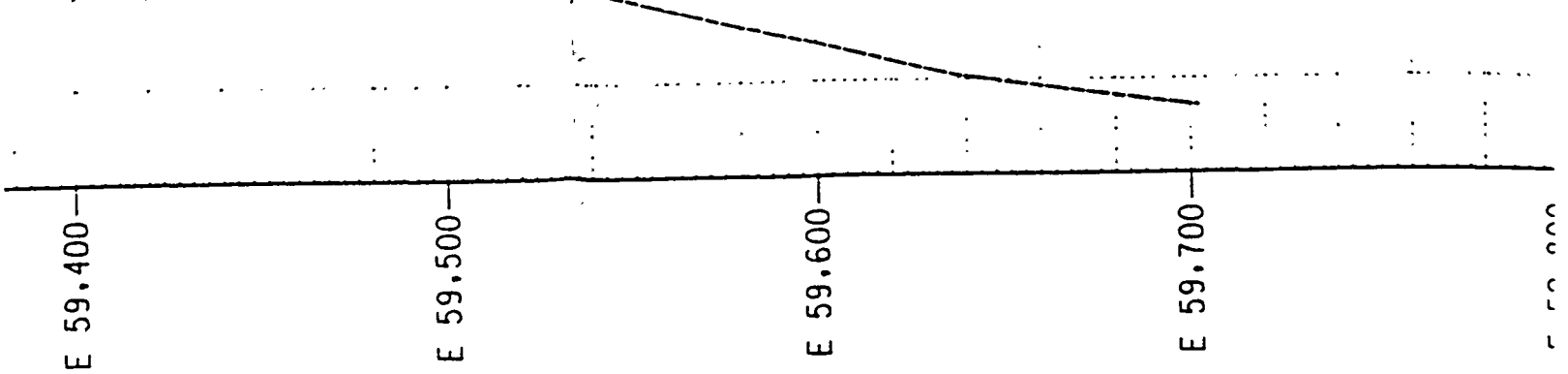
F

920
910
E 58,600
E 58,700

1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010
ELEVATION
℄ MAINTENANCE ROAD
℄ PERIMETER SURFACE WATER CHANNEL
24" COMPOSI
CLAY LINER

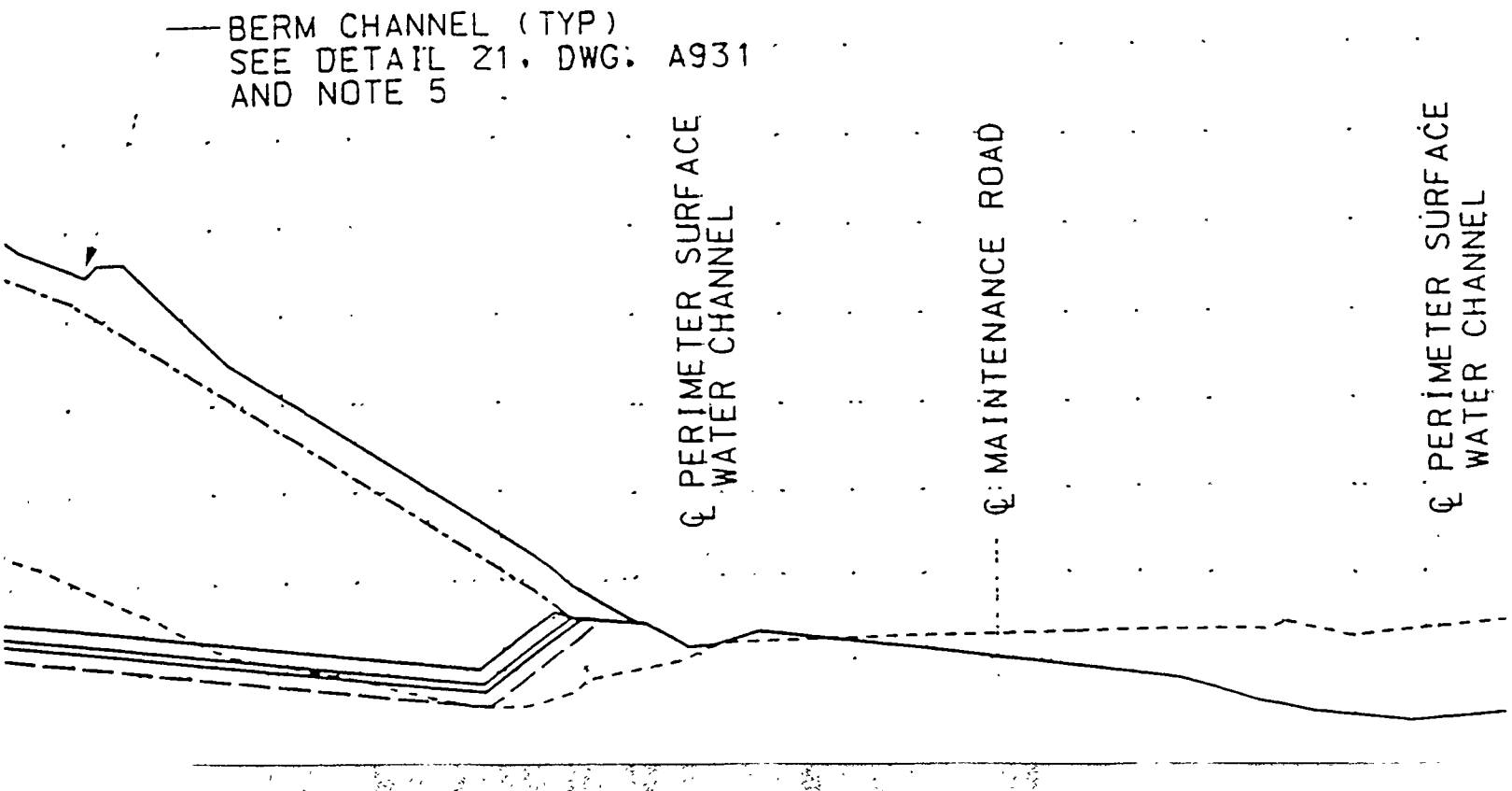

E 58,800
E 58,900
E 59,000
E 59,100
℄ MAINTENANCE ROAD
COM
EXISTI
24" PROTECTIVE SOIL COVER
COMPOSITE
Y LINER
EXCAVATION LIMITS
12" LEACHATE COLLECTION LAYER
PZ32


E 59,100
E 59,200
E 59,300
E 59,400
SECTION
A
A627
A630
A631
NOTE:
GAS VENTS
ARE NOT S
COMPOSITE COVER
TOP OF WASTE
BERM C
SEE DE
AND NC
EXISTING GRADE
ECTIVE
ER
ACHATE
TION



NOTE:

GAS VENTS LOCATED IN THE COMPOSITE COVER ARE NOT SHOWN FOR CLARITY.



920

910

E 59,800

1140

1130

1120

1110

1100

1090

1080

1070

1060

1050

1040

1030

1020

1010

℄ PERIMETER SURFACE
WATER CHANNEL

E

40

30

20

10

00

)90

)80

)70

)60

)50

)40

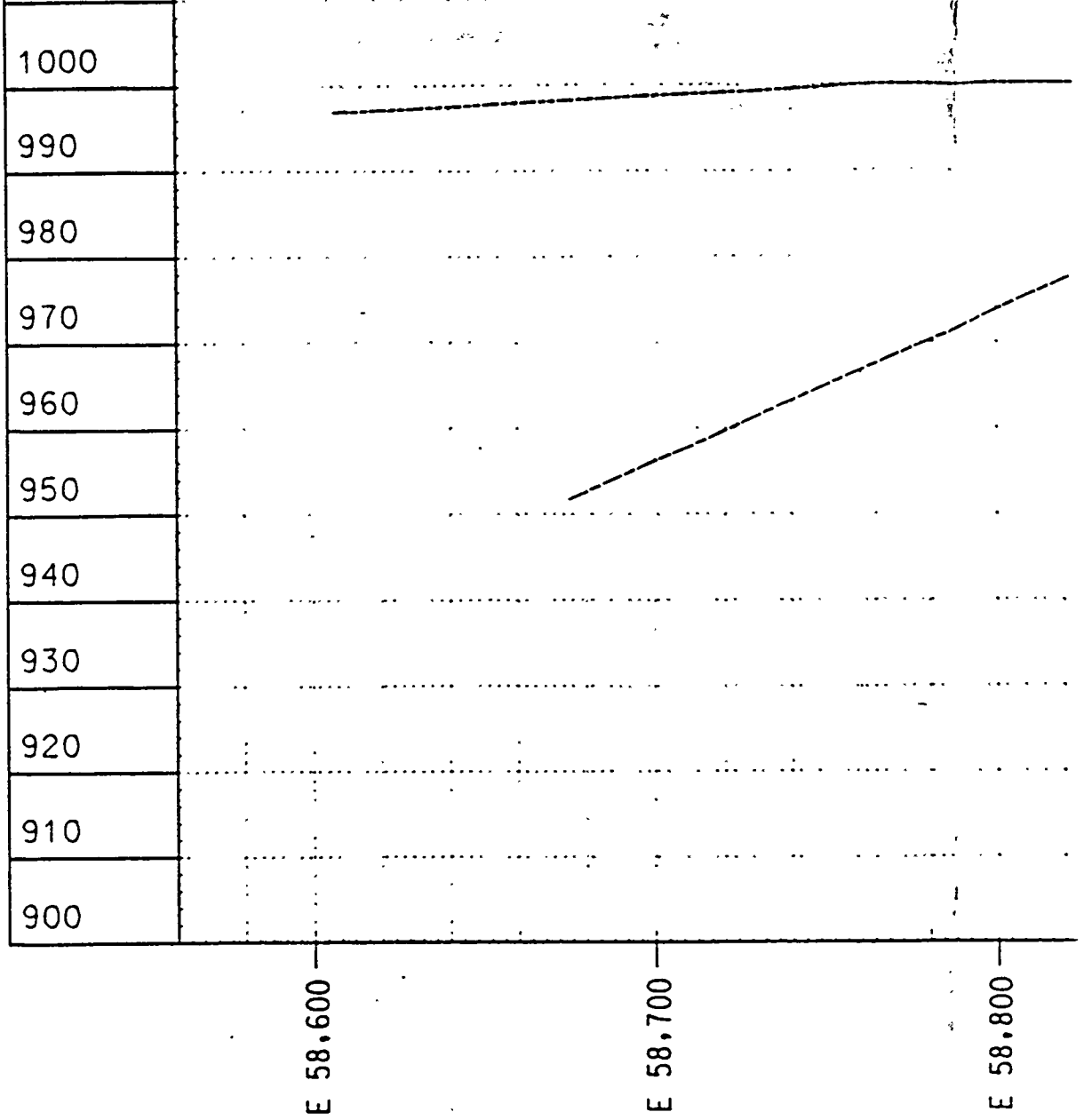
)30

020

)10

ELEVATION

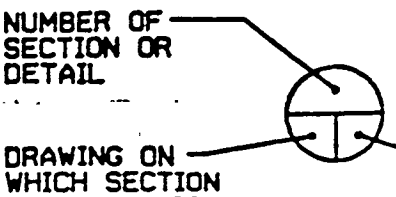
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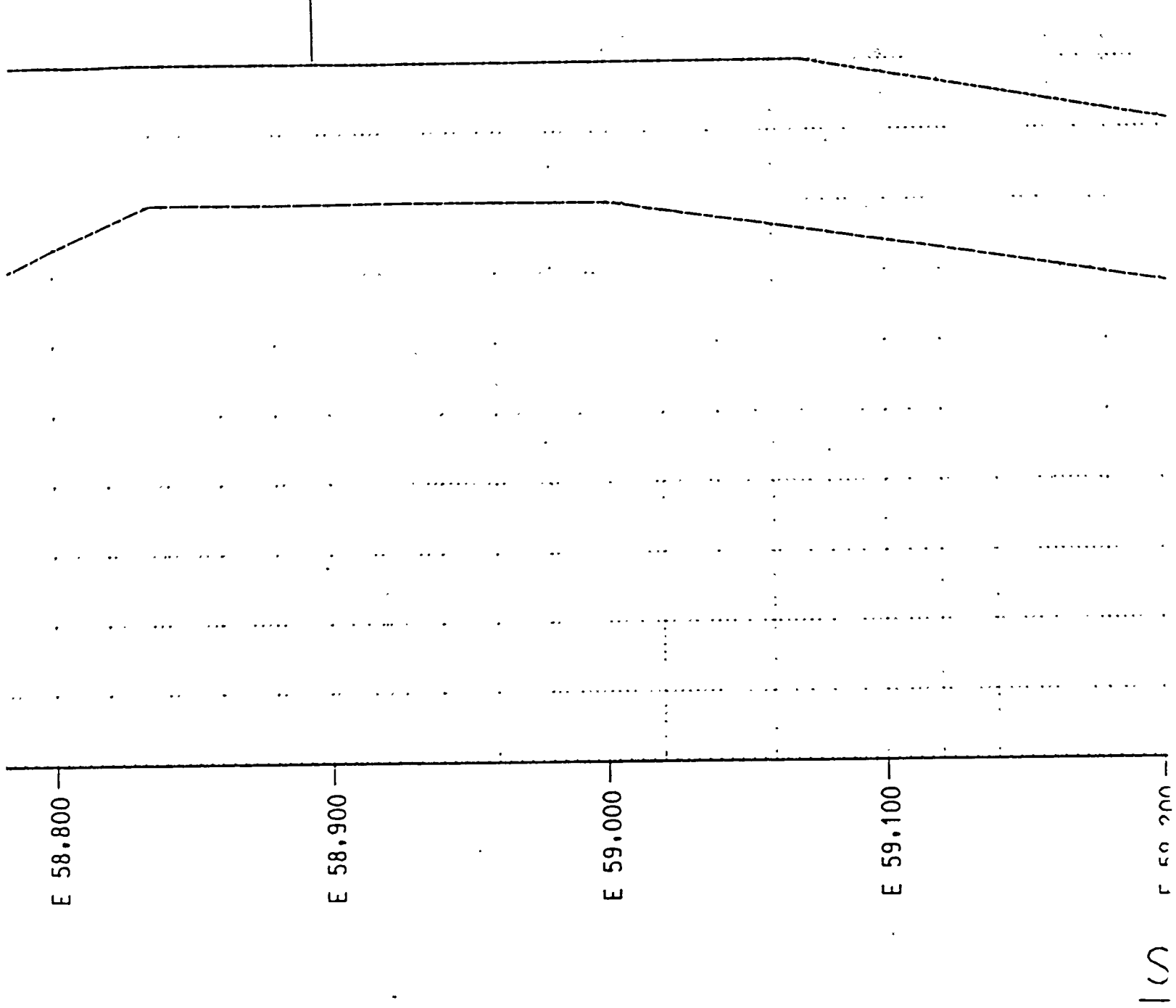
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EG-C-37 Review B
Guideline Docume
UCN-19586 12356

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SECTION AND DETAIL KEY



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Document: _____
(12356 4-93)

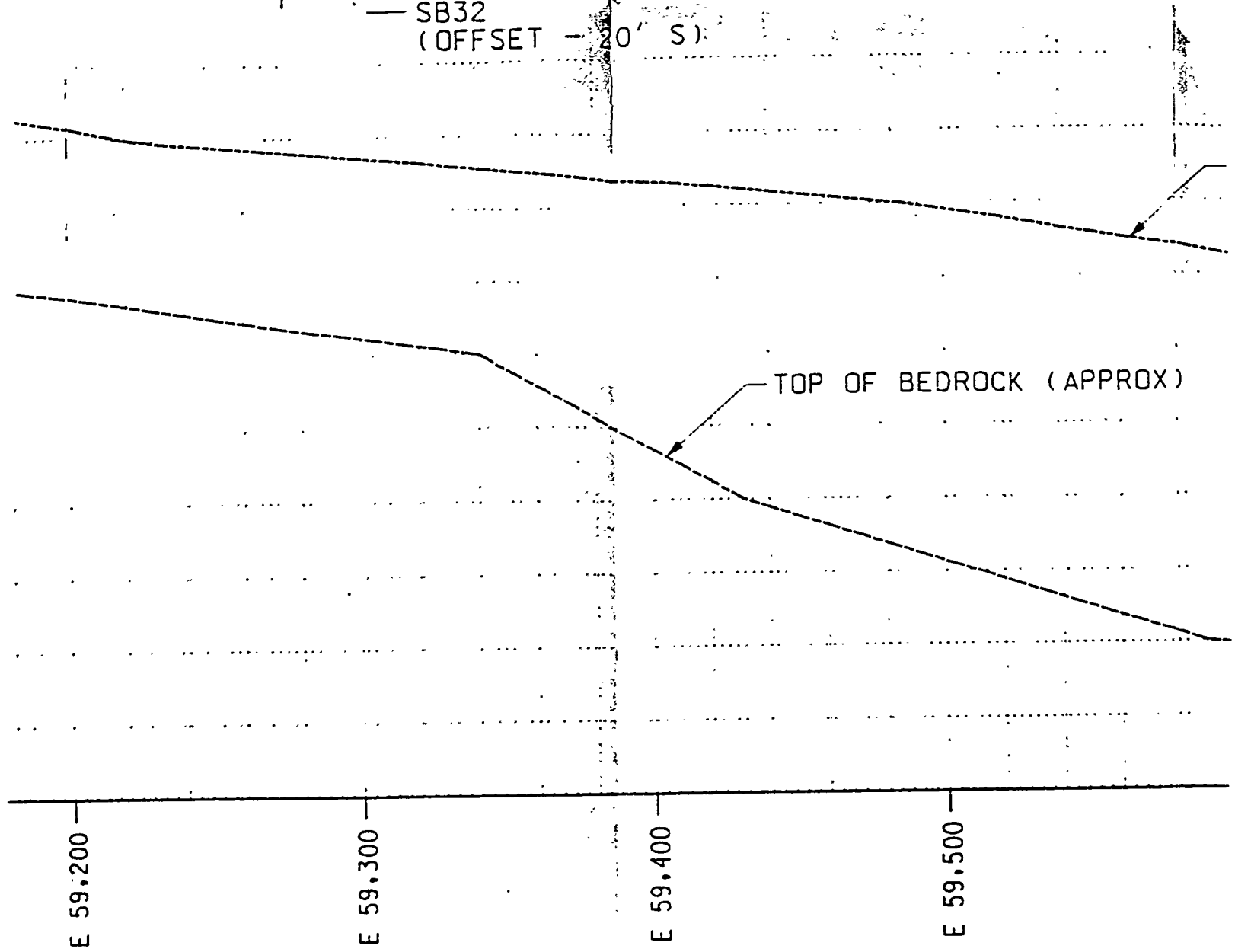
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CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

; ON
ECTION
IL IS

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION
2				ISSUE FOR PERMITTING



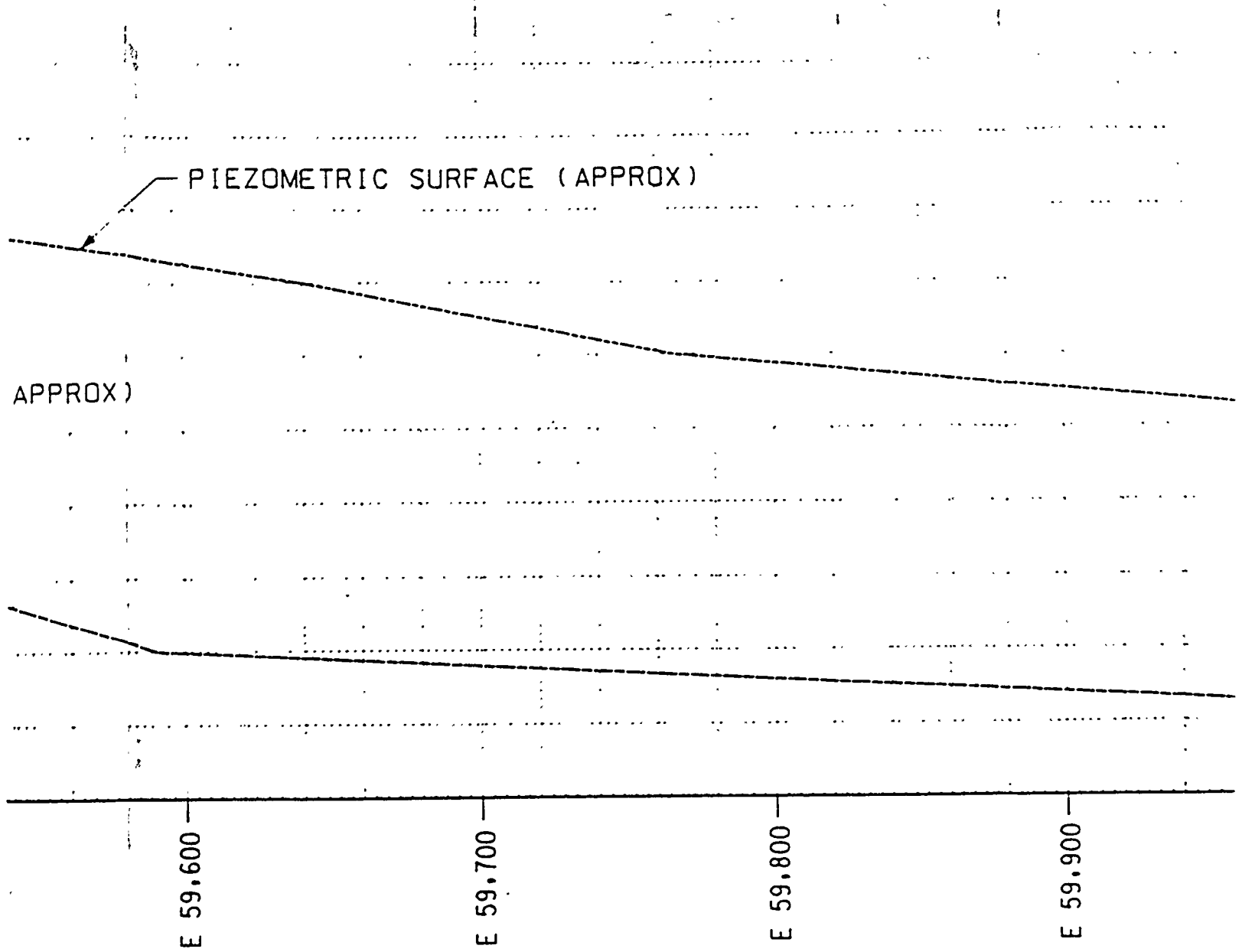
SECTION B

A627
A630
A631

NOTE:

GAS VENTS L
ARE NOT SHC

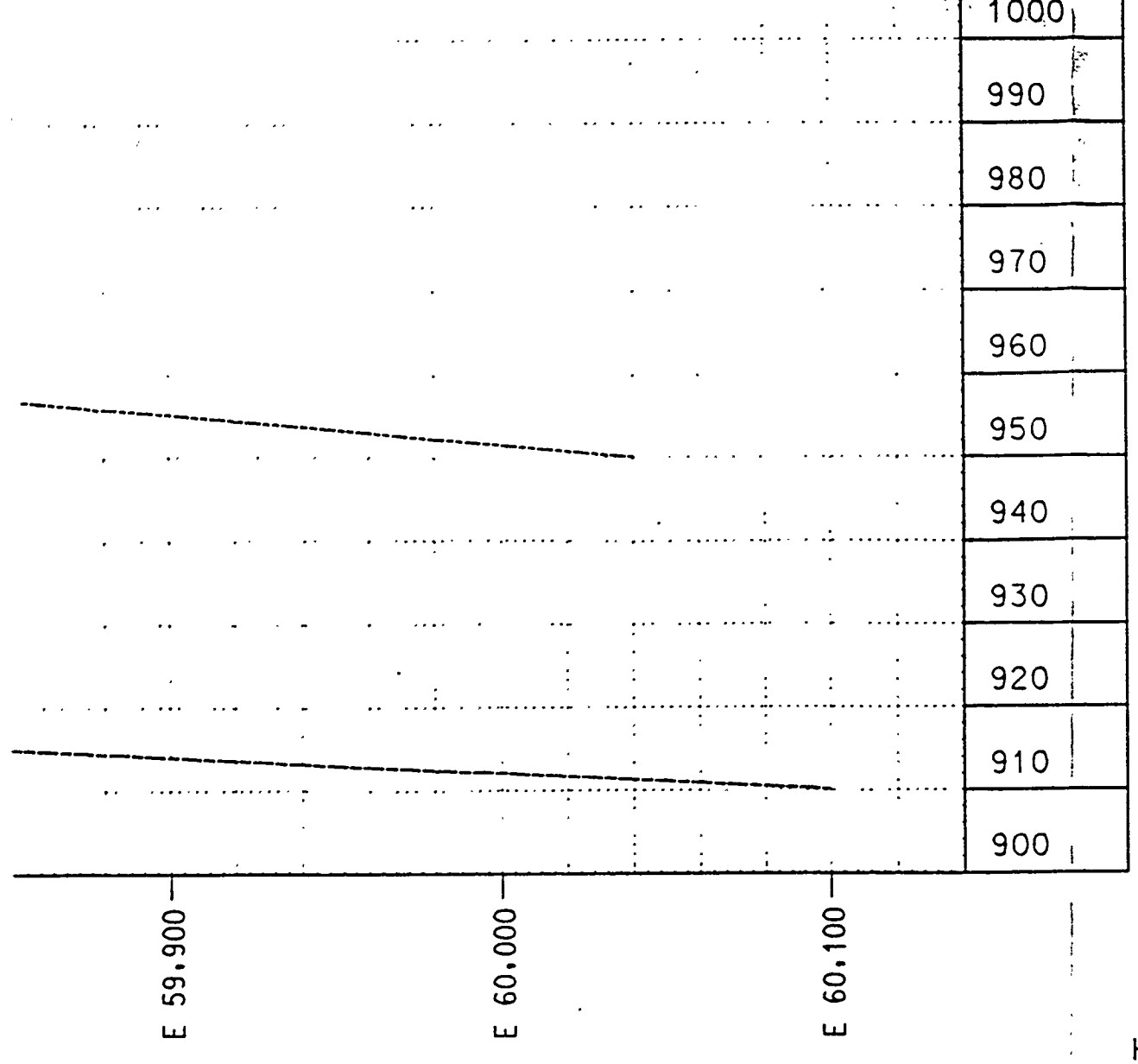
BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RPE	RPE NO	D
JCA	WPT	—	LLC	8/14/95				DNR	8/18/95	WPT	22511	



OTE:

AS VENTS LOCATED IN THE COMPOSITE COVER
RE NOT SHOWN FOR CLARITY.

WPT	22511	9/19/95					—	DLW	—	—	—	—	—	—	—	—
RPE	RPE NO	DATE			QA	DATE	ST	CV	EC	EE	EM	IE	M	PD	SE	ARC



THIS DRAW
CFC (REV.
MISSOURI.
PERMIT PAC
THIS DRAW
REVISIONS
LANDFILL [
TDEC REGUL

THE
THER
AND
MAIN

HORIZONTAL

VERTICAL

					RPE	DSGN	8/19/95
					WILLIAM PATRICK TAYLOR REGISTERED ENGINEER AGRICULTURE 8/19/95 No. 022.811 STATE OF TENNESSEE	DRW	8/19/95
						CHKR	8/19/95
						SECT	
						DEPT	8/19/95
						PE	
						PJ	8/28/95
						REQ	
—	—	—	—	—			
M	PD	SE	ARC	VER	REV. 0 DATE 8/19/95	MMES	
D CHECK					DRAWING APPROVALS		

FOST dong R.

Y—

1 3 | 48 C

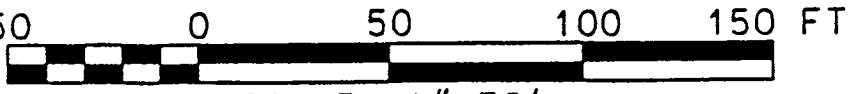
51 NC

THIS DRAWING WAS ORIGINALLY ISSUED FOR PERMITTING/ CFC (REV. 0) BY BURNS AND McDONNELL, KANSAS CITY, MISSOURI, DATED 1/25/92, AND WAS PART OF A LANDFILL PERMIT PACKAGE FOR THE Y-12 INDUSTRIAL LANDFILL V. THIS DRAWING SUPERCEDES THE ORIGINAL DRAWING, AND REVISIONS ARE BEING MADE TO REFLECT ADDITIONAL LANDFILL DEVELOPMENT, AND FOR COMPLIANCE WITH TDEC REGULATORY CHANGES.

△2 GENERAL REVISION - CROSS SECTIONS

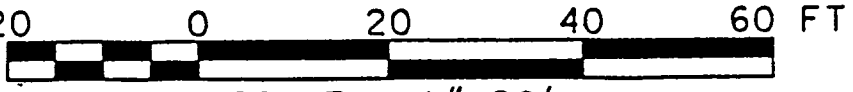
THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, DATES AND WITH THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES.

HORIZONTAL



SCALE: 1"=50'

VERTICAL



SCALE: 1"=20'

	8/19/95
	8/19/95
	8/19/95
	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

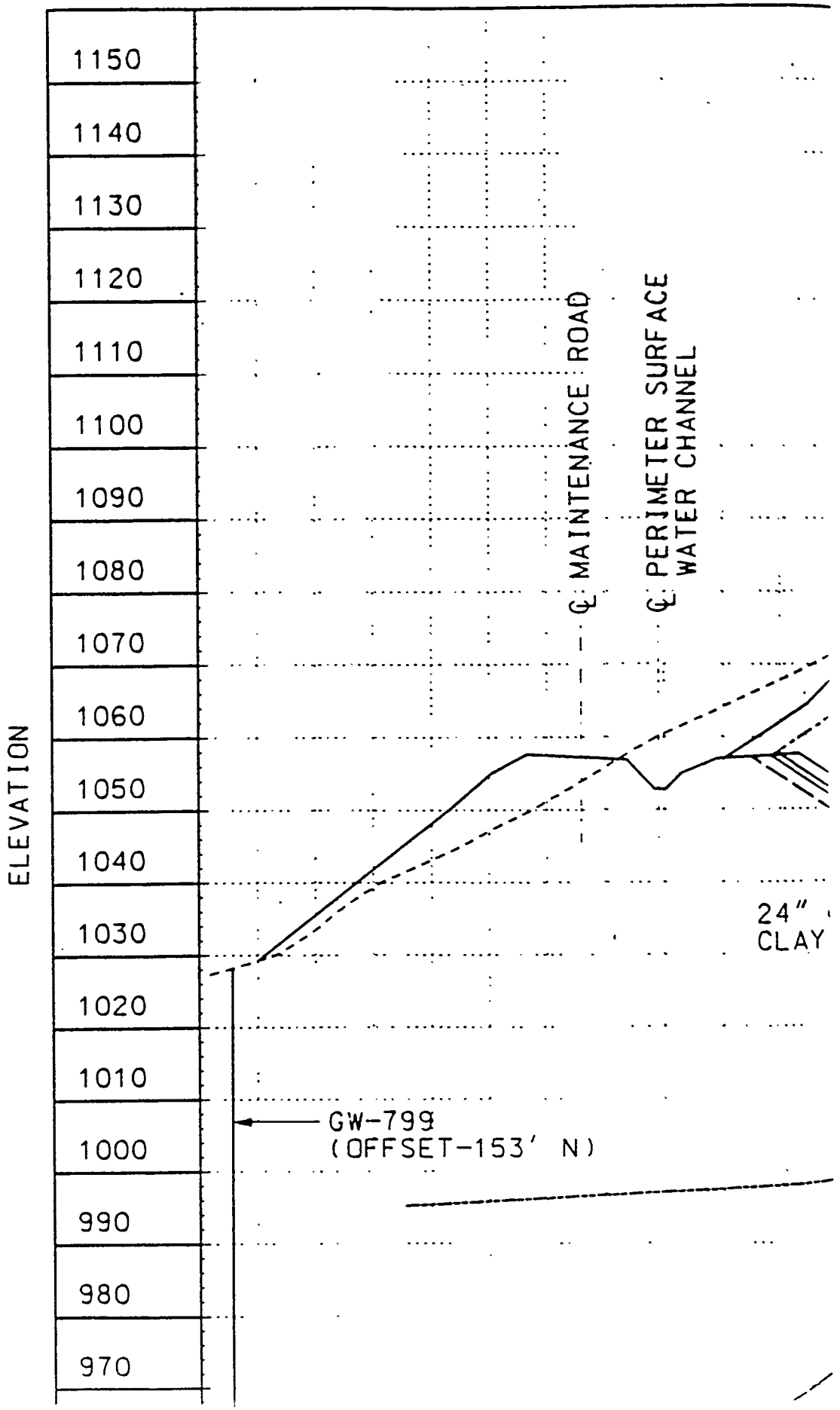
LANDFILL CROSS SECTIONS - I

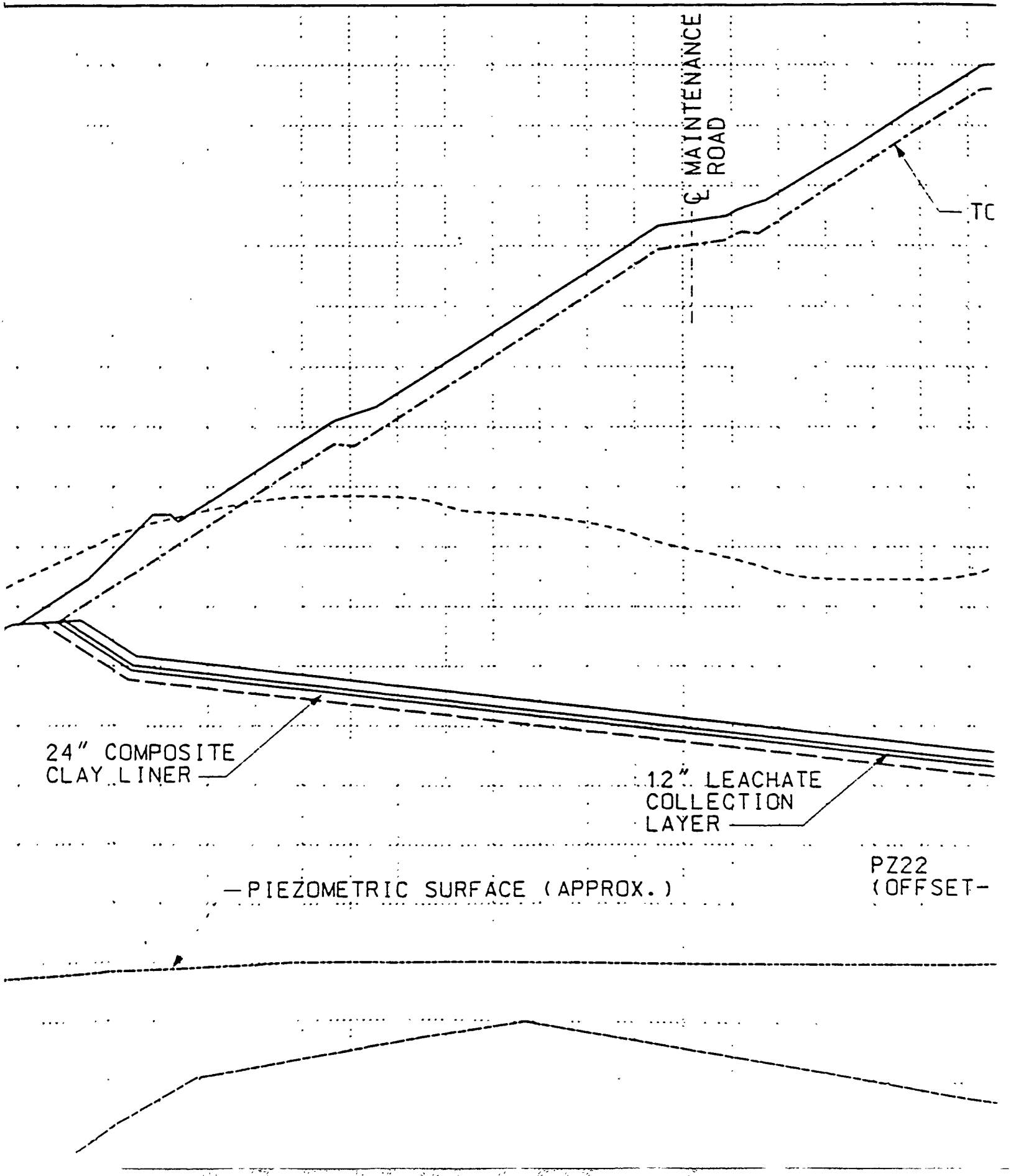
1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U

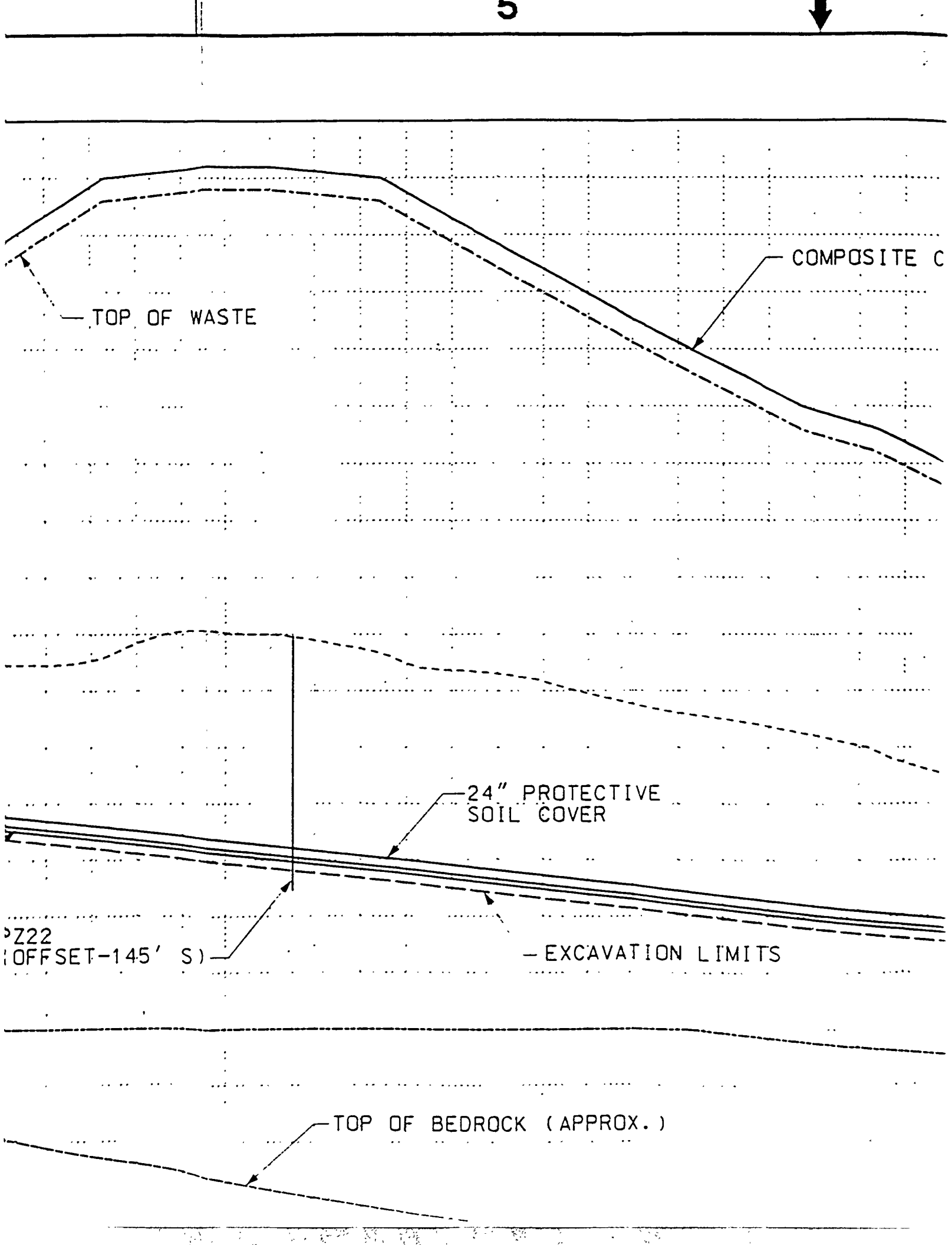
51	52	53		REV
NC	NA	AR	C2E900000A631	2

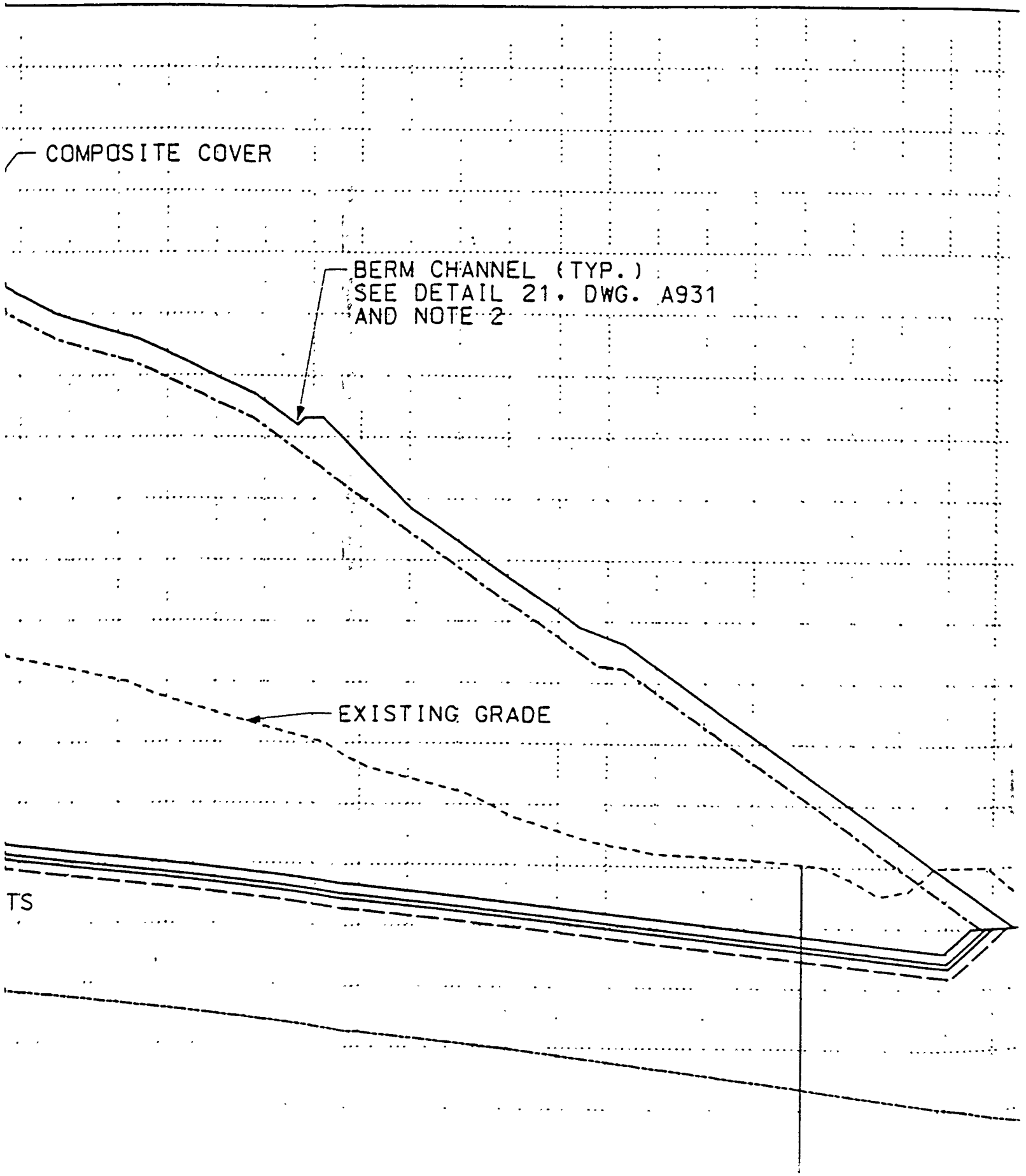
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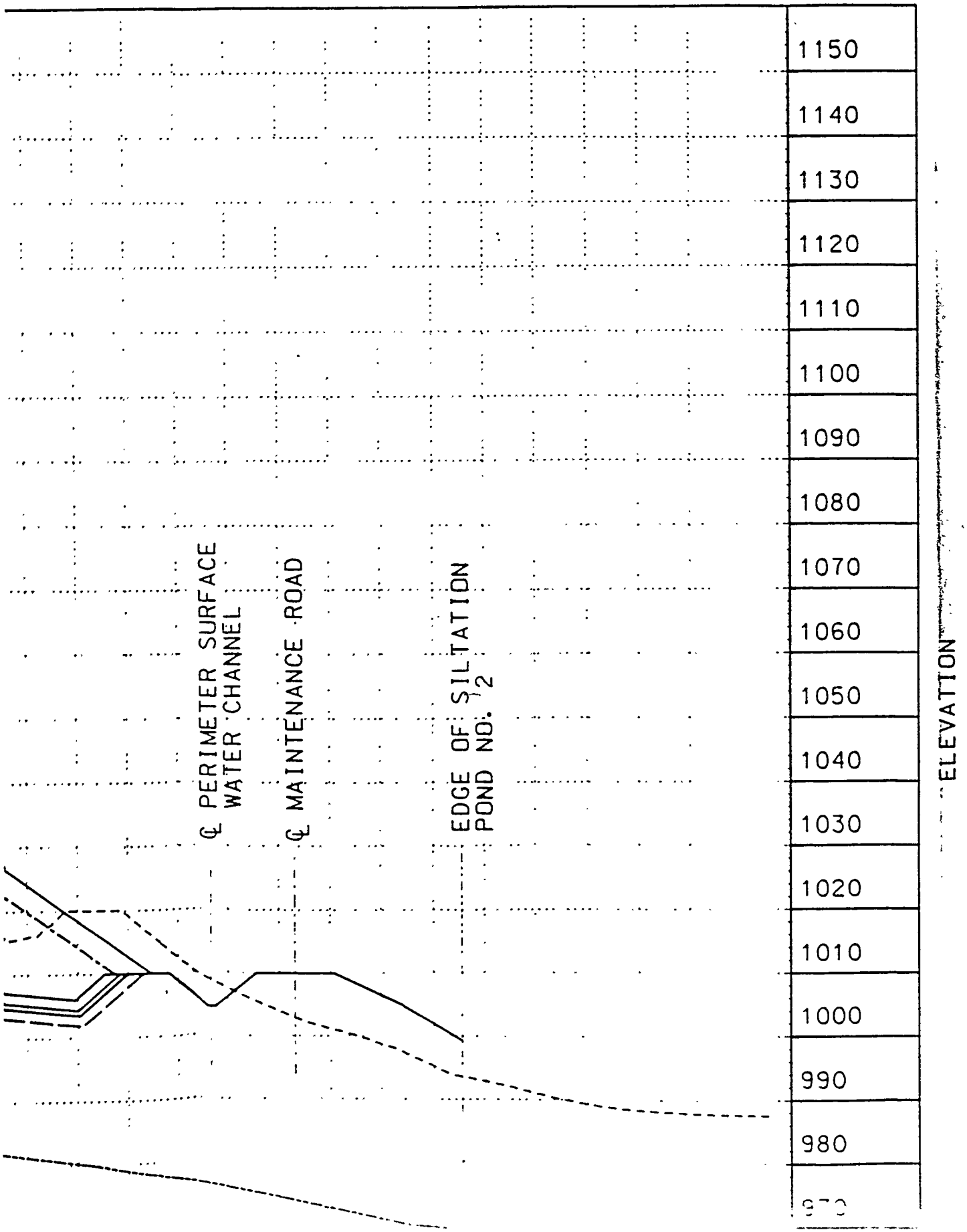
C2E900000A631


1150
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010
1000
990
980
970
ELEVATION
℄ MAINTENANCE ROAD
℄ PERIMETER SURFACE WATER CHANNEL
24"
CLAY
GW-799
(OFFSET-153' N)


℄ MAINTENANCE ROAD
TC
24" COMPOSITE CLAY LINER
12" LEACHATE COLLECTION LAYER
PIEZOMETRIC SURFACE (APPROX.)
PZ22
(OFFSET-


5
COMPOSITE C
TOP OF WASTE
24" PROTECTIVE
SOIL COVER
Z22
OFFSET-145' S)
EXCAVATION LIMITS
TOP OF BEDROCK (APPROX.)


COMPOSITE COVER
BERM CHANNEL (TYP.)
SEE DETAIL 21. DWG. A931
AND NOTE 2
EXISTING GRADE
TS


1150
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010
1000
990
980
ELEVATION
℄ PERIMETER SURFACE WATER CHANNEL
℄ MAINTENANCE ROAD
EDGE OF SILTATION POND NO. 2

2 NEXT ASS'Y: 1 FINAL ASS'Y:

NOTES:

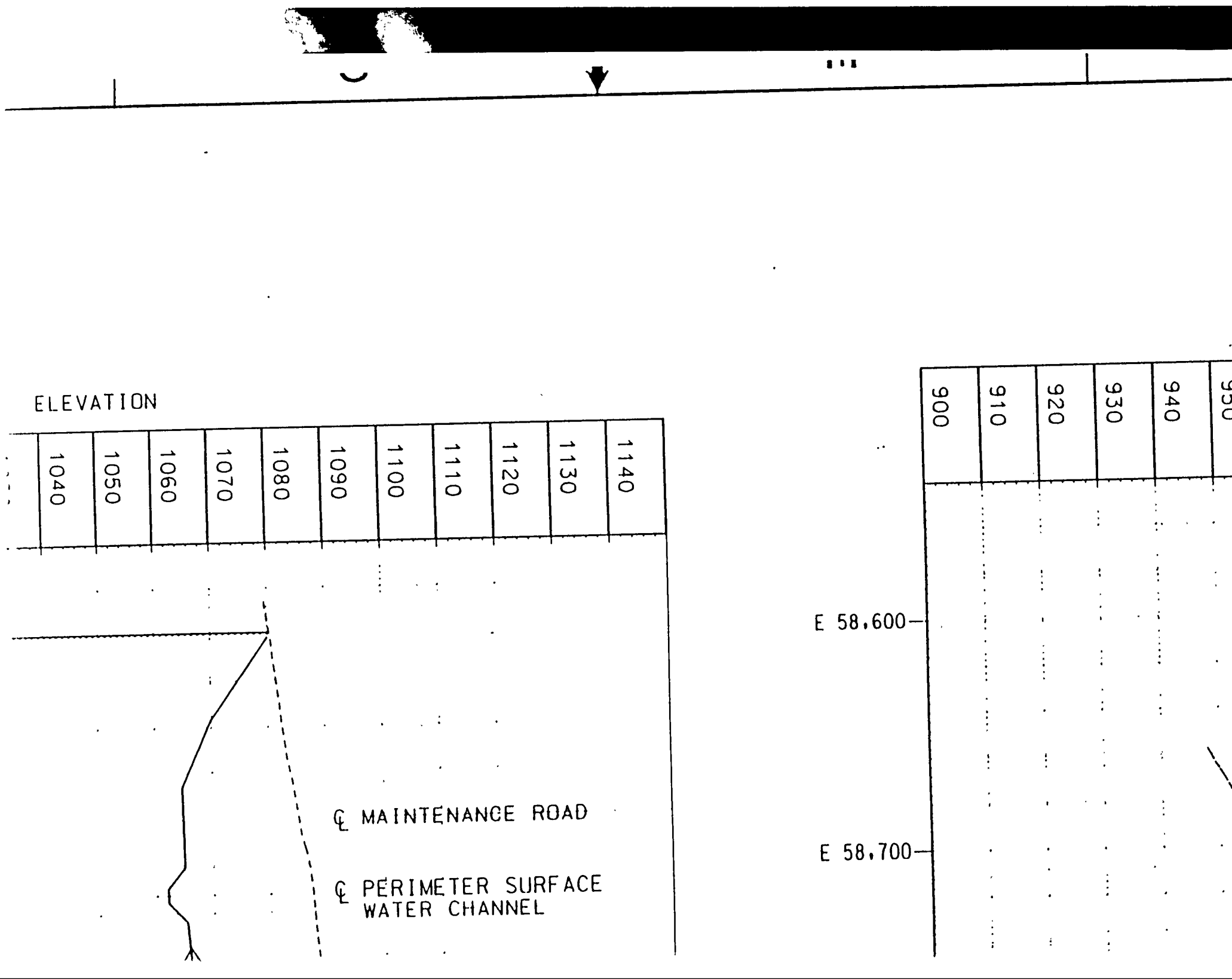
1. FOR ADDITIONAL NOTES FOR CROSS SECTIONS. SEE DWG C2E900000A631.

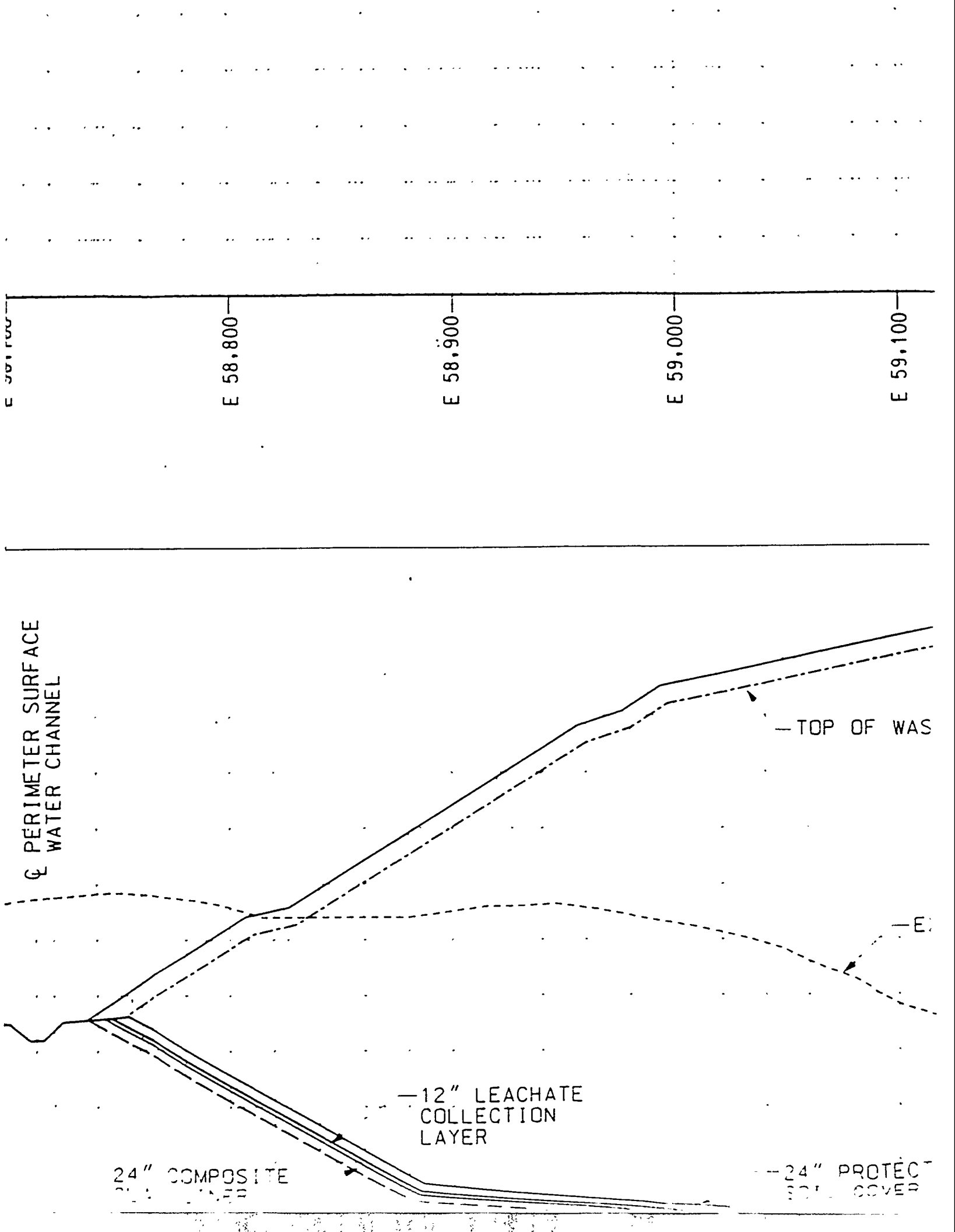
2. ALL BERM CHANNELS ARE NOT SHOWN. FOR APPROXIMATE BERM LOCATIONS SEE DWG C2E900000A630.

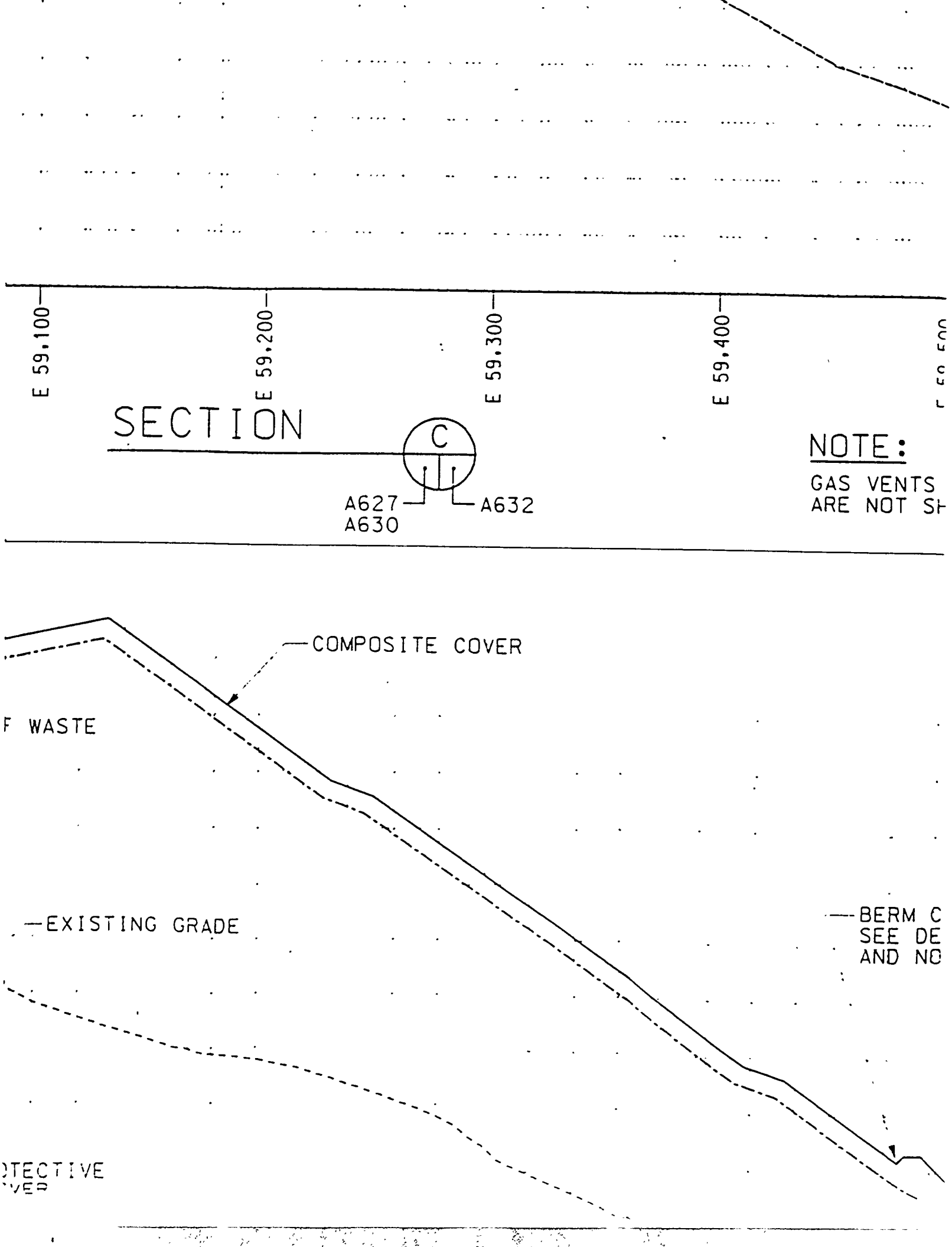
H

G

ELEVATION


ELEVATION
1040
1050
1060
1070
1080
1090
1100
1110
1120
1130
1140
900
910
920
930
940
E 58,600
E 58,700
℄ MAINTENANCE ROAD
℄ PERIMETER SURFACE WATER CHANNEL


E 58,800
E 58,900
E 59,000
E 59,100
℄ PERIMETER SURFACE
WATER CHANNEL
—TOP OF WAS
—E
—12" LEACHATE
COLLECTION
LAYER
24" COMPOSITE
—24" PROTEC


E 59,100
E 59,200
E 59,300
E 59,400
SECTION
C
A627
A630
A632
NOTE:
GAS VENTS
ARE NOT SH
COMPOSITE COVER
F WASTE
EXISTING GRADE
BERM C
SEE DE
AND NO
TECTIVE

E 59,500

E 59,600

E 59,700

E 59,800

ENTS LOCATED IN THE COMPOSITE COVER
OT SHOWN FOR CLARITY.

1140

1130

1120

1110

1100

1090

1080

1070

1060

1050

1040

ERM CHANNEL (TYP.)
EE DETAIL 21, DWG. A931
ND NOTE 2

℄ PERIMETER SURFACE
WATER CHANNEL

℄ MAINTENANCE ROAD

940

930

920

910

900

E 59.900

E 60.000

40

30

20

10

00

90

80

70

60

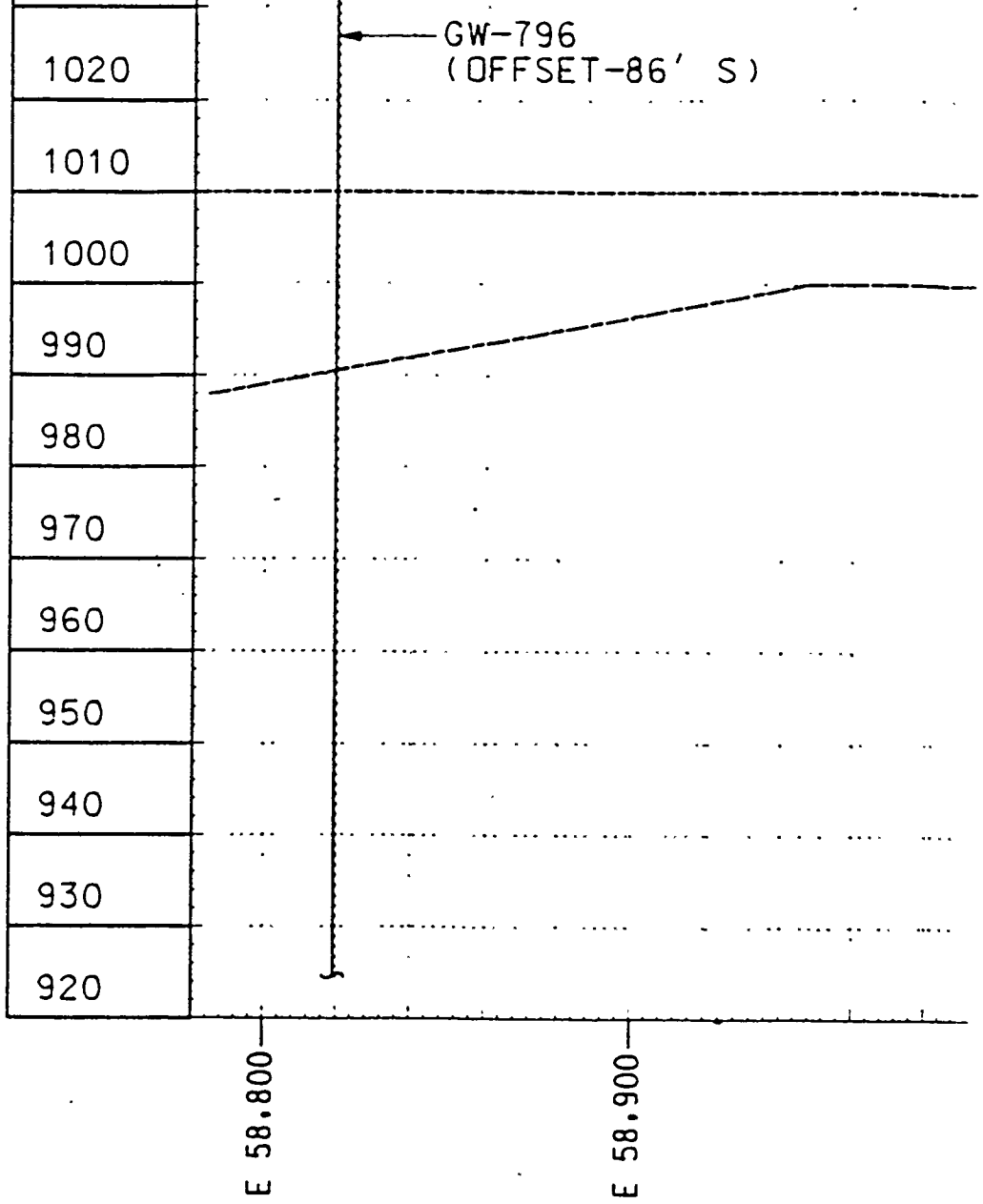
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40

ATION

E

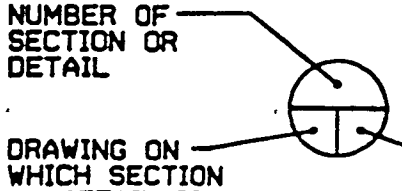
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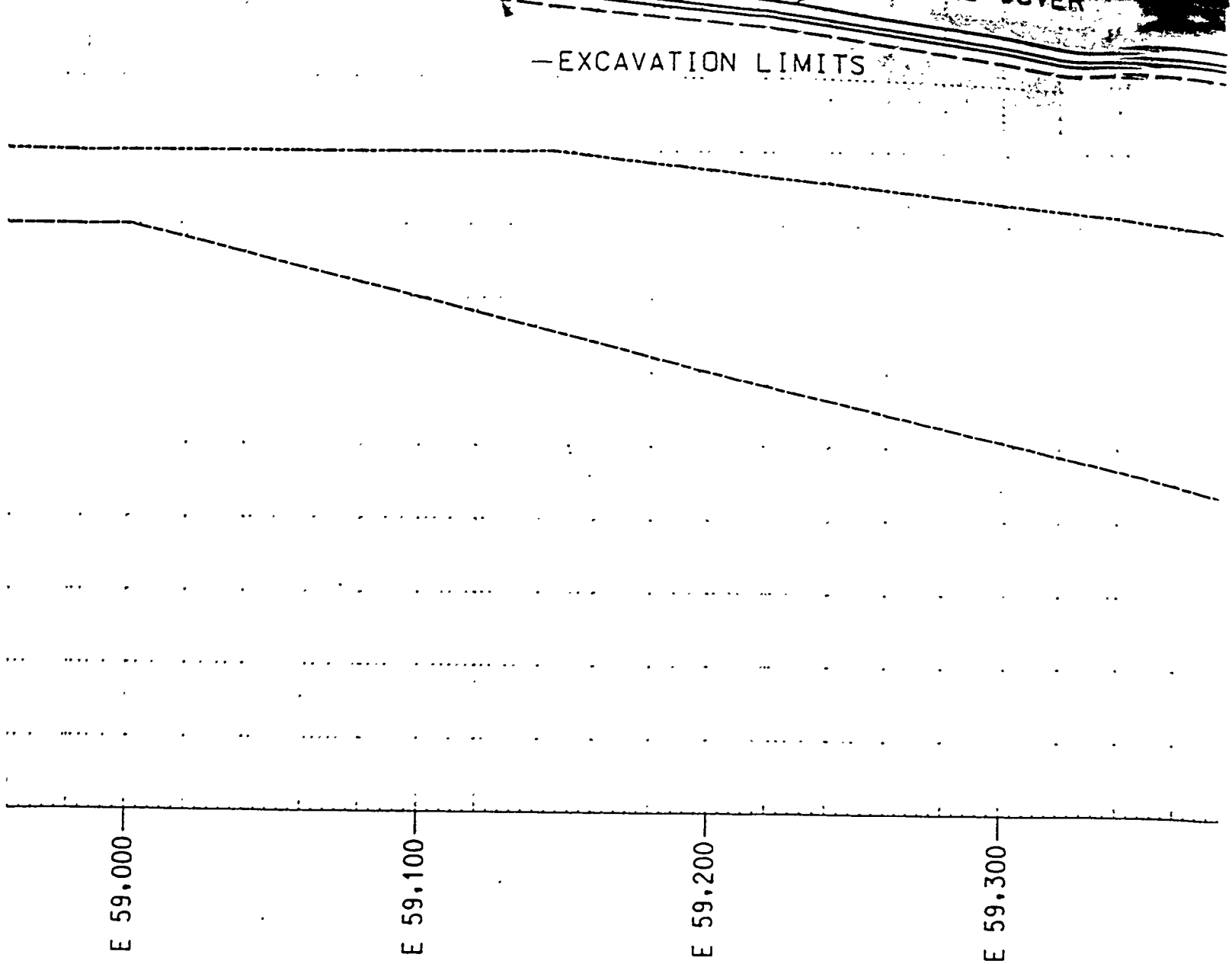
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Guideline Doc
UCN-19586 (12

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SECTION AND DETAIL KEY



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Review By: _____
ıe Document: _____
86 (12356 4-93)

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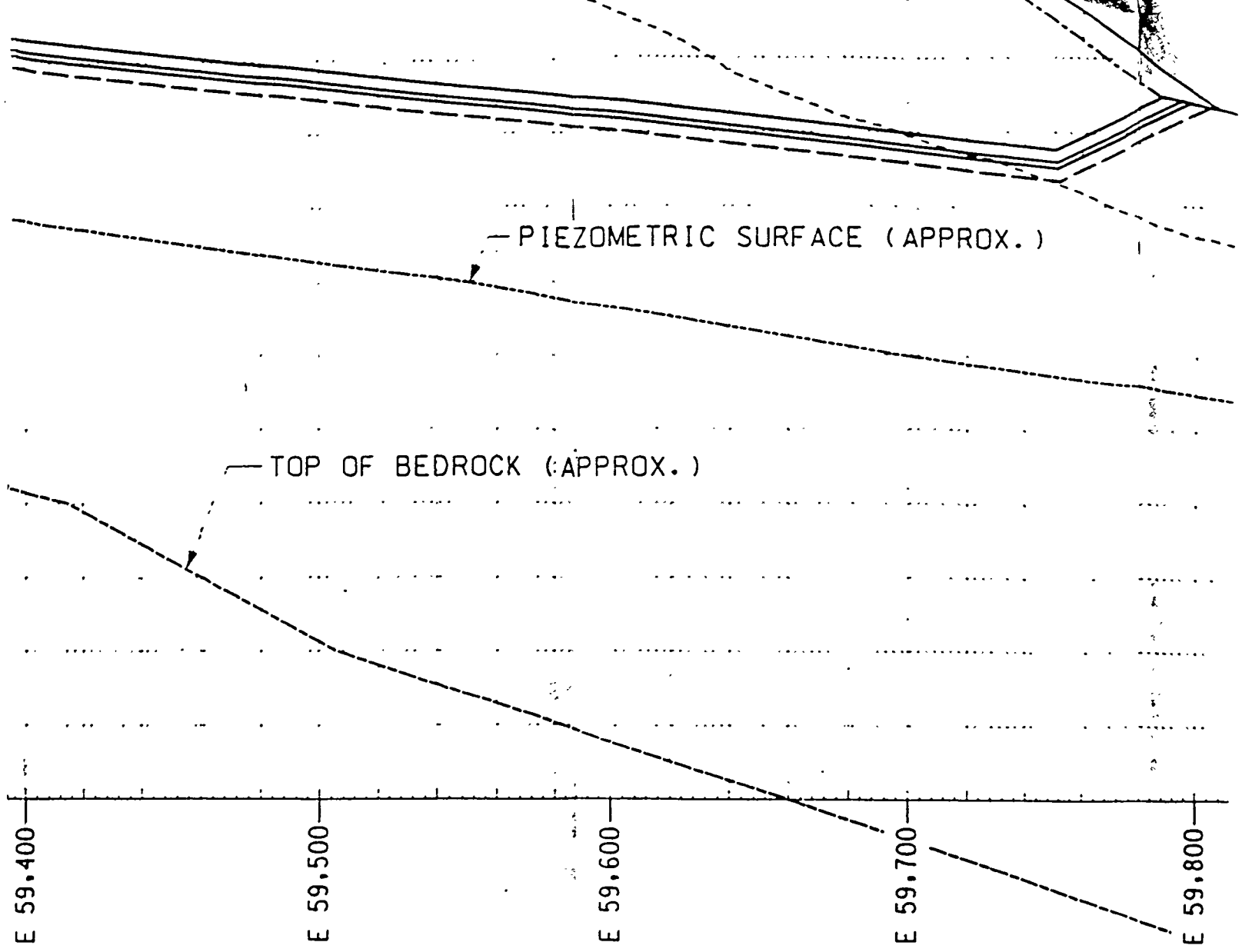
CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-1-0

ING ON
H SECTION
ETAIL IS
/N

KEY

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION
2				ISSUE FOR PERMITTING



ECTION

D

A627
A630

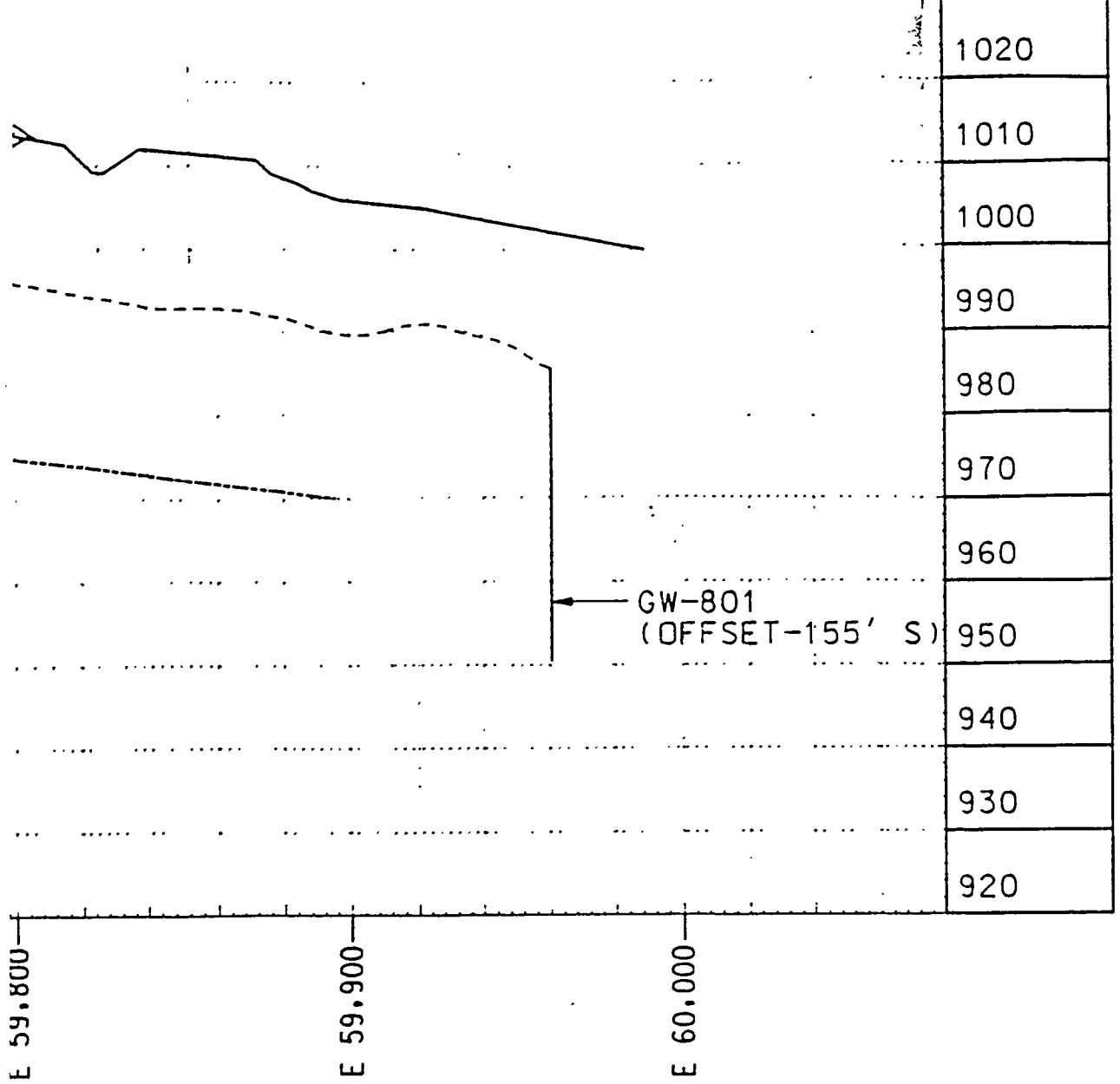
A632

NOTE:

GAS VENTS LOCA
ARE NOT SHOWN F

BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RPE	RPE NO	DATE
JGA	WPT	—	[illegible]	8/14/95				[illegible]	8/28/95	WPT	22811	8/19/95

REVISION APPROVALS



)CATED IN THE COMPOSITE COVER
/N FOR CLARITY.

					—		—	—	—	—	—	—	—	—	—	
E			QA	DATE	ST	CV	EC	EE	EM	IE	M	PD	SE	ARC	VER	REV.

THIS DRAWING WAS ORIGINALLY
CFC (REV. 0) BY BURNS AND Mc
MISSOURI, DATED 1/25/92, AND
PERMIT PACKAGE FOR THE Y-12
THIS DRAWING SUPERCEDES THE
REVISIONS ARE BEING MADE TO
LANDFILL DEVELOPMENT, AND FO
TDEC REGULATORY CHANGES.

2 GENERAL REV

THE ORIGINAL DRAWING A:
THEREOF, WITH APPROVAL
AND WITH THE PE SEAL,
MAINTAINED IN THE FILE:

HORIZONTAL 50 0 SCALE

VERTICAL 20 0 SCALE:

	RPE			
	WILLIAM PATRICK TAYLOR REGISTERED ENGINEER AGRICULTURE STATE OF TENNESSEE	DSGN		8/19/95
		DRW		8/19/95
		CHKR		8/19/95
		SECT		
		DEPT		8/19/95
		PE		
		PJ		8/28/95
		REQ		
—				
VER	REV. 0 DATE 8/19/96	MMES		

FOSTER WHEELER ENVIRONMENTAL CORP
OAK RIDGE, TE
designed for the DEPARTMENT OF ENERGY unc
managed for the DEPARTMENT OF ENERGY
under U.S. GOVERNMENT contracts DE-A
Oak Ridge, Tennessee • Produ

PROJEC

Y-12 INDUSTRI

LAND
CROSS SECT

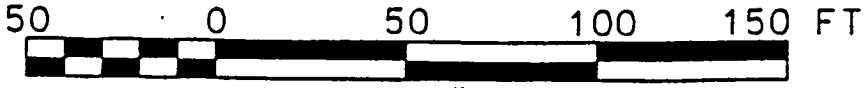
1	48	49	50	PLANT	BLD
3	C	P	N	Y-12	YARE
51		52		53	

THIS DRAWING WAS ORIGINALLY ISSUED FOR PERMITTING/ CFC (REV. 0) BY BURNS AND McDONNELL, KANSAS CITY, MISSOURI, DATED 1/25/92, AND WAS PART OF A LANDFILL PERMIT PACKAGE FOR THE Y-12 INDUSTRIAL LANDFILL V. THIS DRAWING SUPERCEDES THE ORIGINAL DRAWING, AND REVISIONS ARE BEING MADE TO REFLECT ADDITIONAL LANDFILL DEVELOPMENT, AND FOR COMPLIANCE WITH TDEC REGULATORY CHANGES.

2 GENERAL REVISION - CROSS SECTIONS

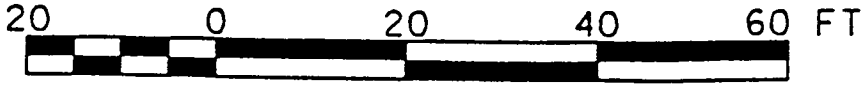
THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, DATES AND WITH THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES.

