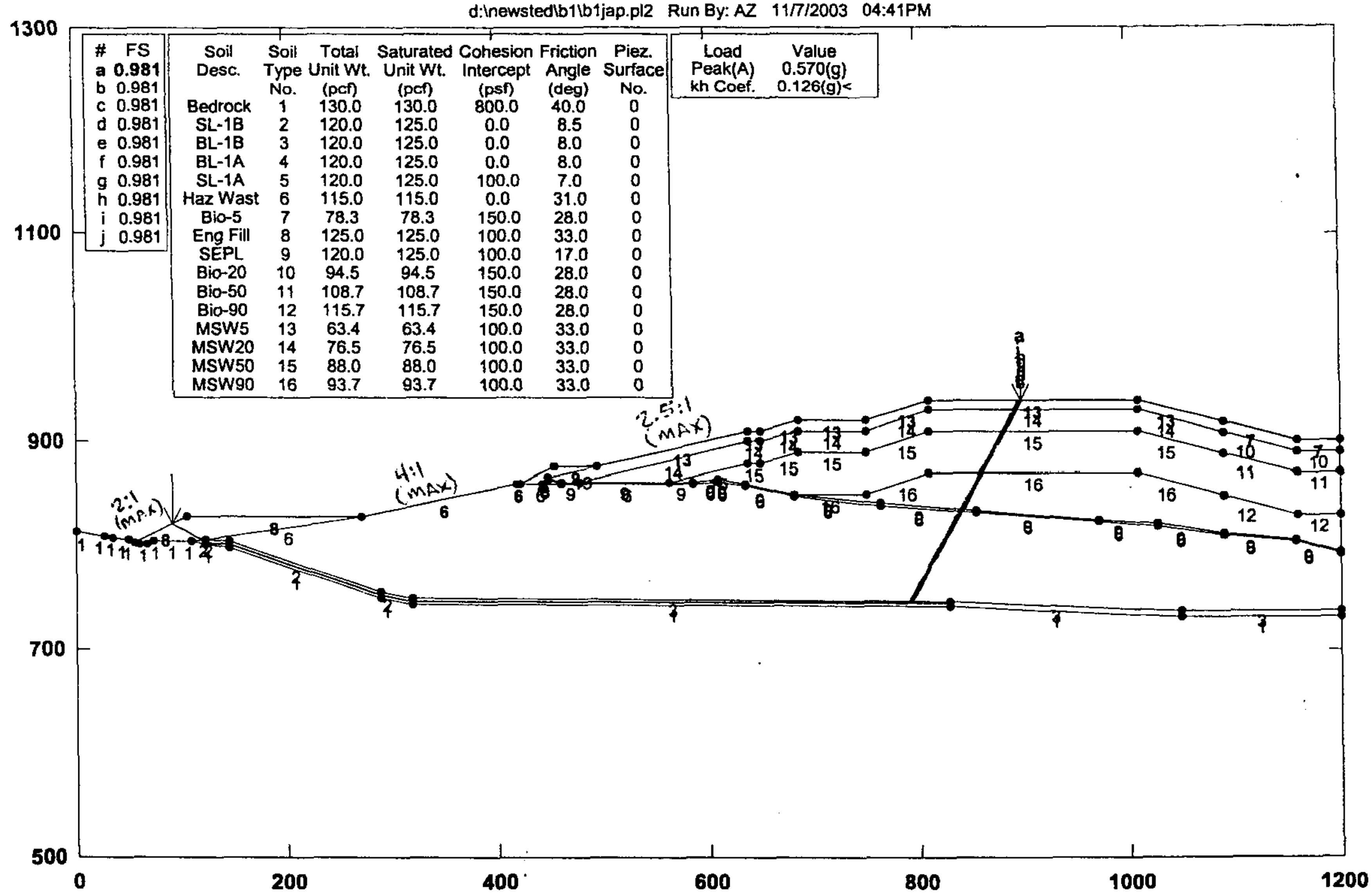
CROSS SECTION B-B'

KHF B-B' Pseudo-Static Janbu Block Search

d:\newsted\b1\b1jap.pl2 Run By: AZ 11/7/2003 04:41PM



#	FS
a	**0.981**
b	0.981
c	0.981
d	0.981
e	0.981
f	0.981
g	0.981
h	0.981
i	0.981
j	0.981

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
Bio-5	7	78.3	78.3	150.0	28.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
Bio-20	10	94.5	94.5	150.0	28.0	0
Bio-50	11	108.7	108.7	150.0	28.0	0
Bio-90	12	115.7	115.7	150.0	28.0	0
MSW5	13	63.4	63.4	100.0	33.0	0
MSW20	14	76.5	76.5	100.0	33.0	0
MSW50	15	88.0	88.0	100.0	33.0	0
MSW90	16	93.7	93.7	100.0	33.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.126(g)<

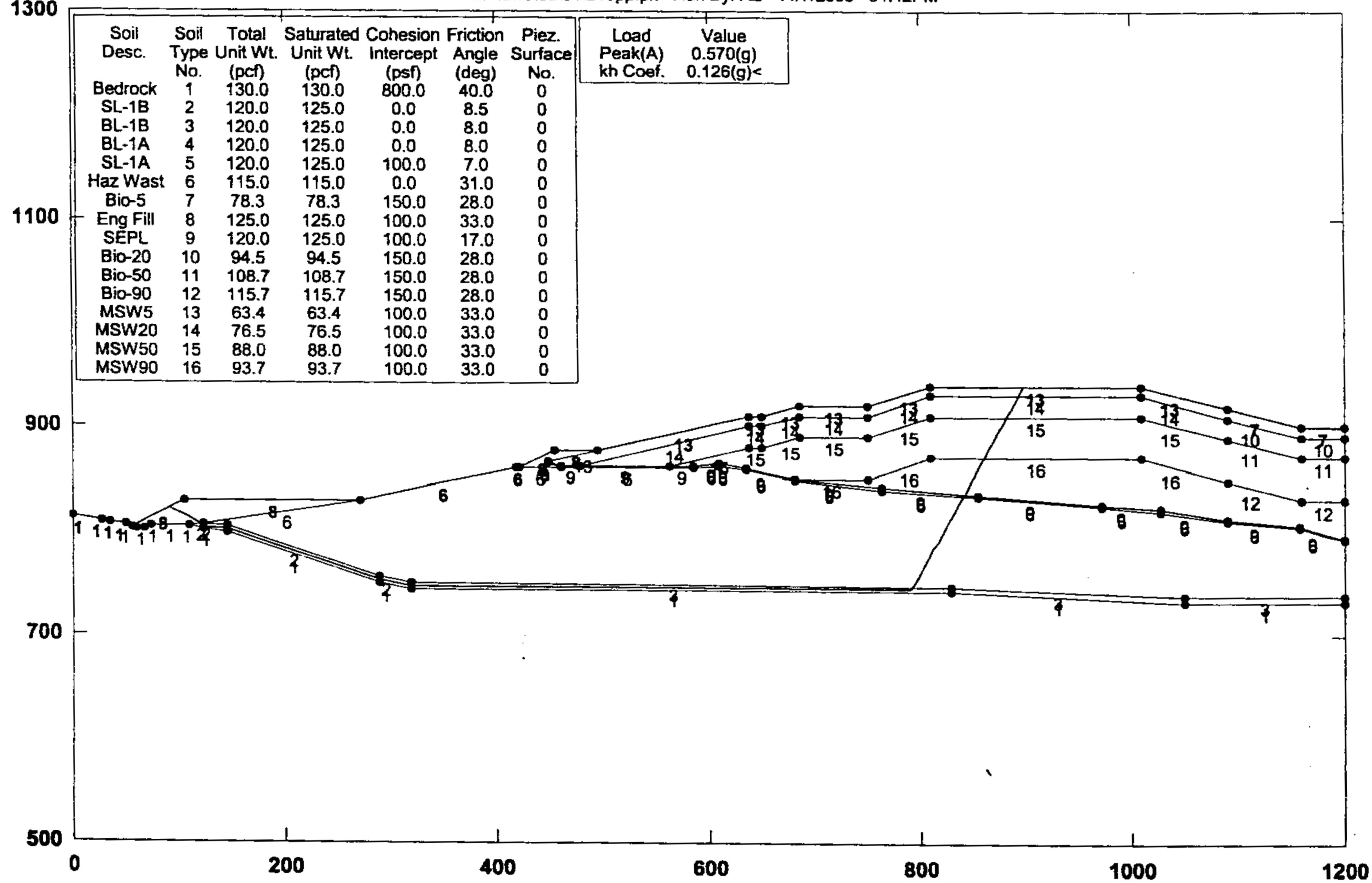
GSTABL7 v.2 FSmin=0.981

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF B-B' Failure Plane 1 Spencer Pseudo-Static Slope Stability

d:\newsted\b1\b1spp.plt Run By: AZ 11/7/2003 04:42PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
Bio-5	7	78.3	78.3	150.0	28.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
Bio-20	10	94.5	94.5	150.0	28.0	0
Bio-50	11	108.7	108.7	150.0	28.0	0
Bio-90	12	115.7	115.7	150.0	28.0	0
MSW5	13	63.4	63.4	100.0	33.0	0
MSW20	14	76.5	76.5	100.0	33.0	0
MSW50	15	88.0	88.0	100.0	33.0	0
MSW90	16	93.7	93.7	100.0	33.0	0

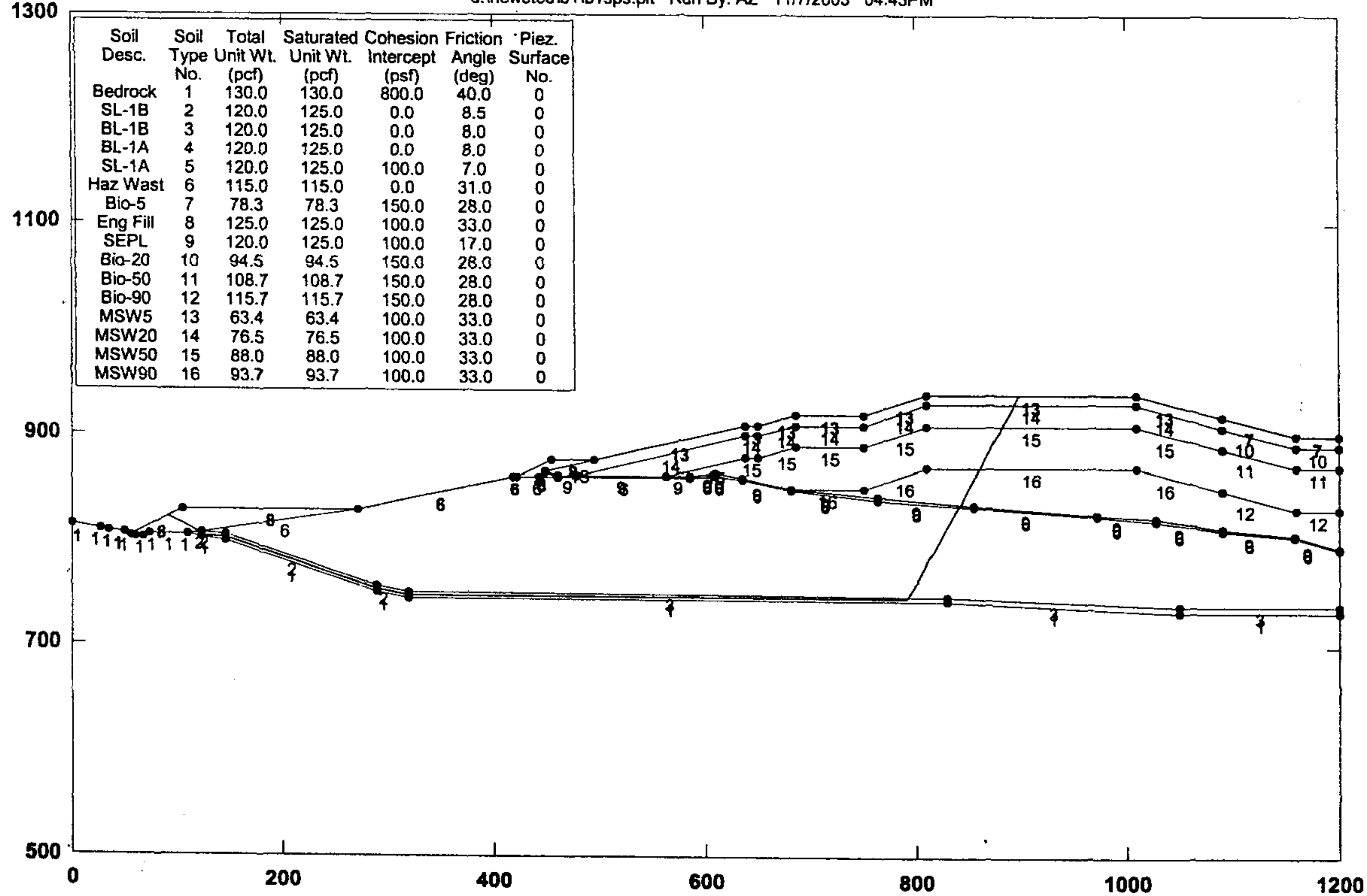
GSTABL7 v.2 FSmin=0.999

Factor Of Safety Is Calculated By GLE (Spencer's) Method (0-2)

GSTABL7

KHF B-B' Failure Plane 1 Spencer Static Slope Stability

d:\newsted\b1\b1sps.plt Run By: AZ 11/7/2003 04:43PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
Bio-5	7	78.3	78.3	150.0	28.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
Bio-20	10	94.5	94.5	150.0	28.0	0
Bio-50	11	108.7	108.7	150.0	28.0	0
Bio-90	12	115.7	115.7	150.0	28.0	0
MSW5	13	63.4	63.4	100.0	33.0	0
MSW20	14	76.5	76.5	100.0	33.0	0
MSW50	15	88.0	88.0	100.0	33.0	0
MSW90	16	93.7	93.7	100.0	33.0	0

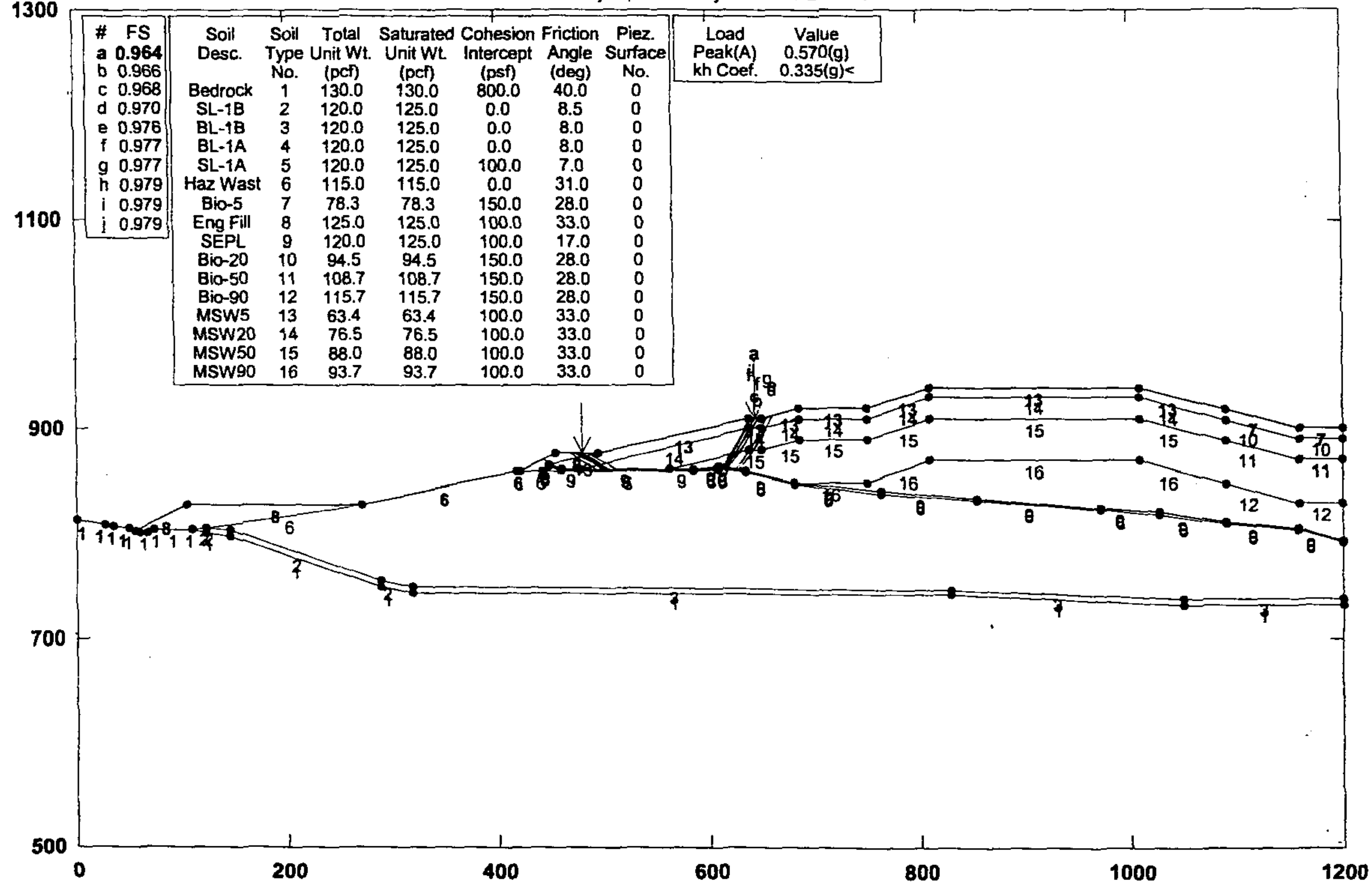
GSTABL7 v.2 FSmin=2.445

Factor Of Safety Is Calculated By GLE (Spencer's) Method (0-2)

GSTABL7

KHF B-B' Pseudo-Static Janbu Block Search

d:\newsted\b2\bj15.pl2 Run By: AZ 11/7/2003 04:46PM



#	FS
a	**0.964**
b	0.966
c	0.968
d	0.970
e	0.976
f	0.977
g	0.977
h	0.979
i	0.979
j	0.979

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
Bio-5	7	78.3	78.3	150.0	28.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
Bio-20	10	94.5	94.5	150.0	28.0	0
Bio-50	11	108.7	108.7	150.0	28.0	0
Bio-90	12	115.7	115.7	150.0	28.0	0
MSW5	13	63.4	63.4	100.0	33.0	0
MSW20	14	76.5	76.5	100.0	33.0	0
MSW50	15	88.0	88.0	100.0	33.0	0
MSW90	16	93.7	93.7	100.0	33.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.335(g)<

GSTABL7 v.2 FSmin=0.964

Safety Factors Are Calculated By The Simplified Janbu Method

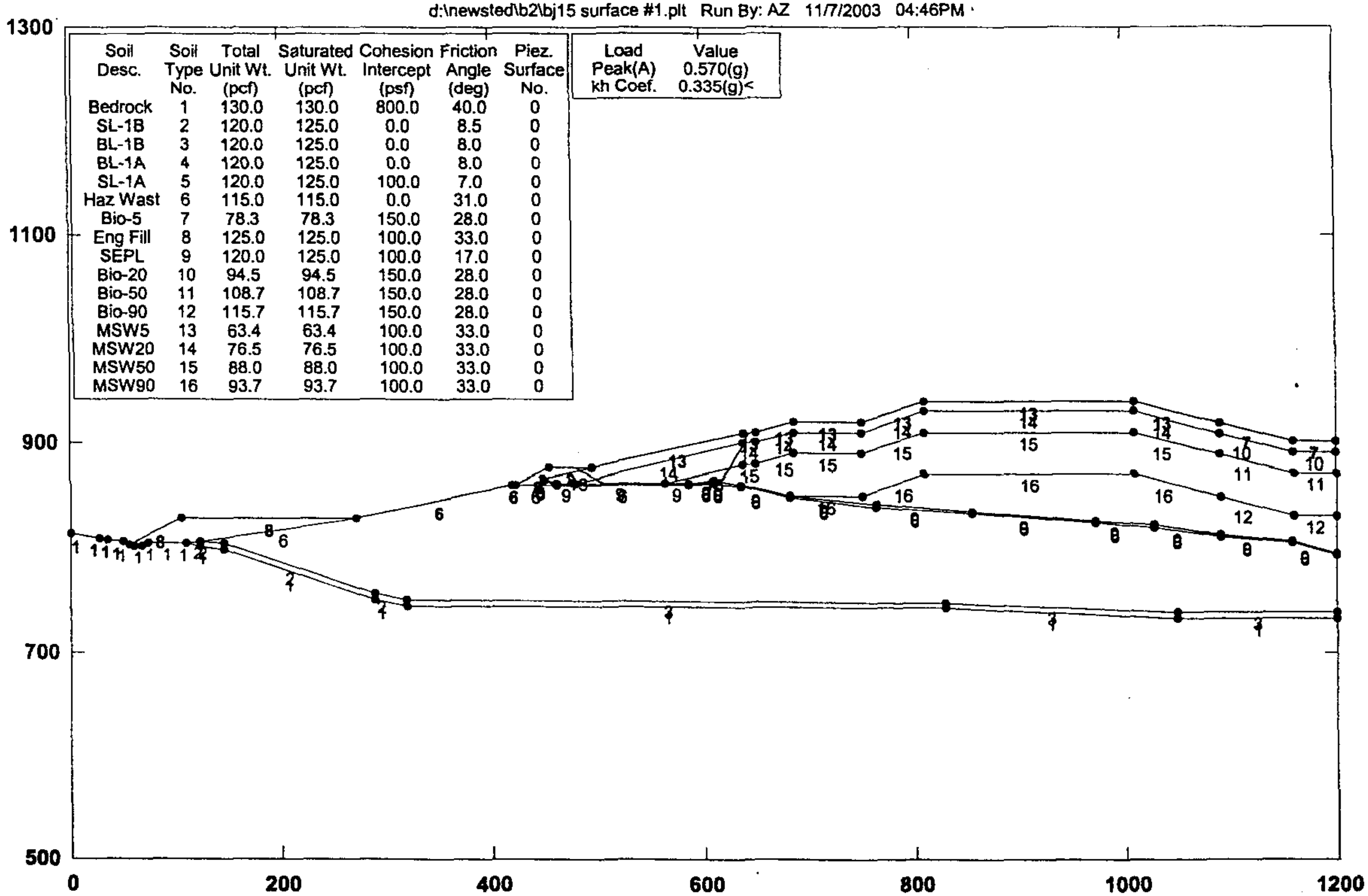
GSTABL7

KHF B-B' Failure Plane 2 Spencer Pseudo-Static Slope Stability

d:\newsted\b2\bj15 surface #1.plt Run By: AZ 11/7/2003 04:46PM

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
Bio-5	7	78.3	78.3	150.0	28.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
Bio-20	10	94.5	94.5	150.0	28.0	0
Bio-50	11	108.7	108.7	150.0	28.0	0
Bio-90	12	115.7	115.7	150.0	28.0	0
MSW5	13	63.4	63.4	100.0	33.0	0
MSW20	14	76.5	76.5	100.0	33.0	0
MSW50	15	88.0	88.0	100.0	33.0	0
MSW90	16	93.7	93.7	100.0	33.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.335(g)<