HORIZONTAL



SCALE: 1"=50'

VERTICAL



SCALE: 1"=20'

C2E900000A632

	8/19/95
	8/19/95
	8/19/95
	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:
Y-12 INDUSTRIAL LANDFILL V

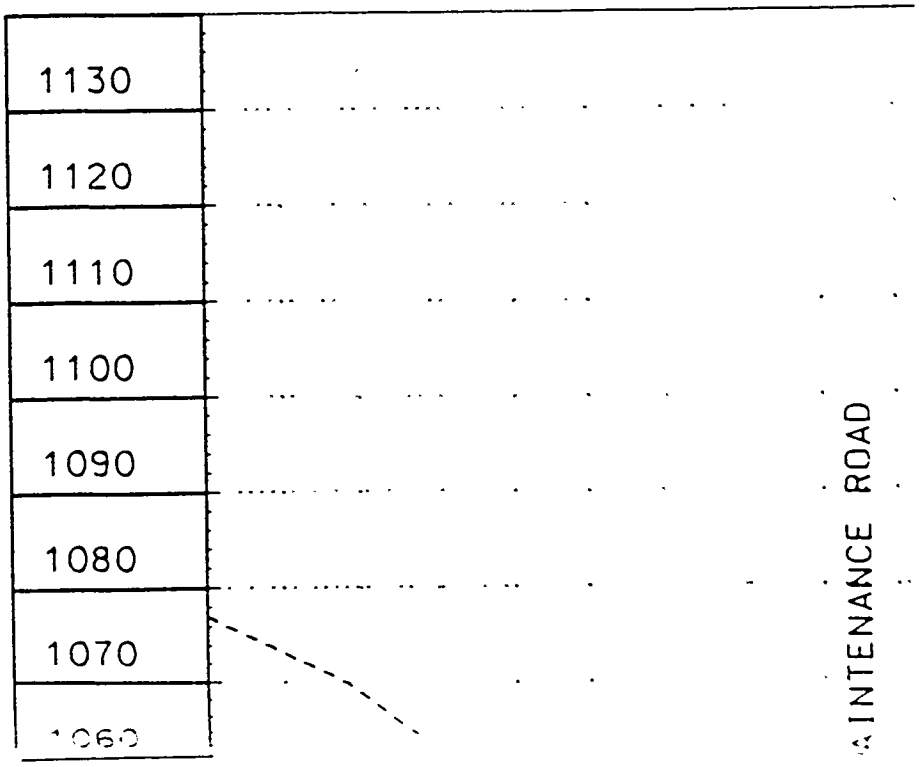
LANDFILL CROSS SECTIONS - II

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U

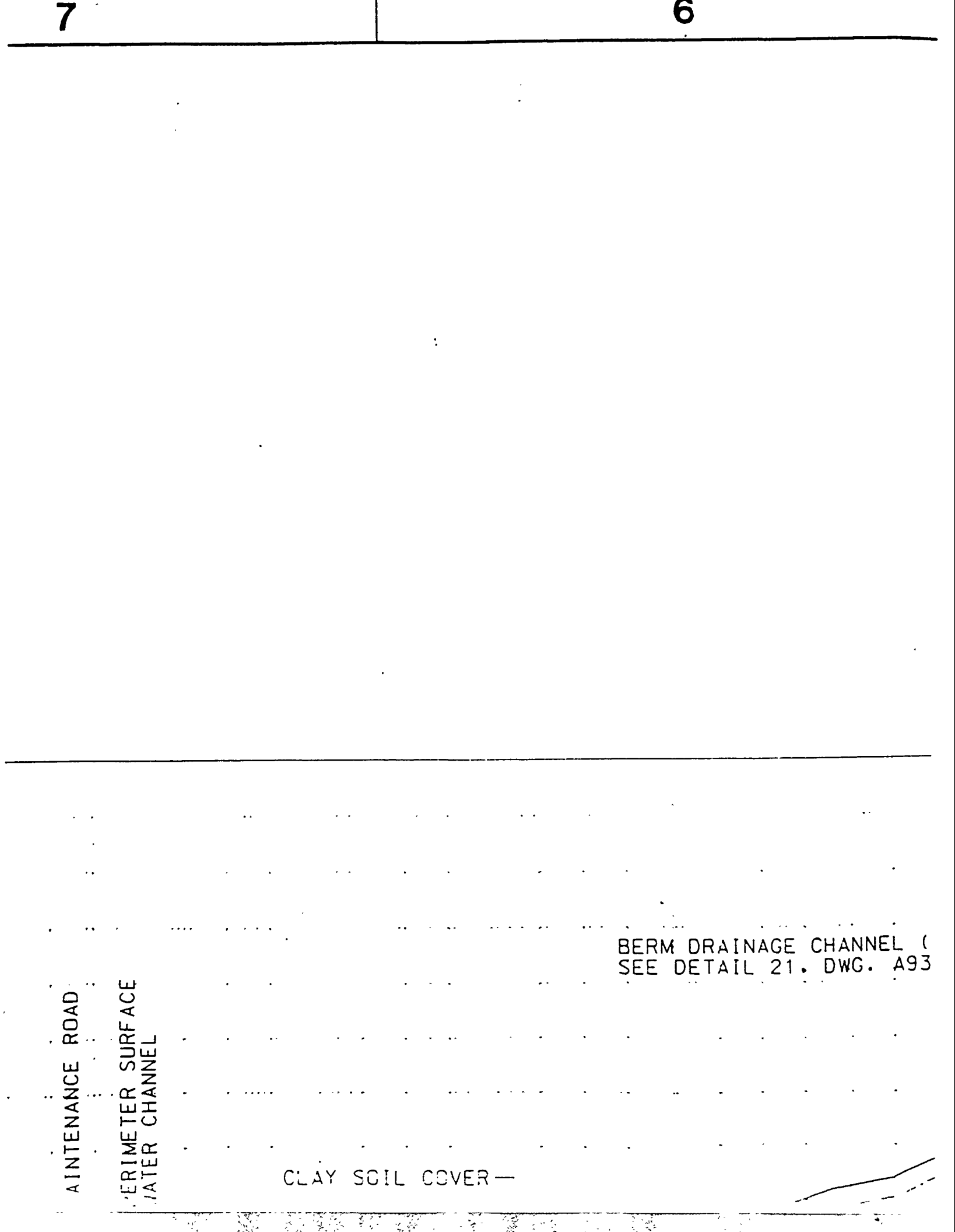
51	52	53		REV
NC	NA	AD	C2E900000A632	2

8

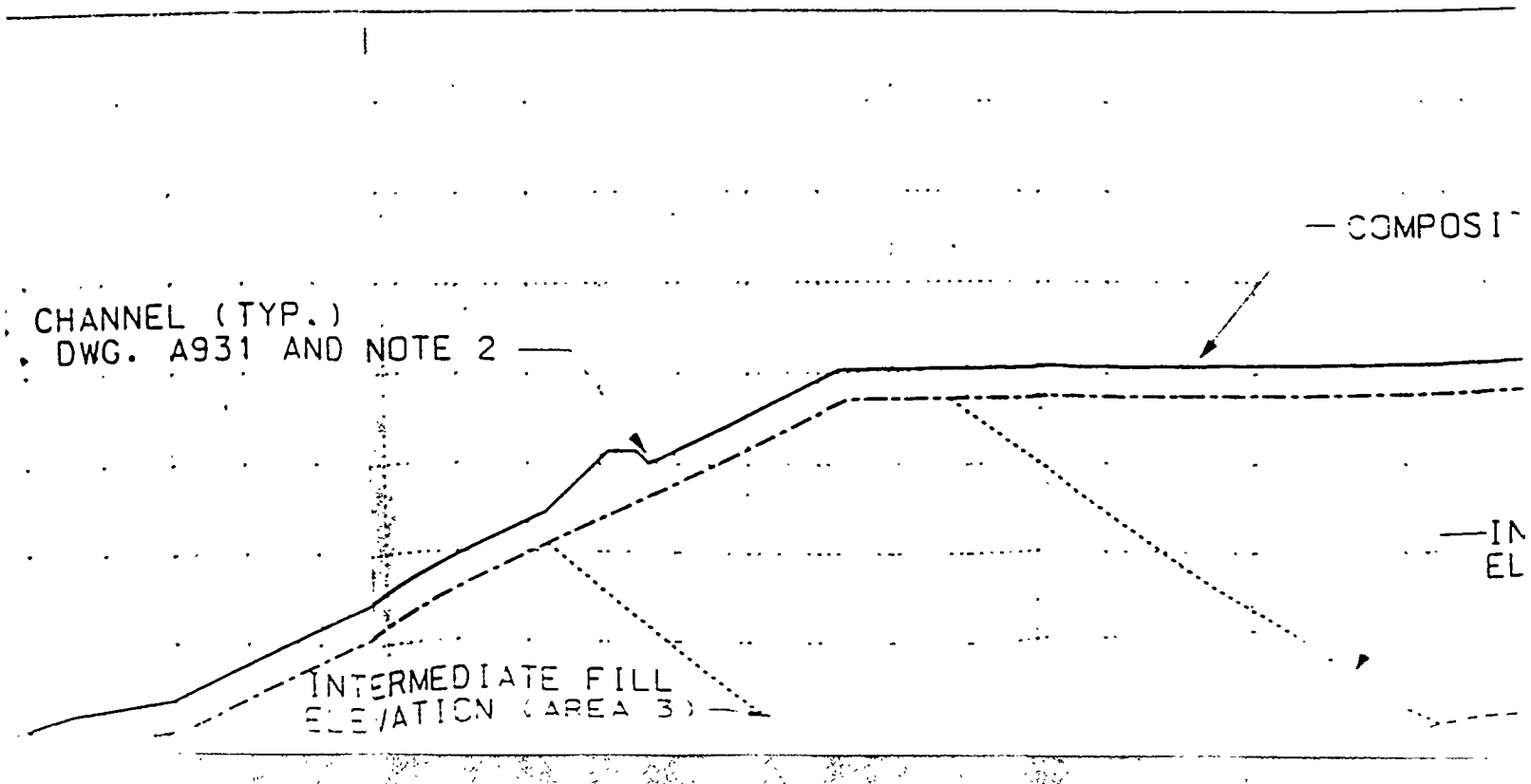
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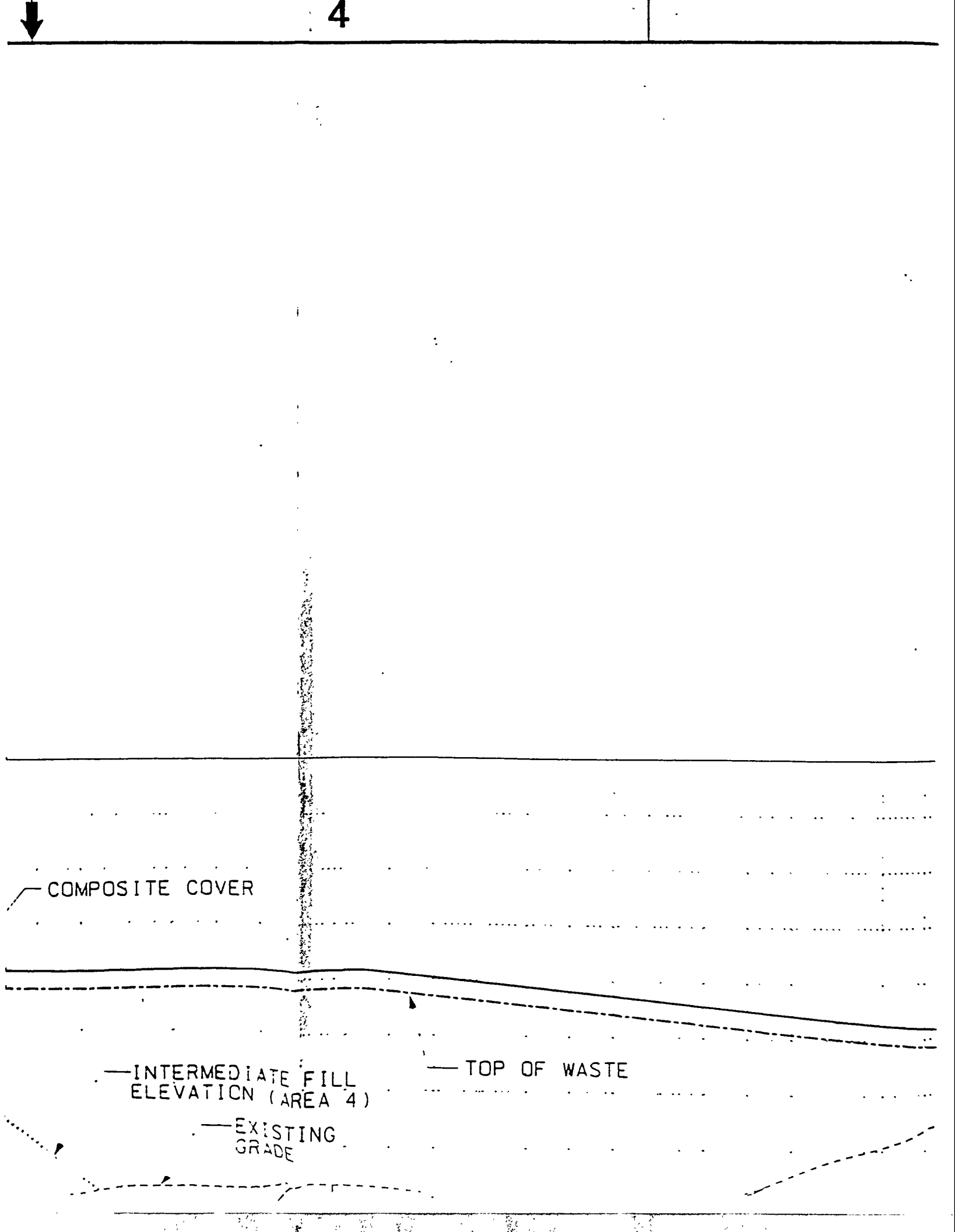


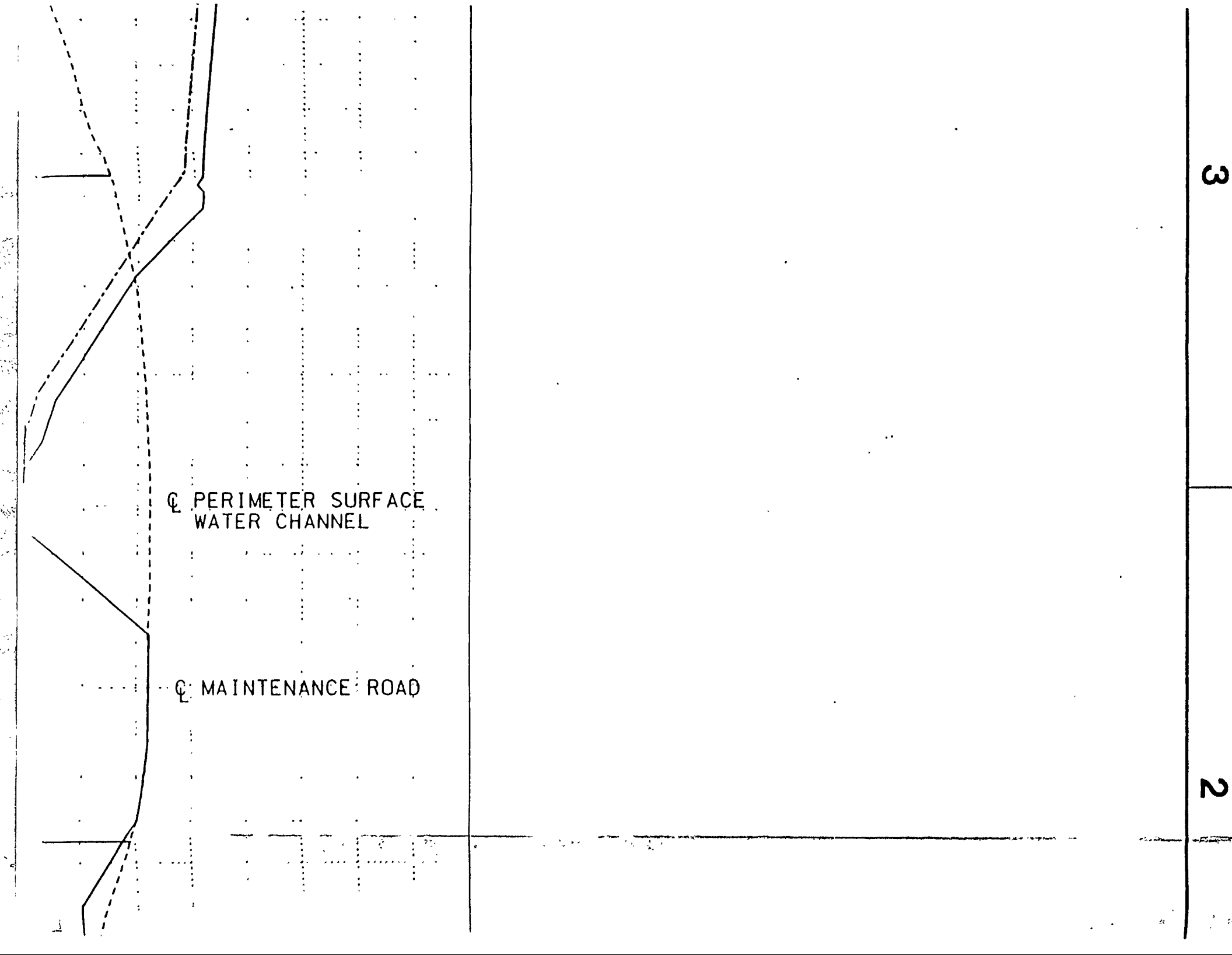
7 6


BERM DRAINAGE CHANNEL (
SEE DETAIL 21. DWG. A93
AINTENANCE ROAD
ERIMETER SURFACE
ATER CHANNEL
CLAY SOIL COVER—

5


— COMPOSI
CHANNEL (TYP.)
DWG. A931 AND NOTE 2 —
—IN
EL
INTERMEDIATE FILL
ELEVATION (AREA 3) —


COMPOSITE COVER
INTERMEDIATE FILL ELEVATION (AREA 4)
TOP OF WASTE
EXISTING GRADE


℄ PERIMETER SURFACE WATER CHANNEL
℄ MAINTENANCE ROAD
3
2

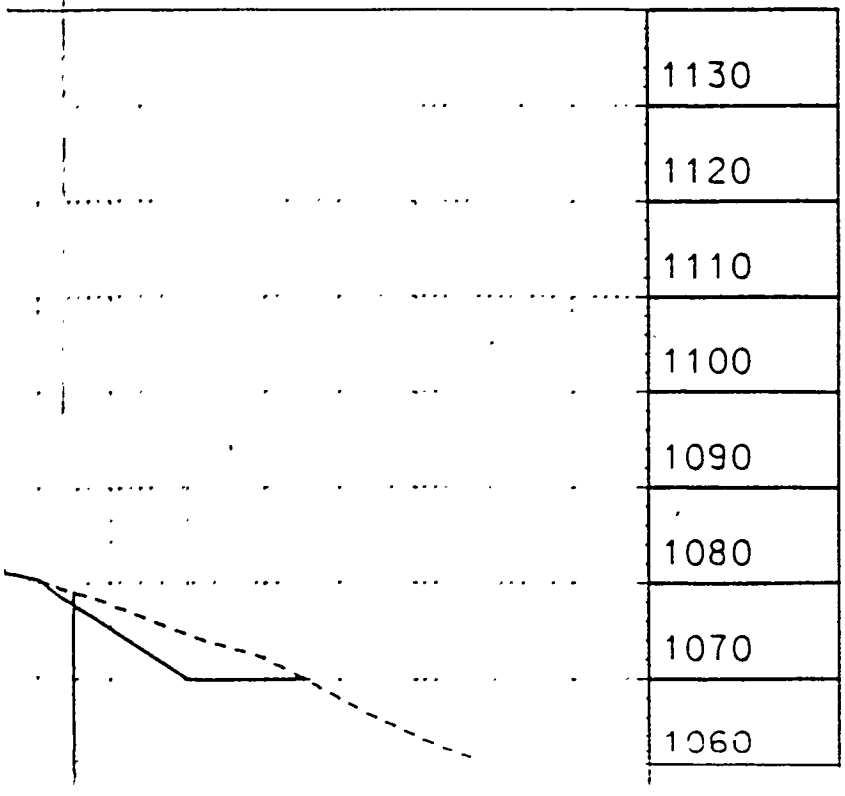
NEXT ASS'Y:

FINAL ASS'Y:

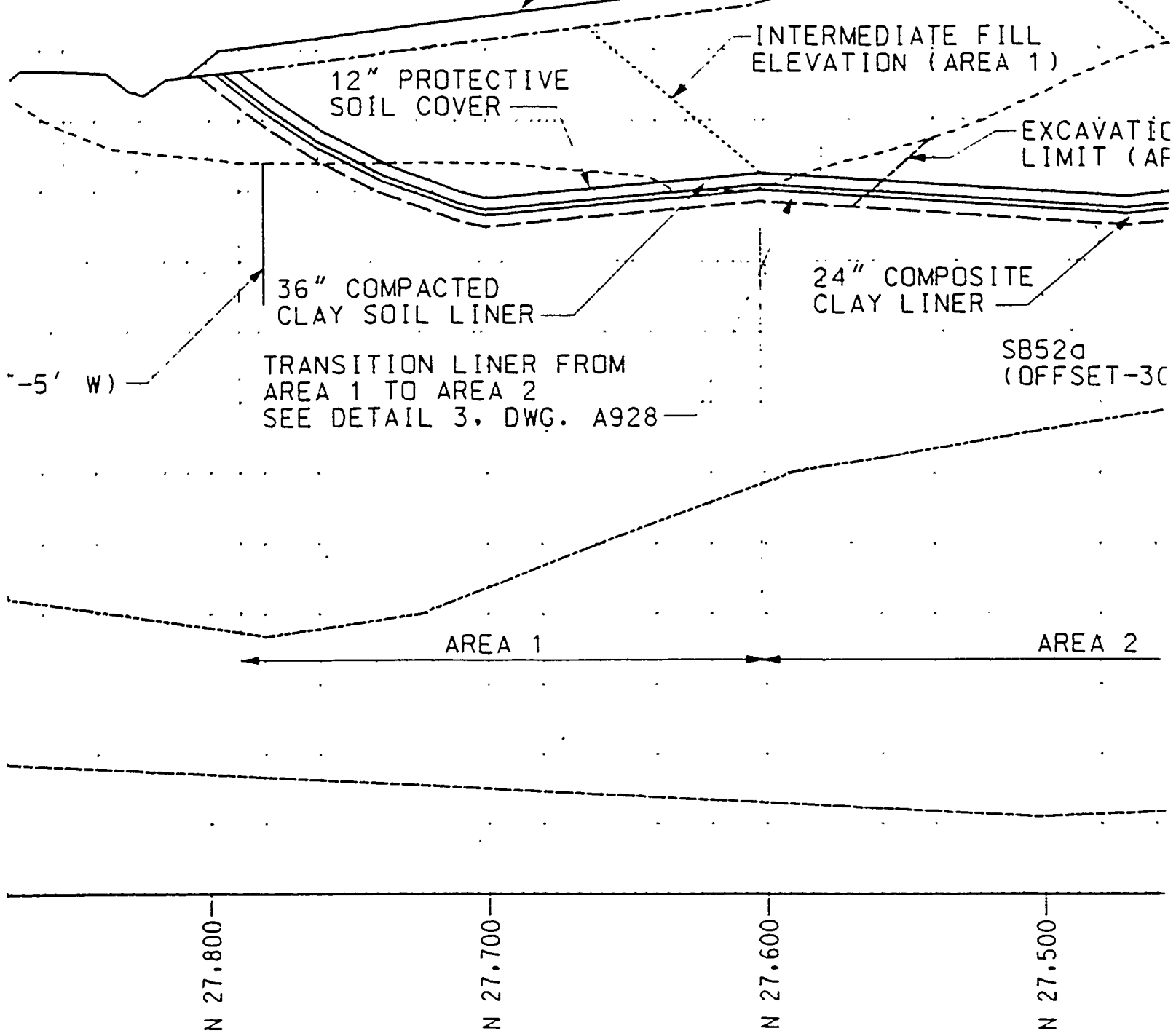
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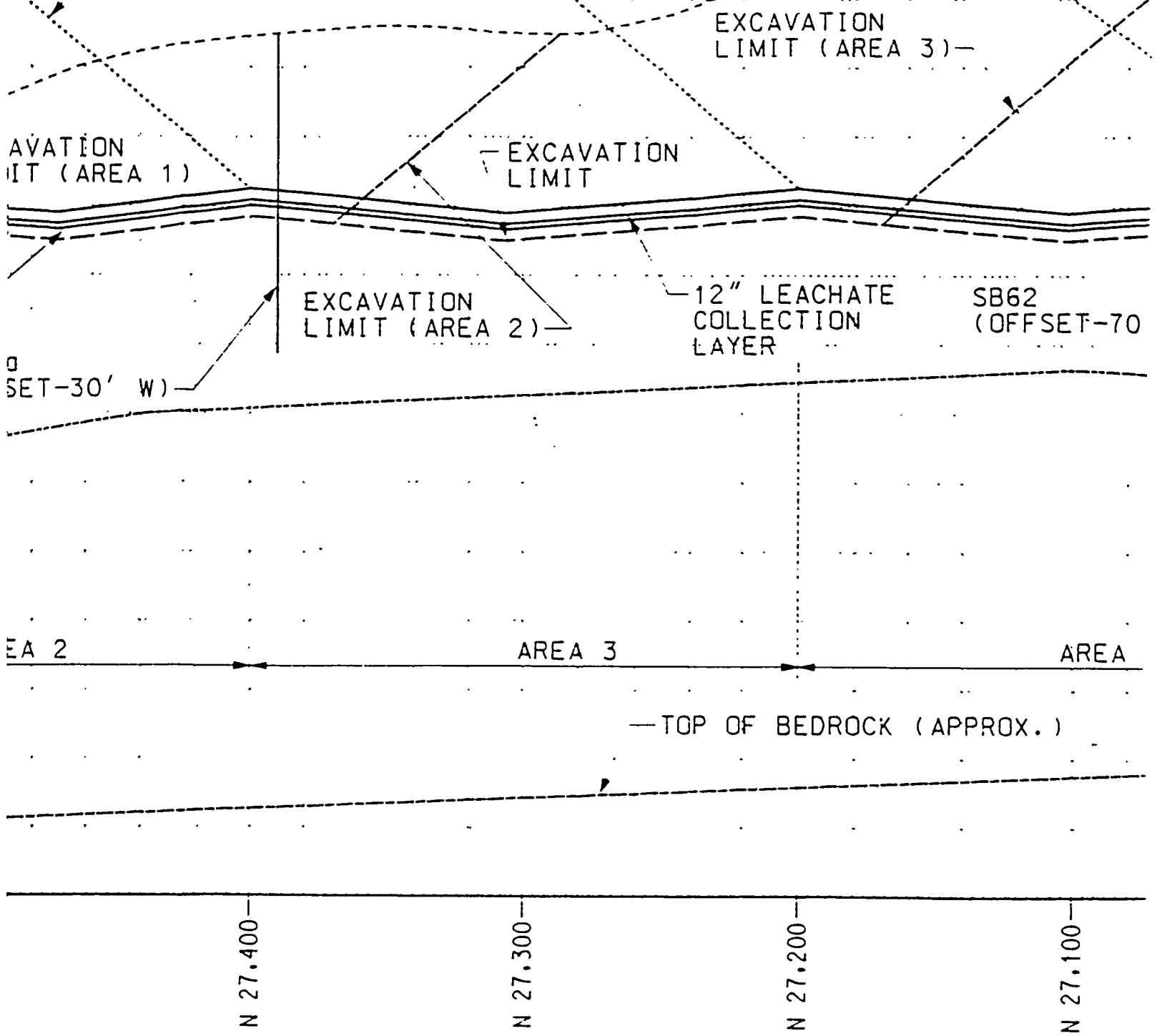
1. FOR ADDITIONAL NOTES FOR CROSS SECTIONS. SEE DWG. C2E900000A631.

2. ALL BERM CHANNELS ARE NOT SHOWN. FOR APPROXIMATE BERM LOCATIONS SEE DWG C2E900000A630.



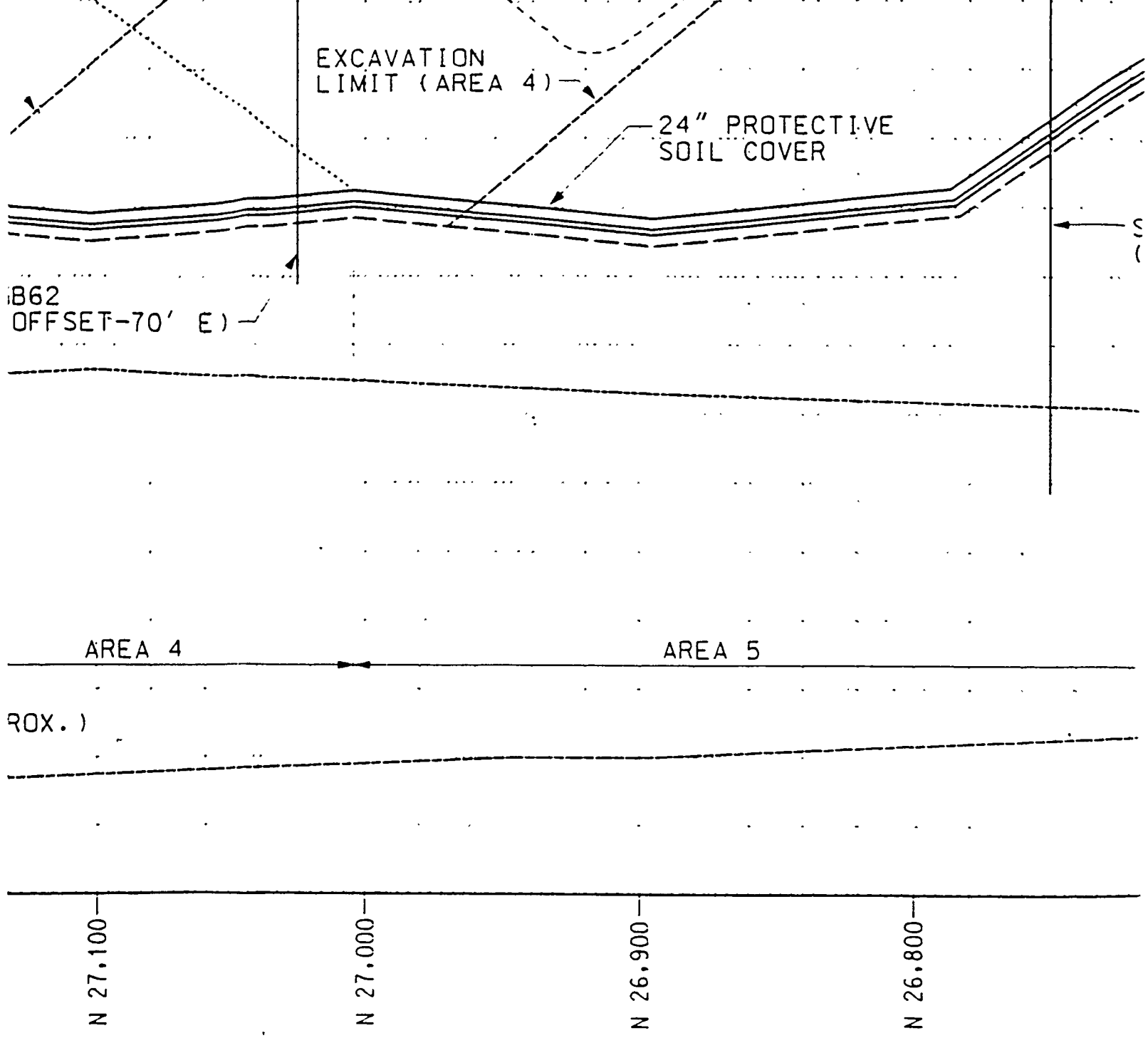
ELEVATION
1040
1030
1020
1010
1000
990
980
970
960
950
940
930
920
SB12
(OFFSET-5' W
N 28,000
N 27,900


INTERMEDIATE FILL
ELEVATION (AREA 1)
12" PROTECTIVE
SOIL COVER
EXCAVATIC
LIMIT (AF
36" COMPACTED
CLAY SOIL LINER
24" COMPOSITE
CLAY LINER
-5' W)
TRANSITION LINER FROM
AREA 1 TO AREA 2
SEE DETAIL 3, DWG. A928
SB52a
(OFFSET-3C
AREA 1
AREA 2
N 27,800
N 27,700
N 27,600
N 27,500

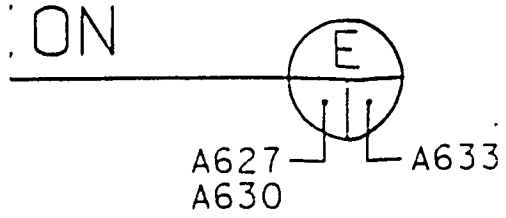


SECTION

A62
A63

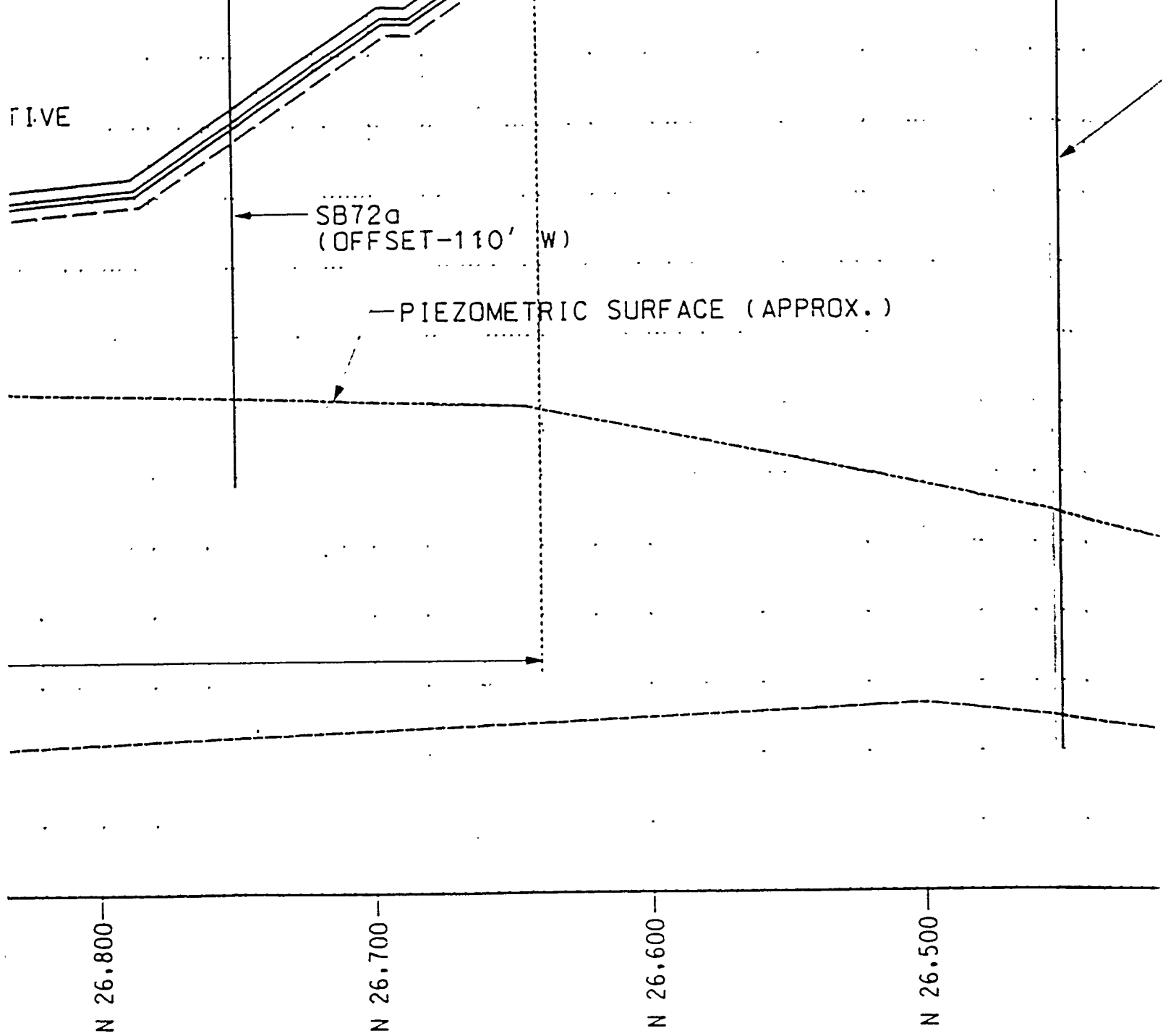


ON



NOTE:

GAS VENTS LOCATED IN THE CL
ARE NOT SHOWN FOR CLARITY.



ITS LOCATED IN THE COMPOSITE COVER
SHOWN FOR CLARITY.

GW-557
(OFFSET-20'E)

1040
1030
1020
1010
1000
990
980
970
960
950
940
930
920

ELEVATION

N 26,400

N 26,300

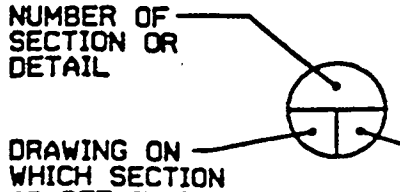
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UCN-19586 (12356

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SECTION AND DETAIL KEY

___ Date: _____

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t: _____

4-93)

THIS DOCUMENT CONTROLLED BY

-ANGE CONTROL YSTEM 2

NGINEERING ROCEDURE EP-C-18

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION
2				ISSUE FOR PERMITTING

REVISION OR ISSUE PURPOSE

BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RPE	RPE NO	DATE
JGA	LJPT	—	[illegible]	8/19/95				[illegible]	8/18/95	LWPT		

															F
			—		—	—	—	—	—	—	—	—	—	—	
		OA	DATE	ST	CV	EC	EE	EM	IE	M	PD	SE	ARC	VER	REV. C

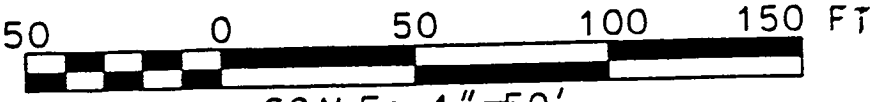
WILLIAM P
REGISTE
AGR
STATE OF

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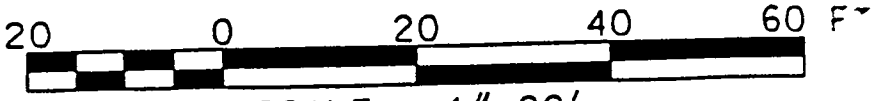
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HORIZONTAL



SCALE: 1"=50'

VERTICAL



SCALE: 1"=20'

	8/19/95
	8/19/95
	8/19/95
	8/17/95
	8/18/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
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Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

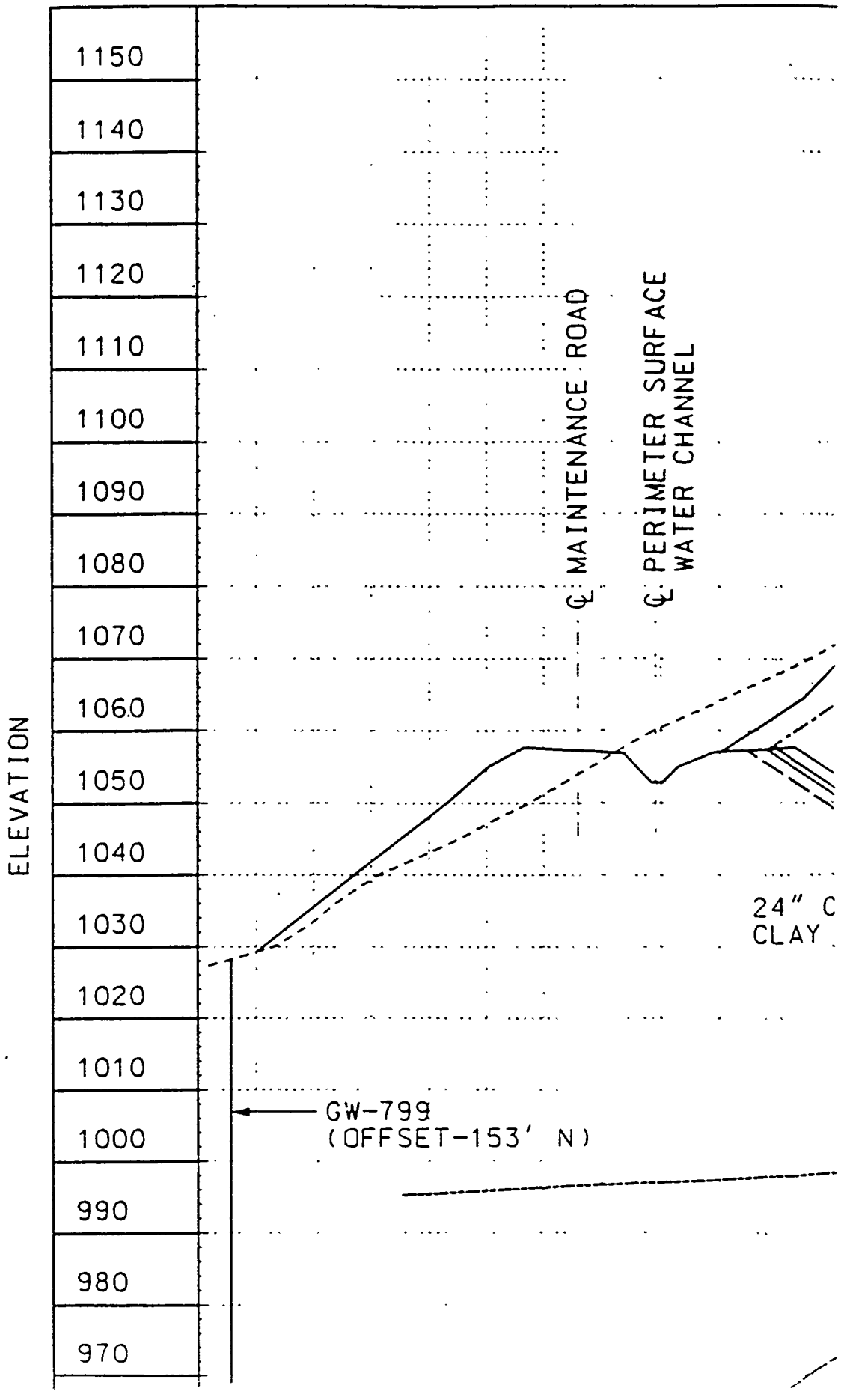
PROJECT NAME:

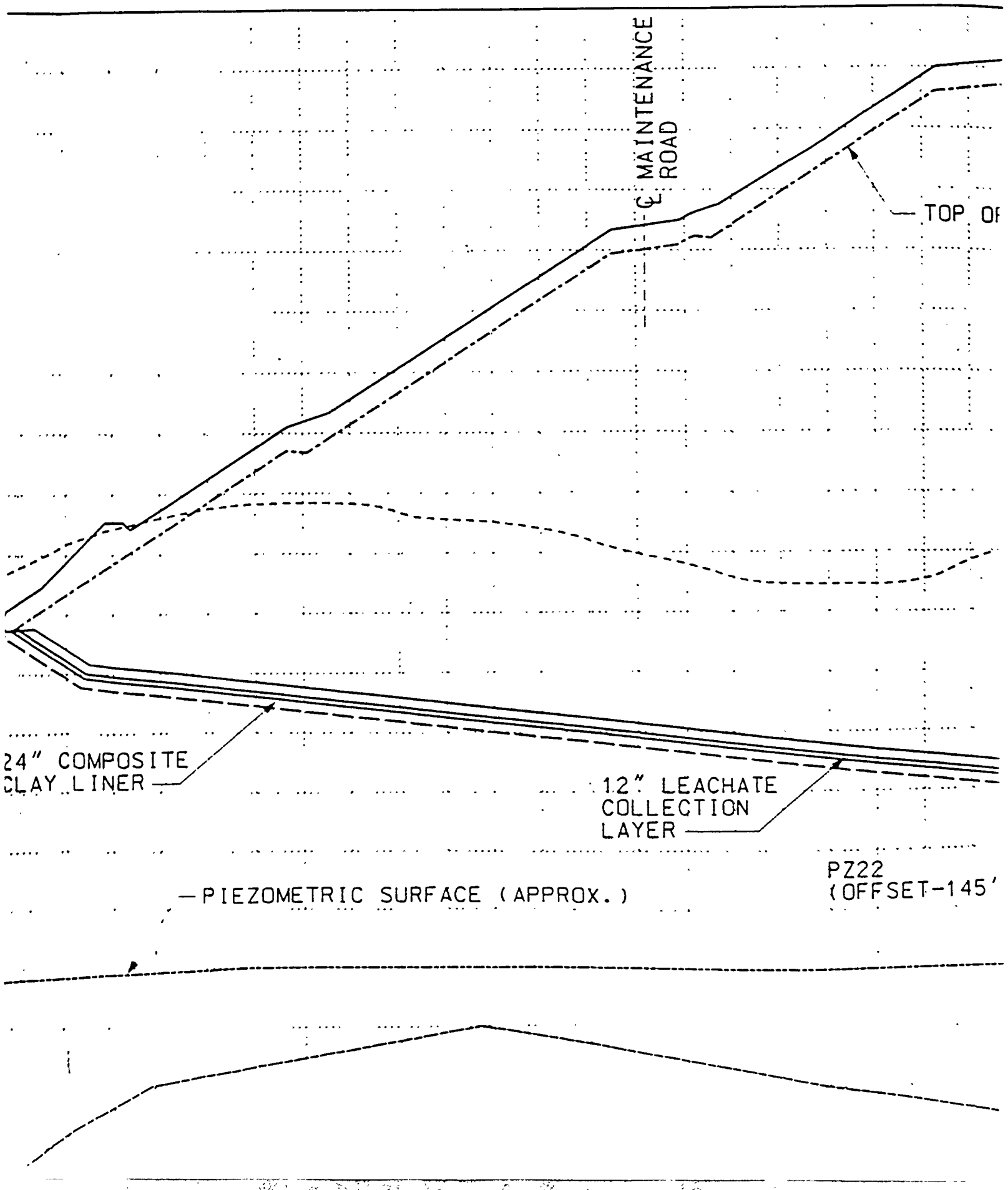
Y-12 INDUSTRIAL LANDFILL V

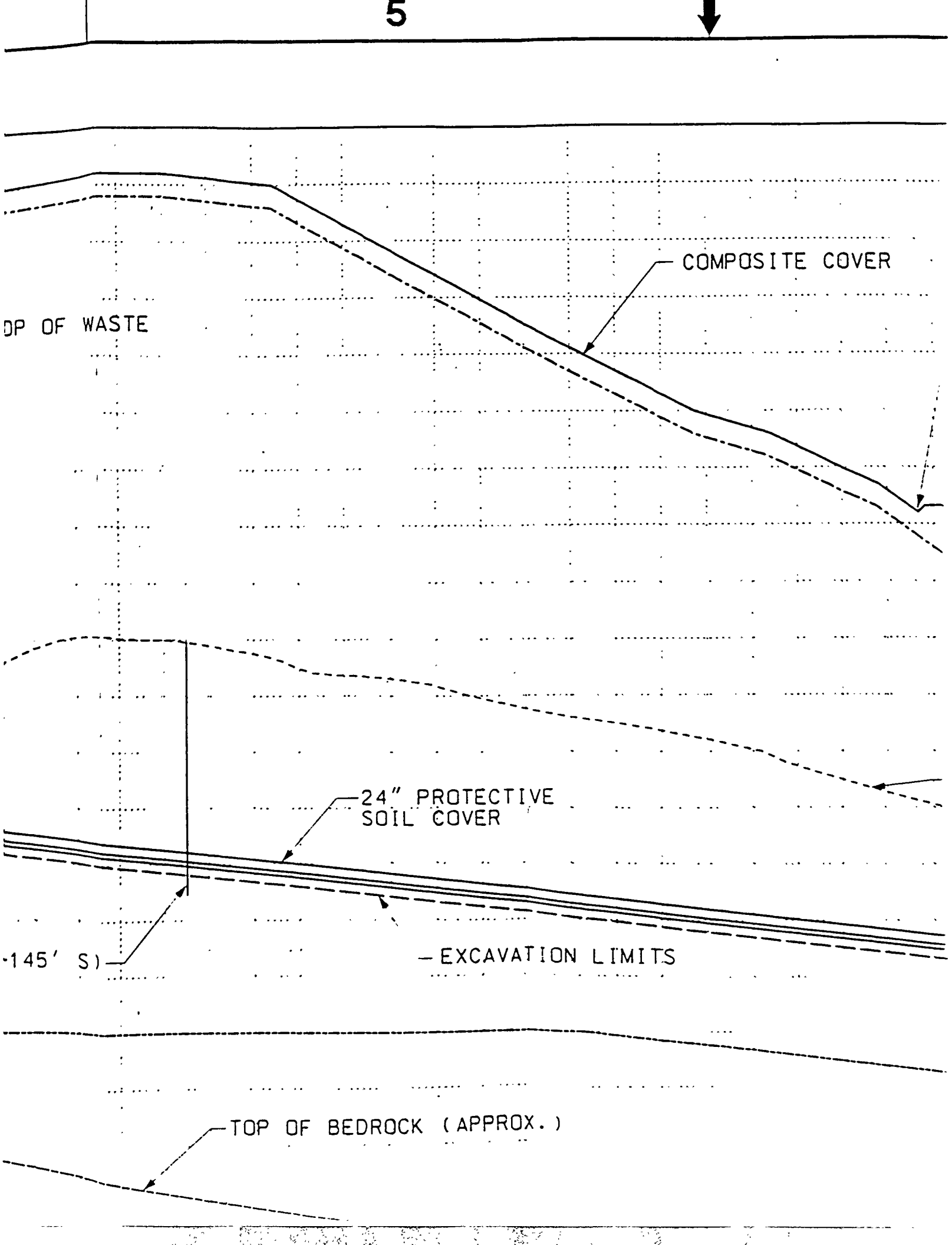
LANDFILL CROSS SECTIONS - III

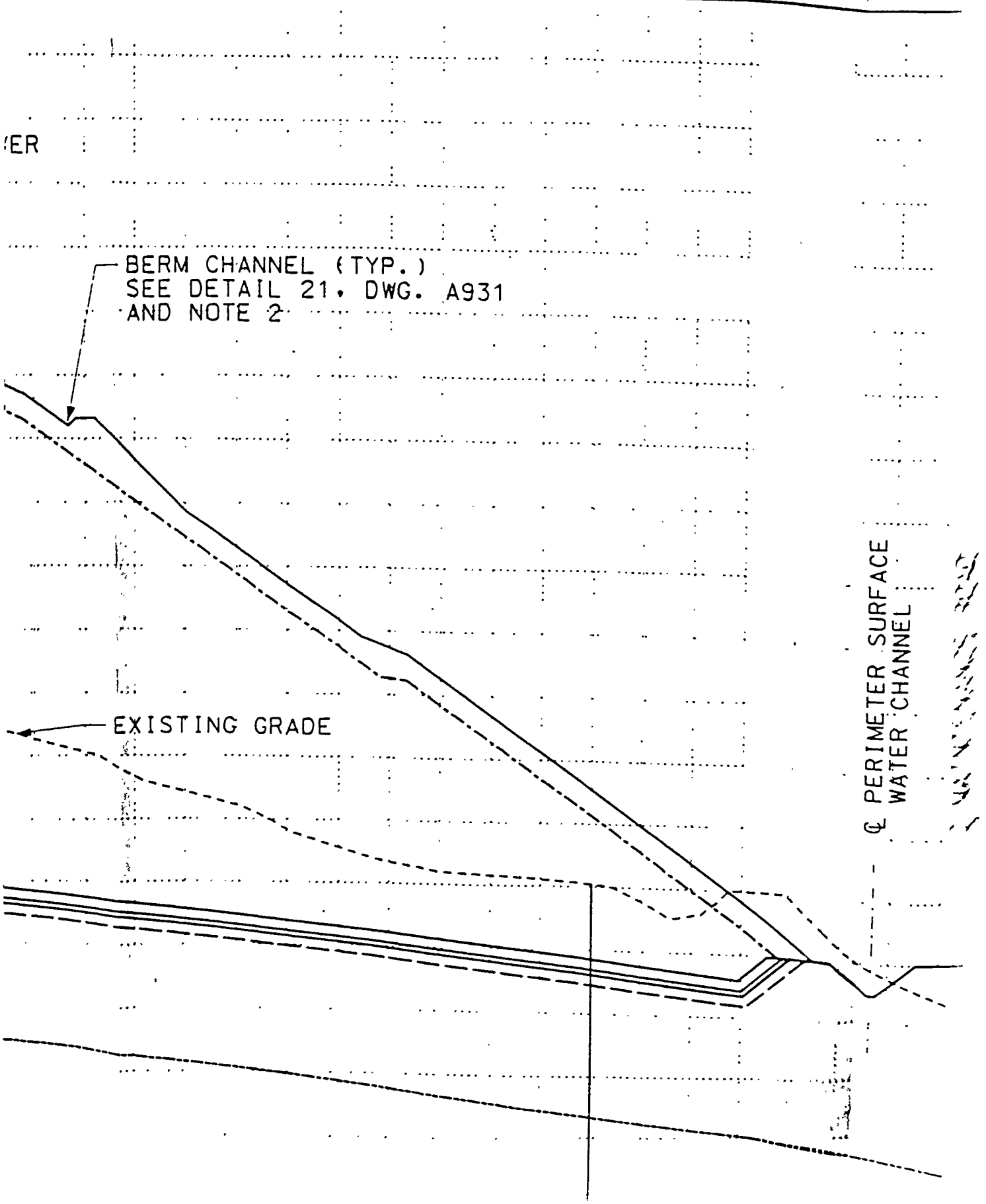
1	48	49	50	PLANT	BLDG	FL	SH.	OF	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	C U

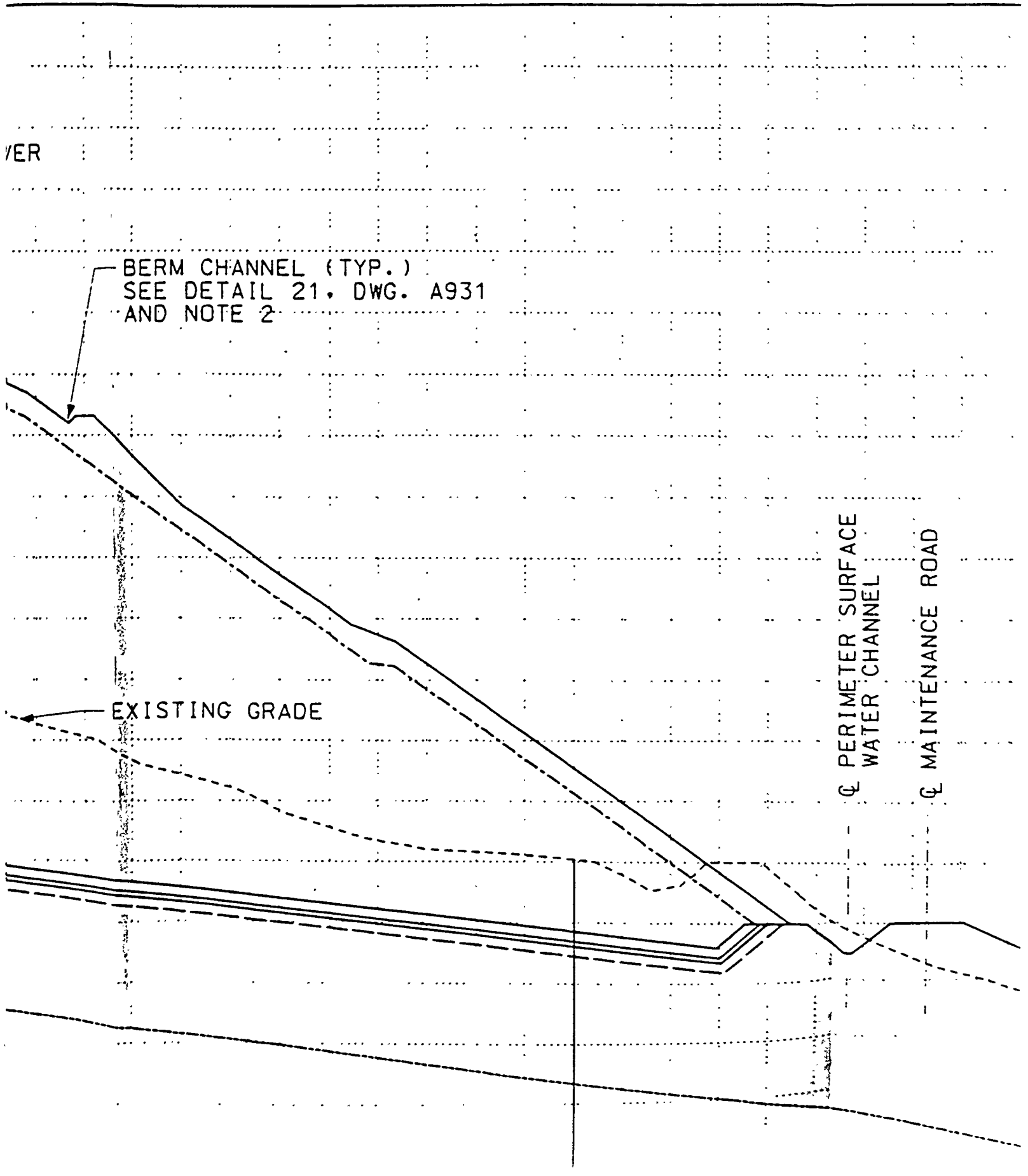
51	52	53		REV
NC	NA	AR	C2E900000A63[illegible]	2


1150
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010
1000
990
980
970
ELEVATION
℄ MAINTENANCE ROAD
℄ PERIMETER SURFACE WATER CHANNEL
24" C
CLAY
GW-799
(OFFSET-153' N)


℄ MAINTENANCE ROAD
TOP OF
24" COMPOSITE CLAY LINER
12" LEACHATE COLLECTION LAYER
PZ22 (OFFSET-145'
PIEZOMETRIC SURFACE (APPROX.)


5
COMPOSITE COVER
DP OF WASTE
24" PROTECTIVE
SOIL COVER
-145' S)
EXCAVATION LIMITS
TOP OF BEDROCK (APPROX.)

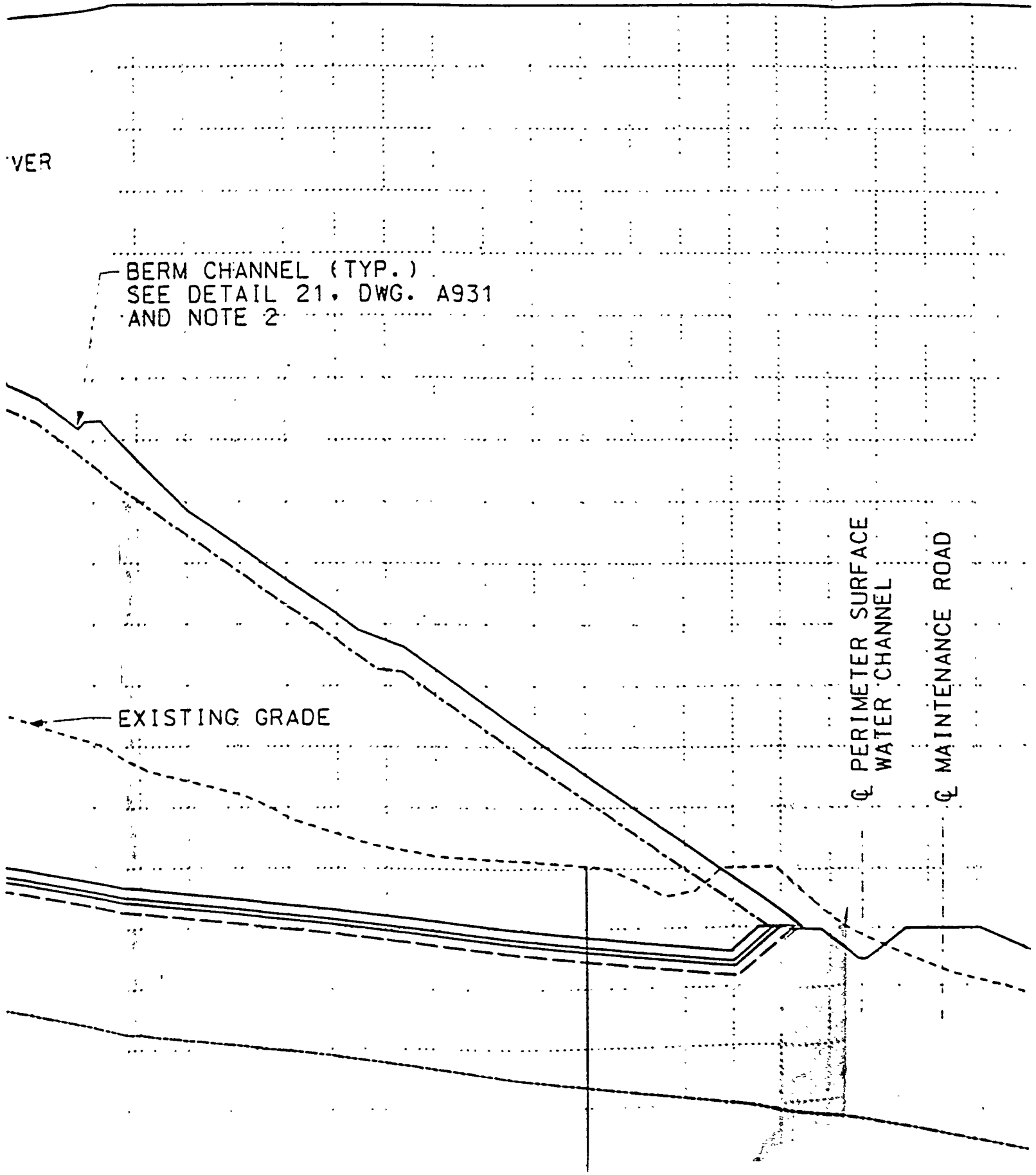

ER
BERM CHANNEL (TYP.)
SEE DETAIL 21, DWG. A931
AND NOTE 2
EXISTING GRADE
℄ PERIMETER SURFACE
WATER CHANNEL

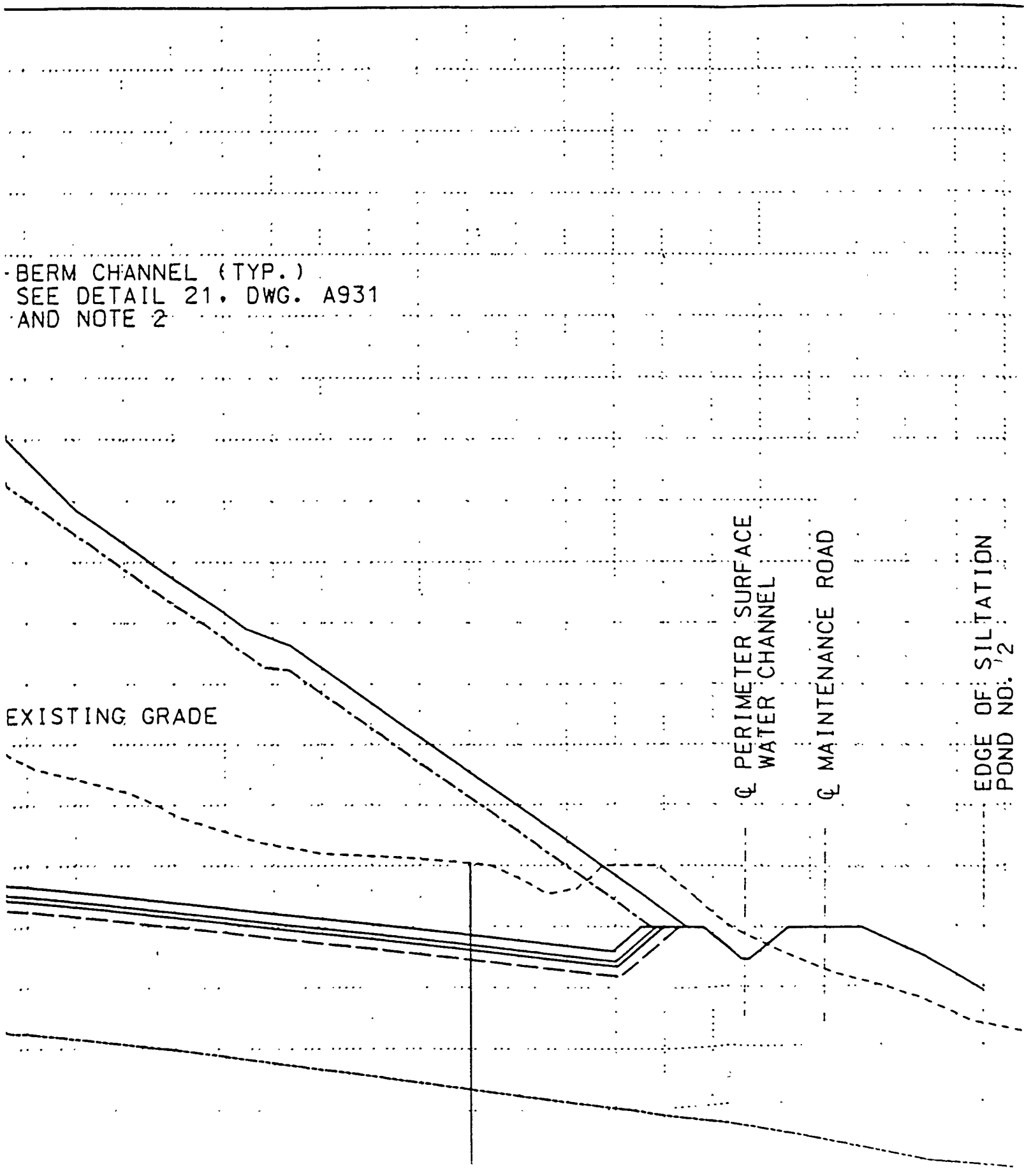

VER
BERM CHANNEL (TYP.)
SEE DETAIL 21. DWG. A931
AND NOTE 2
EXISTING GRADE
℄ PERIMETER SURFACE WATER CHANNEL
℄ MAINTENANCE ROAD

4

3

VER

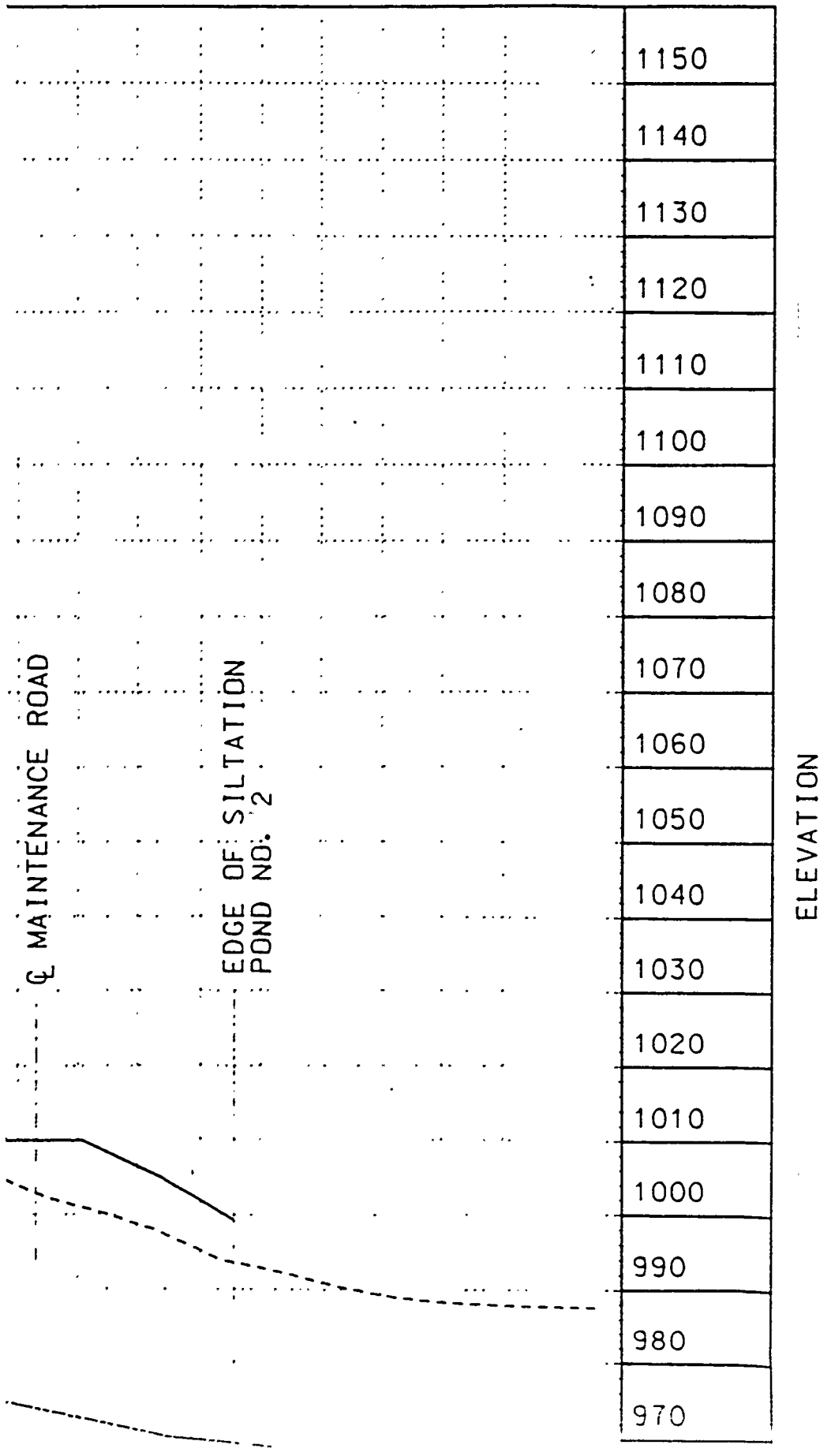

BERM CHANNEL (TYP.)
SEE DETAIL 21. DWG. A931
AND NOTE 2
EXISTING GRADE
℄ PERIMETER SURFACE WATER CHANNEL
℄ MAINTENANCE ROAD


BERM CHANNEL (TYP.)
SEE DETAIL 21. DWG. A931
AND NOTE 2
EXISTING GRADE
℄ PERIMETER SURFACE WATER CHANNEL
℄ MAINTENANCE ROAD
EDGE OF SILTATION POND NO. 2

NOTES:

1. FOR ADD
   SEE DWG

2. ALL BER
   APPROXI
   DWG C2E



NOTES:

1. FOR ADDITIONAL NOTES FOR CROSS SECTIONS, SEE DWG C2E900000A631.

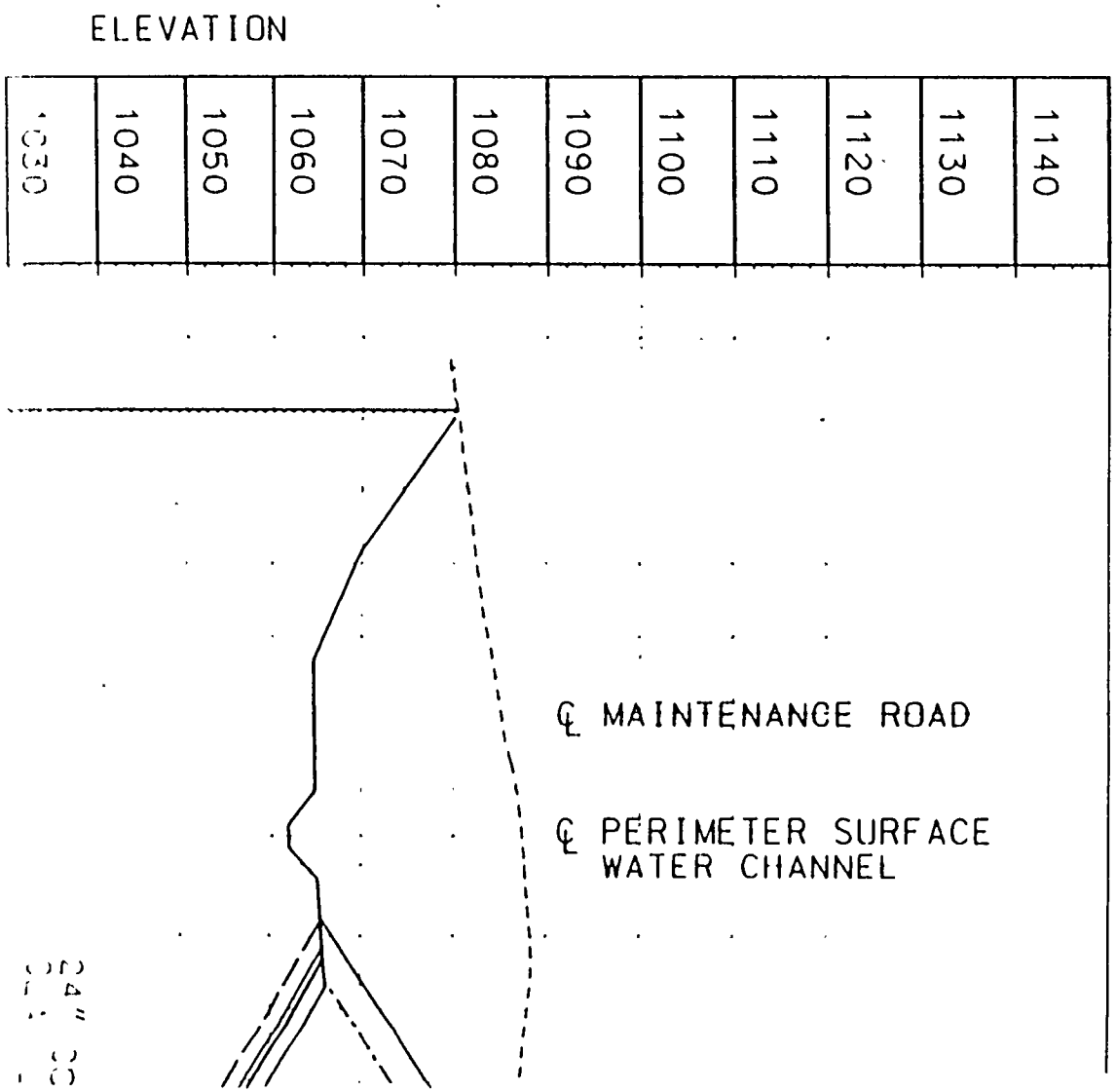
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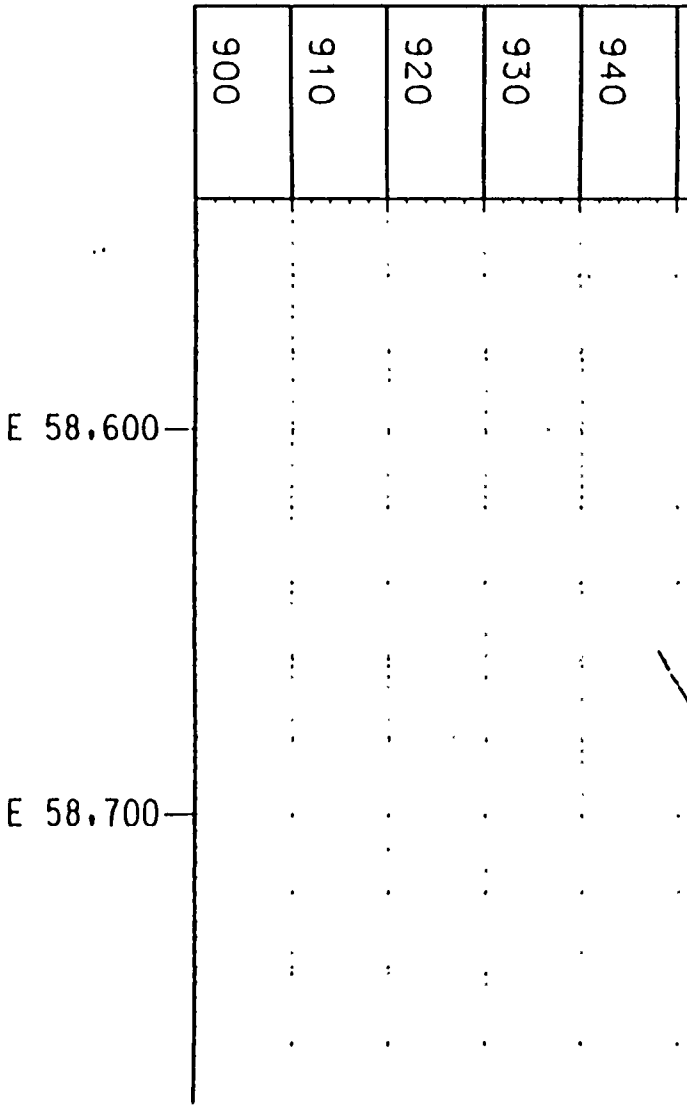
ELEVATION

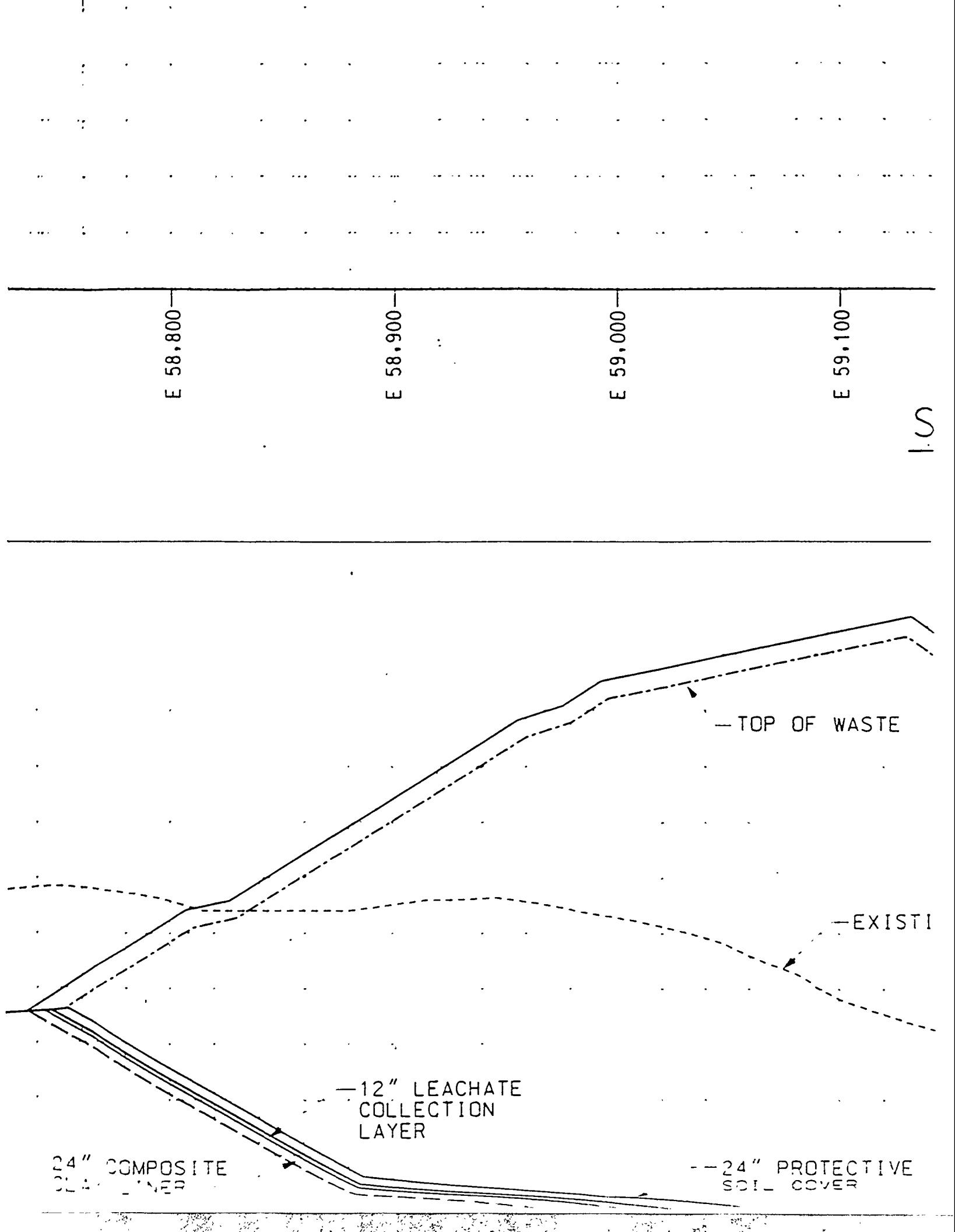
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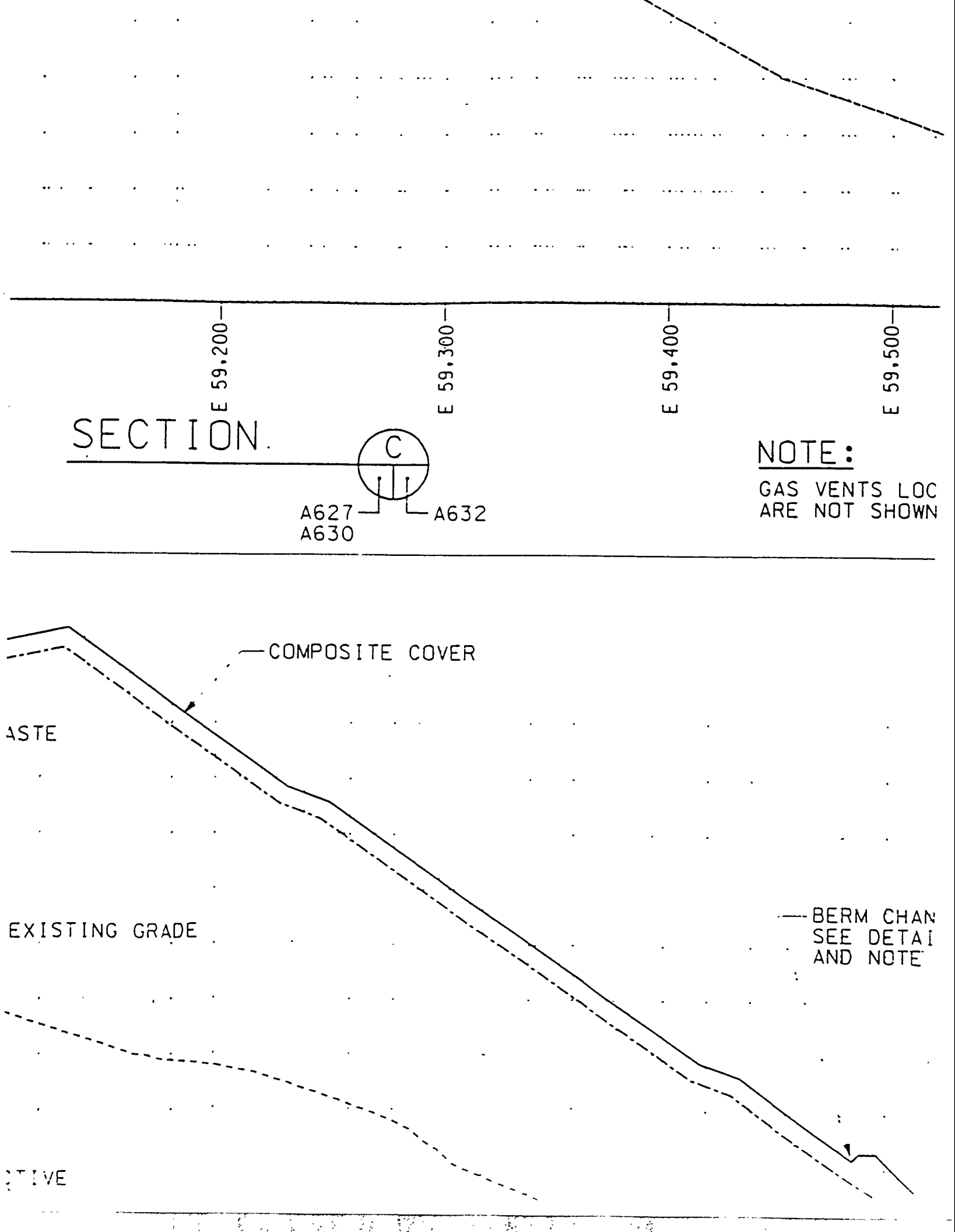
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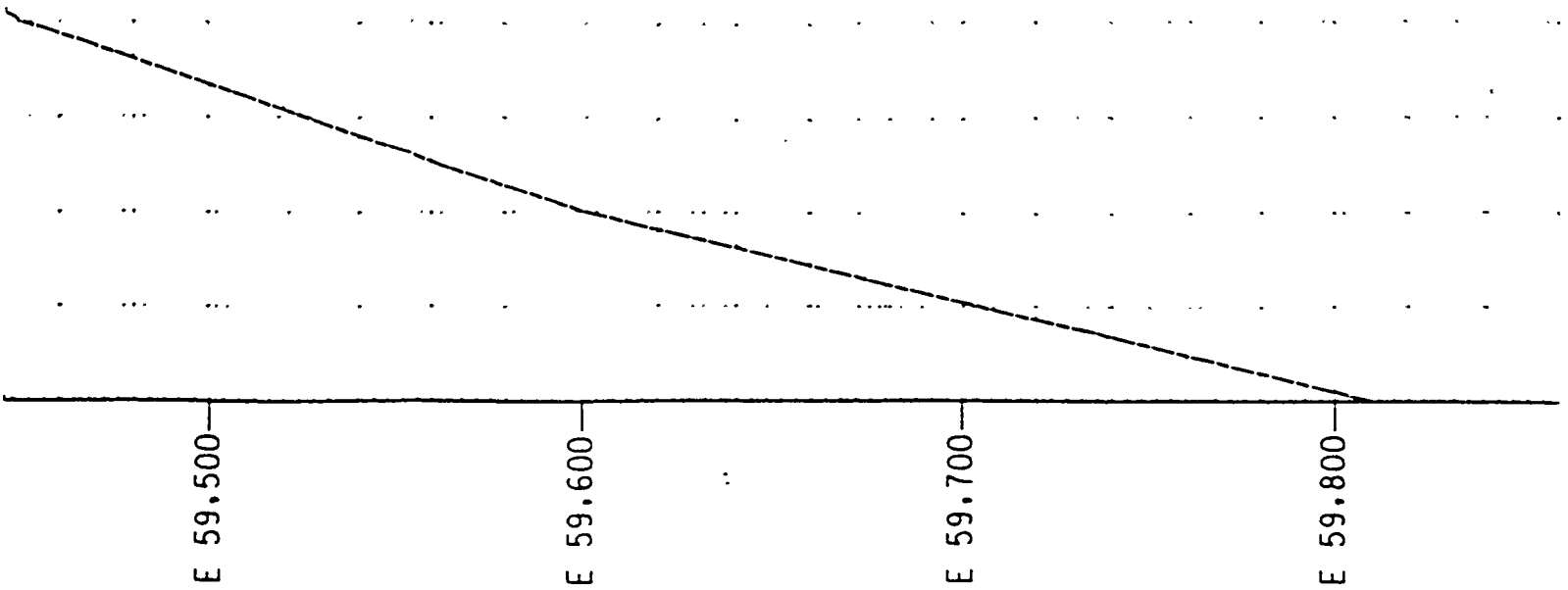
F


ELEVATION
1030
1040
1050
1060
1070
1080
1090
1100
1110
1120
1130
1140
℄ MAINTENANCE ROAD
℄ PERIMETER SURFACE WATER CHANNEL


900
910
920
930
940
E 58,600
E 58,700

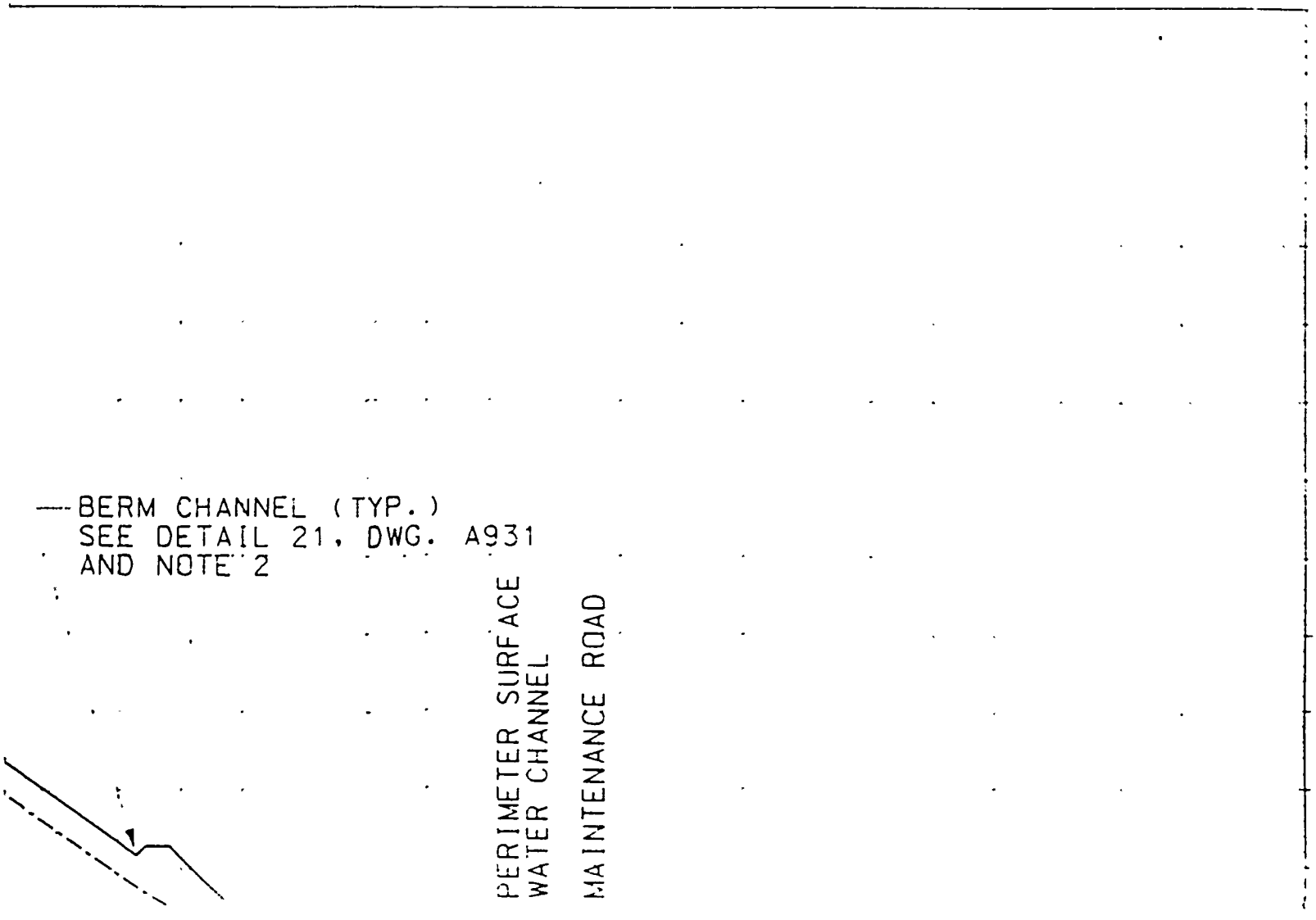

E 58,800
E 58,900
E 59,000
E 59,100
1.S
—TOP OF WASTE
—EXISTI
—12" LEACHATE
COLLECTION
LAYER
24" COMPOSITE
--24" PROTECTIVE
SOIL COVER

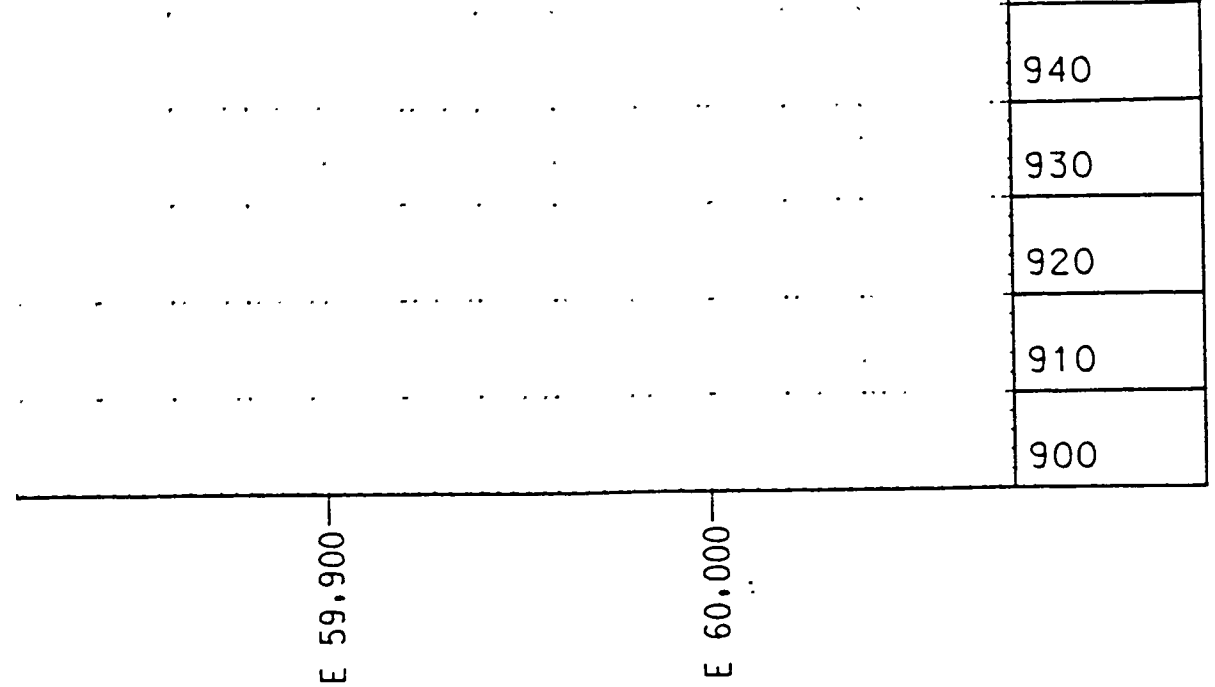

E 59,200
E 59,300
E 59,400
E 59,500
SECTION.
C
A627
A630
A632
NOTE:
GAS VENTS LOC
ARE NOT SHOWN
COMPOSITE COVER
ASTE
EXISTING GRADE
BERM CHAN
SEE DETAI
AND NOTE
TIVE

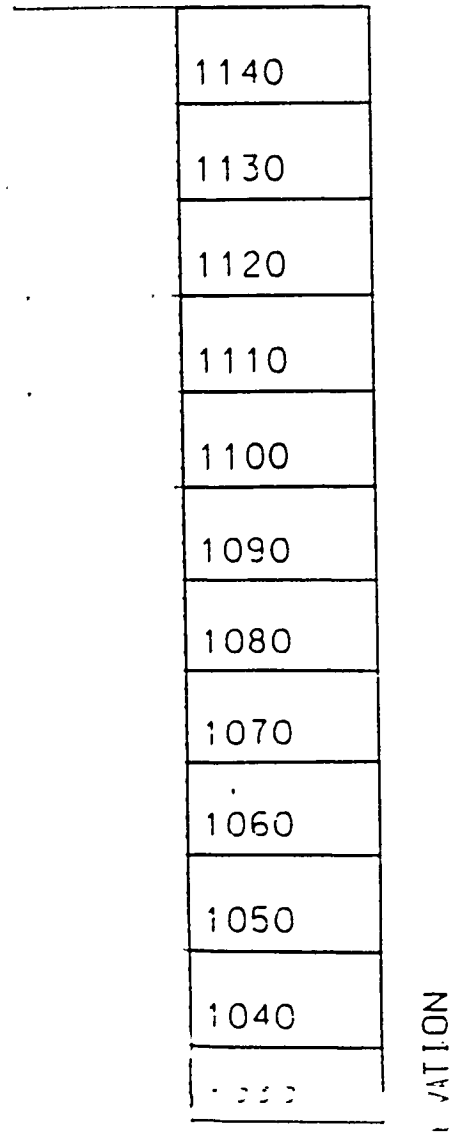


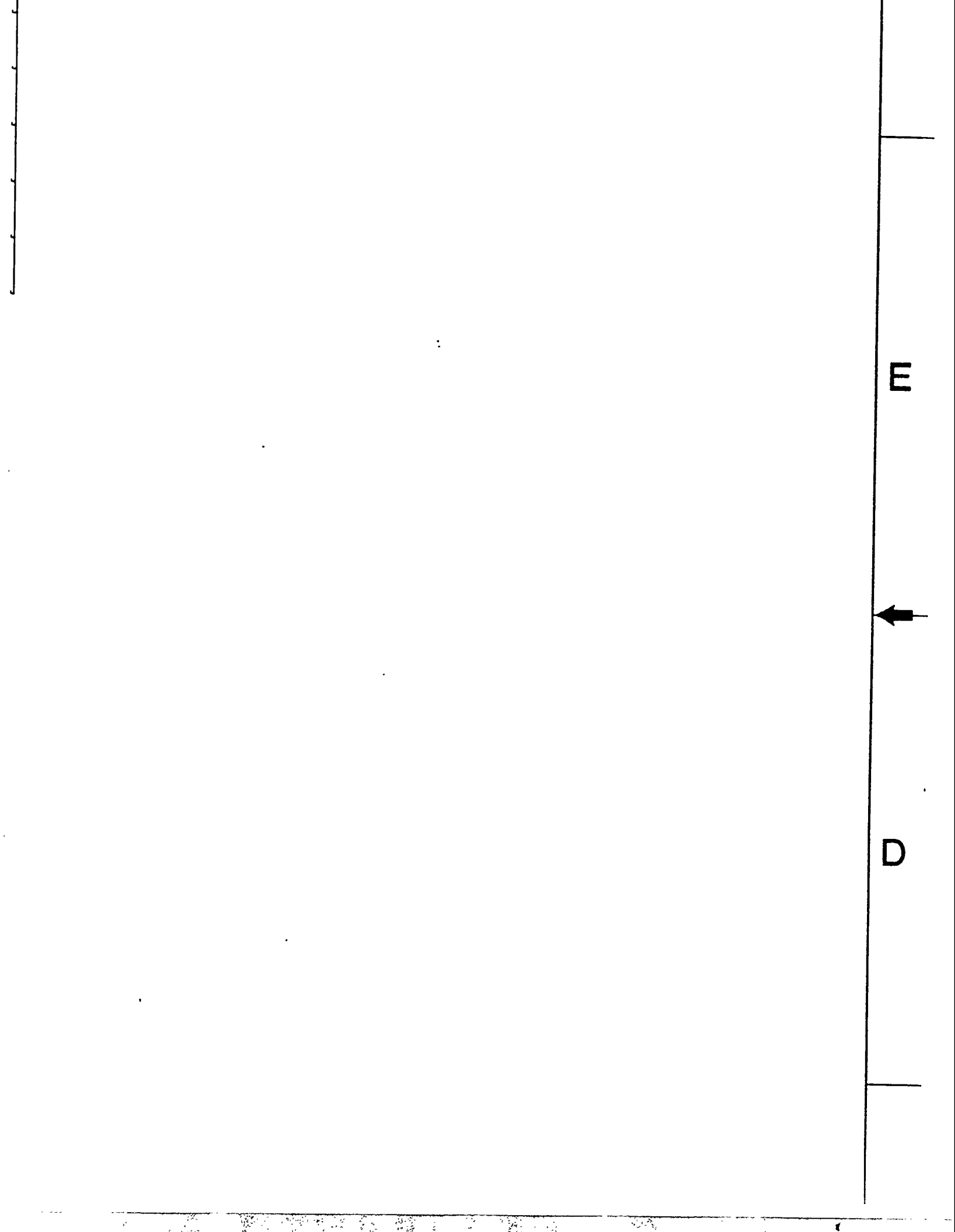
NOTE:

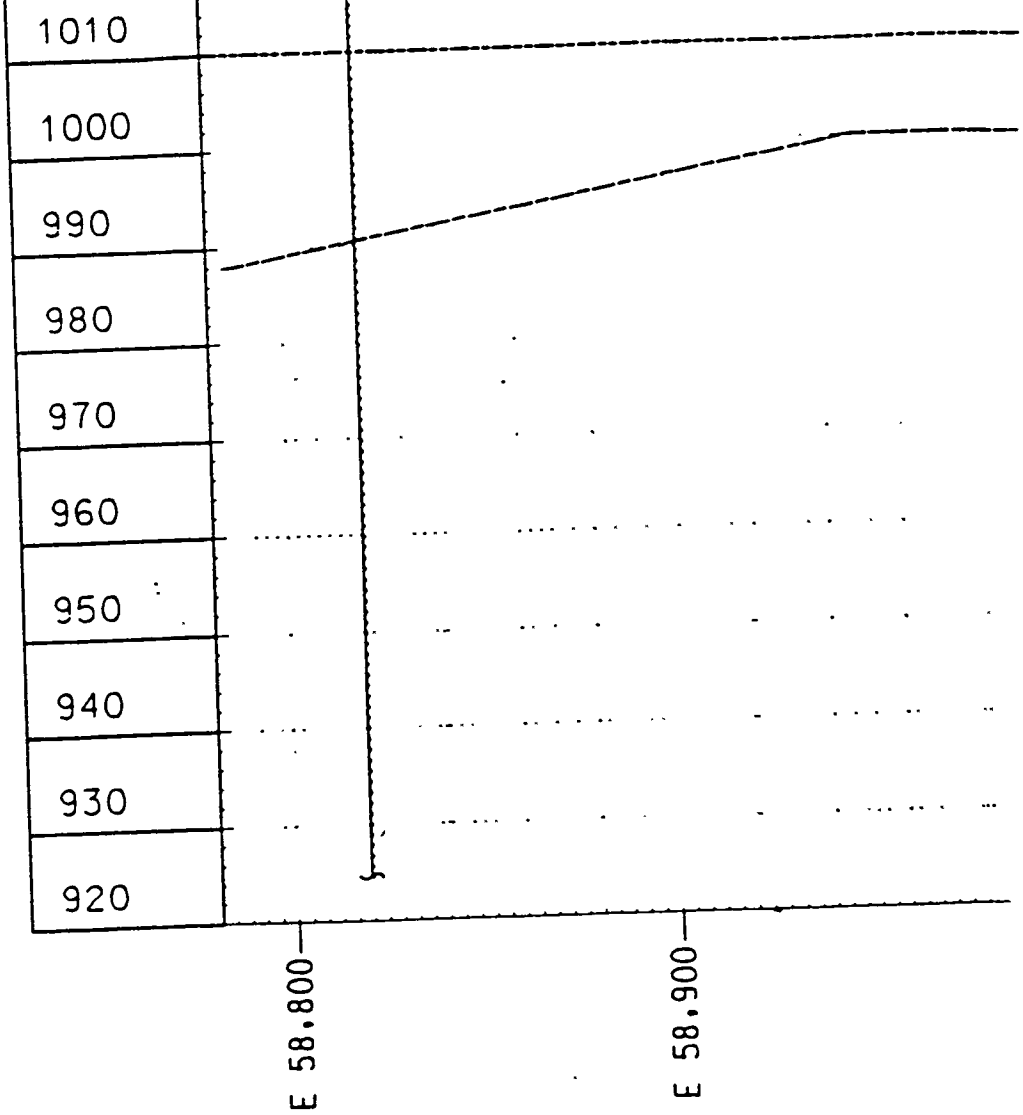
GAS VENTS LOCATED IN THE COMPOSITE COVER ARE NOT SHOWN FOR CLARITY.