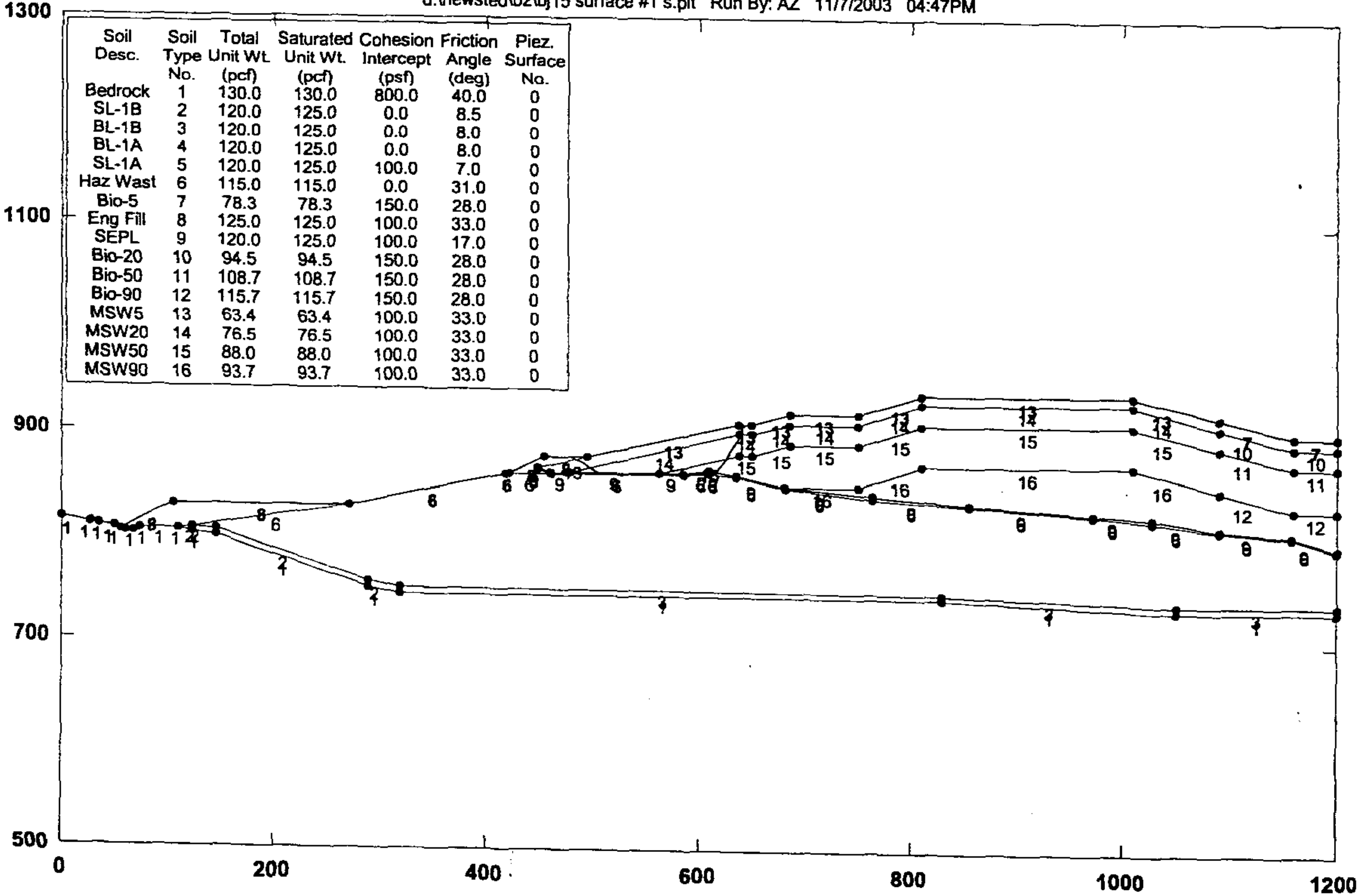


GSTABL7 v.2 FSmin=0.997
Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF B-B' Failure Plane 2 Spencer Static Slope Stability

d:\newsted\b2\bj15 surface #1 s.plt Run By: AZ 11/7/2003 04:47PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
Bio-5	7	78.3	78.3	150.0	28.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
Bio-20	10	94.5	94.5	150.0	28.0	0
Bio-50	11	108.7	108.7	150.0	28.0	0
Bio-90	12	115.7	115.7	150.0	28.0	0
MSW5	13	63.4	63.4	100.0	33.0	0
MSW20	14	76.5	76.5	100.0	33.0	0
MSW50	15	88.0	88.0	100.0	33.0	0
MSW90	16	93.7	93.7	100.0	33.0	0

GSTABL7 v.2 FSmin=3.128

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

CROSS SECTION D-D’

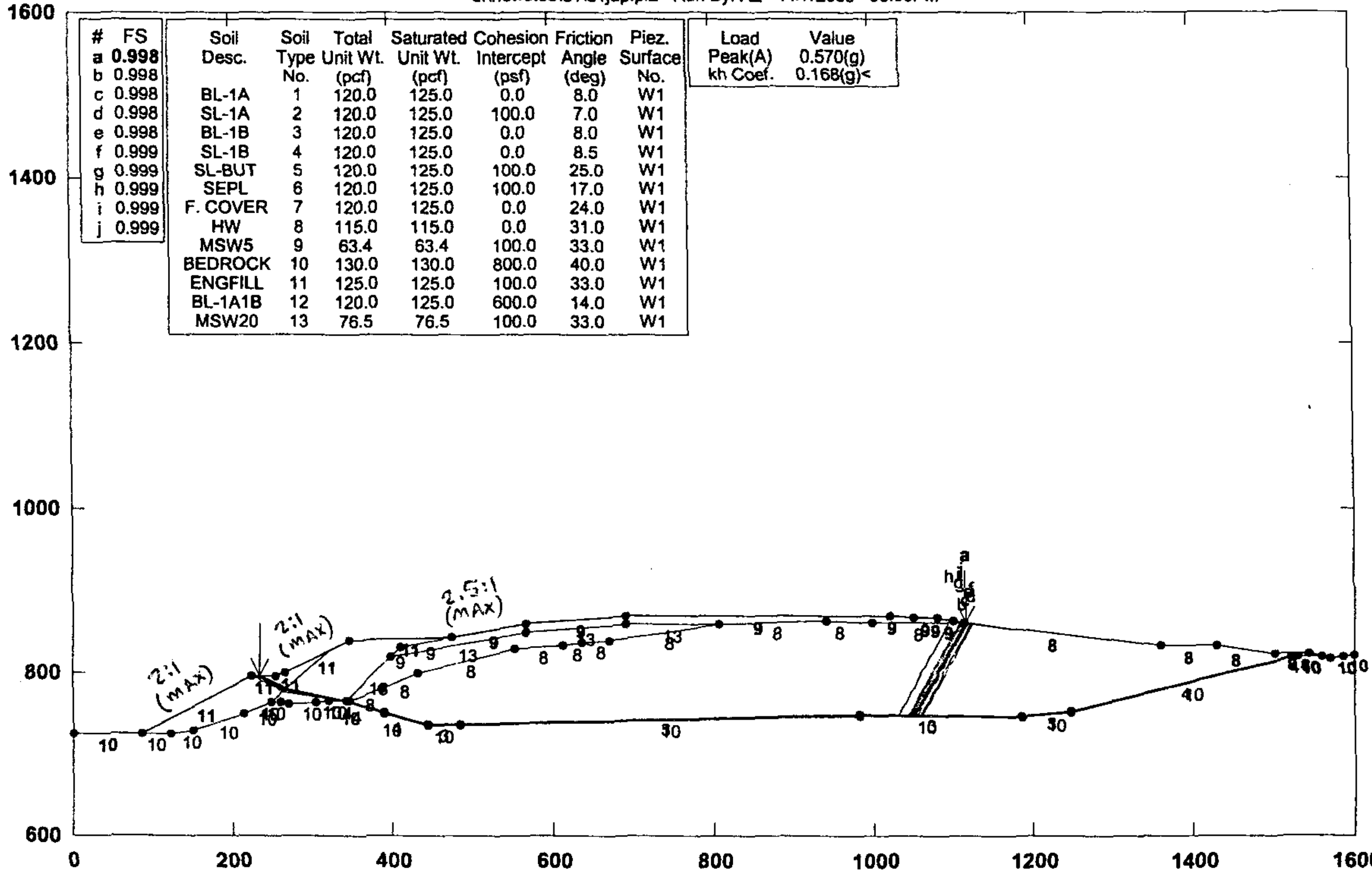
KHF D-D' Pseudo-Static Janbu Block Search

d:\newsted\d1\d1jap.pl2 Run By: AZ 11/7/2003 06:08PM

#	FS
a	**0.998**
b	0.998
c	0.998
d	0.998
e	0.998
f	0.999
g	0.999
h	0.999
i	0.999
j	0.999

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	W1
SL-1A	2	120.0	125.0	100.0	7.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
SL-BUT	5	120.0	125.0	100.0	25.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
MSW5	9	63.4	63.4	100.0	33.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1
MSW20	13	76.5	76.5	100.0	33.0	W1

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.168(g)<



GSTABL7 v.2 FSmin=0.998

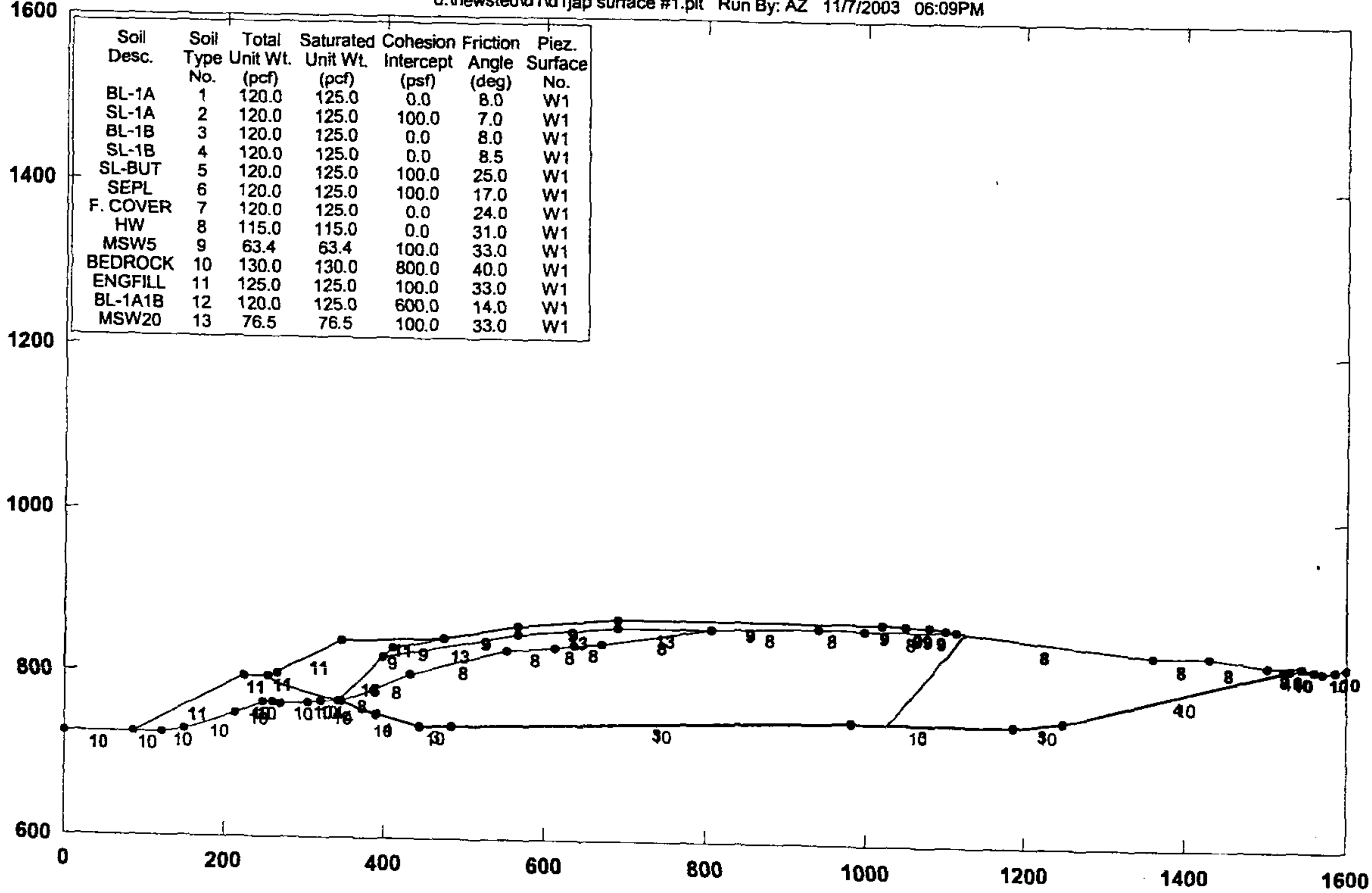
Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF D-D' Failure Plane 1 Janbu Static Slope Stability

d:\newsted\d1\d1jap surface #1.plt Run By: AZ 11/7/2003 06:09PM

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	W1
SL-1A	2	120.0	125.0	100.0	7.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
SL-BUT	5	120.0	125.0	100.0	25.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
MSW5	9	63.4	63.4	100.0	33.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1
MSW20	13	76.5	76.5	100.0	33.0	W1



GSTABL7 v.2 FSmin=4.478

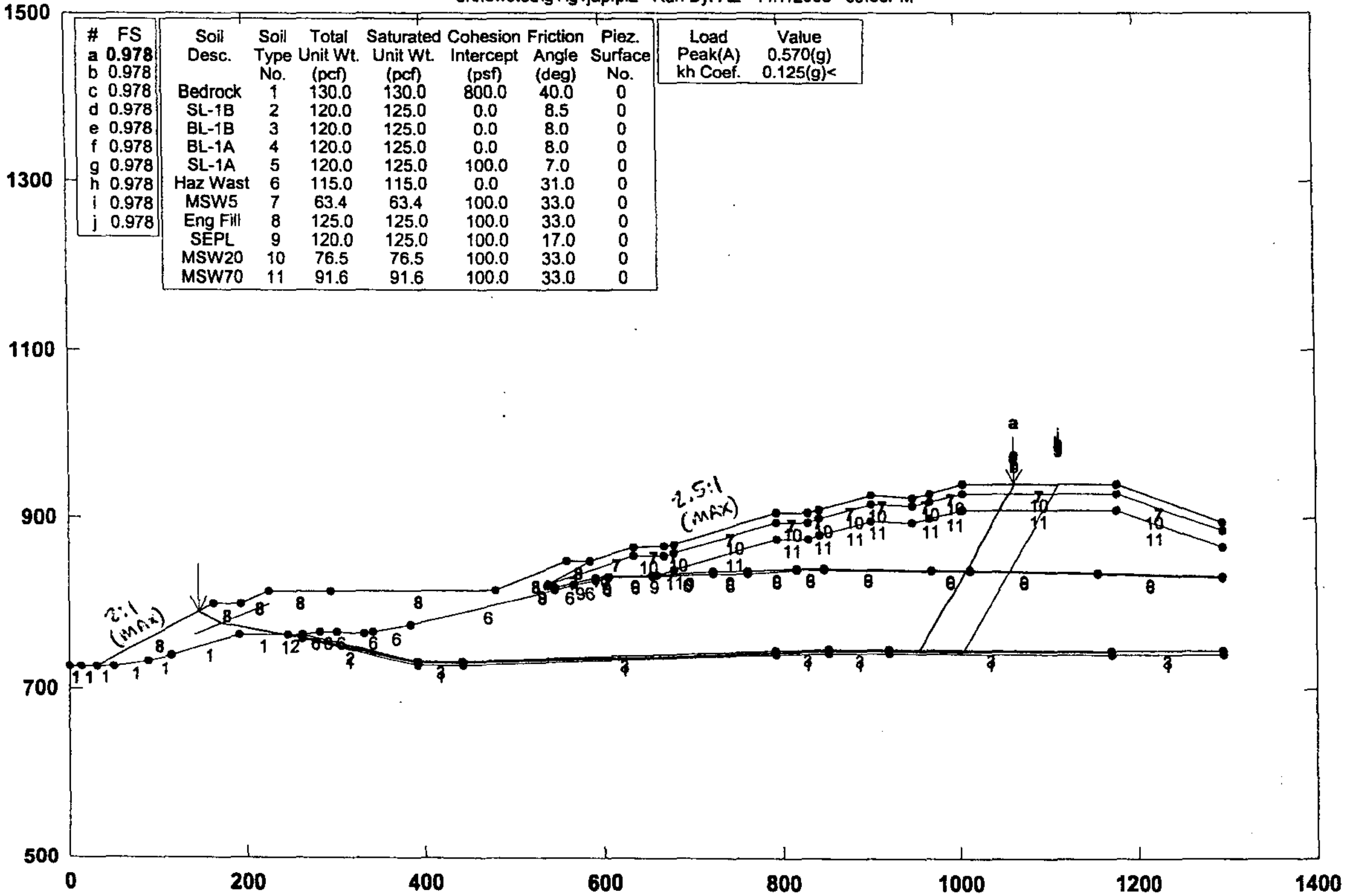
Factor Of Safety Is Calculated By The Simplified Janbu Method

GSTABL7

CROSS SECTION G-G'

KHF G-G' Pseudo-Static Janbu Block Search

d:\newsted\g1\g1jap.pl2 Run By: AZ 11/7/2003 09:36PM



#	FS
a	**0.978**
b	0.978
c	0.978
d	0.978
e	0.978
f	0.978
g	0.978
h	0.978
i	0.978
j	0.978

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW70	11	91.6	91.6	100.0	33.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.125(g)<

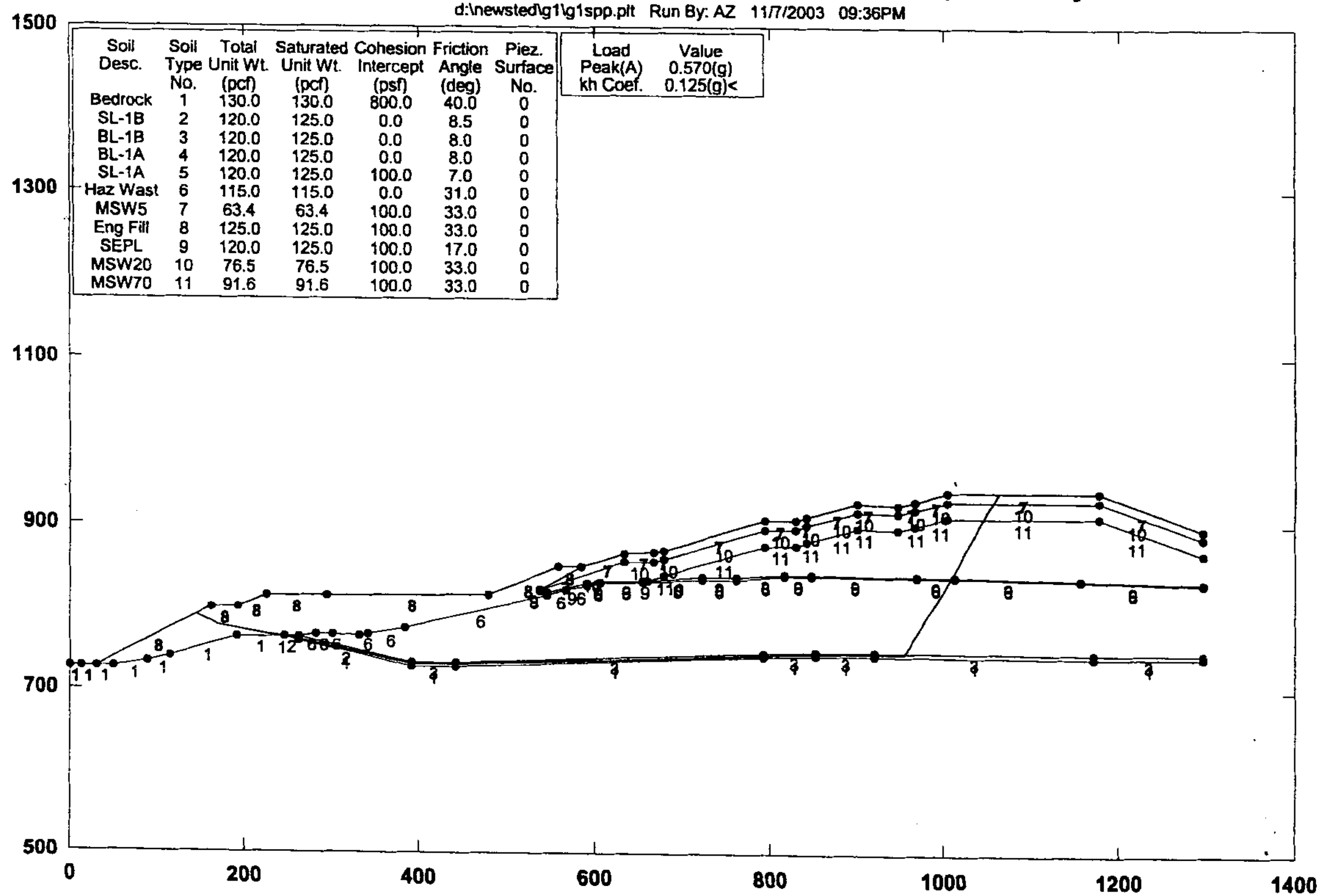
GSTABL7 v.2 FSmin=0.978

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF G-G' Failure Plane 1 Spencer Pseudo-Static Slope Stability

d:\newsted\g1\g1spp.plt Run By: AZ 11/7/2003 09:36PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW70	11	91.6	91.6	100.0	33.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.125(g)<