940
930
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1140
1130
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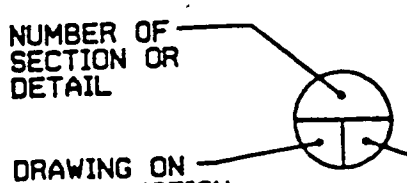

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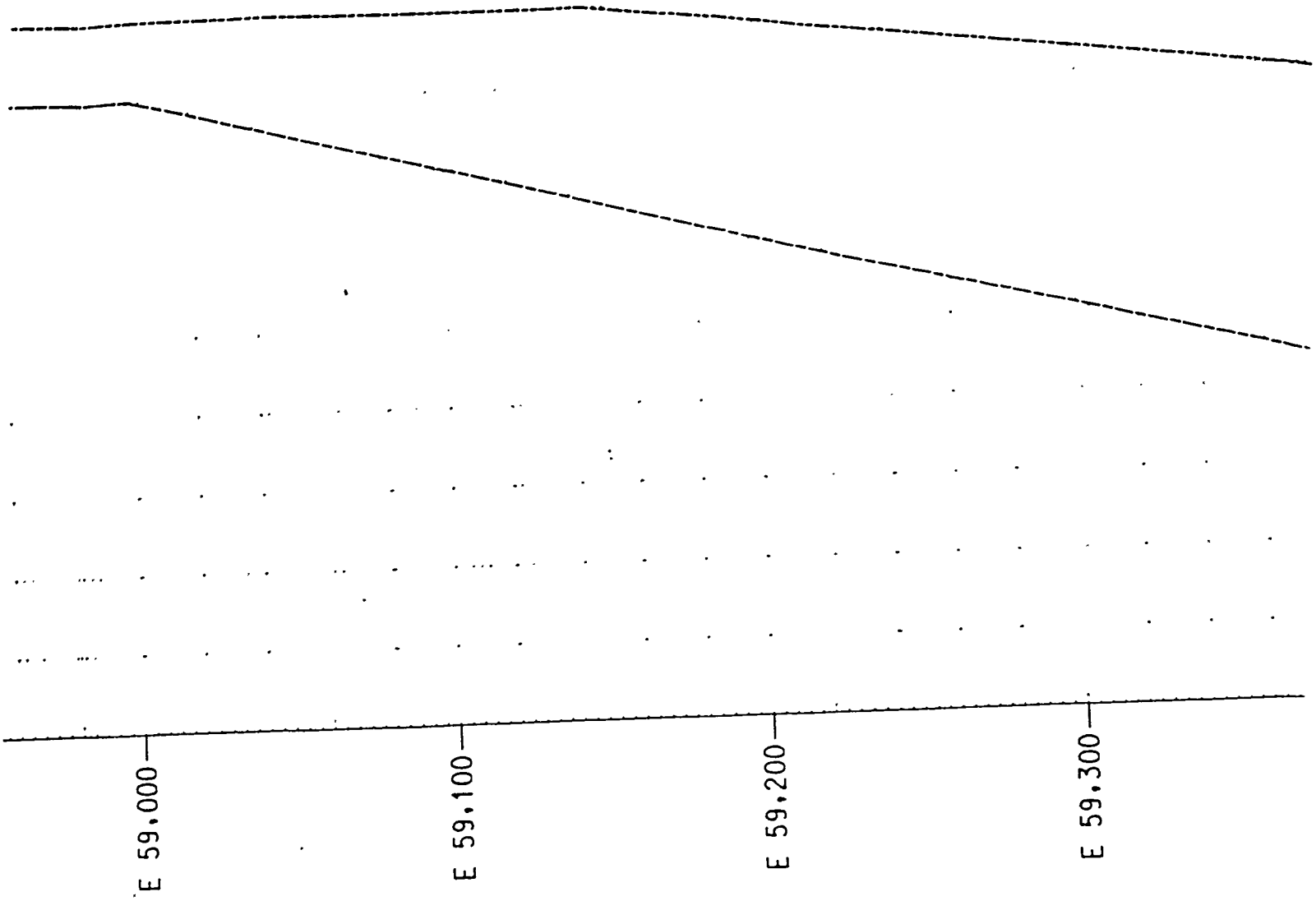
FOR PERMIT USE ONLY

Document F
EG-C-37 Re
Guideline [
UCN-19586

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SECTION AND DETAIL K



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37 Review By: _____
line Document: _____
9586 (12356 4-93)

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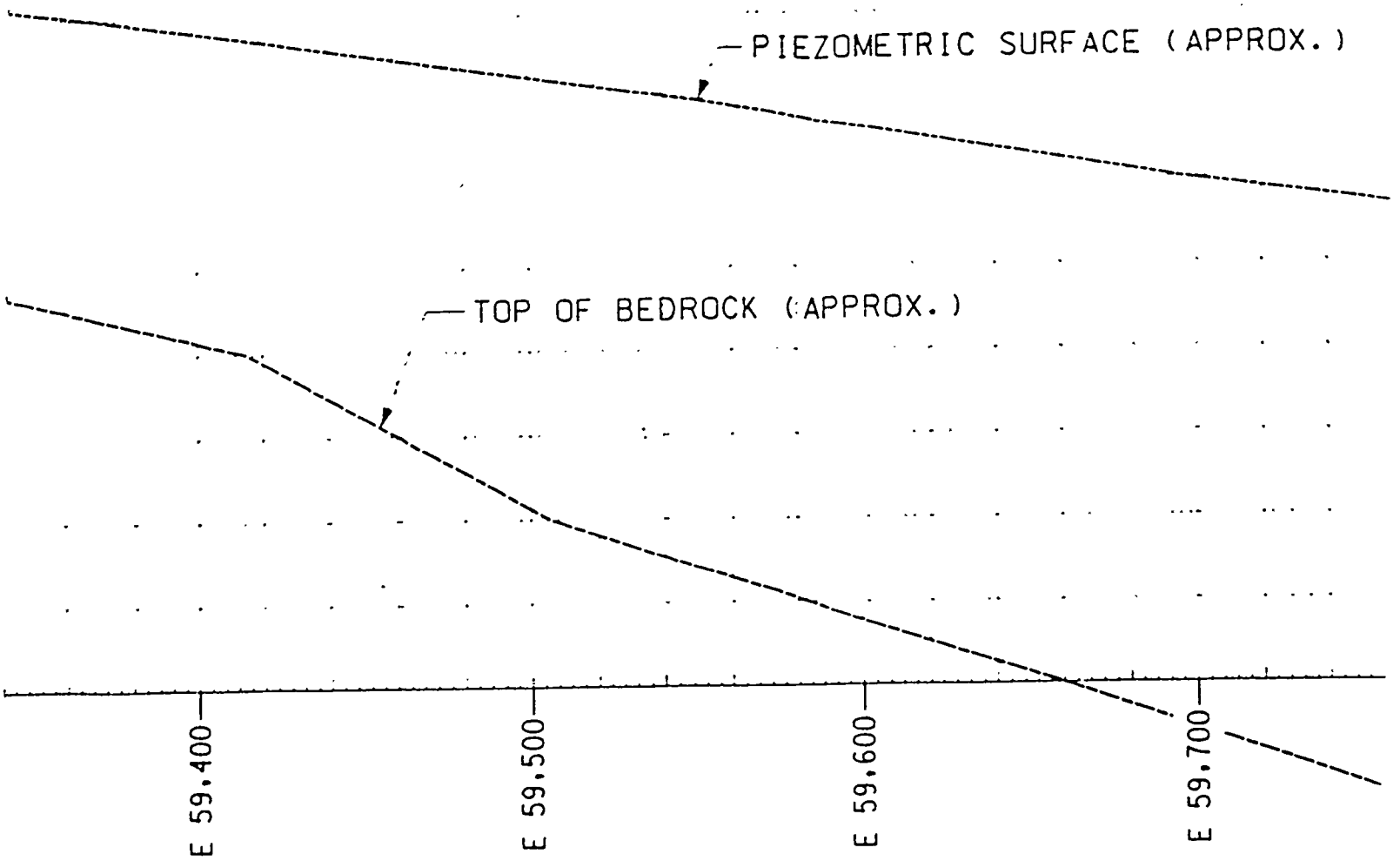
CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

AIL KEY

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION OR REVISION OR ISSUE
2				ISSUE FOR PERMITT



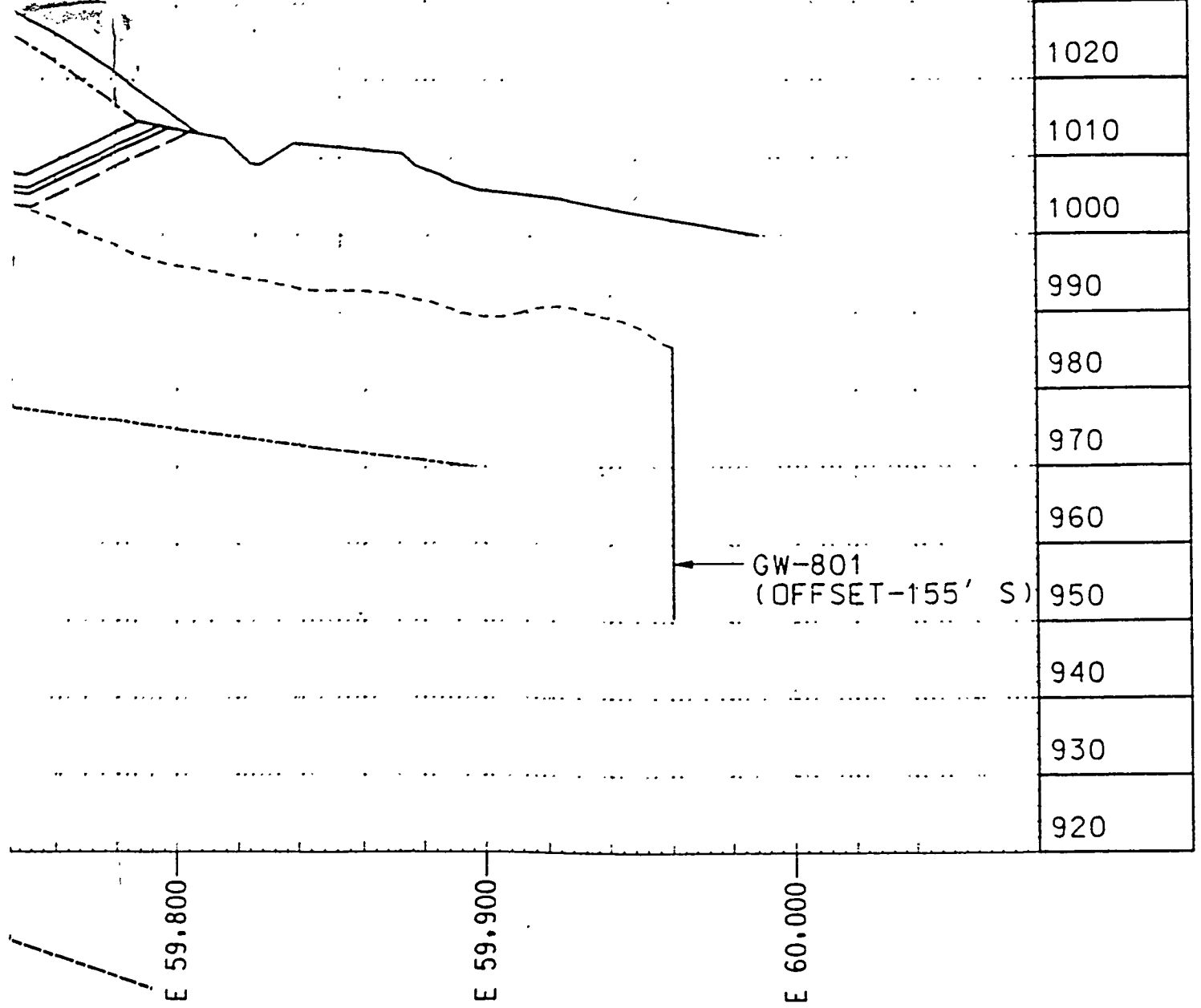
SECTION D

A627
A630
A632

NOTE

GAS V
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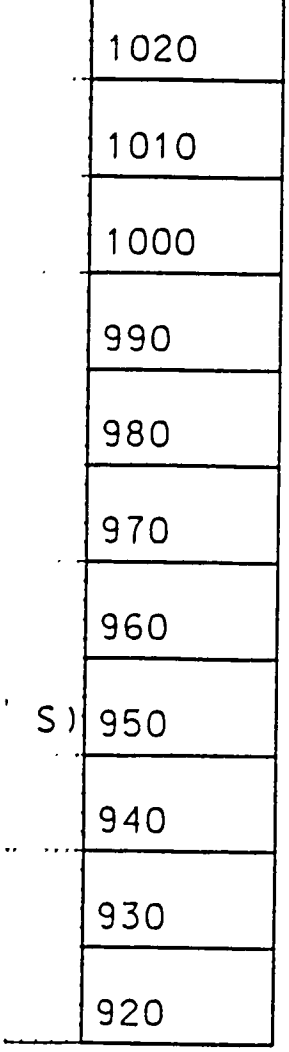
MITTING	JGA	WPT	—		8/14/95					8/28/95	WPT	
SCRIPTION	BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RPE	
OR ISSUE PURPOSE	REVISION APPROVALS											



TE:

VENTS LOCATED IN THE COMPOSITE COVER
NOT SHOWN FOR CLARITY.

RPE NO	DATE			QA	DATE	S	CV	EC	E	EM	IE	M	PD	SE	ARC
T	22811	8/19/99				—	—	—	—	—	—	—	—	—	—



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HORIZONTAL

VERTICAL

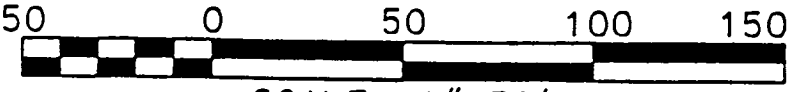
					RPE	DSGN	8/19/95	FOSTER designed
					WILLIAM PATRICK TAYLOR REGISTERED ENGINEER AGRICULTURE STATE OF TENNESSEE	DRW Jimmy G. Ashworth	8/19/95	
						CHKR W P Taylor	8/19/95	
						SECT		Y-12
						DEPT William L Crouch	8/19/95	
						PE		
						PJ	8/28/95	C
						REQ		
								1 48 4
								3 C F
M	PD	SE	ARC	VER	REV. 0 DATE 8/19/95	MMES		51

THIS DRAWING WAS ORIGINALLY ISSUED FOR PERMITTING/ CFC (REV. 0) BY BURNS AND McDONNELL, KANSAS CITY, MISSOURI, DATED 1/25/92, AND WAS PART OF A LANDFILL PERMIT PACKAGE FOR THE Y-12 INDUSTRIAL LANDFILL V. THIS DRAWING SUPERCEDES THE ORIGINAL DRAWING, AND REVISIONS ARE BEING MADE TO REFLECT ADDITIONAL LANDFILL DEVELOPMENT, AND FOR COMPLIANCE WITH TDEC REGULATORY CHANGES.

2 GENERAL REVISION - CROSS SECTIONS

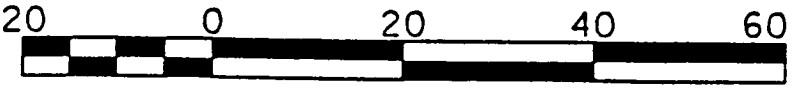
THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, DATES AND WITH THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES.

HORIZONTAL



SCALE: 1"=50'

VERTICAL



SCALE: 1"=20'

C2E900006732

	8/19/95
	8/19/95
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	8/19/95
	8/28/95

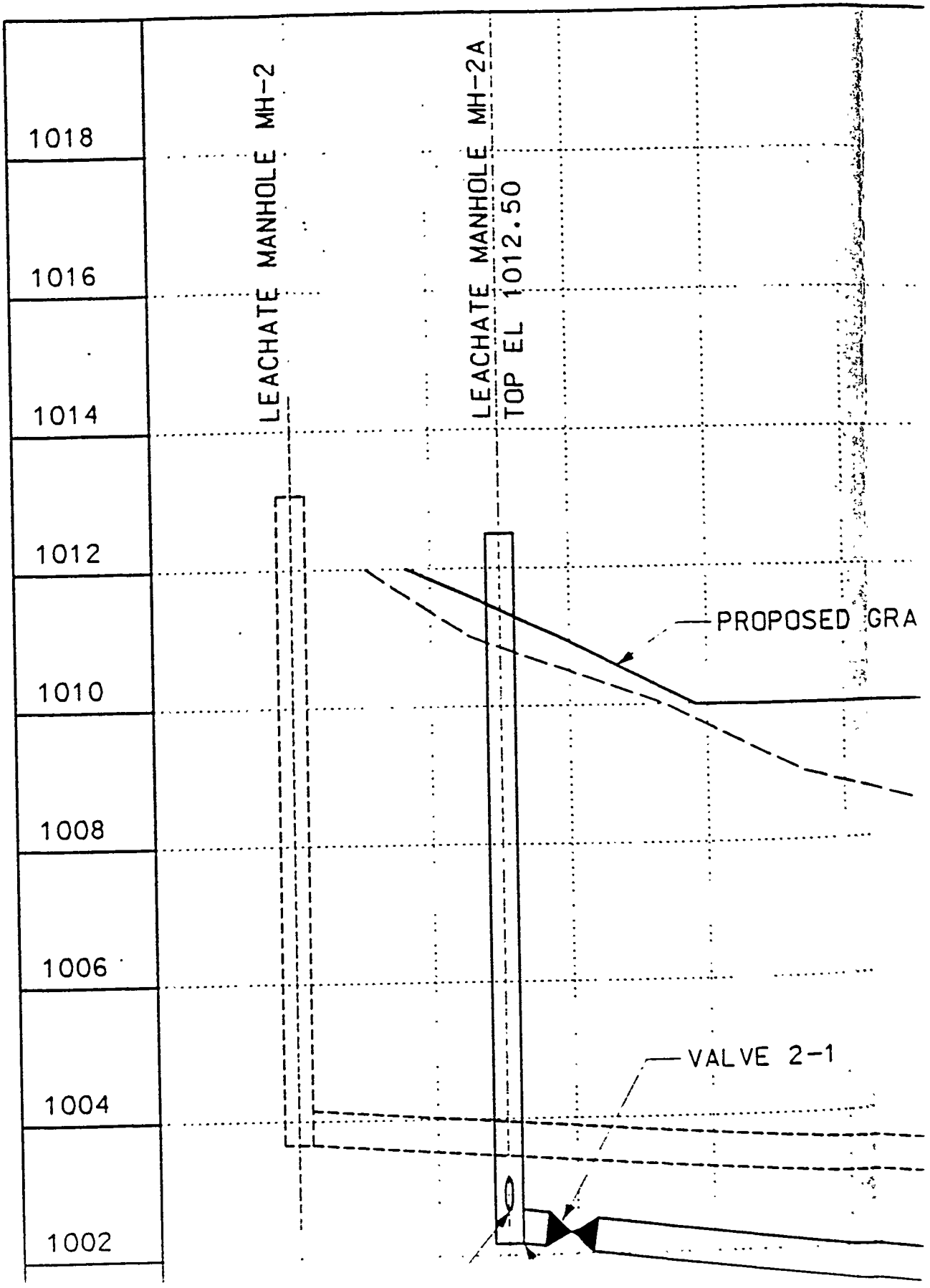
FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

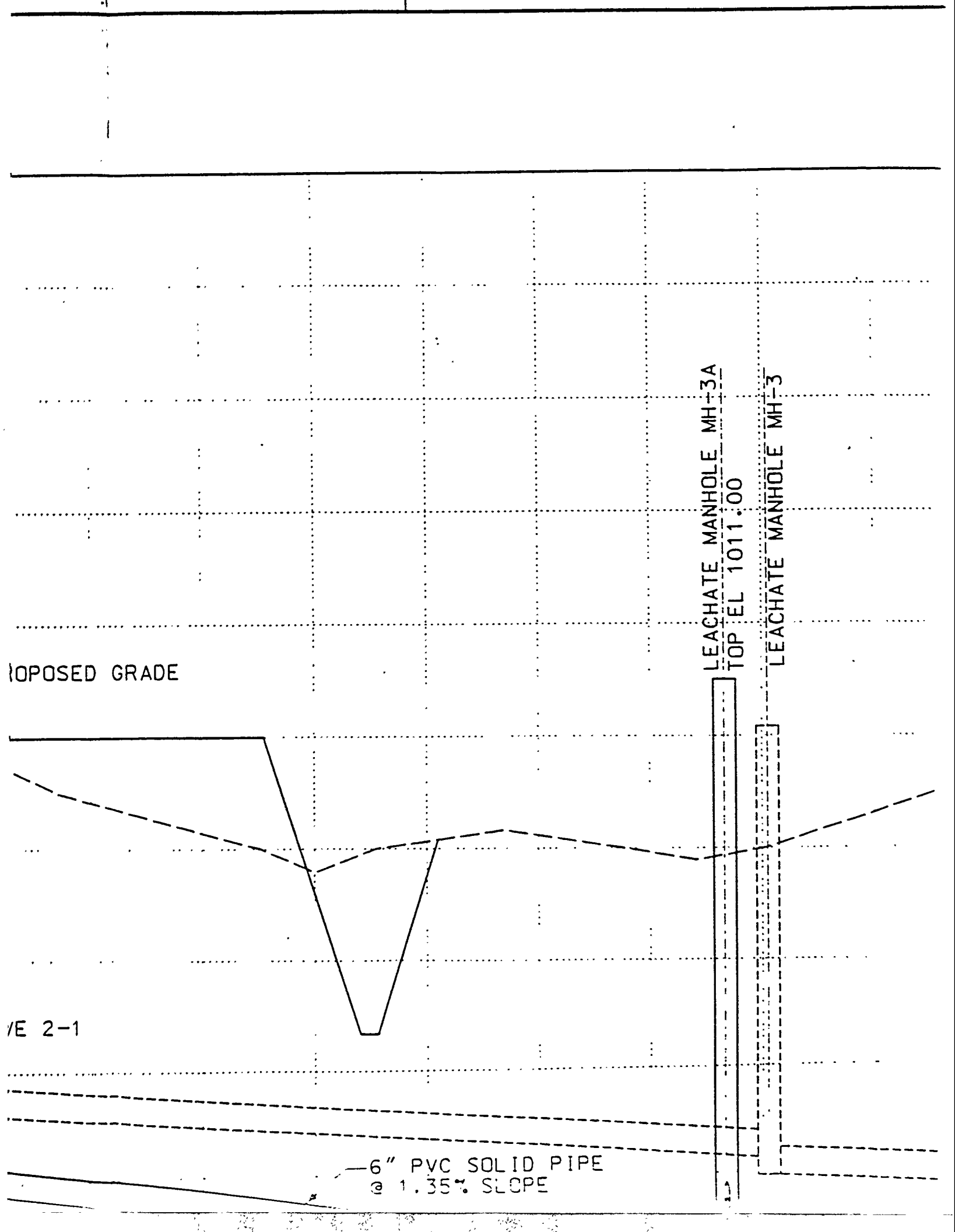
PROJECT NAME:

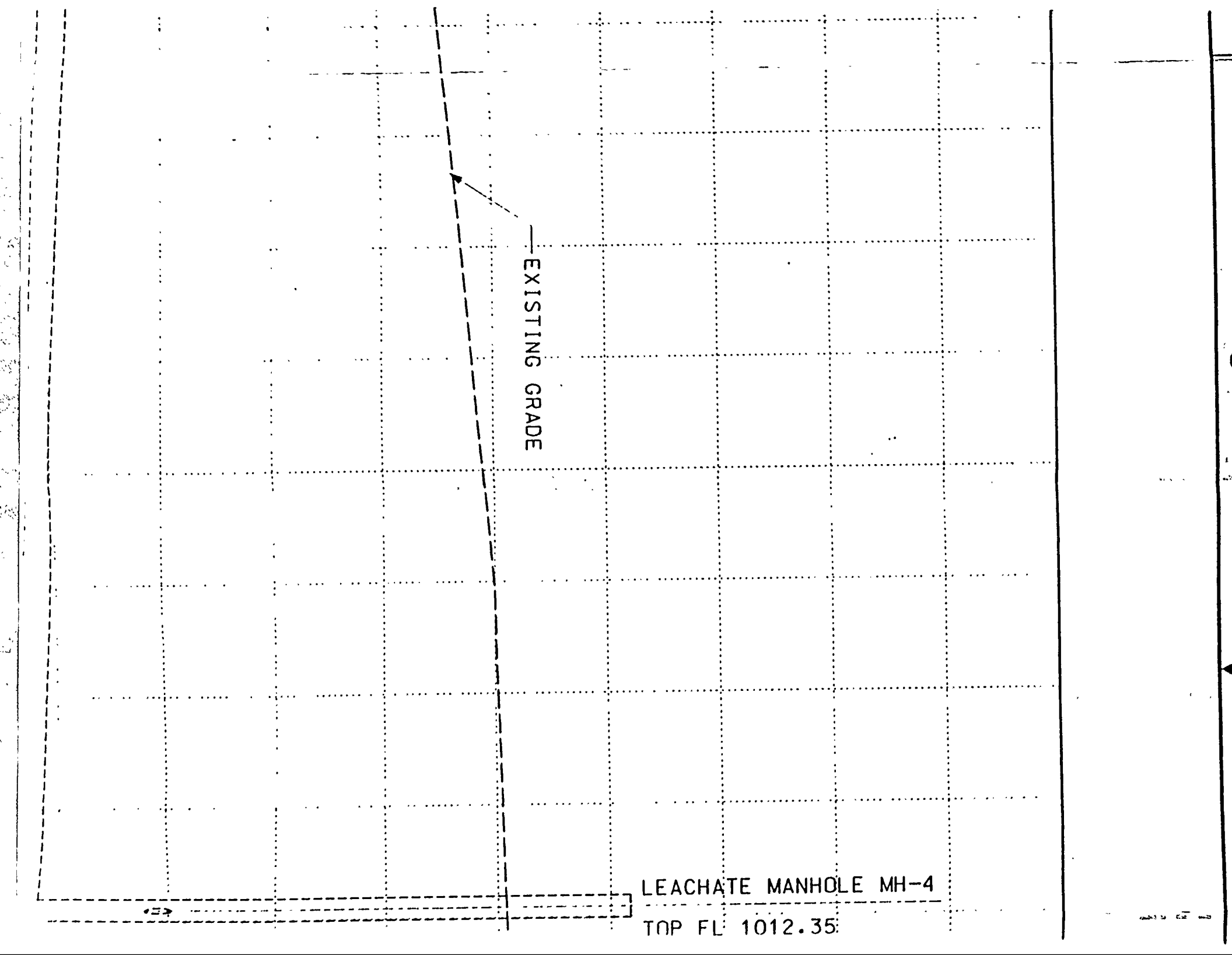
Y-12 INDUSTRIAL LANDFILL V

LANDFILL CROSS SECTIONS - II

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U
51		52		53						REV


1018
1016
1014
1012
1010
1008
1006
1004
1002
LEACHATE MANHOLE MH-2
LEACHATE MANHOLE MH-2A
TOP EL 1012.50
PROPOSED GRA
VALVE 2-1


LEACHATE MANHOLE MH-3A
TOP EL 1011.00
LEACHATE MANHOLE MH-3
6" PVC SOLID PIPE
@ 1.35% SLOPE


EXISTING GRADE
LEACHATE MANHOLE MH-4
TOP FL 1012.35

LEACHATE MANHOLE MH-4
TOP EL 1012.35
1018
1016
1014
1012
1010
1008
1006
1004
1002

NOTE

1. FOR (
   SEE (

2. INVE
   MAY
   CONS

NEXT ASS'Y:

FINAL ASS'Y:

NOTES:

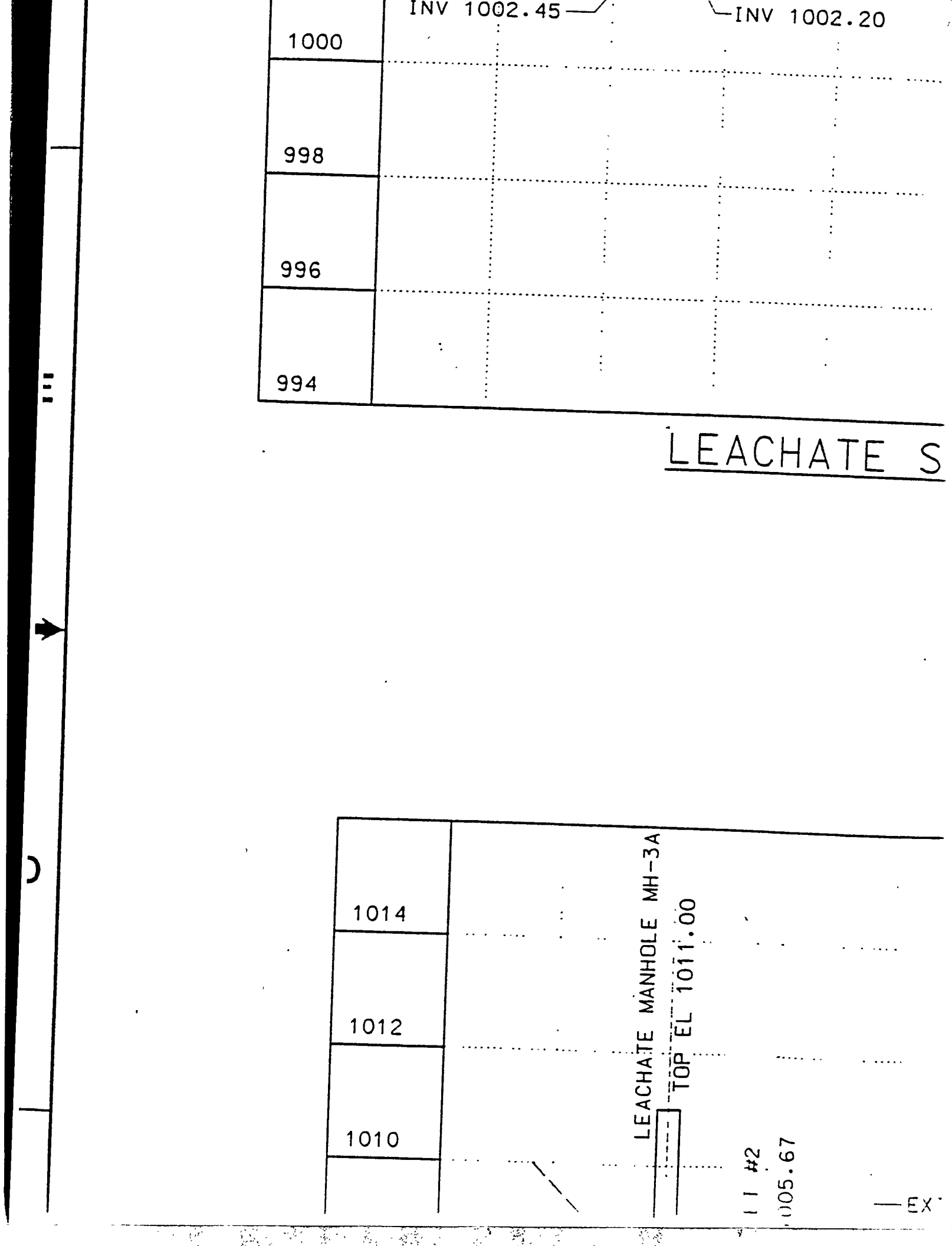
1. FOR DETAILS OF LEACHATE MANHOLE CONSTRUCTION SEE DETAIL 12. DWG C2E900000A929.

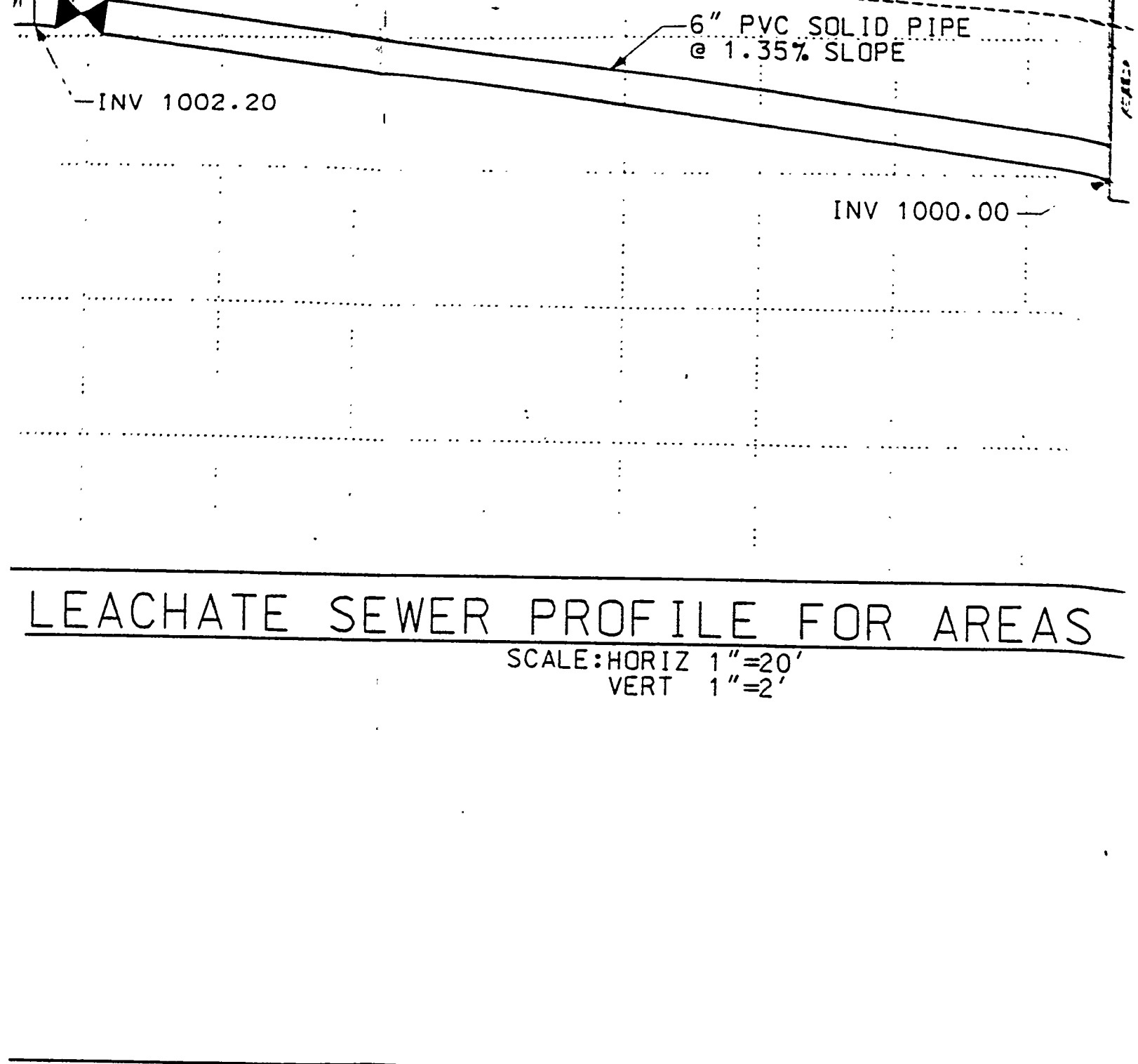
2. INVERT ELEVATIONS AND PIPE SLOPES SHOWN MAY VARY SLIGHTLY DUE TO NORMAL CONSTRUCTION TOLERANCES.

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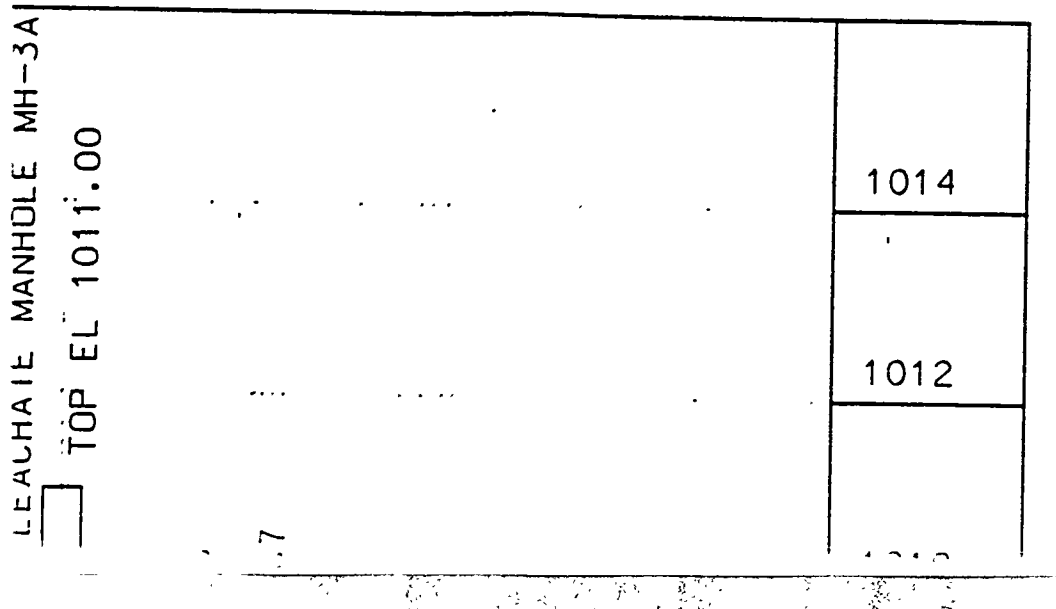
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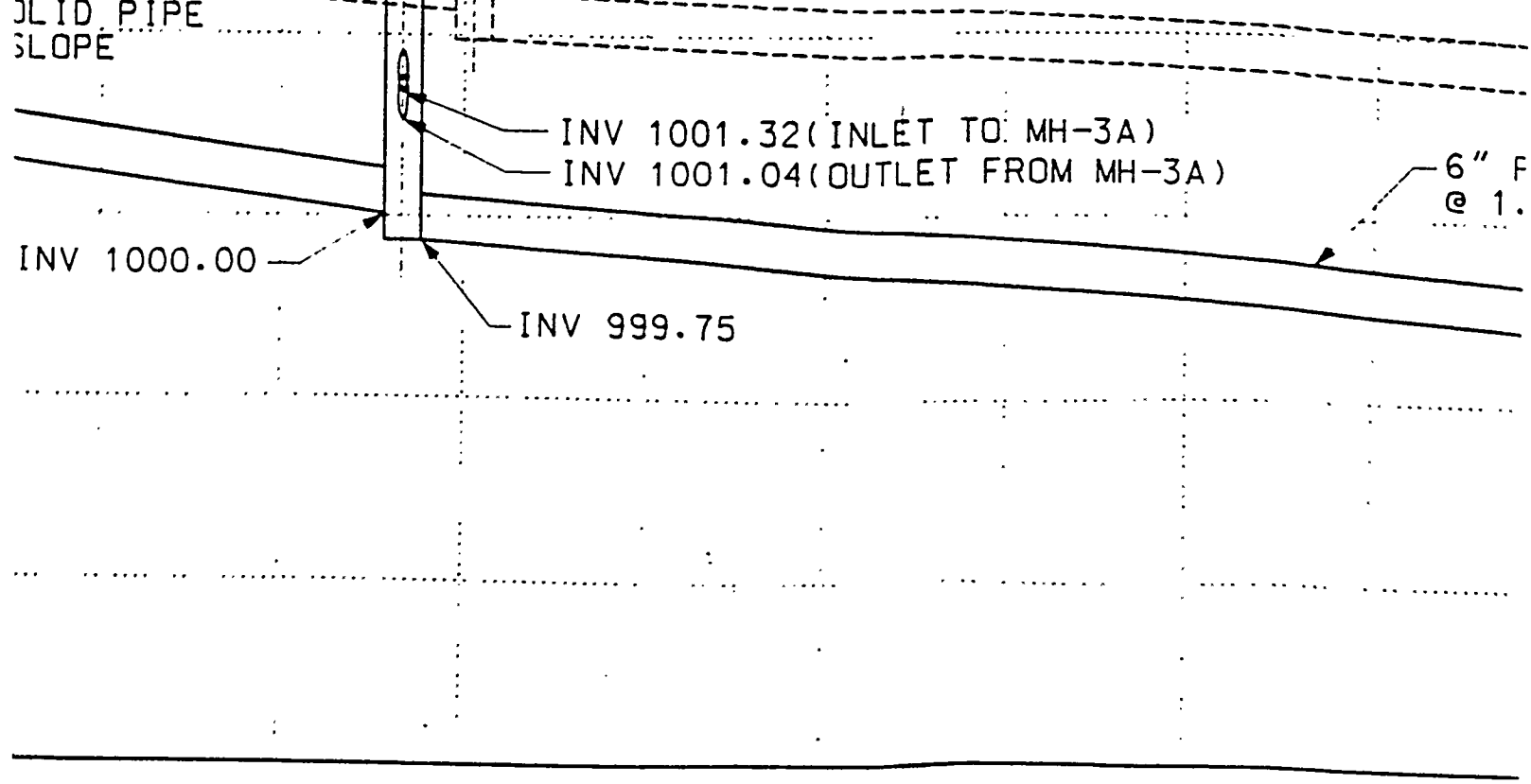

INV 1002.45
INV 1002.20
1000
998
996
994
LEACHATE S
1014
1012
1010
LEACHATE MANHOLE MH-3A
TOP EL 1011.00
#2
005.67
EX



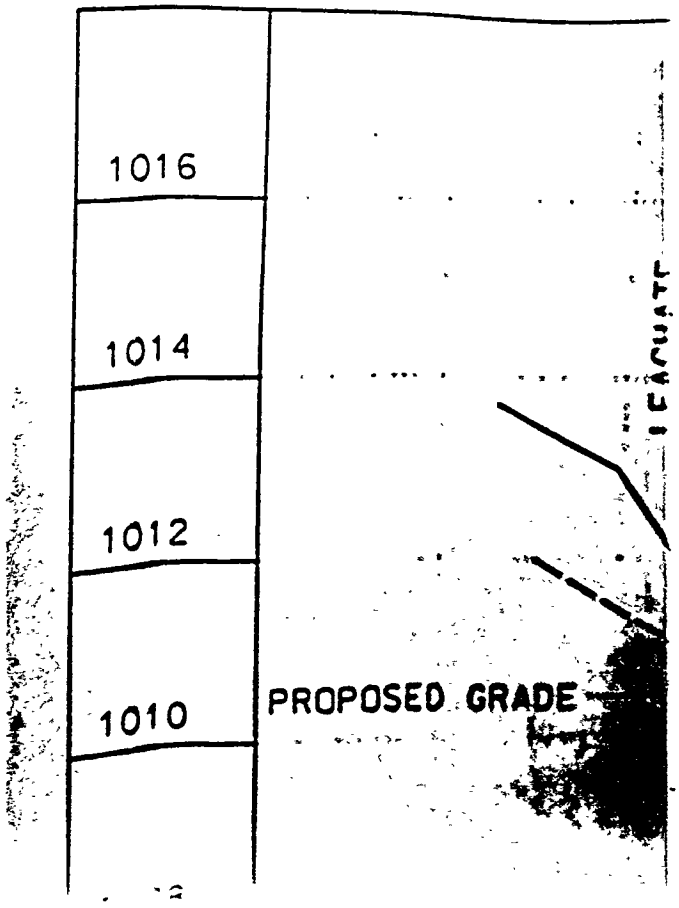
LEACHATE SEWER PROFILE FOR AREAS

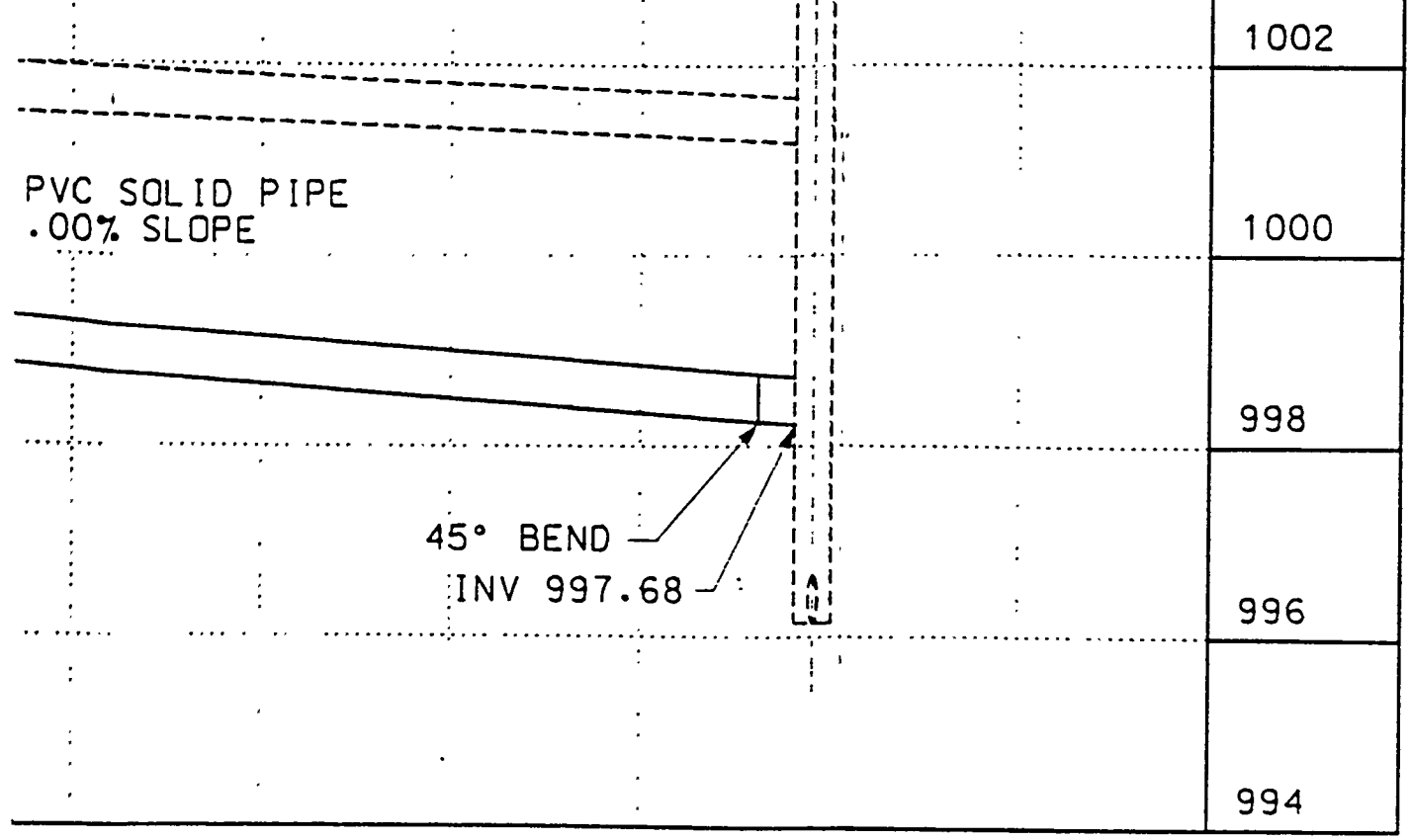
SCALE: HORIZ 1"=20'
VERT 1"=2'

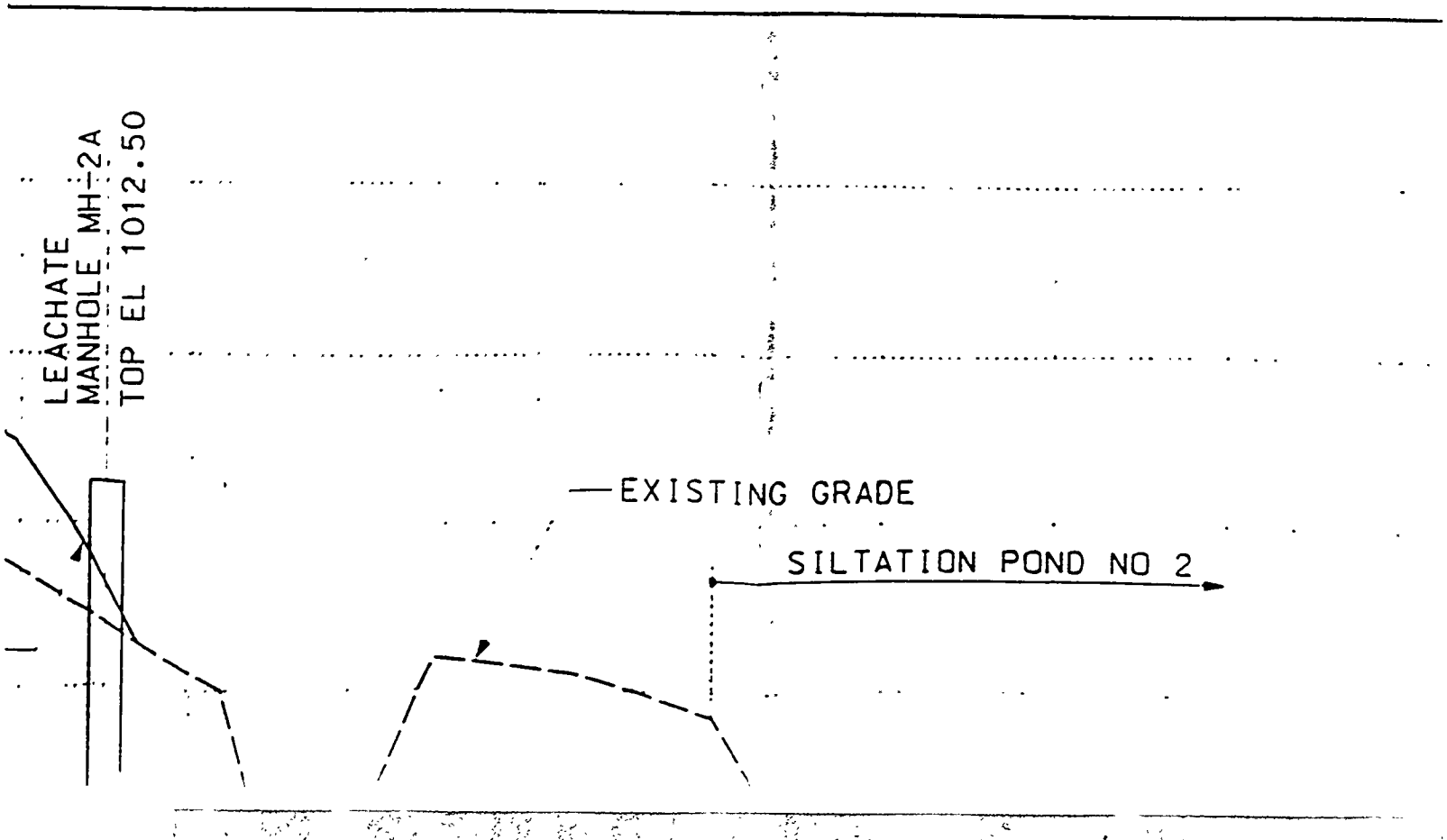


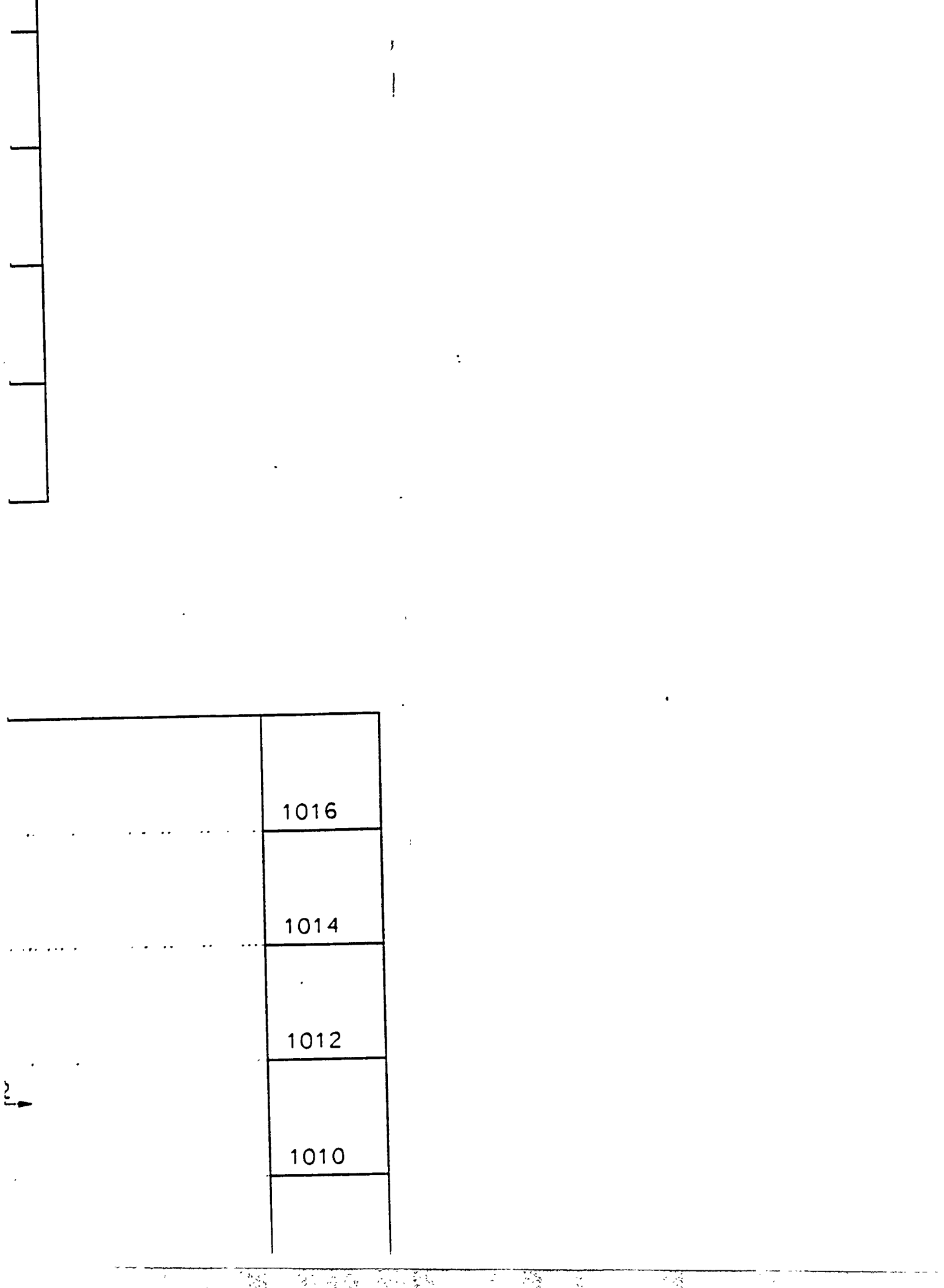

SLOPE
INV 1001.32(INLET TO MH-3A)
INV 1001.04(OUTLET FROM MH-3A)
6" F
@ 1.
INV 1000.00
INV 999.75

OR AREAS 2 & 3

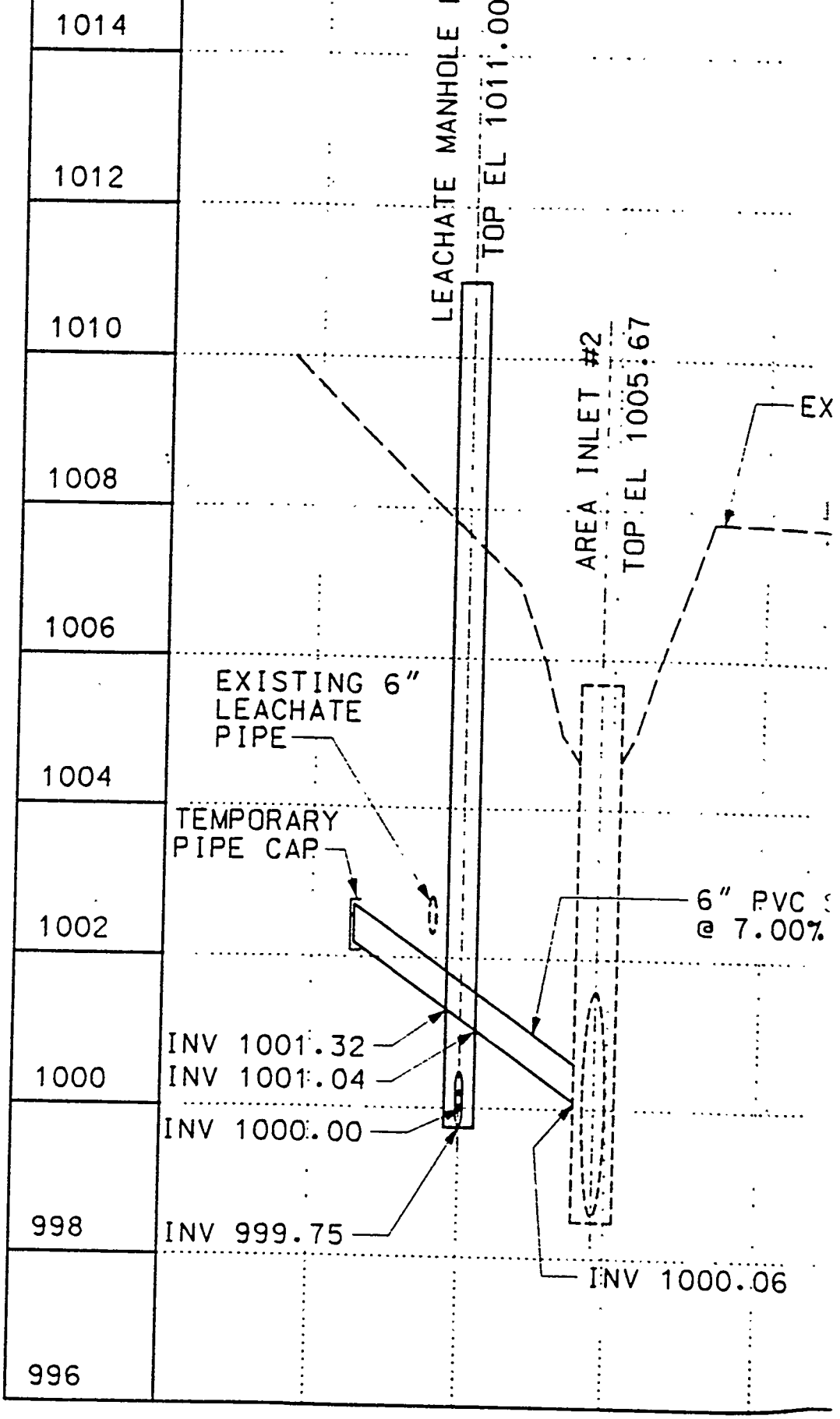

1016
1014
1012
1010
PROPOSED GRADE


1002
PVC SOLID PIPE
.00% SLOPE
1000
998
45° BEND
INV 997.68
996
994


LEACHATE
MANHOLE MH-2A
TOP EL 1012.50
EXISTING GRADE
SILTATION POND NO 2

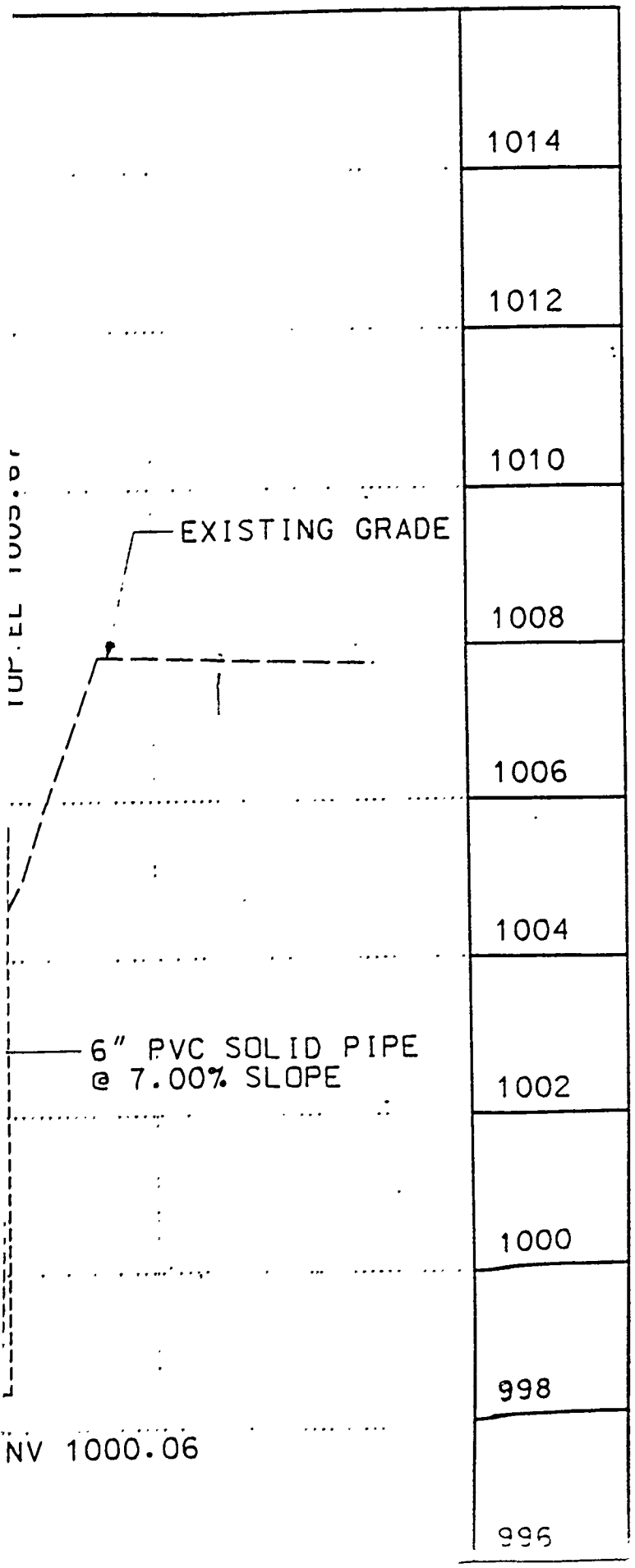

1016
1014
1012
1010

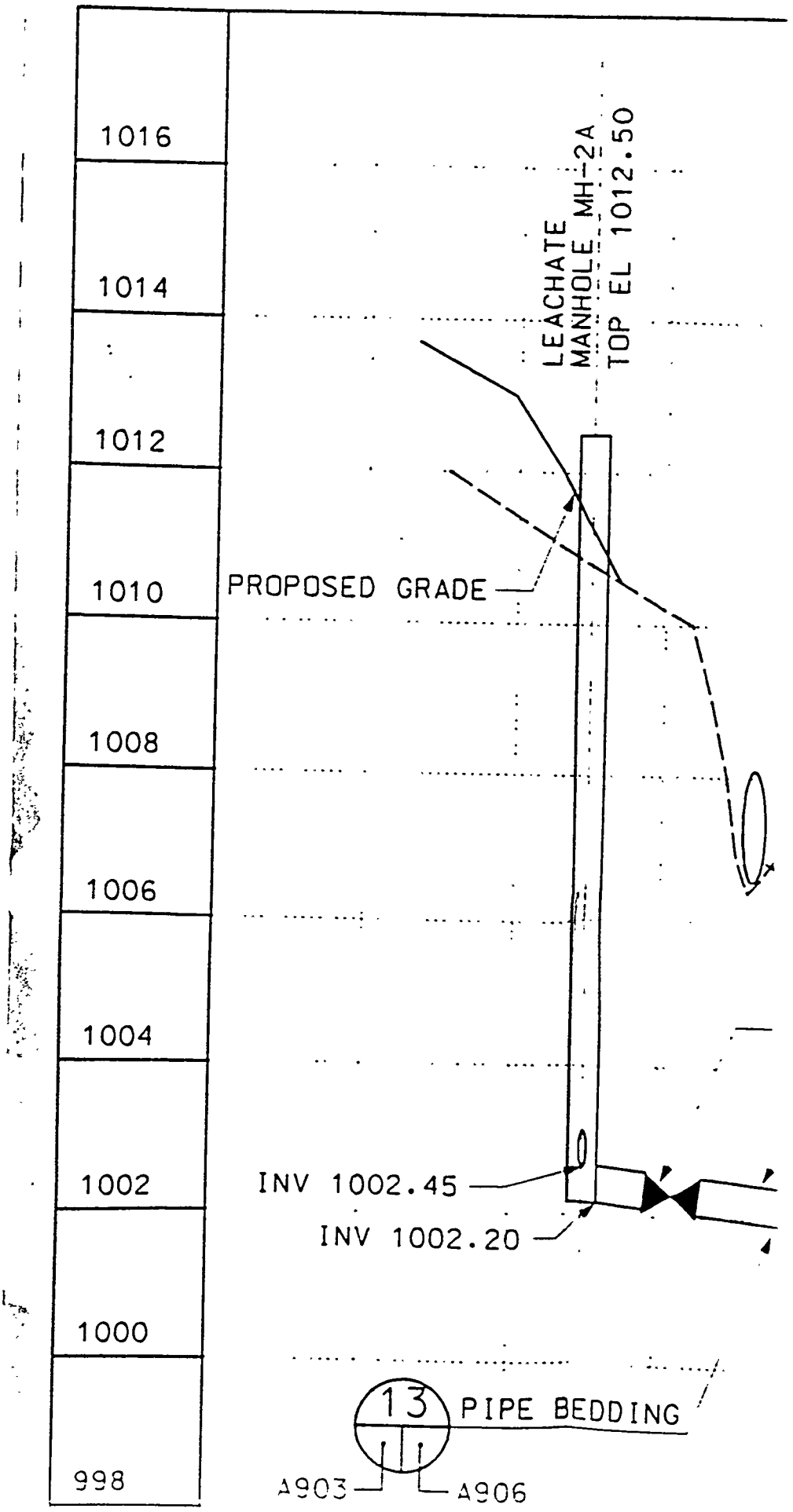

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D

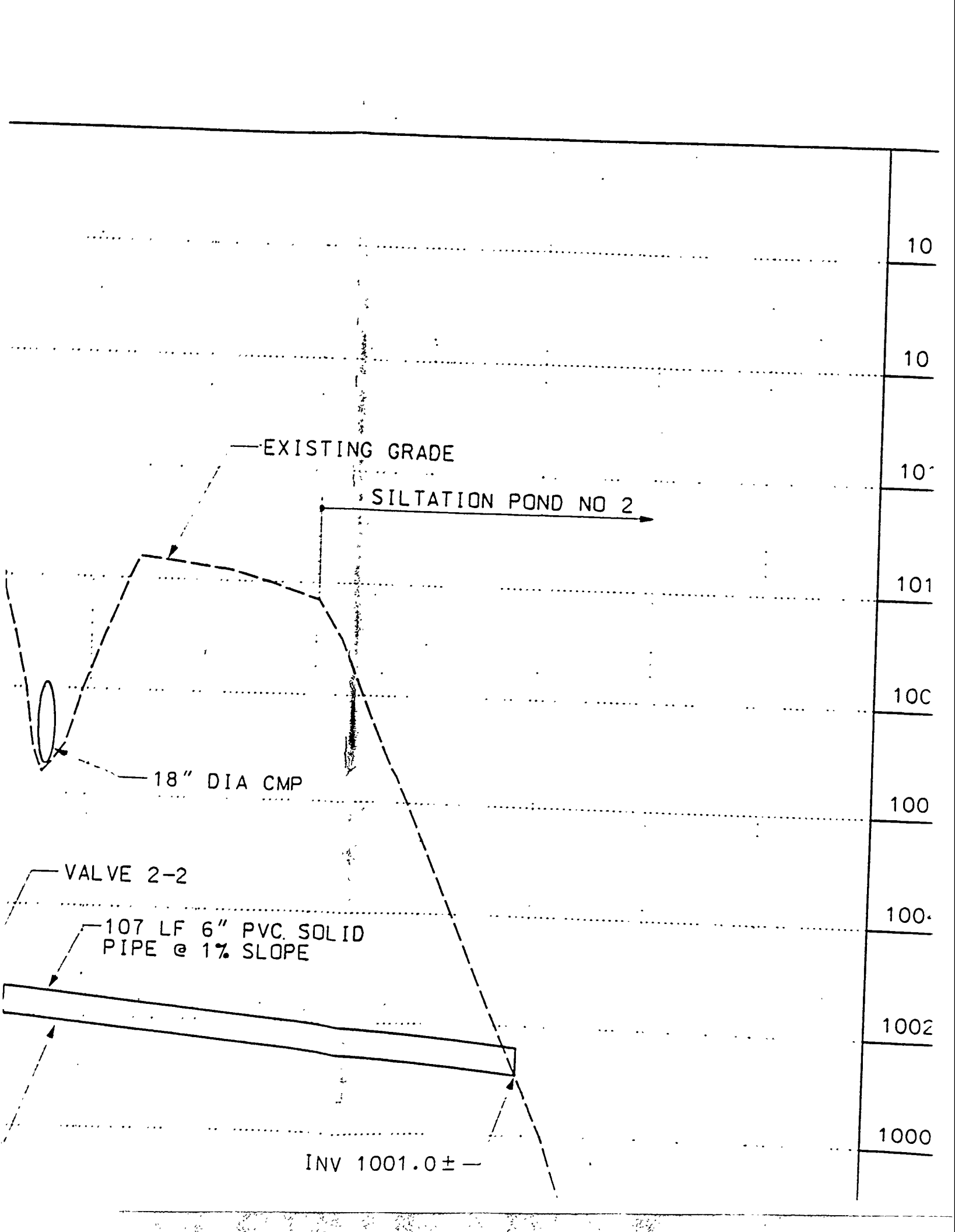


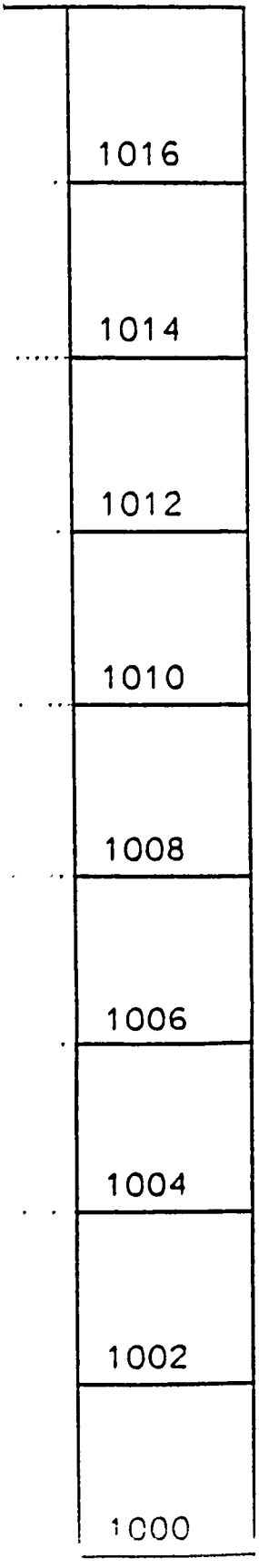
TEMPORARY STORM D
PIPE PROFILE FOR A

SCALE: HORIZ 1"=20'
VERT 1"=2'


1014
1012
1010
EXISTING GRADE
1008
1006
1004
6" PVC SOLID PIPE
@ 7.00% SLOPE
1002
1000
998
NV 1000.06
996


1016
1014
1012
1010
1008
1006
1004
1002
1000
998
LEACHATE MANHOLE MH-2A
TOP EL 1012.50
PROPOSED GRADE
INV 1002.45
INV 1002.20
13
PIPE BEDDING
A903
A906

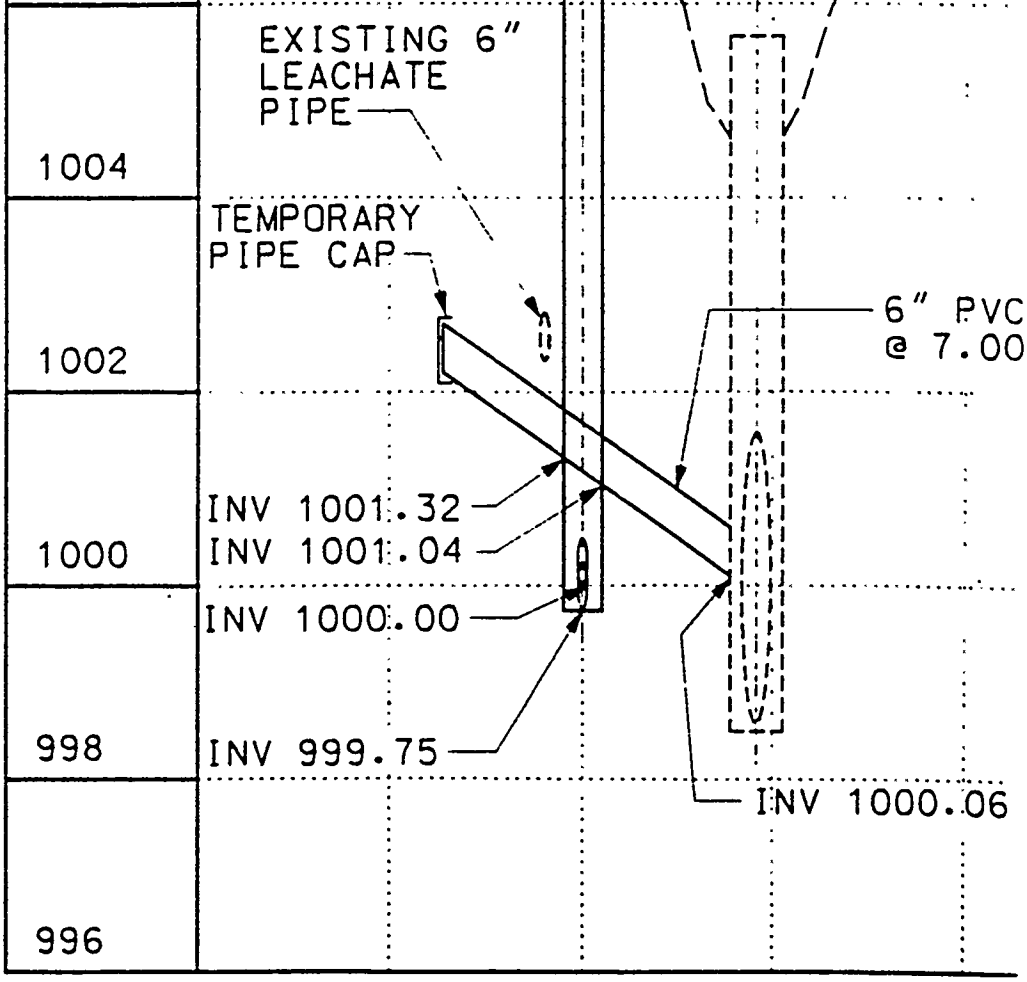

EXISTING GRADE
SILTATION POND NO 2
18" DIA CMP
VALVE 2-2
107 LF 6" PVC. SOLID PIPE @ 1% SLOPE
INV 1001.0±
10
10
10
101
100
100
1002
1000


1016
1014
1012
1010
1008
1006
1004
1002
1000

D

C

127



TEMPORARY STORM PIPE PROFILE FOR

SCALE: HORIZ 1"=20'
VERT 1"=2'

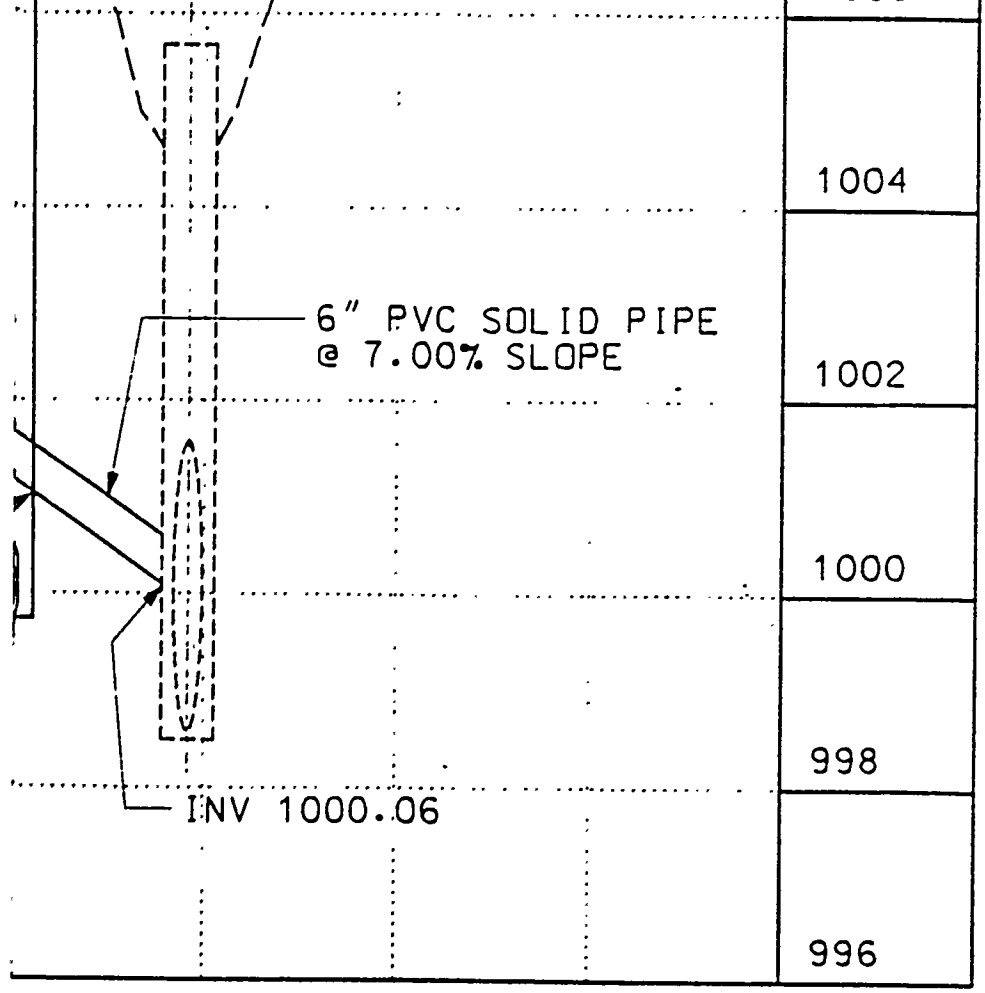
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SECTION AND DETAIL K



ARY STORM DRAIN
OFILE FOR AREA 3

SCALE: HORIZ 1"=20'
VERT 1"=2'

Document Rev. No.: ___ Date: _____
EG-C-37 Review By: _____
Guideline Document: _____
UCN-19586 (12356 4-93)

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REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	

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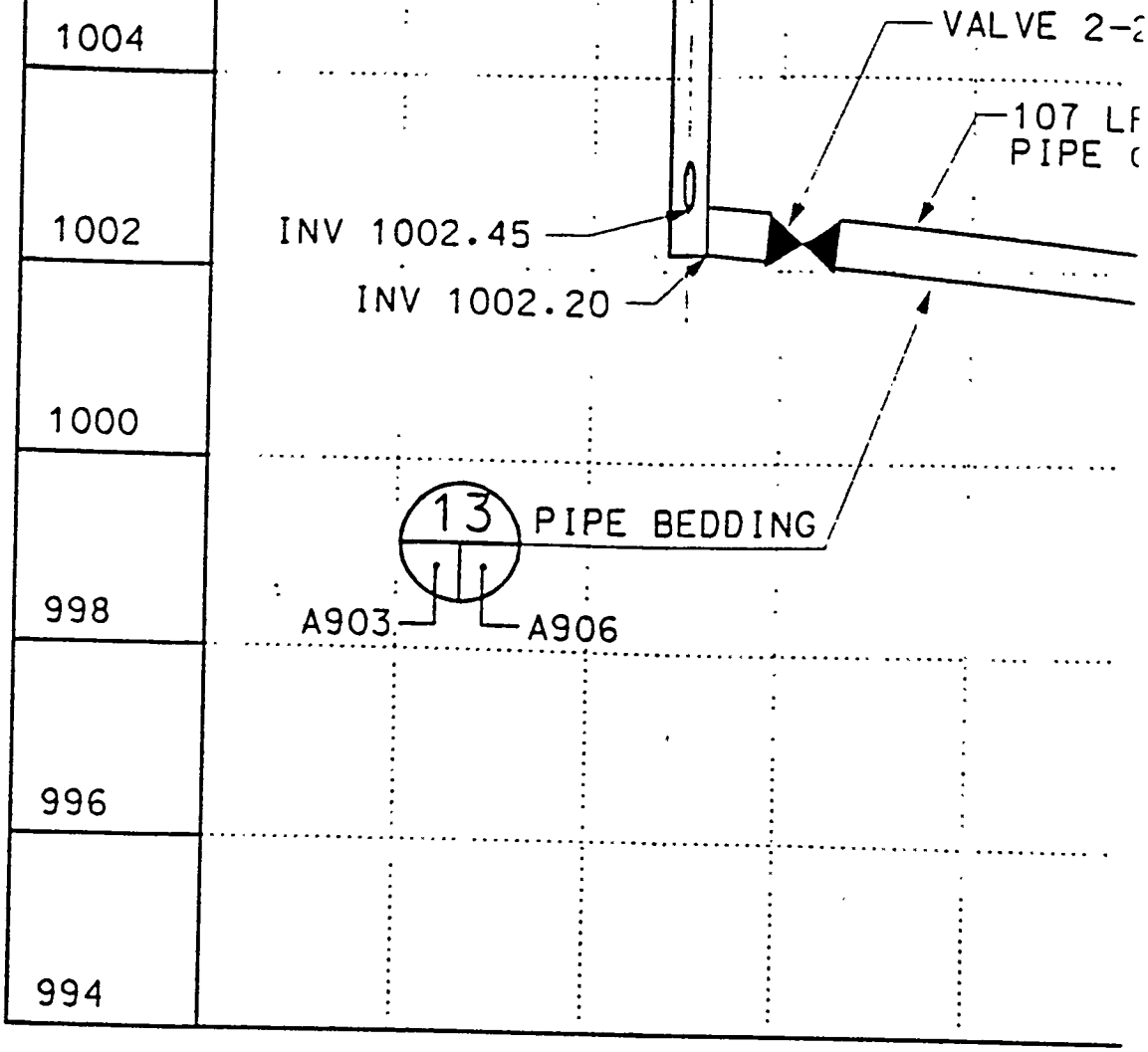
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

ON AND DETAIL KEY

THIS DOCUMENT CONTROLLED BY

CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

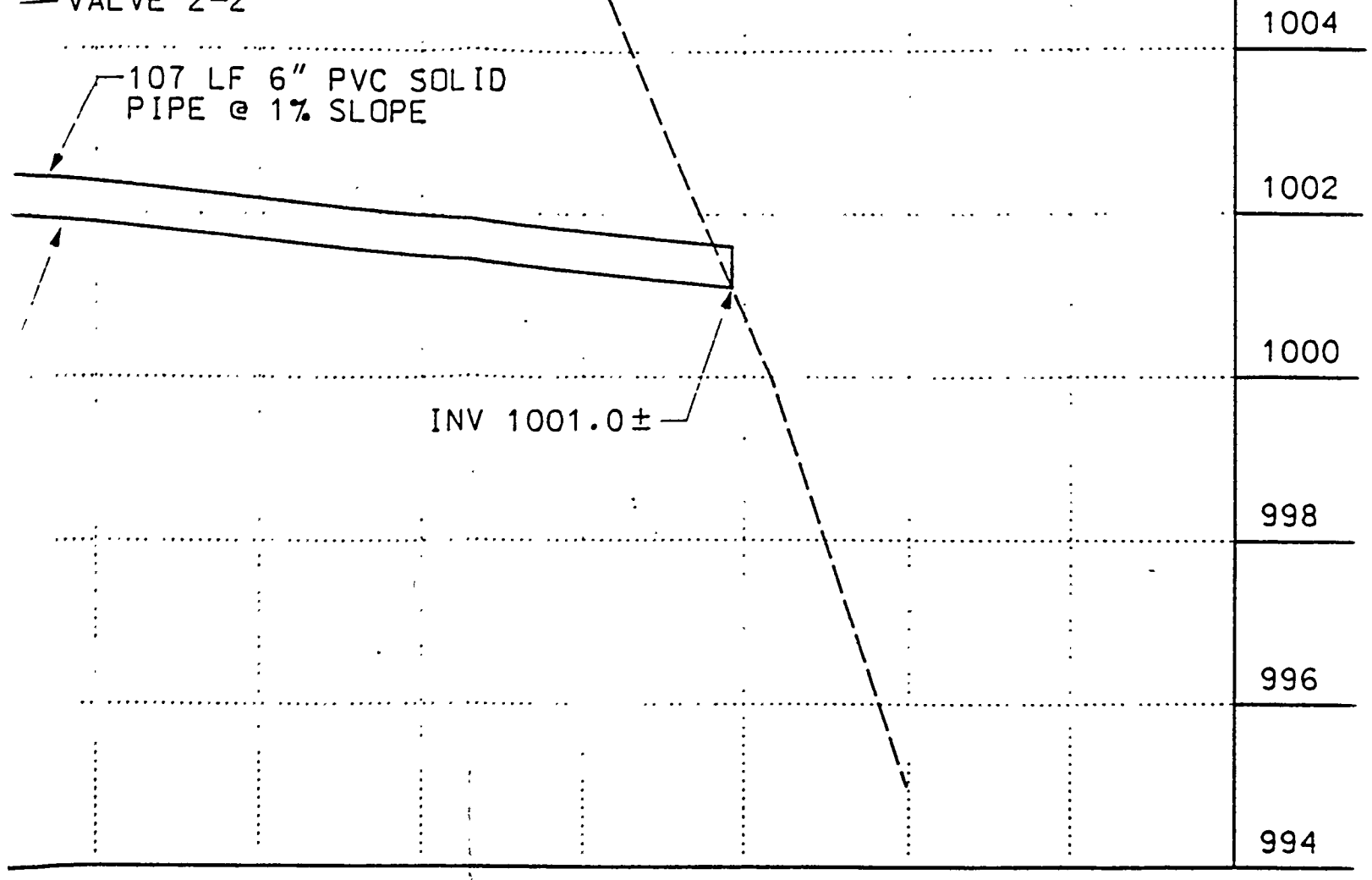


TEMPORARY STORM DRAI

S

REVISION OR ISSUE PURPOSE	DESCRIPTION	BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES
	FOR PERMITTING	SJA	WPT	—	WLC	8/19/15				DBA

REVISION APPRO



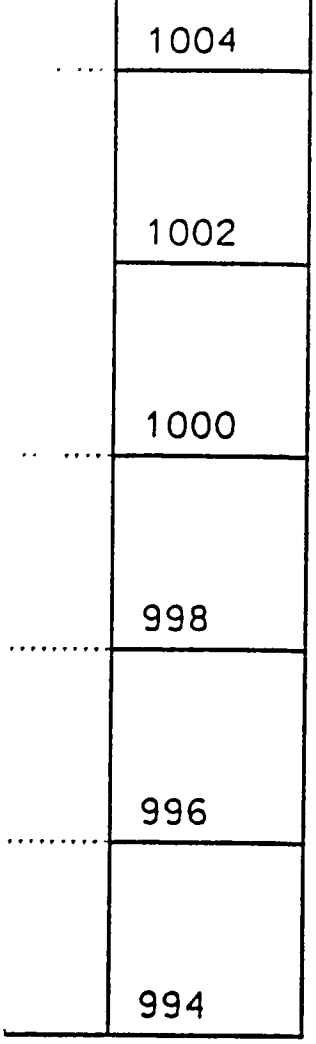
M DRAIN PIPE PROFILE FOR AREA 2

SCALE: HORIZ 1"=20'
VERT 1"=2'

REQ	DATE	MMES	DATE	RPE	RPE NO	DATE			QA	DATE	ST	CV	EC	EE	EM	IE
		DPA	8/28/95	WPT	22911	8/19/96					—	DWL	—	—	—	—

REVISION APPROVALS

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A 2

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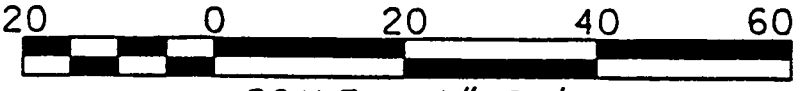
VER

								RPE	DSGN
									DRW
									CHKR WP Taylor
									SECT
									DEPT
									PE
									PJ
									REQ
—	—	—	—	—	—	—	—		
EE	EM	IE	M	PD	SE	ARC	VER	REV. 0 DATE 8/19/99	MMES
SQUAD CHECK								DRAWING APPROVALS	

WILLIAM PATRICK TAYLOR
REGISTERED ENGINEER
AGRICULTURE
No. 822.211
STATE OF TENNESSEE

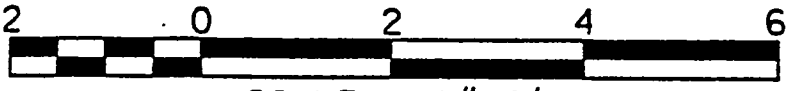
3 2

HORIZONTAL



SCALE: 1"=20'

VERTICAL



SCALE: 1"=2'

	8/19/95
	8/19/95
	8/19/95
	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

LEACHATE SEWER PROFILES AREAS 2 & 3

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U

51	52	53		REV
NC	NA	AR	C2E900000A927	O

CAD FILE: C0001300 .DGN
SCALE: 1"=20'

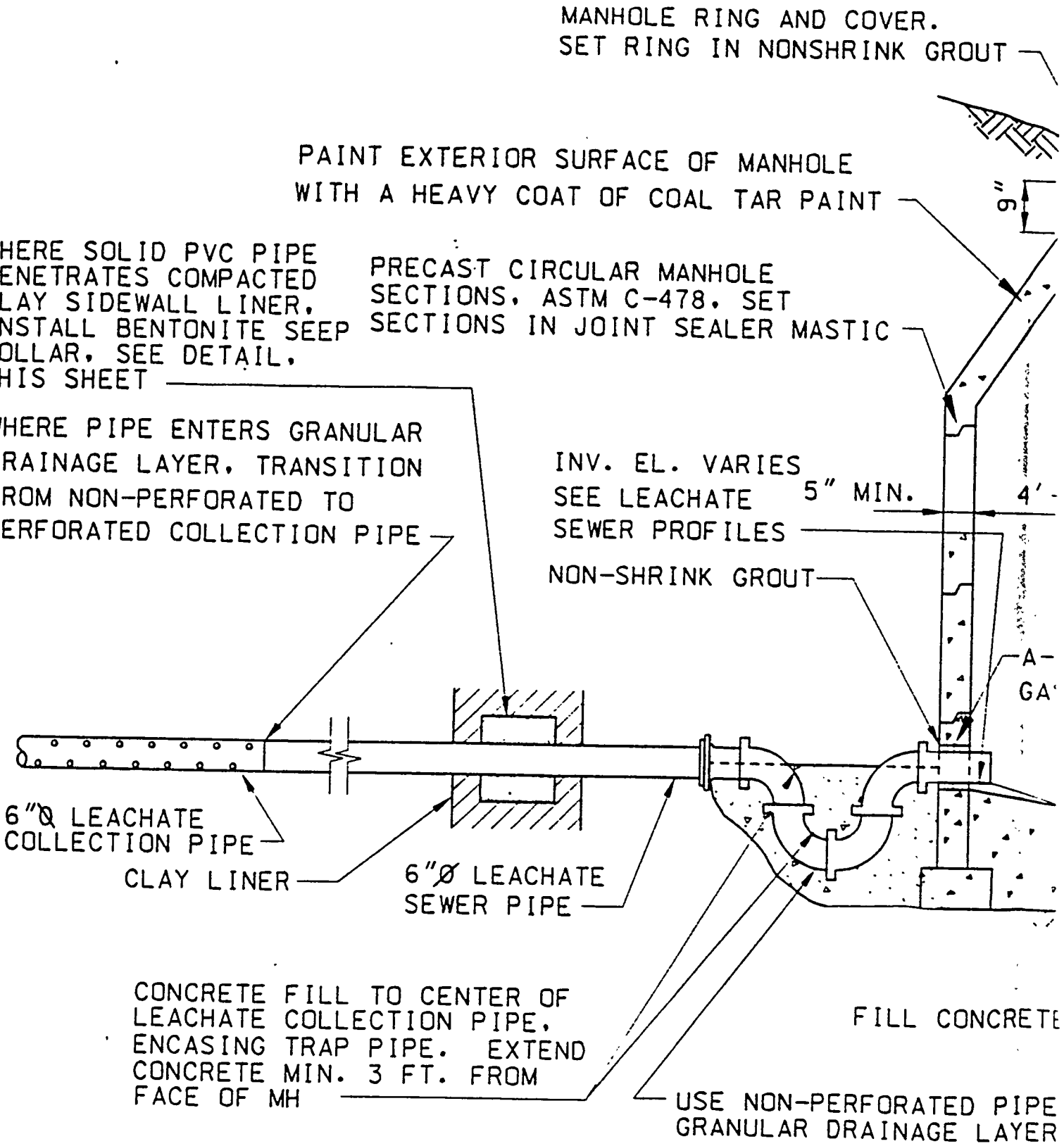
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DATE: Aug 18 1995

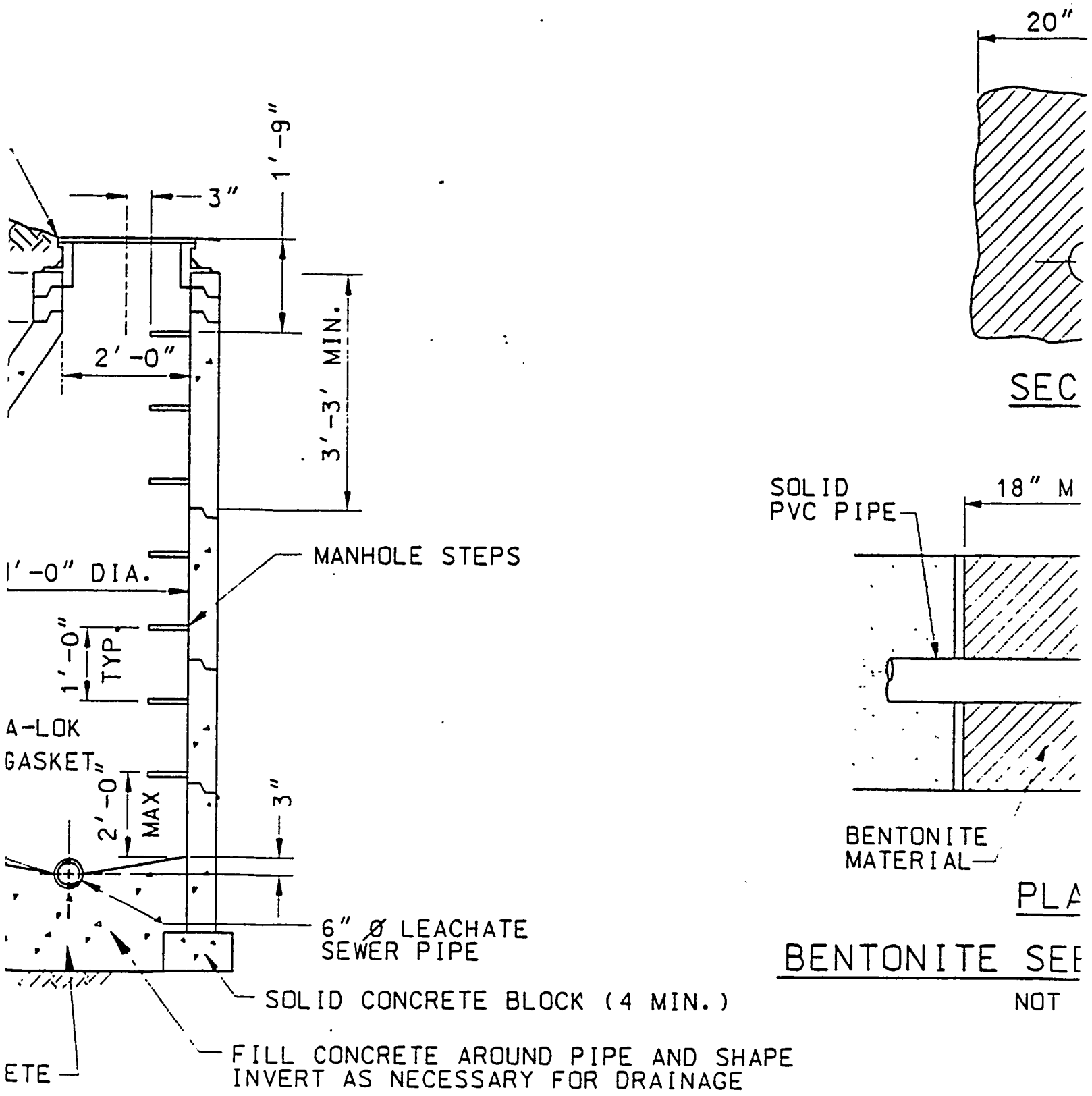
C2E900000A927

B

A



LEACHATE SEWER MANHOLE DET

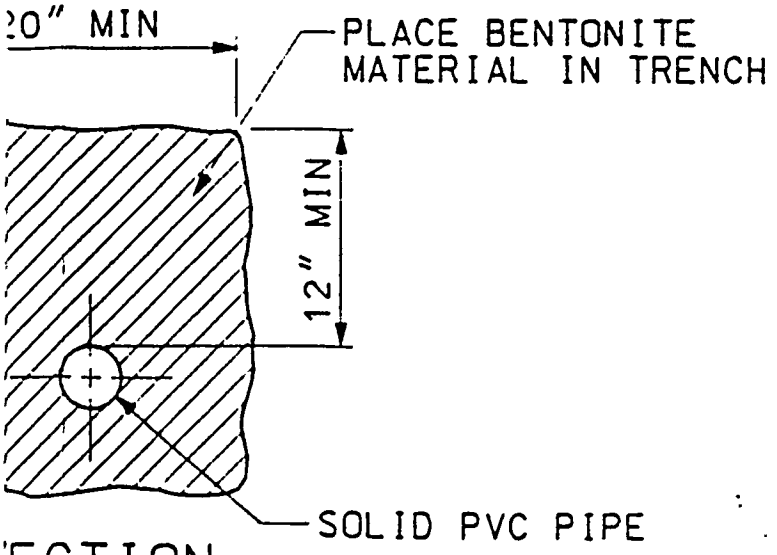


:PE FROM
'ER TO MH

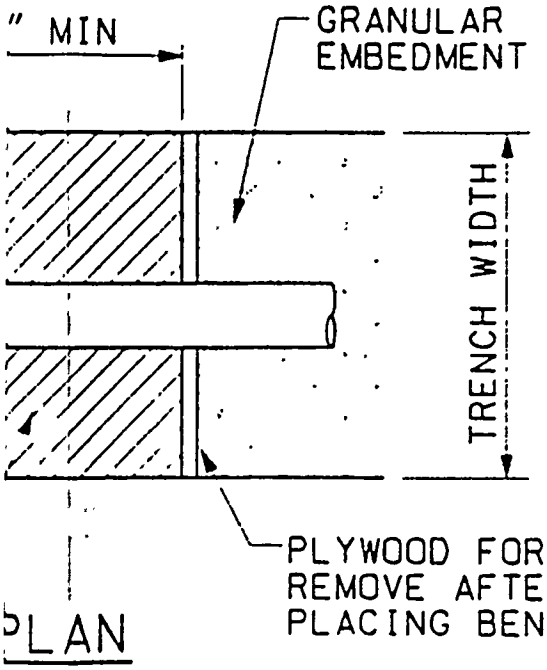
ETAIL

NOTES:

1. SEE LEACHATE SEWER PROFILES, DWG A639 FOR ELEVATIONS.



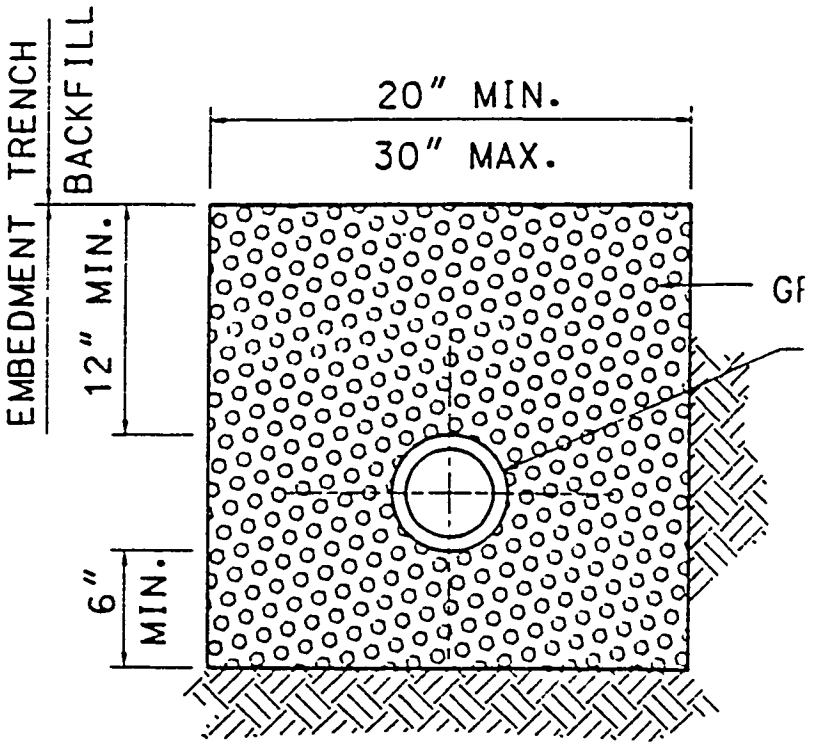
ECTION



PLAN

SEEP COLLAR DETAIL

NOT TO SCALE



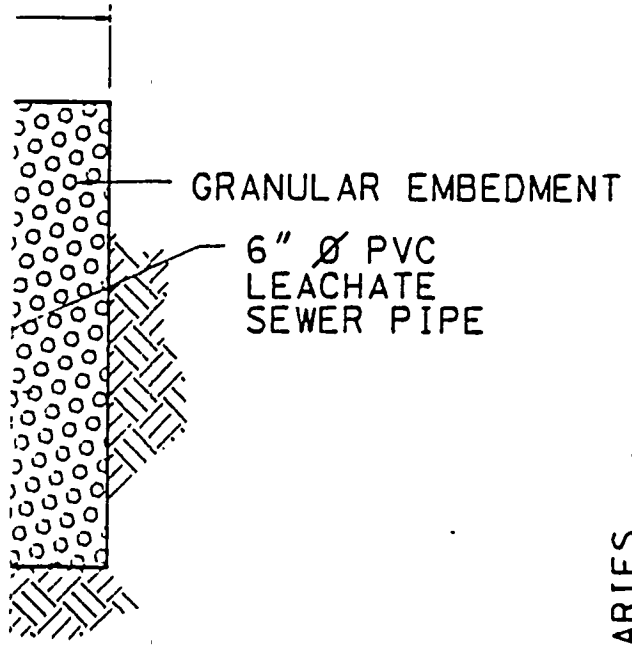
NOTE:

1. CLASS B BEDDING APPLIES TO LEACHATE SEWER PIPE.

PIPE EMBEDMENT DET

CLASS B BEDDING

NOT TO SCALE

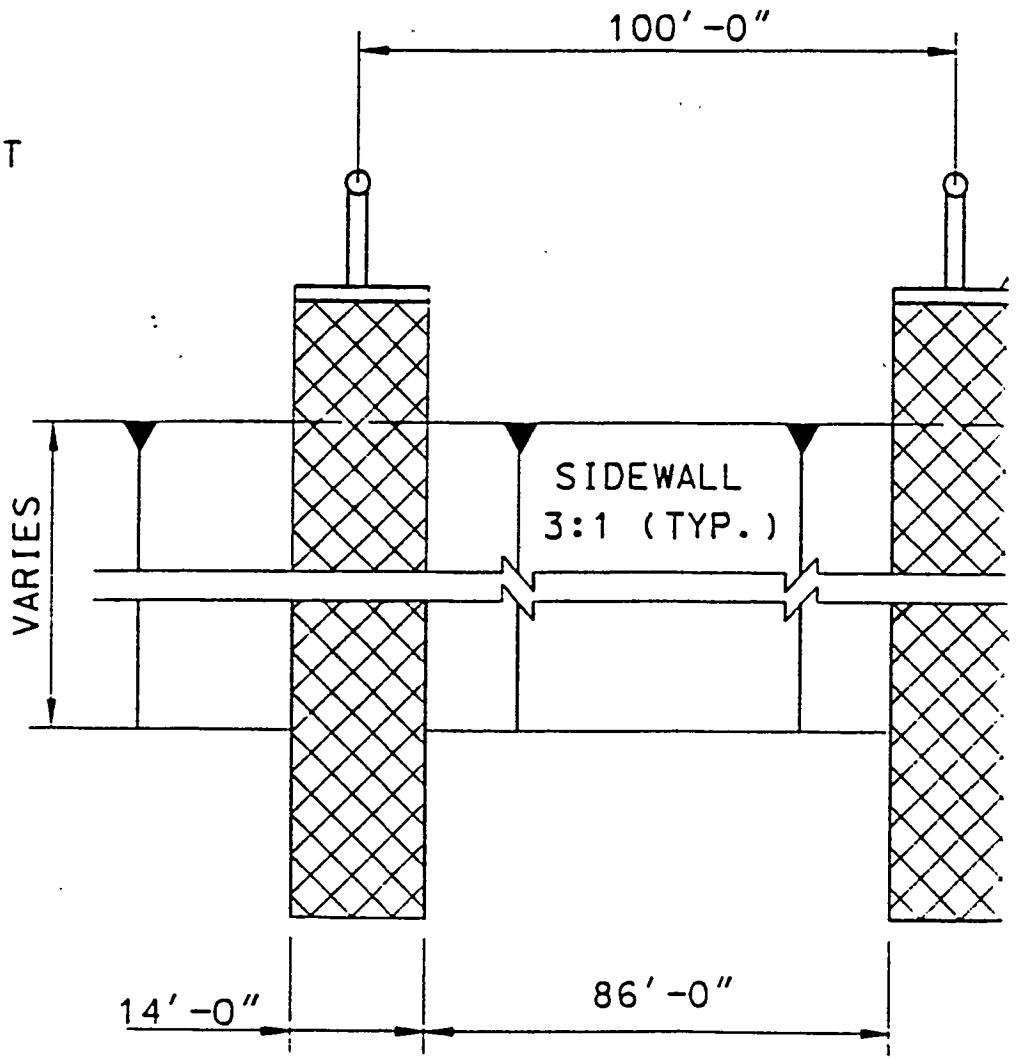


IG APPLIES ONLY
:WER PIPE.

:NT DETAIL

)EDDING

CALE

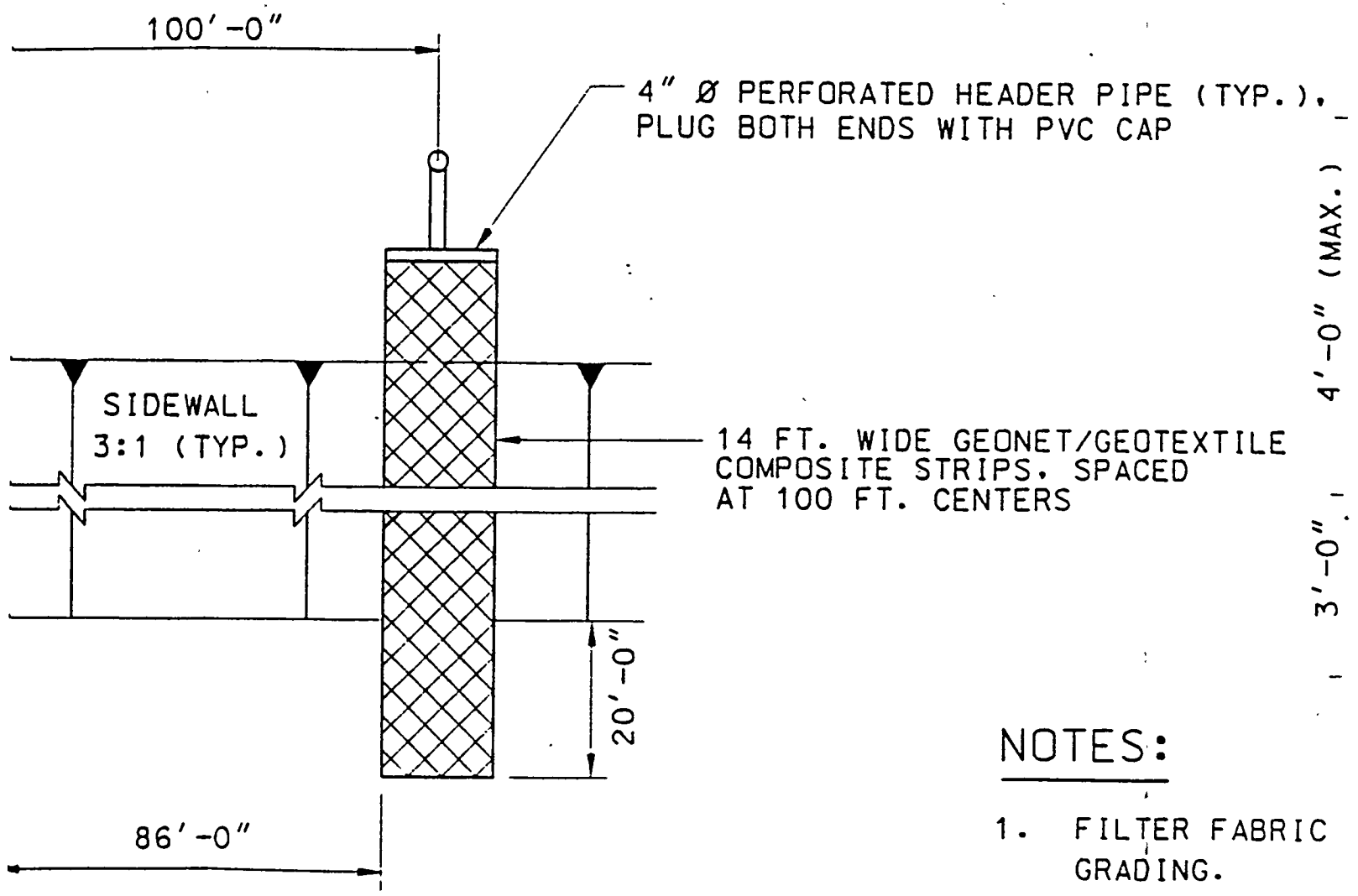


NOTE:

FOR SECTION THROUGH GAS VENT
SEE DETAIL 10. DWG A929.

3 AREA 1 PERIMETER GAS VE

NOT TO SC



E:

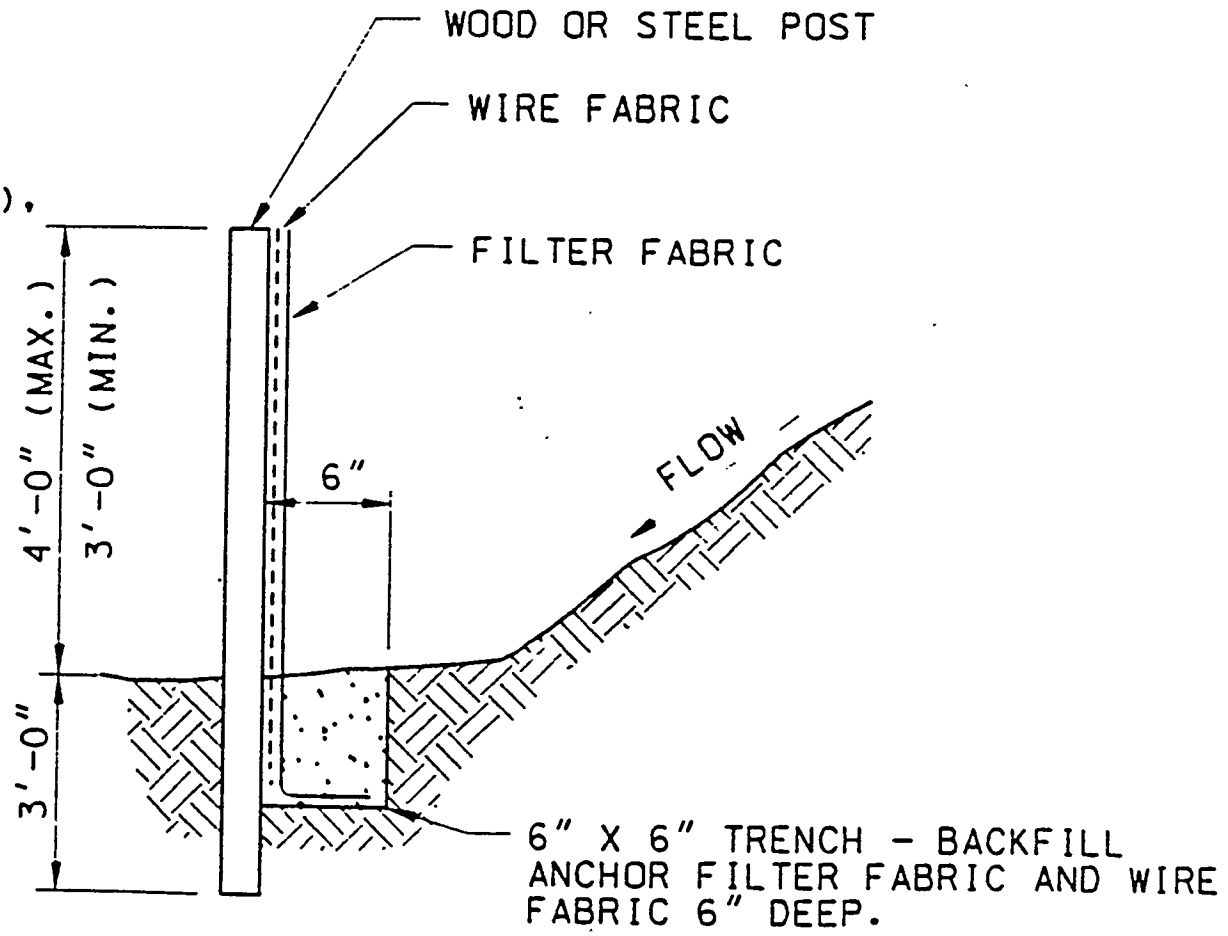
SECTION THROUGH GAS VENT
DETAIL 10. DWG A929.

PERIMETER GAS VENT DETAIL

NOT TO SCALE

NOTES:

1. FILTER FABRIC GRADING.
2. STEEL POSTS SH
3. WOOD POSTS SHA
4. POSTS SHALL BE
5. WIRE FABRIC AN WITH EITHER ST
6. CONTRACTOR SHA FILTER FABRIC COMPANY UNTIL
7. FILTER FABRIC OPENING SIZE C SPEC. CW-02215



IPE (TYP.), CAP

EOTEXTILE ACED

S:

LTER FABRIC FENCE TO BE PLACED PRIOR TO THE START OF ROUGH ADING.

EEL POSTS SHALL BE METAL "T" POSTS - 6' LONG

DD POSTS SHALL BE 2" X 4" MIN. (CCA TREATED)

STS SHALL BE SPACED AT 4' INTERVALS MAX.

RE FABRIC AND FILTER FABRIC SHALL BE SECURELY BOUND TO POSTS TH EITHER STAPLES OR WIRE TIES.

NTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING CONDITION OF .TER FABRIC FENCE IN A CONDITION THAT IS SATISFACTORY TO THE MPANY UNTIL FINAL ACCEPTANCE OF WORK.

.TER FABRIC SHALL BE A POLYPROPYLENE FABRIC WITH AN EQUIVALENT ENING SIZE OF 40-70 AS DETERMINED BY CORPS OF ENGINEERS GUIDE EC. CW-02215.

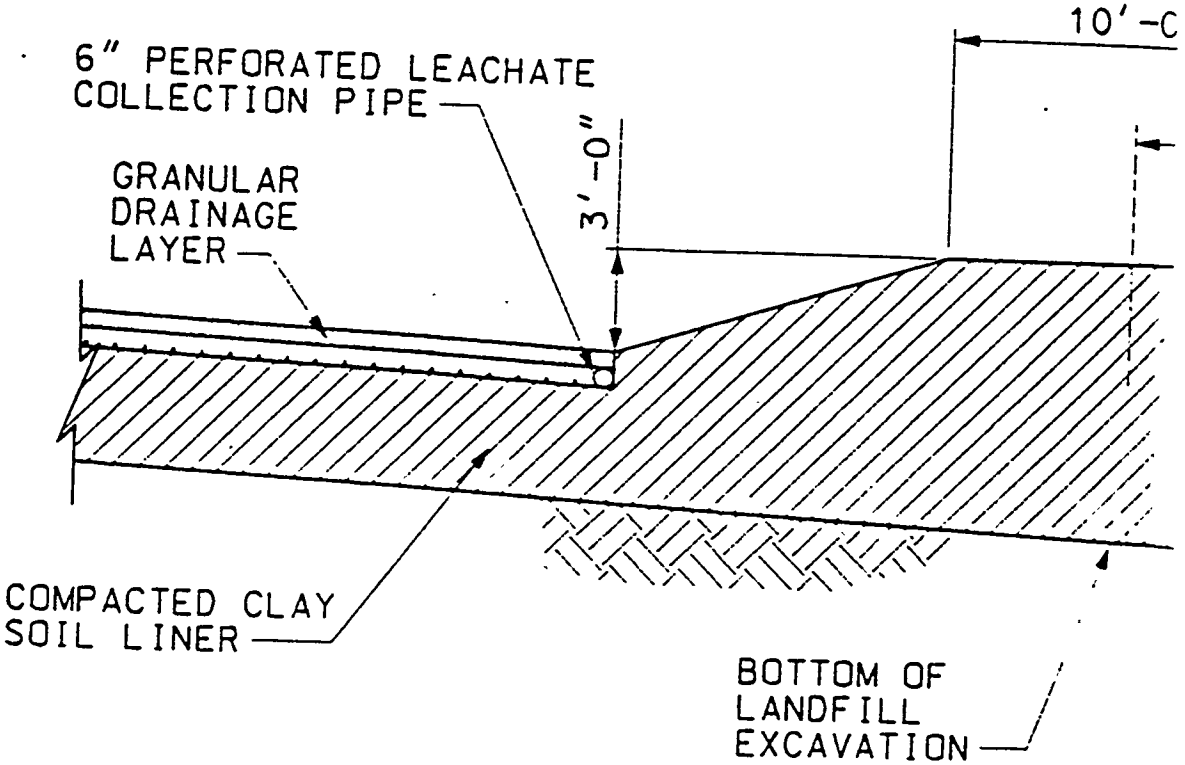
SILT FENCE DETAIL

NOT TO SCALE

H G F

LEACHATE SEWER MANHOLE D

NOT TO SCALE

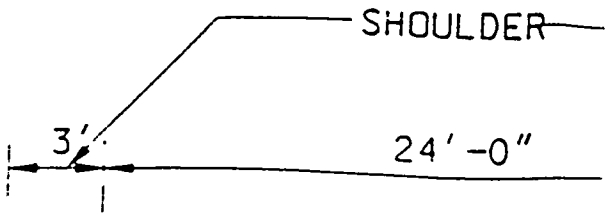


COMPACTED SOIL BERM

NOT TO SCALE

6" STABILIZED AGGREGATE BASE SHOULDER (TYP)

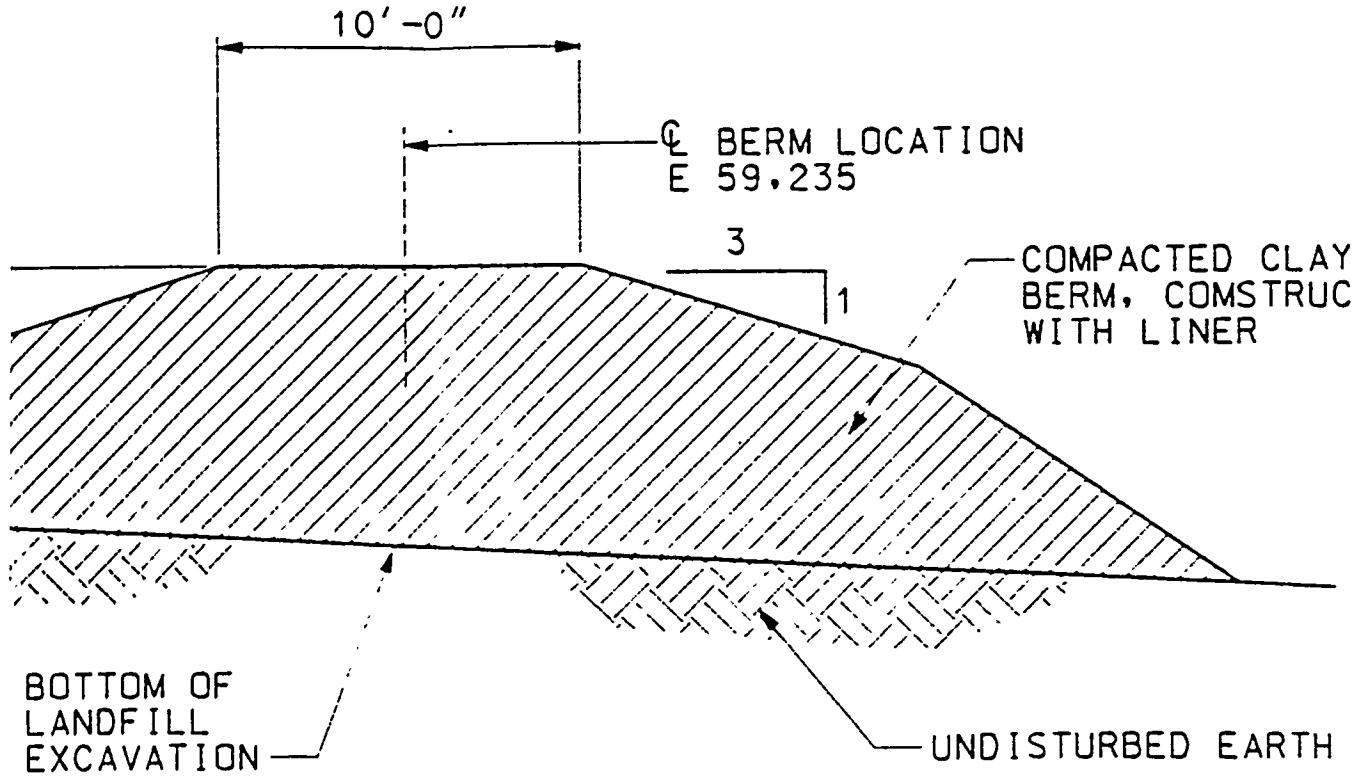
SEE TYP. PERIMETER SURFACE WATER CHANNEL DETAIL



TO SCALE

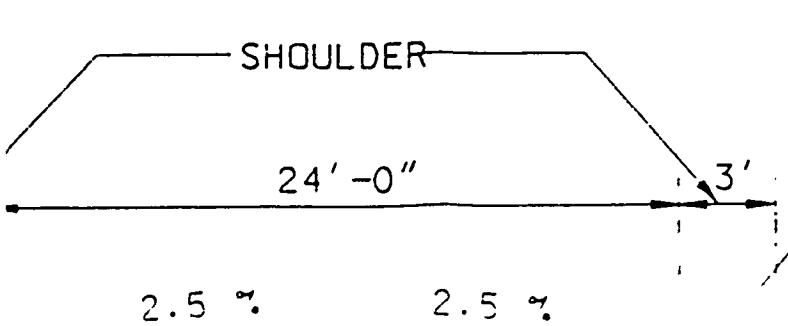
4, & 5. INSTALL WALL PIPE, TRAP PIPE
1 LENGTH OF 6" Ø LEACHATE SEWER PIPE
AND CAP FOR FUTURE LEACHATE COLLECTI
PIPE. INV. ELEVATIONS AS SHOWN ON
LEACHATE SEWER PROFILES, DWG A639.

3. THIS DETAIL APPLIES ONLY TO EXISTIN(
MANHOLES MH-1, MH-2, MH-3, MH-4, AN(



TED SOIL BERM DETAIL

NOT TO SCALE



24" OF STABILIZED AGGRE
BASE ROCK. INSTALL 8 OZ
GEOTEXTILE UNDER BASE R
WHENEVER IN FILL AREAS.

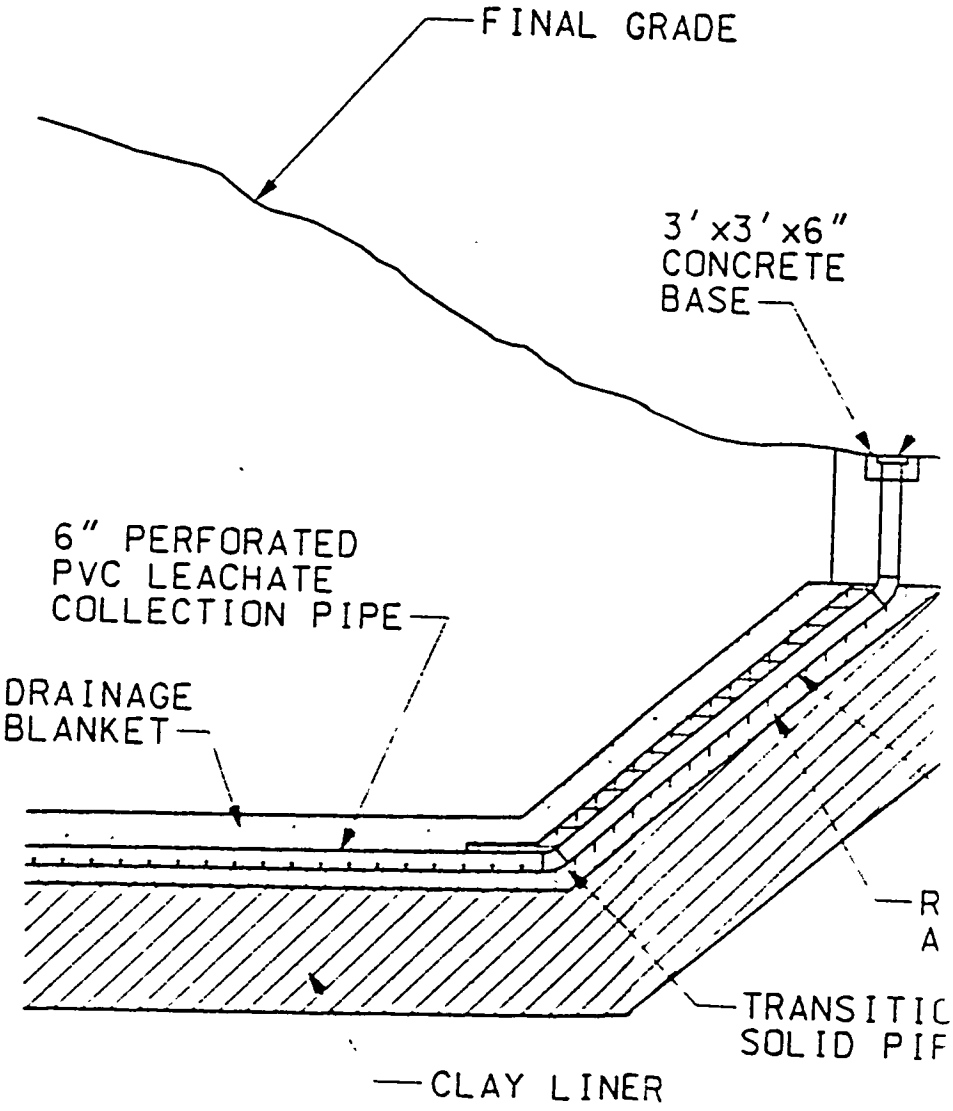
NOTES:

MH-2, 3,
TRAP PIPE AND
EWER PIPE
COLLECTION
HOWN ON
G A639.

EXISTING LEACHATE SEWER
MH-4, AND MH-5.

IL

D AGGREGATE
LL 8 OZ./SY
BASE ROCK
AREAS.



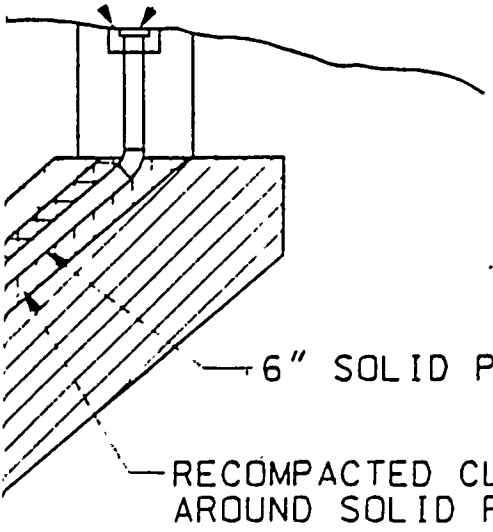
LEACHATE COLLECTION

SECTION FOR PERIMETER CLAY SOIL COVER HAS BEEN MOVED TO DWG. C2E900000A929.

3

x6"
IETE

— CLEANOUT FRAME AND COVER. NEENAH R-1971 OR EQUAL



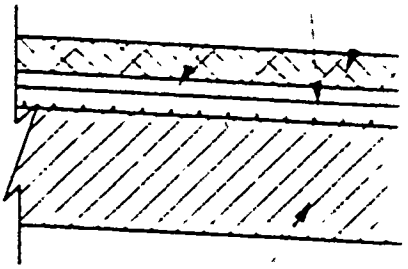
— 6" SOLID PVC PIPE

— RECOMPACTED CLAY AROUND SOLID PIPE

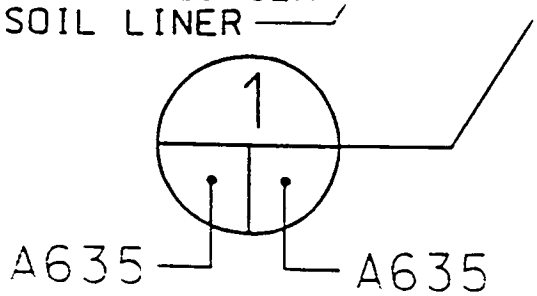
TRANSITION FROM PERFORATED TO SOLID PIPE USING 2-22½° BENDS

PERFORATED LEACHATE COLLECTION PIPE —

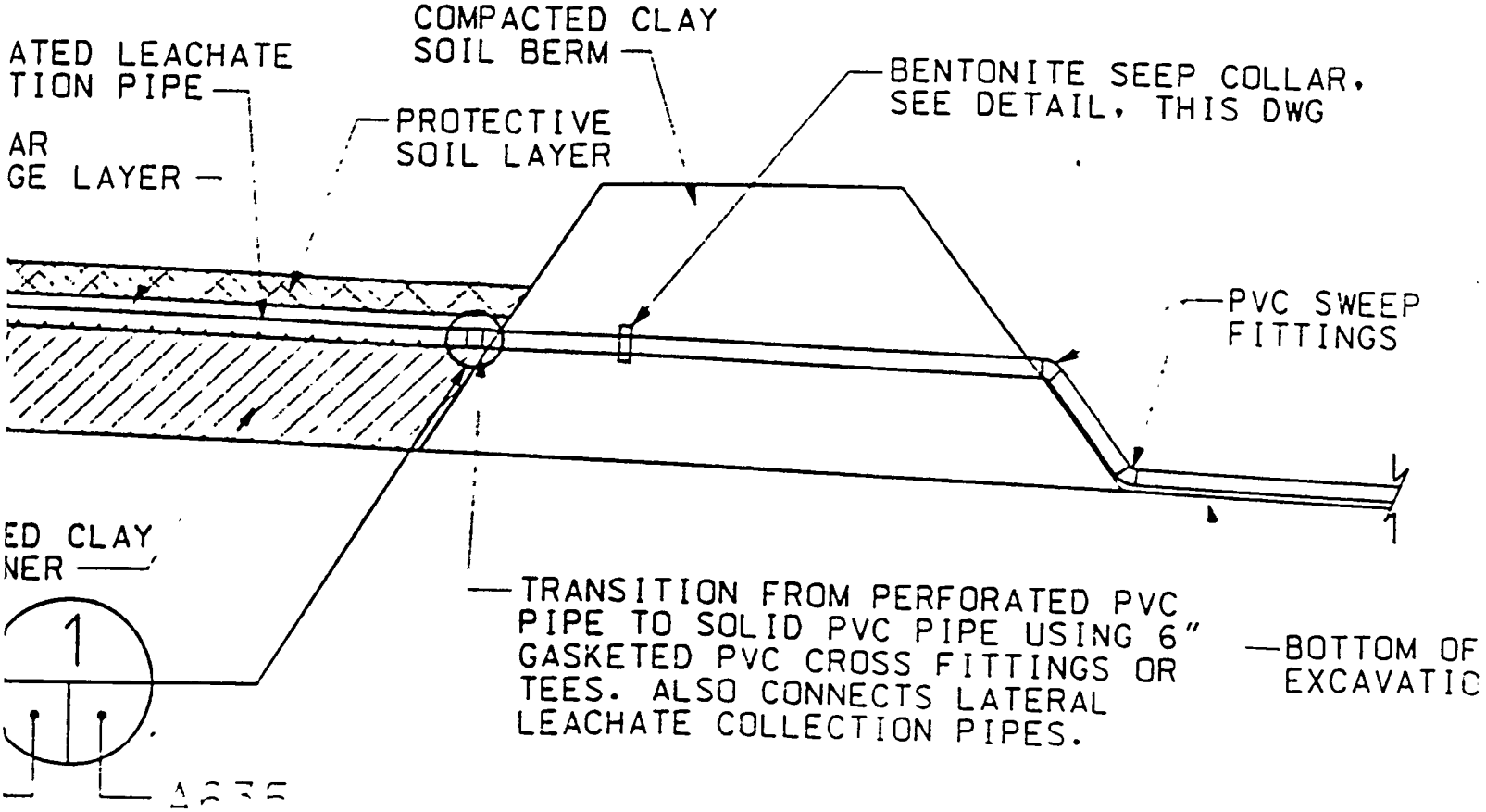
GRANULAR DRAINAGE LAYER —



COMPACTED CLAY SOIL LINER —



R HAS BEEN


ATED LEACHATE
TION PIPE
AR
GE LAYER
COMPACTED CLAY
SOIL BERM
PROTECTIVE
SOIL LAYER
BENTONITE SEEP COLLAR.
SEE DETAIL. THIS DWG
PVC SWEEP
FITTINGS
ED CLAY
NER
1
TRANSITION FROM PERFORATED PVC
PIPE TO SOLID PVC PIPE USING 6"
GASKETED PVC CROSS FITTINGS OR
TEES. ALSO CONNECTS LATERAL
LEACHATE COLLECTION PIPES.
BOTTOM OF
EXCAVATIC

EQ. CW-02215.

SILT FENCE DETAIL

NOT TO SCALE

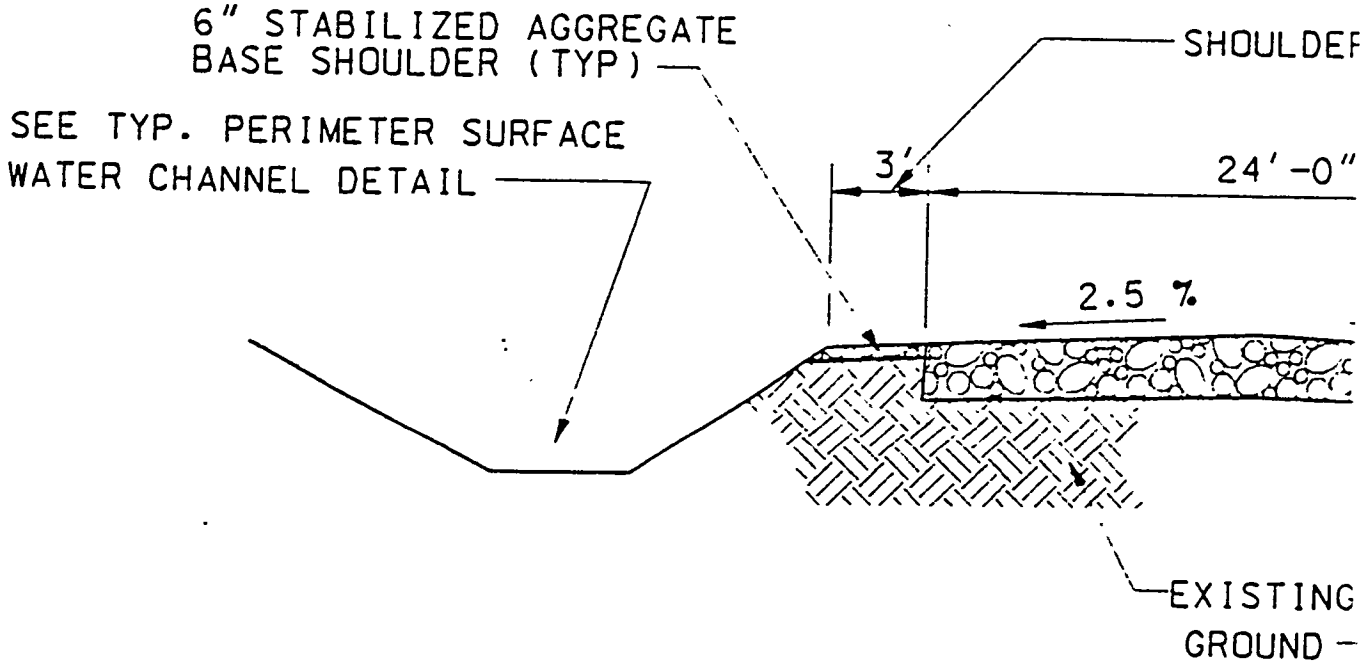
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ON

NOT TO SCALE



MAINTENANCE ROAD T

NOT TO SCAL

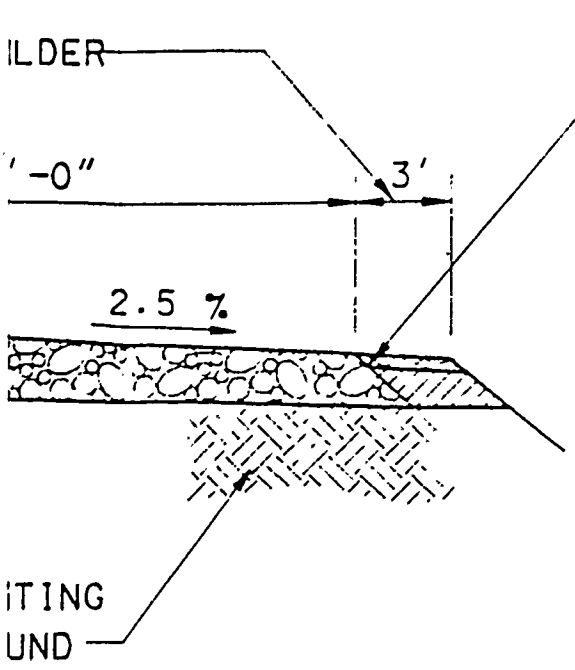
AREA 1 LANDFILL LINER SECTION HAS BEEN MOVED TO DWG. C2E900000A928.

3



BERM DETAIL

ALE



24" OF STABILIZED AGGREGATE BASE ROCK. INSTALL 8 OZ./SY GEOTEXTILE UNDER BASE ROCK WHENEVER IN FILL AREAS.

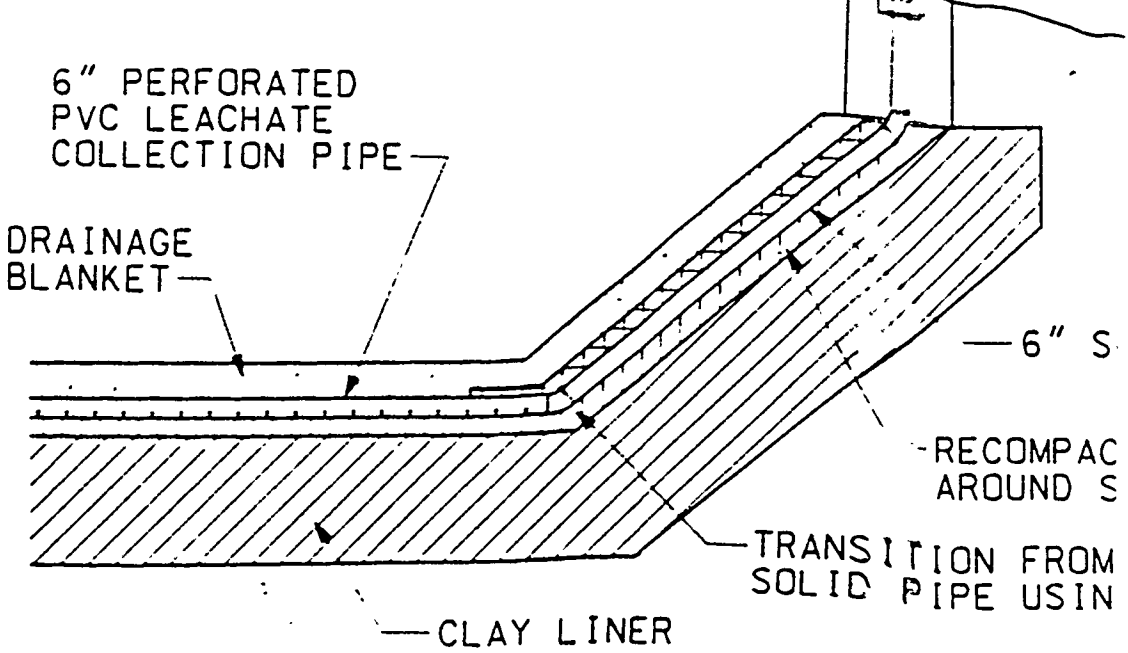
) TYPICAL SECTION

SCALE

NOTES:

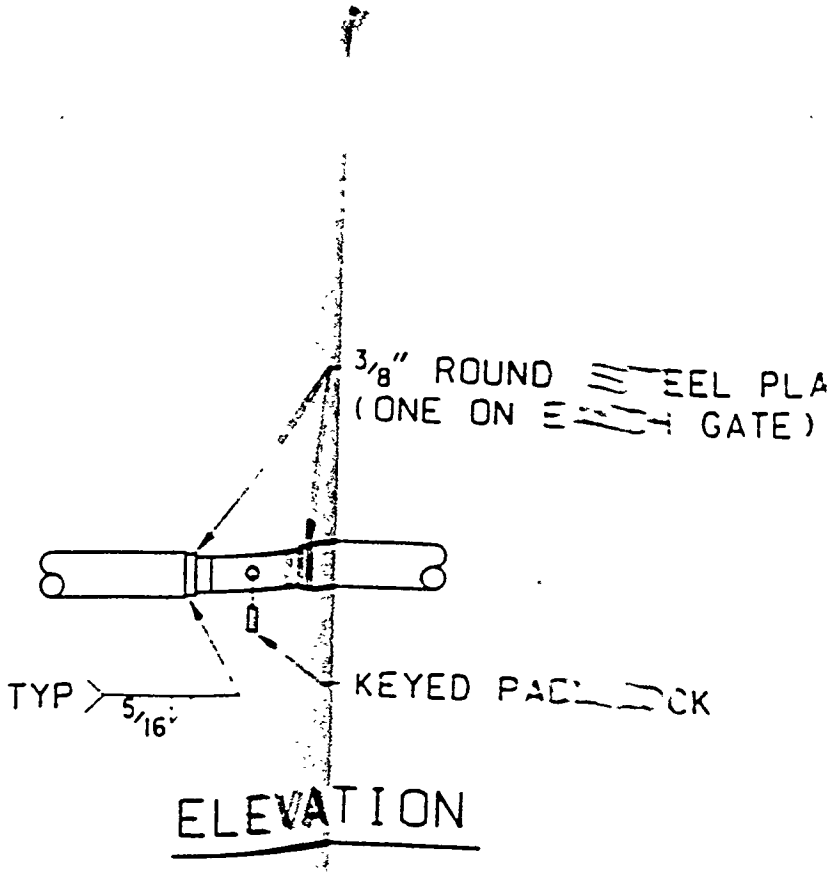
1. RECOMPACT TOP 6" OF EXISTING GROUND TO 95% STANDARD PROCTOR DENSITY AT MOISTURE CONTENT BETWEEN 2% AND 4% ABOVE OPTIMUM
2. SELLER HAS OPTION TO EXCAVATE ROADWAY SUBGRADE FOR STABILIZED ROCK BASE OR PLACE STABILIZED AGGREGRATE BASE ON EXISTING SUBGRADE AND CONSTRUCT SHOULDERS AS EMBANKMENT.

BEEN



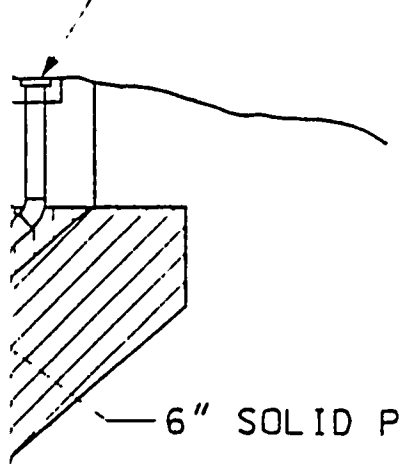
LEACHATE COLLECTION PIPE CLEANOUT POR

NOT TO SCALE



ELEVATION

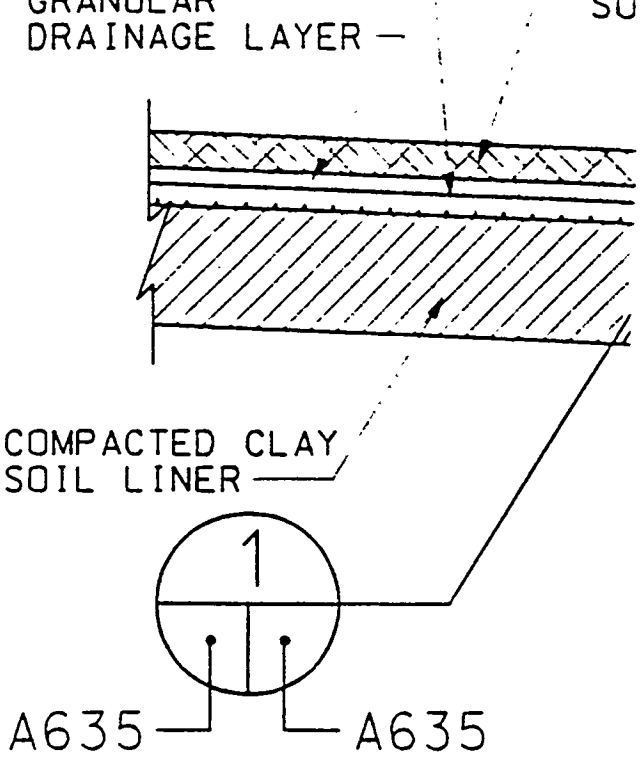
3/8" STEEL PLATE
(ONE ON EACH GATE)



SITION FROM PERFORATED TO
) PIPE USING 2-22½° BENDS

ON PIPE

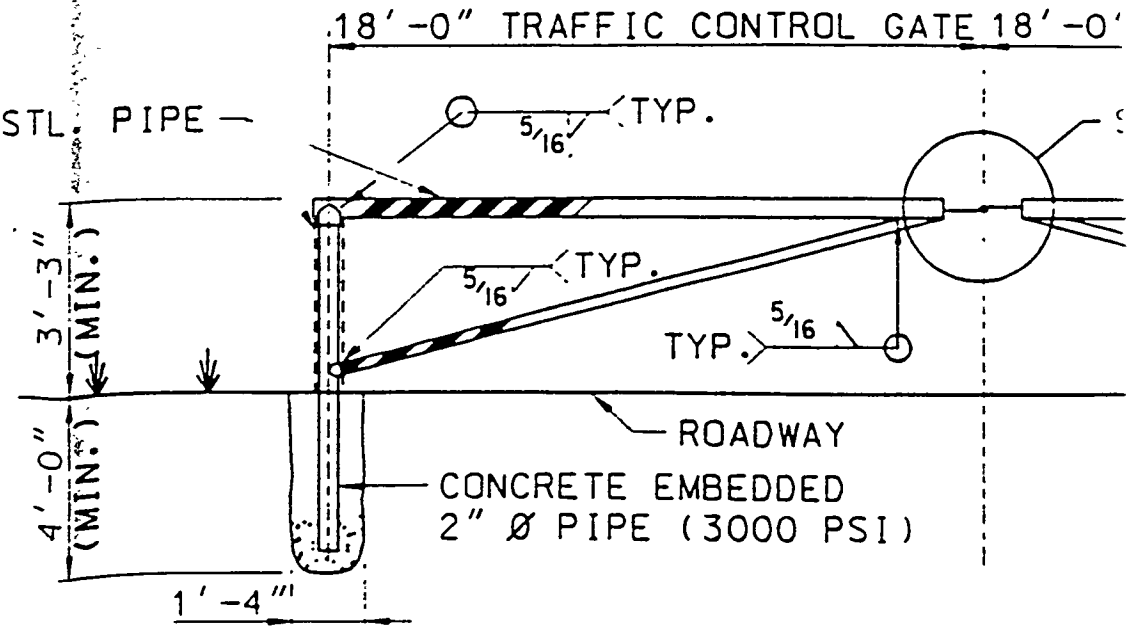
T



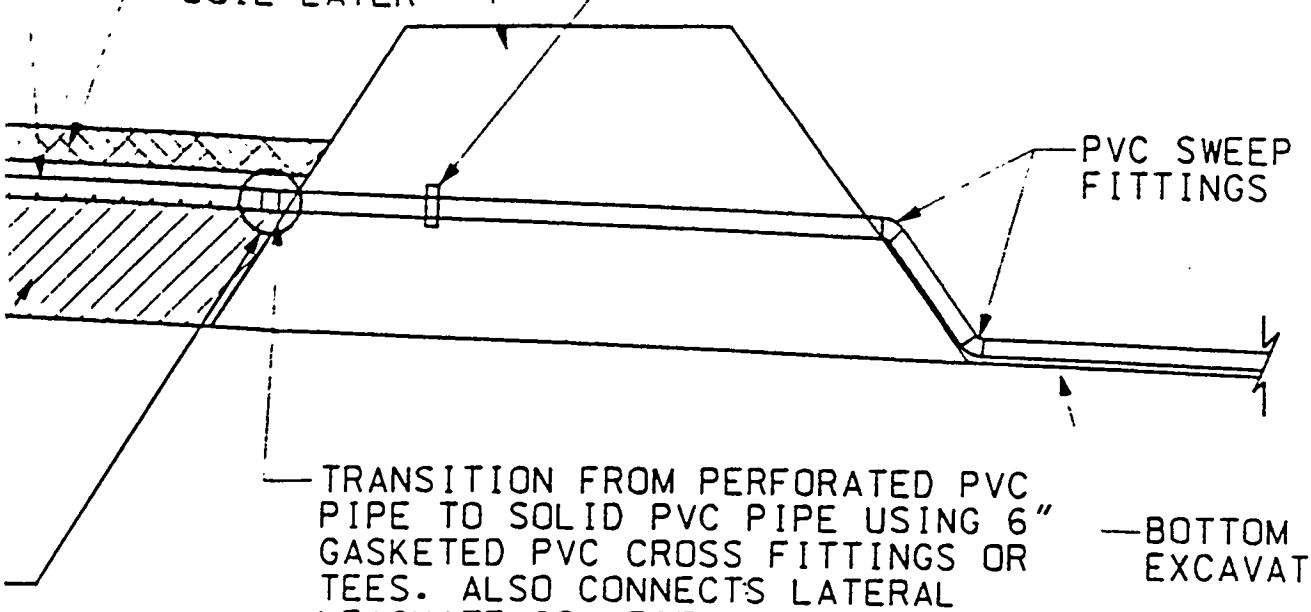
LEACHATE COLL

I STEEL PLATE
EACH GATE)

IDLOCK



NOTE:



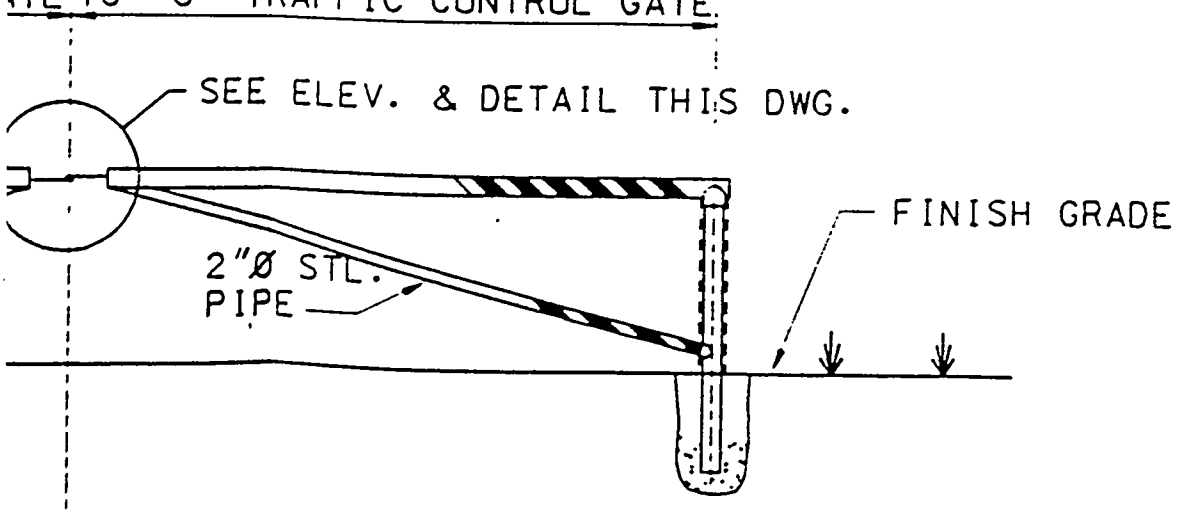
35

E COLLECTION/TEMPORARY LEACHATE SEWER TRANSITION DETAIL

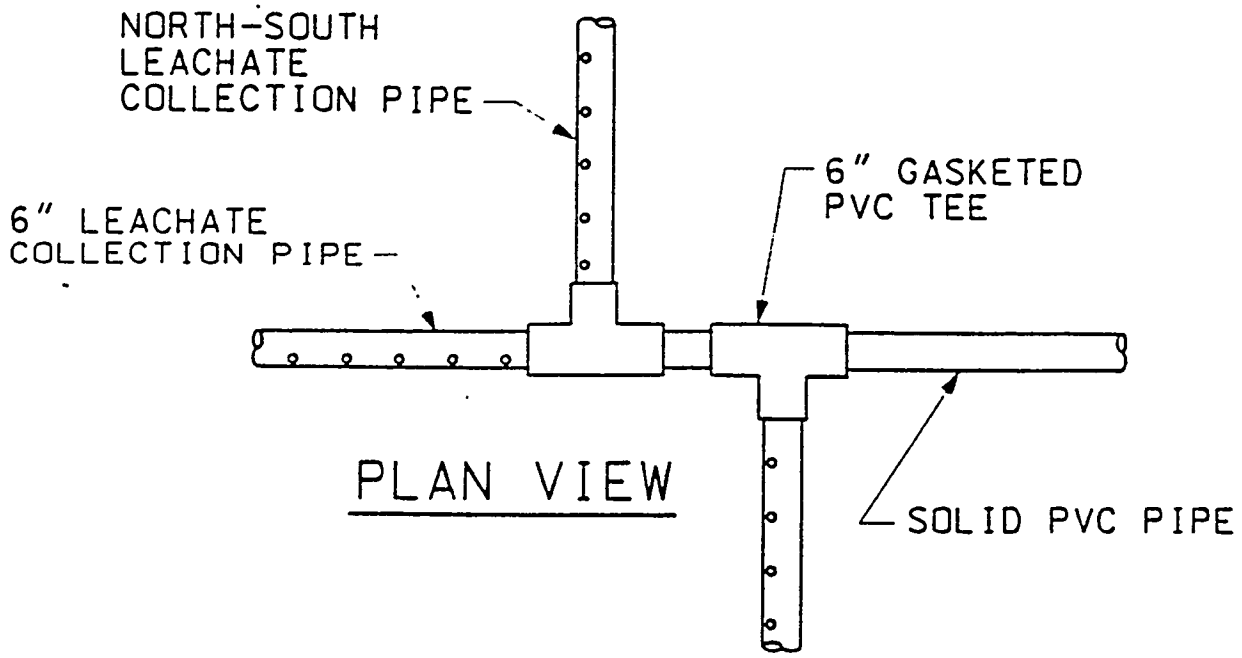
NOT TO SCALE

6" L
COLL

ATE 18'-0" TRAFFIC CONTROL GATE.



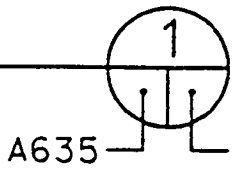
THIS D
CFC (R
MISSOU



PLAN VIEW

DETAIL

NOT TO SCALE



THIS DRAWING WAS ORIGINALLY ISSUED FOR PERMITTING/ CFC (REV. 0) BY BURNS AND McDONNELL, KANSAS CITY, MISSOURI, DATED 1/25/92, AND WAS PART OF A LANDFILL PERMIT PACKAGE FOR THE Y-12 INDUSTRIAL LANDFILL V. THIS DRAWING SUPERCEDES THE ORIGINAL DRAWING, AND

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GROUND

MAINTENANCE ROAD TY

NOT TO SCALE

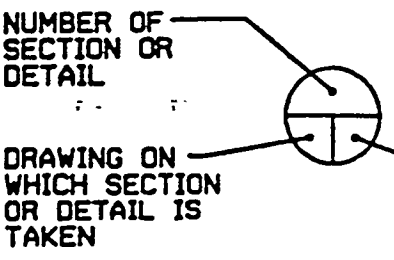
AREA 1 LANDFILL LINER SECTION HAS BEEN MOVED TO DWG. C2E900000A928.

3

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Document R
EG-C-37 Re
Guideline D
UCN-19586 (

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SECTION AND DETAIL KE

GROUND

)AD TYPICAL SECTION

TO SCALE

2. SELLER HAS OPTION TO EXCAVATE ROADWAY SUBGRADE FOR STABILIZED ROCK BASE OR PLACE STABILIZED AGGREGRATE BASE ON EXISTING SUBGRADE AND CONSTRUCT SHOULDERS AS EMBANKMENT.

HAS BEEN

cument Rev. No.: ___ Date: _____
-C-37 Review By: _____
ideline Document: _____
N-19586 (12356 4-93)

THIS DOCUMENT CONTROLLED BY

CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

—DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

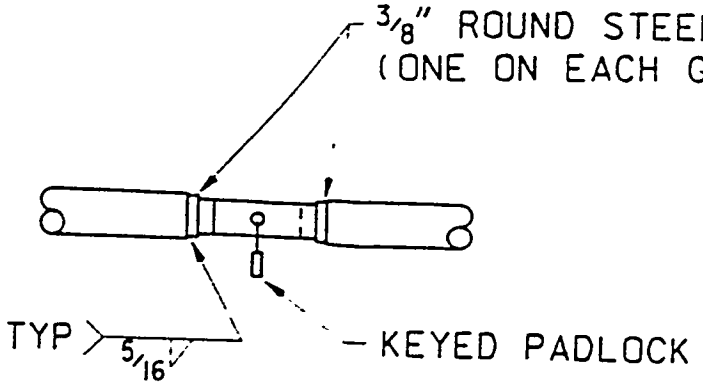
TAIL KEY

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCR
3				ISSUE FOR PERMIT

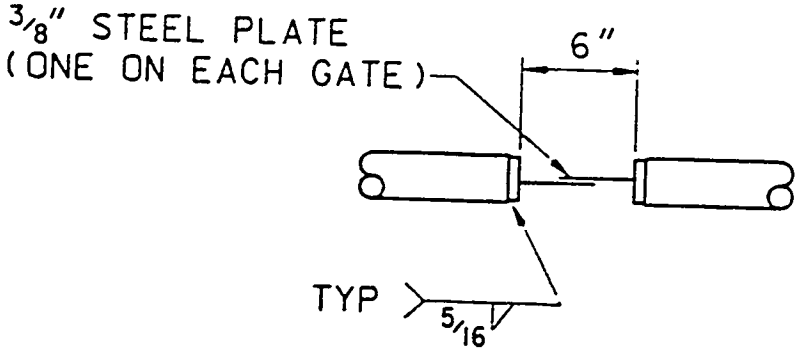
REVISION OR

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6



ELEVATION



PLAN

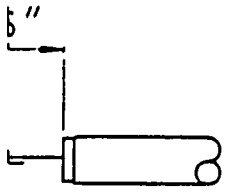
ING	JLA	WPT	—	[illegible]	2/19/97								
TION	BY	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RPE	RPE N	
UE PURPOSE	REVISION APPROVALS												

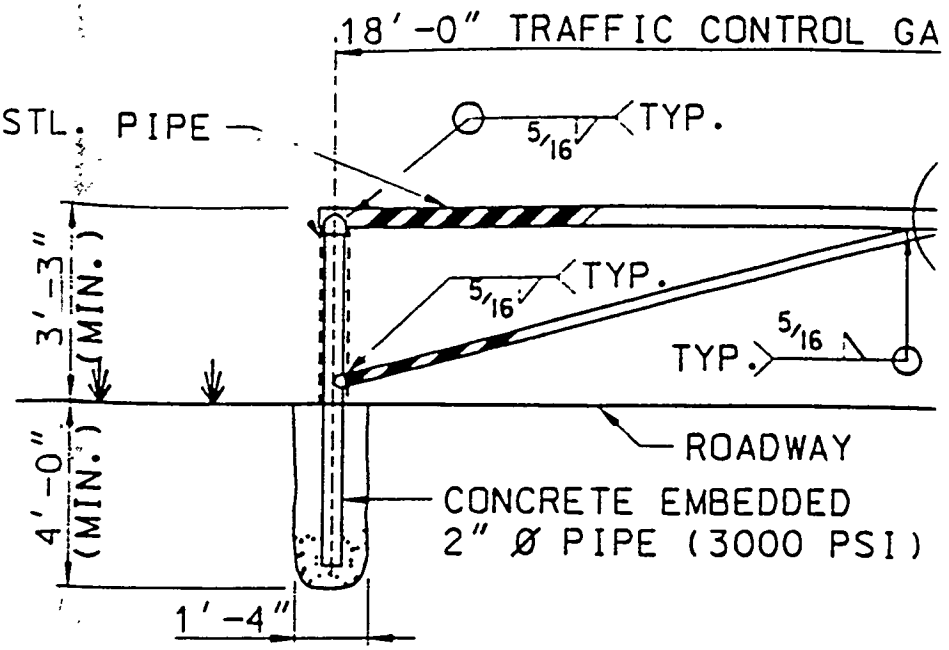
3/8" ROUND STEEL PLATE
(ONE ON EACH GATE)

KEYED PADLOCK

TION

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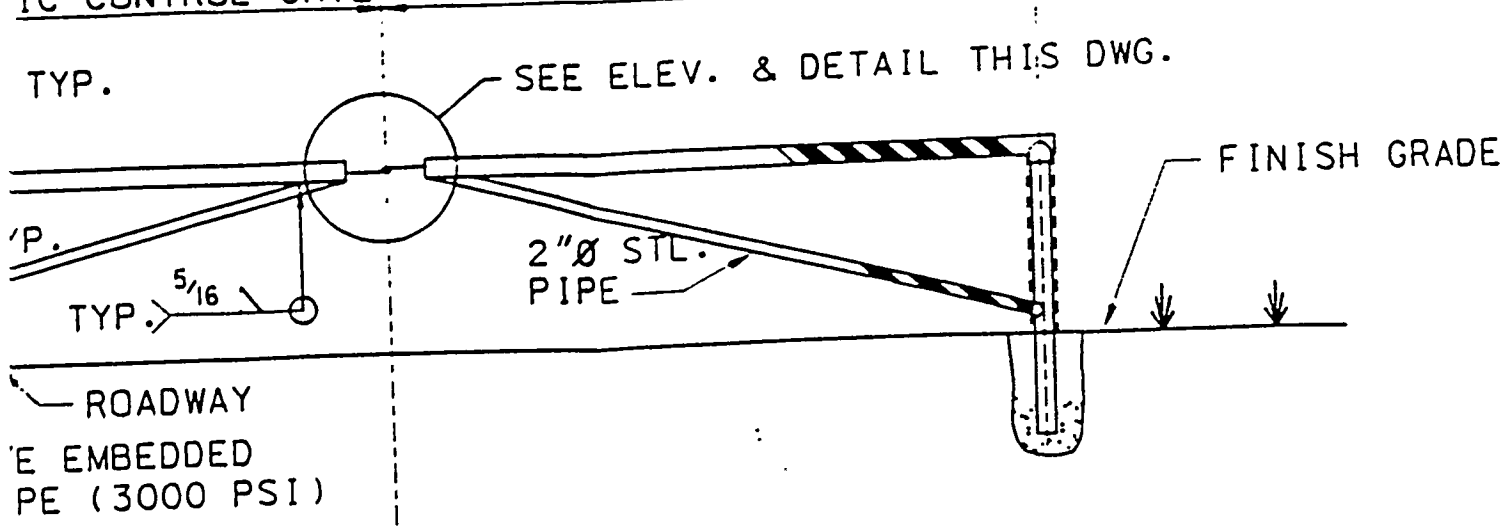


NOTE:

1. TRAFFIC CONTROL GA
STRIPED IN ACCORDAI
SHALL ALTERNATE 8"
& BE CONTINUOUS FOF

TRAFFIC

IC CONTROL GATE 18'-0" TRAFFIC CONTROL GATE.