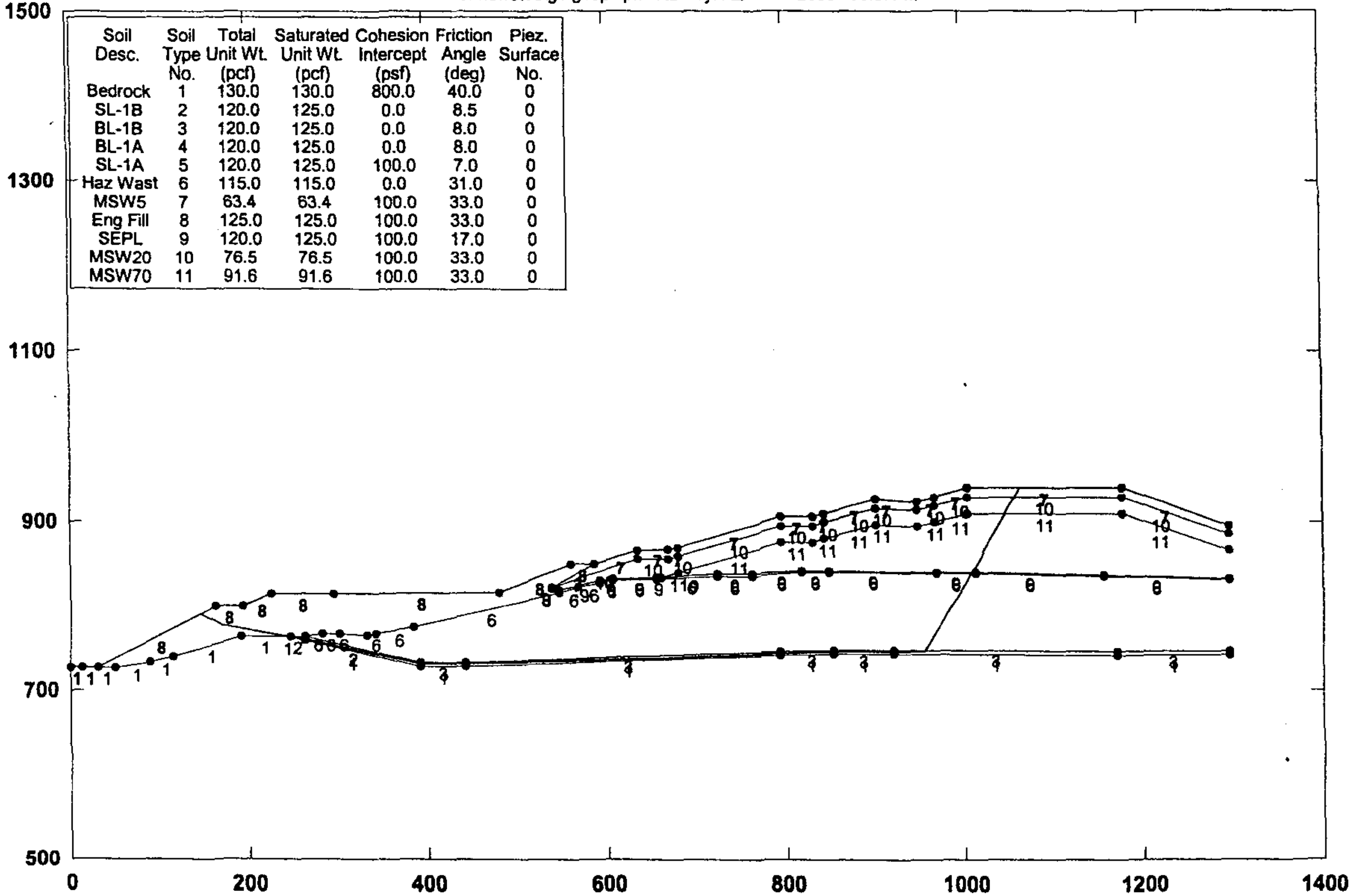
GSTABL7 v.2 FSmin=0.996

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF G-G' Failure Plane 1 Spencer Static Slope Stability

d:\newsted\g1\g1sps.plt Run By: AZ 11/7/2003 09:37PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW70	11	91.6	91.6	100.0	33.0	0

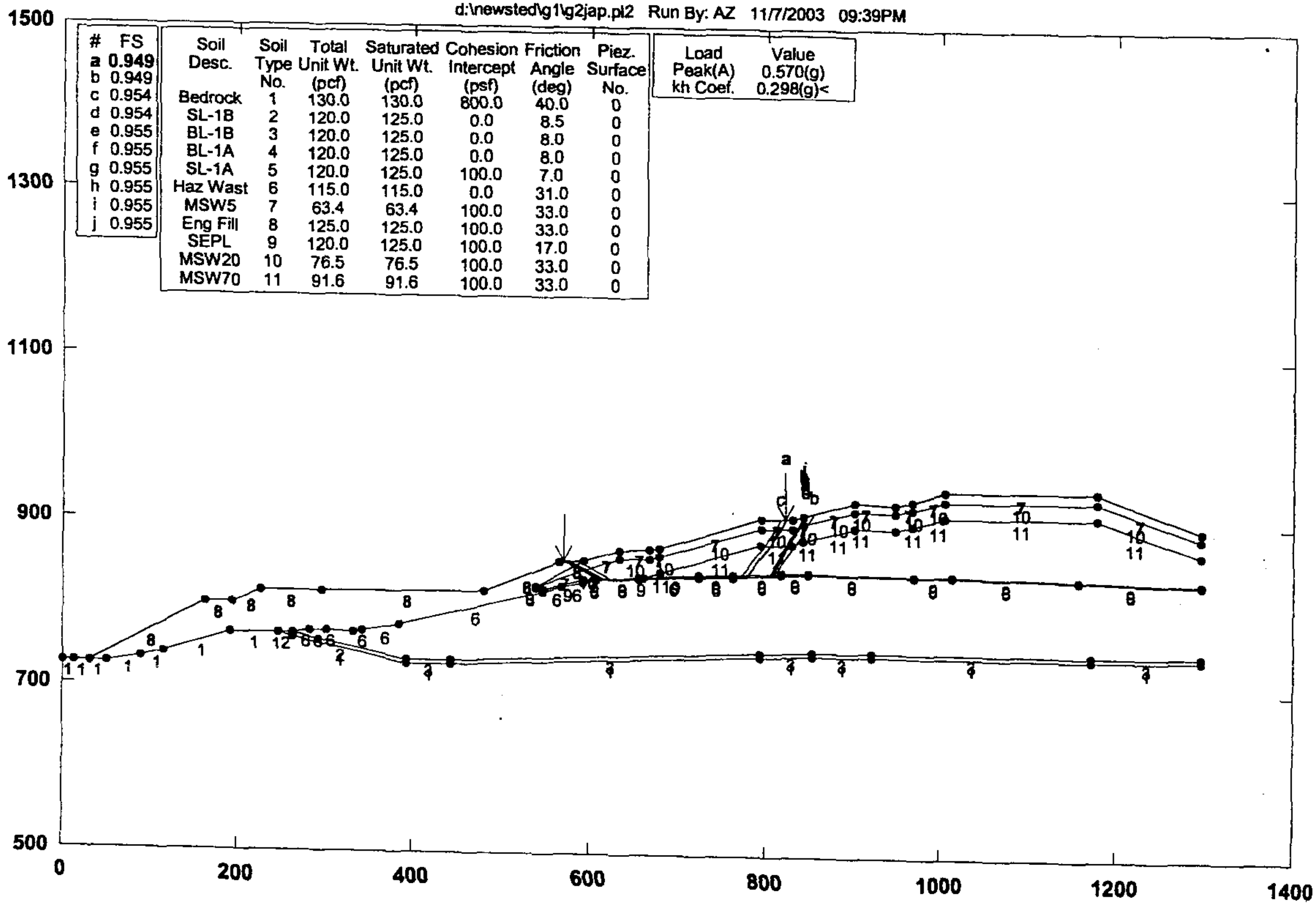
GSTABL7 v.2 FSmin=2.220

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF G-G' Pseudo-Static Janbu Block Search

d:\newsted\g1\g2jap.pl2 Run By: AZ 11/7/2003 09:39PM



#	FS
a	**0.949**
b	0.949
c	0.954
d	0.954
e	0.955
f	0.955
g	0.955
h	0.955
i	0.955
j	0.955

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW70	11	91.6	91.6	100.0	33.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.298(g)<

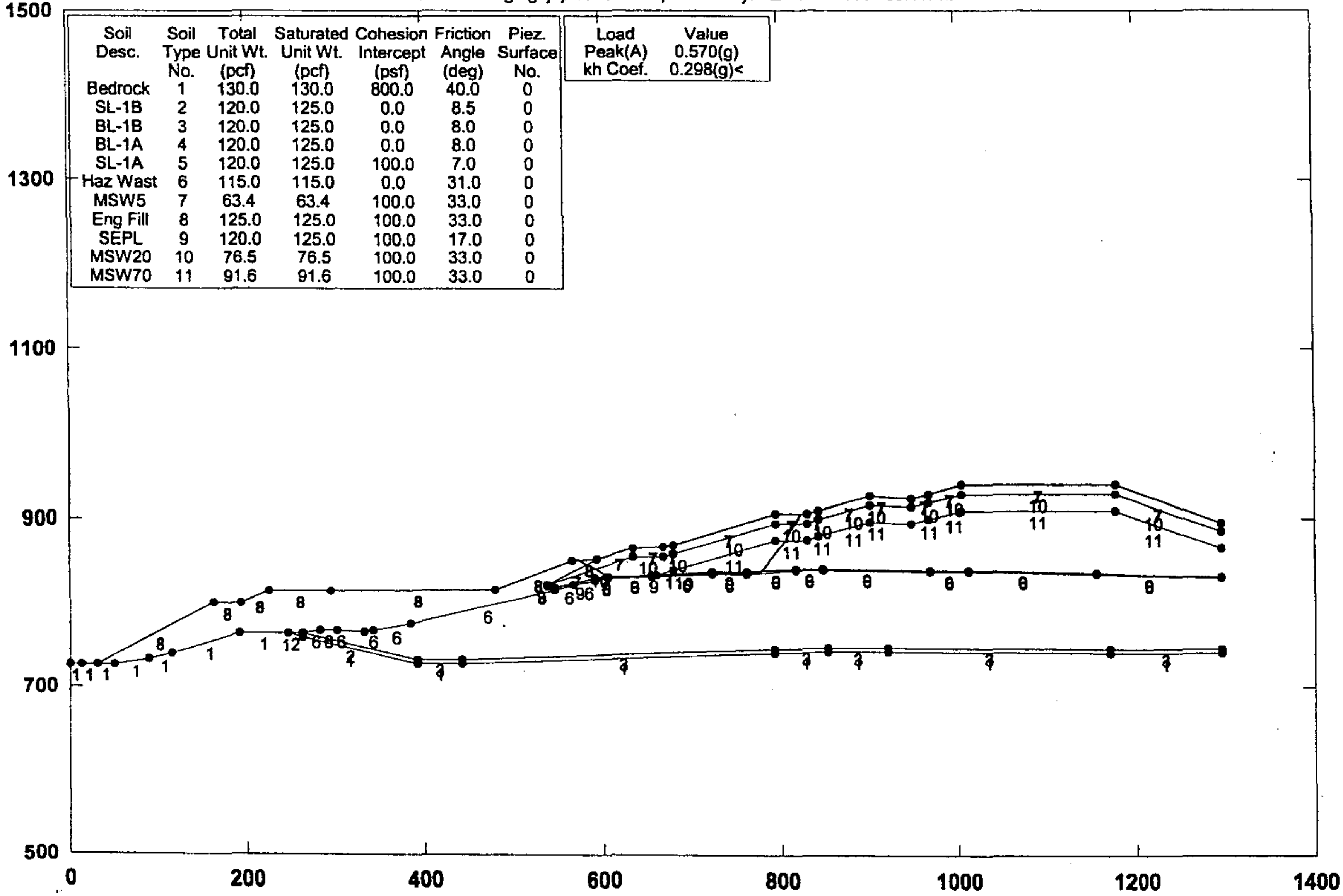
GSTABL7 v.2 FSmin=0.949

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF G-G' Failure Plane 2 Spencer Pseudo-Static Slope Stability

d:\newsted\g1\g2jap surface #1.plt Run By: AZ 11/7/2003 09:41PM



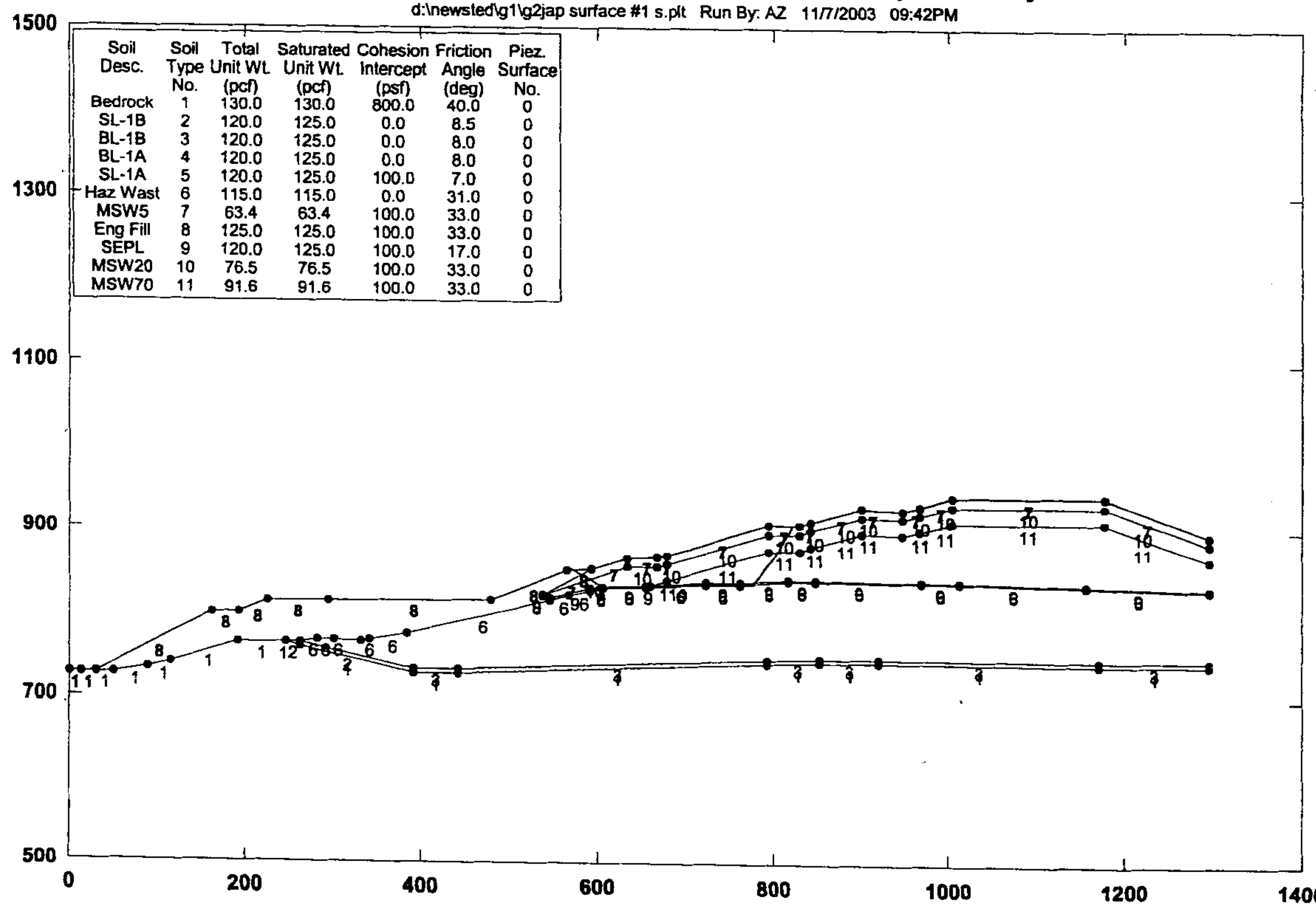
GSTABL7 v.2 FSmin=0.995

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF G-G' Failure Plane 2 Spencer Static Slope Stability

d:\newsted\g1\g2jap surface #1 s.plt Run By: AZ 11/7/2003 09:42PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW70	11	91.6	91.6	100.0	33.0	0

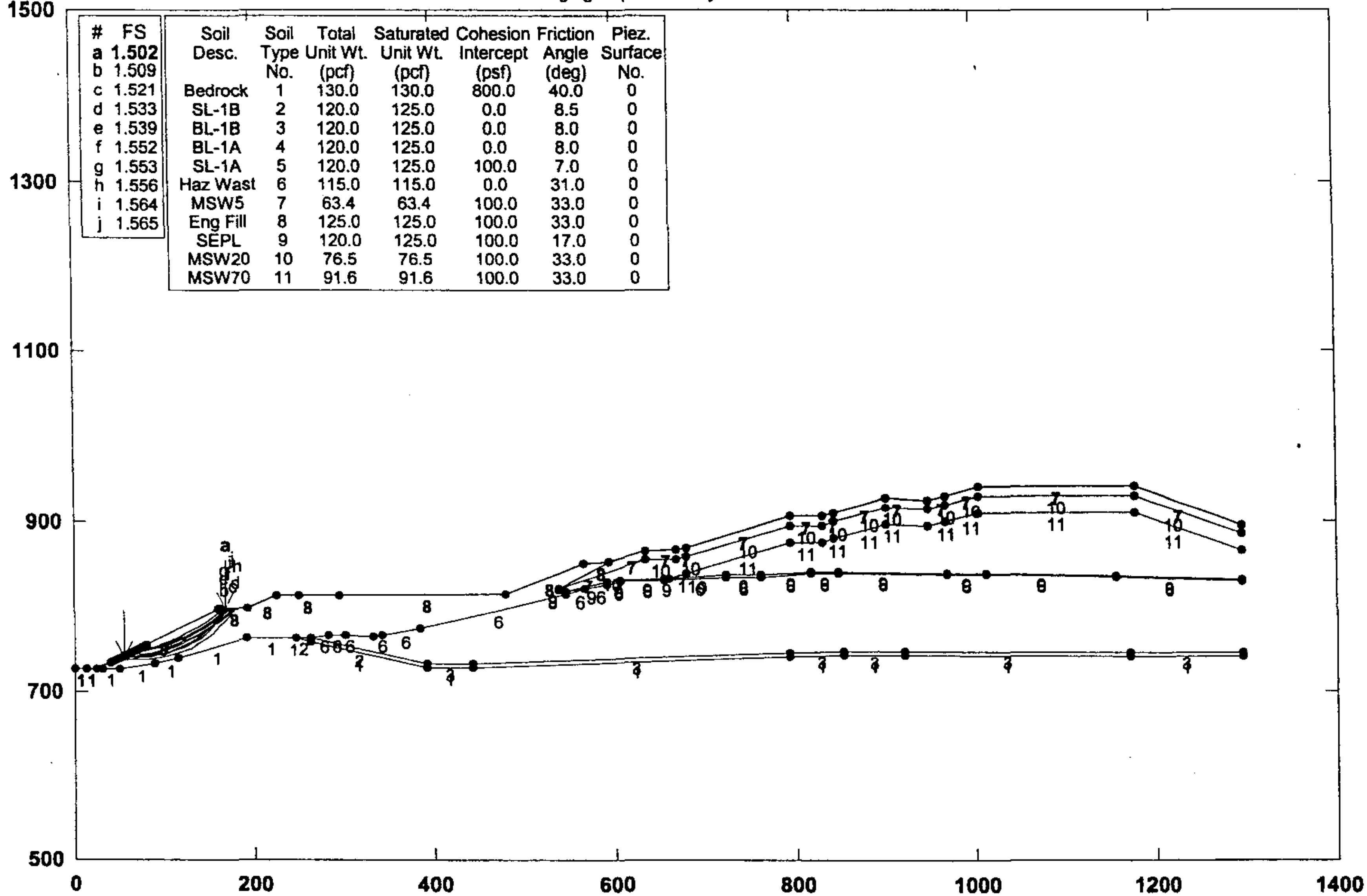
GSTABL7 v.2 FSmin=2.665

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF G-G' Failure Plane 3 Static Bishop Slope Stability

d:\newsted\g1\g3bi.pl2 Run By: AZ 11/8/2003 05:00PM



#	FS
a	**1.502**
b	1.509
c	1.521
d	1.533
e	1.539
f	1.552
g	1.553
h	1.556
i	1.564
j	1.565

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW70	11	91.6	91.6	100.0	33.0	0

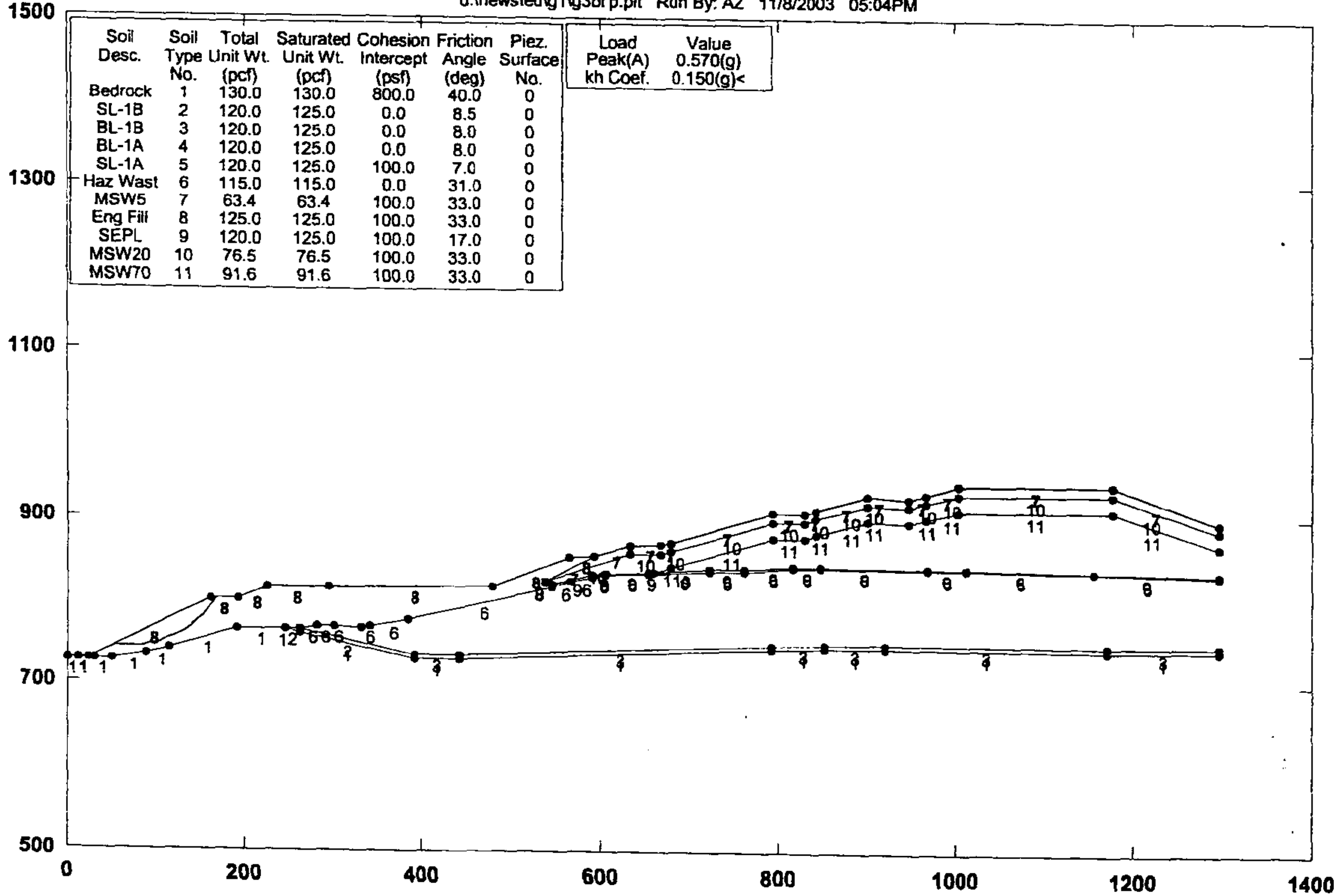
GSTABL7 v.2 FSmin=1.502

Safety Factors Are Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF G-G' Failure Plane 3 Pseudo-Static Bishop Slope Stability

d:\newsted\g1\g3bi p.plt Run By: AZ 11/8/2003 05:04PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW70	11	91.6	91.6	100.0	33.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.150(g)<

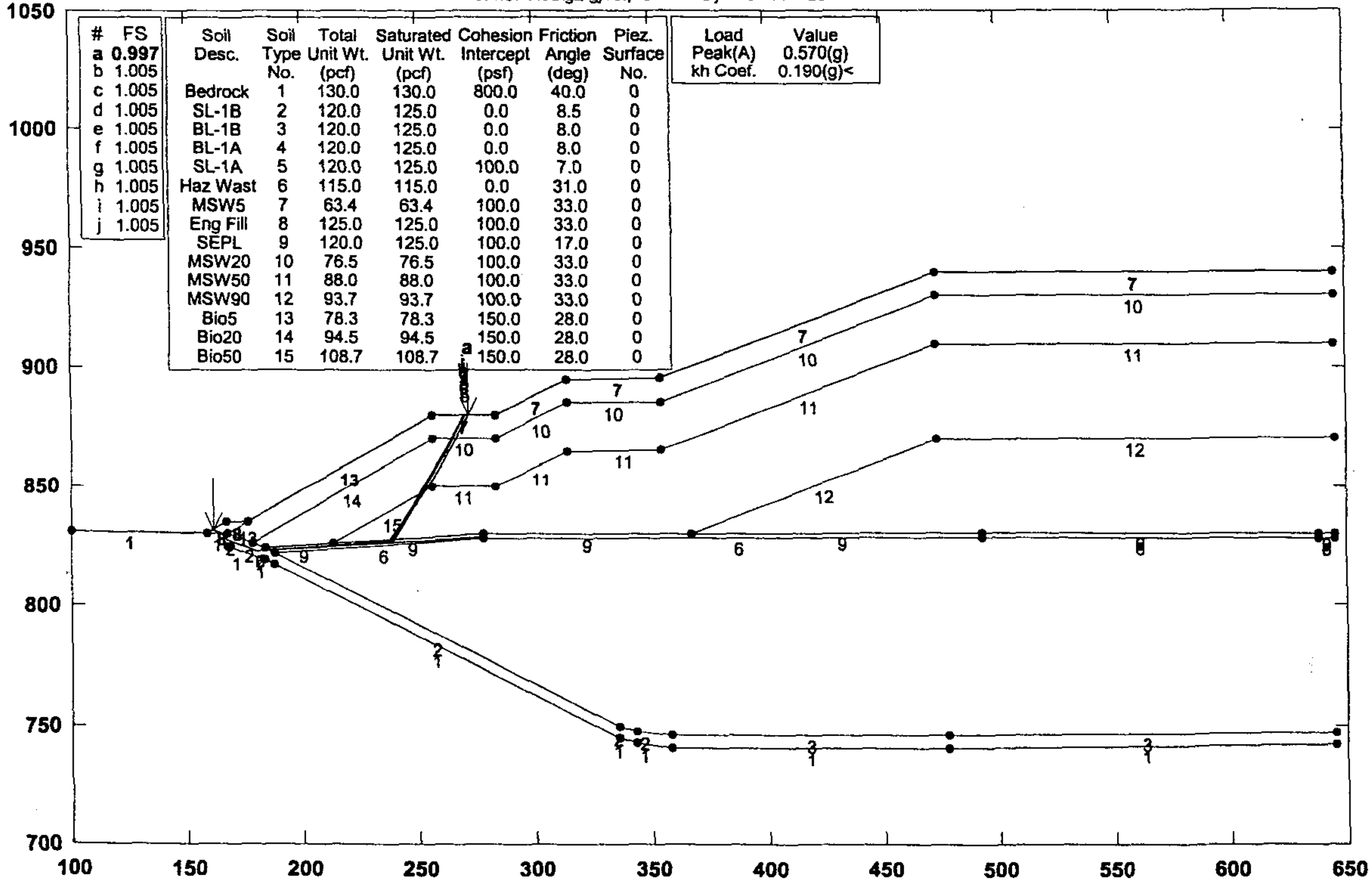
GSTABL7 v.2 FSmin=1.156

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF G-G' Pseudo-Static Janbu Block Search

d:\newsted\g2\gj13.pl2 Run By: AZ 11/7/2003 08:58PM



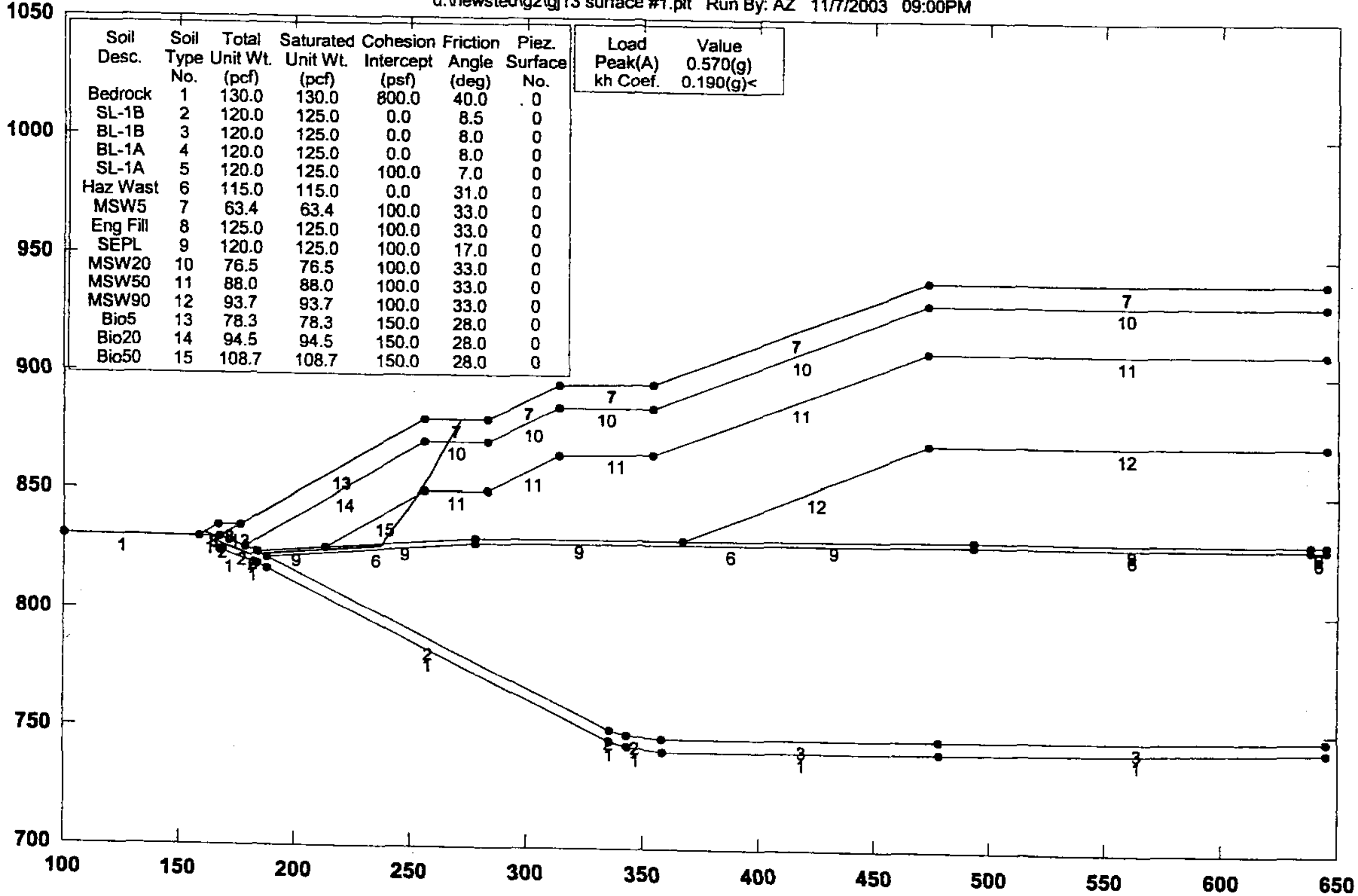
GSTABL7 v.2 FSmin=0.997

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF G-G' Failure Plane 4 Janbu Pseudo-Static Slope Stability

d:\newsted\g2\gj13 surface #1.plt Run By: AZ 11/7/2003 09:00PM



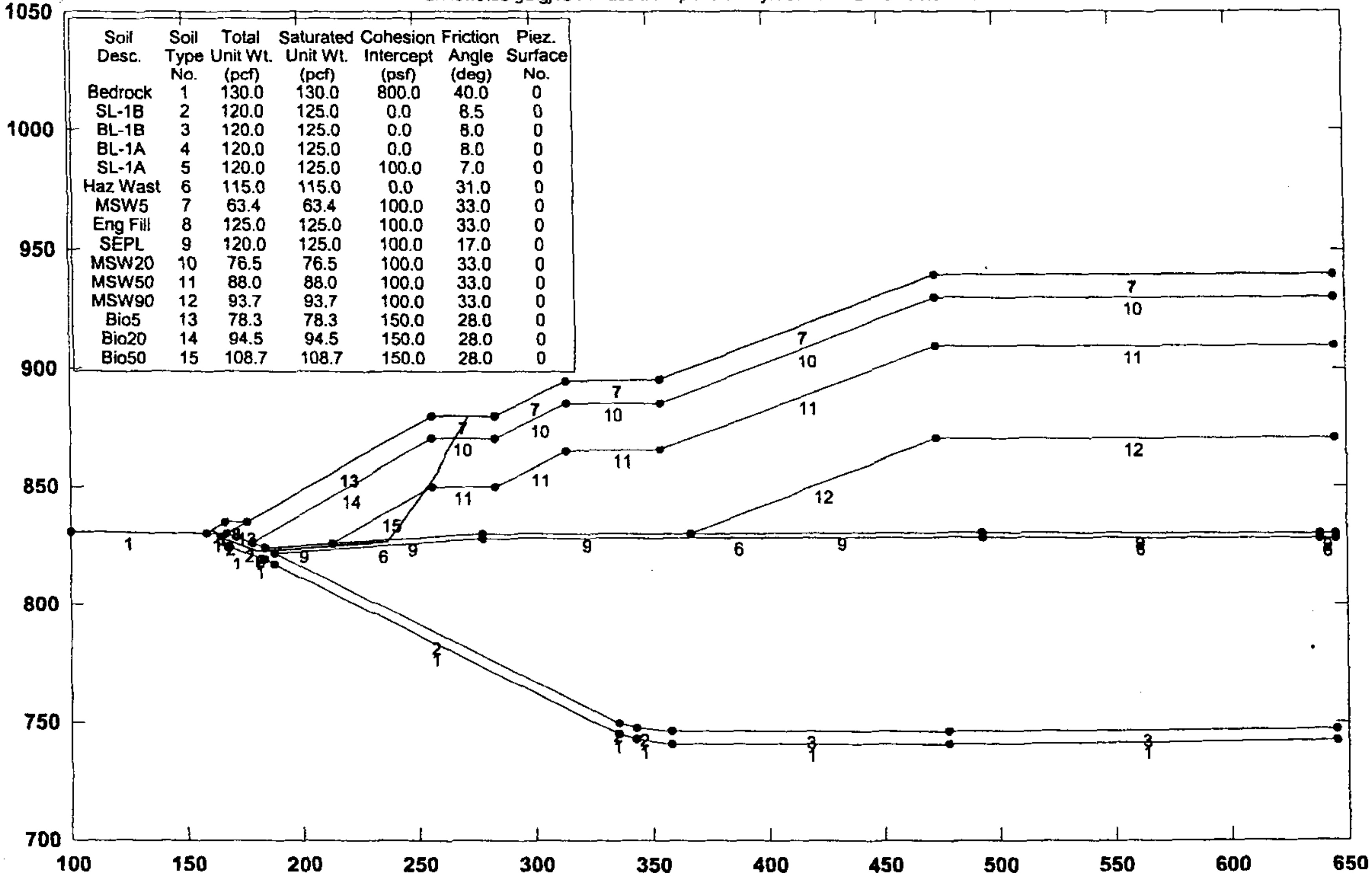
GSTABL7 v.2 FSmin=0.997

Factor Of Safety Is Calculated By The Simplified Janbu Method

GSTABL7

KHF G-G' Failure Plane 4 Spencer Static Slope Stability

d:\newsted\g2\gj13 surface #1 s.plt Run By: AZ 11/7/2003 09:01PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW50	11	88.0	88.0	100.0	33.0	0
MSW90	12	93.7	93.7	100.0	33.0	0
Bio5	13	78.3	78.3	150.0	28.0	0
Bio20	14	94.5	94.5	150.0	28.0	0
Bio50	15	108.7	108.7	150.0	28.0	0

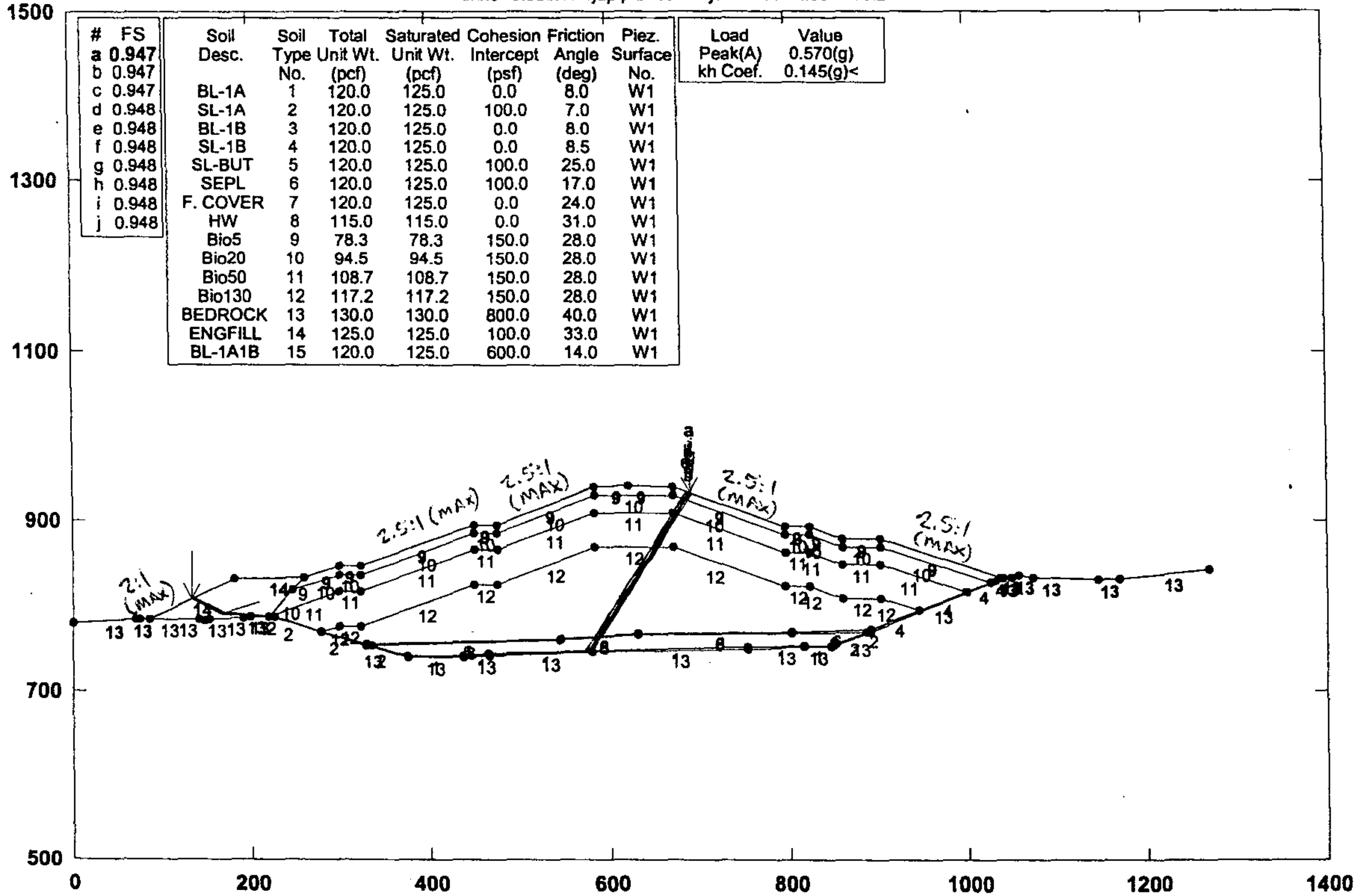
GSTABL7 v.2 FSmin=1.714
Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

CROSS SECTION H-H'

KHF H-H' Pseudo-Static Janbu Block Search

d:\newsted\h1\h1jap.pl2 Run By: AZ 11/6/2003 06:28PM



#	FS
a	0.947
b	0.947
c	0.947
d	0.948
e	0.948
f	0.948
g	0.948
h	0.948
i	0.948
j	0.948

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	W1
SL-1A	2	120.0	125.0	100.0	7.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
SL-BUT	5	120.0	125.0	100.0	25.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
Bio5	9	78.3	78.3	150.0	28.0	W1
Bio20	10	94.5	94.5	150.0	28.0	W1
Bio50	11	108.7	108.7	150.0	28.0	W1
Bio130	12	117.2	117.2	150.0	28.0	W1
BEDROCK	13	130.0	130.0	800.0	40.0	W1
ENGFILL	14	125.0	125.0	100.0	33.0	W1
BL-1A1B	15	120.0	125.0	600.0	14.0	W1

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.145(g)<

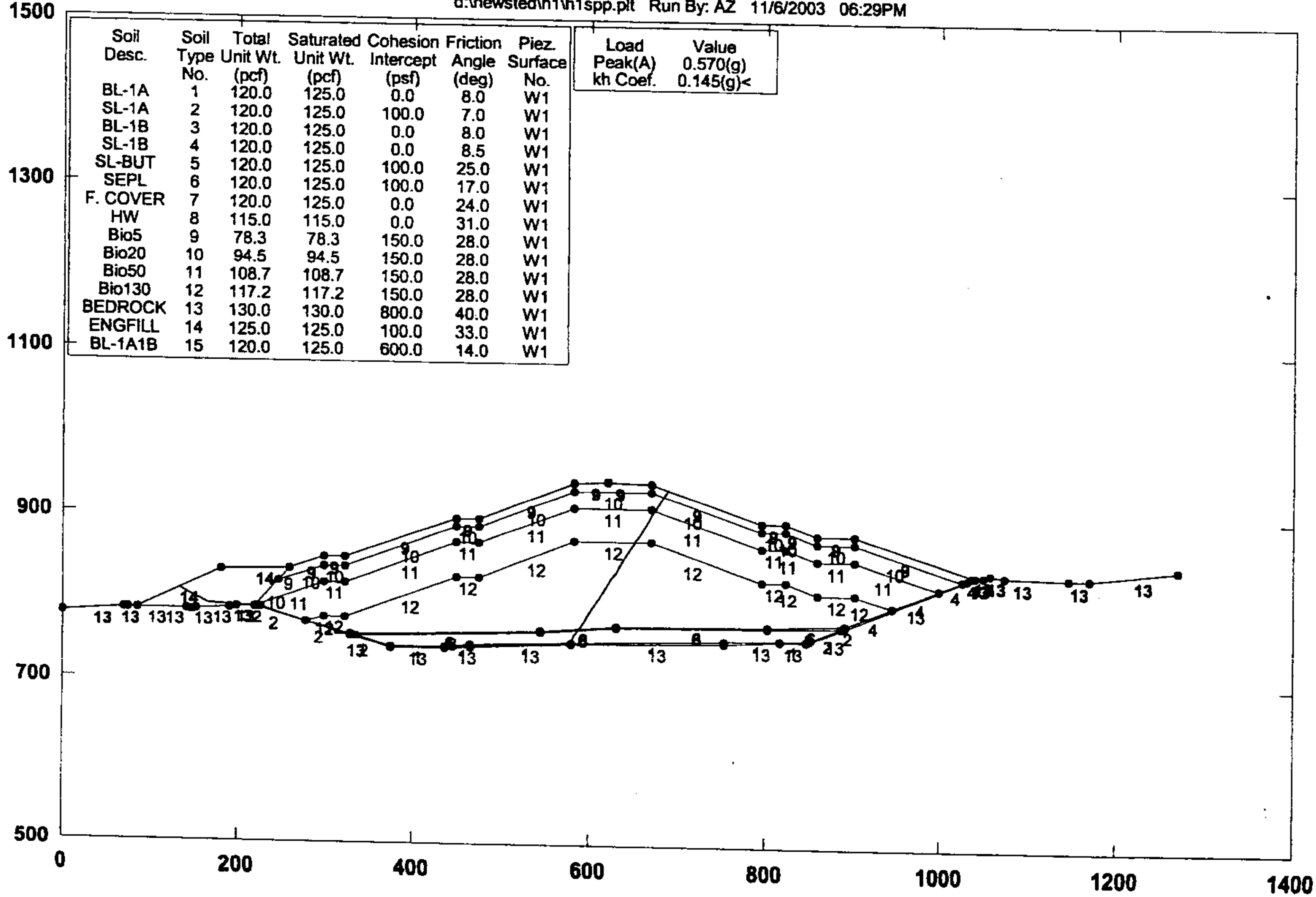
GSTABL7 v.2 FSmin=0.947

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF H-H' Failure Plane 1 Spencer Pseudo-Static Slope Stability

d:\newsted\h1\h1spp.plt Run By: AZ 11/6/2003 06:29PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	W1
SL-1A	2	120.0	125.0	100.0	7.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
SL-BUT	5	120.0	125.0	100.0	25.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
Bio5	9	78.3	78.3	150.0	28.0	W1
Bio20	10	94.5	94.5	150.0	28.0	W1
Bio50	11	108.7	108.7	150.0	28.0	W1
Bio130	12	117.2	117.2	150.0	28.0	W1
BEDROCK	13	130.0	130.0	800.0	40.0	W1
ENGFILL	14	125.0	125.0	100.0	33.0	W1
BL-1A1B	15	120.0	125.0	600.0	14.0	W1