'IC CONTROL GATE TO BE PAINTED BLACK & YELLOW
'ED IN ACCORDANCE WITH OSHA 1910.144. STRIPING
- ALTERNATE 8" YELLOW STRIPE AT 45° FROM HORIZONTAL
CONTINUOUS FOR ENTIRE GATE.

TRAFFIC CONTROL GATE DETAIL

NOT TO SCALE

ST	CV	EC	EE	EM	IE	M	PD	SE	ARC	VER
—	MW	—	—	—	—	—	—	—	—	—

SQUAD CHECK

RPE

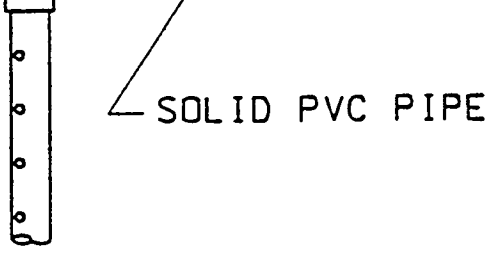
WILLIAM PATRICK TAYLOR REGISTERED ENGINEER AGRICULTURE STATE OF TENNESSEE

REV. O DATE 8/19/95

DRAWING APPROVALS

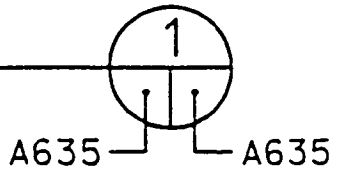
DSGN DJH
DRWN
CHKR WJT
SECT —
DEPT Wtr
PE
PJ WMA
REQ
MMES

PLAN VIEW



DETAIL

NOT TO SCALE



THIS DRAWING WAS ORIGINALLY ISSUED FOR PERMITTING/ CFC (REV. 0) BY BURNS AND McDONNELL, KANSAS CITY, MISSOURI, DATED 1/25/92, AND WAS PART OF A LANDFILL PERMIT PACKAGE FOR THE Y-12 INDUSTRIAL LANDFILL V. THIS DRAWING SUPERCEDES THE ORIGINAL DRAWING, AND REVISIONS ARE BEING MADE TO REFLECT ADDITIONAL LANDFILL DEVELOPMENT, AND FOR COMPLIANCE WITH TDEC REGULATORY CHANGES.

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, DATES AND WITH THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES.

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	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

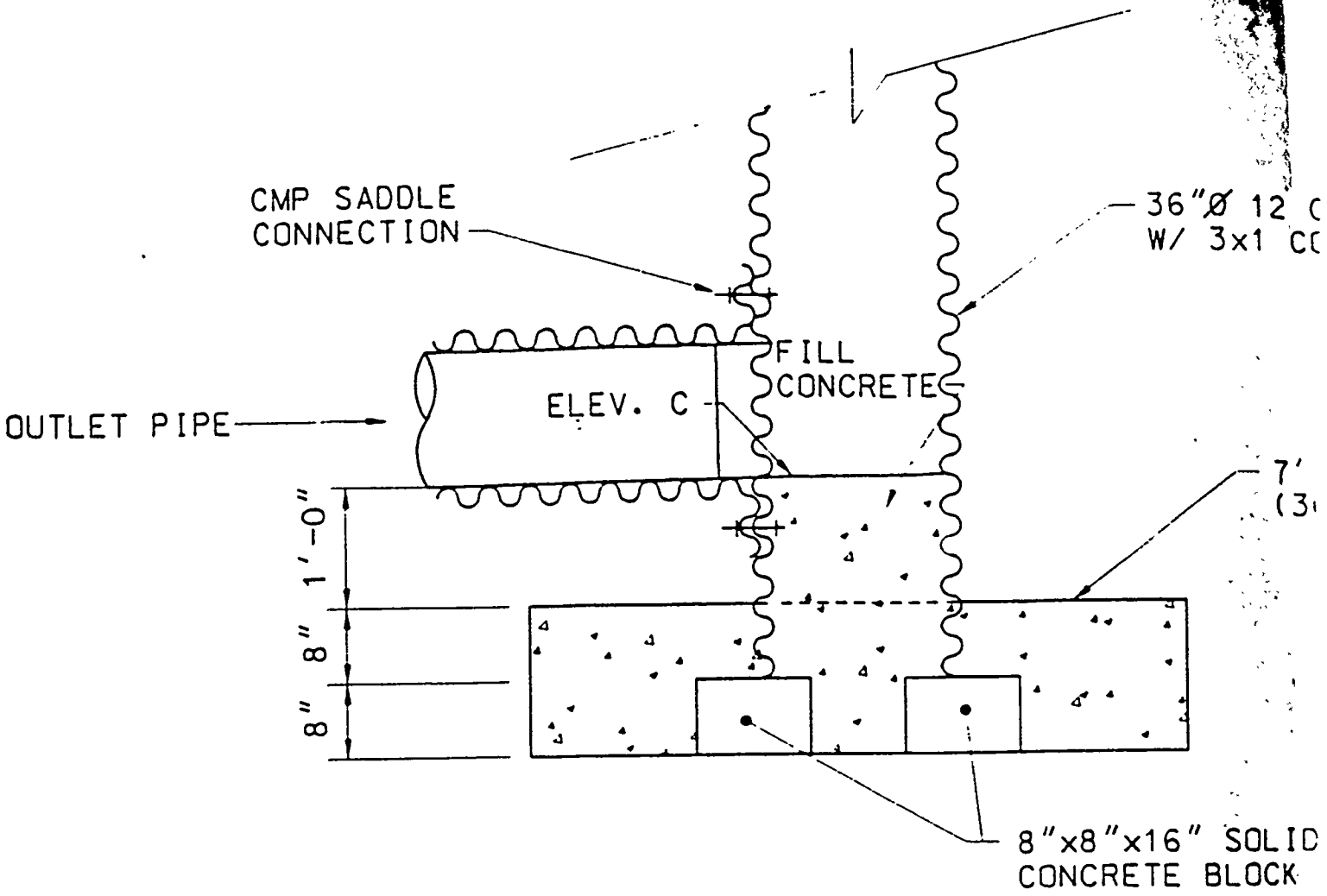
Y-12 INDUSTRIAL LANDFILL V

LANDFILL DETAILS - I

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U

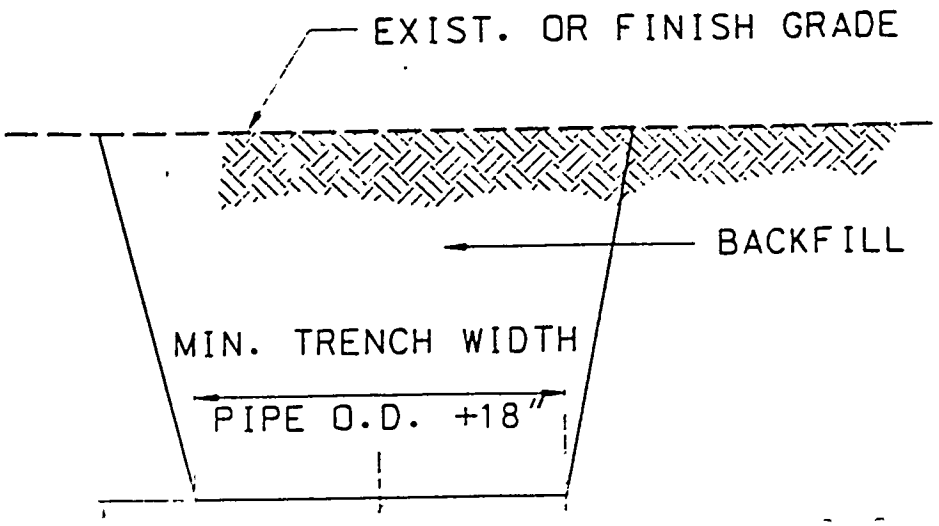
51	52	53		REV
NC	NA	AR	C2E900000A635	3

CAD FILE: C0001292 .DGN



CONCRETE SUPPORT DETAIL

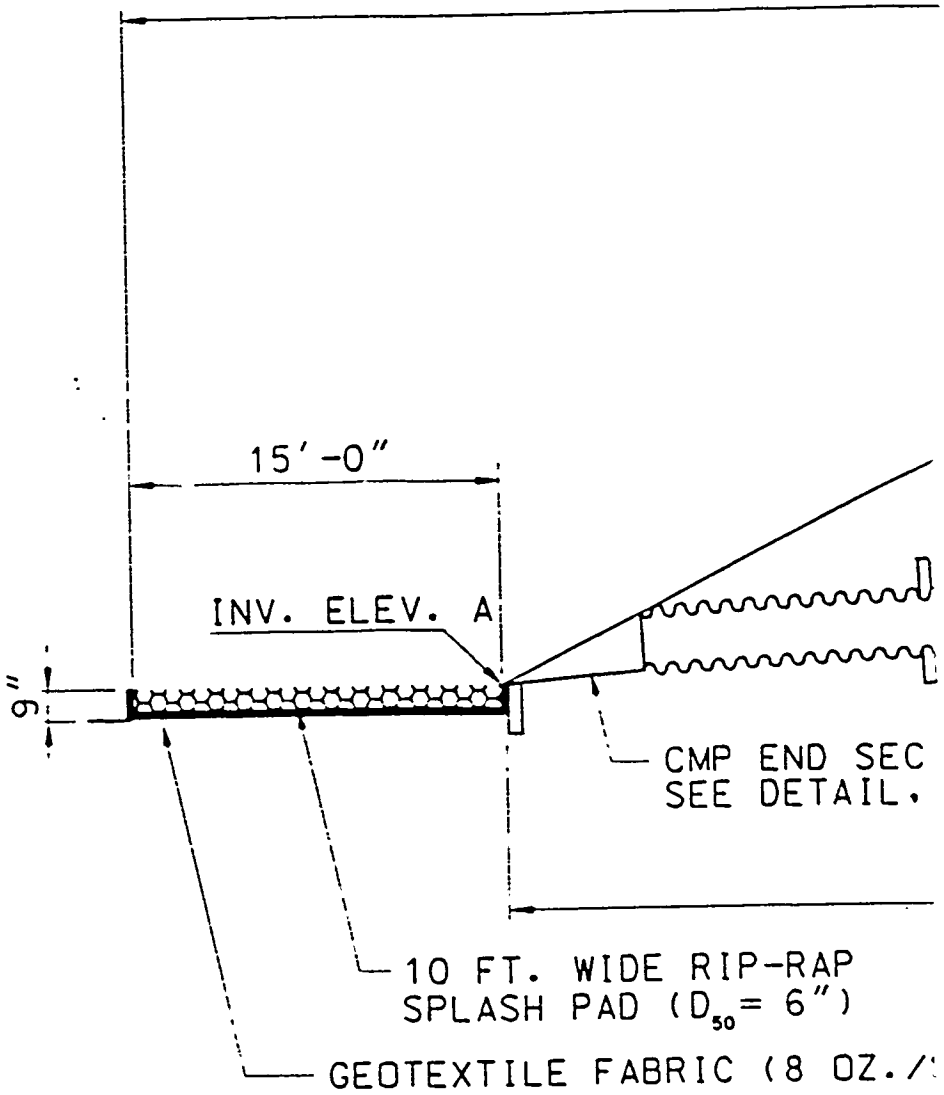
NOT TO SCALE



AREA

ø 12 GA. CMP RISER
3x1 CORRUGATIONS

7'x7' BASE SLAB
(3000 PSI)

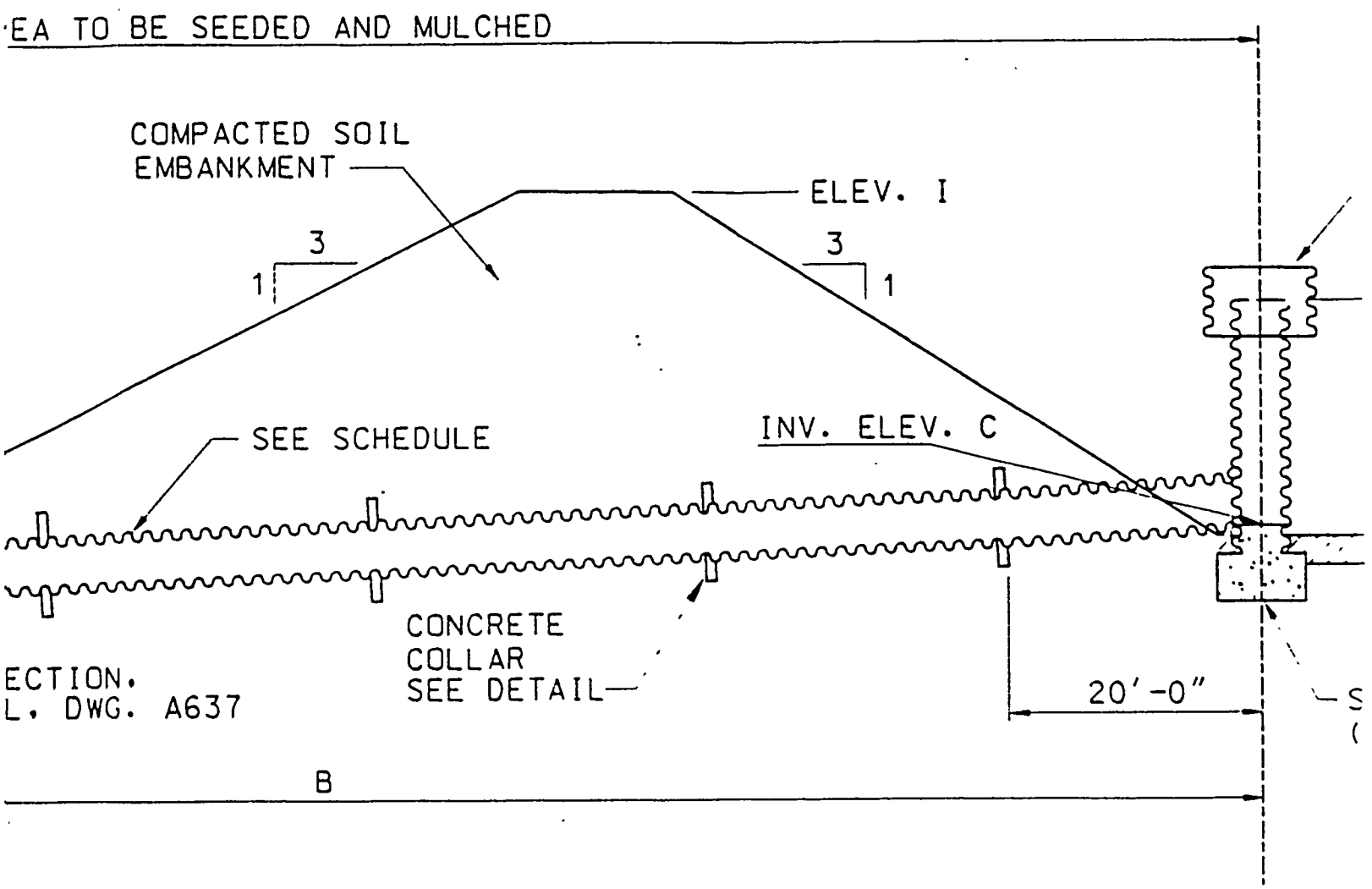


SOLID
BLOCK

TYPICAL SILTATI
DISCHARGE PIPE

NOT TO SCAL

POND	RISER PIPE DIA.	DISCHARGE PIPE DIA.	DISCHARGE PIPE	SLO
1	36"	21"	12 GA. CMP	0.(
2	36"	24"	12 GA. CMP/ CL. V CONC.	0.(
*	36"	15"	12 GA. CMP	0.



ECTION.
L. DWG. A637

./S.Y. MIN.)

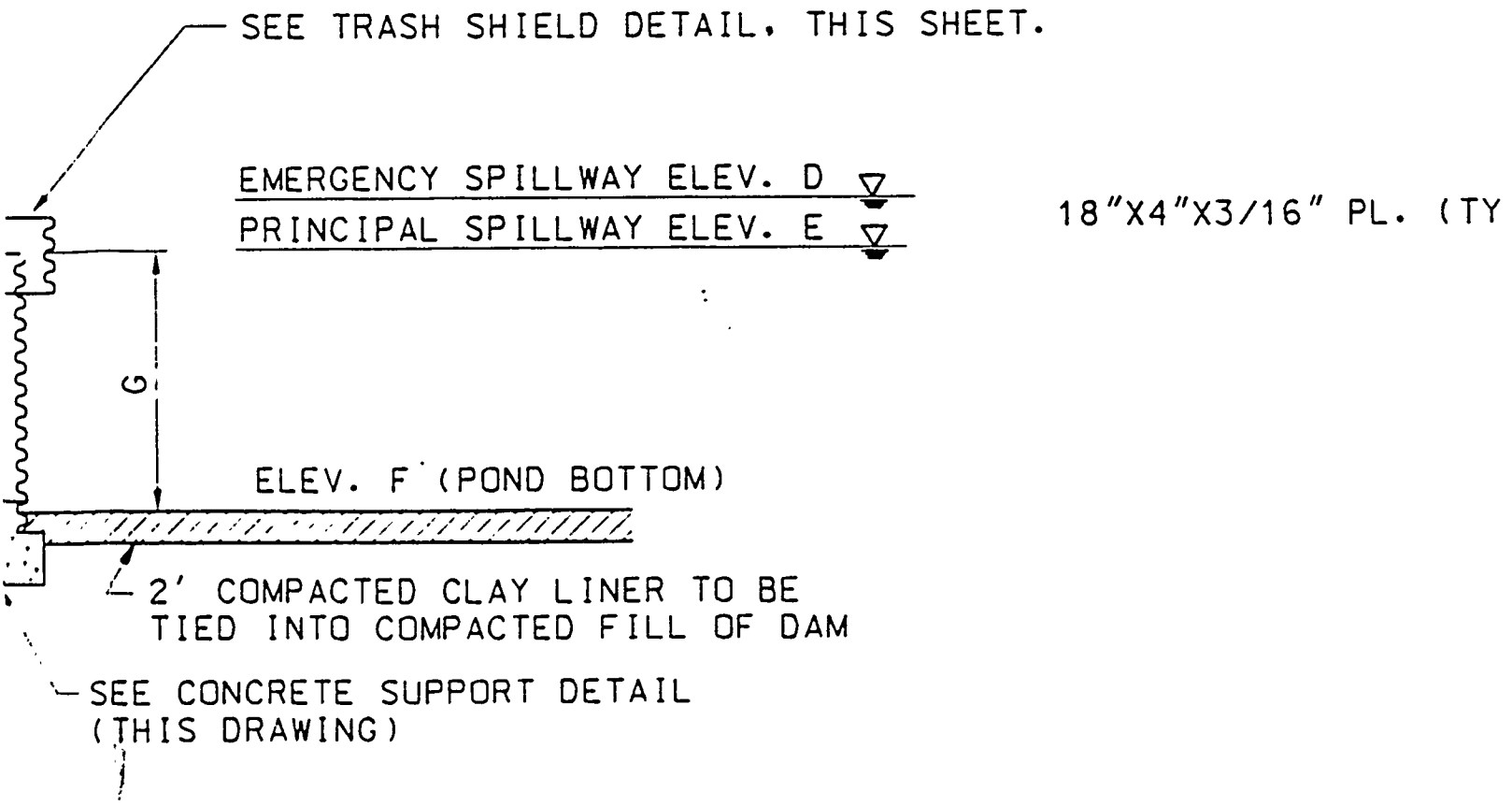
ION POND
E DETAIL
ALE

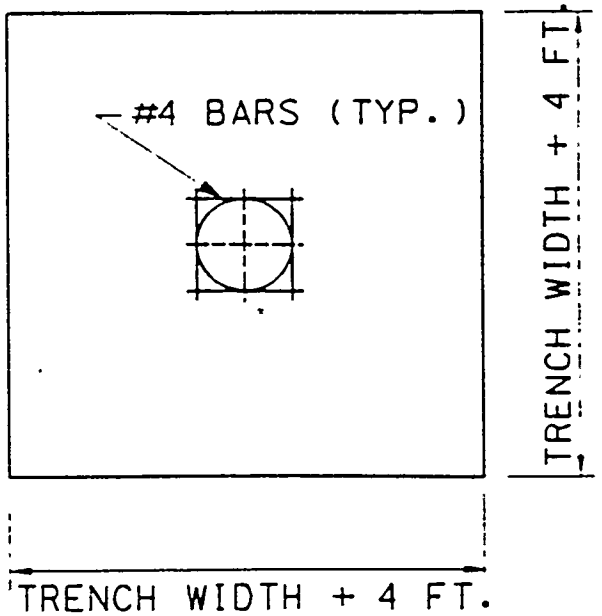
NOTES:

1. SEE SILTATION POND SCHEDULE FOR ELEVATIONS AND DIMENSIONS
2. RIP-RAP SPLASH PAD IS FOR THE DISCHARGE PIPE FROM POND NO.1 ONLY. THE DISCHARGE PIPE FROM POND NO.2 DISCHARGES INTO STORMWATER MANHOLE, NO.2.

SILTATION POND SCHEDULE

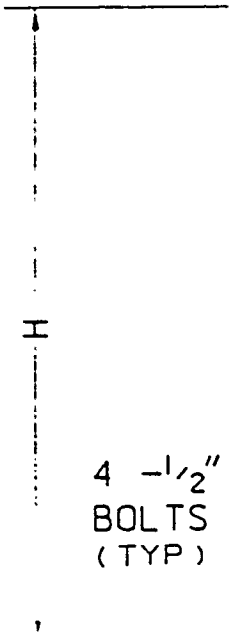
SLOPE	NO. OF ORIFICE HOLES	ORIFICE SPACING	A	B (FT.)	C	D	E (FT.)	F	G (FT.)	H (FT.)	
0.028	33	4"	971.0	237.3	977.6	1006.0	1000.8	990.0	10.8	7.2	1(
0.021	28	5"	977.7	206.0	982.0	996.0	993.4	982.0	11.4	4.6	1(
0.053	—	—	986.2	412.0	1008.0	NONE	1018.0	1008.0	10.0	5.5	



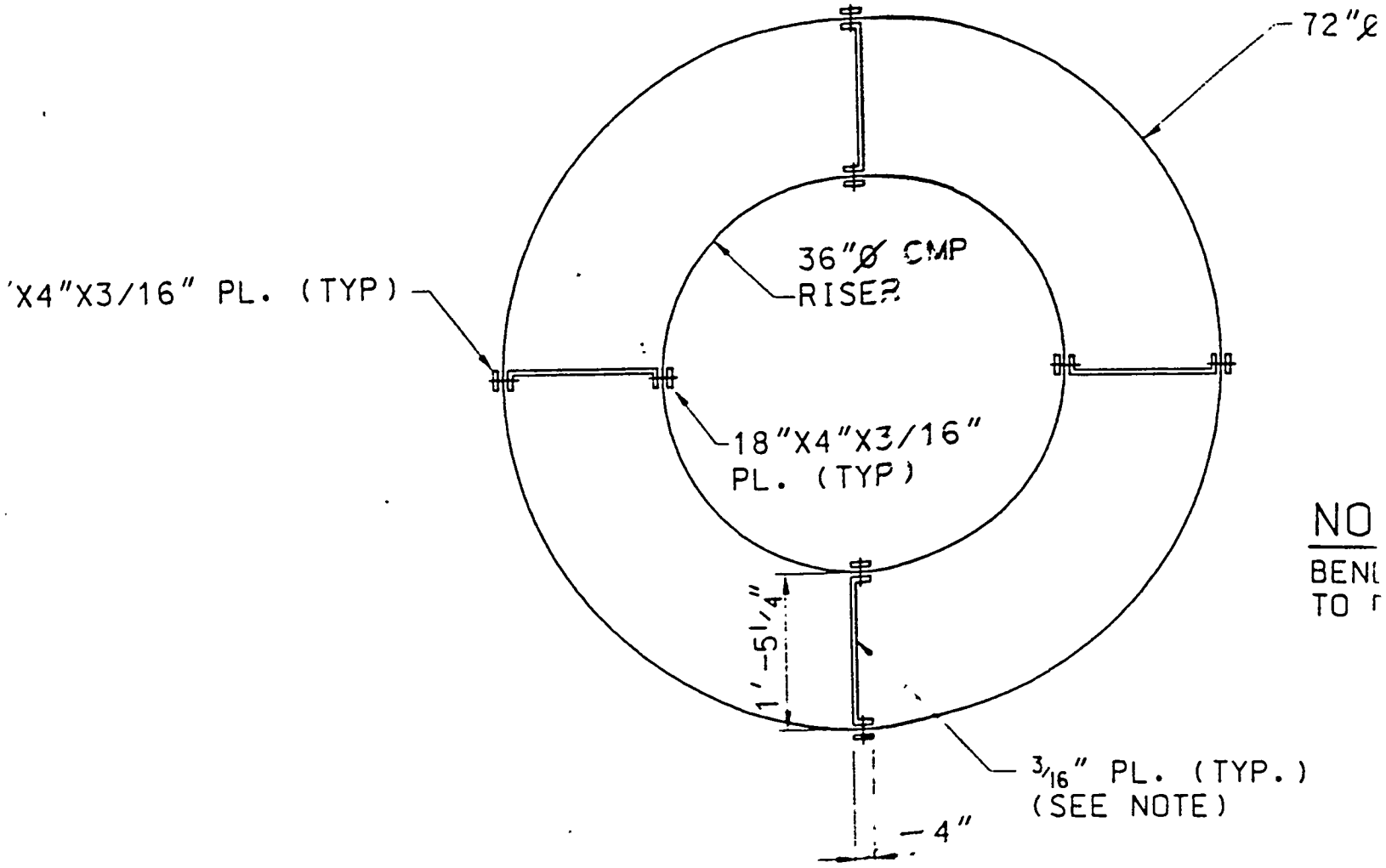


SECTION A

A

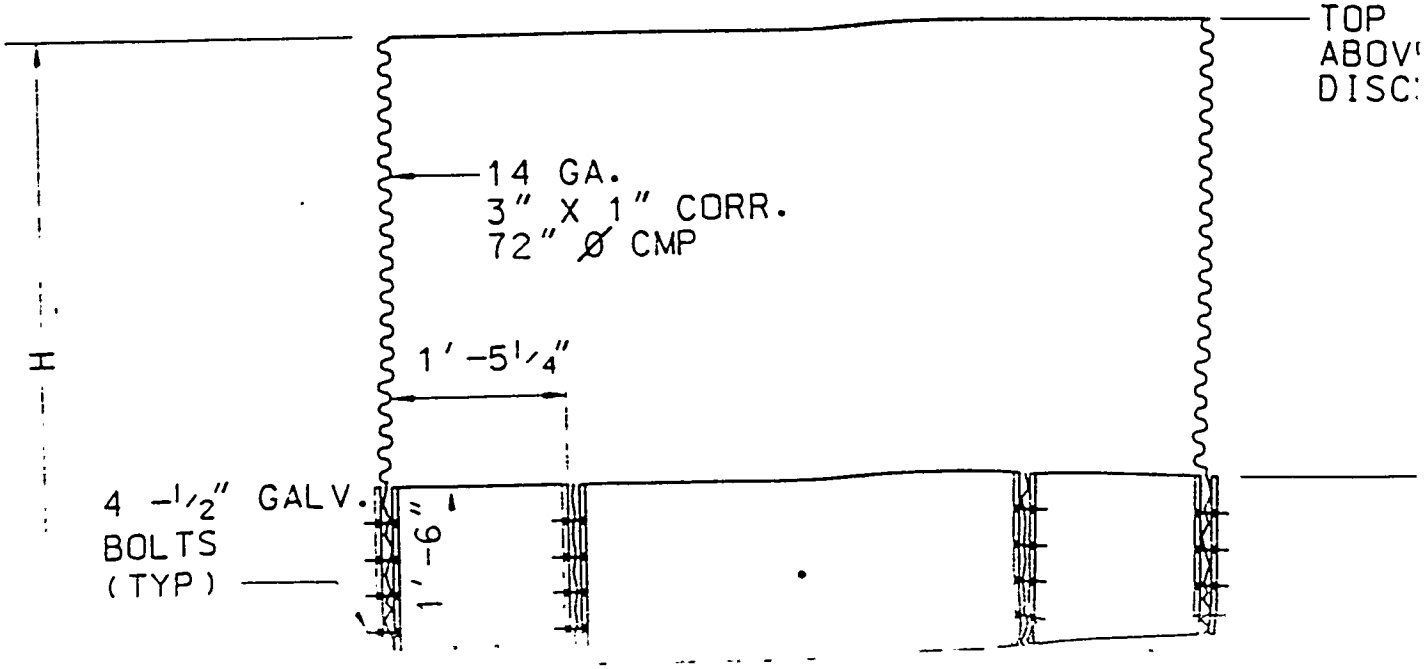


FT.)	I
2	1010.0
6	1000.0
5	1040.0



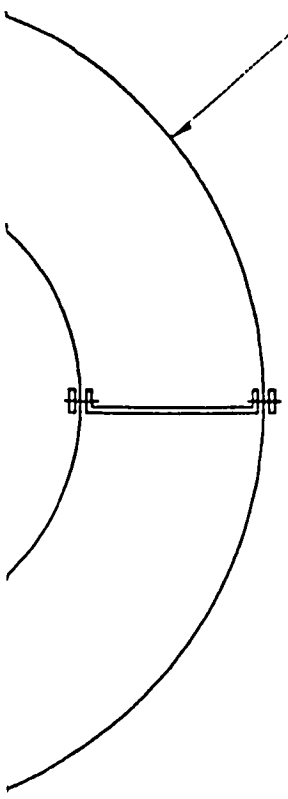
PLAN

NO
BENI
TO r



NEXT ASS'Y:

FINAL ASS'Y:



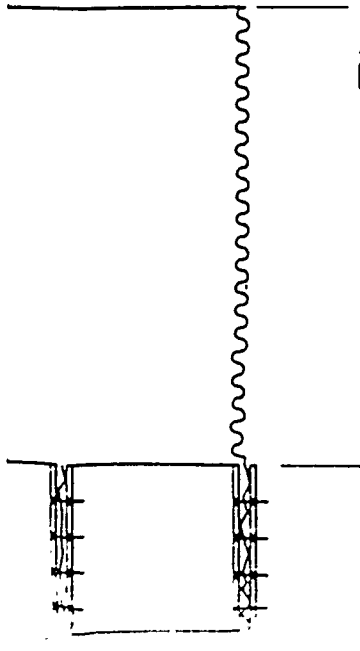
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NOTE:

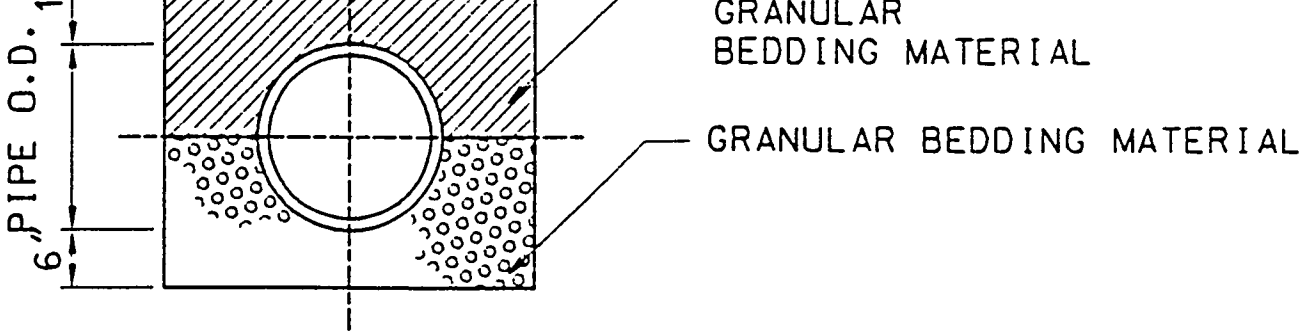
BEND PL 2'-2"X1'-6"X3/16"
TO DIMENSIONS SHOWN.

- 3/16" PL. (TYP.)
(SEE NOTE)

G

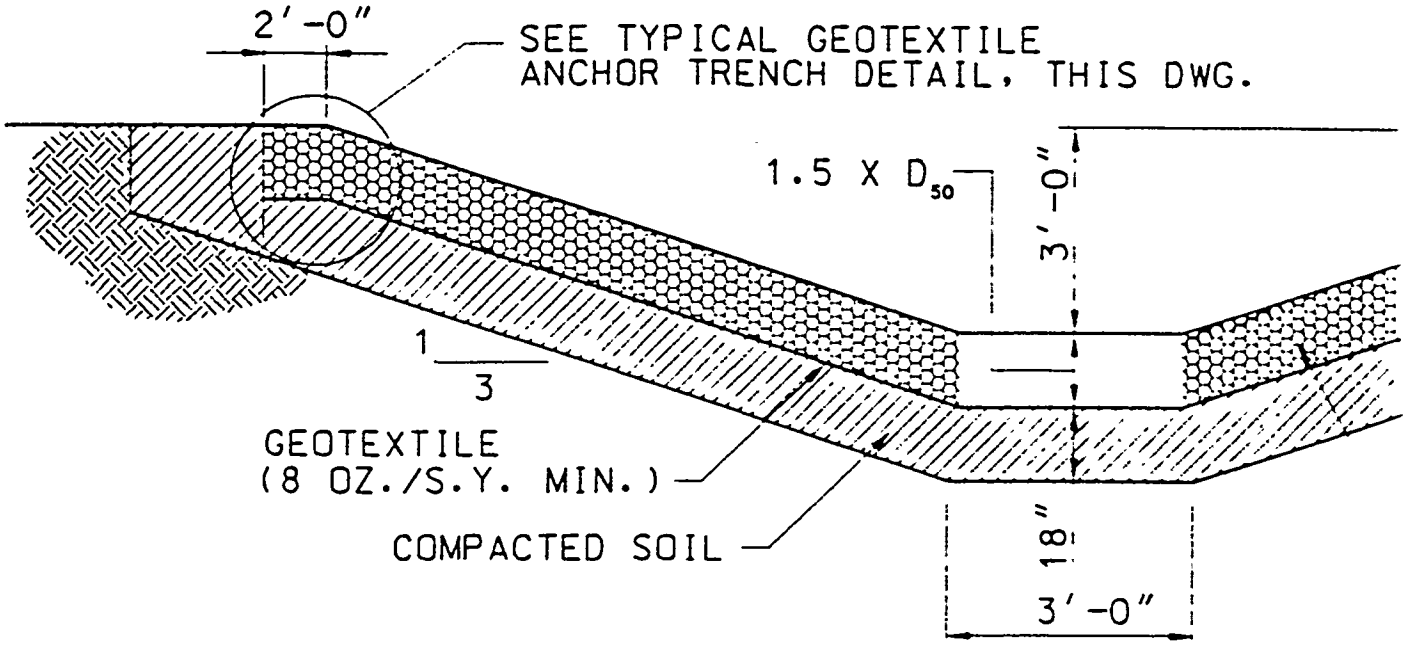


F



CMP TRENCH BEDDING

NOT TO SCALE



TYPICAL PERIMETER SURFA

NOT TO

) OR

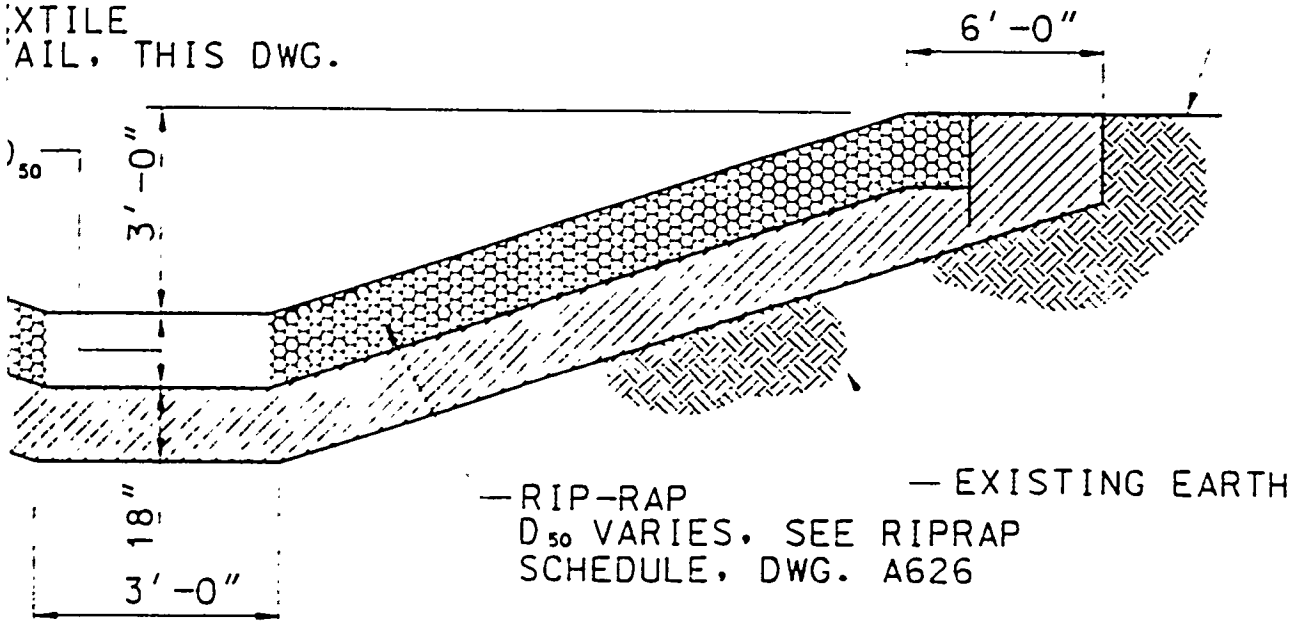
TERIAL

EDDING MATERIAL

LET [
MOVE[

— FINAL GRADE

XTILE
AIL, THIS DWG.



ERIMETER SURFACE WATER CHANNEL DETAIL

NOT TO SCALE

* OFFSITE RUNOFF COLLECTION POND

LET DOWN CHANNEL DETAIL HAS BEEN MOVED TO DWG. C2E900000A931

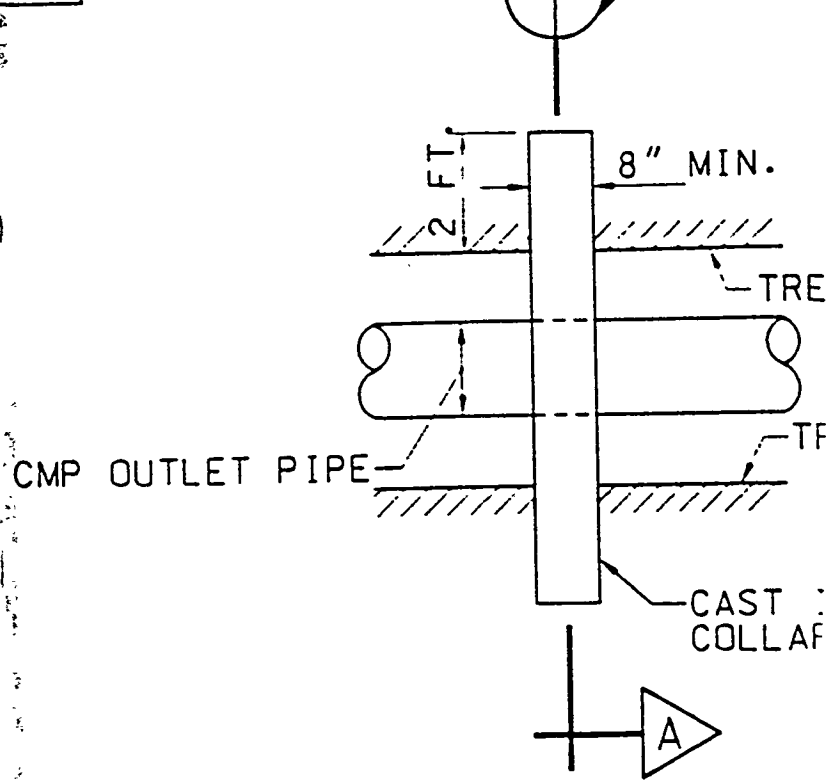
3

FINAL GRADE

4

IL

TYPICAL TERRACE CHA
DRAINAGE DETAIL) HA



CONCRETE COLLAR

NOT TO SCALE

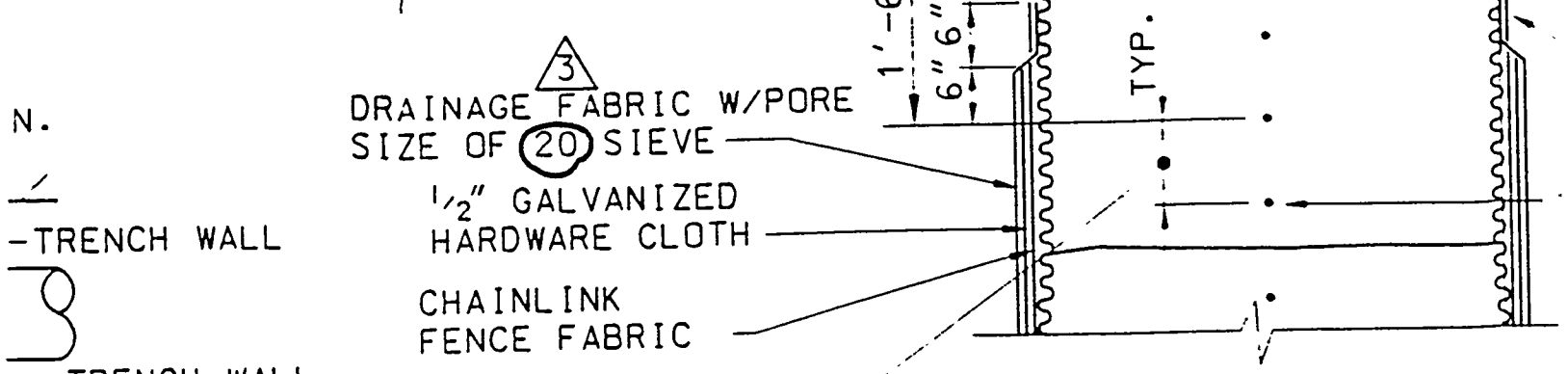
CHANNEL DETAIL (RENAMED TYPICAL BERM) HAS BEEN MOVED TO DWG. C2E900000A931

3

N.

-TRENCH WALL

-TRENCH WALL



ST IN PLACE CONCRETE
LLAR ON 20' CTRS.

AR DETAIL

CALE

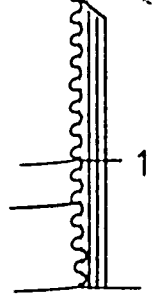
NOTES:

1. WRAP CHAINLINK FENCE FABR AND SECURE WITH WIRE TIES
2. WRAP EXTERIOR OF WIRE FABI OF 1/2" GALVANIZED HARDWARE LAYERS OF 4 OZ./SY MIN. D
3. TIE HARDWARE CLOTH TO CHA WIRE TIES.
4. SECURE DRAINAGE FABRIC US BANDS ON 2' CENTERS.
5. NOTES 1 THRU 4 DO NOT APP RUNOFF COLLECTION POND RI RUNOFF COLLECTION POND RI NOT CONTAIN 1" HOLES.

SECTION

TRASH SHIELD

NOT TO SC



2" STAINLESS STEEL BAND

1" DIA. HOLES (SINGLE ROW, EVENLY SPACED, ON OPPOSITE SIDE OF RISER FROM OUTLET PIPE)

FABRIC AROUND RISER PIPE
TIES.

E FABRIC WITH 1 LAYER
RDWARE CLOTH AND 2
IN. DRAINAGE FABRIC.

D CHAINLINK FABRIC WITH

IC USING STAINLESS STEEL

T APPLY TO THE OFFSITE
ND RISER PIPE. OFFSITE
ND RISER PIPE ALSO DOES

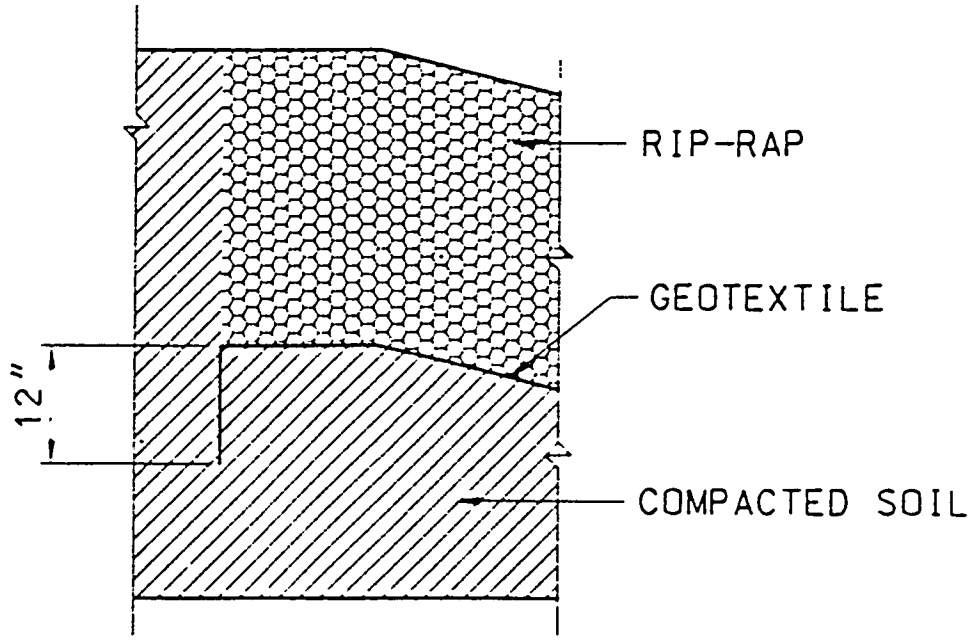
JN

IELD DETAIL

O SCALE

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D

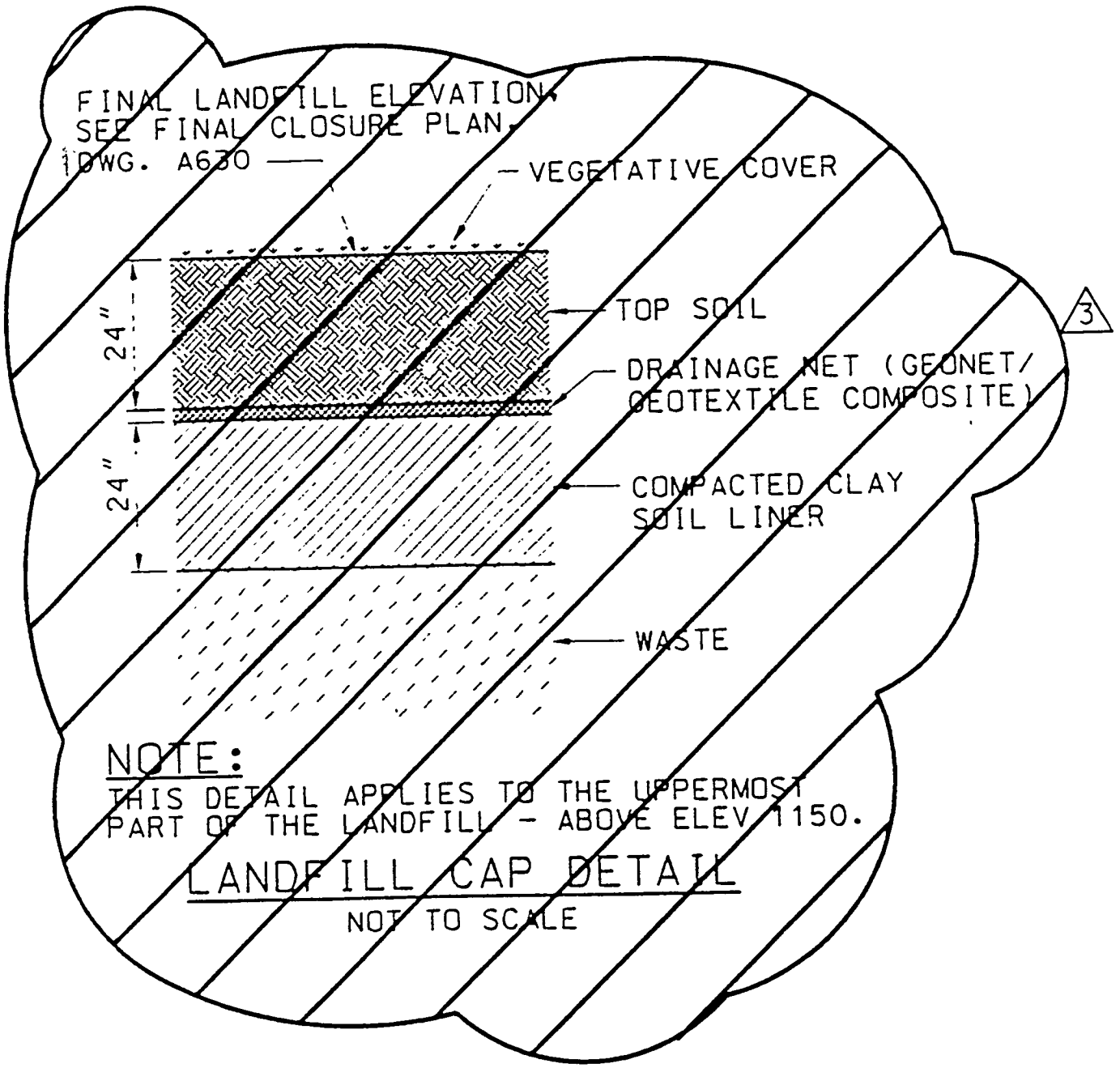


TYPICAL GEOTEXTILE ANCHOR TRENCH DETAIL

NOT TO SCALE

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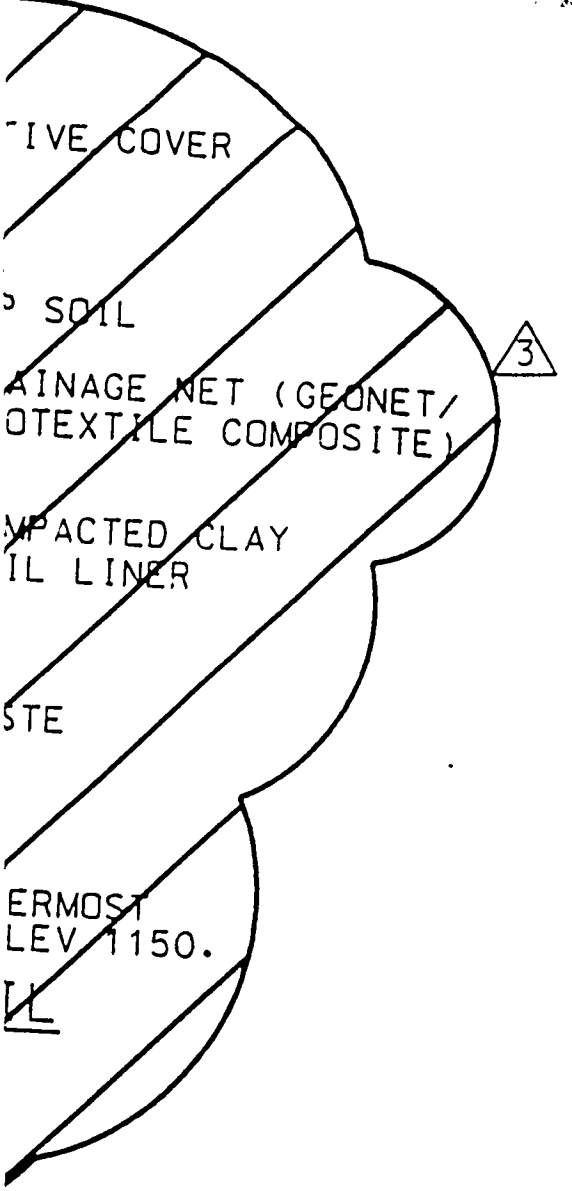
Document Rev.
EG-C-37 Revie
Guideline Doc
UCN-19586 (12



LANDFILL CAP DETAIL

NOT TO SCALE

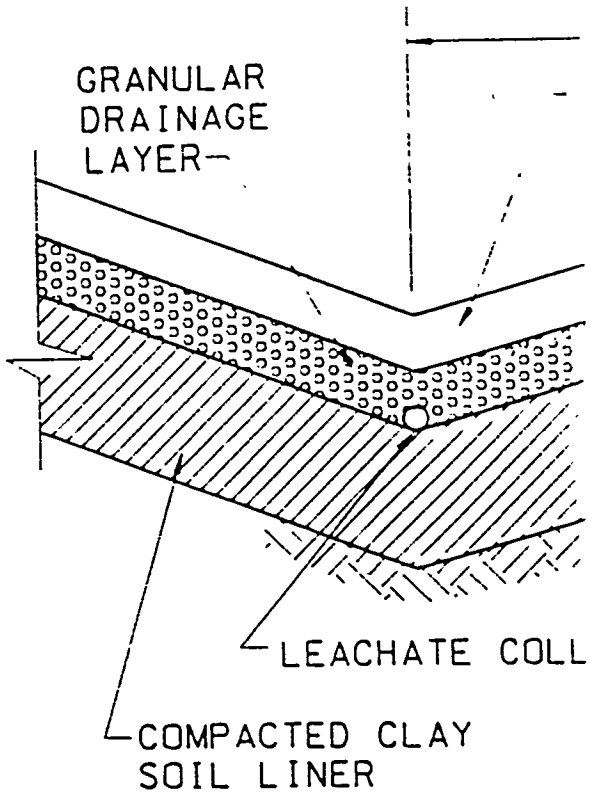
Document Rev. No.: ___ Date: _____
EG-C-37 Review By: _____
Guideline Document: _____
UCN-19586 (12356 4-93)

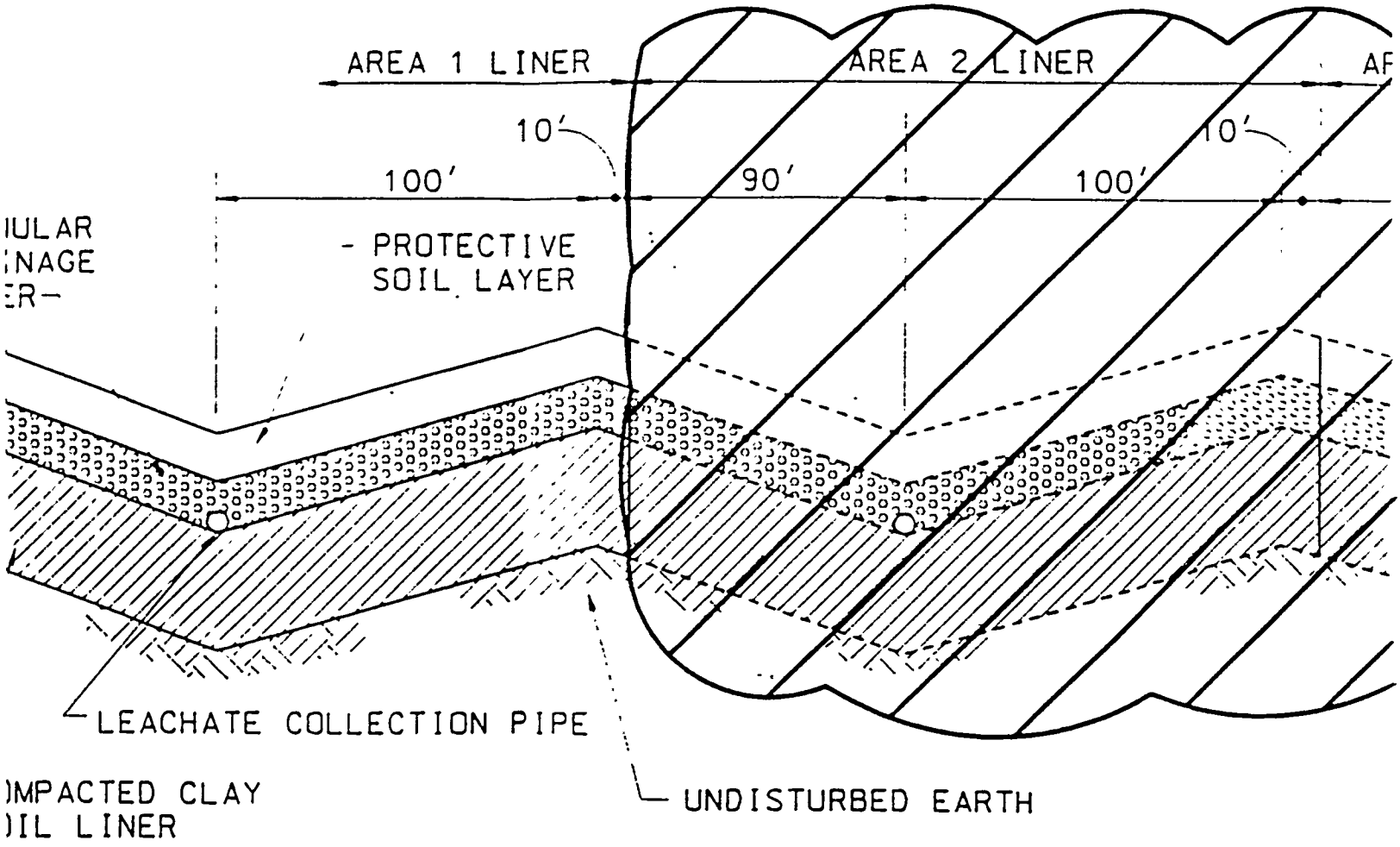


LANDFILL COVER DETAIL (
COVER) HAS BEEN MOVED T

3

ENAMED CLAY SOIL
DWG. C2E900000A930





SECTION

NOT TO SCALE

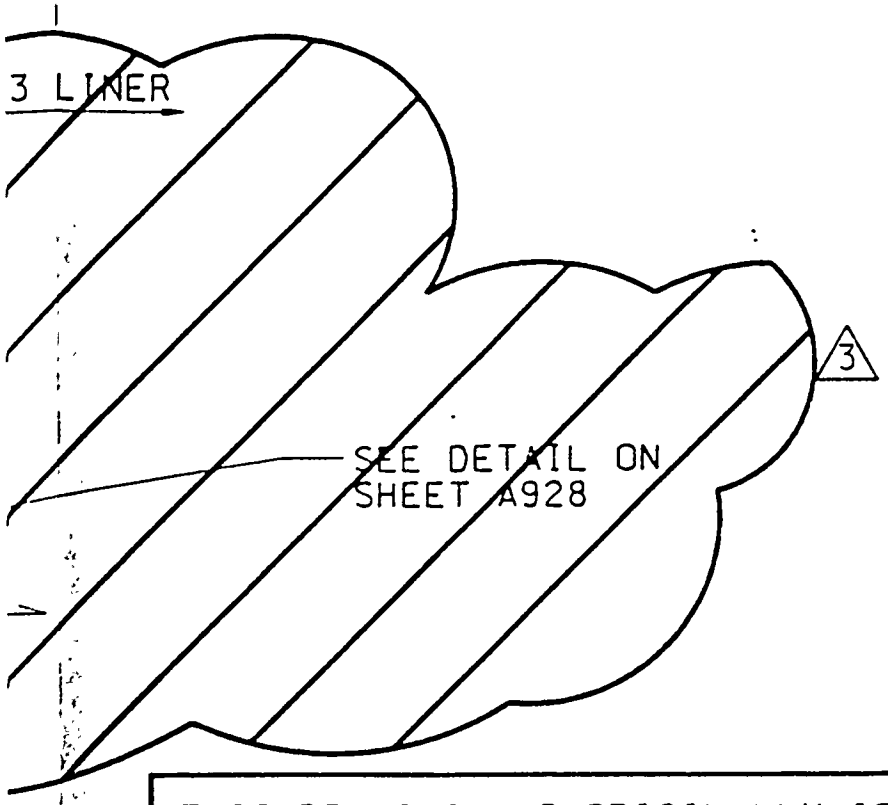
B

A628 — A636

RPE

WILLIAM PATRICK TAYLOR
REGISTERED ENGINEER
AGRICULTURE
STATE OF TENNESSEE

DSGN
DRWN
CHKR
SECT
DEPT
PE
PJ
REQ



THIS DRAWING WAS ORIGINALLY ISSUED FOR PERMITTING/ CFC (REV. 0) BY BURNS AND McDONNELL, KANSAS CITY, MISSOURI, DATED 1/25/92, AND WAS PART OF A LANDFILL PERMIT PACKAGE FOR THE Y-12 INDUSTRIAL LANDFILL V. THIS DRAWING SUPERCEDES THE ORIGINAL DRAWING, AND REVISIONS ARE BEING MADE TO REFLECT ADDITIONAL LANDFILL DEVELOPMENT, AND FOR COMPLIANCE WITH TDEC REGULATORY CHANGES.

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	8/19/95
	8/19/95
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	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

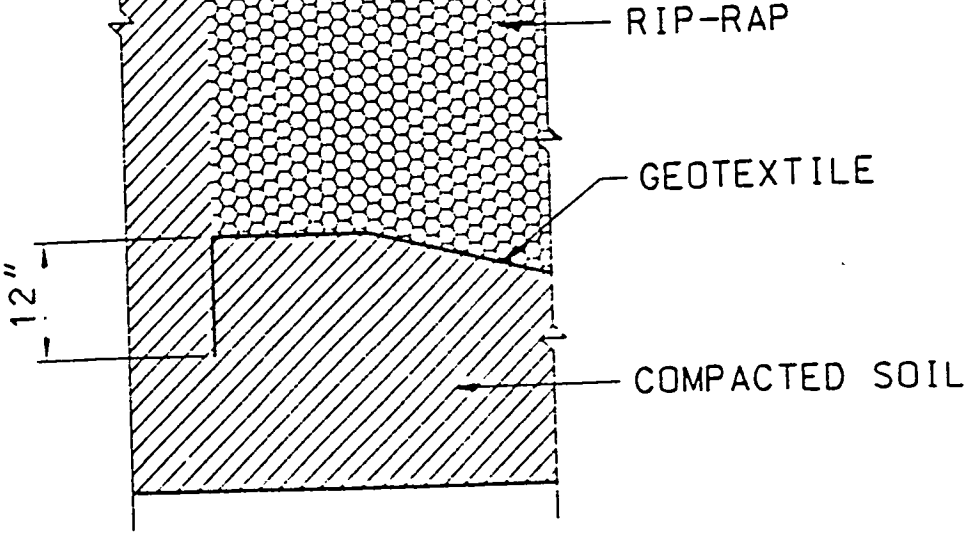
PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

LANDFILL DETAILS - II

C2E900000A636

C B A



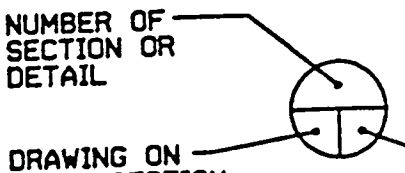
TYPICAL GEOTEXTILE ANCHOR TRENCH DETAIL

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EG-C-37 R
Guideline
UCN-19586

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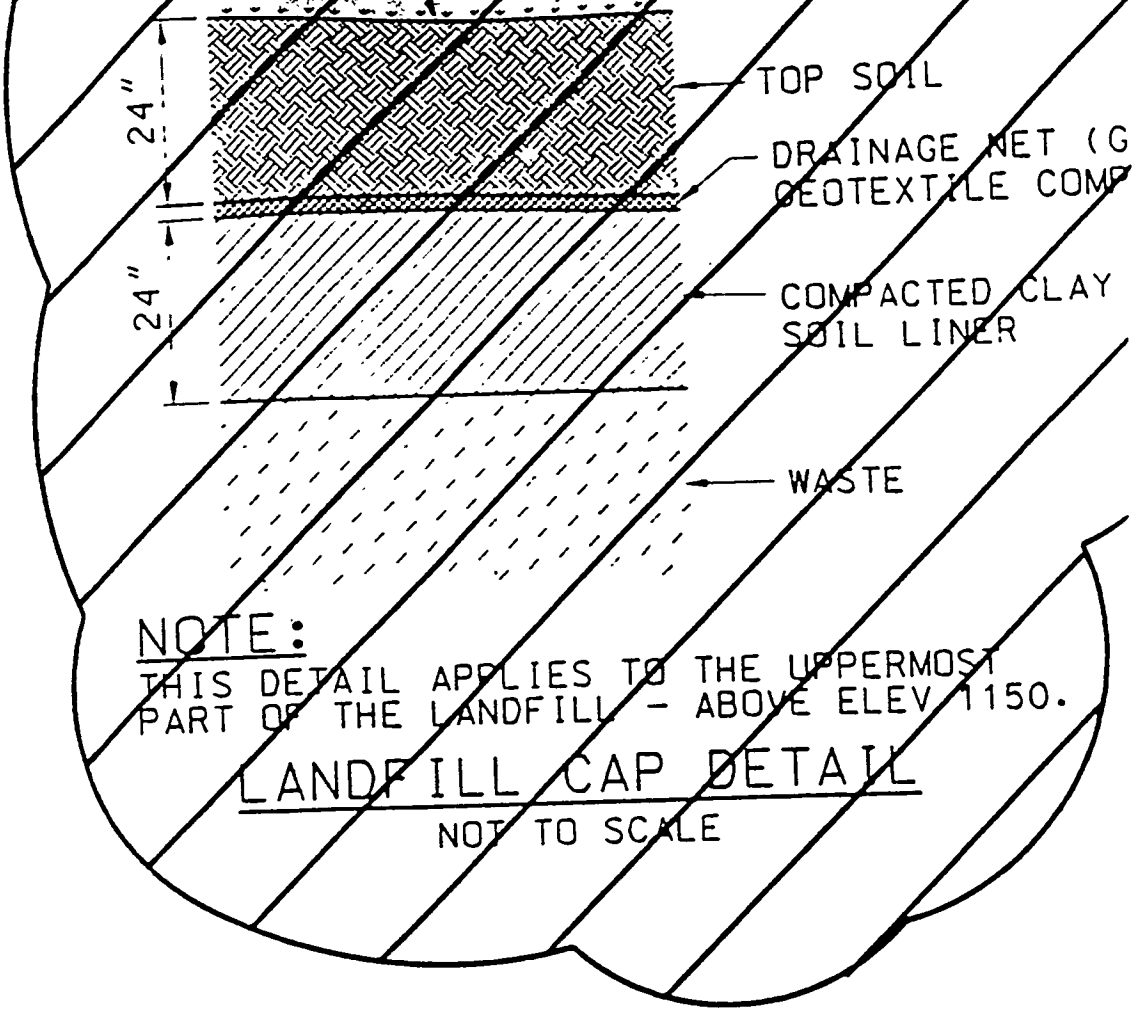
SECTION AND DETAIL K

-RAP

)TEXTILE

IPACTED SOIL

ICHOR



NOTE:
THIS DETAIL APPLIES TO THE UPPERMOST PART OF THE LANDFILL - ABOVE ELEV 1150.

LANDFILL CAP DETAIL

NOT TO SCALE

LY

Document Rev. No.: ___ Date: _____
EG-C-37 Review By: _____
Guideline Document: _____
UCN-19586 (12356 4-93)

NUMBER OF SECTION OR DETAIL

DRAWING ON WHICH SECTION OR DETAIL IS TAKEN

DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

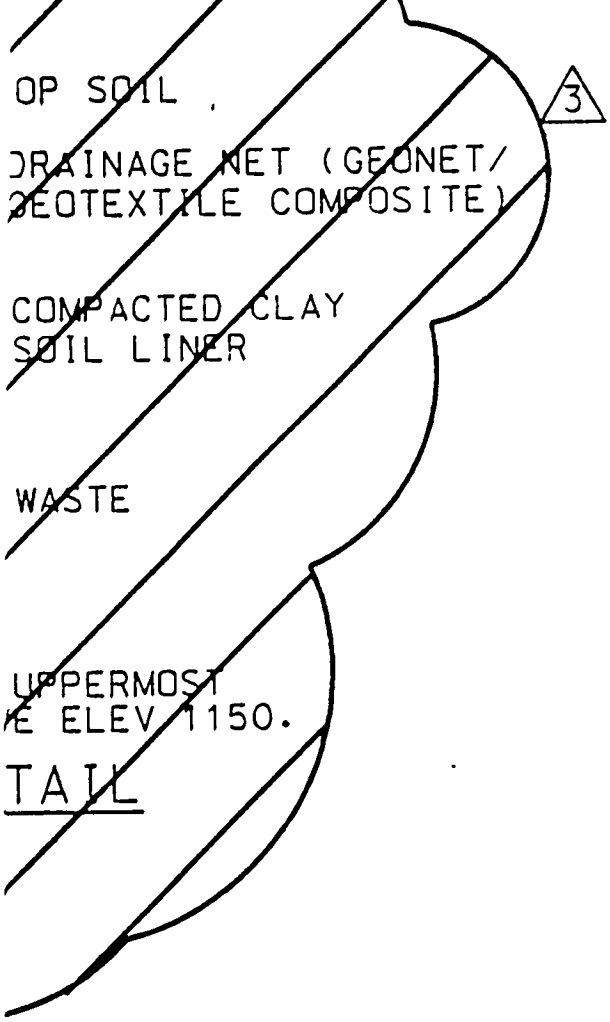
SECTION AND DETAIL KEY

THIS DOCUMENT CONTROLLED BY

CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER
3			



LANDFILL COVER DETAIL
COVER) HAS BEEN MOVED

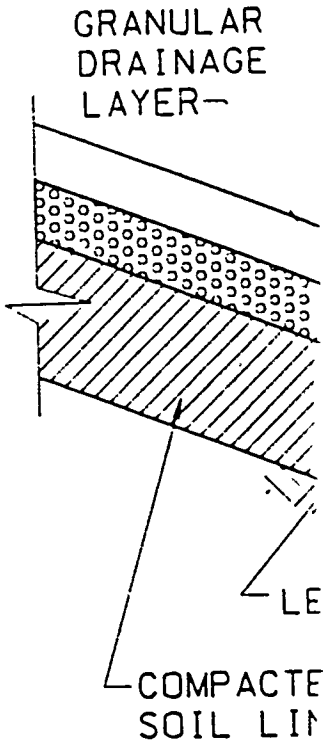
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EV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION	BY	CHK	SECT	DEPT
3				ISSUE FOR PERMITTING	JGA	WPT	—	WW

REVISION OR ISSUE PURPOSE

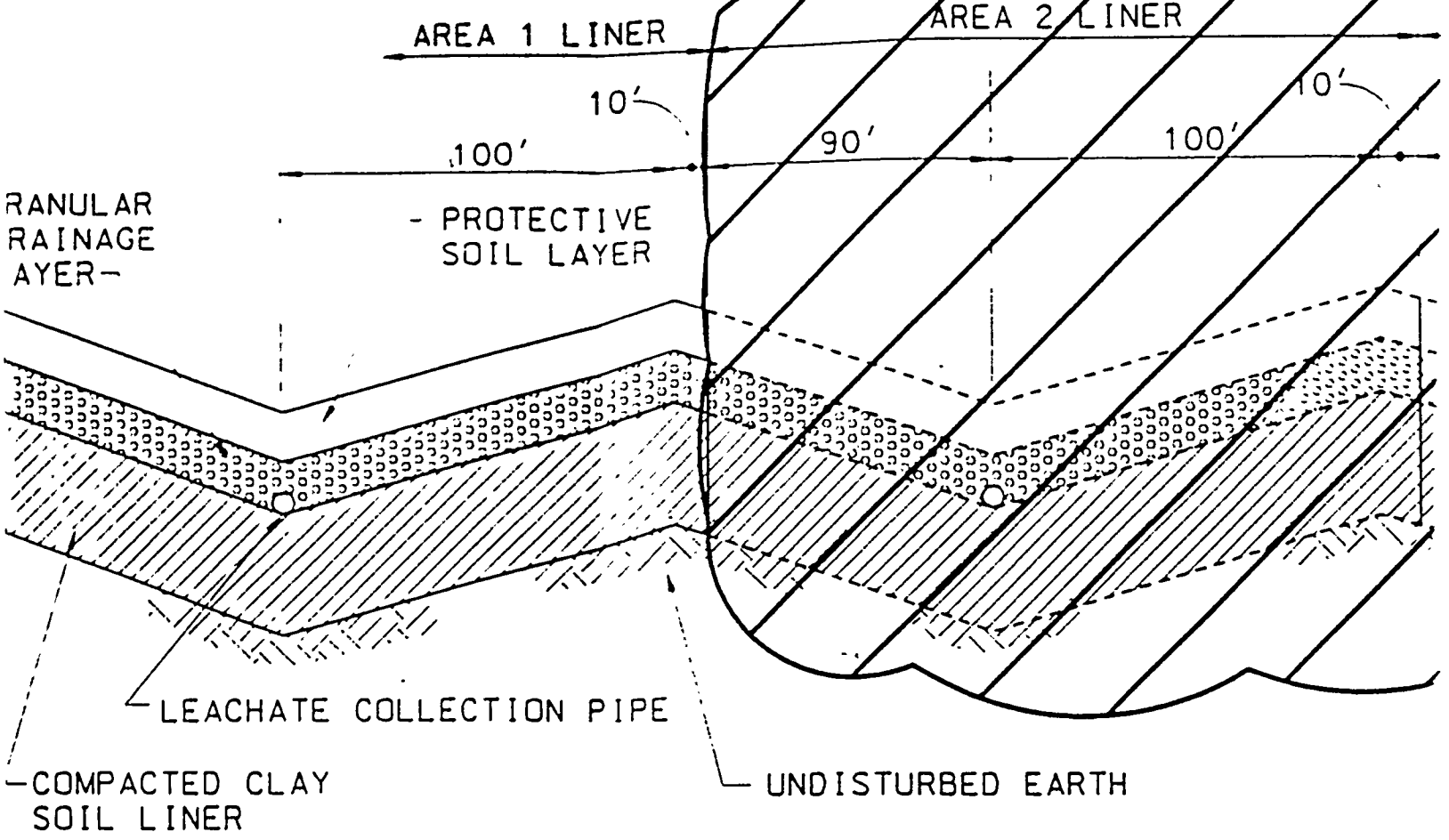
TAIL (RENAMED CLAY SOIL
OVED TO DWG. C2E900000A930

3



—	WCC	8/19/95				SSC	8/28/95	WPT	22511	8/19/95					—	DWL
ECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	RPE	RPE NO	DATE			QA	DATE	ST	CV
	REVISION APPROVALS															

4



SECTION

NOT TO SCALE

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A628 — A636

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ST	CV	EC	EE	EM	IE	M	PD	SE	ARC	VER

SQUAD CHECK

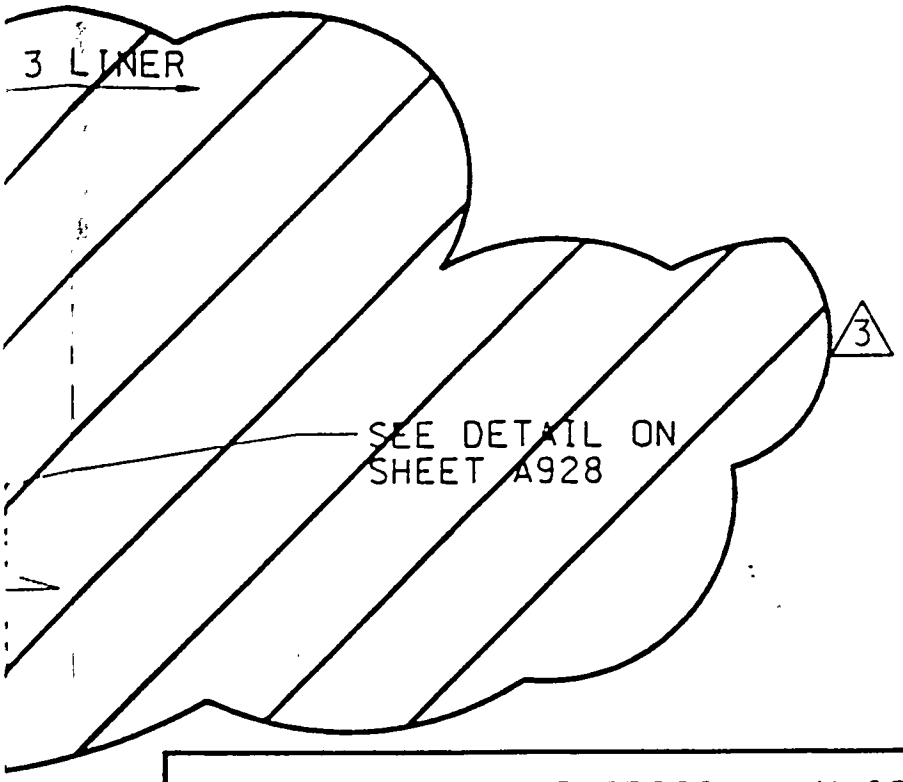
RPE

WILLIAM PATRICK TAYLOR
REGISTERED ENGINEER
AGRICULTURE
STATE OF TENNESSEE

DSGN
DRWN
CHKR
SECT
DEPT
PE
PJ
REQ

REV. 0 DATE 8/19/95 MMES

DRAWING APPROVALS



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Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

LANDFILL DETAILS - II

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U

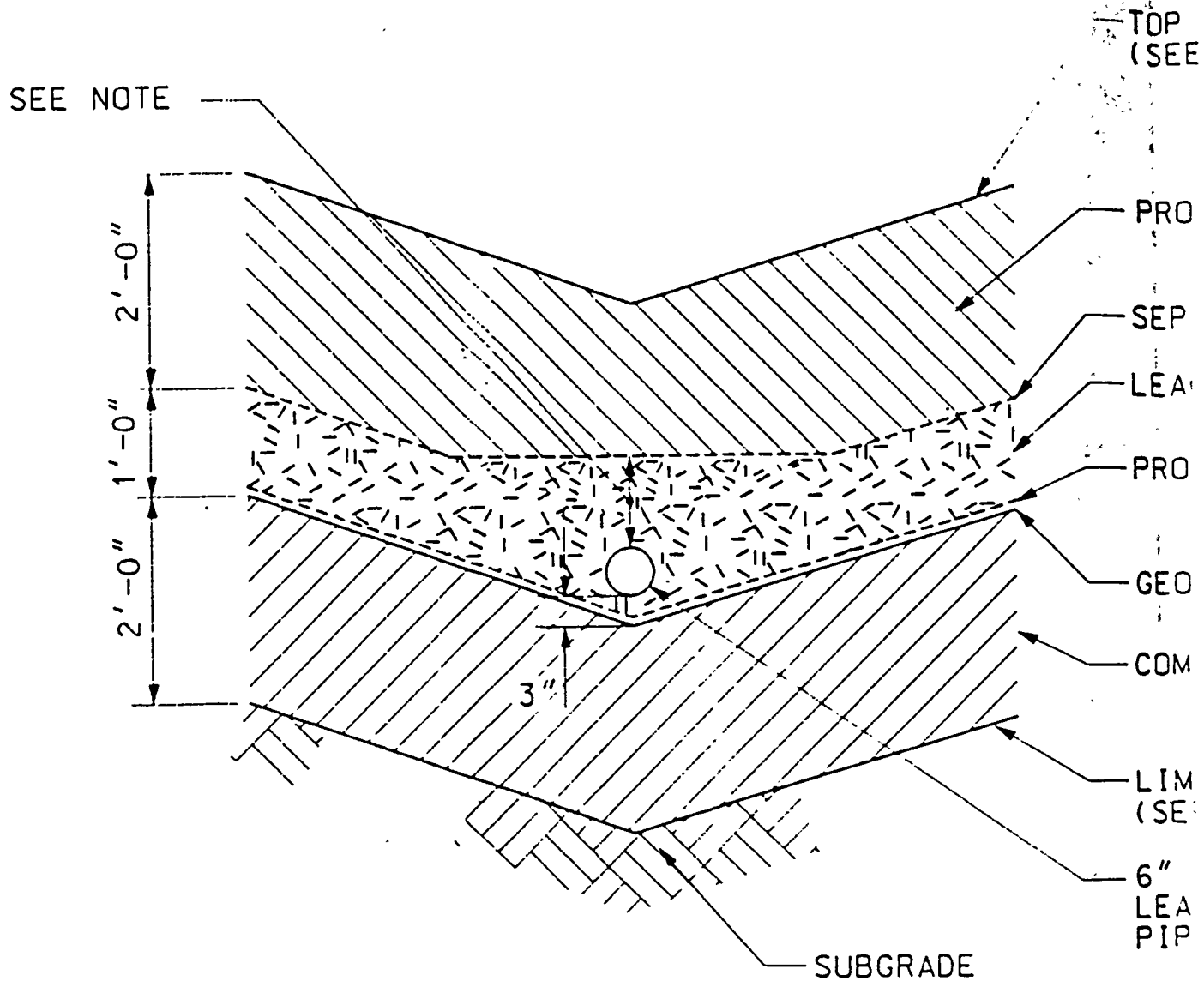
51	52	53		REV
NC	NA	AR	C2E900000A636	3

CAD FILE: C0001293.DGN
SCALE: 20'=1'-0"

DATE: Aug 19 1995

C2E900000A636

C
B
A



NOTE:

PLACE 9" OF AGGREGATE OVER LEACHATE COLLECTION PIPE.

COMPOSITE CLAY LINER

-TOP OF PROTECTIVE SOIL COVER
(SEE DWG C2E900000A900)

— PROTECTIVE SOIL COVER

— SEPARATOR GEOTEXTILE FABRIC

— LEACHATE COLLECTION LAYER

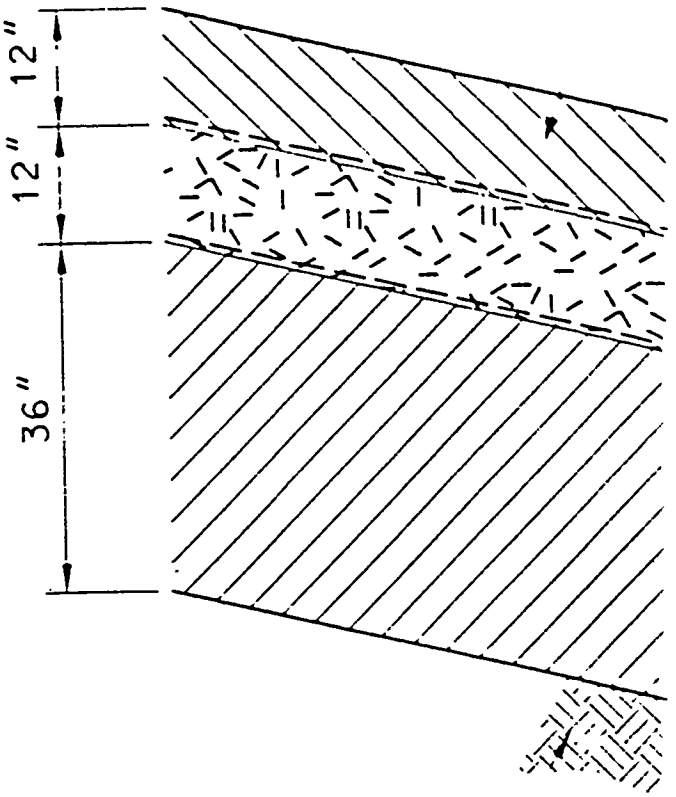
— PROTECTIVE GEOTEXTILE FABRIC

— GEOMEMBRANE

— COMPACTED CLAY SOIL LINER

— LIMIT OF SUBGRADE EXCAVATION
(SEE DWG C2E900000A899)

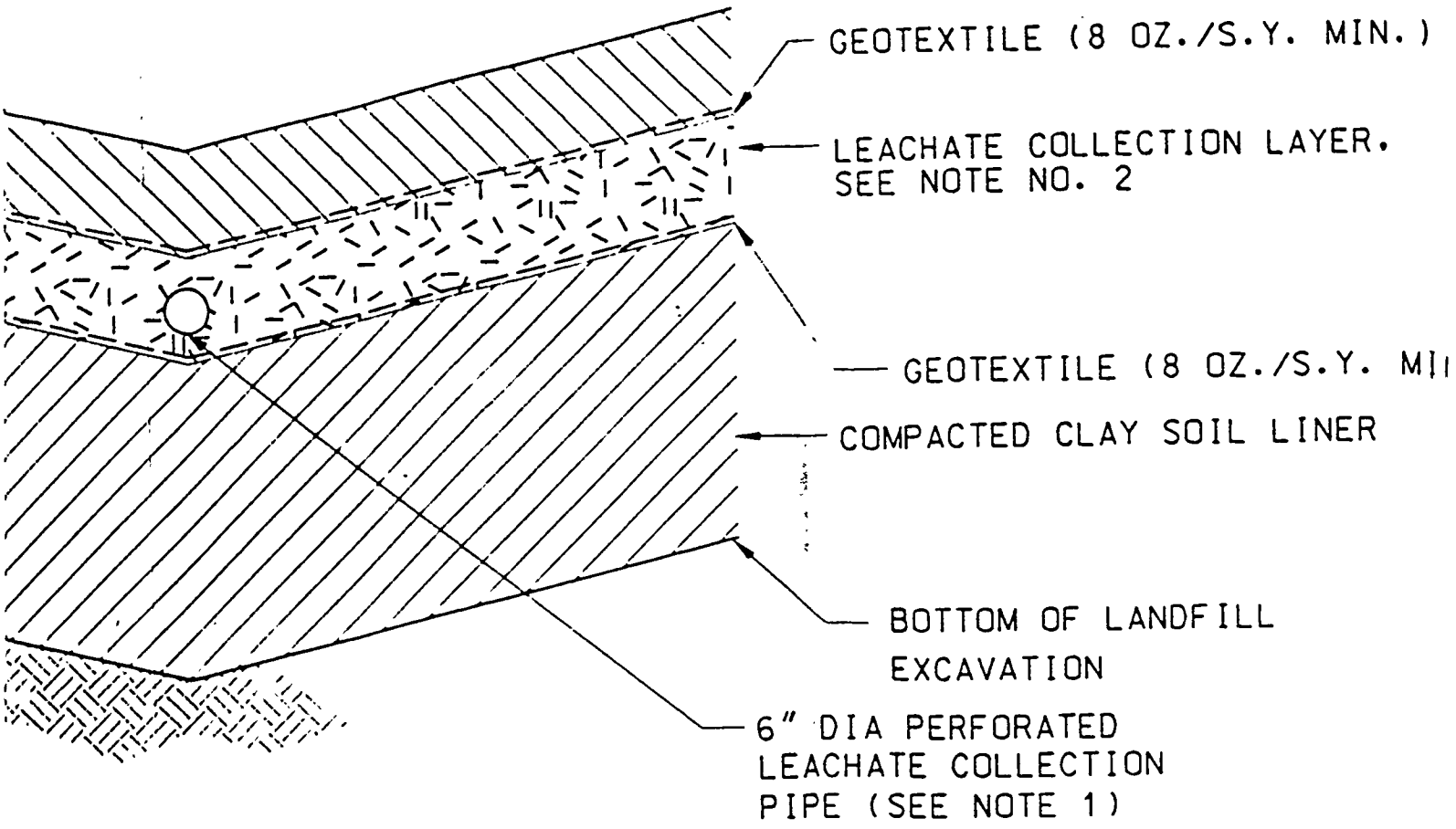
— 6" DIA PERFORATED
LEACHATE COLLECTION
PIPE (SEE NOTE 3)



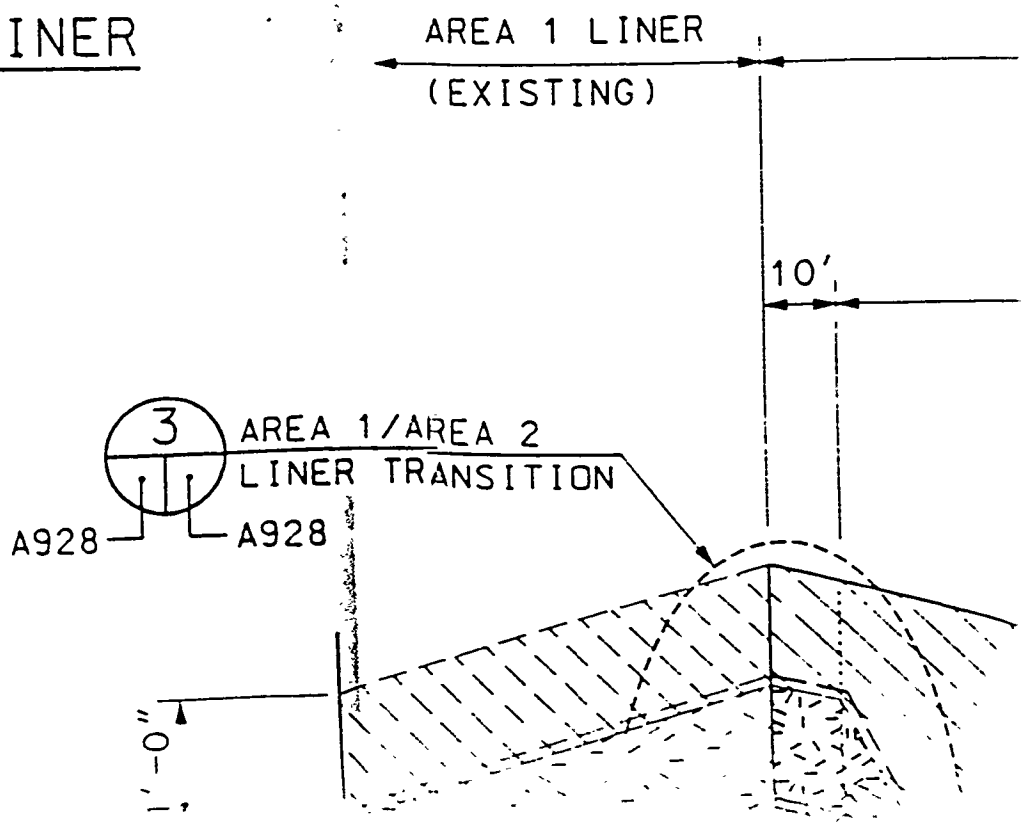
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DETAIL 1
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-- PROTECTIVE SOIL COVER



CTED CLAY SOIL LINER



. MIN.)

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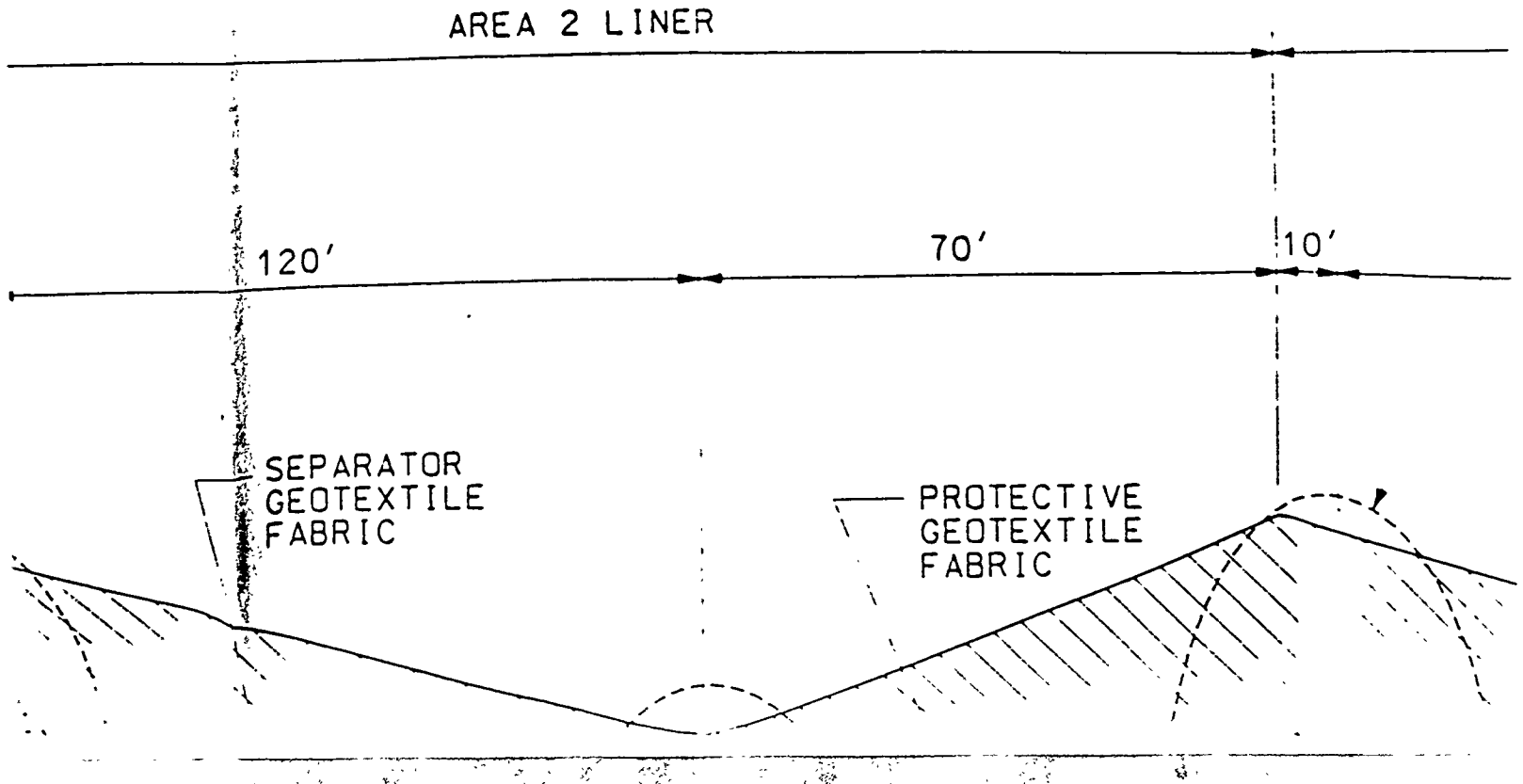
/S.Y. MIN.)

.INER

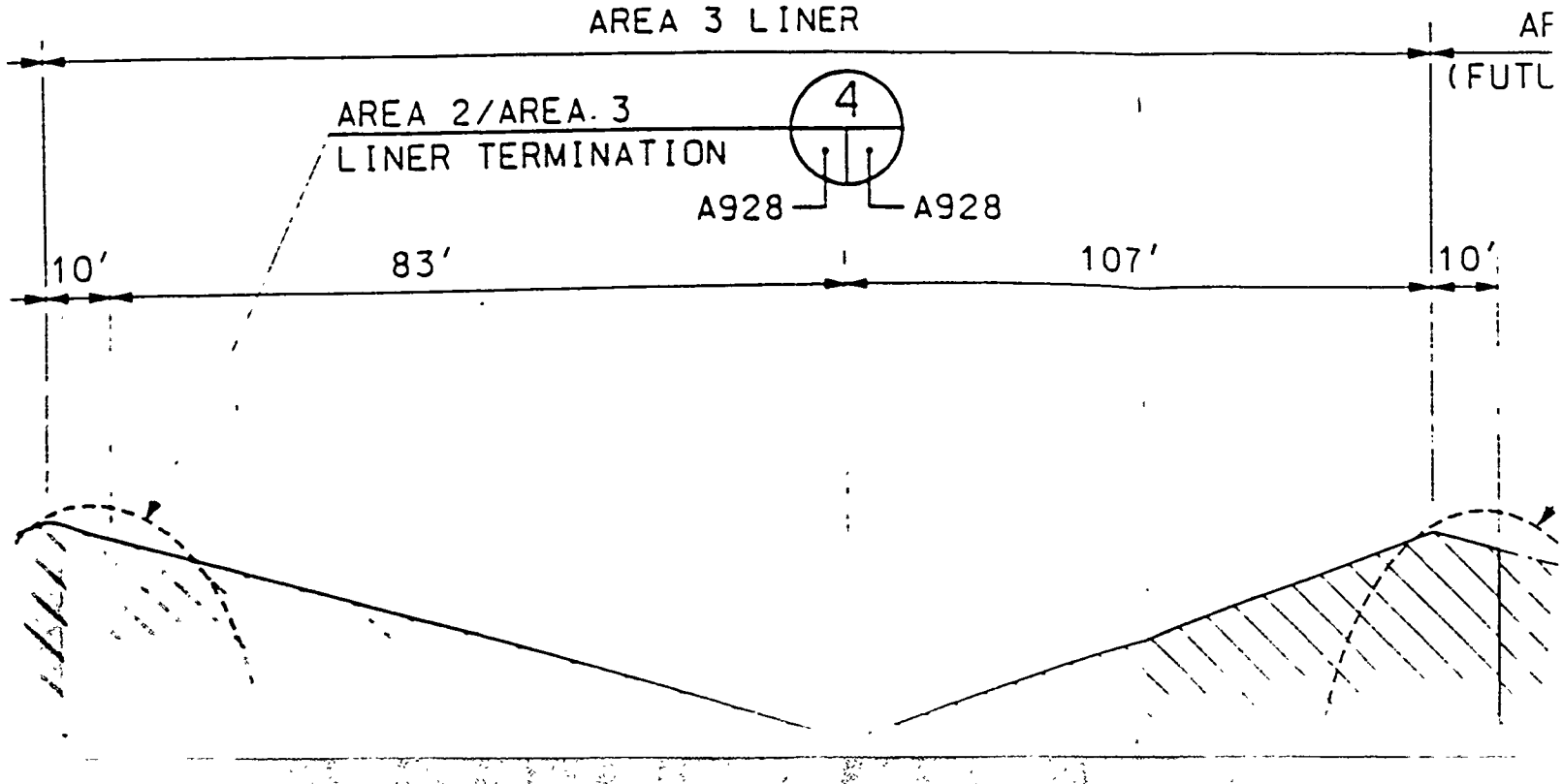
NOTES:

1. LONGITUDINAL SLOPE OF 6" DIA PERFORATED PVC PIPE IS THE SAME AS THE EXCAVATED GRADE. APPROXIMATELY 4.4%
2. GRANULAR MATERIAL USED FOR LEACHATE COLLECTION LAYER SHALL BE CRUSHED LIMESTONE CONFORMING TO ASTM C33-#4 STONE AND HAVING THE FOLLOWING GRADATION:

SIEVE SIZE	% PASSING
2"	100
1 1/2"	90-100
1"	20-55
3/4"	0-10
NO. 4	0-5



3 | 2


AREA 3 LINER
AF
(FUTL
AREA 2/AREA 3
LINER TERMINATION
4
A928
A928
10'
83'
107'
10'

2

NEXT ASS'Y:

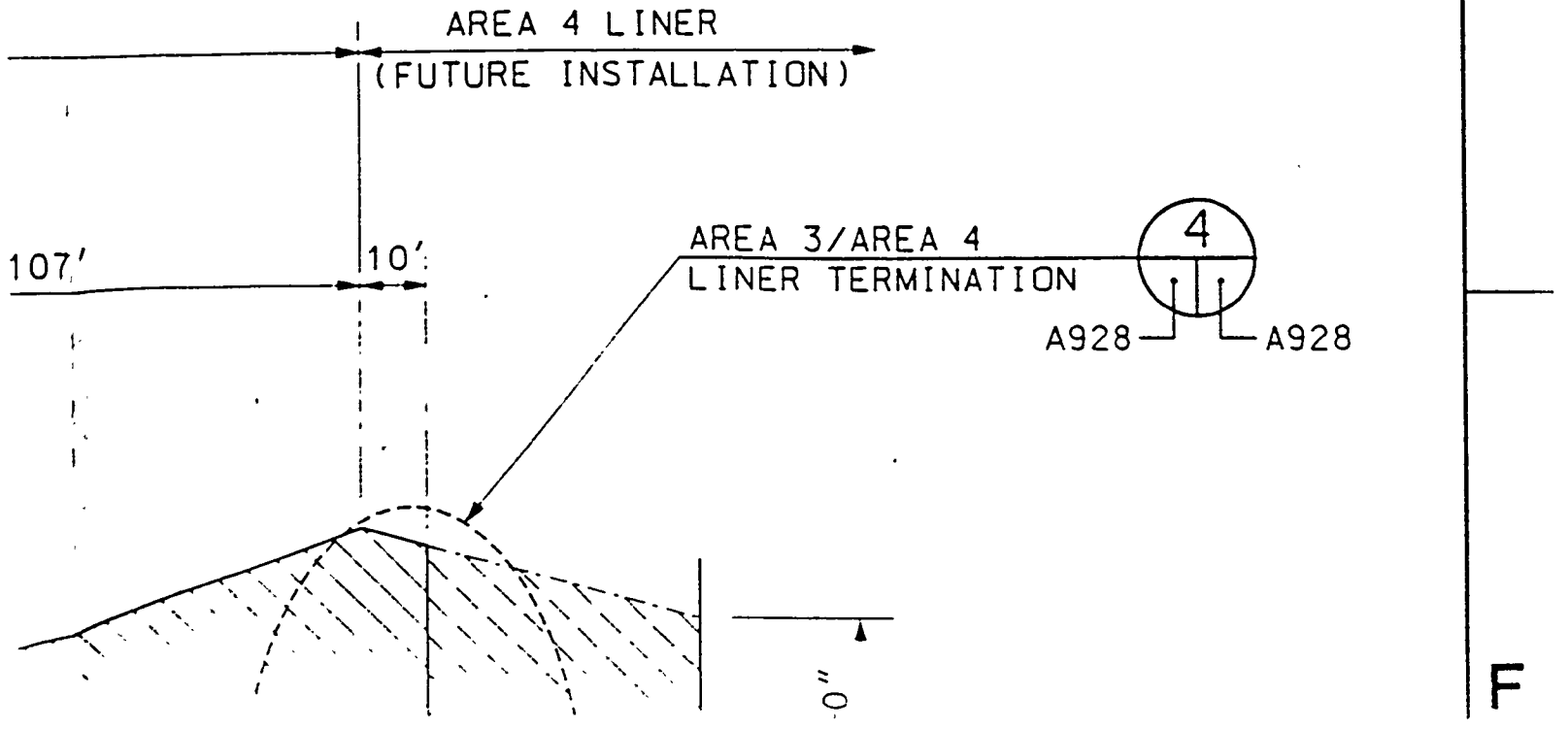
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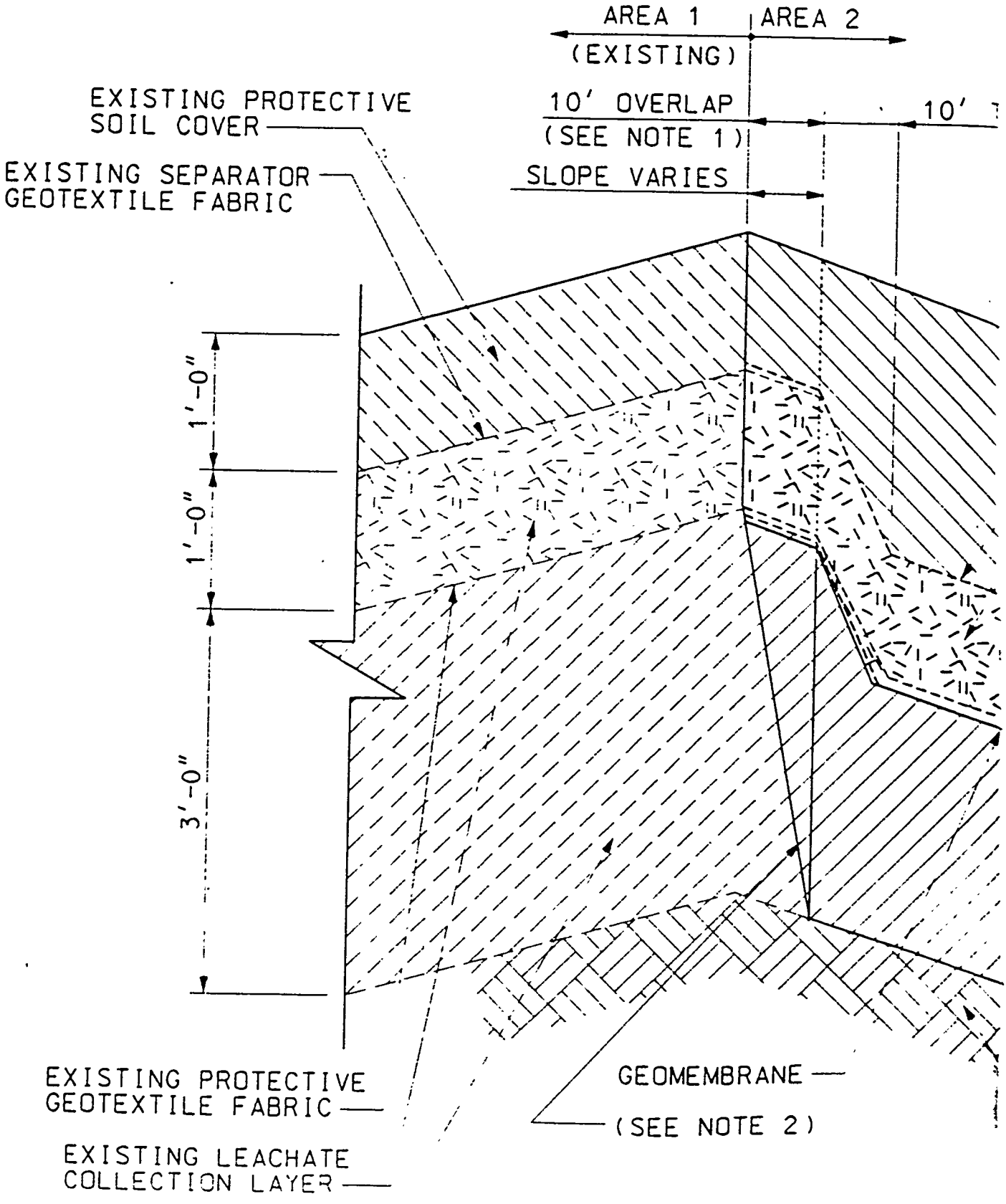
FINAL ASS'Y:

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G

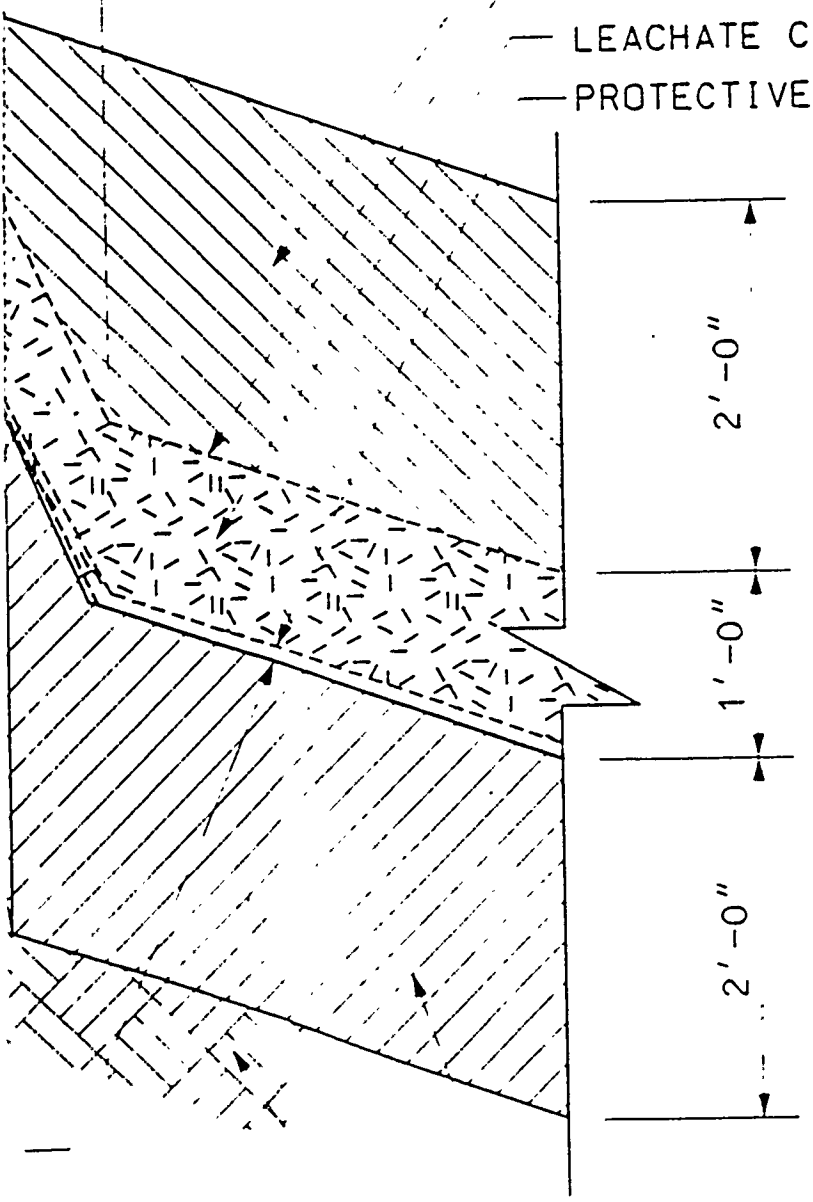
F




AREA 1
AREA 2
(EXISTING)
10' OVERLAP
(SEE NOTE 1)
10'
SLOPE VARIES
EXISTING PROTECTIVE SOIL COVER
EXISTING SEPARATOR GEOTEXTILE FABRIC
1'-0"
1'-0"
3'-0"
EXISTING PROTECTIVE GEOTEXTILE FABRIC
EXISTING LEACHATE COLLECTION LAYER
GEOMEMBRANE
(SEE NOTE 2)

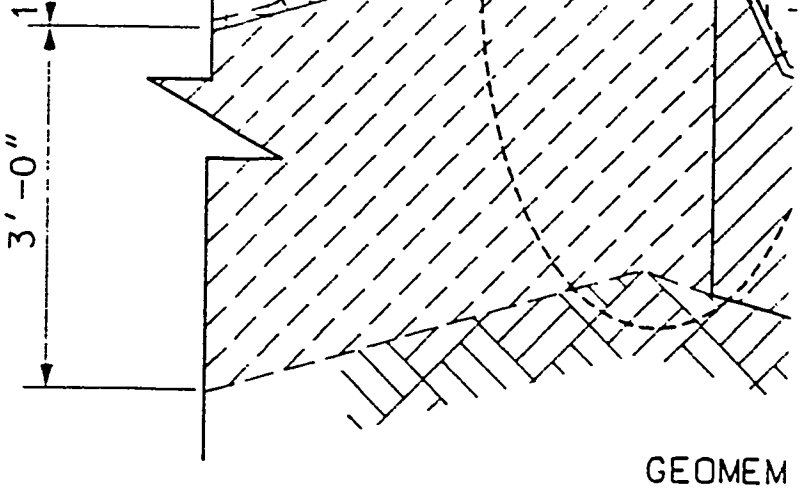
2

10' TRANSITION



SEPAR

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GEOMEM

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L

C

1 LANDFILL

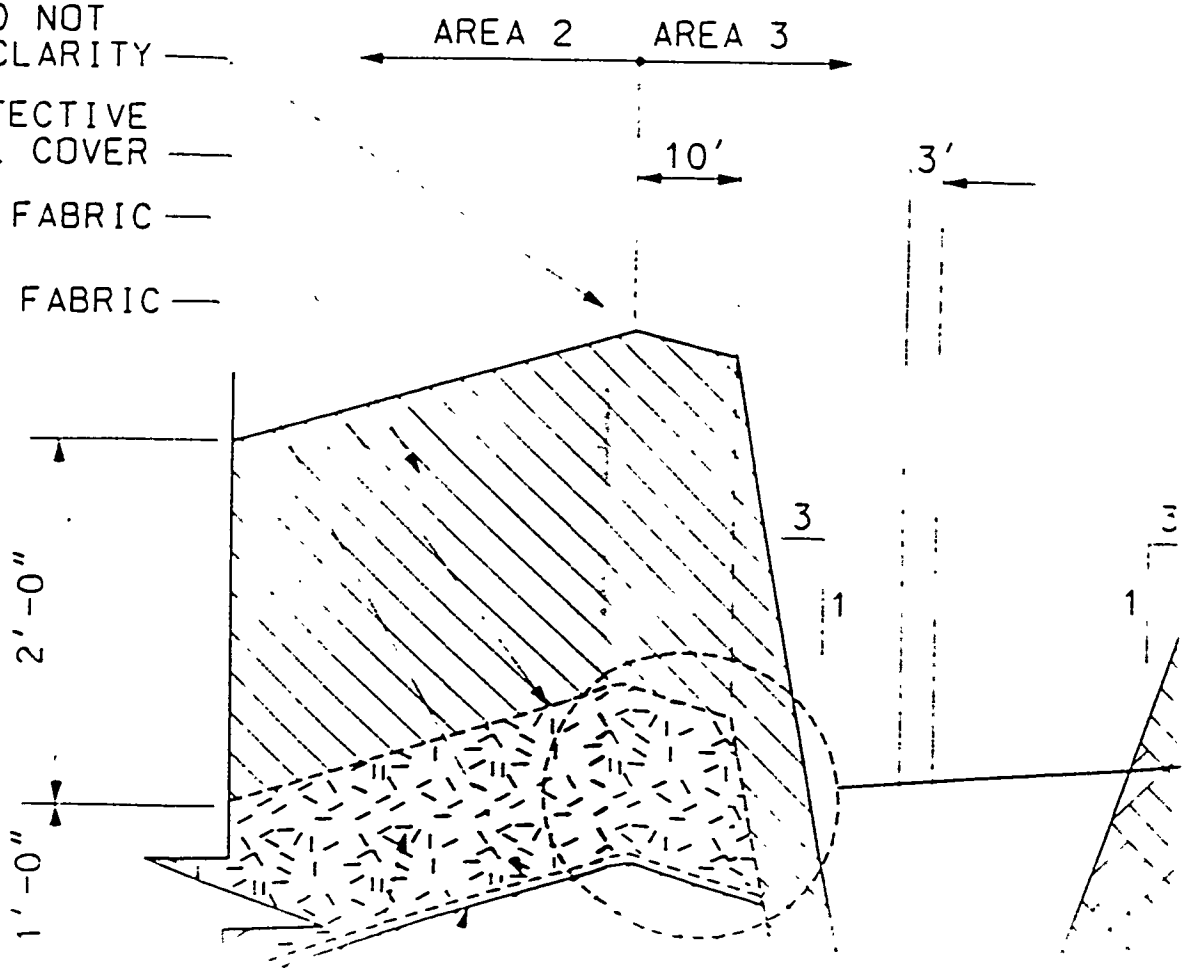
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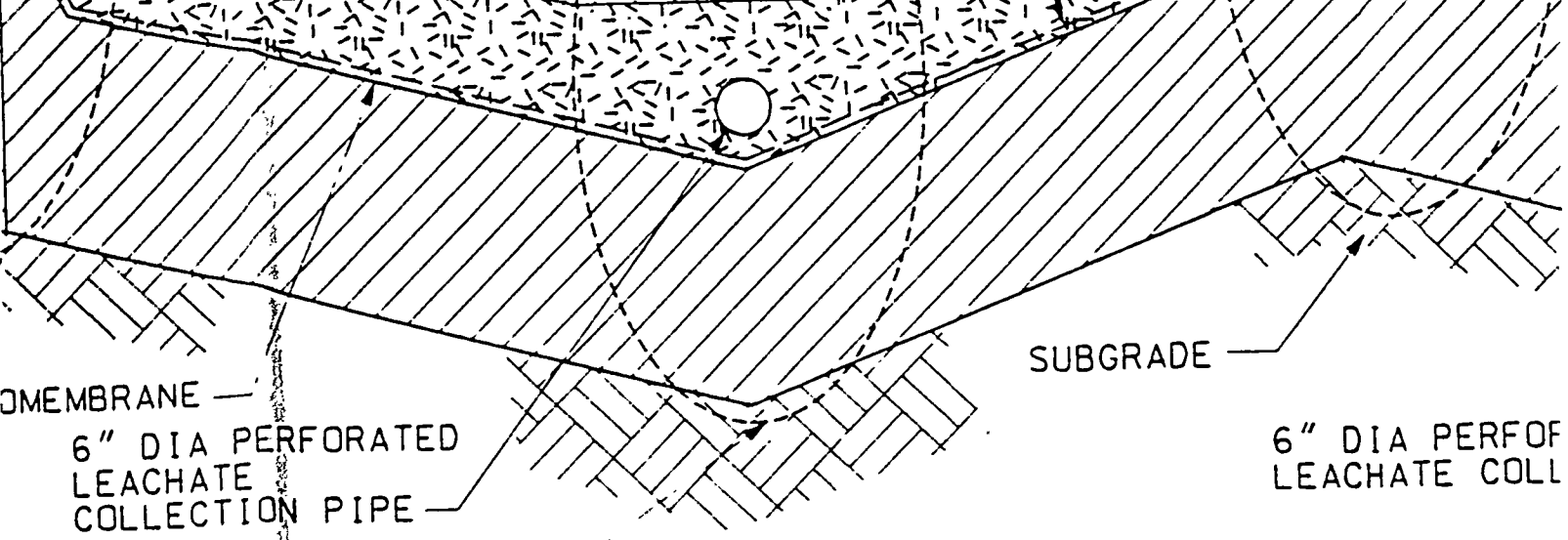
ACCESS ROAD NOT SHOWN FOR CLARITY

PROTECTIVE SOIL COVER

ARATOR GEOTEXTILE FABRIC

TECTIVE GEOTEXTILE FABRIC





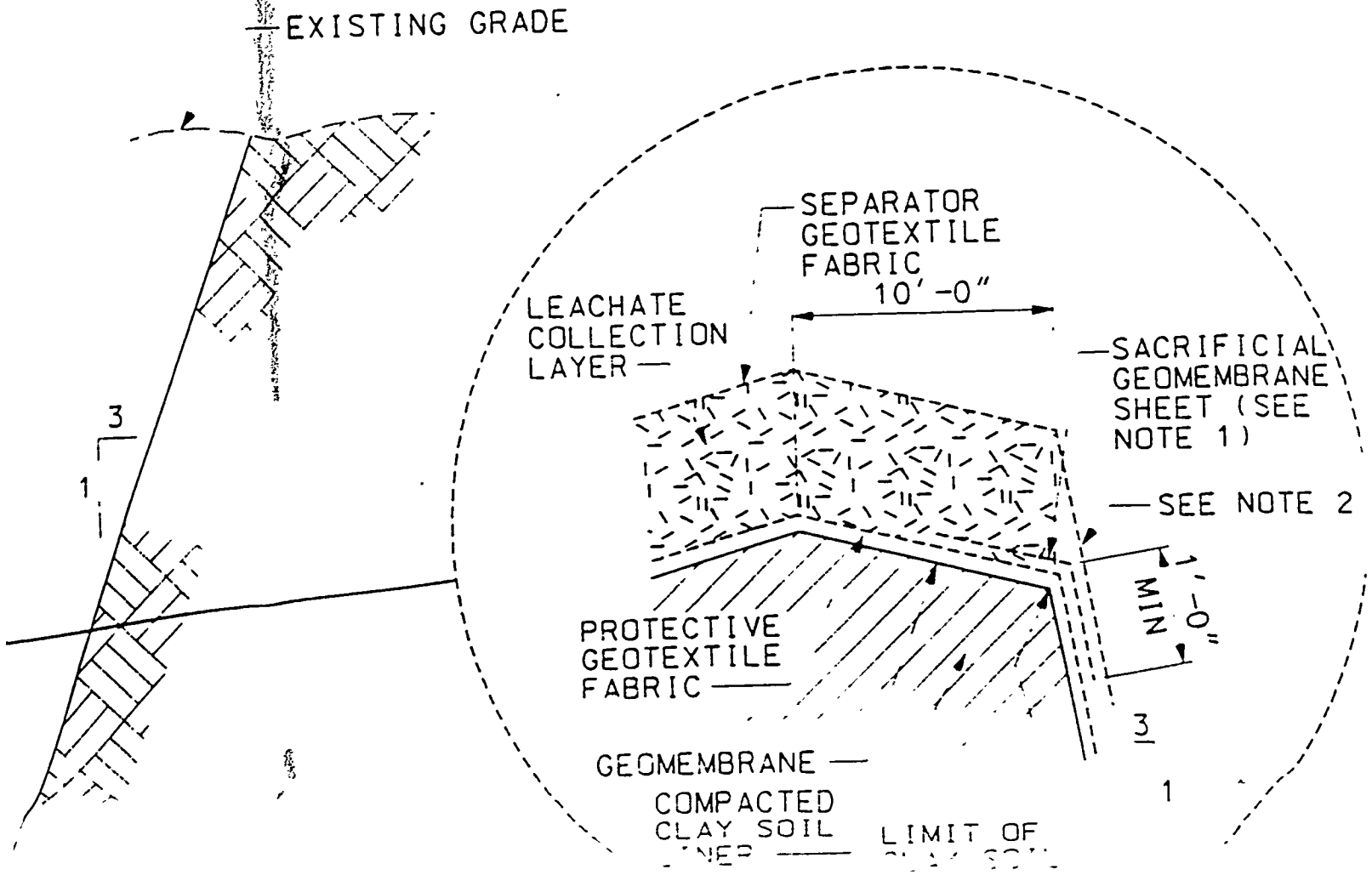
FILL CROSS SECTION

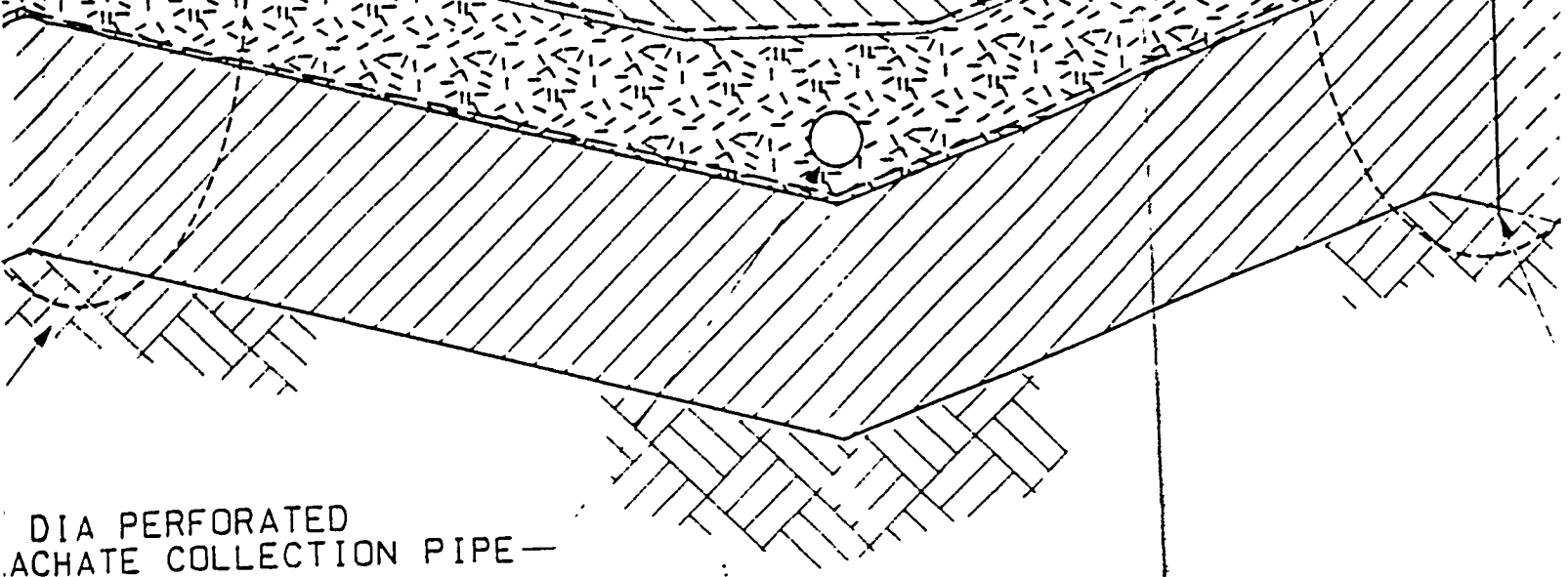
LINER PHASING - AREA 2

DETAIL

NOT TO SCALE

AS
AS

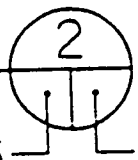




DIA PERFORATED
ACHATE COLLECTION PIPE—

LINER PHASING - AREA 3

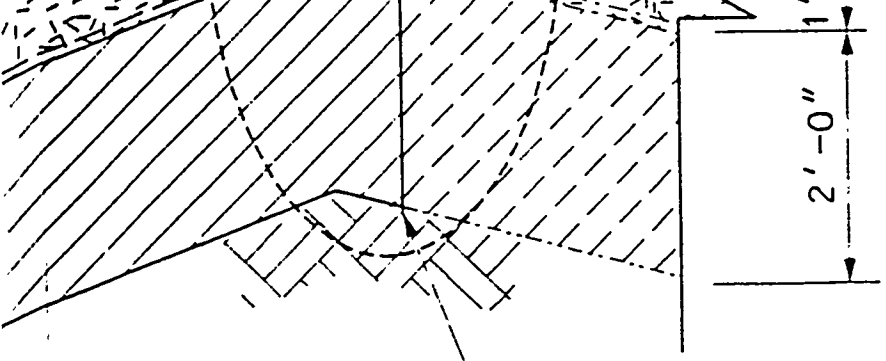
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CRIFICIAL
OMEMBRANE
EET (SEE
ITE 1)

SEE NOTE 2

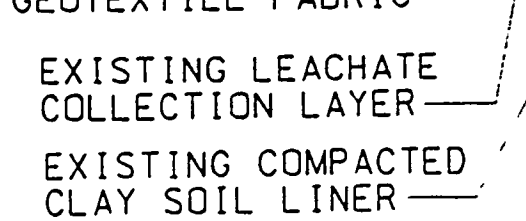


LIMIT OF COMPACTED CLAY SOIL LINER, LEACHATE COLLECTION LAYER AND PROTECTIVE SOIL COVER INSTALLATION FOR AREA 3.

AREA 3

E

D



LINER TRANSITION NOTES:

1. REMOVE EXISTING 1'-0" PROTECTIVE EXISTING 1'-0" LEACHATE COLLECT AREA 2 TO THE LIMITS SHOWN AND AND PROTECTIVE GEOTEXTILE FABRI PROTECTIVE GEOTEXTILE FABRIC. RE LAYER AND INSTALL SEPARATOR GEO EXISTING AND NEW SEPARATOR GEOT: PROTECTIVE SOIL COVER. INSTALL

2. A PORTION OR ALL OF SOIL WITHIN REQUIRE REMOVAL AS DETERMINED B' CONTRACTOR SHALL NOT REMOVE THE THE LIMITS OF AREA 2.

AREA 1/AREA 2 LINE

DETAIL

NOT TO SCALE

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Guideline Doc
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NUMBER OF

— COMPACTED CLAY SOIL LINER

— SUBGRADE

ON NOTES:

-0" PROTECTIVE SOIL COVER AND
CHATE COLLECTION LAYER LOCATED IN
TS SHOWN AND INSTALL GEOMEMBRANE
TEXTILE FABRIC. OVERLAP EXISTING AND NEW
ILE FABRIC. REPLACE LEACHATE COLLECTION
SEPARATOR GEOTEXTILE FABRIC. OVERLAP
EPARATOR GEOTEXTILE FABRIC. REPLACE
VER. INSTALL TEMPORARY SYNTHETIC COVER.

F SOIL WITHIN THE 10' OVERLAP MAY
DETERMINED BY THE FACILITIES MANAGER.
OT REMOVE THE CLAY SOIL LINER BEYOND
2.

REA 2 LINER TRANSITION

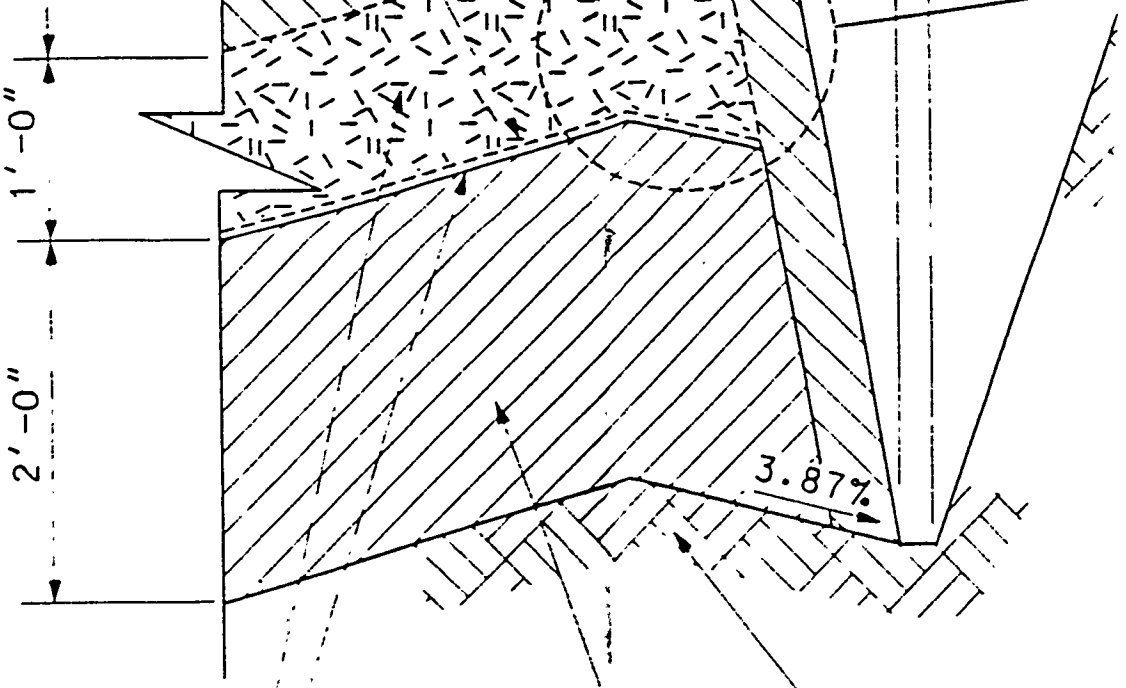
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EG-C-37 Review By: _____
Guideline Document: _____
UCN-19586 (12356 4-93)

THIS DOCUMENT



LEACHATE COLLECTION LAYER

GEOMEMBRANE

SUBGRADE

COMPACTED CLAY SOI

LINER TERMINATION NOTES:

1. EXTEND GEOMEMBRANE AND PROTECTIVE GEOTE 1'-0" MINIMUM BEYOND THE LIMIT OF COMPA LINER. PLACE A SACRIFICIAL GEOMEMBRANE MINIMUM) OVER THE PROTECTIVE GEOTEXTILE SEPARATOR GEOTEXTILE OVER THE SACRIFICI

2. WRAP SEPERATOR GEOTEXTILE FABRIC AROUND LEACHATE COLLECTION LAYER AND PROVIDE 1 MINIMUM OVERLAP WITH PROTECTIVE GEOTEXT

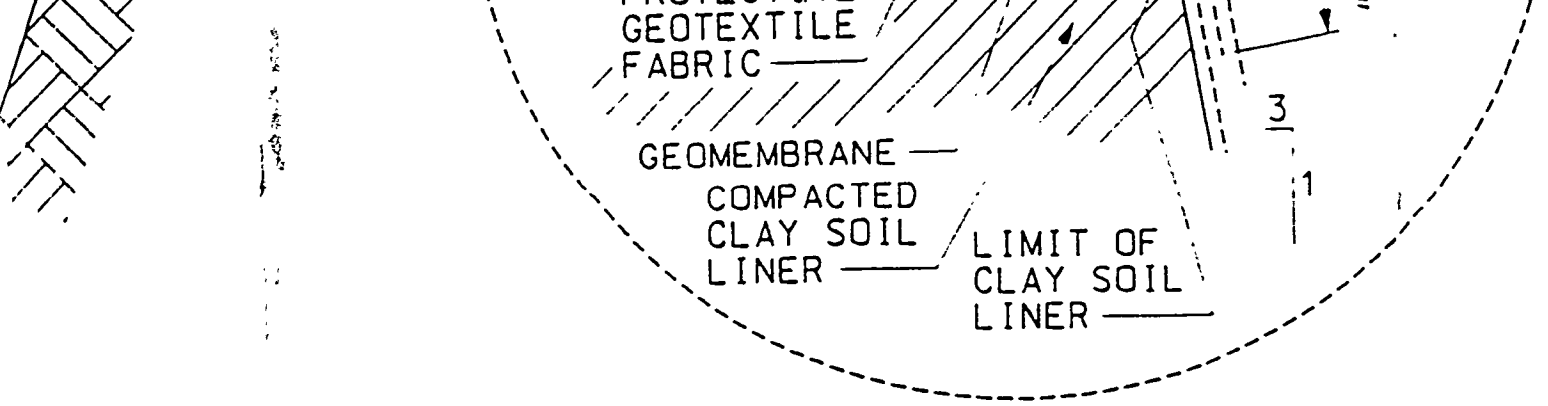
AREA 2/AREA 3 LINER TERMIN
AREA 3/AREA 4 LINER TERMIN

DETAIL

NOT TO SCALE

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DIL LINER

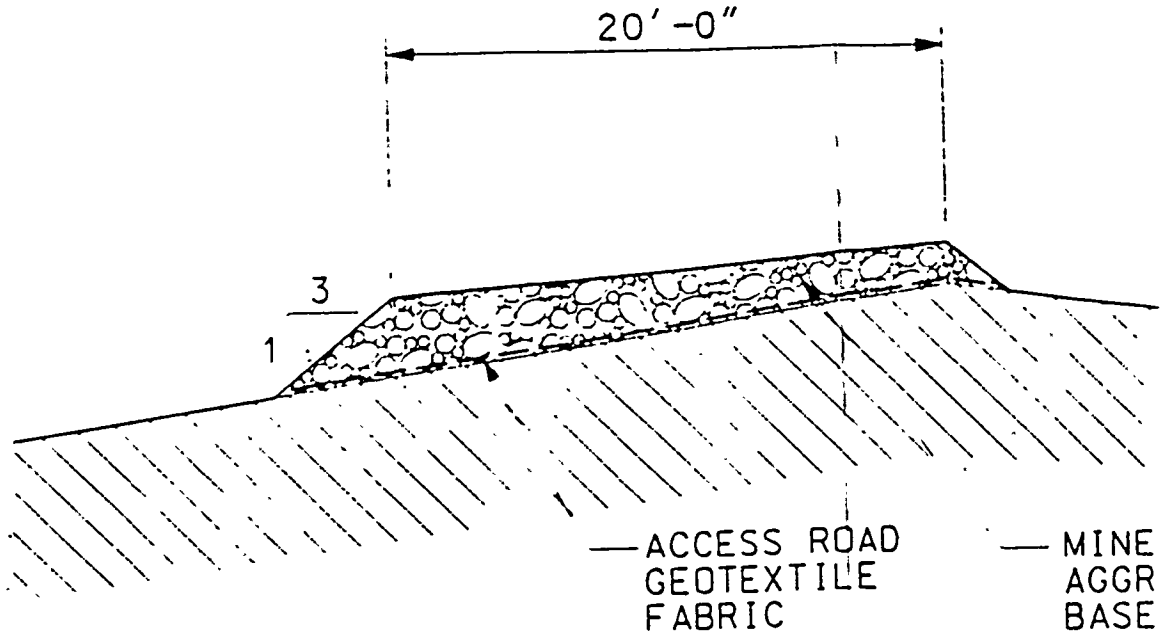
EXTILE FABRIC
PACTED CLAY SOIL
E SHEET (4'-0" WIDE
LE AS SHOWN. LAP
CIAL GEOMEMBRANE SHEET.

ND
1'-0"
TILE FABRIC.

NATION
NATION

3

1



LANDFILL ACCESS ROAD

DETAIL

NOT TO SCALE

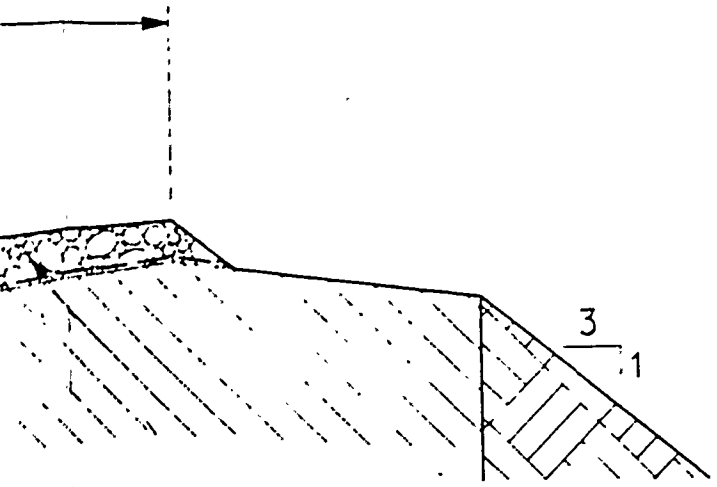
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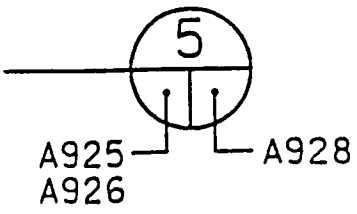
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	DRW	8/19/95	
	CHKR W P Taylor	8/19/95	
	SECT		Y
	DEPT	8/19/95	
	PE		
	PJ	8/24/95	
	REQ		

WILLIAM PATRICK TAYLOR
REGISTERED ENGINEER
AGRICULTURE
No. 18,885
STATE OF TENNESSEE



ROAD
TILE
MINERAL
AGGREGATE
BASE

ESS ROAD



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	8/19/95
	8/19/95
Taylor	8/19/95
L Cund	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

LANDFILL DETAILS - V

1. REMOVE EXISTING 1'-0" PROTECTIVE
EXISTING 1'-0" LEACHATE COLLECT.
AREA 2 TO THE LIMITS SHOWN AND
AND PROTECTIVE GEOTEXTILE FABRIC
PROTECTIVE GEOTEXTILE FABRIC. RE
LAYER AND INSTALL SEPARATOR GEO
EXISTING AND NEW SEPARATOR GEOTE
PROTECTIVE SOIL COVER. INSTALL

2. A PORTION OR ALL OF SOIL WITHIN
REQUIRE REMOVAL AS DETERMINED BY
CONTRACTOR SHALL NOT REMOVE THE
THE LIMITS OF AREA 2.

AREA 1/AREA 2 LINE

DETAIL

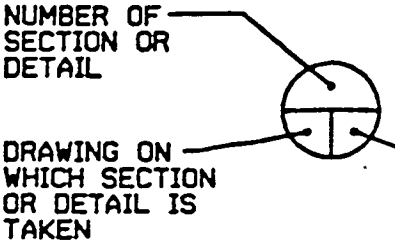
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SECTION AND DETAIL KEY

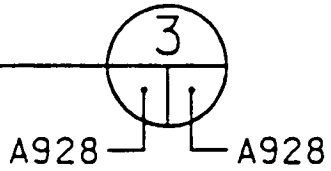
-0" PROTECTIVE SOIL COVER AND
CHATE COLLECTION LAYER LOCATED IN
TS SHOWN AND INSTALL GEOMEMBRANE
TEXTILE FABRIC. OVERLAP EXISTING AND NEW
ILE FABRIC. REPLACE LEACHATE COLLECTION
SEPARATOR GEOTEXTILE FABRIC. OVERLAP
EPARATOR GEOTEXTILE FABRIC. REPLACE
VER. INSTALL TEMPORARY SYNTHETIC COVER.

F SOIL WITHIN THE 10' OVERLAP MAY
DETERMINED BY THE FACILITIES MANAGER.
OT REMOVE THE CLAY SOIL LINER BEYOND
2.

REA 2 LINER TRANSITION

TAIL

TO SCALE



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EG-C-37 Review By: _____
Guideline Document: _____
UCN-19586 (12356 4-93)

DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

DETAIL KEY

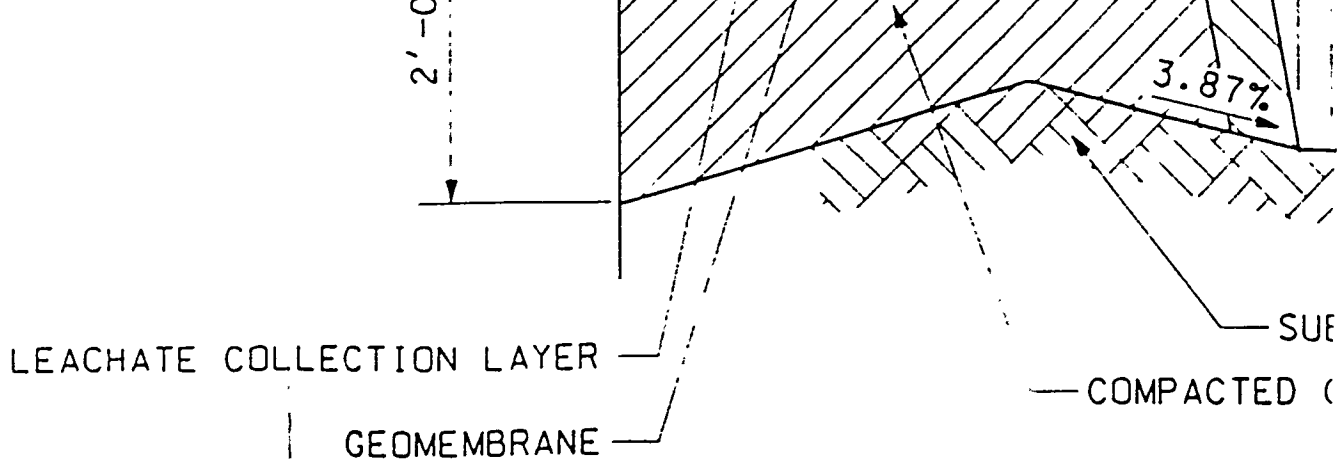
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CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	REVISION
0				ISSUE FOR PEF

7 6



LINER TERMINATION NOTES:

1. EXTEND GEOMEMBRANE AND PROTECTIVE 1'-0" MINIMUM BEYOND THE LIMIT OF LINER. PLACE A SACRIFICIAL GEOMEMBRANE (MINIMUM) OVER THE PROTECTIVE GEOMEMBRANE. SEPARATOR GEOTEXTILE OVER THE SA

2. WRAP SEPERATOR GEOTEXTILE FABRIC OVER LEACHATE COLLECTION LAYER AND PROVIDE MINIMUM OVERLAP WITH PROTECTIVE

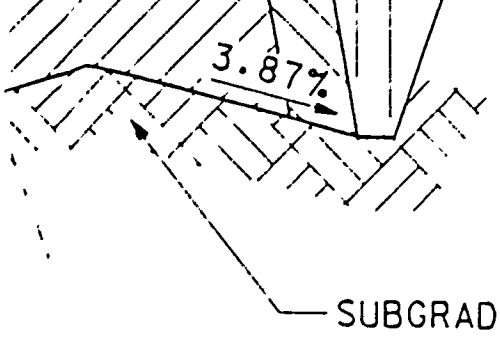
AREA 2/AREA 3 LINER T
AREA 3/AREA 4 LINER T

DETAIL

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DESCRIPTION	BY	CHK	SECT	DEPT	DATE	PE	REQ	DAT
ISSUE FOR PERMITTING	JGA	WPT	—	WLL	6MKR			
REVISION OR ISSUE PURPOSE								REVIS



SUBGRADE

COMPACTED CLAY SOIL LINER

ATION NOTES:

ANE AND PROTECTIVE GEOTEXTILE FABRIC
EYOND THE LIMIT OF COMPACTED CLAY SOIL
SACRIFICIAL GEOMEMBRANE SHEET (4'-0" WIDE
HE PROTECTIVE GEOTEXTILE AS SHOWN. LAP
XTILE OVER THE SACRIFICIAL GEOMEMBRANE SHEET.

GEOTEXTILE FABRIC AROUND
TION LAYER AND PROVIDE 1'-0"
WITH PROTECTIVE GEOTEXTILE FABRIC.

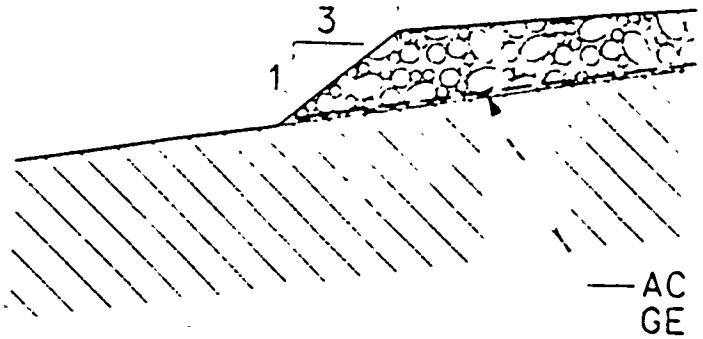
A 3 LINER TERMINATION
A 4 LINER TERMINATION

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REVISION APPROVALS



LANDFILL A

DETAIL

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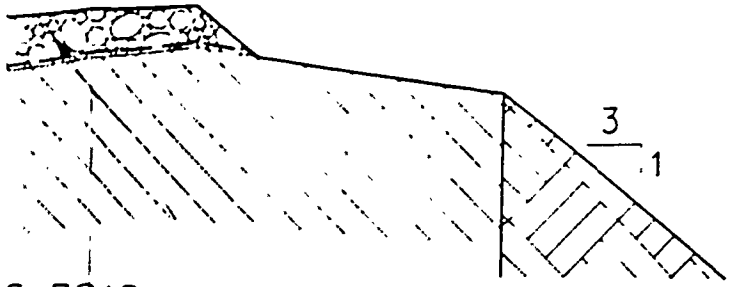
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WILLIAM PATRICK TAYLOR
REGISTERED ENGINEER
AGRICULTURE
No. 21,176
STATE OF TENNESSEE

REV. 0 DATE 8/19/95

DRAWING APPROVALS

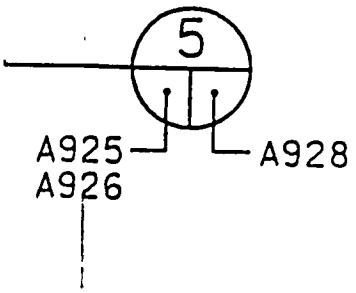
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S ROAD
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BASE

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	8/19/95
	8/19/95
Taylor	8/19/95
	8/19/95
	8/28/95

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Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

LANDFILL DETAILS - V

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U

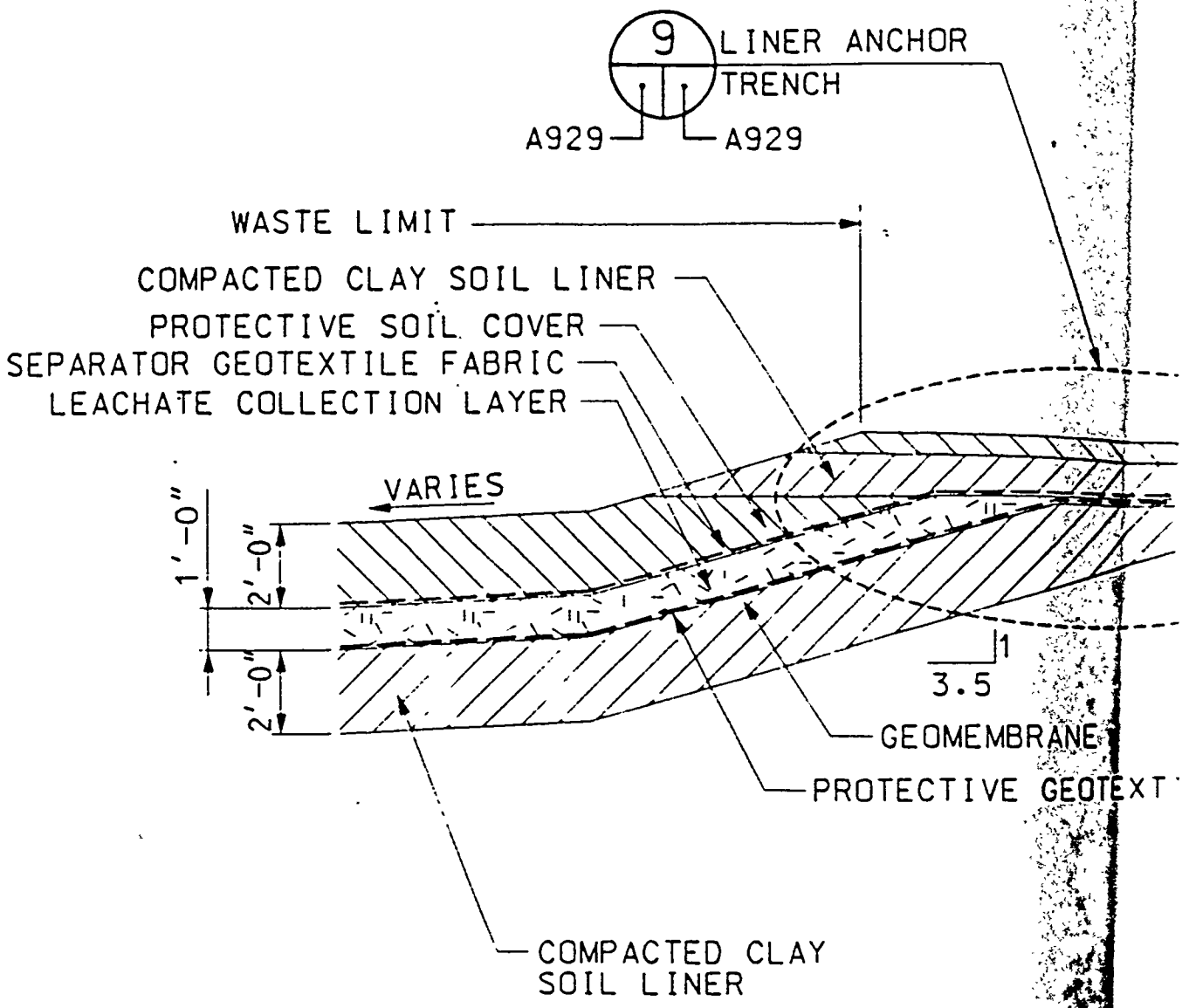
51	52	53		REV
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SCALE: 3/64"=1'

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DATE: 4-19-1995

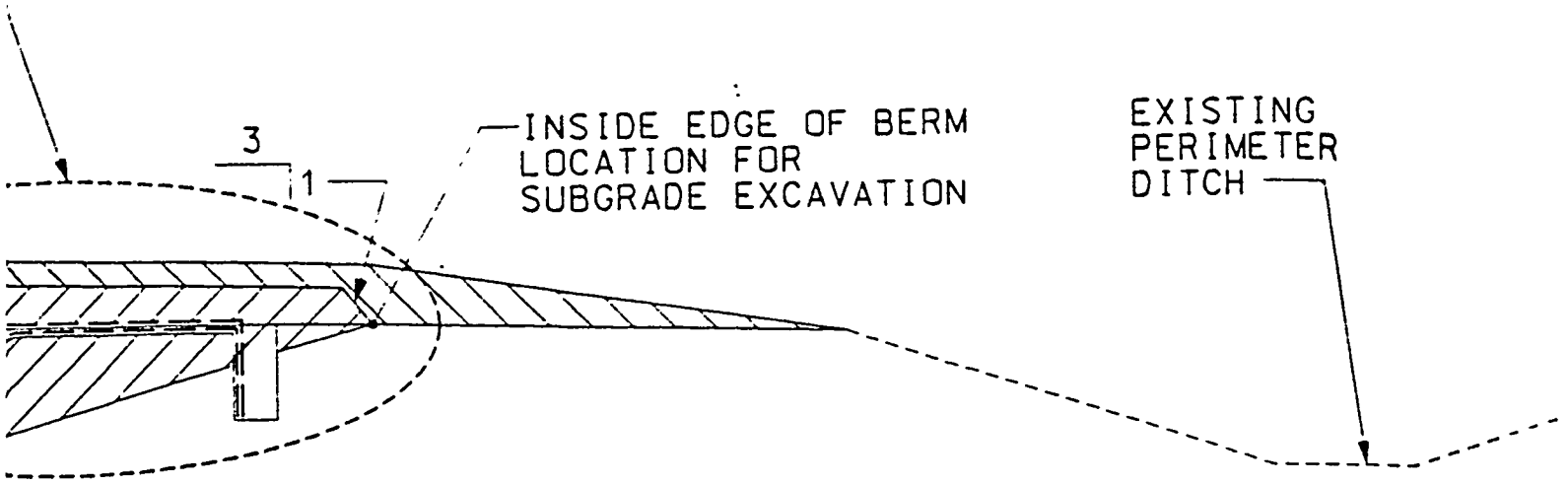


COMPOSITE CLAY LINE

DETAI

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12'-3"



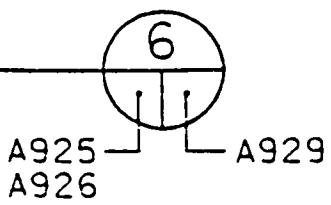
:ANE

GEOTEXTILE FABRIC

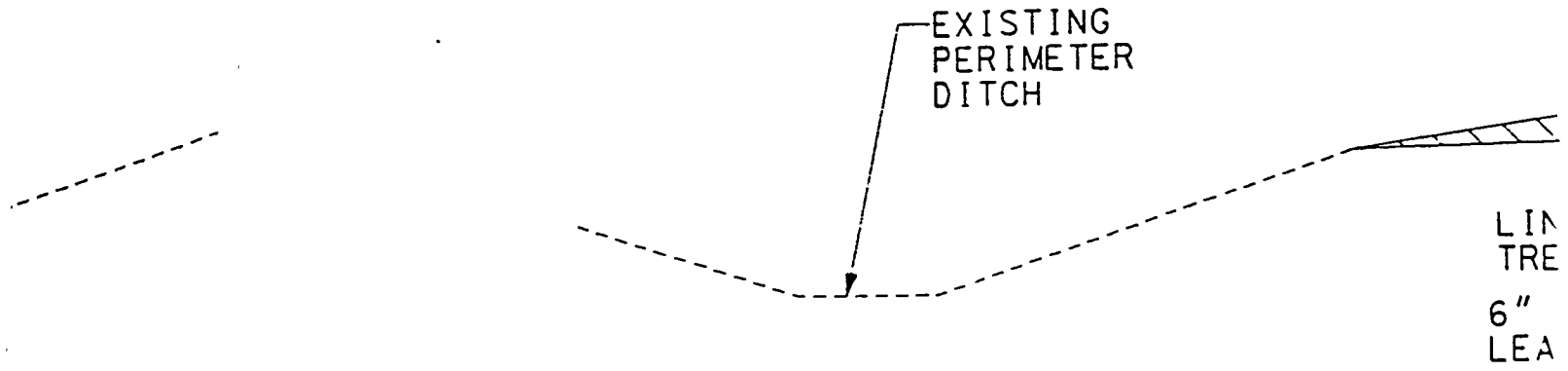
LINER PERIMETER SECTION

)ETAIL

OT TO SCALE



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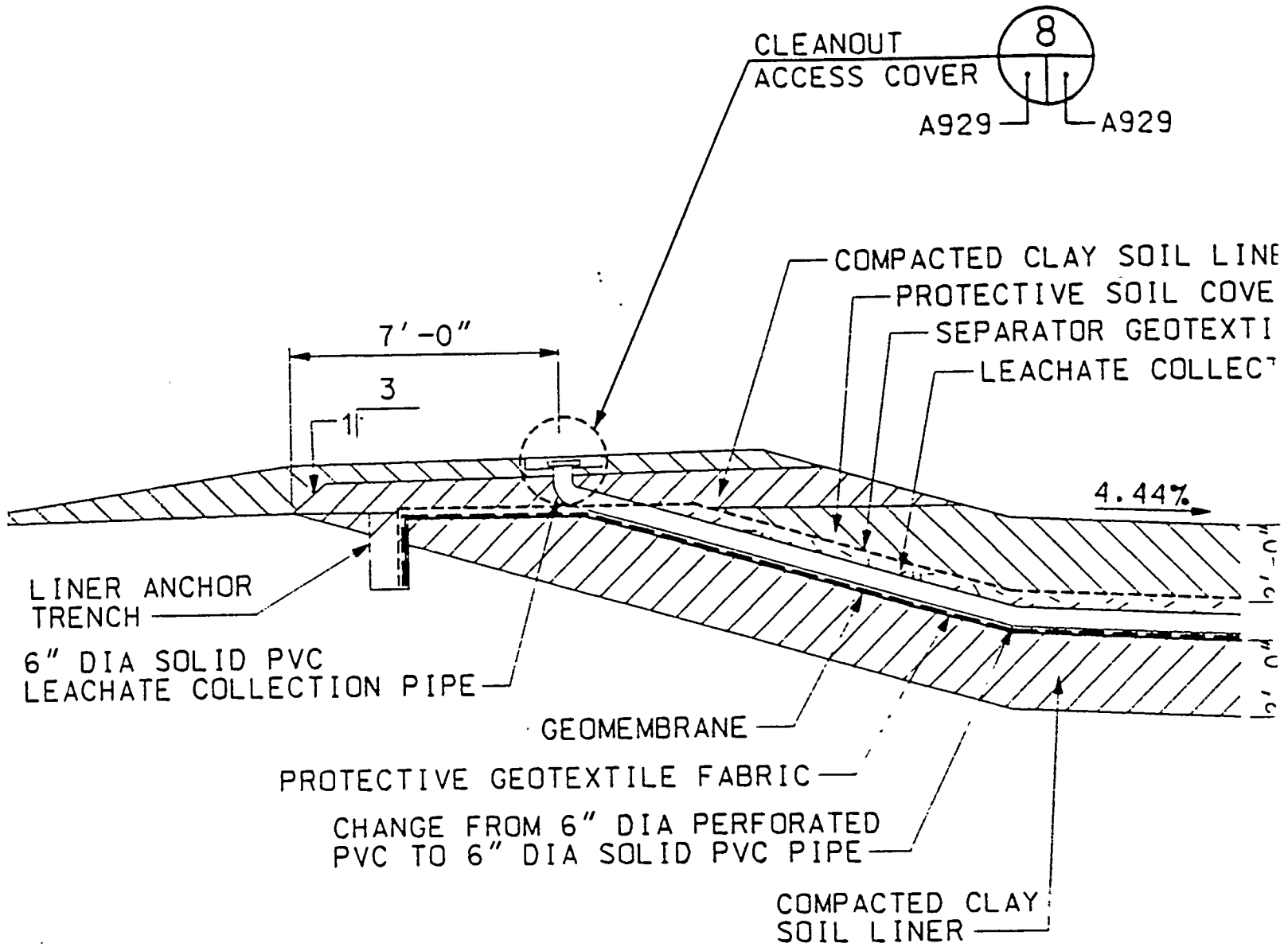


LEACHATE CO

D

NO

- LIMIT OF SOLID WASTE



COLLECTION PIPE CLEANOUT DETAIL

NOT TO SCALE

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STAI

4" DIA SCHE
STAINLESS S

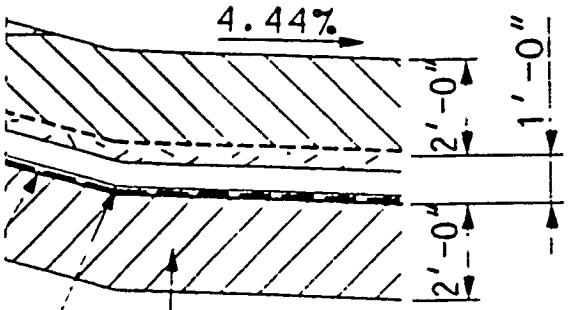
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STE

FINAL GRADE

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ICTED CLAY SOIL LINER
ROTECTIVE SOIL COVER
-SEPARATOR GEOTEXTILE FABRIC
LEACHATE COLLECTION LAYER



D CLAY
IER

2'
COI

NEENAH R-1792-AL
FRAME OR EQUAL A

FERNCO QWIK CAP QC1C
OR EQUAL AS A MINIML

EXCAVATE SOIL FRON
AROUND PIPE ENDS

6" DIA SOLI
LEACHATE CC

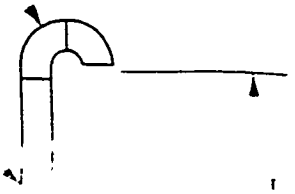
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2 - 4" DIA SCHEDULE 40S
STAINLESS STEEL 90° BENDS

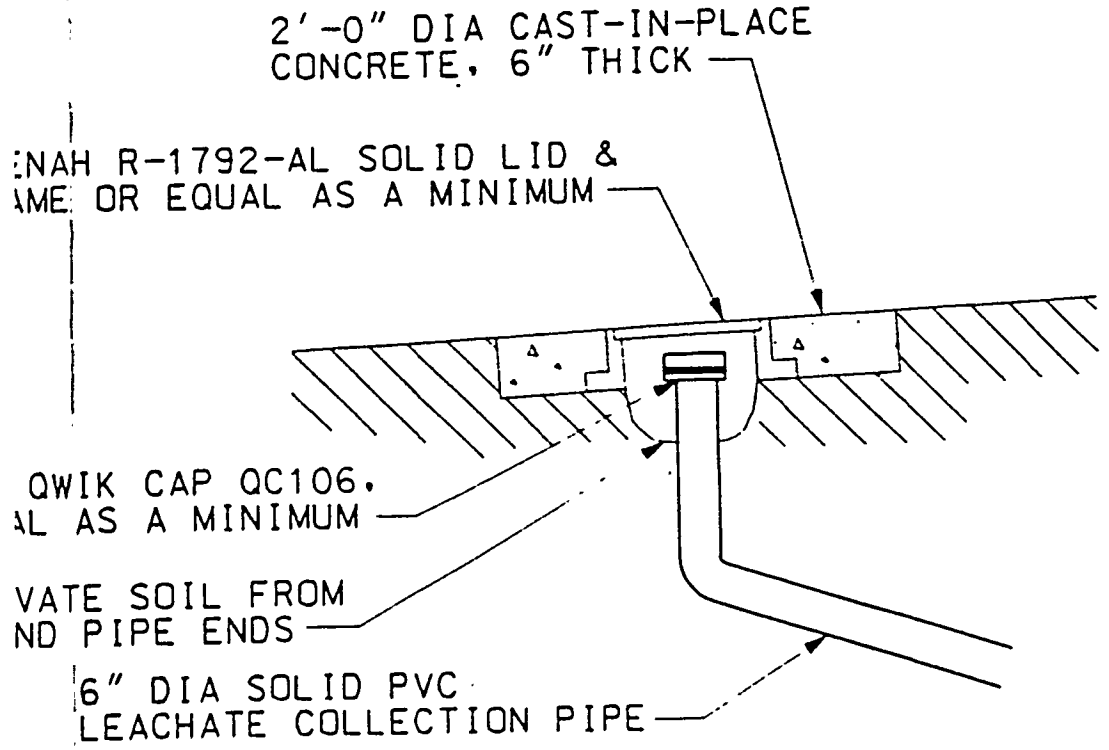
4" DIA SCHEDULE 40S
STAINLESS STEEL RISER PIPE



NAL GRADE

NEXT ASS'Y:

FINAL ASS'Y:



CLEANOUT ACCESS COVER DETAIL

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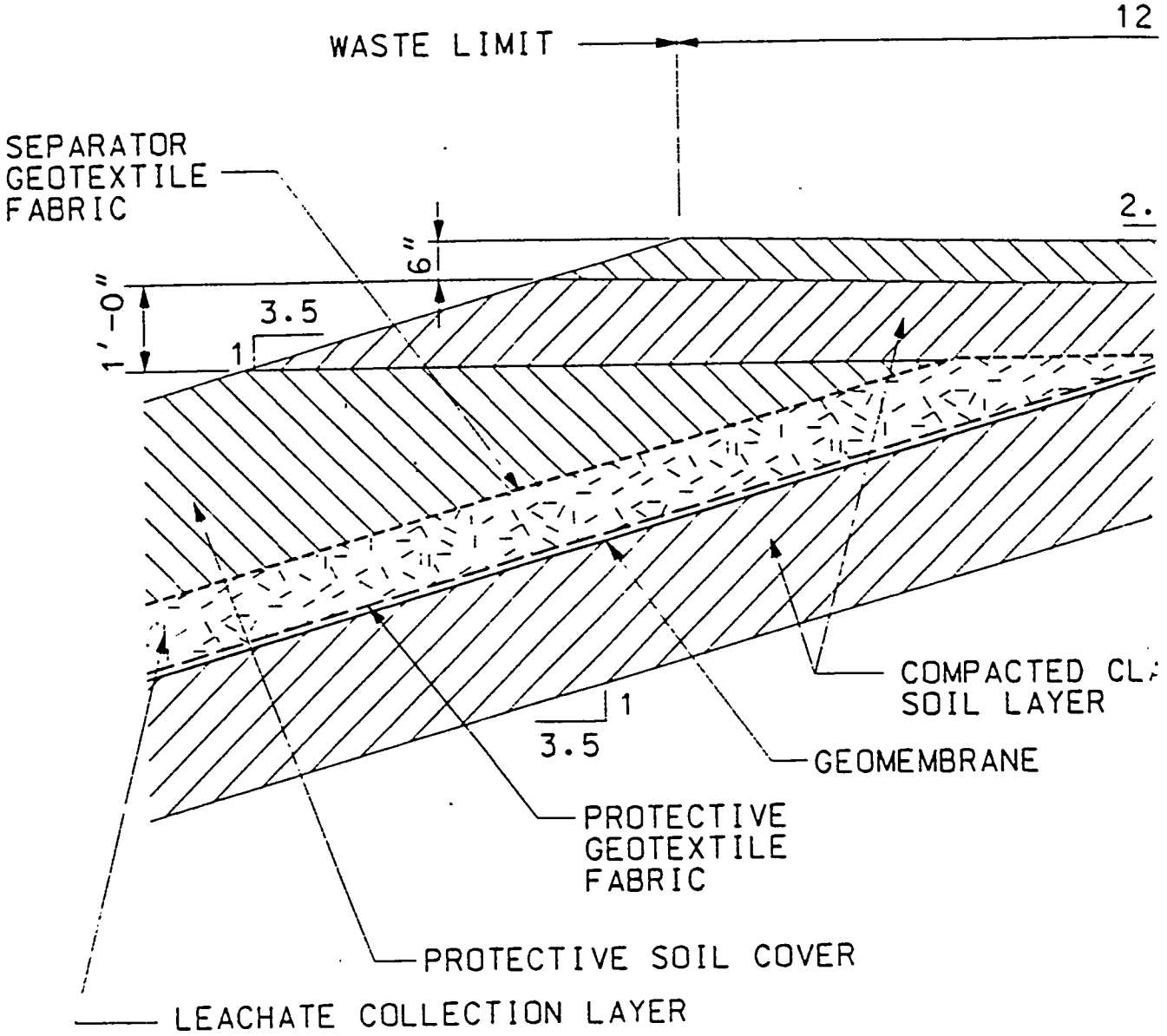
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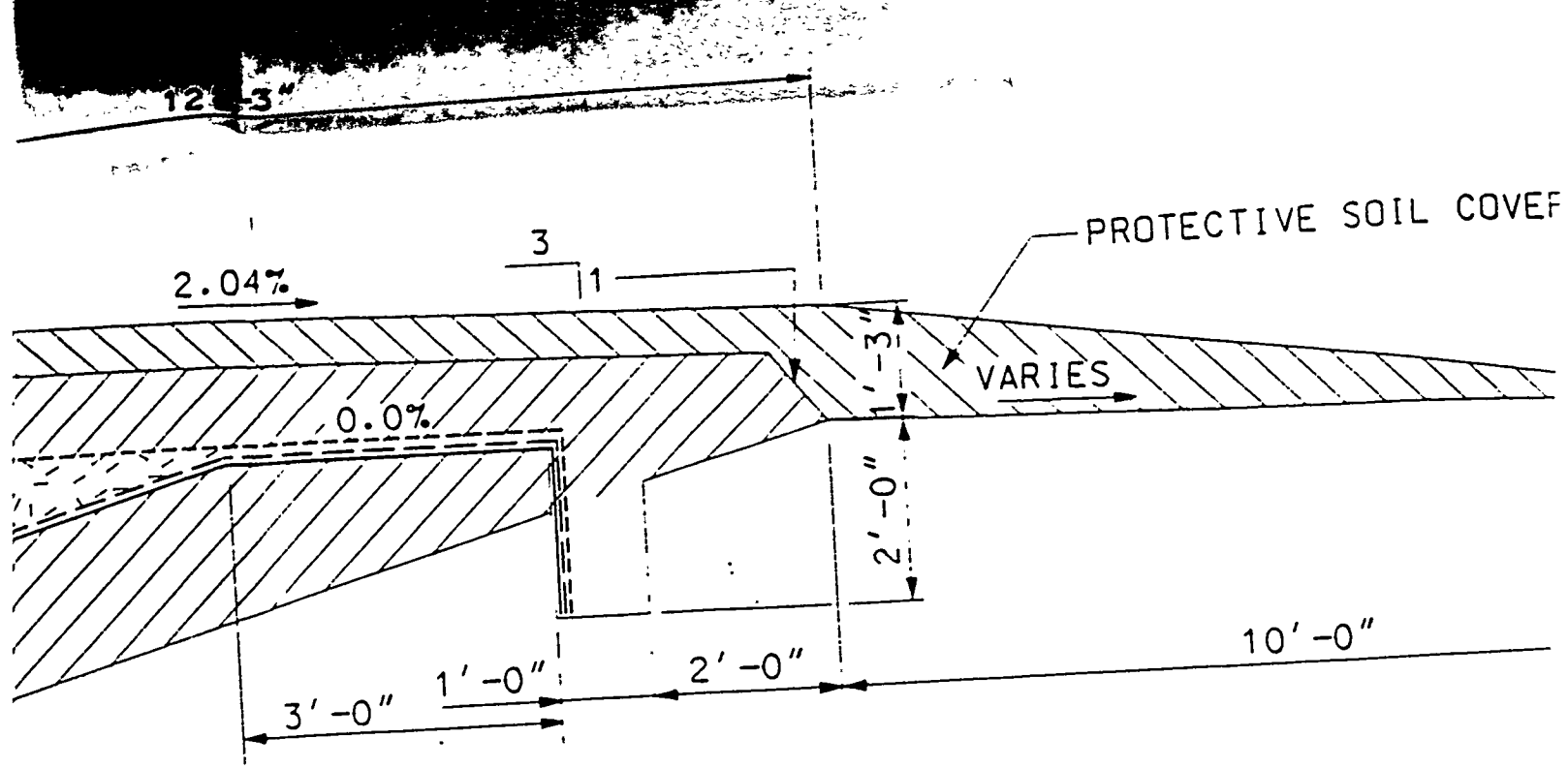