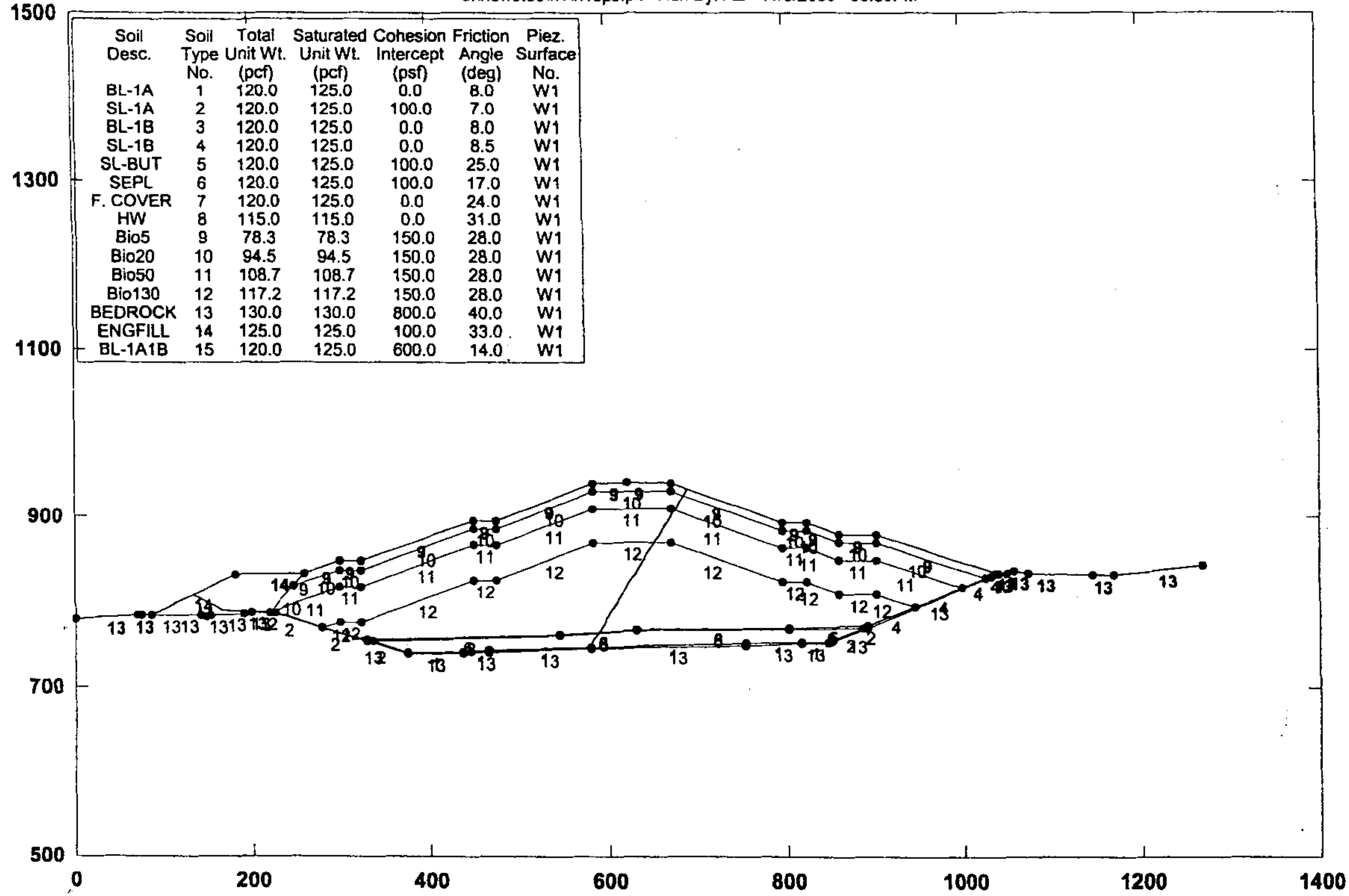
GSTABL7 v.2 FSmin=1.002

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF H-H' Failure Plane 1 Spencer Static Slope Stability

d:\newsted\h1\h1sps.plt Run By: AZ 11/6/2003 06:30PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	W1
SL-1A	2	120.0	125.0	100.0	7.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
SL-BUT	5	120.0	125.0	100.0	25.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
Bio5	9	78.3	78.3	150.0	28.0	W1
Bio20	10	94.5	94.5	150.0	28.0	W1
Bio50	11	108.7	108.7	150.0	28.0	W1
Bio130	12	117.2	117.2	150.0	28.0	W1
BEDROCK	13	130.0	130.0	800.0	40.0	W1
ENGFILL	14	125.0	125.0	100.0	33.0	W1
BL-1A1B	15	120.0	125.0	600.0	14.0	W1

GSTABL7 v.2 FSmin=1.943

Factor Of Safety Is Calculated By GLE (Spencer's) Method (0-2)

GSTABL7

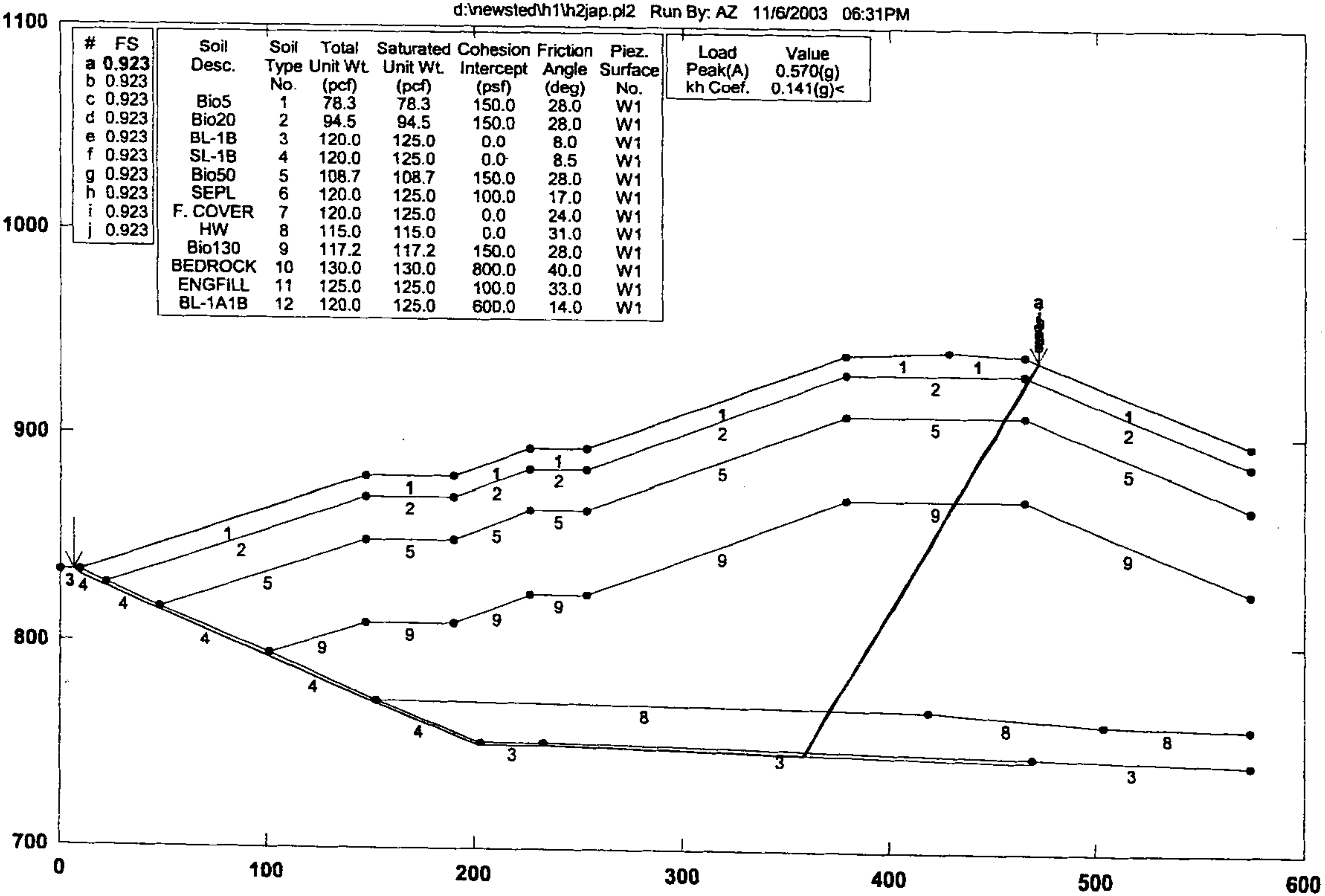
KHF H-H' Dynamic Pseudo-Static Block Search

d:\newsted\h1\h2jap.pl2 Run By: AZ 11/6/2003 06:31PM

#	FS
a	**0.923**
b	0.923
c	0.923
d	0.923
e	0.923
f	0.923
g	0.923
h	0.923
i	0.923
j	0.923

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bio5	1	78.3	78.3	150.0	28.0	W1
Bio20	2	94.5	94.5	150.0	28.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
Bio50	5	108.7	108.7	150.0	28.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
Bio130	9	117.2	117.2	150.0	28.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.141(g)<



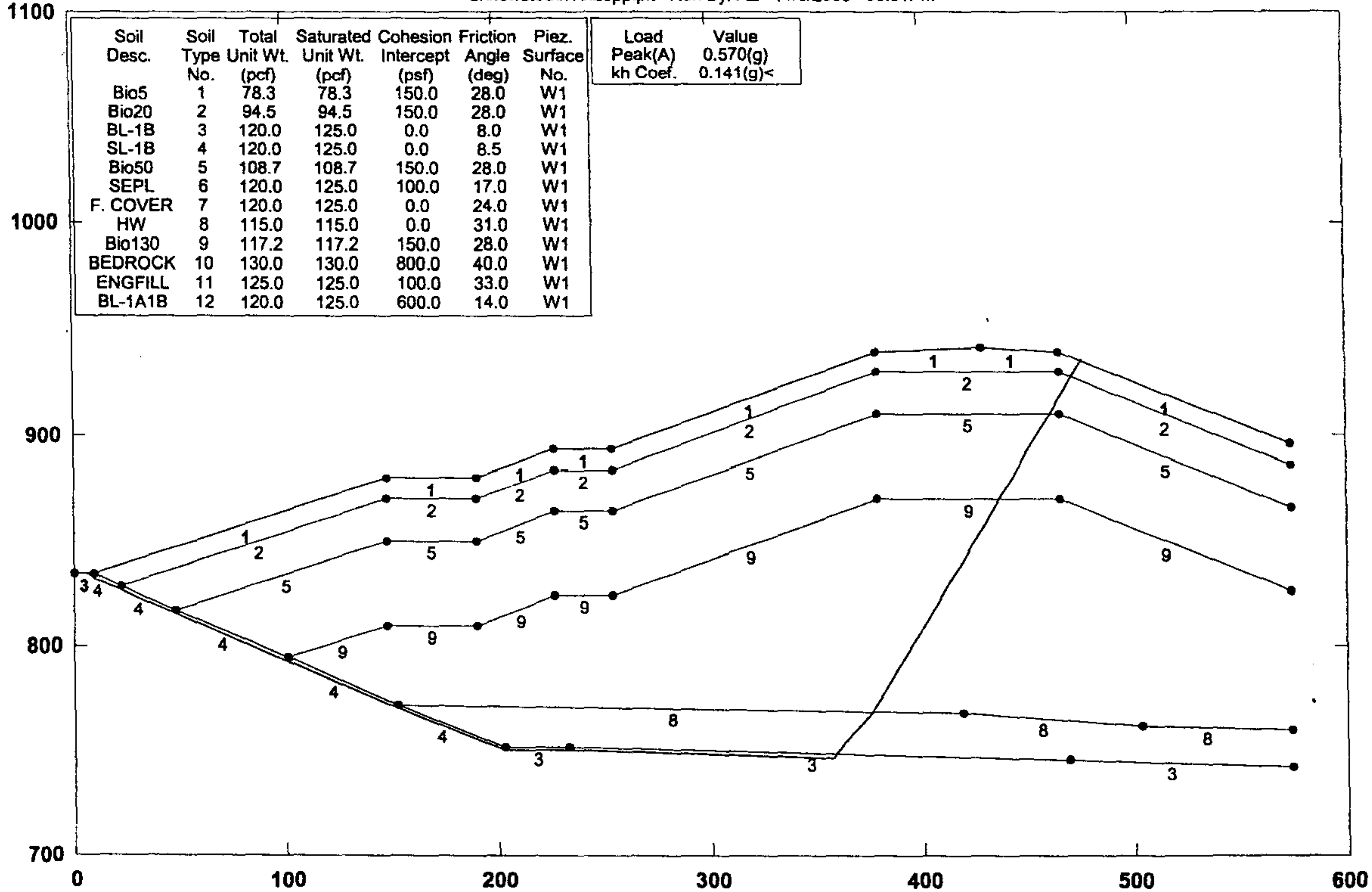
GSTABL7 v.2 FSmin=0.923

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF H-H' Failure Plane 2 Spencer Pseudo-Static Slope Stability

d:\newsted\h1\h2spp.plt Run By: AZ 11/6/2003 06:31PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bio5	1	78.3	78.3	150.0	28.0	W1
Bio20	2	94.5	94.5	150.0	28.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
Bio50	5	108.7	108.7	150.0	28.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
Bio130	9	117.2	117.2	150.0	28.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.141(g)<

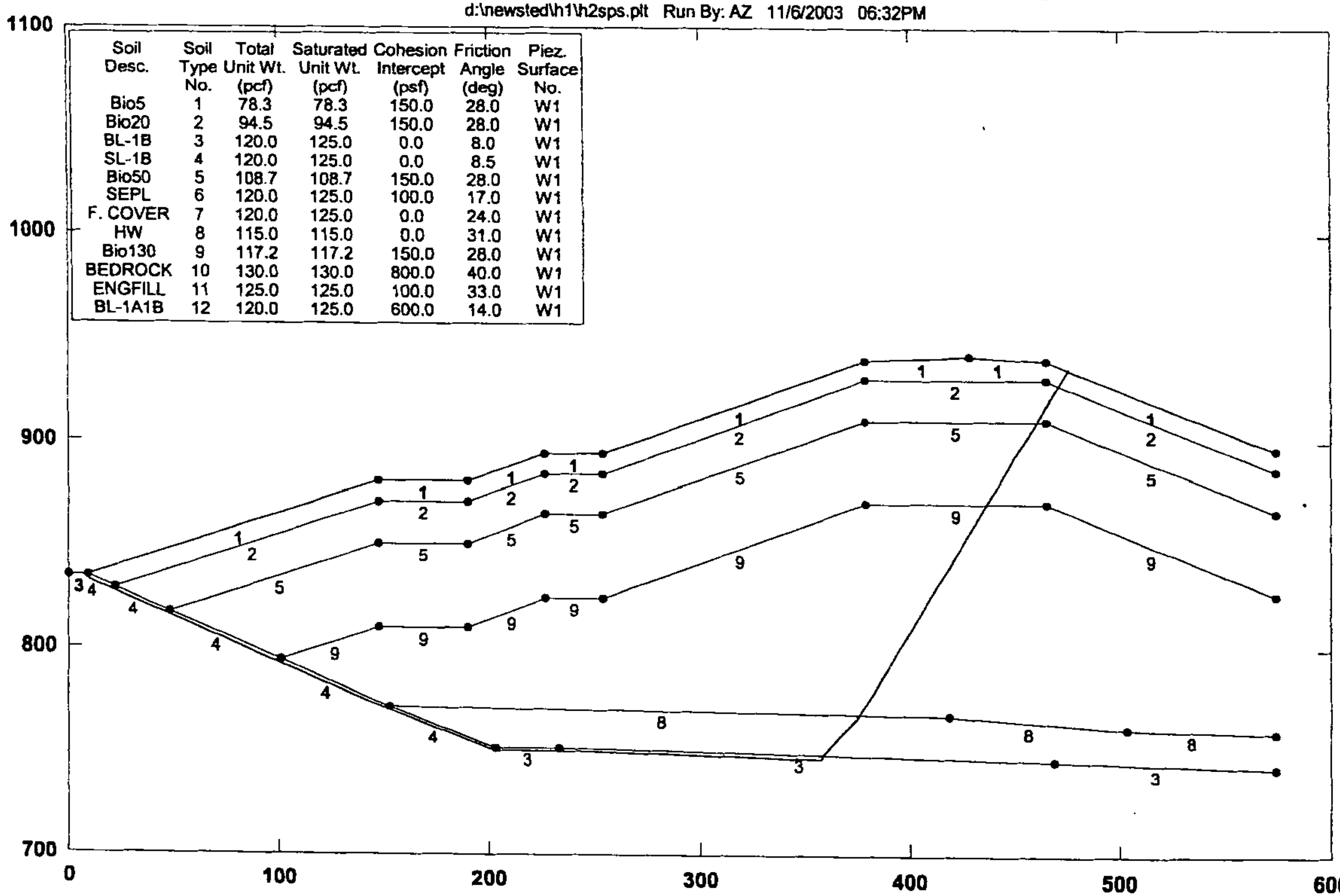
GSTABL7 v.2 FSmin=1.001

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF H-H' Failure Plane 2 Spencer Static Slope Stability

d:\newsted\h1\h2sps.plt Run By: AZ 11/6/2003 06:32PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bio5	1	78.3	78.3	150.0	28.0	W1
Bio20	2	94.5	94.5	150.0	28.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
Bio50	5	108.7	108.7	150.0	28.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
Bio130	9	117.2	117.2	150.0	28.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1

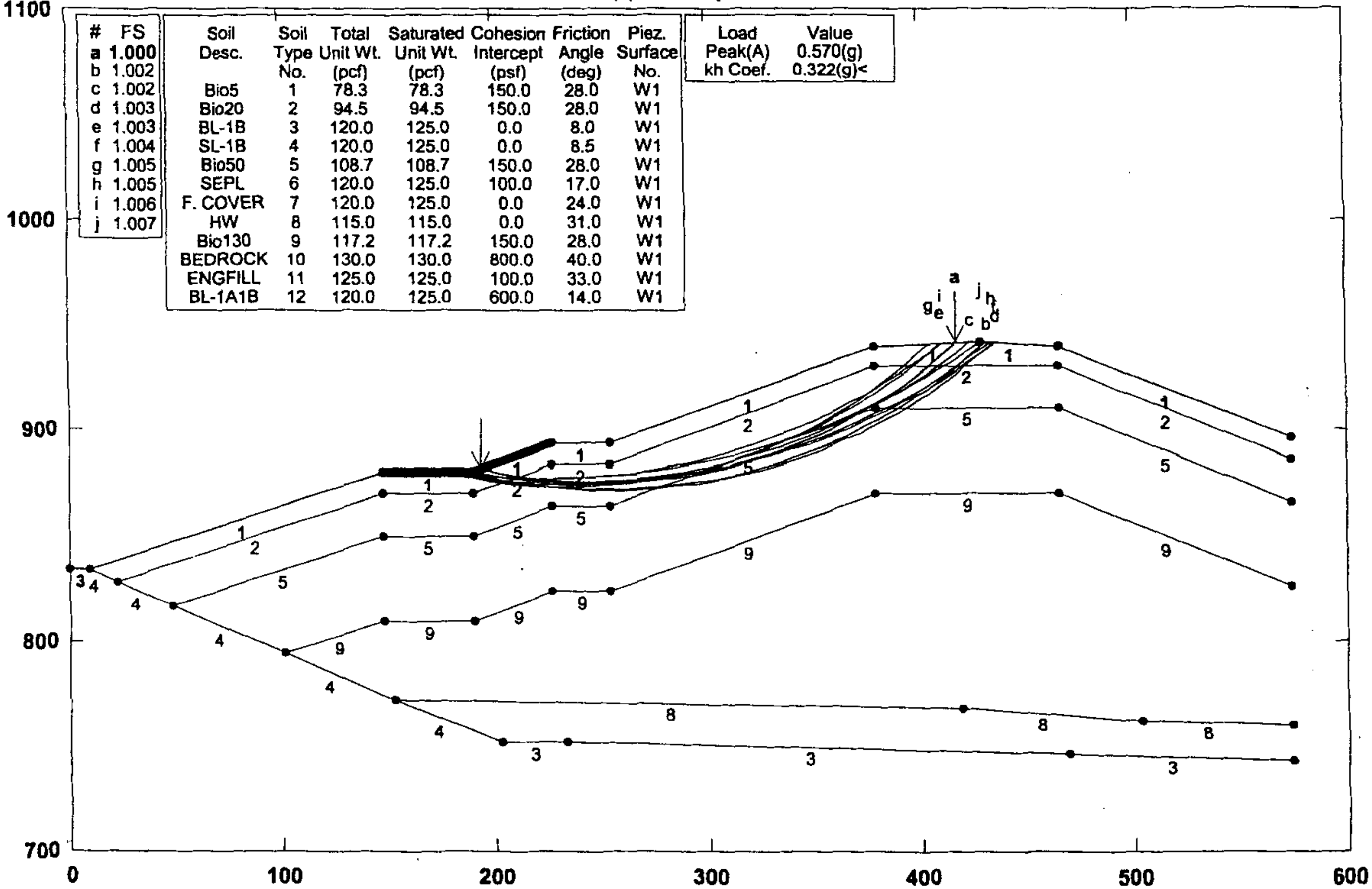
GSTABL7 v.2 FSmin=2.220

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF H-H' Pseudo-Static Bishop Slope Stability

d:\newsted\h1\h3bip.pl2 Run By: AZ 11/6/2003 06:32PM



#	FS
a	**1.000**
b	1.002
c	1.002
d	1.003
e	1.003
f	1.004
g	1.005
h	1.005
i	1.006
j	1.007

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bio5	1	78.3	78.3	150.0	28.0	W1
Bio20	2	94.5	94.5	150.0	28.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
Bio50	5	108.7	108.7	150.0	28.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
Bio130	9	117.2	117.2	150.0	28.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.322(g)<