6" DIA PERFORATED PVC PIPE @ 4.44%

A

PVC PIPE CONNECTION

PROTECTIVE



IPACTED CLAY
IL LAYER

IRANE

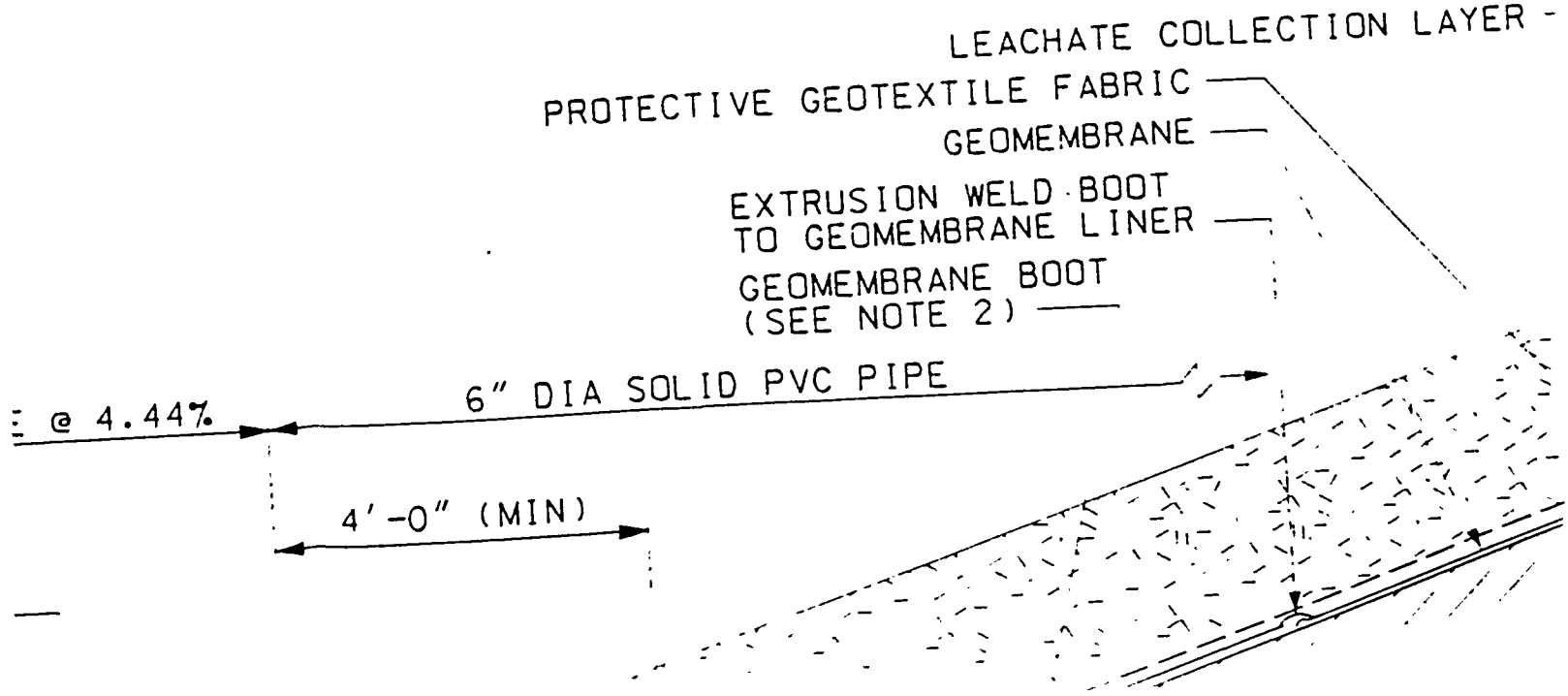
LINER ANCHOR TRENCH

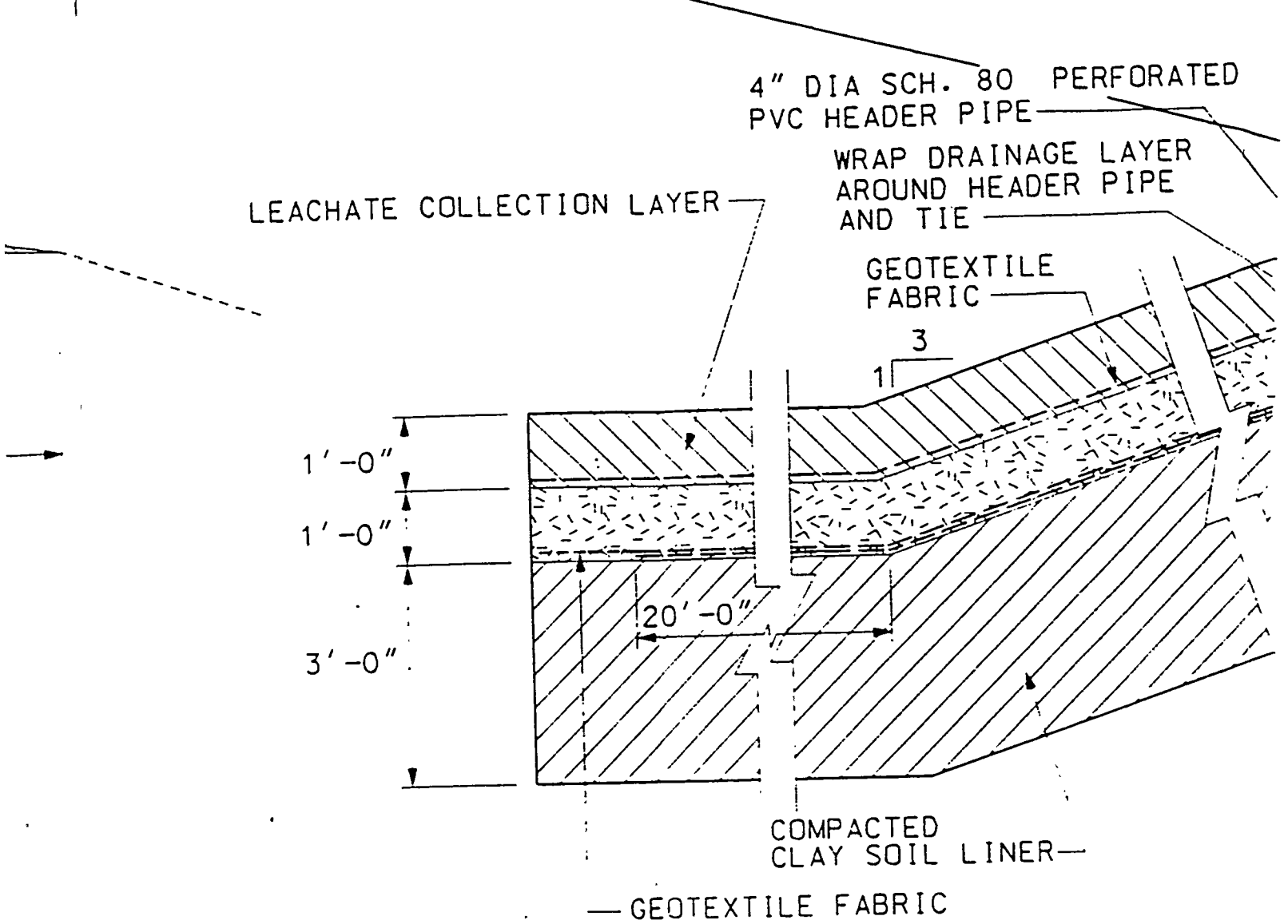
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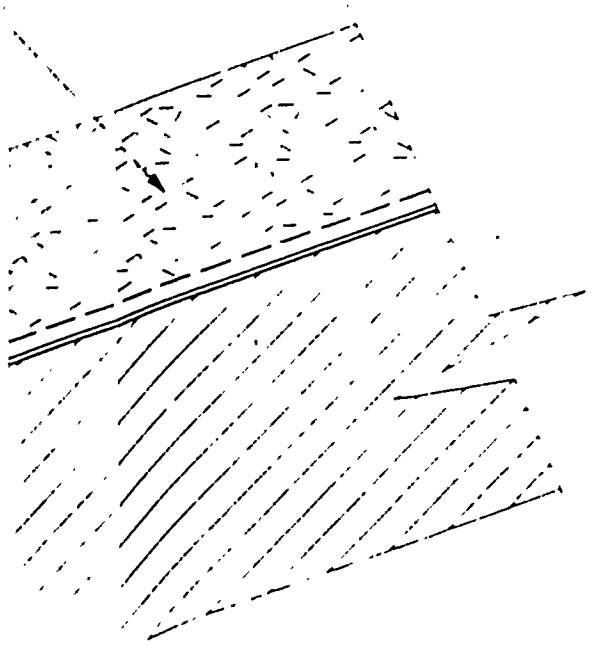
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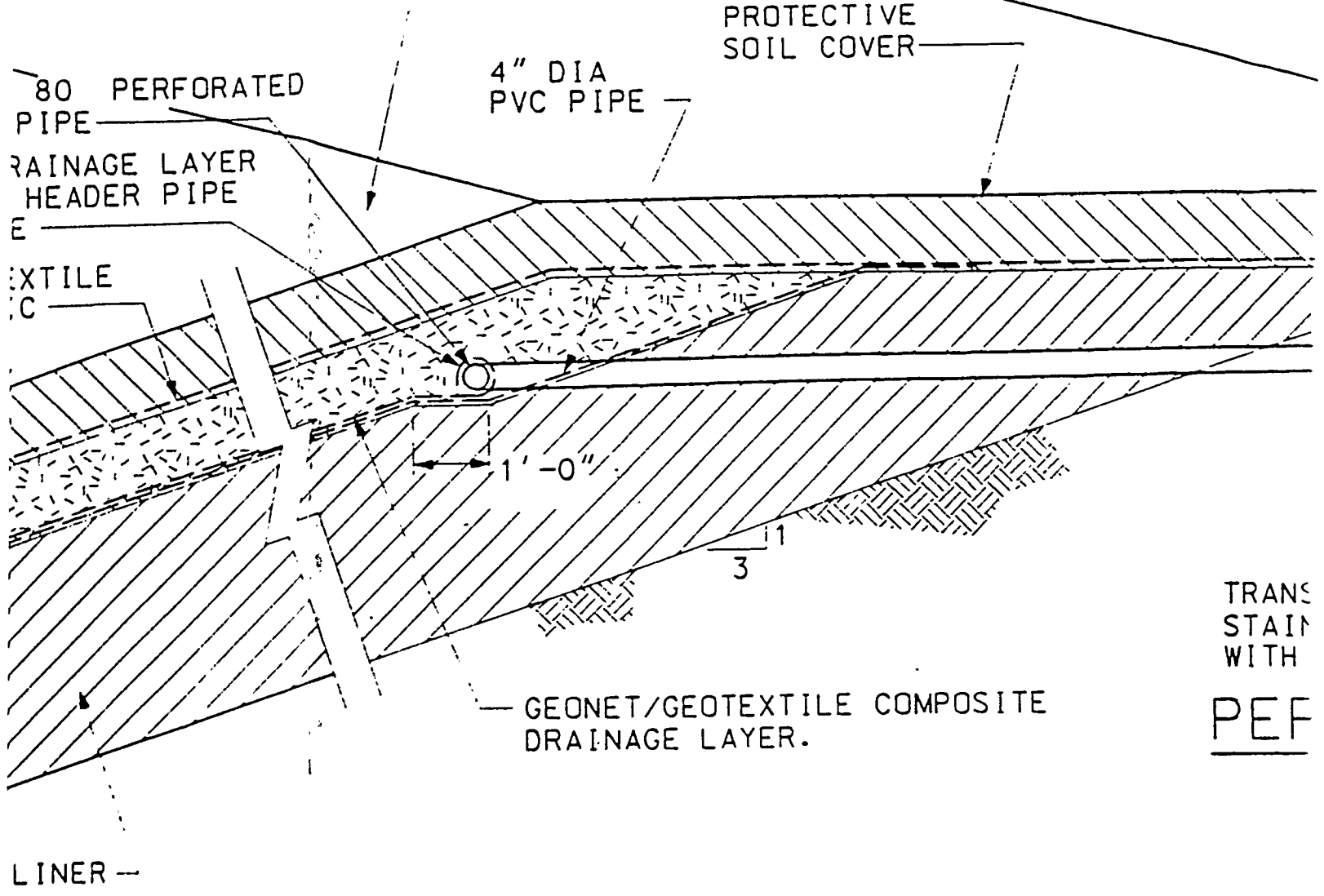


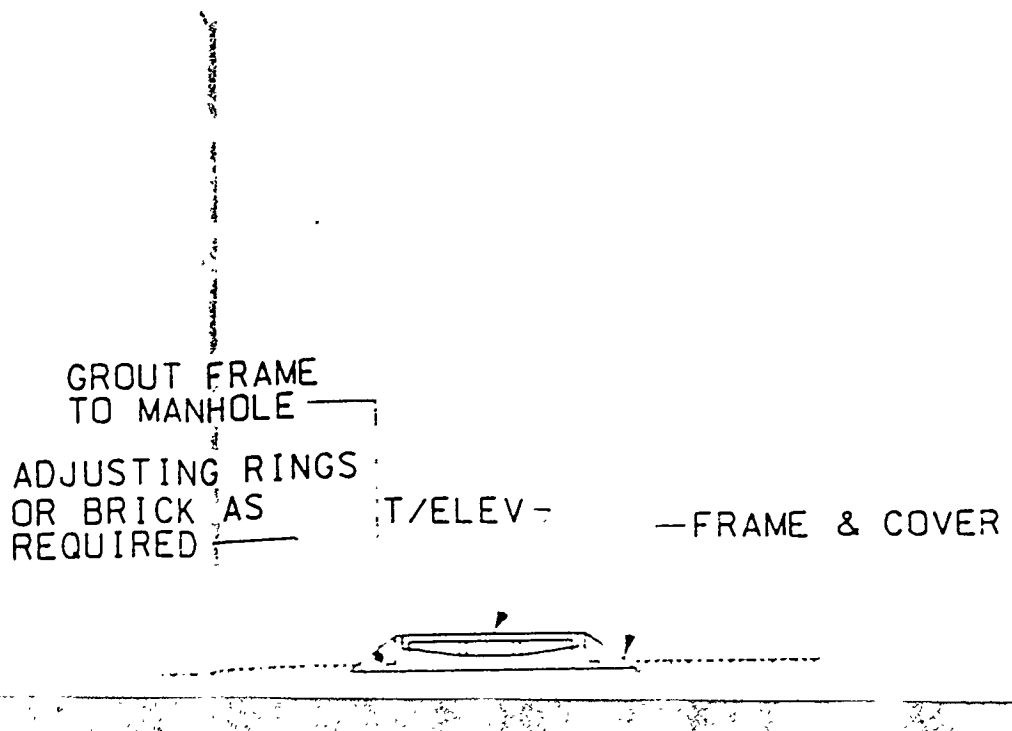


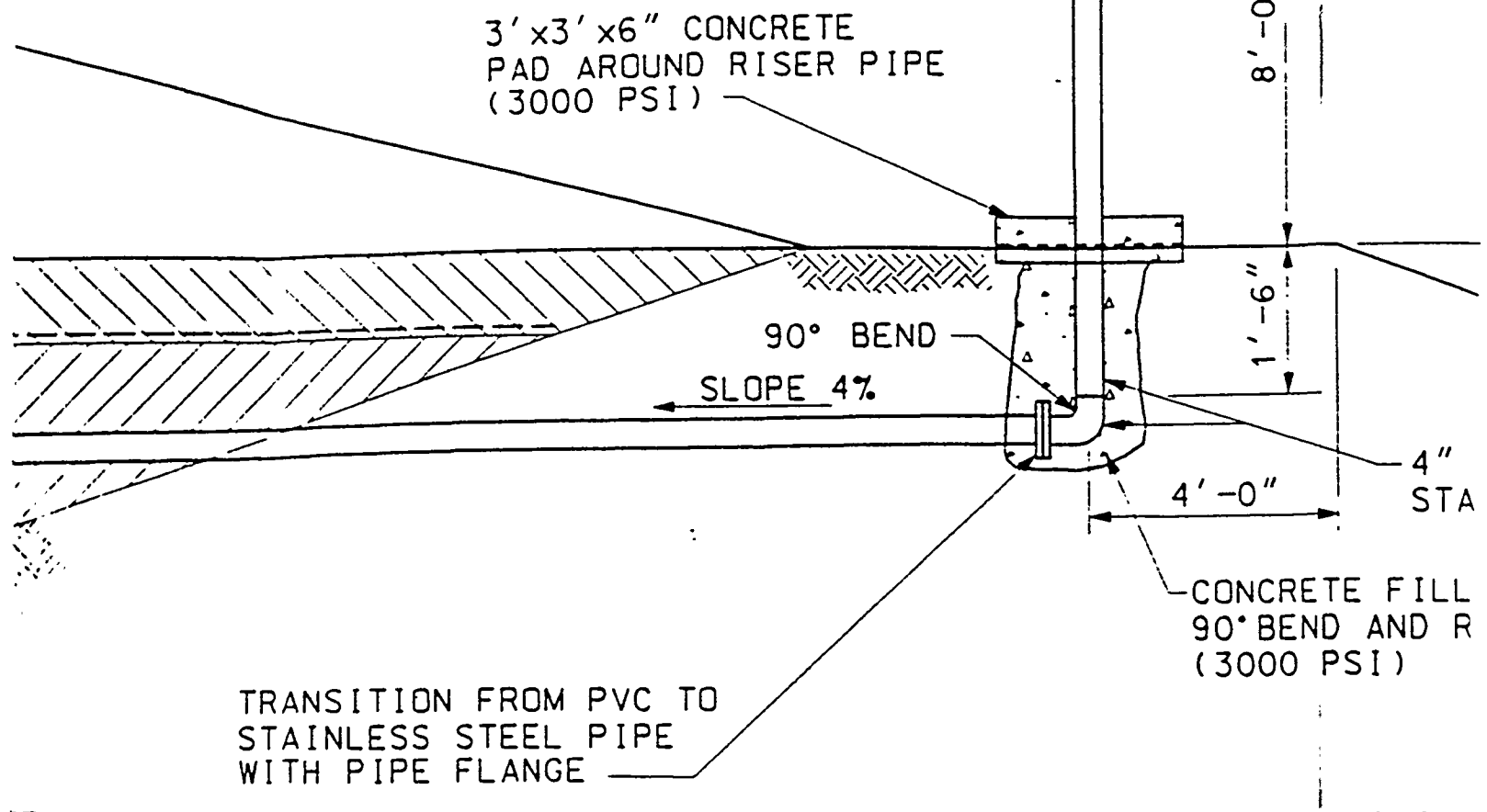


GROUT F
TO MANH

ADJUSTING
OR BRICK
REQUIRED -


PROTECTIVE
SOIL COVER
4" DIA
PVC PIPE
80 PERFORATED
PIPE
RAINAGE LAYER
HEADER PIPE
E
XTILE
C
1'-0"
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WITH
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GEONET/GEOTEXTILE COMPOSITE
DRAINAGE LAYER.
LINER


GROUT FRAME
TO MANHOLE
ADJUSTING RINGS
OR BRICK AS
REQUIRED
T/ELEV
FRAME & COVER



TE

PERIMETER CLAY SOIL LINER/COV

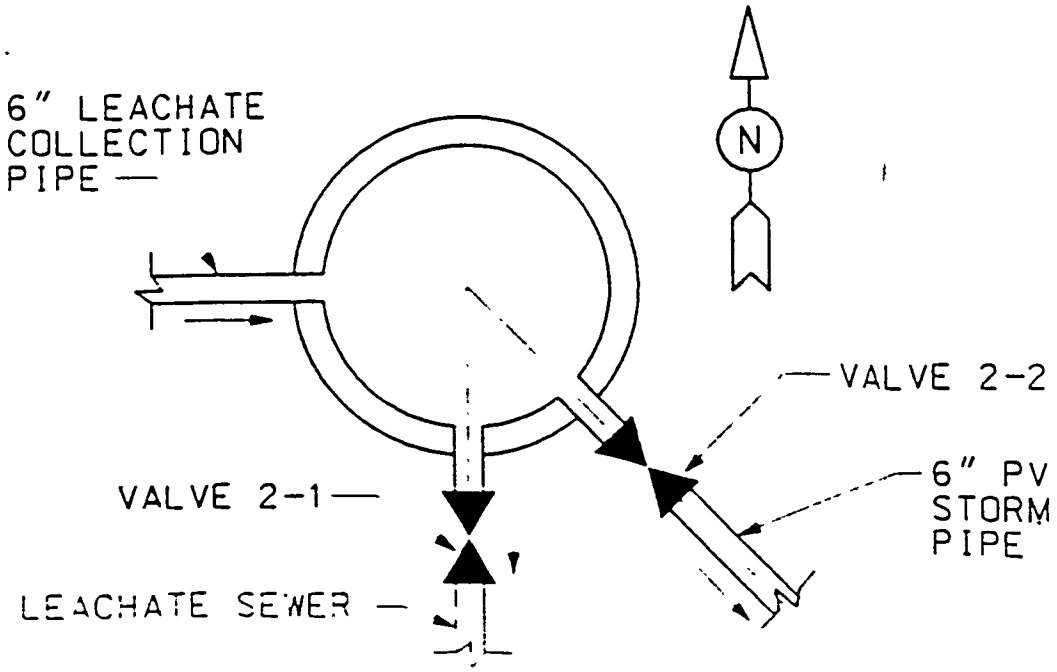
AREA 1 ONLY

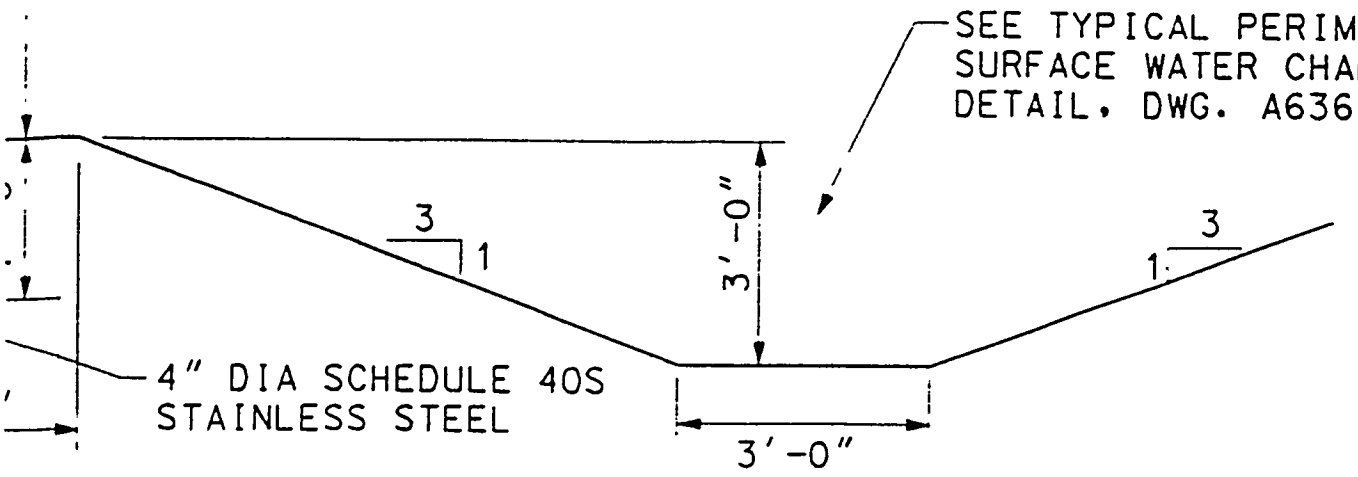
DETAIL 10

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:RETE FILL AROUND
iEND AND RISER PIPE
iO PSI)

E

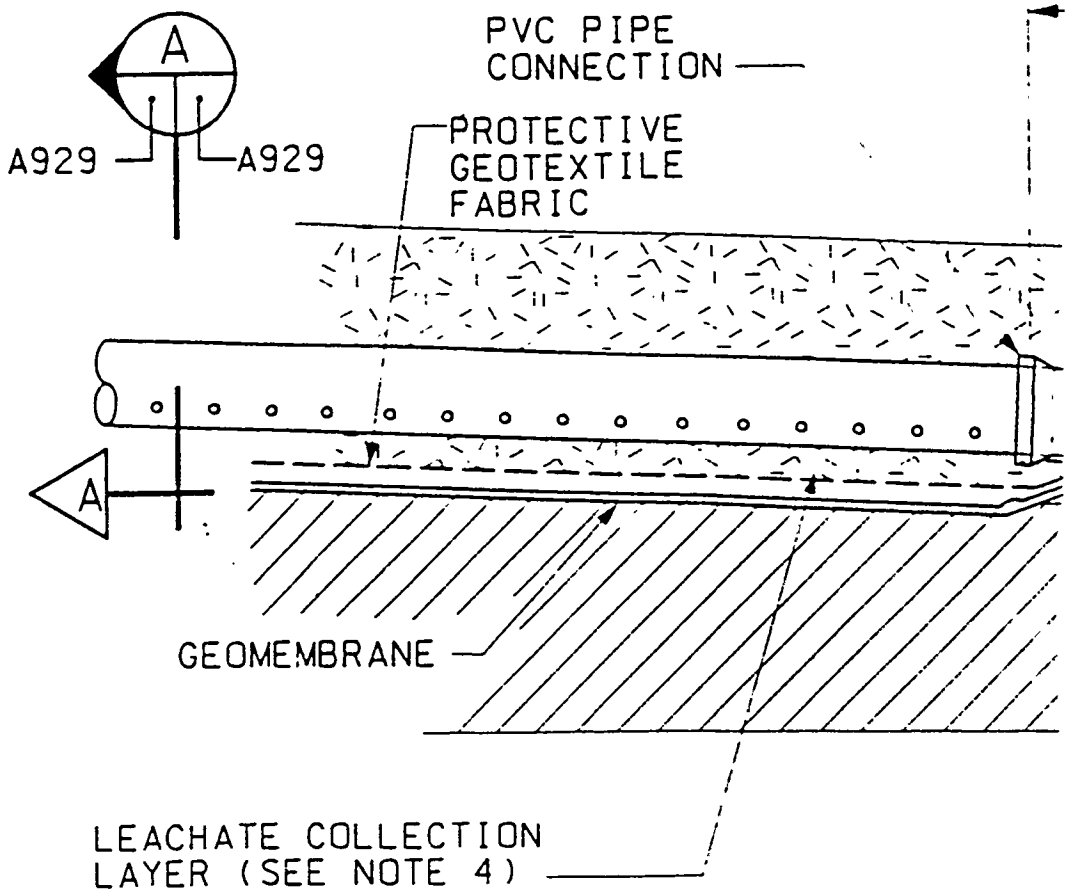
R/COVER SECTION

D

/ALVE 2-2

6" PVC TEMPORARY
STORMWATER DRAIN
PIPE

NOTES:



NOTES:

1. SEPARATOR GEOTEXTILE FABRIC AND PROTECTIV
2. FABRICATE PIPE BOOT IN ACCORDANCE WITH AP
3. INSTALL PIPE BY TRENCHING THROUGH THE COM. THROUGH COMPACTED CLAY SOIL LINER WITH BE. OF COMPACTED CLAY SOIL LINER USING LIKE M
4. PLACE LEACHATE COLLECTION LAYER AGGREGATE COVERED WITH AGGREGATE. CLEARANCE BETWEEN MINIMUM, 6" MAXIMUM.

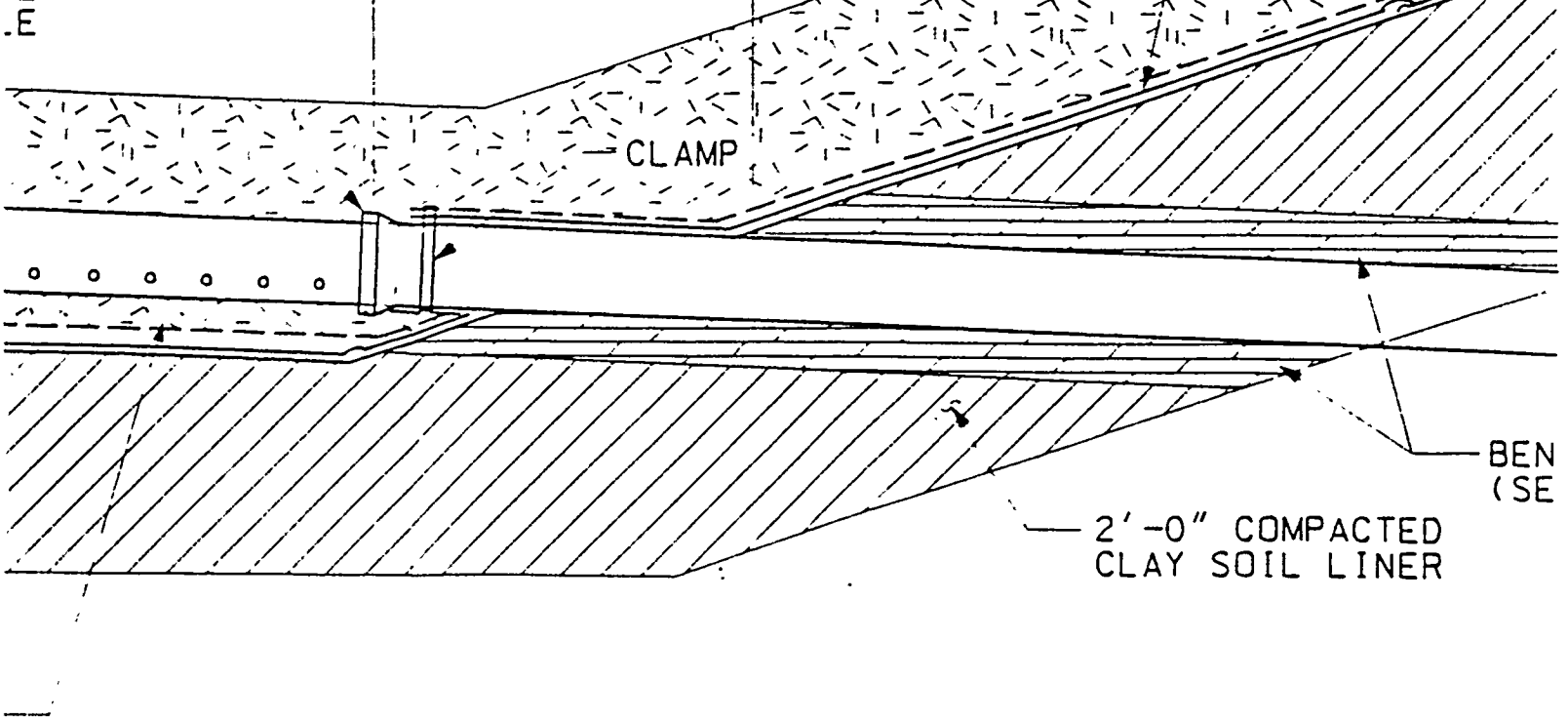
LINER PENETRA

DETAIL

NOT TO SCALE

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RIC AND PROTECTIVE SOIL COVER NOT SHOWN FOR CLARITY.

CCORDANCE WITH APPROVED INSTALLATION SHOP DRAWING.

G THROUGH THE COMPLETED COMPACTED CLAY SOIL LINER. BACKFILL TRENCH OIL LINER WITH BENTONITE ALL AROUND PIPE, MINIMUM 3". COMPLETE BAC INER USING LIKE MATERIAL.

N LAYER AGGREGATE AROUND AND UNDERNEATH PIPE BY HAND UNTIL PIPE IS CLEARANCE BETWEEN BOTTOM OF LEACHATE COLLECTION PIPE AND LINER IS 3

R PENETRATION

AIL

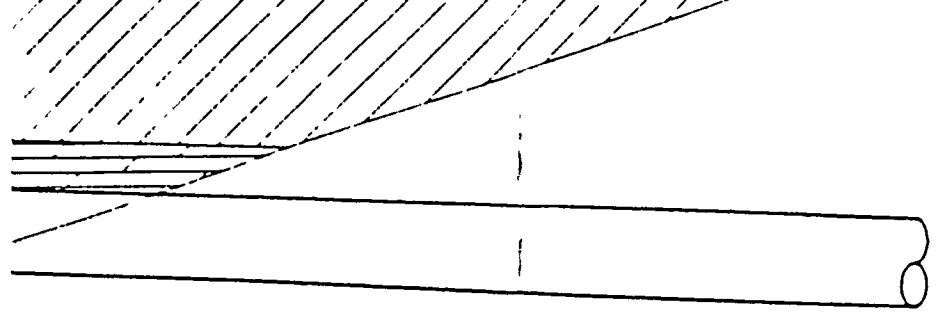
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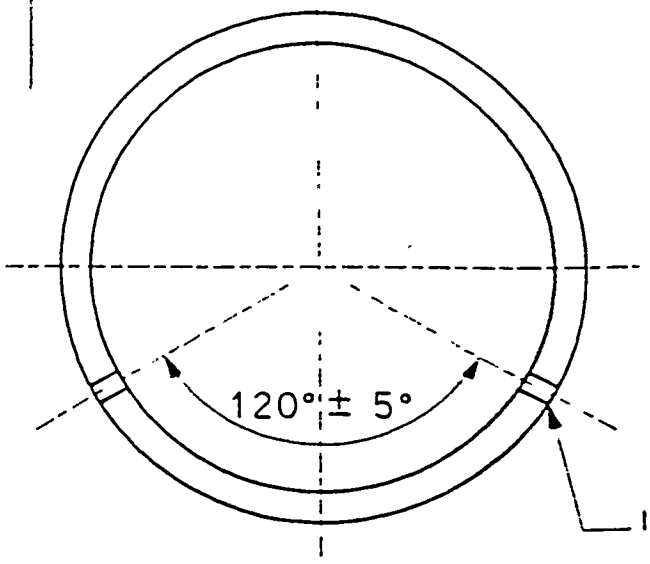
—BENTONITE
(SEE NOTE 3)

6" DI
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SEWEF

NO.

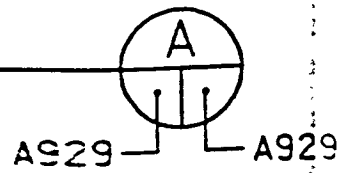
RENCH
E BACKFILL

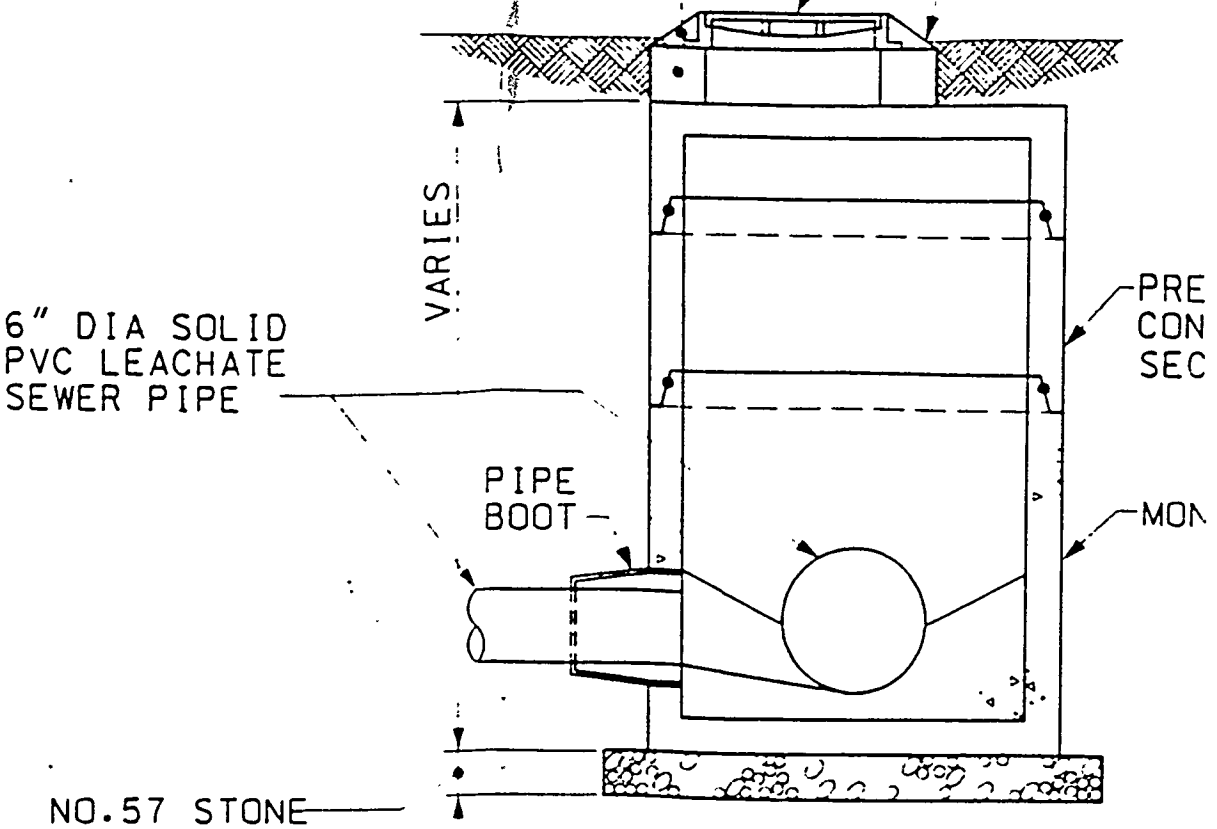
E IS
IS 3"



SECTION

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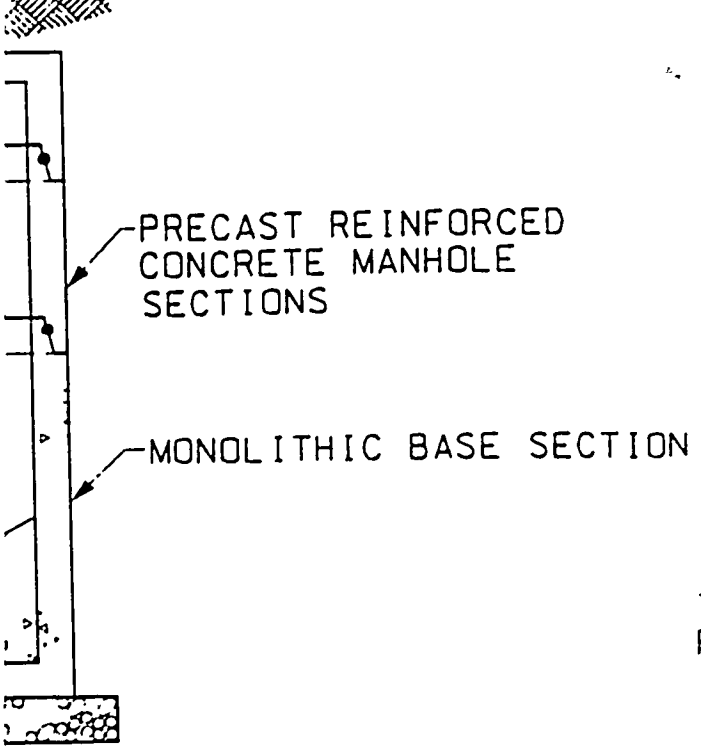


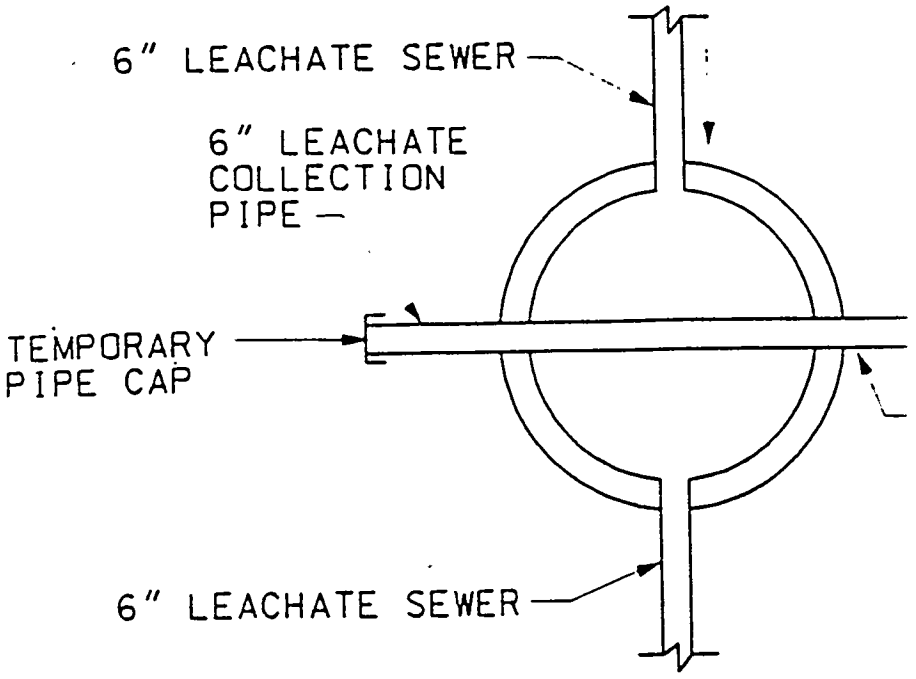
-1/2" DIA HOLE (TYP)

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LEACHATE MANH
MH-2A PLAN





LEACHATE MANHC
MH-3A PLAN

LEACHATE MANHOLE DETAIL

NOT TO SCALE

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RPE

WILLIAM PATRICK TAYLOR
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 112995
STATE OF TENNESSEE

DSGN
DRW
CHKR
SECT
DEPT
PE
PJ
REQ

NOTES:

1. FOR MH-2A, THE OPERATIONAL SEQUENCE IS AS FOLLOWS: CONSTRUCT MH-2A, 6" DIA LEACHATE SEWER WITH VALVE 2-1, AND 6" DIA PVC TEMPORARY STORMWATER DRAIN PIPE WITH VALVE 2-2. DURING CONSTRUCTION, AND PRIOR TO OPERATION OF AREA 2, VALVE 2-1 WILL REMAIN CLOSED AND VALVE 2-2 WILL REMAIN OPEN. STORMWATER ACCUMULATING IN AREA 2 WILL DRAIN THROUGH THE 6" DIA TEMPORARY STORMWATER DRAIN PIPE TO SILTATION POND NO.2. PRIOR TO PLACEMENT OF WASTE IN AREA 2, THE TEMPORARY STORMWATER DRAIN PIPE WILL EITHER BE REMOVED, PLUGGED OR REROUTED TO FUTURE LEACHATE COLLECTION SYSTEM STORAGE TANKS. VALVES 2-1 AND 2-2 WILL REMAIN TO PROVIDE FLOW CONTROL FOR FUTURE STORAGE TANKS.

2. FOR MH-3A, THE OPERATIONAL SEQUENCE IS AS FOLLOWS: CONSTRUCT MH-3A, 6" DIA LEACHATE SEWER, AND THE 6" DIA LEACHATE COLLECTION PIPE/TEMPORARY STORMWATER DRAIN. DURING CONSTRUCTION OF AREA 3, AND PRIOR TO PLACEMENT OF WASTE IN AREA 3, STORMWATER WILL BE ROUTED THROUGH THE 6" DIA TEMPORARY STORMWATER DRAIN PIPE TO SILTATION POND NO.2 VIA AREA INLET NO.2. PRIOR TO PLACEMENT OF WASTE IN AREA 3, THE 6" DIA LEACHATE COLLECTION PIPE/TEMPORARY STORMWATER PIPE WILL BE CUT (SEPARATED). THE 6" DIA TEMPORARY STORMWATER PIPE WILL BE GROUTED OR PLUGGED AND LEACHATE FROM AREA 3 WILL DRAIN TO THE LEACHATE COLLECTION SYSTEM STORAGE TANKS VIA THE LEACHATE SEWER.

C
RARY
IWATER
PIPE

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B

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[C2E0000926]

2	8/19/95
Wilmoth	8/19/95
Taylor	8/19/95
—	
L Crook	8/19/95
)	8/28/95

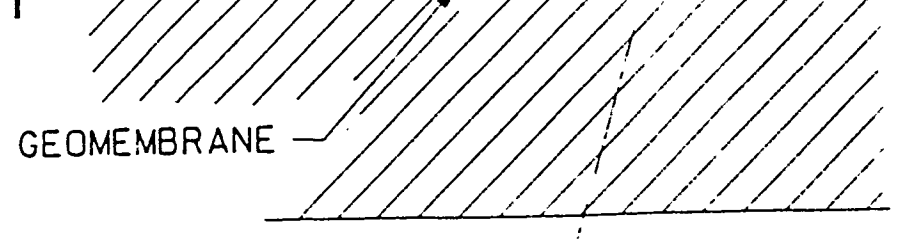
FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-85-84OR21400 and DE-AC-85-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

LANDFILL DETAILS - VI

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
—	-	—	-	-	— —				—	



LEACHATE COLLECTION
LAYER (SEE NOTE 4)

NOTES:

1. SEPARATOR GEOTEXTILE FABRIC AND PROTECTI
2. FABRICATE PIPE BOOT IN ACCORDANCE WITH A
3. INSTALL PIPE BY TRENCHING THROUGH THE CC THROUGH COMPACTED CLAY SOIL LINER WITH B OF COMPACTED CLAY SOIL LINER USING LIKE
4. PLACE LEACHATE COLLECTION LAYER AGGREGAT COVERED WITH AGGREGATE. CLEARANCE BETWEE MINIMUM, 6" MAXIMUM.

LINER PENETR

DETAIL

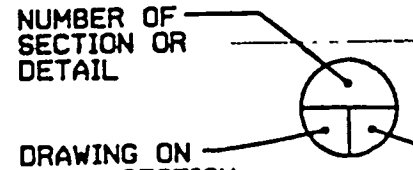
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Guideline
UCN-1958

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SECTION AND DETAIL

HEYGREEN



(SEE NOTE 3)

2'-0" COMPACTED CLAY SOIL LINER

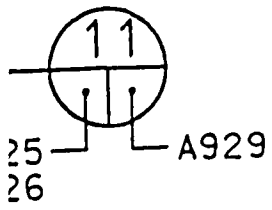
TIVE SOIL COVER NOT SHOWN FOR CLARITY.

I APPROVED INSTALLATION SHOP DRAWING.

COMPLETED COMPACTED CLAY SOIL LINER. BACKFILL TRENCH
I BENTONITE ALL AROUND PIPE, MINIMUM 3". COMPLETE BACKFILL
:E MATERIAL.

;ATE AROUND AND UNDERNEATH PIPE BY HAND UNTIL PIPE IS
VEEN BOTTOM OF LEACHATE COLLECTION PIPE AND LINER IS 3"

'RATION



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37 Review By: _____
Line Document: _____
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)RAWING ON
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)R DETAIL IS
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AIL KEY

THIS DOCUMENT CONTROLLED BY

CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

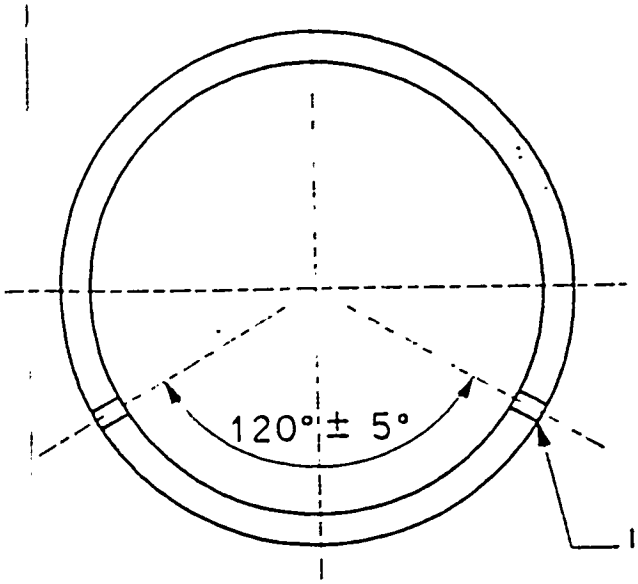
REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION OR ISSUE
0				ISSUE FOR PERMITTI

DESCRIPTI

REVISION OR ISS

3)

6" DIA SOLID
PVC LEACHATE
SEWER PIPE



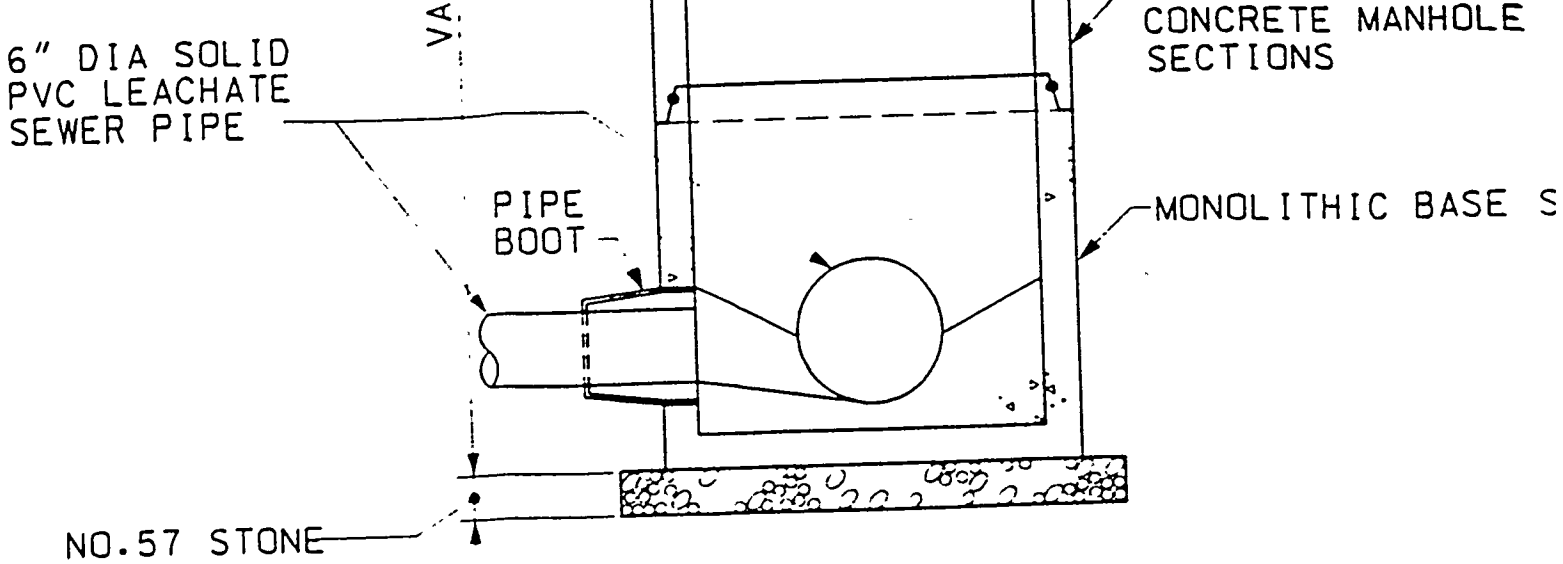
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SECTION
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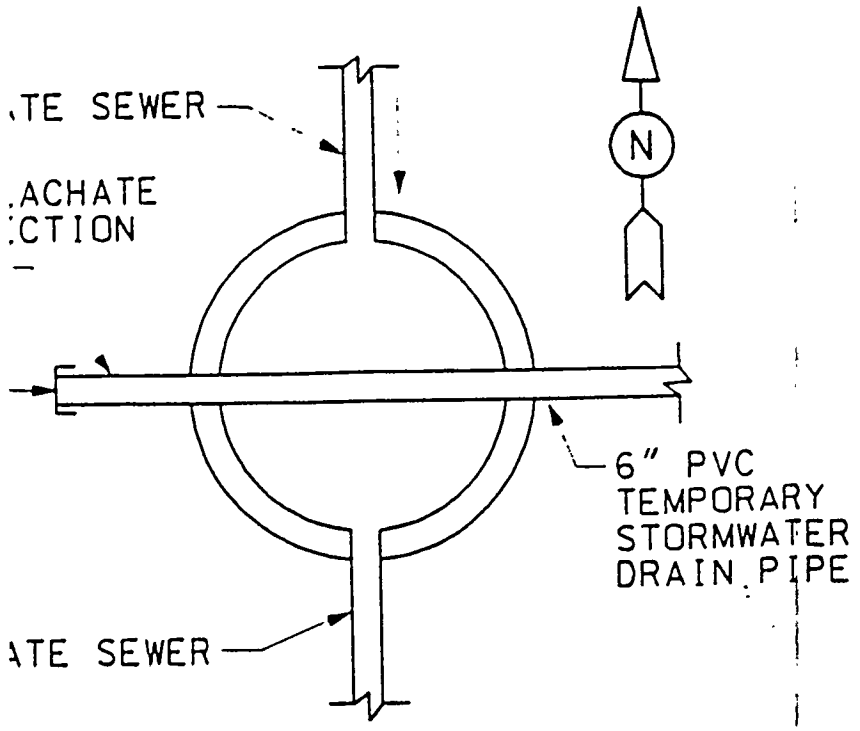
SION OR ISS. PURPOSE — REVISION APPROVALS



(TYP)

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REVISION APPROVALS

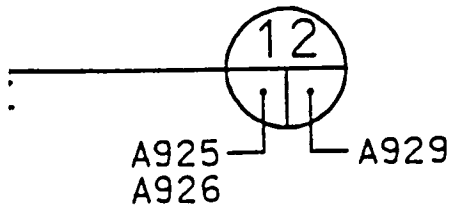


LEACHATE MANHOLE
MH-3A PLAN

VALVE 2-2 WILL REMAIN OPEN. S
IN AREA 2 WILL DRAIN THROUGH
STORMWATER DRAIN PIPE TO SILT
TO PLACEMENT OF WASTE IN ARE
STORMWATER DRAIN PIPE WILL EI
PLUGGED OR REROUTED TO FUTURE
SYSTEM STORAGE TANKS. VALVES
TO PROVIDE FLOW CONTROL FOR F

2. FOR MH-3A. THE OPERATIONAL SE
CONSTRUCT MH-3A. 6" DIA LEACH
DIA LEACHATE COLLECTION PIPE,
DRAIN. DURING CONSTRUCTION OF
PLACEMENT OF WASTE IN AREA 3
ROUTED THROUGH THE 6" DIA TE
PIPE TO SILTATION POND NO.2
PRIOR TO PLACEMENT OF WASTE
LEACHATE COLLECTION PIPE/TEM
WILL BE CUT (SEPARATED). THE
STORMWATER PIPE WILL BE GROU
LEACHATE FROM AREA 3 WILL DR
COLLECTION SYSTEM STORAGE TA
SEWER.

E MANHOLE



RPE	DSGN	8/19/95	FOSTER WHEELER ENVIRONMENTAL COF OAK RIDGE. designed for the DEPARTMENT OF ENERGY u managed for the DEPARTMENT OF ENER under U.S. GOVERNMENT contracts DE Oak Ridge, Tennessee • Pa
	DRW	8/19/95	
	CHKR W P Taylor	8/19/95	
	SECT		PROJE
	DEPT	8/19/95	Y-12 INDUSTR
	PE		LANDFILL DE
	PJ	8/28/95	
	REQ		

WILLIAM PATRICK TAYLOR REGISTERED ENGINEER AGRICULTURE 19 COMMERCE NO. 19 STATE OF TENNESSEE

1	48	49	50	PLANT	B
3	C	P	N	Y-12	YAF
51		52		53	
NC		NA		AR	C2

VER REV. 0 DATE 8/19/95 MMES

DRAWING APPROVALS

CAD FILE: C000129

OPERATION OF AREA 2. VALVE 2-1 WILL REMAIN CLOSED AND VALVE 2-2 WILL REMAIN OPEN. STORMWATER ACCUMULATING IN AREA 2 WILL DRAIN THROUGH THE 6" DIA TEMPORARY STORMWATER DRAIN PIPE TO SILTATION POND NO.2. PRIOR TO PLACEMENT OF WASTE IN AREA 2, THE TEMPORARY STORMWATER DRAIN PIPE WILL EITHER BE REMOVED, PLUGGED OR REROUTED TO FUTURE LEACHATE COLLECTION SYSTEM STORAGE TANKS. VALVES 2-1 AND 2-2 WILL REMAIN TO PROVIDE FLOW CONTROL FOR FUTURE STORAGE TANKS.

2. FOR MH-3A, THE OPERATIONAL SEQUENCE IS AS FOLLOWS: CONSTRUCT MH-3A, 6" DIA LEACHATE SEWER, AND THE 6" DIA LEACHATE COLLECTION PIPE/TEMPORARY STORMWATER DRAIN. DURING CONSTRUCTION OF AREA 3, AND PRIOR TO PLACEMENT OF WASTE IN AREA 3, STORMWATER WILL BE ROUTED THROUGH THE 6" DIA TEMPORARY STORMWATER DRAIN PIPE TO SILTATION POND NO.2 VIA AREA INLET NO.2. PRIOR TO PLACEMENT OF WASTE IN AREA 3, THE 6" DIA LEACHATE COLLECTION PIPE/TEMPORARY STORMWATER PIPE WILL BE CUT (SEPARATED). THE 6" DIA TEMPORARY STORMWATER PIPE WILL BE GROUTED OR PLUGGED AND LEACHATE FROM AREA 3 WILL DRAIN TO THE LEACHATE COLLECTION SYSTEM STORAGE TANKS VIA THE LEACHATE SEWER.

C
RARY
WATER
PIPE

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B

A

	8/19/95
	8/19/95
Taylor	8/19/95
Crook	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
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Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

LANDFILL DETAILS - VI

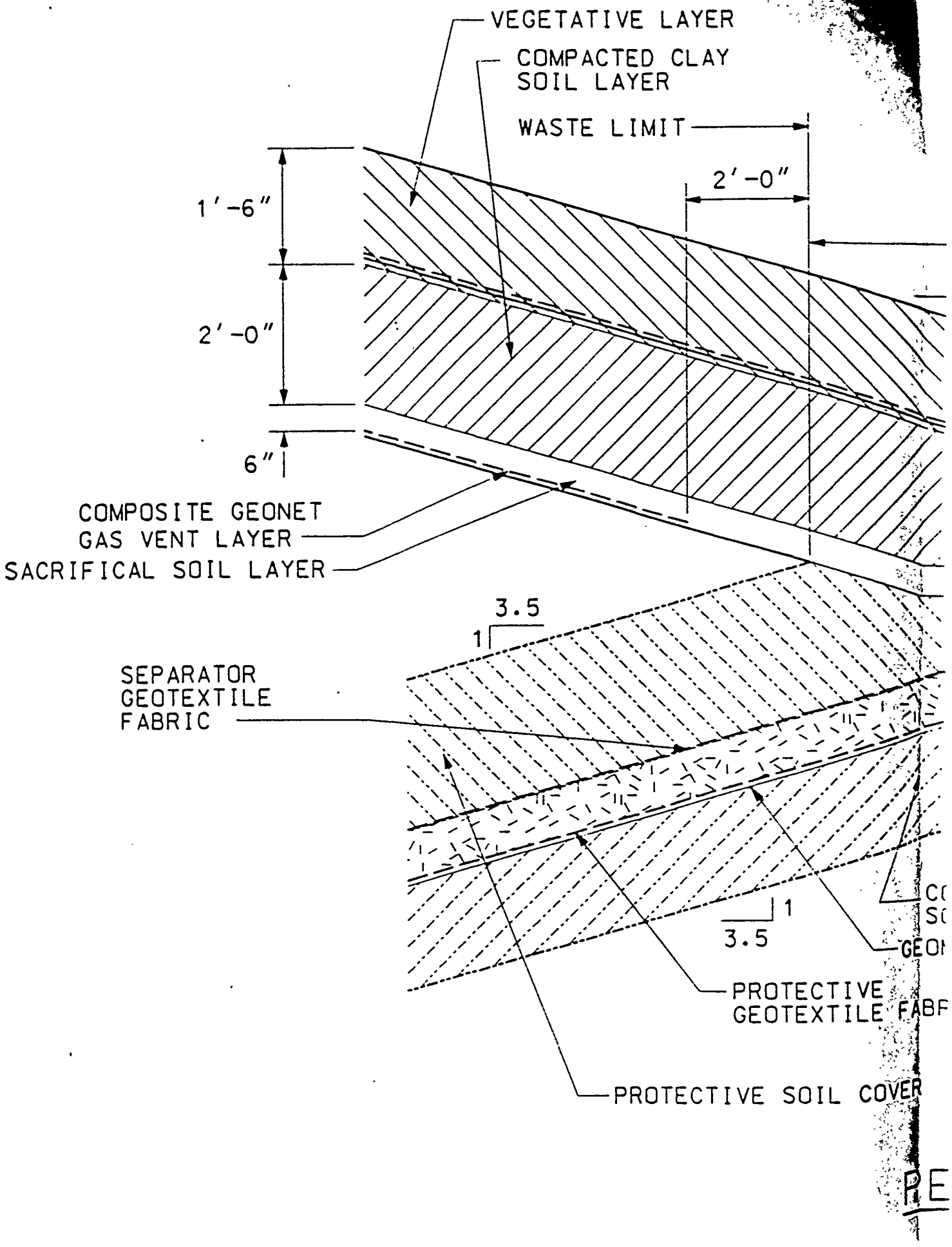
1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U

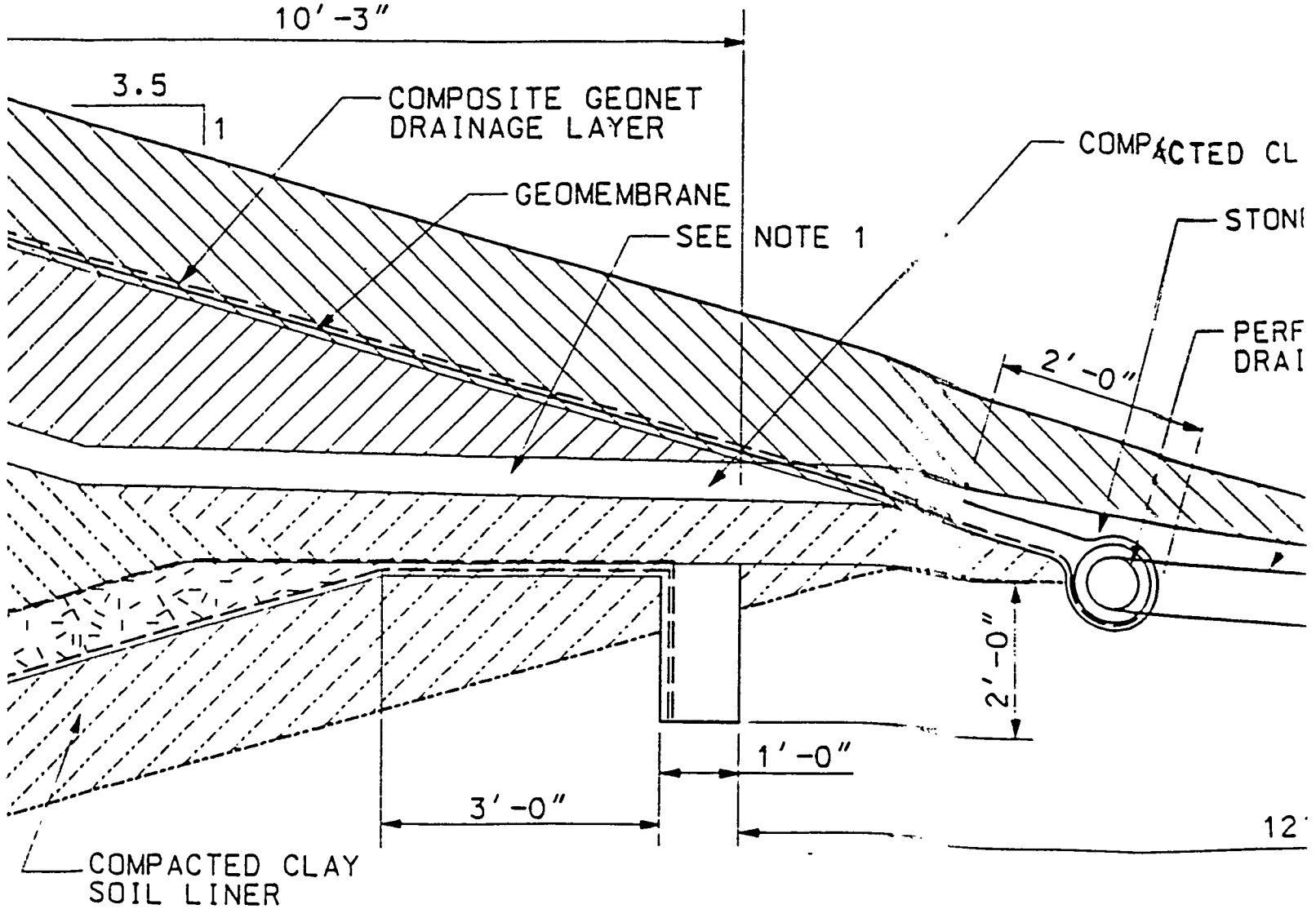
51	52	53		REV
NC	NA	AR	C2E900000A929	0

CAD FILE: C0001299 .DGN

1

DATE: Aug 18, 1995


VEGETATIVE LAYER
COMPACTED CLAY SOIL LAYER
WASTE LIMIT
2'-0"
1'-6"
2'-0"
6"
COMPOSITE GEONET
GAS VENT LAYER
SACRIFICAL SOIL LAYER
3.5
1
SEPARATOR GEOTEXTILE FABRIC
1
3.5
PROTECTIVE GEOTEXTILE FABR
PROTECTIVE SOIL COVER



—GEOMEMBRANE

E
E FABRIC

OVER

NOTE:

1. REMOVE SOIL AND VEGETATION TO EXPOSE UNDERL SOIL. SCARIFY CLAY SOIL AND PLACE COMPACTE
2. DRAIN PIPE TO BE PLACED AT A MAXIMUM 250' LANDFILL PERIMETER.

PERIMETER COMPOSITE CLAY LINER/C

DETAIL

5

COMPACTED CLAY
VEGETA
COMPO:
DRAIN
GEOM

1'-6

ED CLAY

-STONE BACKFILL

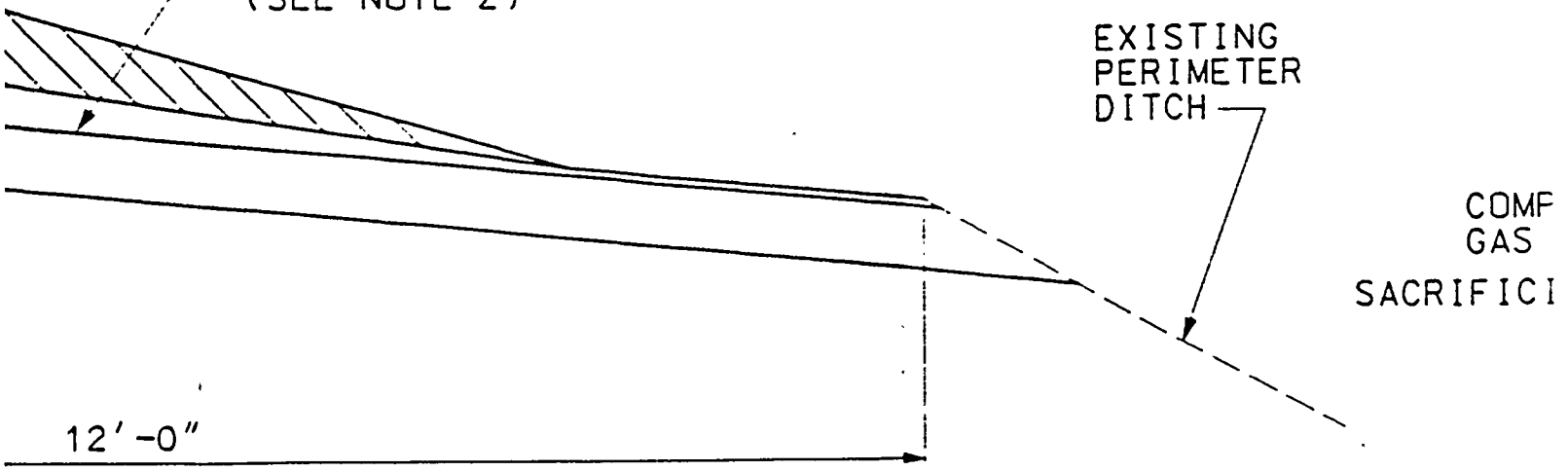
2'-(

-PERFORATED 4"
DRAIN PIPE

6

SOLID 4" DIA
DRAIN PIPE (1% MIN SLOPE)
(SEE NOTE 2)

1'-(



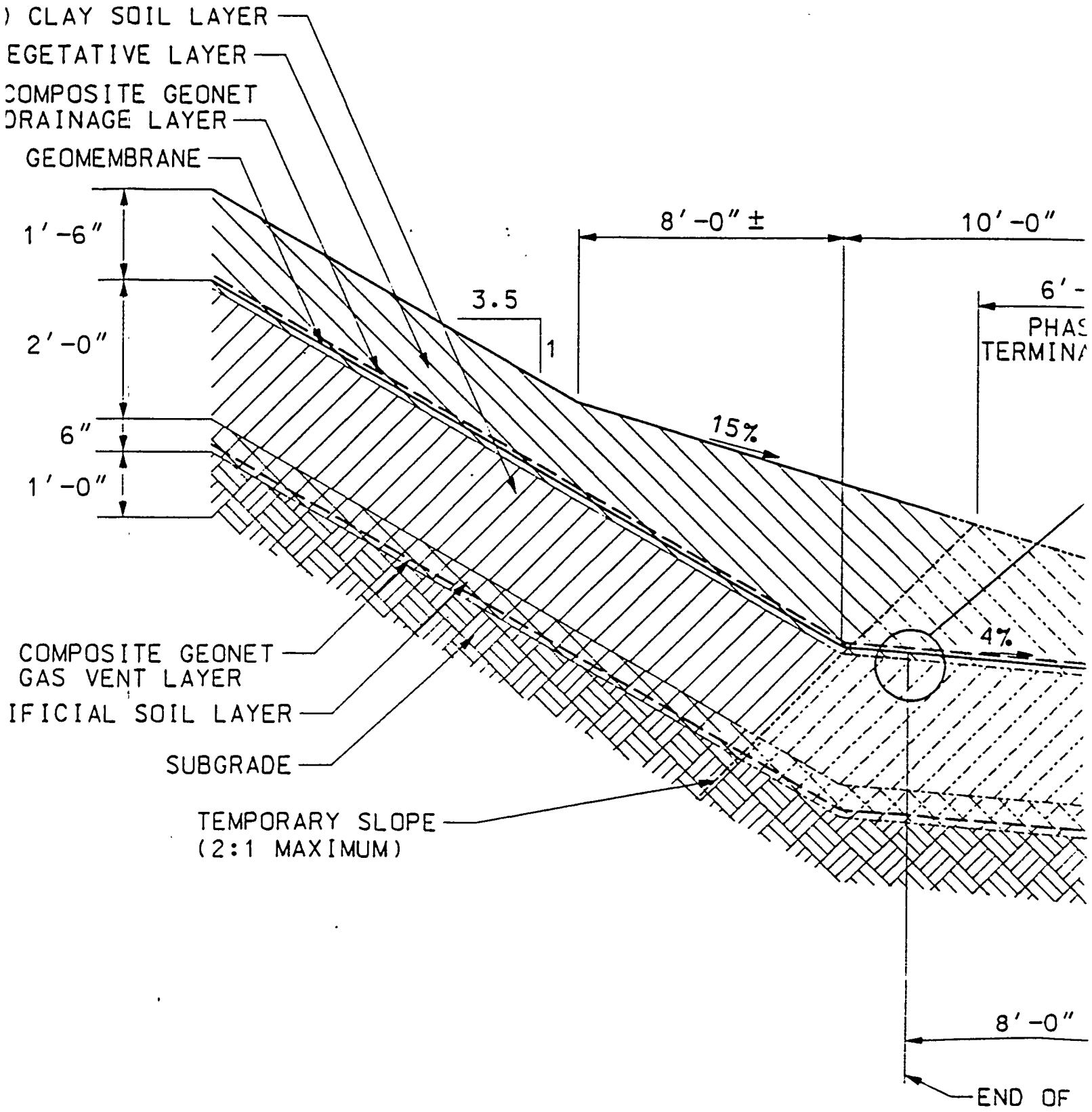
COMF
GAS

SACRIFICI

JNDERLYING CLAY
MPACTED CLAY SOIL.

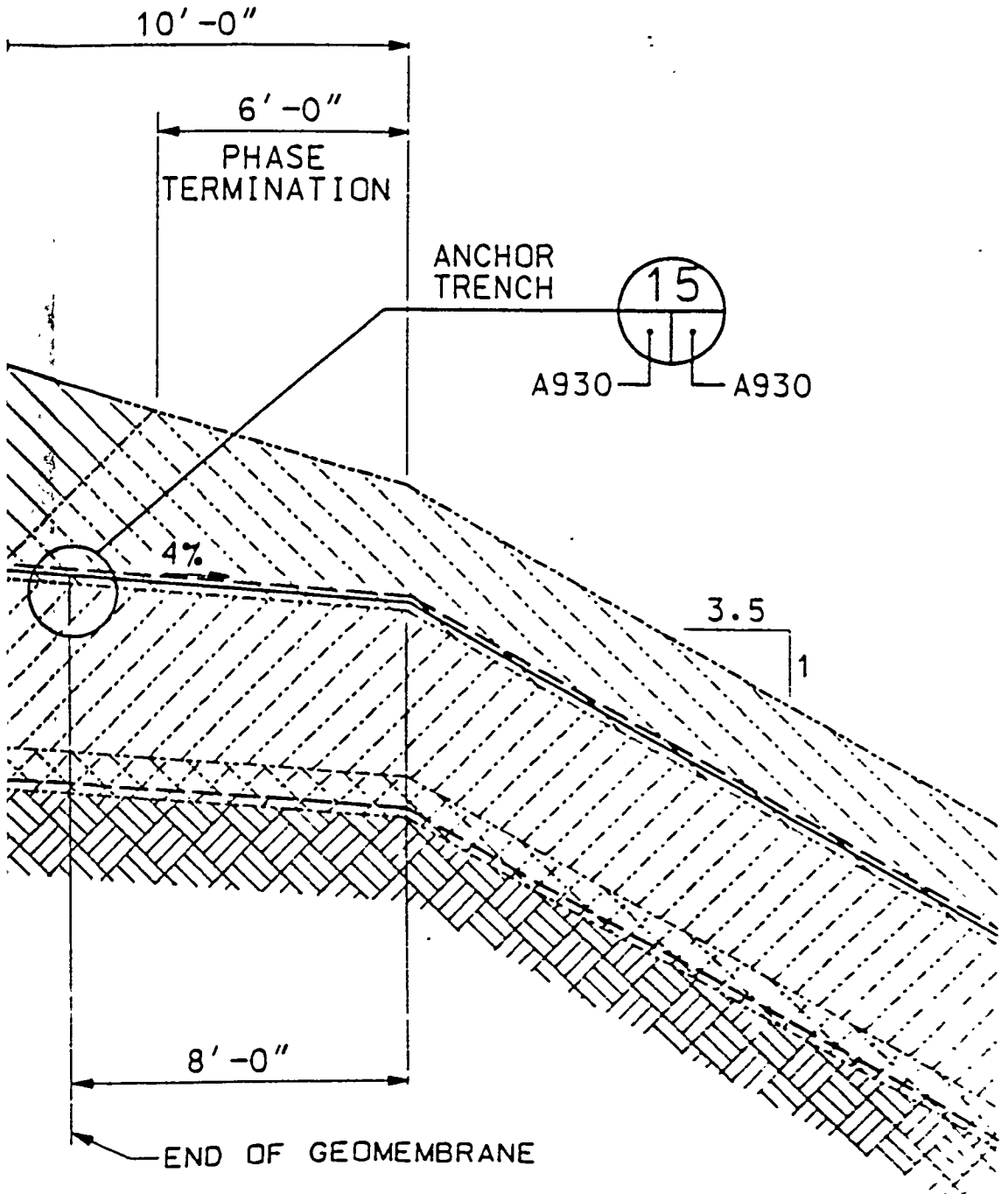
250' INTERVALS AROUND

R/COMPOSITE COVER



NOTE:

THIS DETAIL DEPICTS CONSTRUCTION OF THE LOWER TE
ADJACENT TO FIRST STAGE COVER. CONSTRUCTION OF



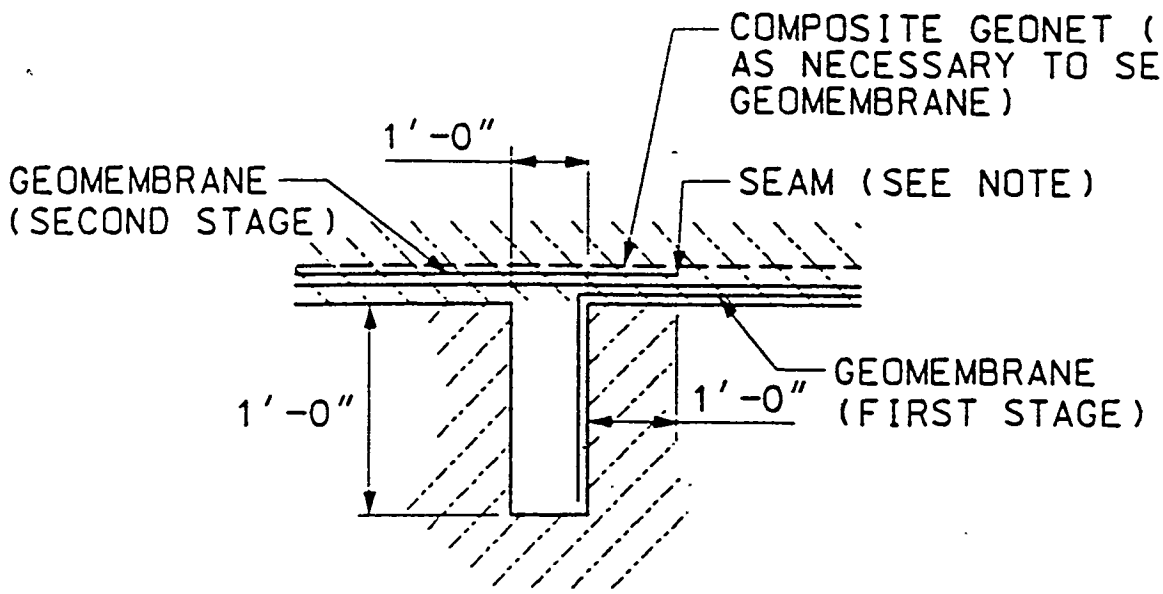
GEOMEMBRANE —
(SECOND STAGE

1'-

NOTE:

GEOMEMBRAI
LAP GEOMEI

OF THE LOWER TERRACE
NSTRUCTION OF REMAINDER
E WILL BE IDENTICAL.



NOTE:

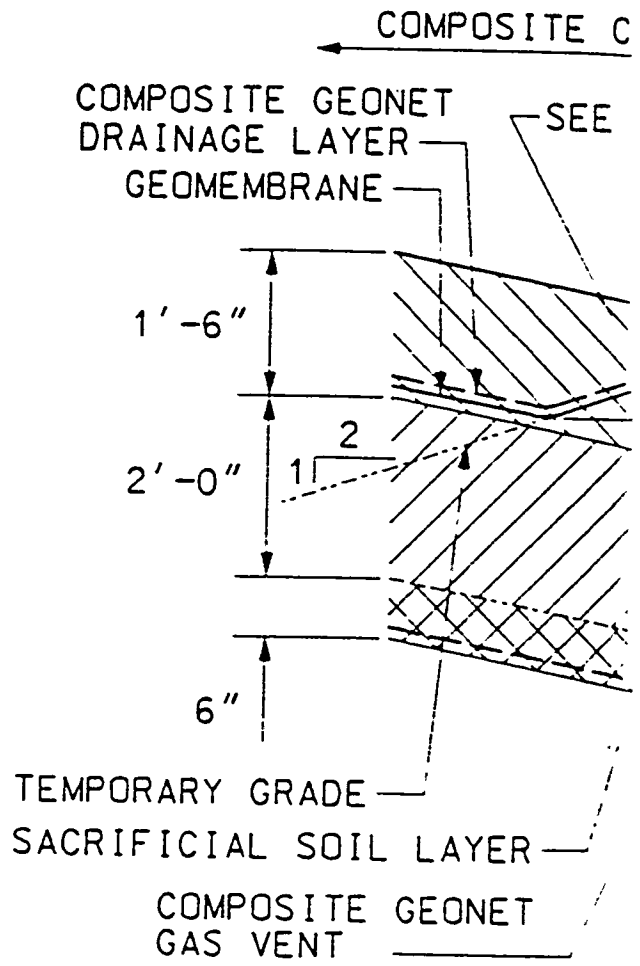
GEOMEMBRANE TO BE TERMINATED BETWEEN TERRACES. LAP GEOMEMBRANE AS SHOWN AND WELD SEAM.

ANCHOR TRENCH DETAIL

NOT TO SCALE

15

A930 A930



NOTE:

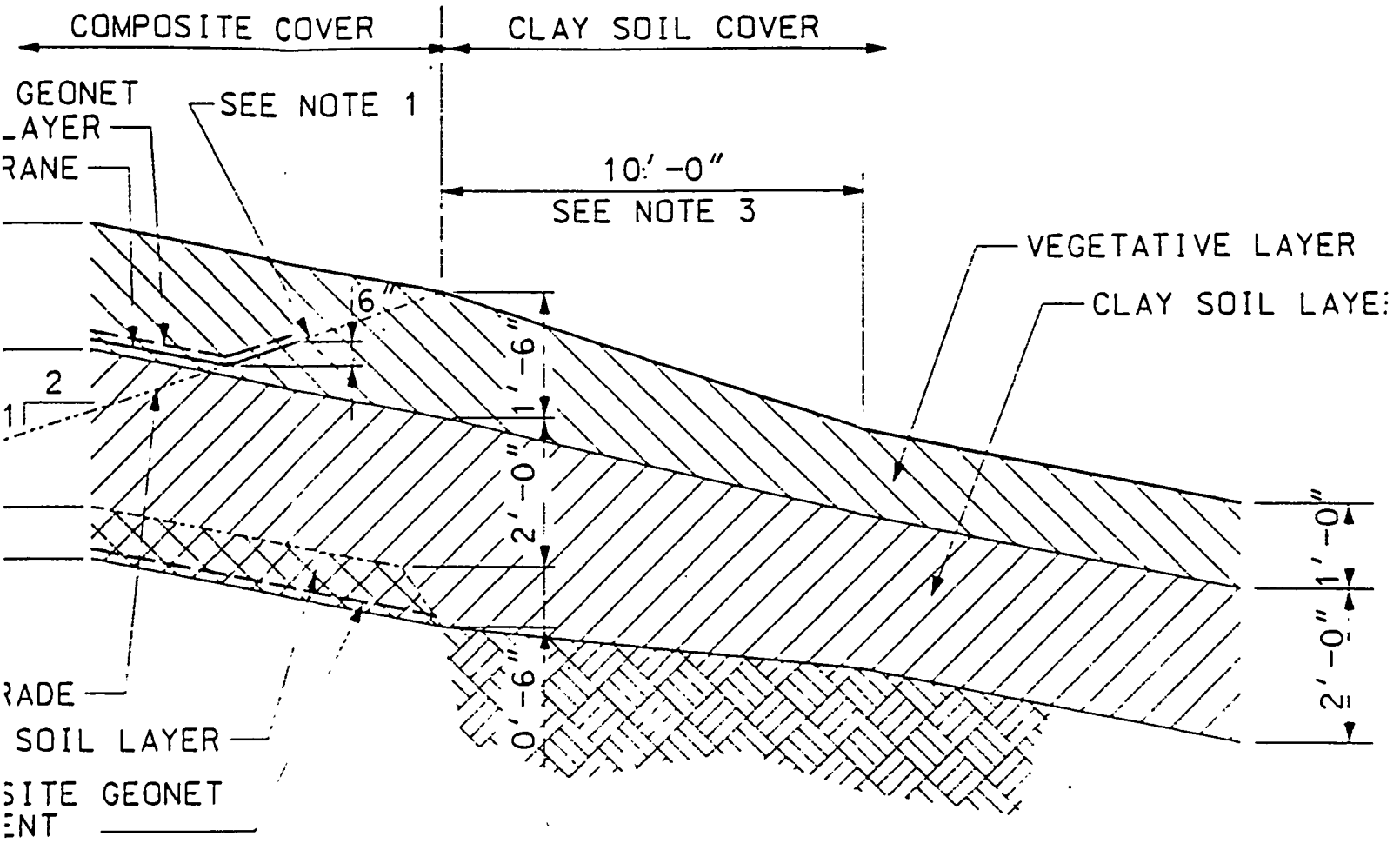
1. TERMINA
   ALONG TE
2. SECTION
3. TRANSIT
   INCREASI

COMPOSITE CO

DETAIL

NOT TO SCALE

A630



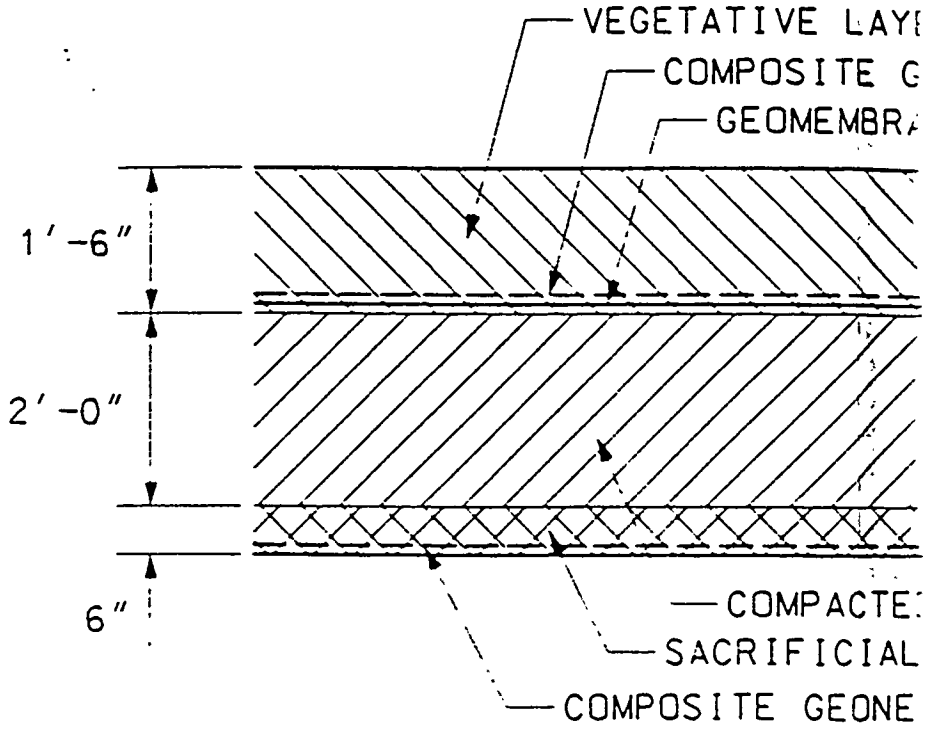
SECTION

NOTE:

1. TERMINATE COMPOSITE GEONET DRAINAGE LAYER ALONG TEMPORARY GRADE ESTABLISHED DURING PHASED CLOSURE.
2. SECTION IS TAKEN PERPENDICULAR TO THE COVER INTERFACE.
3. TRANSITION OVERALL COVER THICKNESS FROM 3' TO 4' BY INCREASING INDIVIDUAL LAYER THICKNESSES AS SHOWN.