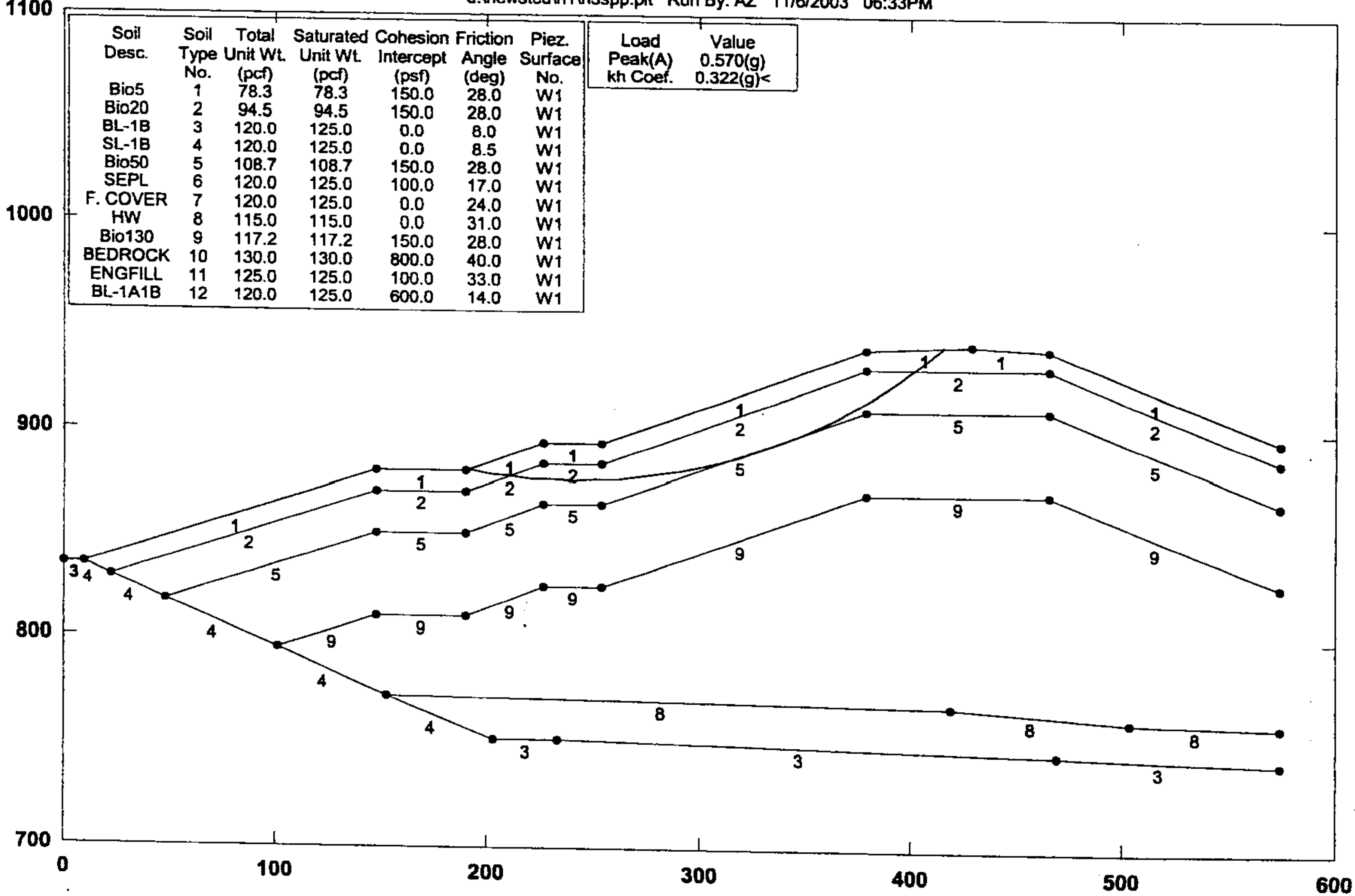
GSTABL7 v.2 FSmin=1.000

Safety Factors Are Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF H-H' Failure Plane 3 Spencer Pseudo-Static Slope Stability

d:\newsted\h1\h3spp.plt Run By: AZ 11/6/2003 06:33PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bio5	1	78.3	78.3	150.0	28.0	W1
Bio20	2	94.5	94.5	150.0	28.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
Bio50	5	108.7	108.7	150.0	28.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
Bio130	9	117.2	117.2	150.0	28.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1

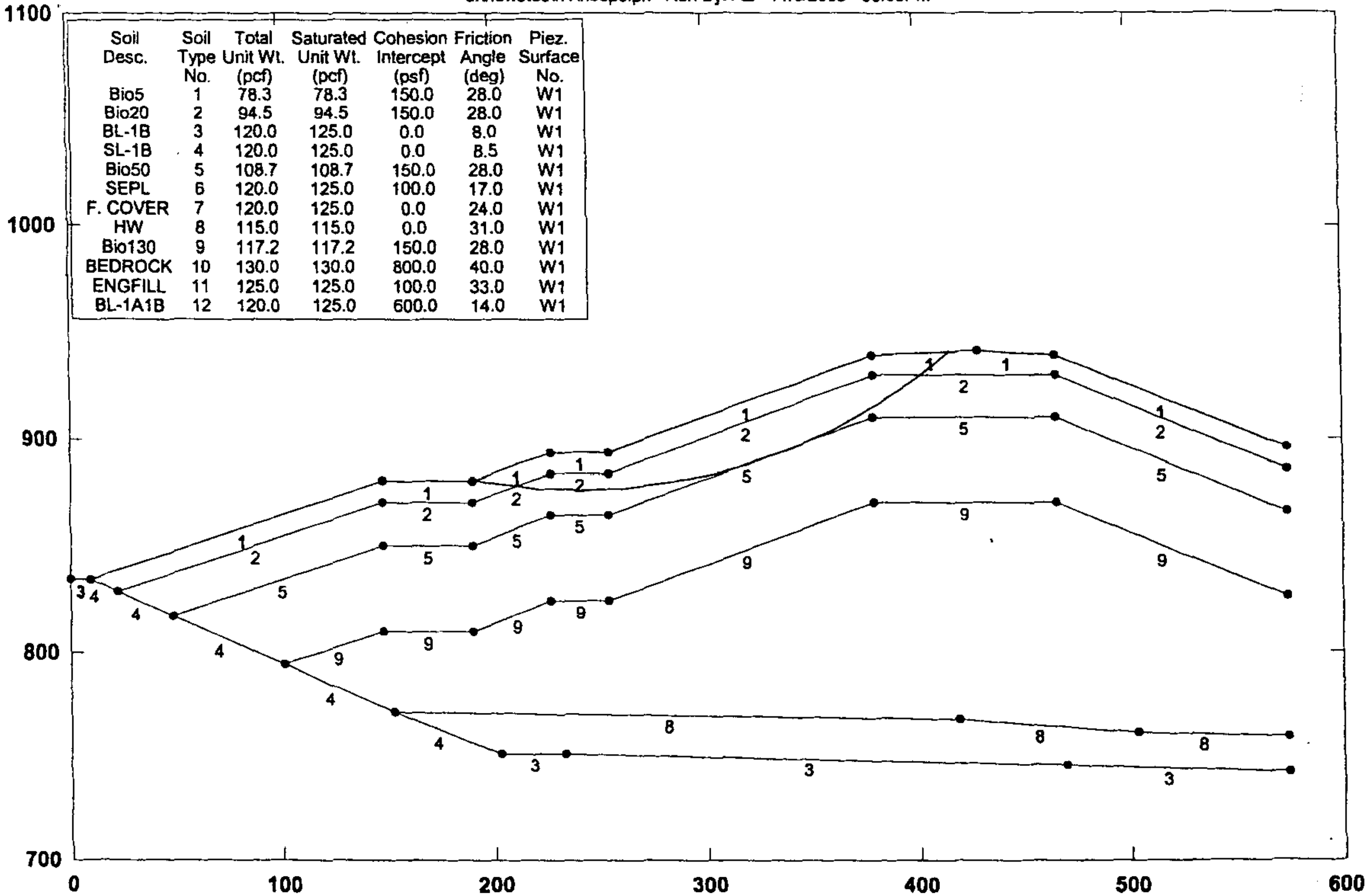
GSTABL7 v.2 FSmin=0.998

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF H-H' Failure Plane 3 Spencer Static Slope Stability

d:\newsted\h1\h3sps.plt Run By: AZ 11/6/2003 06:33PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bio5	1	78.3	78.3	150.0	28.0	W1
Bio20	2	94.5	94.5	150.0	28.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
Bio50	5	108.7	108.7	150.0	28.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
Bio130	9	117.2	117.2	150.0	28.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1

GSTABL7 v.2 FSmin=2.278

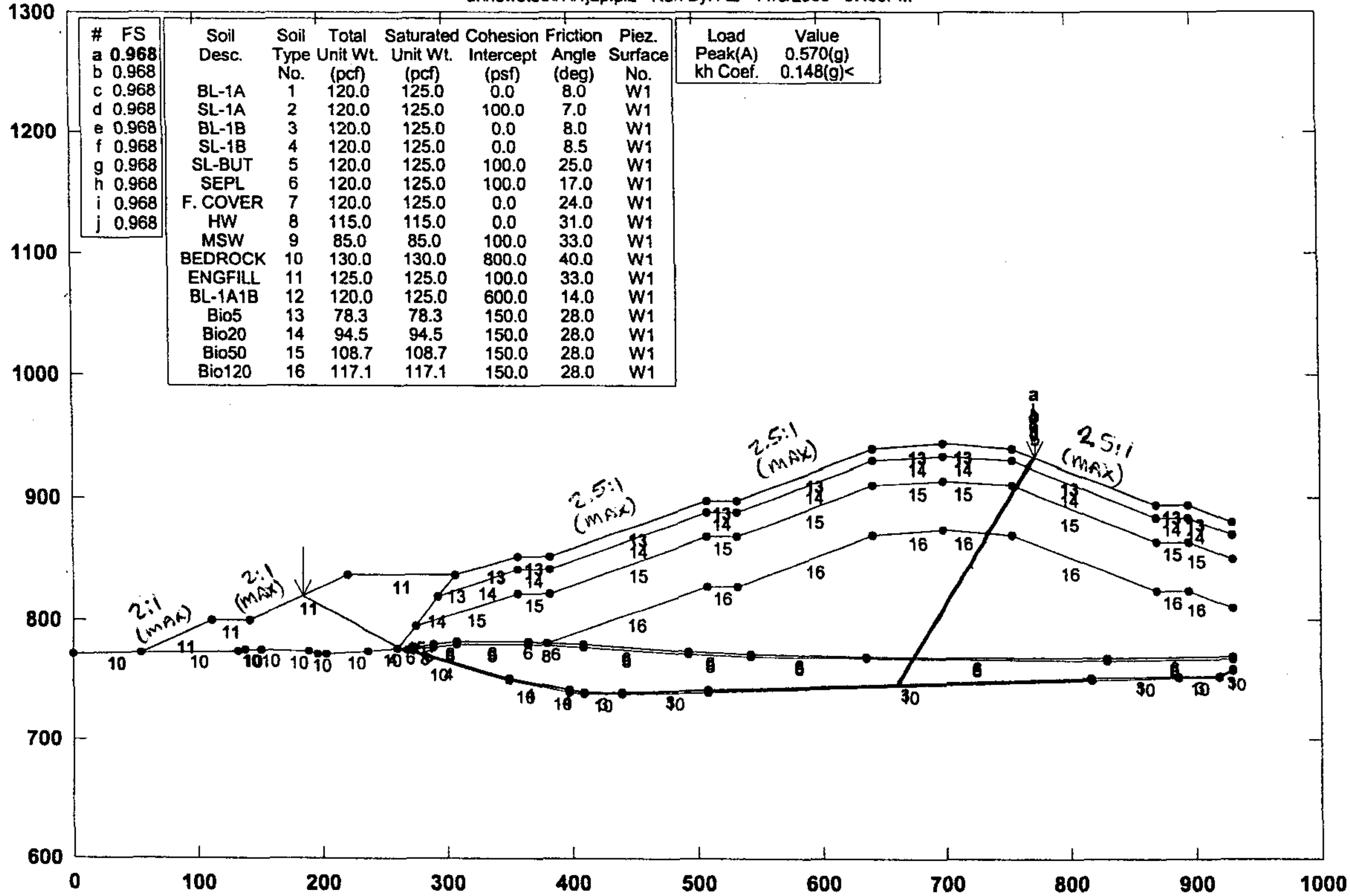
Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

CROSS SECTION I-I'

KHF I-I' Pseudo-Static Janbu Block Search

d:\newsted\i1\i1jap.pl2 Run By: AZ 11/6/2003 07:00PM



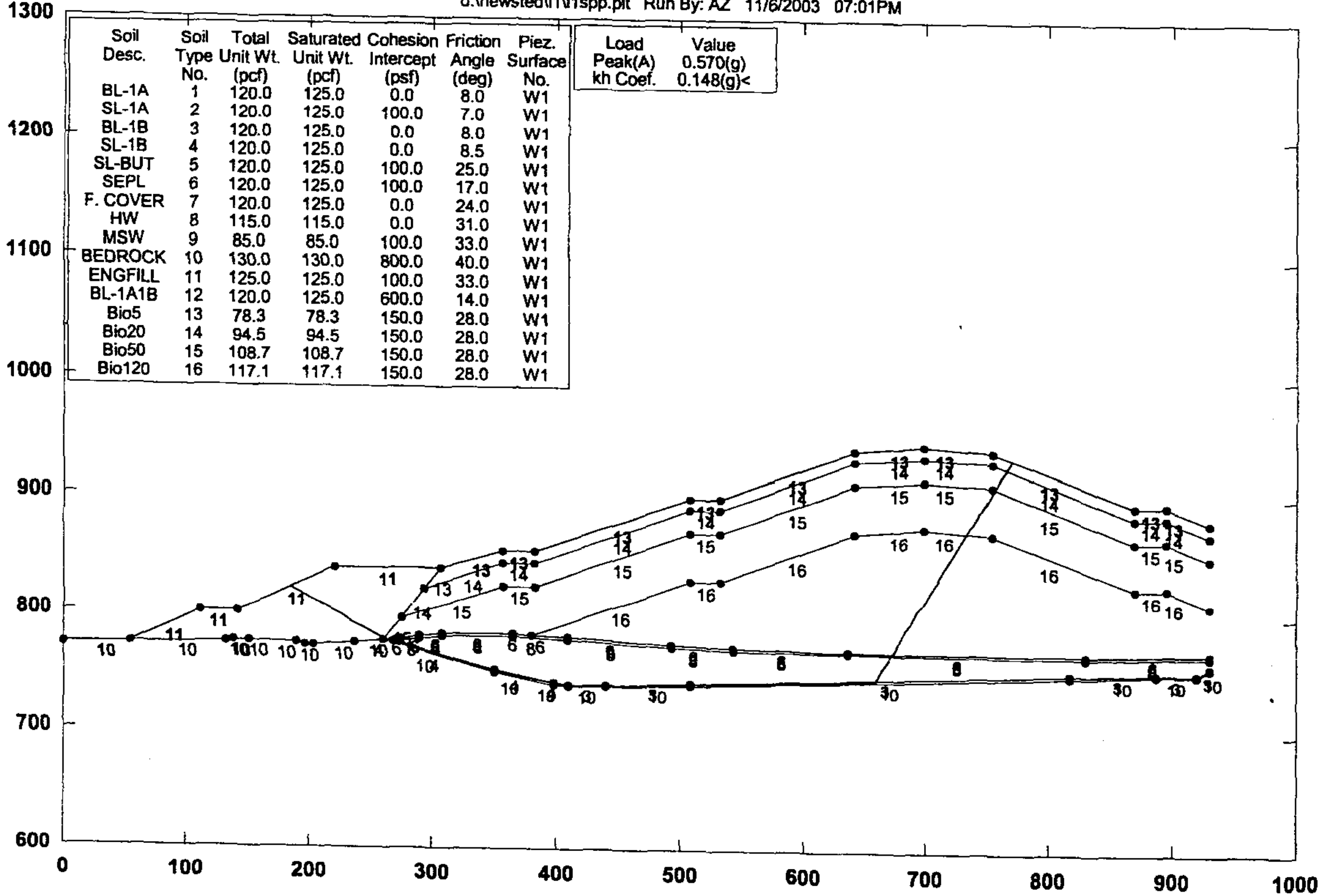
GSTABL7 v.2 FSmin=0.968

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF I-I' Failure Plane 1 Spencer Pseudo-Static Slope Stability

d:\newsted\i1\i1spp.plt Run By: AZ 11/6/2003 07:01PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	W1
SL-1A	2	120.0	125.0	100.0	7.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
SL-BUT	5	120.0	125.0	100.0	25.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
MSW	9	85.0	85.0	100.0	33.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1
Bio5	13	78.3	78.3	150.0	28.0	W1
Bio20	14	94.5	94.5	150.0	28.0	W1
Bio50	15	108.7	108.7	150.0	28.0	W1
Bio120	16	117.1	117.1	150.0	28.0	W1

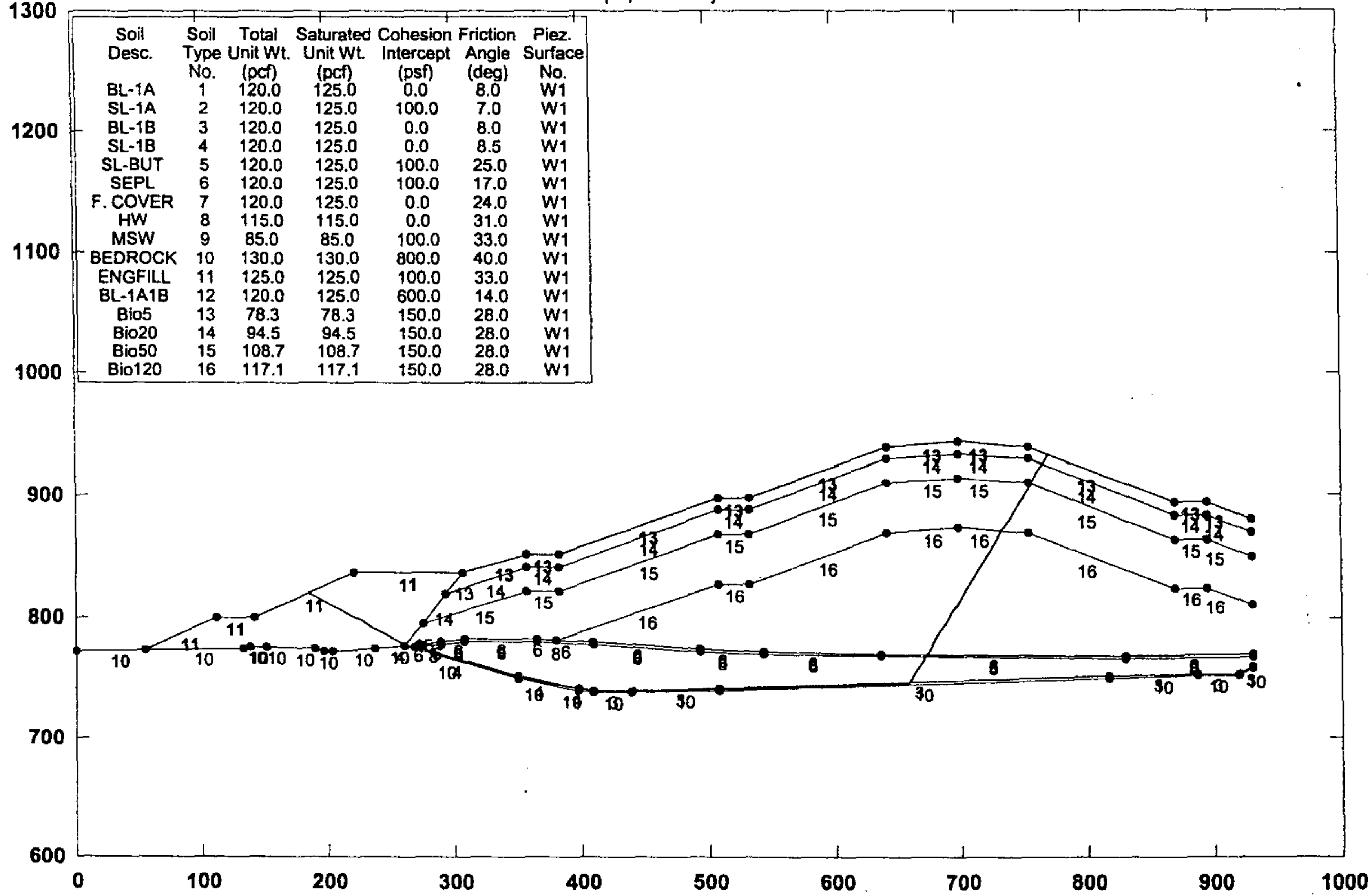
GSTABL7 v.2 FSmin=1.004

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF I-I' Failure Plane 1 Spencer Static Slope Stability

d:\newsted\i1\i1sps.plt Run By: AZ 11/6/2003 07:01PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	W1
SL-1A	2	120.0	125.0	100.0	7.0	W1
BL-1B	3	120.0	125.0	0.0	8.0	W1
SL-1B	4	120.0	125.0	0.0	8.5	W1
SL-BUT	5	120.0	125.0	100.0	25.0	W1
SEPL	6	120.0	125.0	100.0	17.0	W1
F. COVER	7	120.0	125.0	0.0	24.0	W1
HW	8	115.0	115.0	0.0	31.0	W1
MSW	9	85.0	85.0	100.0	33.0	W1
BEDROCK	10	130.0	130.0	800.0	40.0	W1
ENGFILL	11	125.0	125.0	100.0	33.0	W1
BL-1A1B	12	120.0	125.0	600.0	14.0	W1
Bio5	13	78.3	78.3	150.0	28.0	W1
Bio20	14	94.5	94.5	150.0	28.0	W1
Bio50	15	108.7	108.7	150.0	28.0	W1
Bio120	16	117.1	117.1	150.0	28.0	W1

GSTABL7 v.2 FSmin=2.065

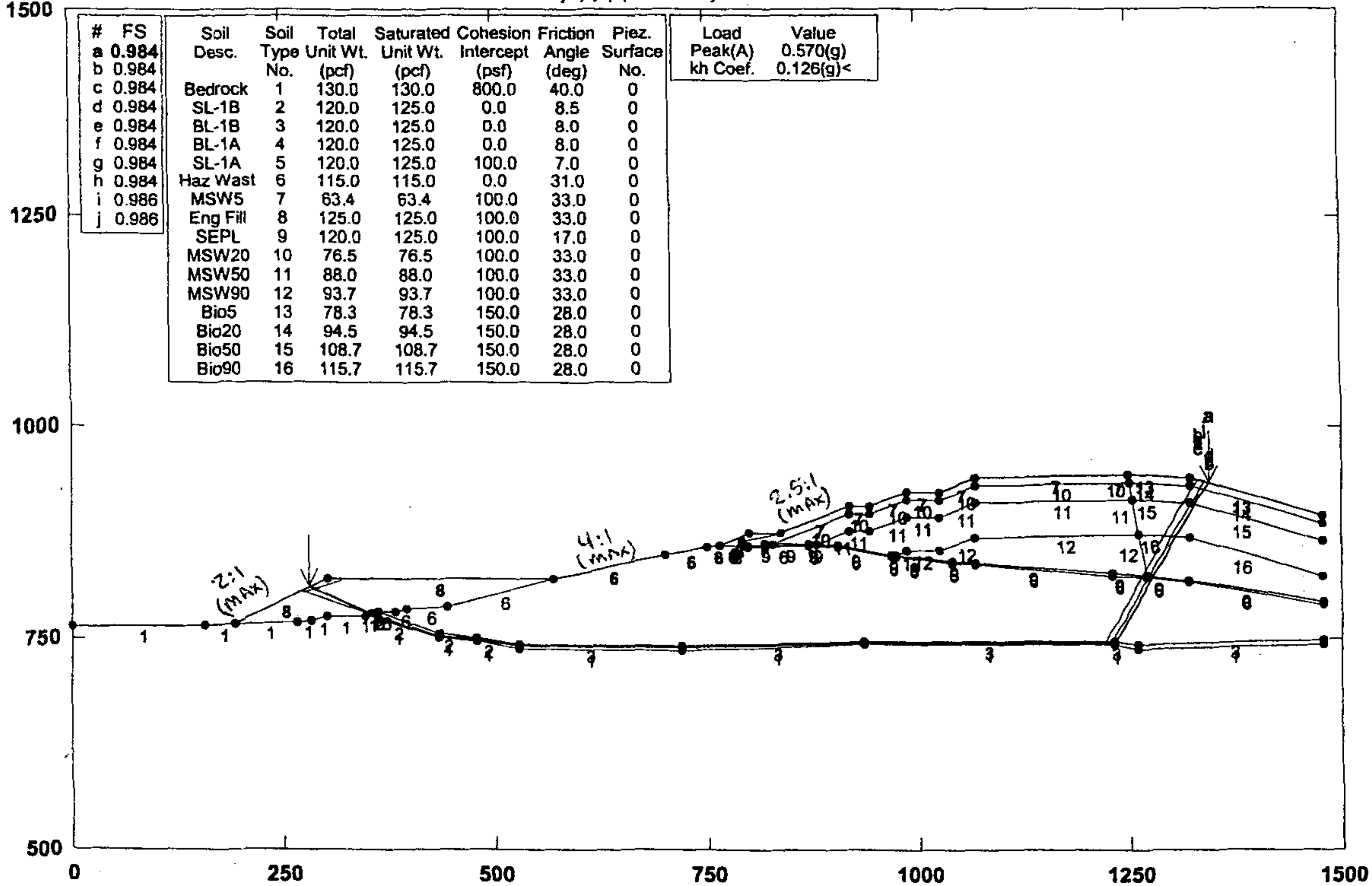
Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

CROSS SECTION J-J’

KHF J-J' Pseudo-Static Janbu Block Search

d:\newsted\j1\j1jap.pl2 Run By: AZ 11/6/2003 07:46PM



#	FS
a	**0.984**
b	0.984
c	0.984
d	0.984
e	0.984
f	0.984
g	0.984
h	0.984
i	0.986
j	0.986

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW50	11	88.0	88.0	100.0	33.0	0
MSW90	12	93.7	93.7	100.0	33.0	0
Bio5	13	78.3	78.3	150.0	28.0	0
Bio20	14	94.5	94.5	150.0	28.0	0
Bio50	15	108.7	108.7	150.0	28.0	0
Bio90	16	115.7	115.7	150.0	28.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.126(g)<

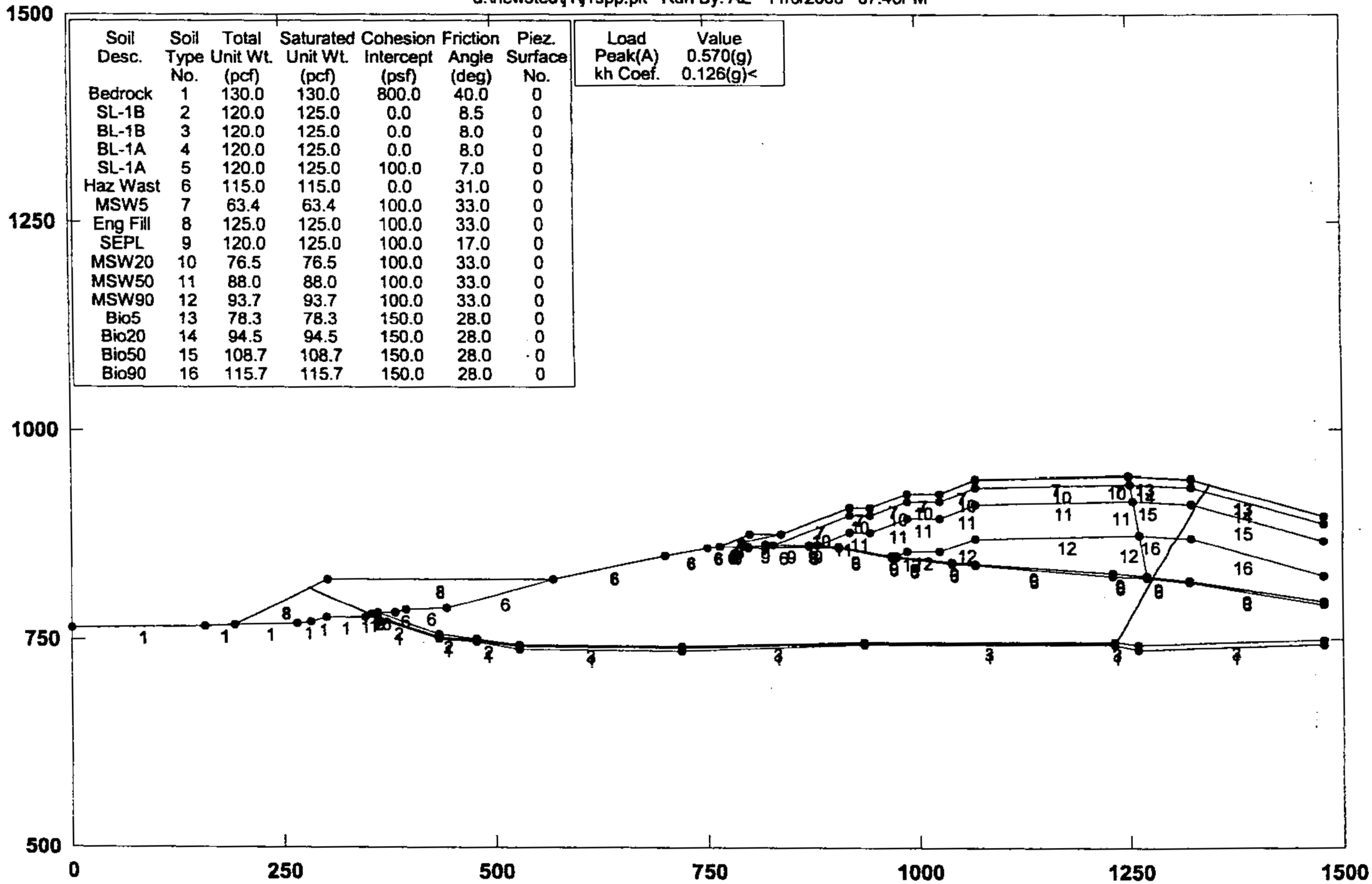
GSTABL7 v.2 FSmin=0.984

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF J-J' Failure Plane 1 Spencer Pseudo-Static Slope Stability

d:\newsted\j1\j1spp.plt Run By: AZ 11/6/2003 07:46PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW50	11	88.0	88.0	100.0	33.0	0
MSW90	12	93.7	93.7	100.0	33.0	0
Bio5	13	78.3	78.3	150.0	28.0	0
Bio20	14	94.5	94.5	150.0	28.0	0
Bio50	15	108.7	108.7	150.0	28.0	0
Bio90	16	115.7	115.7	150.0	28.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.126(g)<

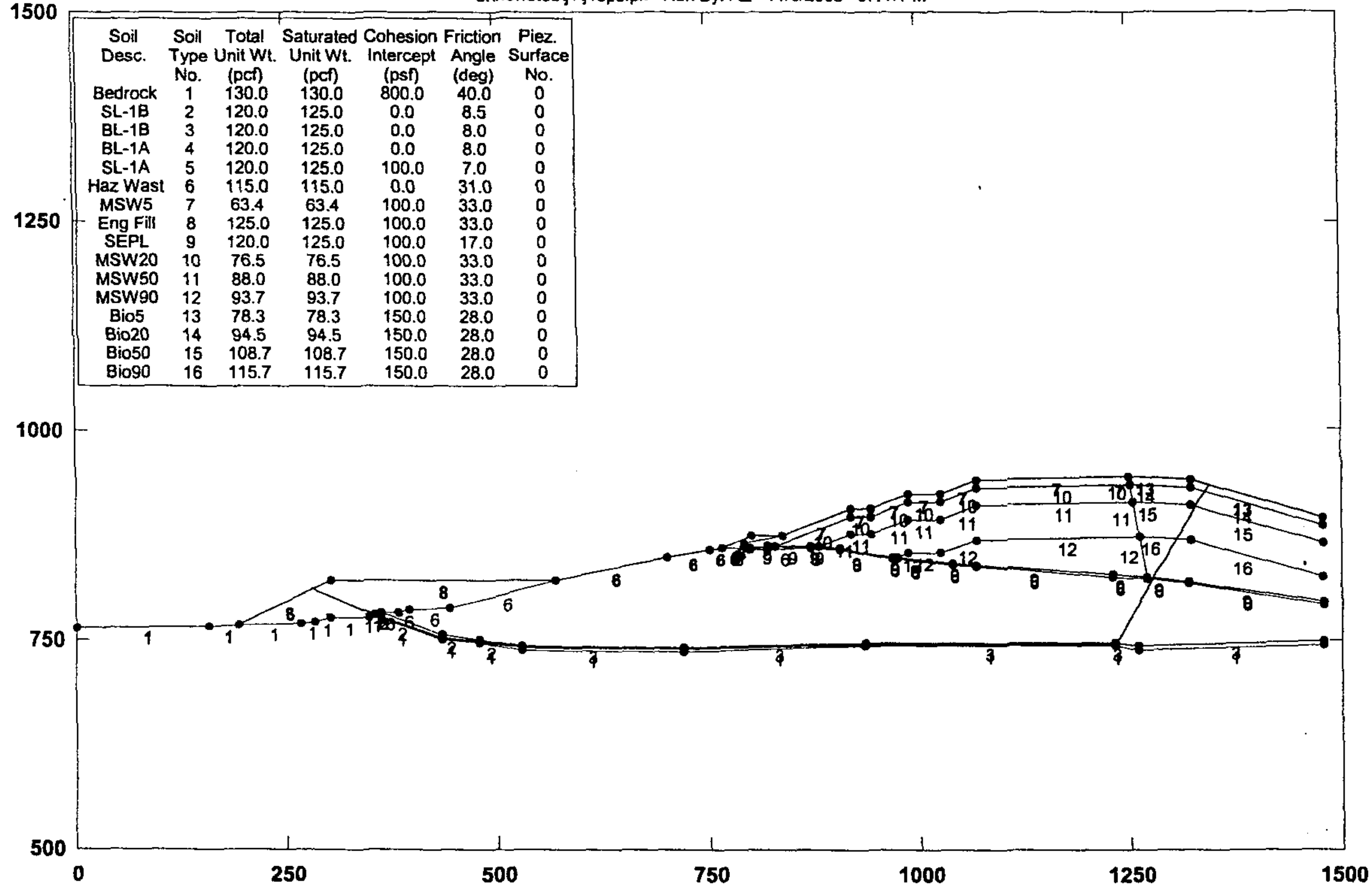
GSTABL7 v.2 FSmin=0.998

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF J-J' Failure Plane 1 Spencer Static Slope Stability

d:\newsted\j1\j1sps.plt Run By: AZ 11/6/2003 07:47PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Bedrock	1	130.0	130.0	800.0	40.0	0
SL-1B	2	120.0	125.0	0.0	8.5	0
BL-1B	3	120.0	125.0	0.0	8.0	0
BL-1A	4	120.0	125.0	0.0	8.0	0
SL-1A	5	120.0	125.0	100.0	7.0	0
Haz Wast	6	115.0	115.0	0.0	31.0	0
MSW5	7	63.4	63.4	100.0	33.0	0
Eng Fill	8	125.0	125.0	100.0	33.0	0
SEPL	9	120.0	125.0	100.0	17.0	0
MSW20	10	76.5	76.5	100.0	33.0	0
MSW50	11	88.0	88.0	100.0	33.0	0
MSW90	12	93.7	93.7	100.0	33.0	0
Bio5	13	78.3	78.3	150.0	28.0	0
Bio20	14	94.5	94.5	150.0	28.0	0
Bio50	15	108.7	108.7	150.0	28.0	0
Bio90	16	115.7	115.7	150.0	28.0	0

GSTABL7 v.2 FSmin=2.474

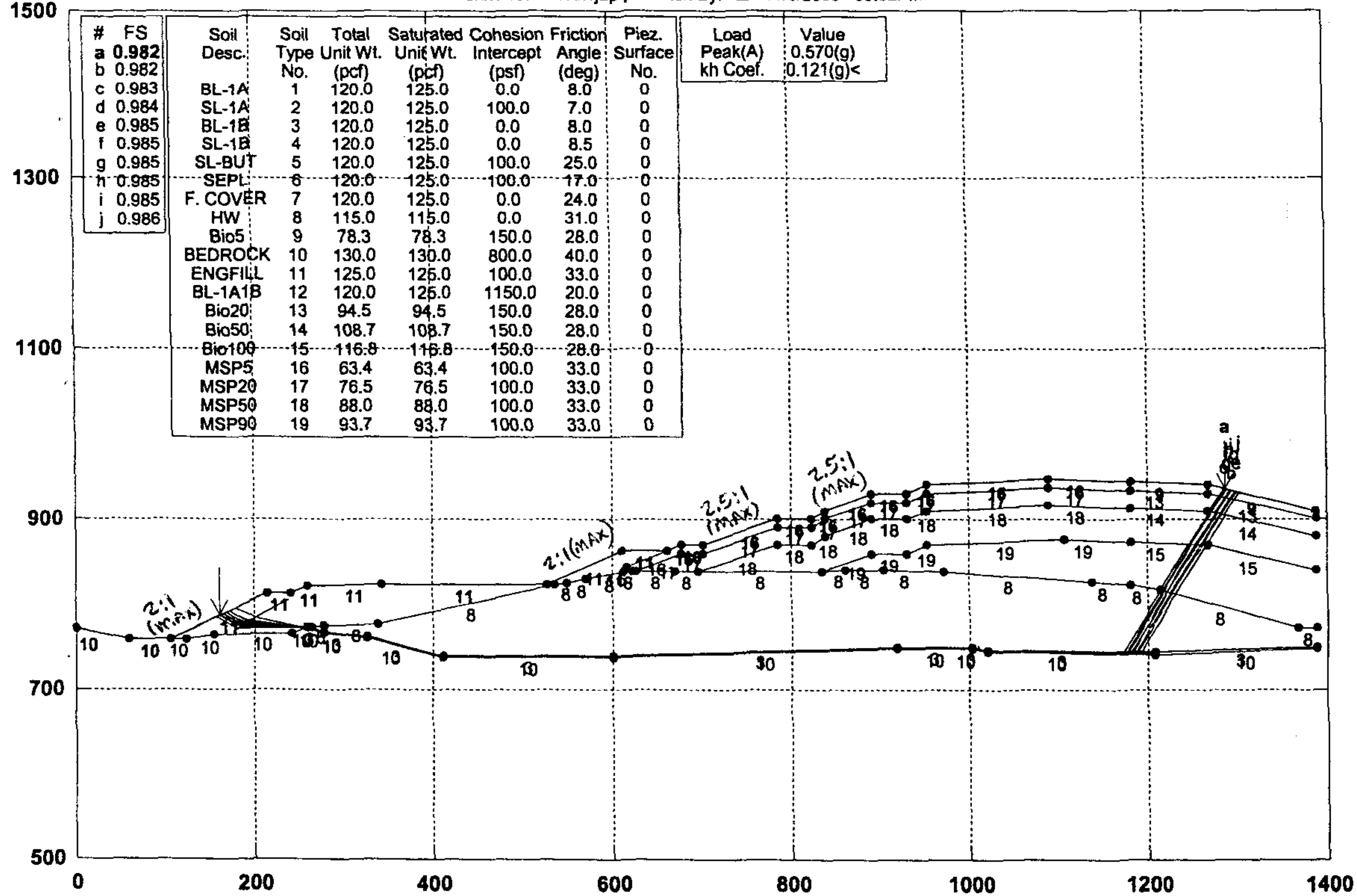
Factor Of Safety Is Calculated By GLE (Spencer's) Method (0-2)

GSTABL7

CROSS SECTION K-K'

KHF K-K' Pseudo-Static Janbu Block Search

d:\newsted\k1\k1jap.pl2 Run By: AZ 11/6/2003 09:02PM



#	FS
a	**0.982**
b	0.982
c	0.983
d	0.984
e	0.985
f	0.985
g	0.985
h	0.985
i	0.985
j	0.986

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	0
SL-1A	2	120.0	125.0	100.0	7.0	0
BL-1B	3	120.0	125.0	0.0	8.0	0
SL-1B	4	120.0	125.0	0.0	8.5	0
SL-BUT	5	120.0	125.0	100.0	25.0	0
SEPL	6	120.0	125.0	100.0	17.0	0
F. COVER	7	120.0	125.0	0.0	24.0	0
HW	8	115.0	115.0	0.0	31.0	0
Bio5	9	78.3	78.3	150.0	28.0	0
BEDROCK	10	130.0	130.0	800.0	40.0	0
ENGFILL	11	125.0	125.0	100.0	33.0	0
BL-1A1B	12	120.0	125.0	1150.0	20.0	0
Bio20	13	94.5	94.5	150.0	28.0	0
Bio50	14	108.7	108.7	150.0	28.0	0
Bio100	15	116.8	116.8	150.0	28.0	0
MSP5	16	63.4	63.4	100.0	33.0	0
MSP20	17	76.5	76.5	100.0	33.0	0
MSP50	18	88.0	88.0	100.0	33.0	0
MSP90	19	93.7	93.7	100.0	33.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.121(g)<

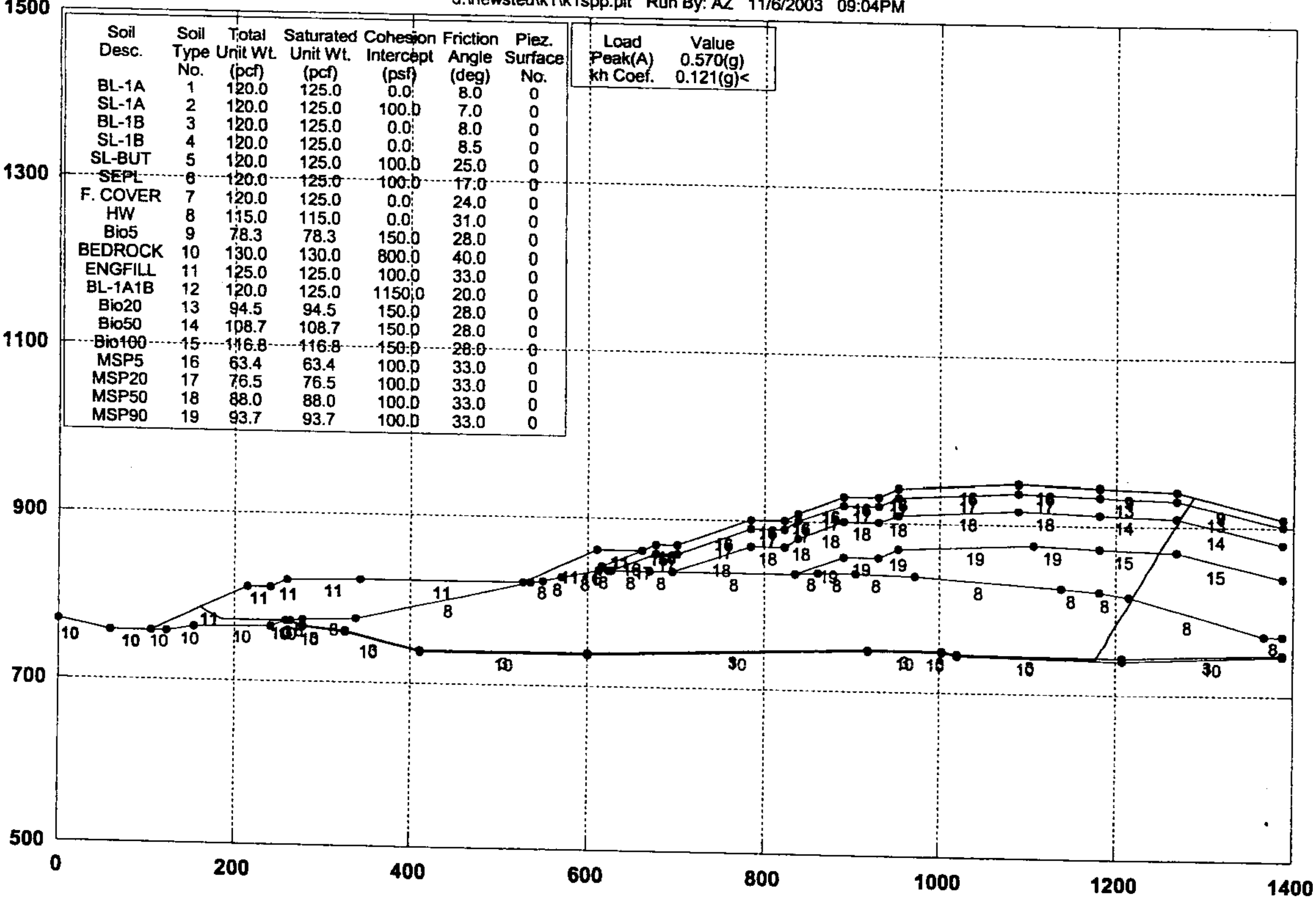
GSTABL7 v.2 FSmin=0.982

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF K-K' Failure Plane 1 Spencer Pseudo-Static Slope Stability

d:\newsted\k1\k1spp.plt Run By: AZ 11/6/2003 09:04PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	0
SL-1A	2	120.0	125.0	100.0	7.0	0
BL-1B	3	120.0	125.0	0.0	8.0	0
SL-1B	4	120.0	125.0	0.0	8.5	0
SL-BUT	5	120.0	125.0	100.0	25.0	0
SEPL	6	120.0	125.0	100.0	17.0	0
F. COVER	7	120.0	125.0	0.0	24.0	0
HW	8	115.0	115.0	0.0	31.0	0
Bio5	9	78.3	78.3	150.0	28.0	0
BEDROCK	10	130.0	130.0	800.0	40.0	0
ENGFILL	11	125.0	125.0	100.0	33.0	0
BL-1A1B	12	120.0	125.0	1150.0	20.0	0
Bio20	13	94.5	94.5	150.0	28.0	0
Bio50	14	108.7	108.7	150.0	28.0	0
Bio100	15	116.8	116.8	150.0	28.0	0
MSP5	16	63.4	63.4	100.0	33.0	0
MSP20	17	76.5	76.5	100.0	33.0	0
MSP50	18	88.0	88.0	100.0	33.0	0
MSP90	19	93.7	93.7	100.0	33.0	0