OSITE COVER/CLAY SOIL COVER INTERF

DETAIL



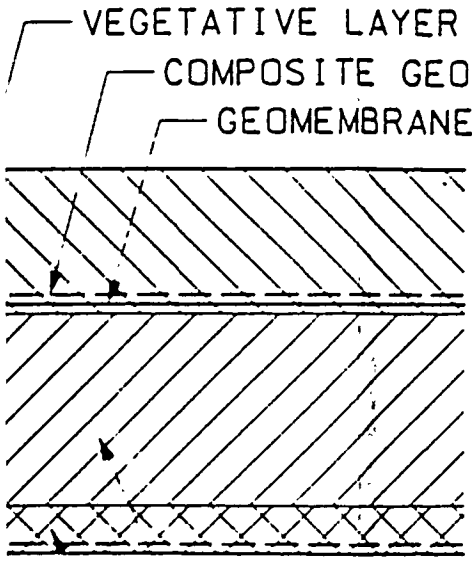
COMPOSITE COVE

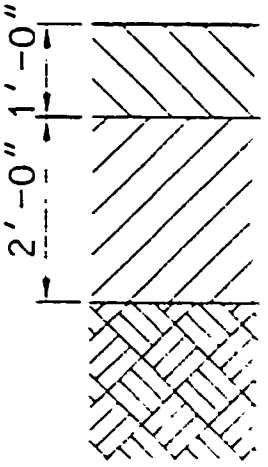
THIS DETAIL DEPICTS CONSTRUCTION OF THE L
ADJACENT TO FIRST STAGE COVER. CONSTRUCT
OF LOWER TERRACE AND UPPER TERRACE WILL E

TYPICAL TERRACE FOR

DETAIL

NOT TO SCALE





SITE COVER

CLAY S

DETAIL

NOT TO SCALE

17

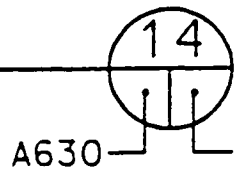
A630

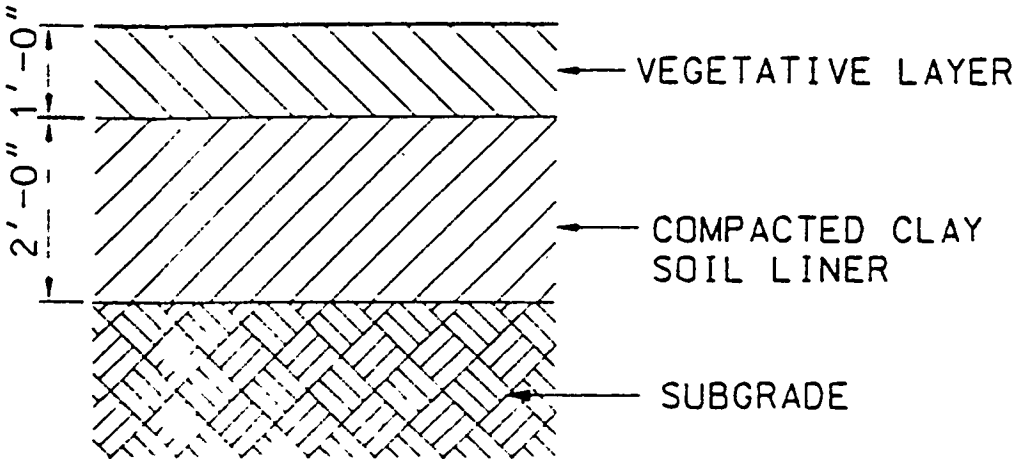
A930

S CONSTRUCTION OF THE LOWER TERRACE
STAGE COVER. CONSTRUCTION OF REMAINDER
ND UPPER TERRACE WILL BE IDENTICAL.

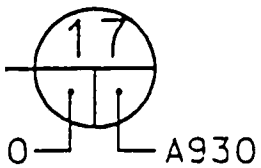
TERRACE FOR COMPOSITE COVER

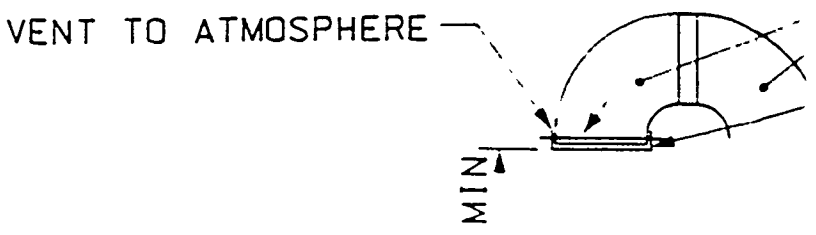
DETAIL
NOT TO SCALE

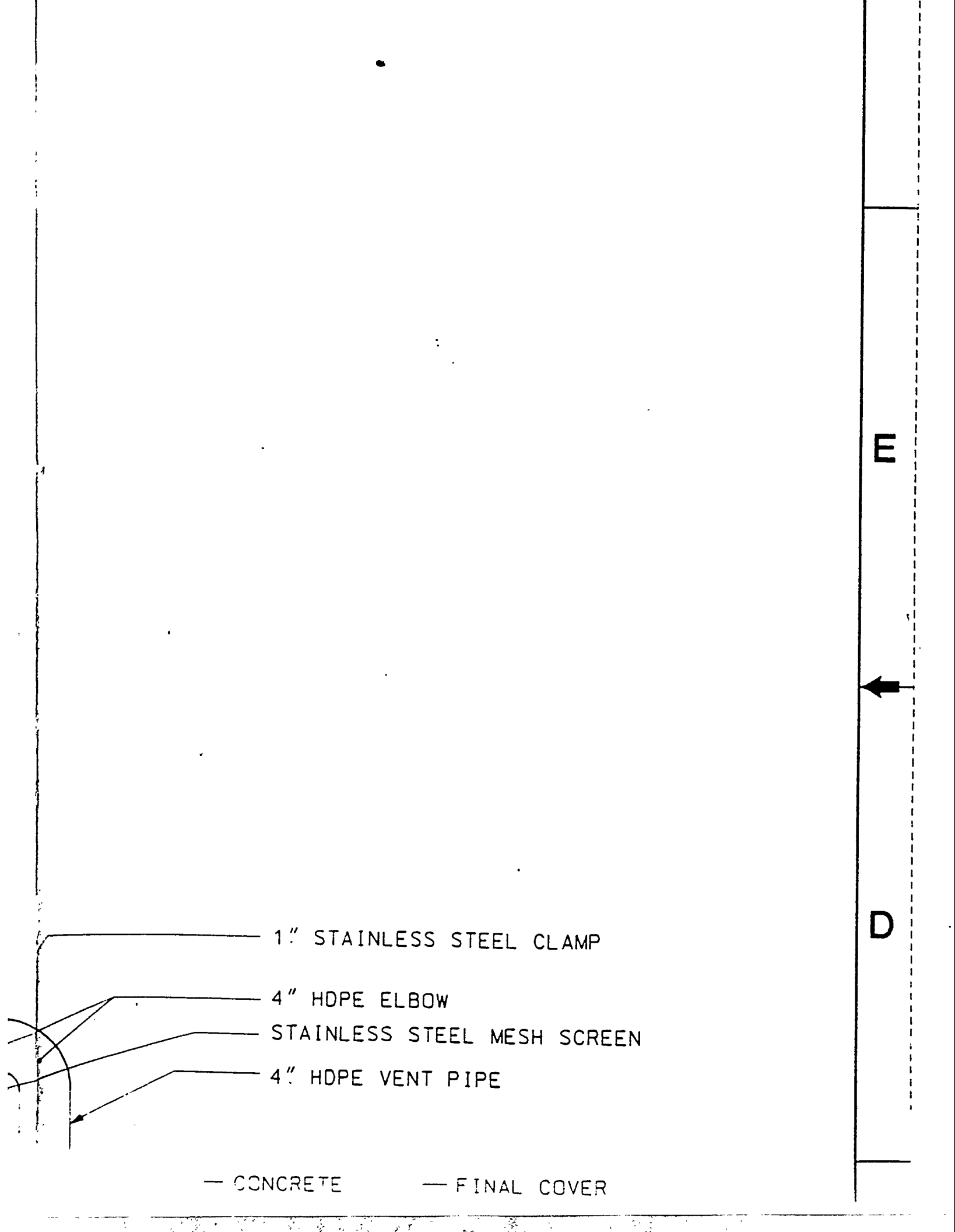




CLAY SOIL COVER





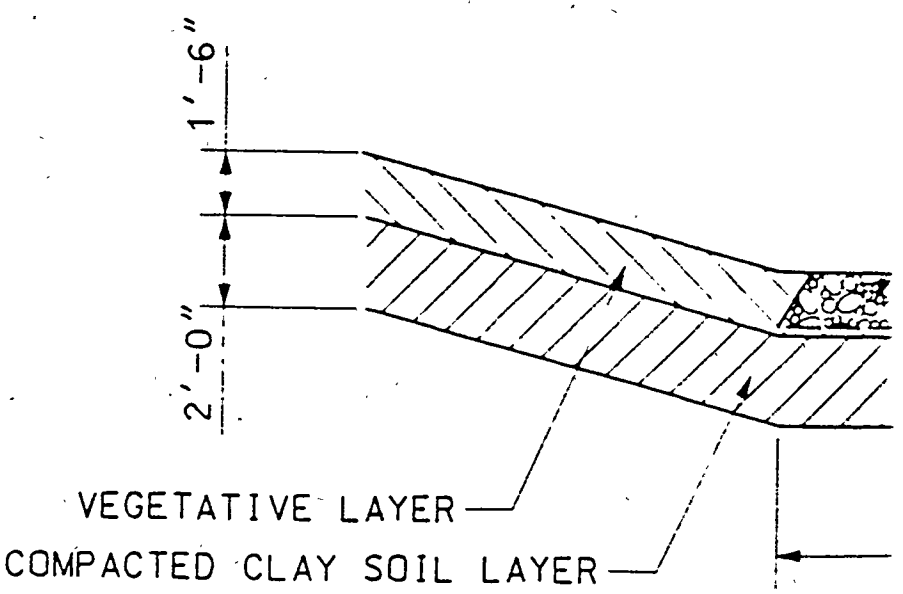

E
D
1" STAINLESS STEEL CLAMP
4" HDPE ELBOW
STAINLESS STEEL MESH SCREEN
4" HDPE VENT PIPE
— CONCRETE
— FINAL COVER

1. TERMI
ALONG

2. SECTI(

3. TRANS
INCRE/

COMPOSITE C



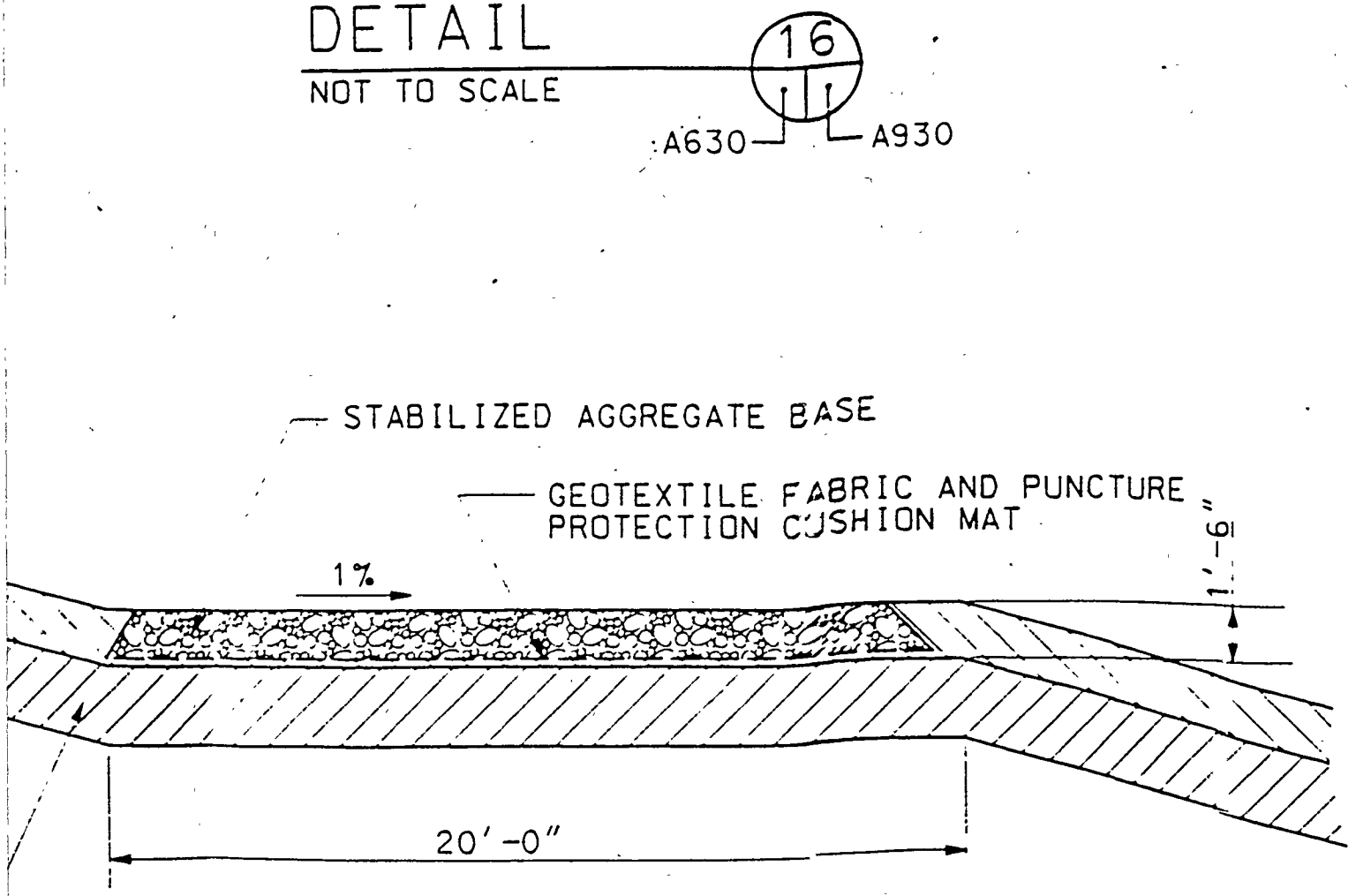
NOTE:

1. GEOME
LANDF

1. TERMINATE COMPOSITE GEONET DRAINAGE LAYER ALONG TEMPORARY GRADE ESTABLISHED DURING PHASED CLOSURE.
2. SECTION IS TAKEN PERPENDICULAR TO THE COVER INTERFACE.
3. TRANSITION OVERALL COVER THICKNESS FROM 3' TO 4' BY INCREASING INDIVIDUAL LAYER THICKNESSES AS SHOWN.

ITE COVER/CLAY SOIL COVER INTERFAC

DETAIL 16
NOT TO SCALE
A630 A930

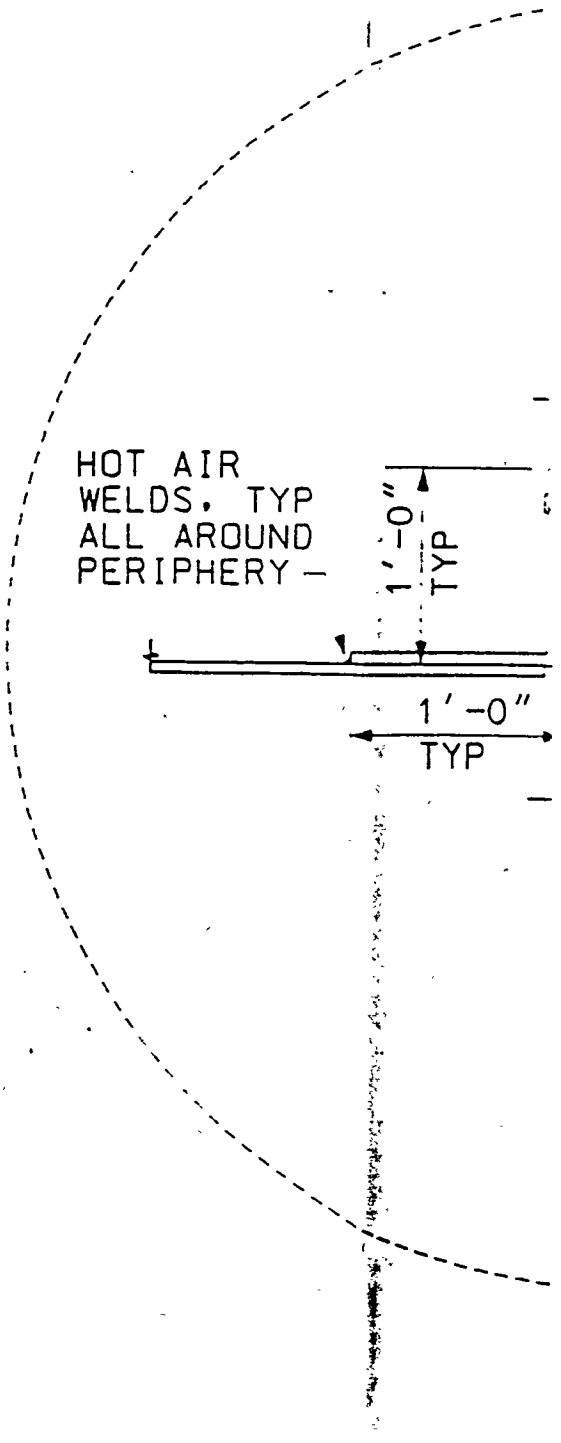


NOTE:

1. GEOMEMBRANE, GAS VENT, DRAINAGE, AND SACRIFICAL SOIL LAYERS WI LANDFILL COVER ARE NOT SHOWN FOR CLARITY.

COVER ACCESS ROAD

DETAIL 18
NOT TO SCALE

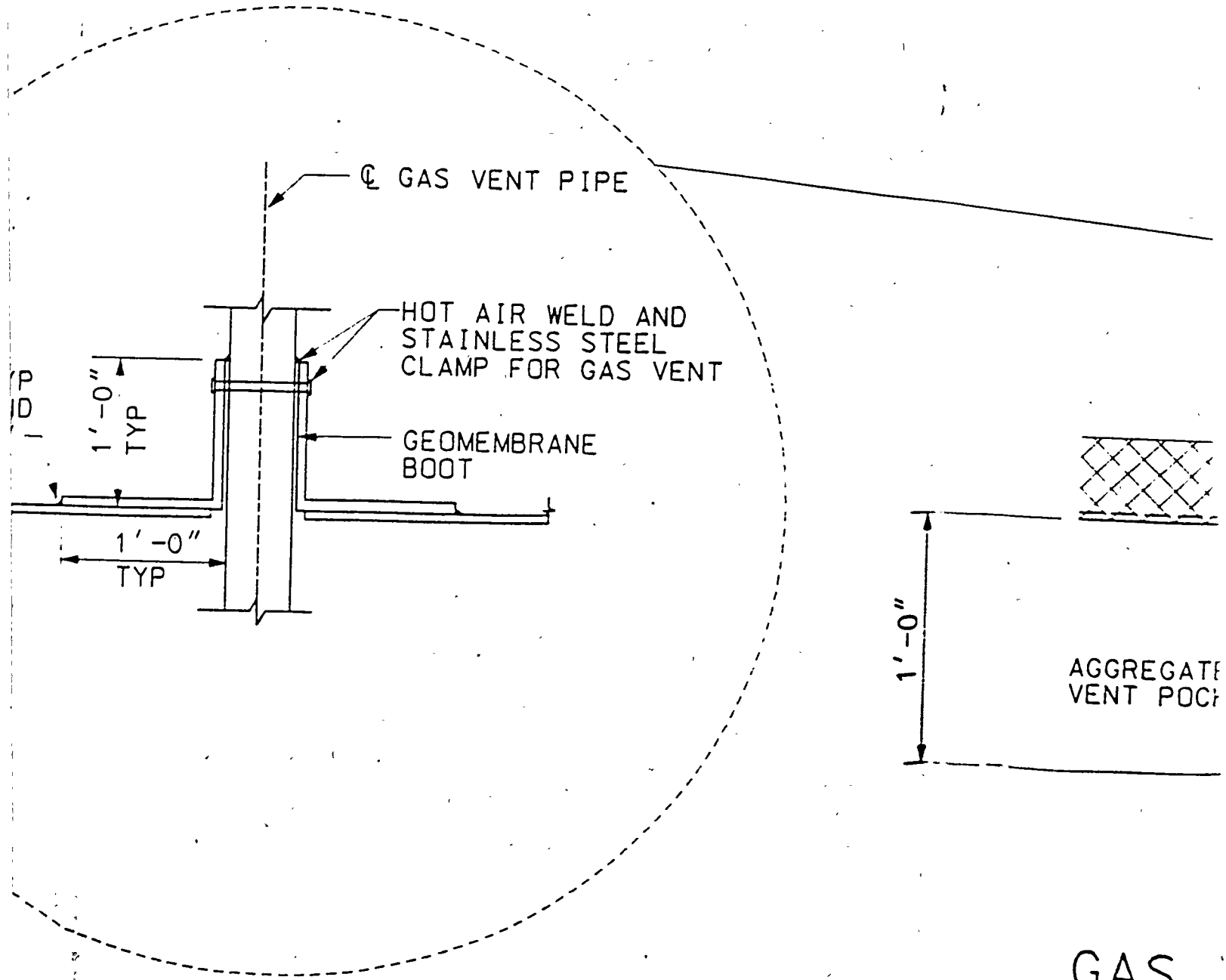

HOT AIR
WELDS. TYP
ALL AROUND
PERIPHERY
1'-0"
TYP
1'-0"
TYP

DETAIL

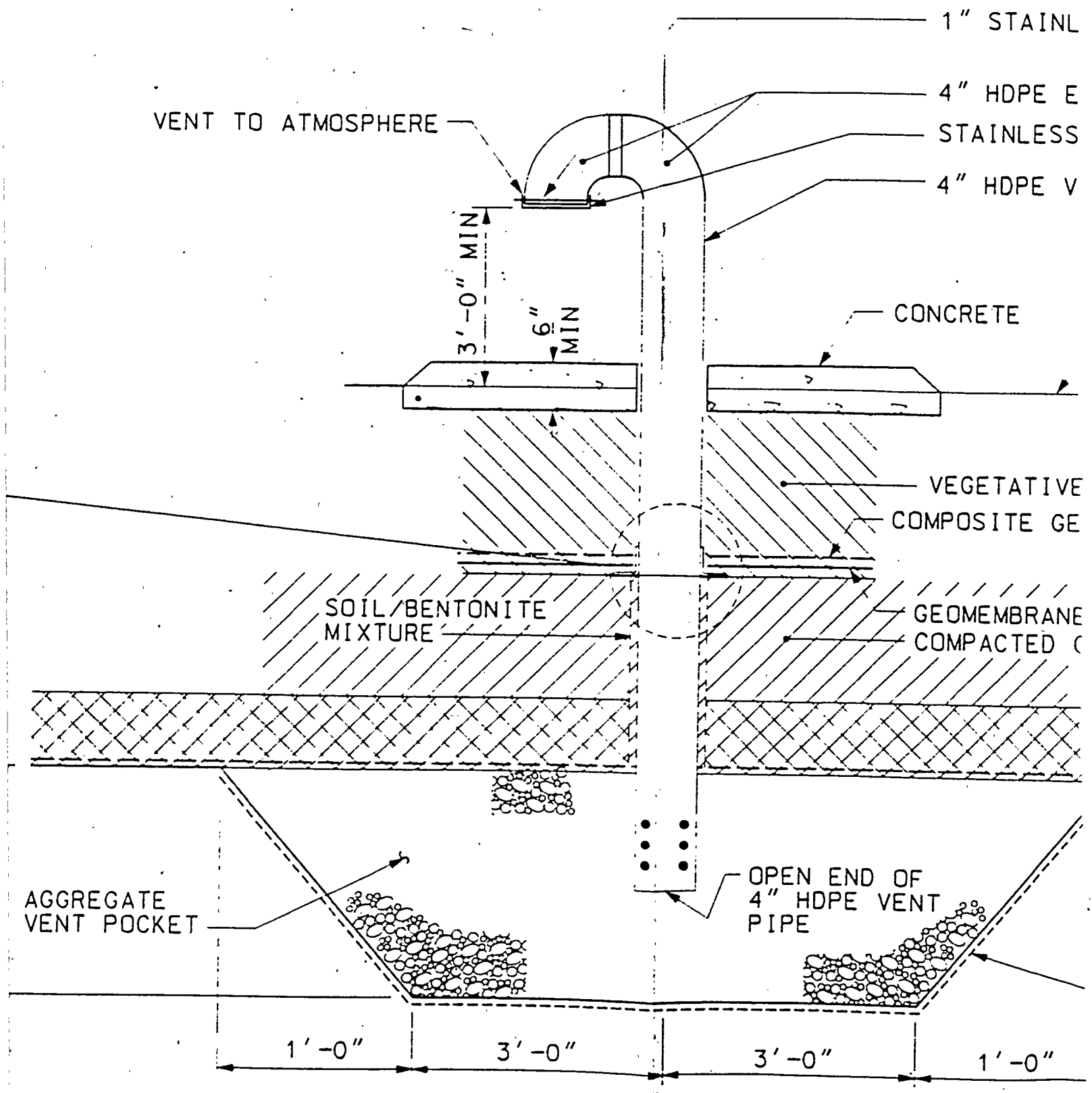
NOT TO SCALE

17

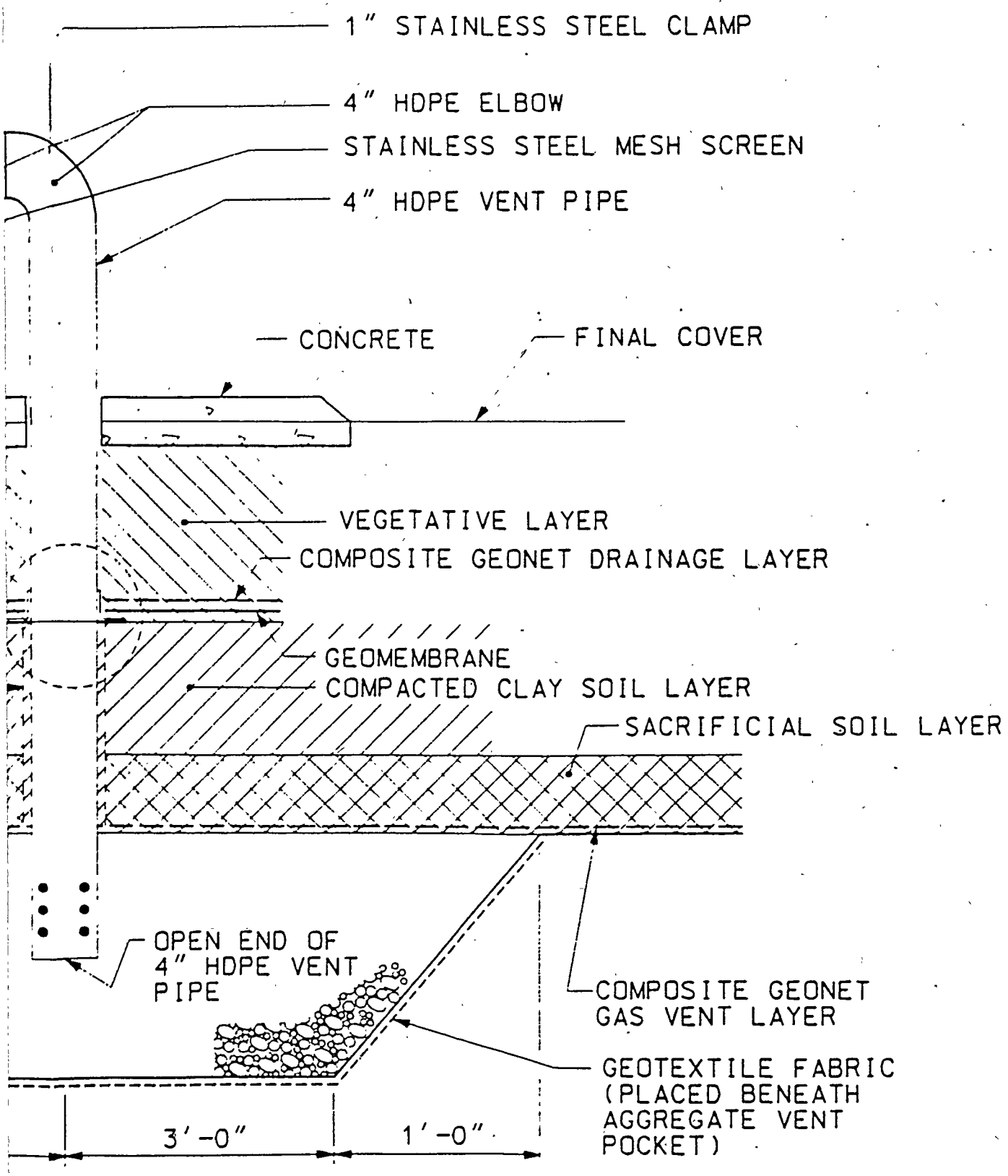
A630 — A930



GAS



GAS VENT SECTION FOR COMPOSITE CO



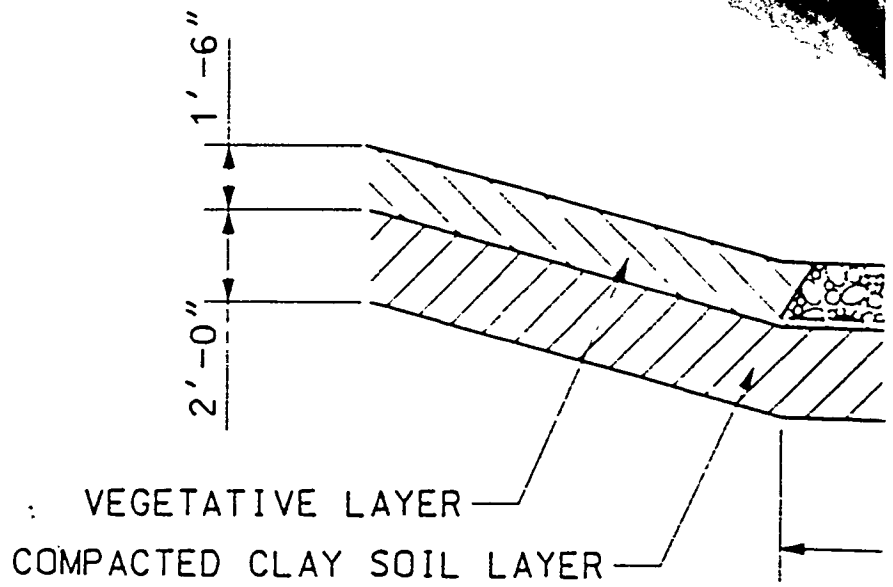
OR COMPOSITE COVER

D

C

B

C2F900006930



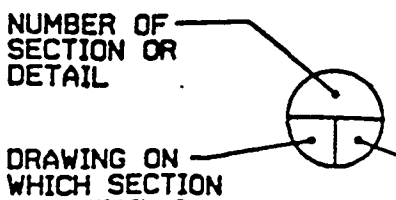
NOTE:

1. GEOME
   LANDF

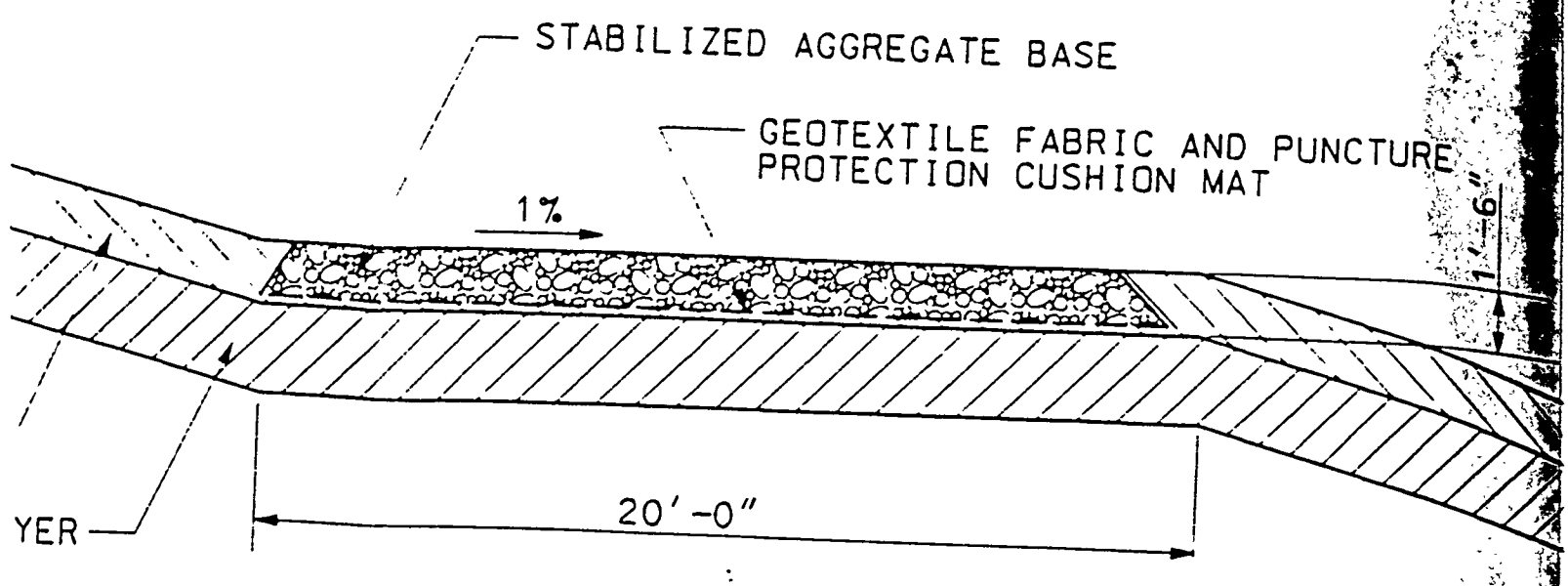
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EG-C-37 Revi
Guideline Do
UCN-19586 (12

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SECTION AND DETAIL KEY



NOTE:

1. GEOMEMBRANE, GAS VENT, DRAINAGE, AND SACRIFICAL SOIL LAYE LANDFILL COVER ARE NOT SHOWN FOR CLARITY.

COVER ACCESS ROAD DETAIL

NOT TO SCALE

18
A630 A930

Document Rev. NO: ___ Date: ___
EG-C-37 Review By: ___
Guideline Document: ___
UCN-19586 (12356 4-93)

DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

DETAIL KEY

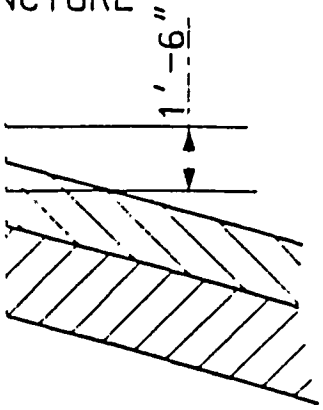
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CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

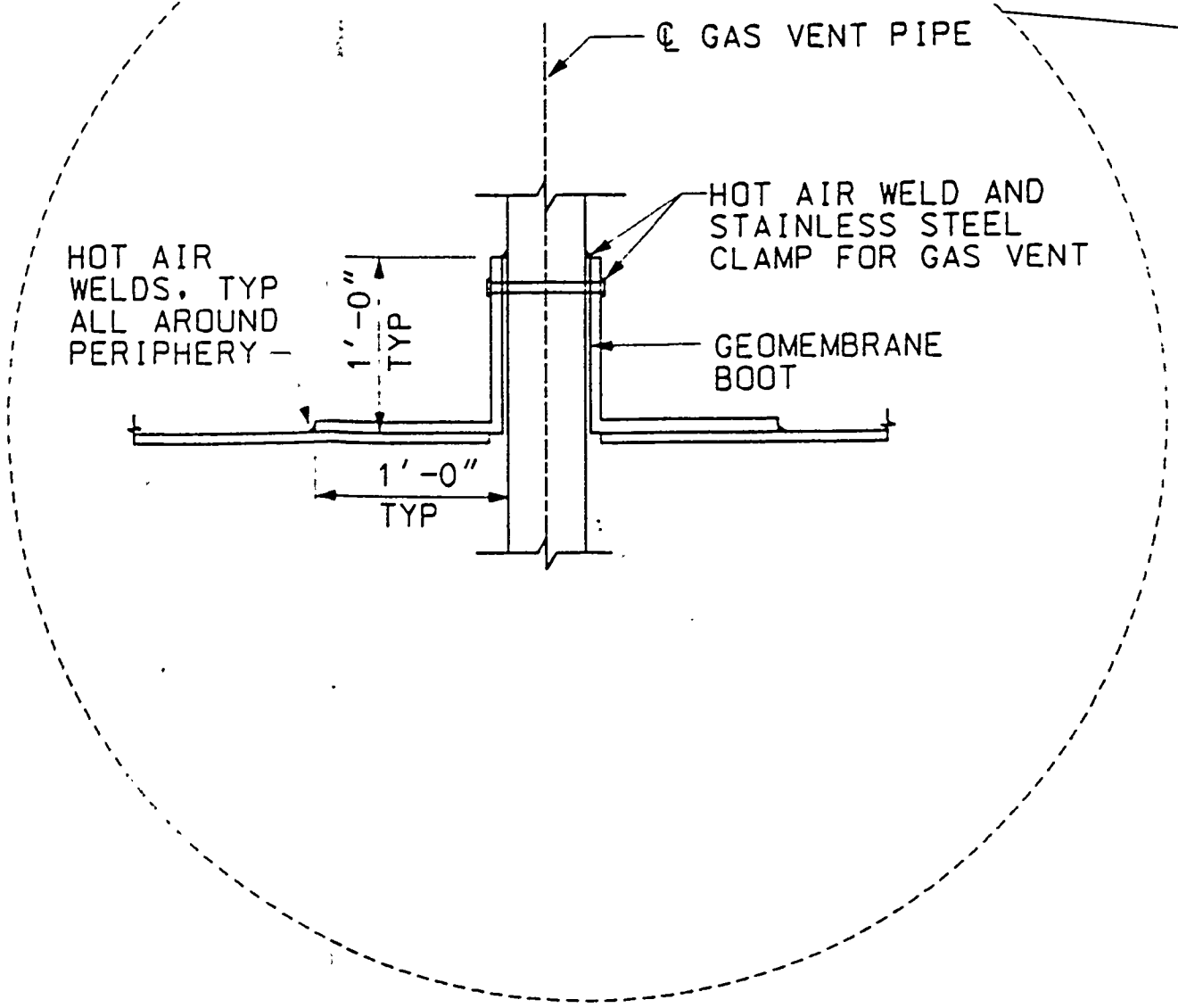
REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	REVISION
0				ISSUE FOR PE

NCTURE



IL SOIL LAYERS WITHIN

DESCRIPTION	BY	CHK	SECT	DEPT	DATE	PE	REQ	DA
ISSUE FOR PERMITTING	JGA	WPT	—	JLC	8/19/95			
REVISION OR ISSUE PURPOSE								REV



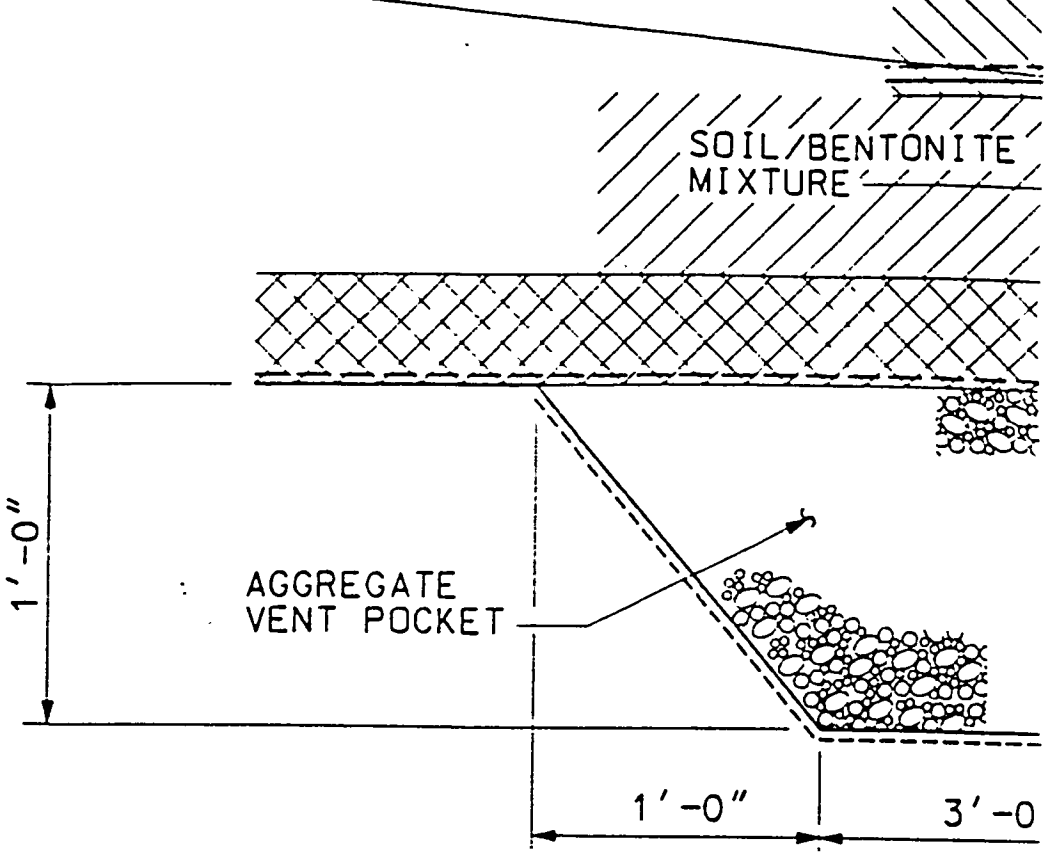
E	MMES	DATE	RPE	RPE NO	DATE			QA	DATE	ST	CV	EC	EE	EM	IE	M	F
	WMS	8/18/99	WPT	22911	8/19/99					—	ORV	—	—	—	—	—	

ION APPROVALS

SQUAD CHECK

AIR WELD AND
NLESS STEEL
P FOR GAS VENT

EMBRANE



GAS VENT SECTION

DETAIL

NOT TO SCALE

CV	EC	EE	EM	IE	M	PD	SE	ARC	VER
	—	—	—	—	—	—	—	—	—

SQUAD CHECK

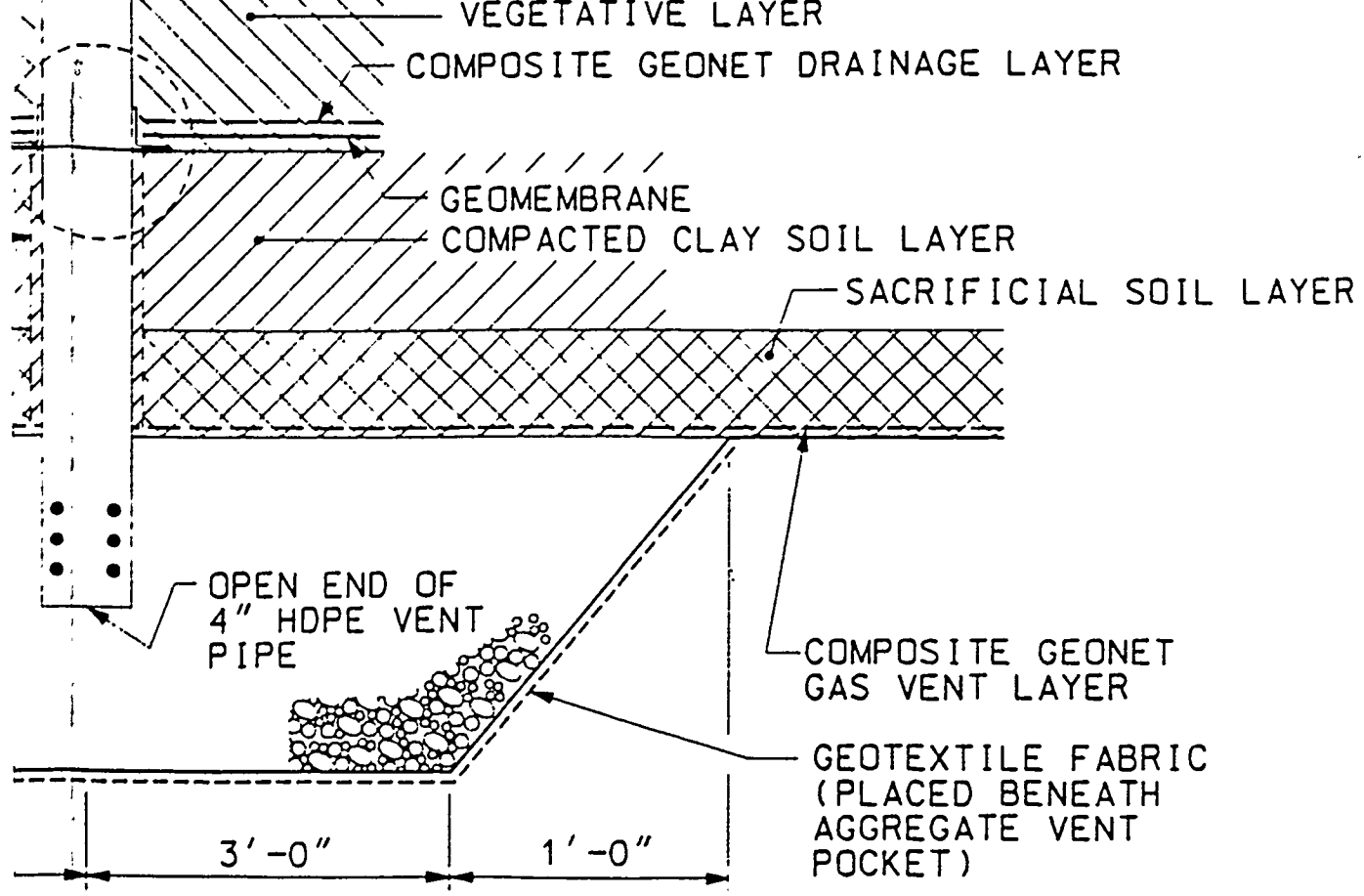
RPE

WILLIAM PATRICK TAYLOR
REGISTERED ENGINEER
AGRICULTURE
No. 022811
STATE OF TENNESSEE

REV. 0 DATE 8/19/95

DRAWING APPROVALS

DSGN	
DRW	
CHKR	
SECT	—
DEPT	
PE	
PJ	
REQ	
MMES	



OR COMPOSITE COVER

19

A630 — A930

	8/19/95
	8/19/95
	8/19/95
	8/19/95
	8/28/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-85-84OR21400 and DE-AC-85-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

LANDFILL DETAILS - VII

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U

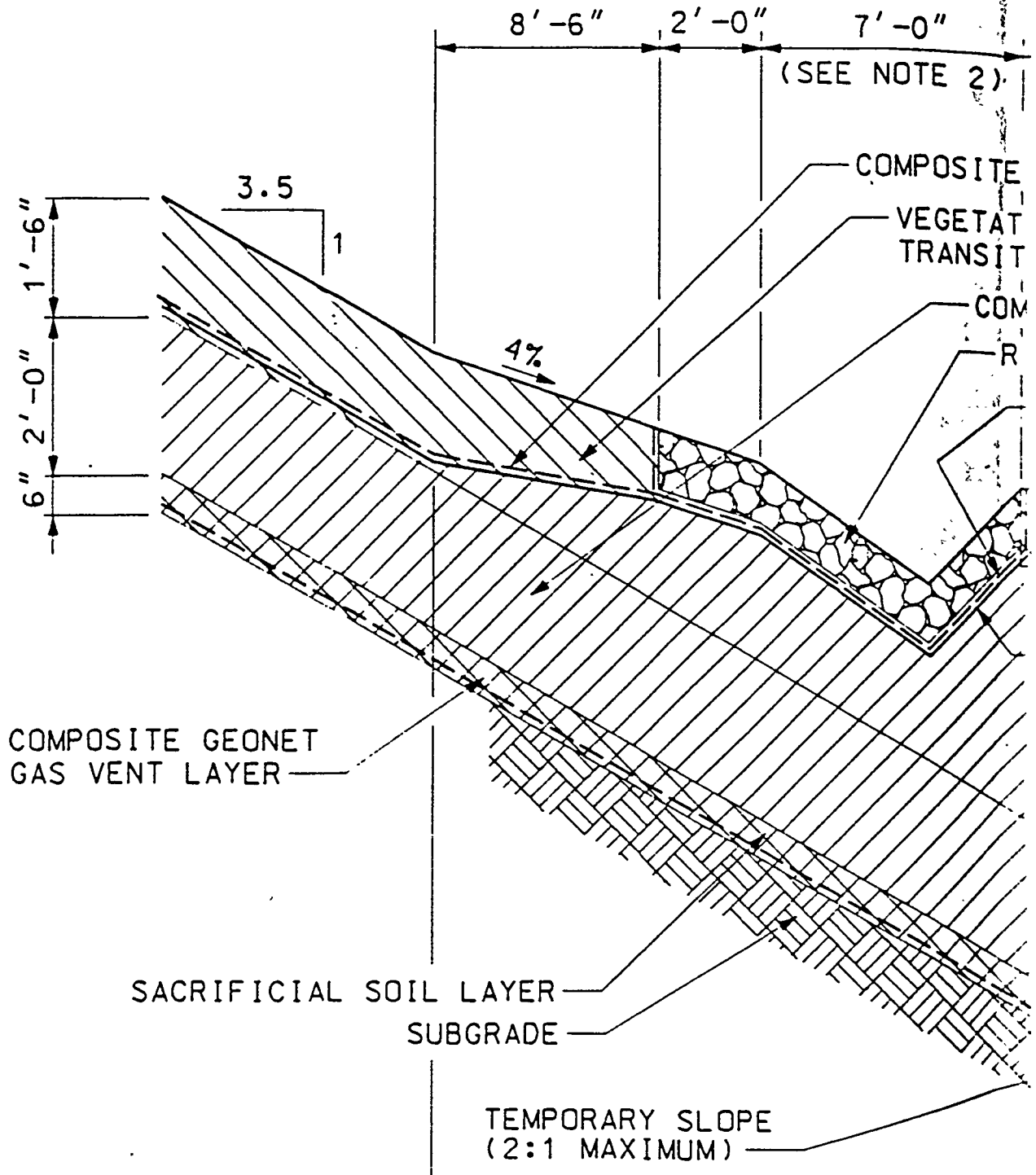
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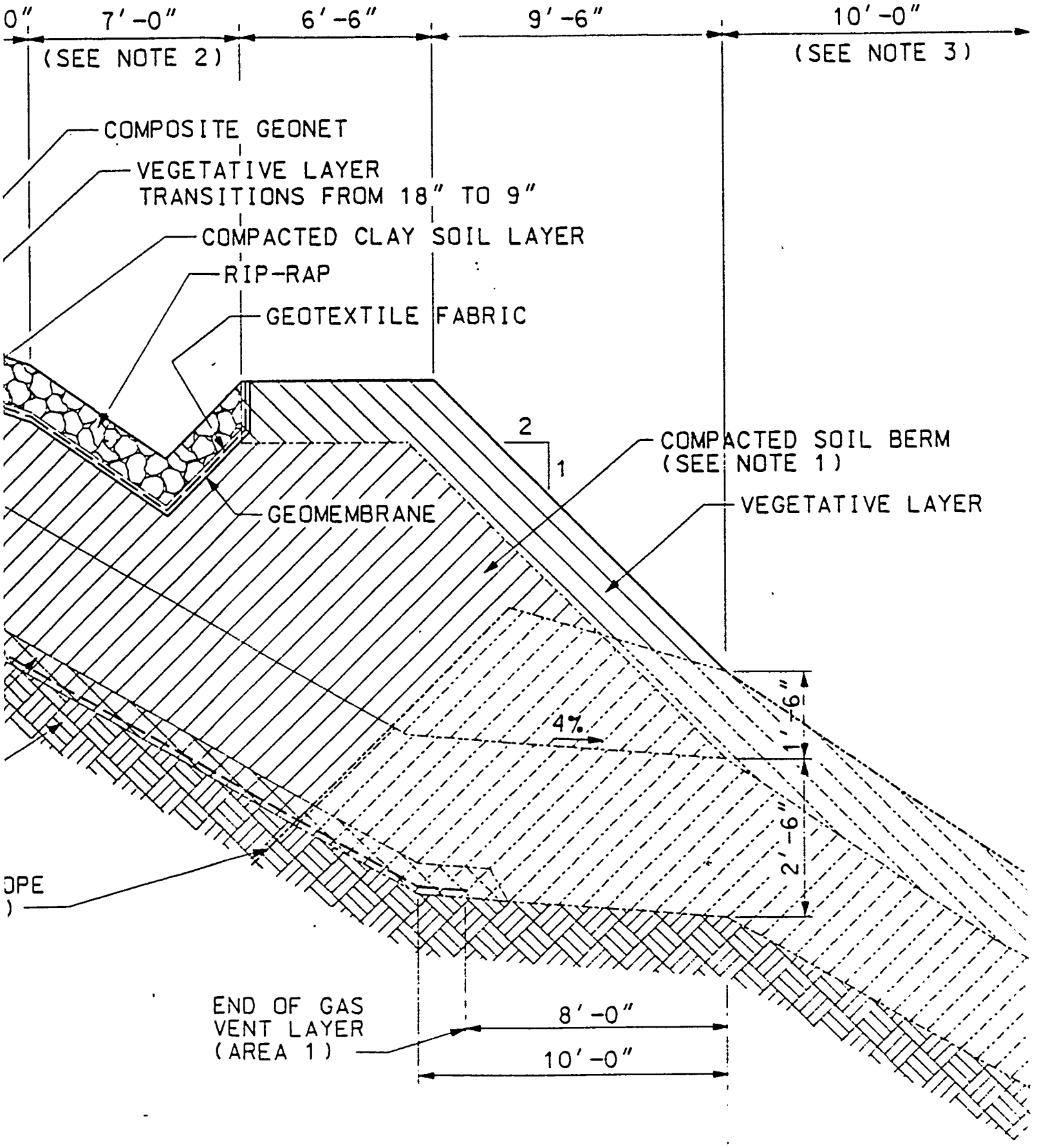
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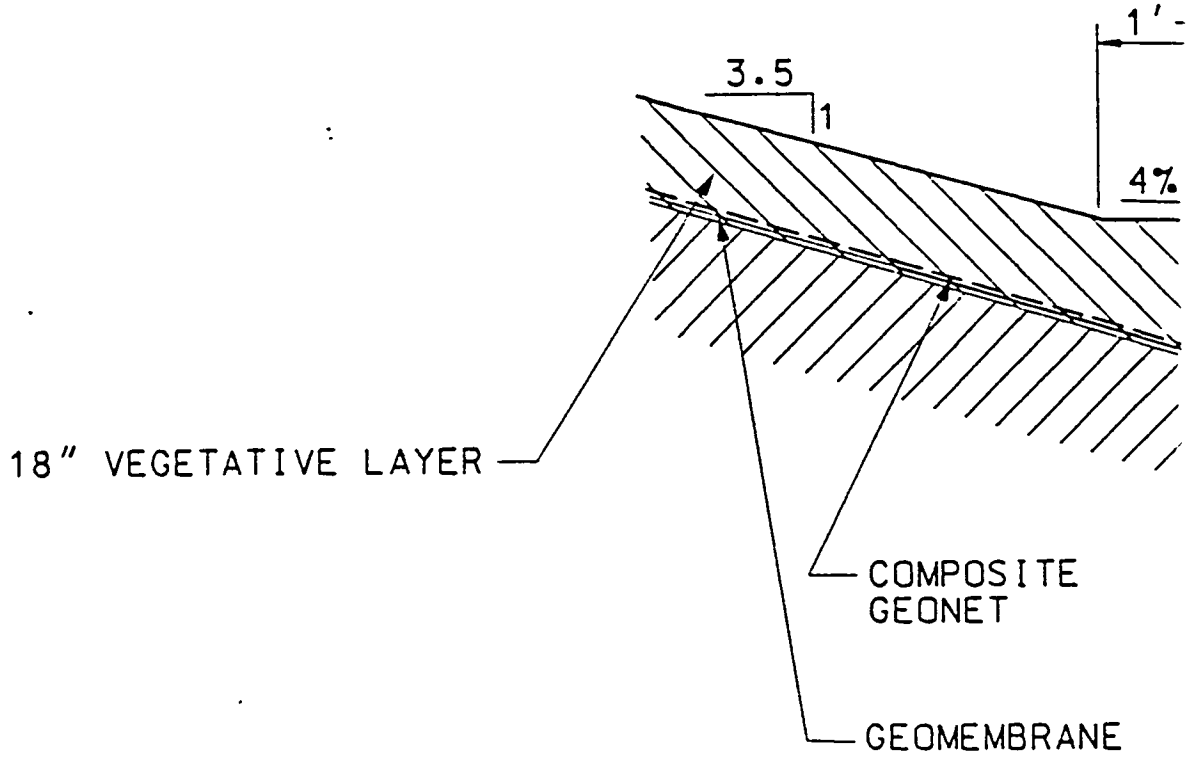
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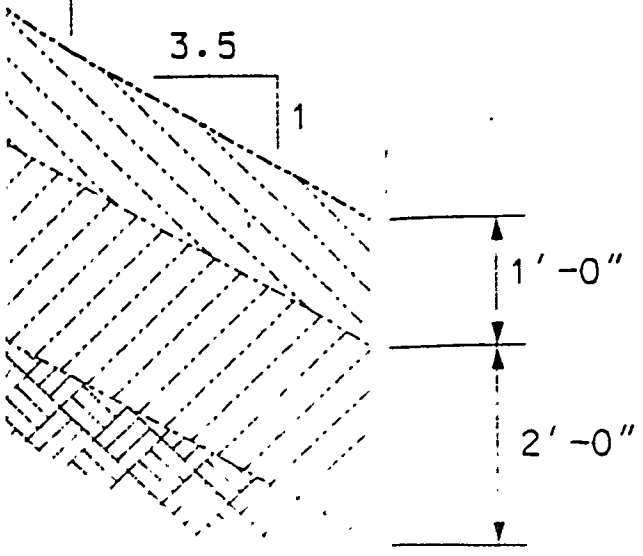
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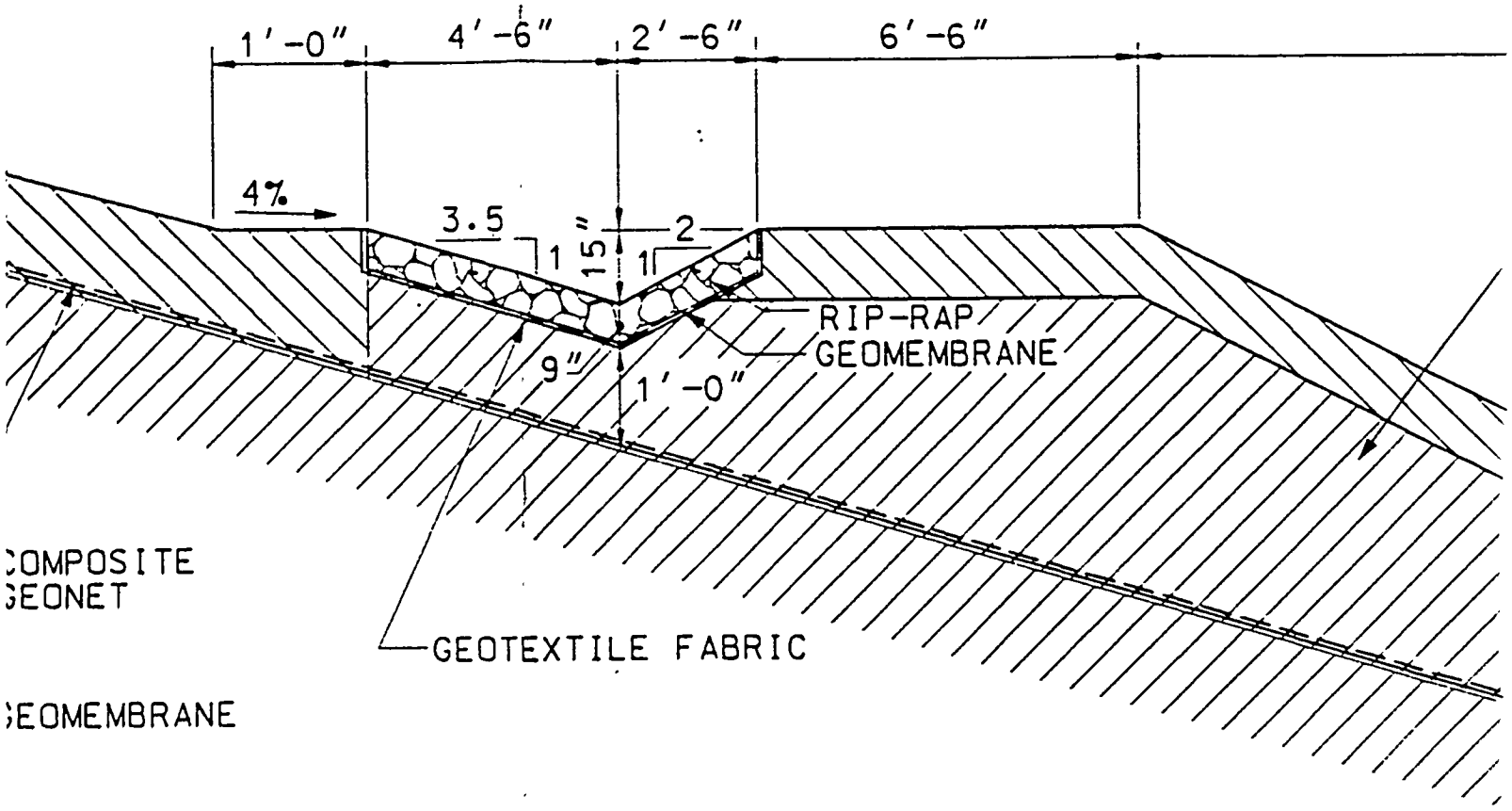
A


8'-6"
2'-0"
7'-0"
(SEE NOTE 2)
3.5
1
1'-6"
2'-0"
6"
4%
COMPOSITE
VEGETAT
TRANSIT
COM
R
COMPOSITE GEONET
GAS VENT LAYER
SACRIFICIAL SOIL LAYER
SUBGRADE
TEMPORARY SLOPE
(2:1 MAXIMUM)
END
VEN
(AR


0"
7'-0"
(SEE NOTE 2)
6'-6"
9'-6"
10'-0"
(SEE NOTE 3)
COMPOSITE GEONET
VEGETATIVE LAYER
TRANSITIONS FROM 18" TO 9"
COMPACTED CLAY SOIL LAYER
RIP-RAP
GEOTEXTILE FABRIC
2
1
COMPACTED SOIL BERM
(SEE NOTE 1)
VEGETATIVE LAYER
GEOMEMBRANE
4%
6"
1'
2'-6"
OPE
)
END OF GAS
VENT LAYER
(AREA 1)
8'-0"
10'-0"


1'-
3.5
1
4%
18" VEGETATIVE LAYER
COMPOSITE
GEONET
GEOMEMBRANE


3.5
1
1'-0"
2'-0"



NOTES:

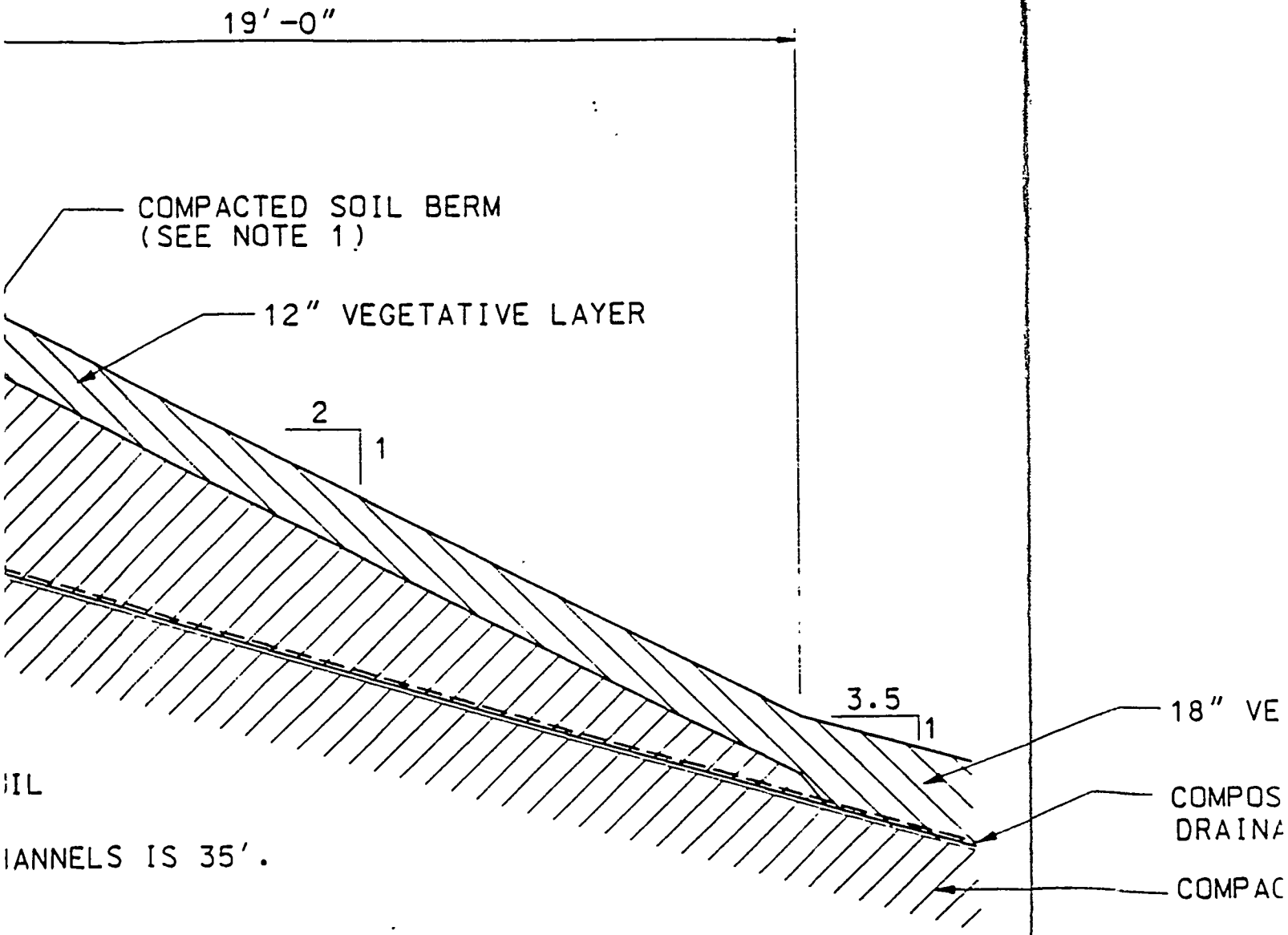
1. COMPACTED SOIL BERM. APPLY TOP 12" TOPSOIL TO SUPPORT VEGETATIVE COVER.
2. MAXIMUM VERTICAL SPACING BETWEEN BERM CHANN
3. MAXIMUM SLOPE OF BERM CHANNEL IS 5%.
4. GEOMEMBRANE USED TO LINE BERM DRAINAGE CHAN BE THE SAME AS THE GEOMEMBRANE USED IN THE

TYPICAL BERM DRAINAGE CHANN

DETAIL

NOT TO SCALE

21



IL

IANNELS IS 35'.

CHANNEL SHALL
THE COMPOSITE COVER.

NNEL DETAIL

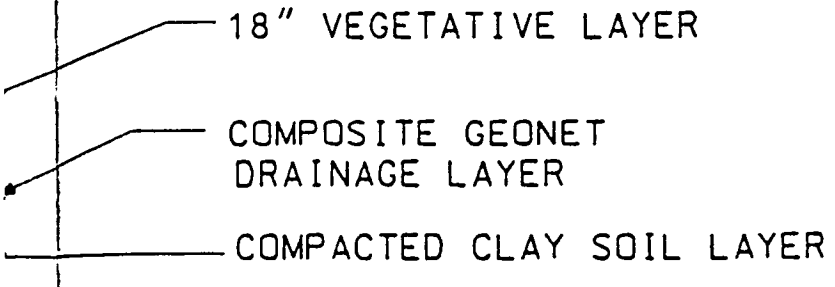
NEXT ASS'Y:

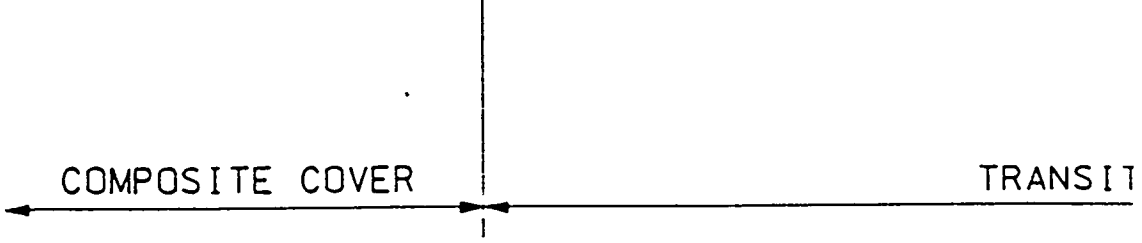
1 FINAL ASS'Y:

H

G

F





NOTES:

1. COMPACTED TO SUPPORT
2. FOR DIMENS
3. TRANSITION INCREASING

BERM DRAINAGE



ES:

:MPACTED SOIL BERM. APPLY TOP 12" TOPSOIL
; SUPPORT VEGETATIVE COVER.

)R DIMENSIONS OF DRAINAGE CHANNEL. SEE DETAIL 21.

?ANSITION OVERALL COVER THICKNESS FROM 3' TO 4' BY
'ICREASING INDIVIDUAL LAYER THICKNESSES AS SHOWN.

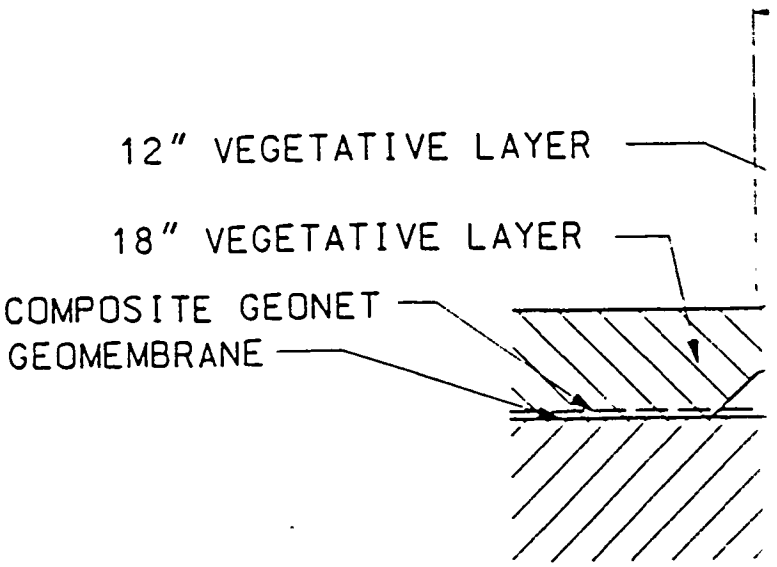
INAGE CHANNEL WITH COVER TRANSITIC

DETAIL 20

NOT TO SCALE

A630 A931



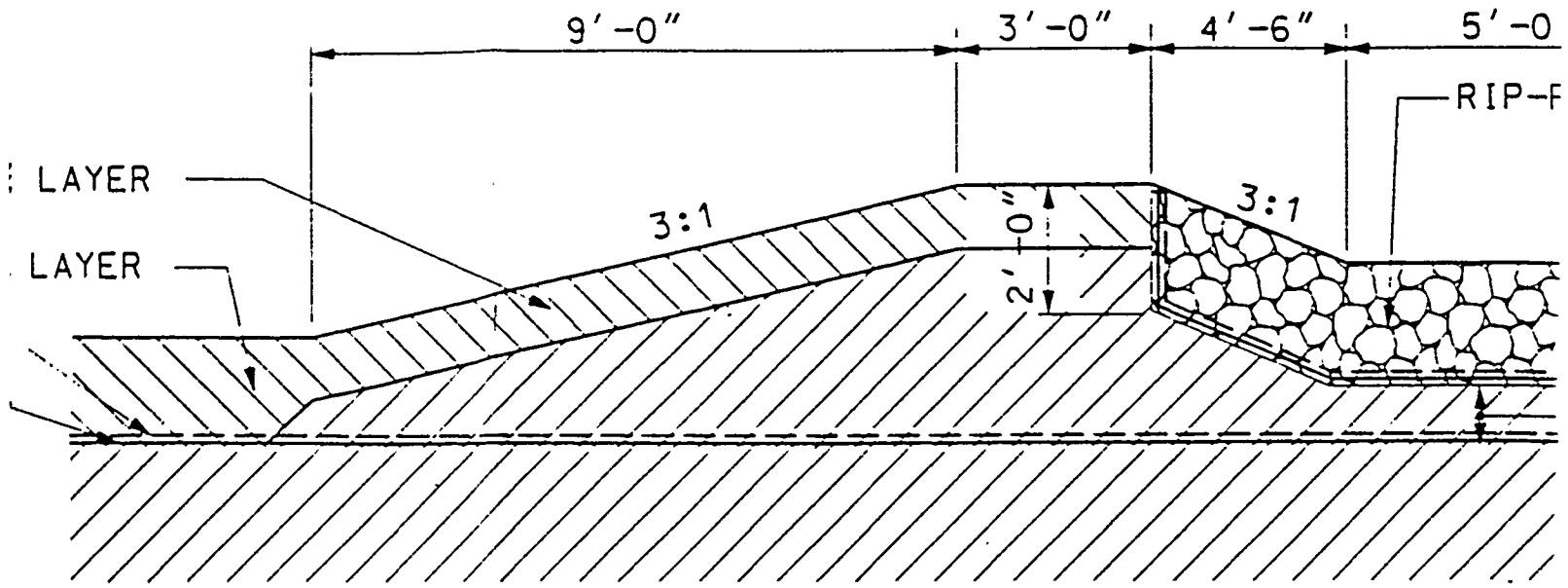

12" VEGETATIVE LAYER
18" VEGETATIVE LAYER
COMPOSITE GEONET
GEOMEMBRANE

ION

NOT TO SCALE

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NOTES:

1. COMPACTED SOIL BERM. APPLY TOP TO SUPPORT VEGETATIVE COVER.
2. GEOMEMBRANE USED TO LINE BERM. C BE THE SAME AS THE GEOMEMBRANE

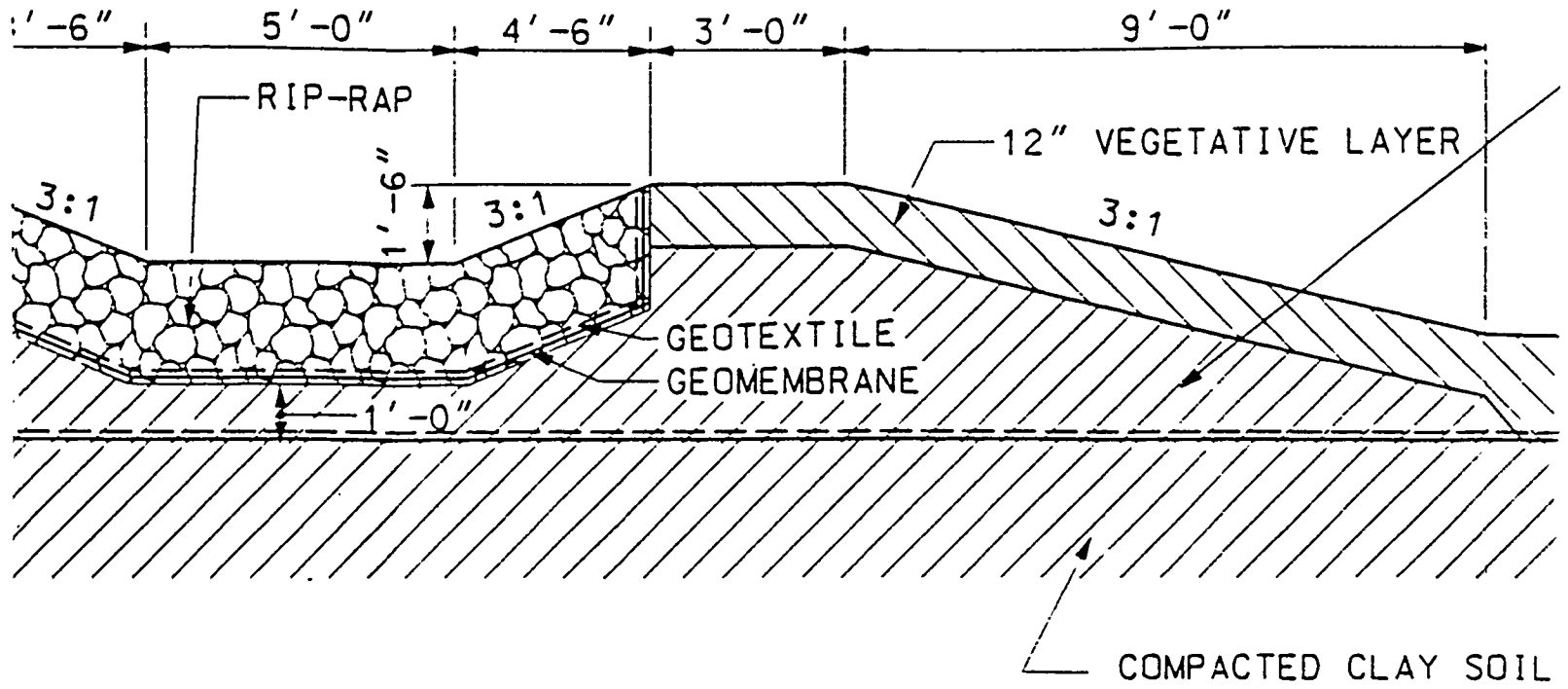
LET DOWN CHANNEL

DETAIL

NOT TO SCALE

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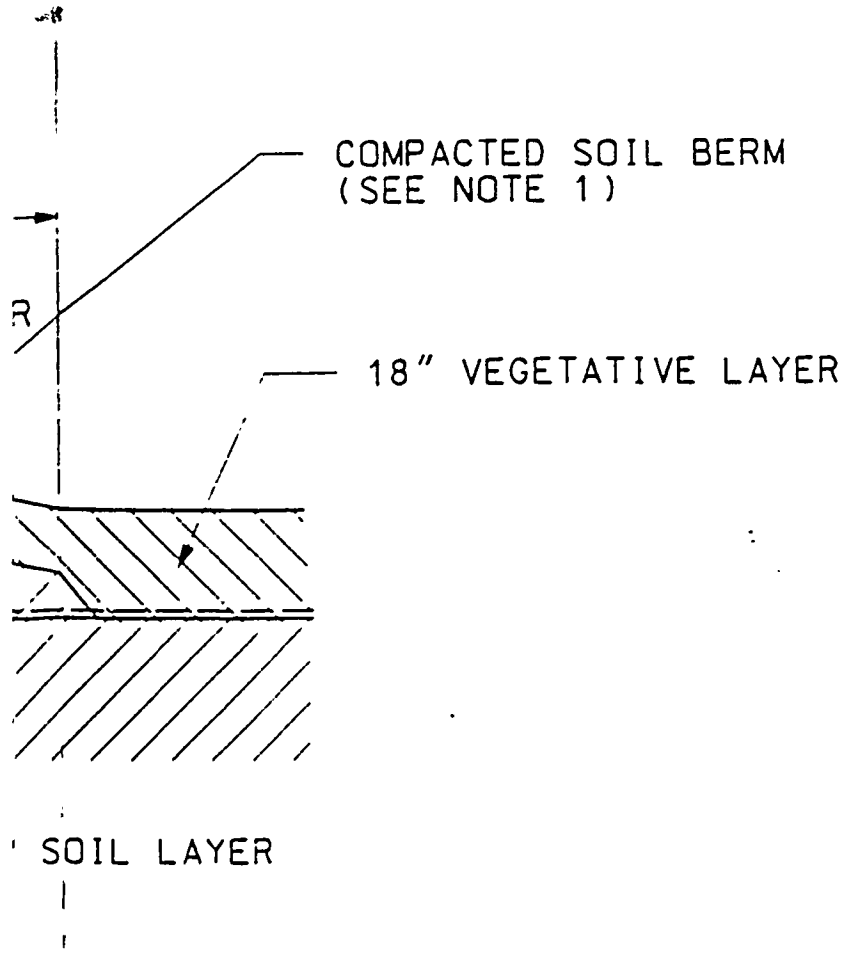


ERM. APPLY TOP 12" TOPSOIL
ATIVE COVER.

TO LINE BERM DRAINAGE CHANNEL SHALL
HE GEOMEMBRANE USED IN THE COMPOSITE COVER.

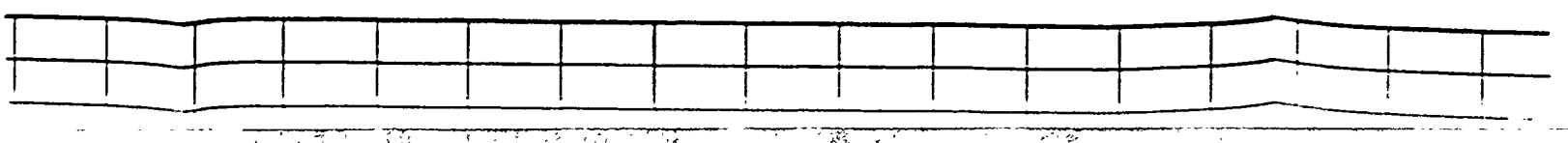
CHANNEL DETAIL

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COMPACTED SOIL BERM
(SEE NOTE 1)
18" VEGETATIVE LAYER
SOIL LAYER

E

D



							RPE	DSGN
							PATRICK	DRW G. Ashworth

C

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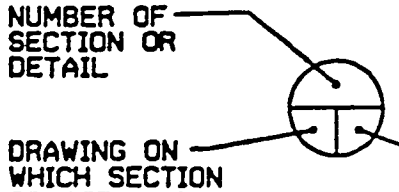
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	8/9/95

FOSTER WHEELER ENVIRONMENTAL CORPORATION / PARSONS ENGINEERING SCIENCE, INC.
OAK RIDGE, TENNESSEE
designed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-91OR21928
managed for the DEPARTMENT OF ENERGY by MARTIN MARIETTA ENERGY SYSTEMS, INC.
under U.S. GOVERNMENT contracts DE-AC-05-84OR21400 and DE-AC-05-76OR00001
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

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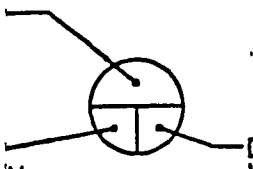


SECTION AND DETAIL KE

8

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Document Rev. No.: ___ Date: _____
EG-C-37 Review By: _____
Guideline Document: _____
UCN-19586 (12356 4-93)



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DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

AND DETAIL KEY

THIS DOCUMENT CONTROLLED BY

CHANGE CONTROL SYSTEM 2

ENGINEERING PROCEDURE EP-C-18

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	
0				ISSUE F

	DESCRIPTION	BY	CHK	SECT	DEPT	DATE	PE	RE
	ISSUE FOR PERMITTING	JBA	WPT	—	[illegible]	3/19/95		

REVISION OR ISSUE PURPOSE

3/19/95							WPT	22811	3/19/95					—		—	—
DATE	PE	REQ	DATE	MMES	DATE	RPE	RPE NO	DATE			QA	DATE	ST	CV	EC	EE

REVISION APPROVALS

CV	EC	EE	EM	IE	M	PD	SE	ARC	VER
DKL	—	—	—	—	—	—	—	—	—

SQUAD CHECK

RPE



REV. 0 DATE 8/19/95

DRAWING APPROVALS

DSGN	DKL
DRW	
CHKR	
SECT	—
DEPT	
PE	
PJ	
REQ	
MMES	

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Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

Y-12 INDUSTRIAL LANDFILL V

LANDFILL DETAILS - VIII

A

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	C	P	N	Y-12	YAREA	A	1	1	S	U

51	52	53		REV
NC	NA	AR	C2E900000A931	0

CAD FILE: C0001353 .DGN
SCALE: 20ft=1in

DATE: Aug. 18, 1995