GSTABL7 v.2 FSmin=0.996

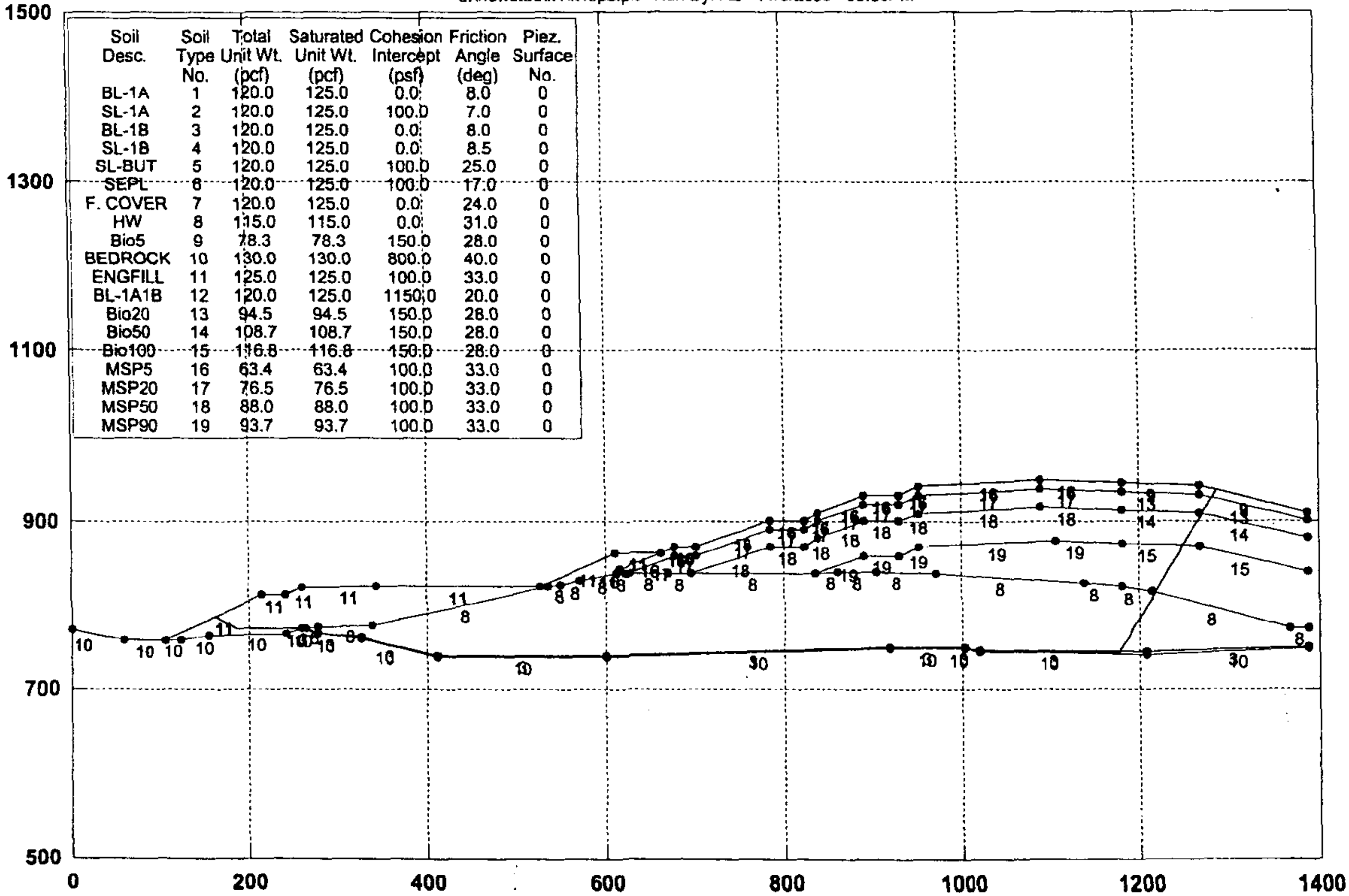
Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF K-K' Failure Plane 1 Spencer Static Slope Stability

d:\newsted\k1\k1sps.plt Run By: AZ 11/6/2003 09:06PM

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	0
SL-1A	2	120.0	125.0	100.0	7.0	0
BL-1B	3	120.0	125.0	0.0	8.0	0
SL-1B	4	120.0	125.0	0.0	8.5	0
SL-BUT	5	120.0	125.0	100.0	25.0	0
SEPL	6	120.0	125.0	100.0	17.0	0
F. COVER	7	120.0	125.0	0.0	24.0	0
HW	8	115.0	115.0	0.0	31.0	0
Bio5	9	78.3	78.3	150.0	28.0	0
BEDROCK	10	130.0	130.0	800.0	40.0	0
ENGFILL	11	125.0	125.0	100.0	33.0	0
BL-1A1B	12	120.0	125.0	1150.0	20.0	0
Bio20	13	94.5	94.5	150.0	28.0	0
Bio50	14	108.7	108.7	150.0	28.0	0
Bio100	15	116.8	116.8	150.0	28.0	0
MSP5	16	63.4	63.4	100.0	33.0	0
MSP20	17	76.5	76.5	100.0	33.0	0
MSP50	18	88.0	88.0	100.0	33.0	0
MSP90	19	93.7	93.7	100.0	33.0	0



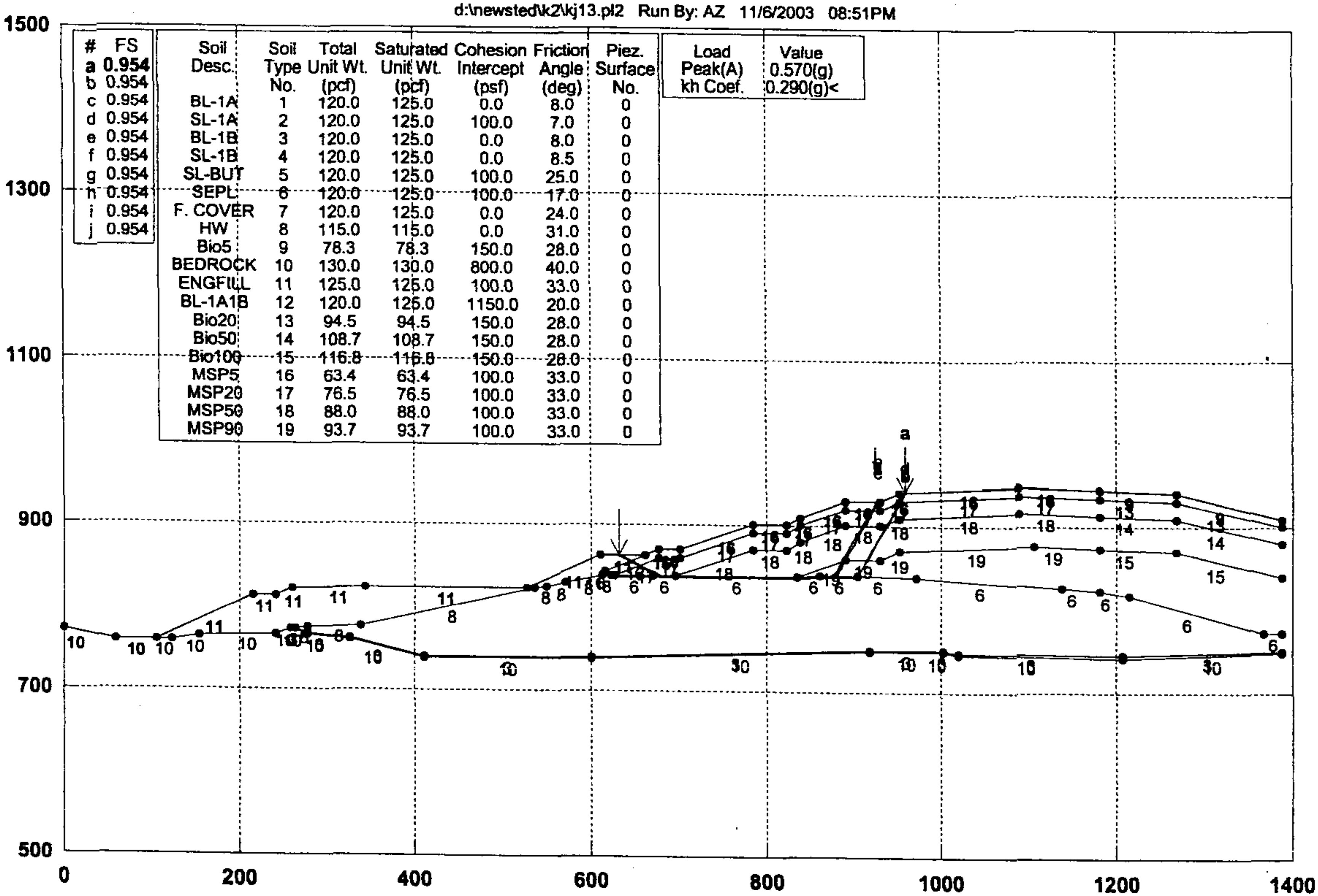
GSTABL7 v.2 FSmin=2.358

Factor Of Safety Is Calculated By GLE (Spencer's) Method (0-2)

GSTABL7

KHF K-K' Pseudo-Static Janbu Block Search

d:\newsted\k2\kj13.pl2 Run By: AZ 11/6/2003 08:51PM



#	FS
a	**0.954**
b	0.954
c	0.954
d	0.954
e	0.954
f	0.954
g	0.954
h	0.954
i	0.954
j	0.954

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	0
SL-1A	2	120.0	125.0	100.0	7.0	0
BL-1B	3	120.0	125.0	0.0	8.0	0
SL-1B	4	120.0	125.0	0.0	8.5	0
SL-BUT	5	120.0	125.0	100.0	25.0	0
SEPL	6	120.0	125.0	100.0	17.0	0
F. COVER	7	120.0	125.0	0.0	24.0	0
HW	8	115.0	115.0	0.0	31.0	0
Bio5	9	78.3	78.3	150.0	28.0	0
BEDROCK	10	130.0	130.0	800.0	40.0	0
ENGFILL	11	125.0	125.0	100.0	33.0	0
BL-1A1B	12	120.0	125.0	1150.0	20.0	0
Bio20	13	94.5	94.5	150.0	28.0	0
Bio50	14	108.7	108.7	150.0	28.0	0
Bio100	15	116.8	116.8	150.0	28.0	0
MSP5	16	63.4	63.4	100.0	33.0	0
MSP20	17	76.5	76.5	100.0	33.0	0
MSP50	18	88.0	88.0	100.0	33.0	0
MSP90	19	93.7	93.7	100.0	33.0	0

Load	Value
Peak(A)	0.570(g)
kh Coef.	0.290(g)<

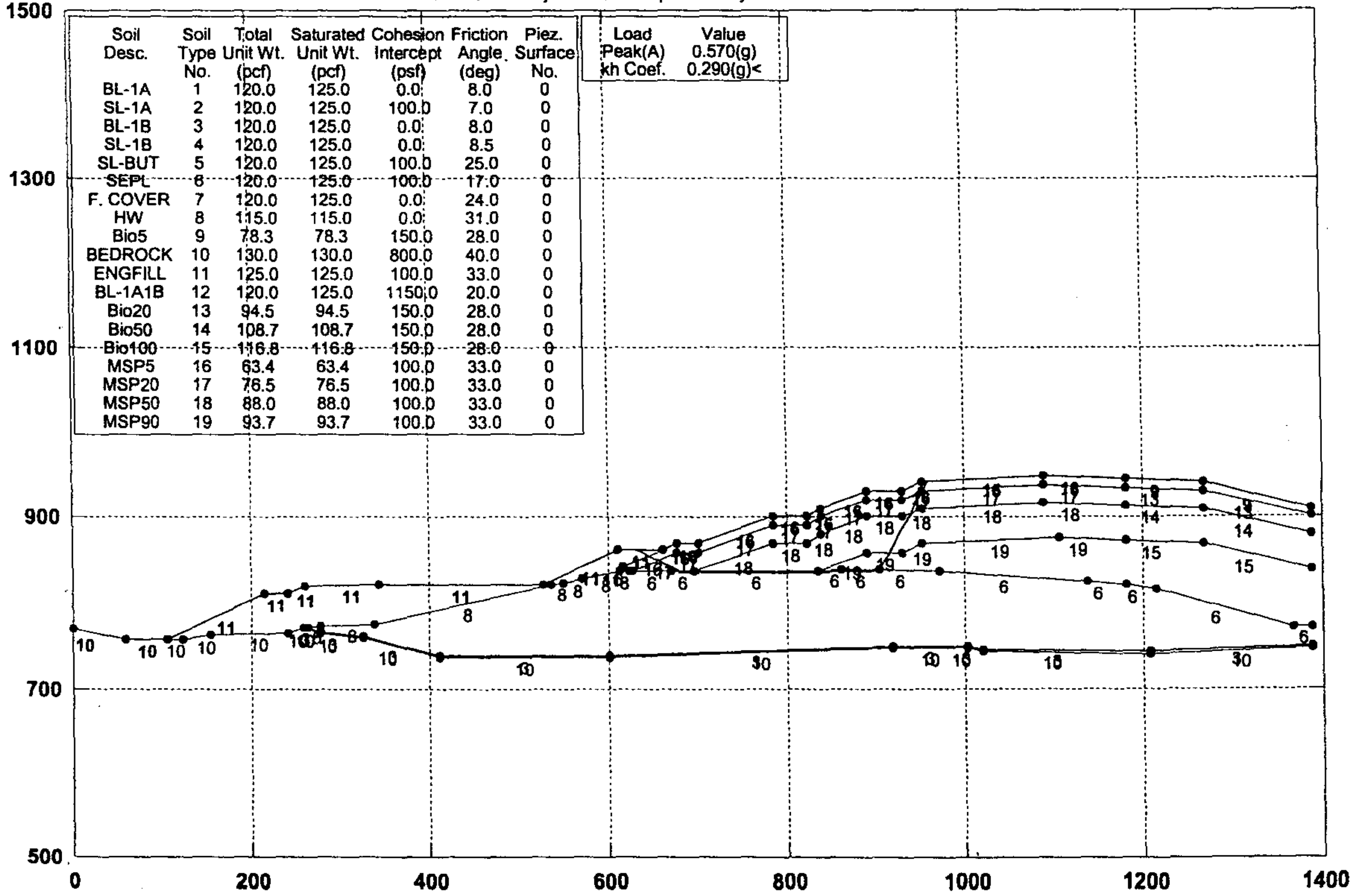
GSTABL7 v.2 FSmin=0.954

Safety Factors Are Calculated By The Simplified Janbu Method

GSTABL7

KHF K-K' Failure Plane 2 Spencer Pseudo-Static Slope Stability

d:\newsted\k2\kj13 surface #1.plt Run By: AZ 11/6/2003 08:53PM



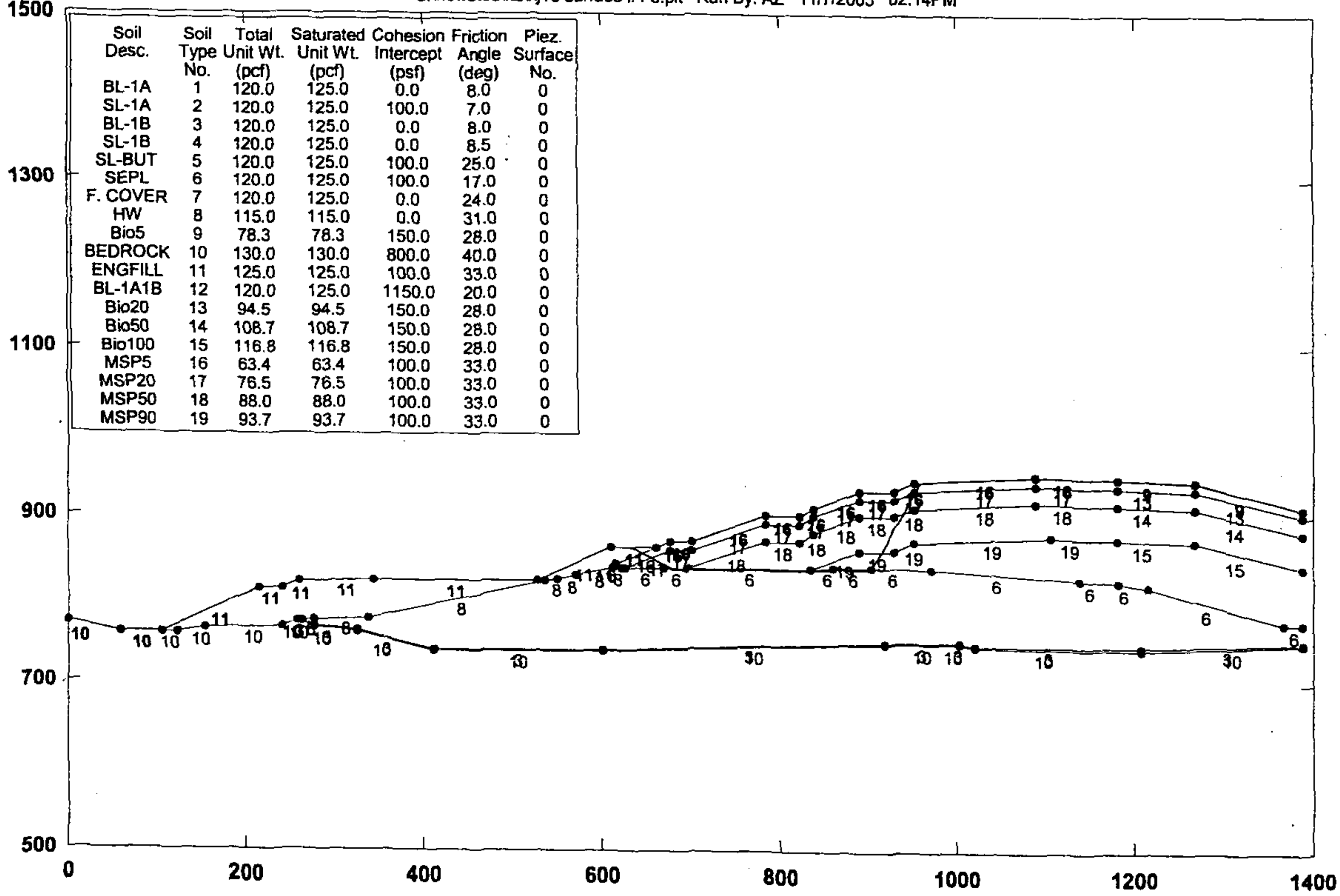
GSTABL7 v.2 FSmin=1.001

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

KHF K-K' Failure Plane 2 Spencer Static Slope Stability

d:\newsted\k2\kj13 surface #1 s.plt Run By: AZ 11/7/2003 02:14PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
BL-1A	1	120.0	125.0	0.0	8.0	0
SL-1A	2	120.0	125.0	100.0	7.0	0
BL-1B	3	120.0	125.0	0.0	8.0	0
SL-1B	4	120.0	125.0	0.0	8.5	0
SL-BUT	5	120.0	125.0	100.0	25.0	0
SEPL	6	120.0	125.0	100.0	17.0	0
F. COVER	7	120.0	125.0	0.0	24.0	0
HW	8	115.0	115.0	0.0	31.0	0
Bio5	9	78.3	78.3	150.0	28.0	0
BEDROCK	10	130.0	130.0	800.0	40.0	0
ENGFILL	11	125.0	125.0	100.0	33.0	0
BL-1A1B	12	120.0	125.0	1150.0	20.0	0
Bio20	13	94.5	94.5	150.0	28.0	0
Bio50	14	108.7	108.7	150.0	28.0	0
Bio100	15	116.8	116.8	150.0	28.0	0
MSP5	16	63.4	63.4	100.0	33.0	0
MSP20	17	76.5	76.5	100.0	33.0	0
MSP50	18	88.0	88.0	100.0	33.0	0
MSP90	19	93.7	93.7	100.0	33.0	0

GSTABL7 v.2 FSmin=2.864

Factor Of Safety Is Calculated By GLE (Spencer`s) Method (0-2)

GSTABL7

APPENDIX C

Static and Seismic Stability of Final Cover

CLASS I WASTE FINAL COVER STABILITY

Objective:
Evaluate static and seismic stability (long term condition) and temporary stability during construction of the final landfill cover for Class I waste area at Kettleman Hills Facility (KHF) Landfill Unit B-19.

Performance Criteria:

- Static Loading: Minimum Factor of Safety of 1.5.
- Dynamic Loading: Allowable seismic displacements up to 12 inches.
- Temporary Loading Case during Construction: Minimum Factor of Safety 1.25.

Geometry:
The typical cover system for Class I waste is shown on Figure 1.

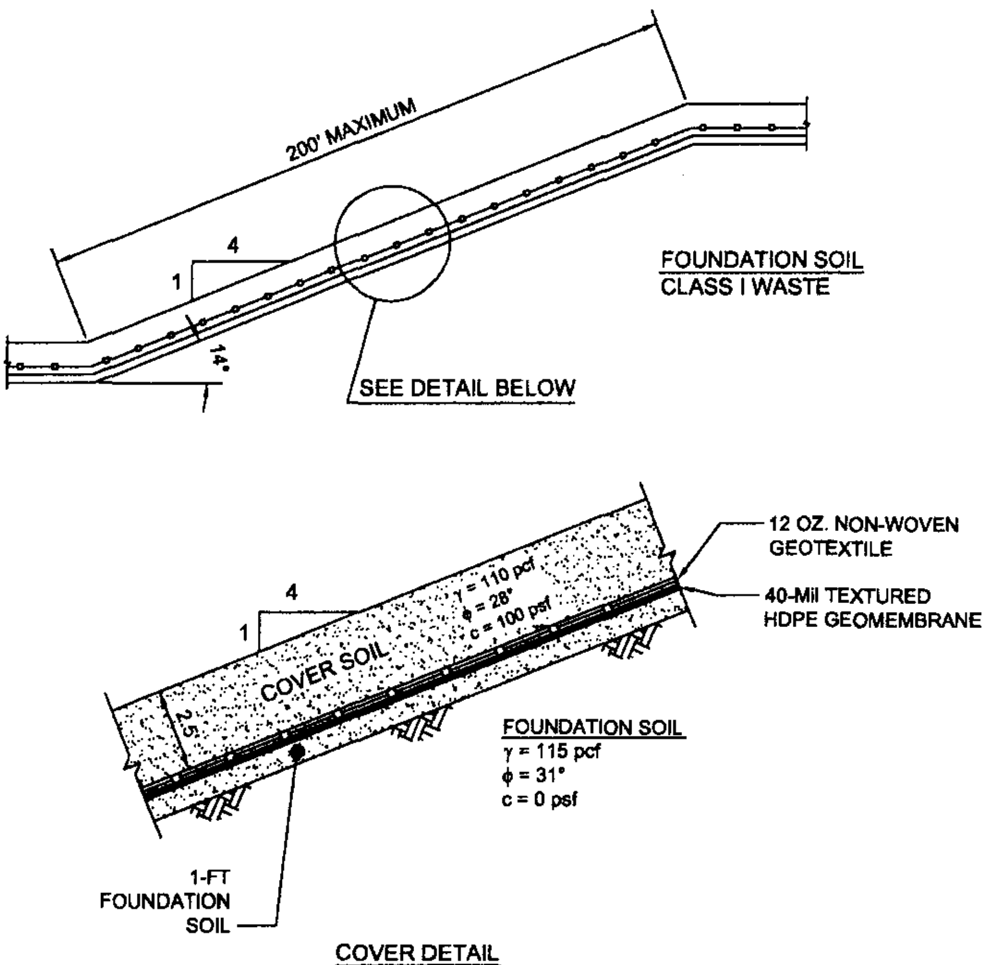


Figure 1. Cover Geometry for Class I Waste

The shear strength parameters of the cover interfaces are shown in Table 1. The site-specific values of these parameters should be verified prior to the construction of the cover.

Table 1. Shear Strength Properties for Interfaces in Figure 1

INTERFACE	STRENGTH PARAMETERS		
	γ (pcf)	c (psf)	ϕ (degrees)
Cover Soil / Geotextile	110	0	21
Geotextile / 40-Mil HDPE	110	0	25*
40-Mil HDPE / Intermediate Soil	110	0	28
Foundation Soil / Class I Waste	110	0	31

* Results of site-specific laboratory interface direct shear tests performed on textured geomembrane and geotextile materials to be used for Class I waste cover construction under low confining pressures (pressure due to the weight of cover soil) indicate a residual friction angle of approximately 28 degrees for this interface (see attached). A conservative value of 25 degrees, however, was used in our analyses.

Design Theory:
The long-term stability of the cover (stability analysis for static case) is based on the infinite slope model shown in Figure 2.

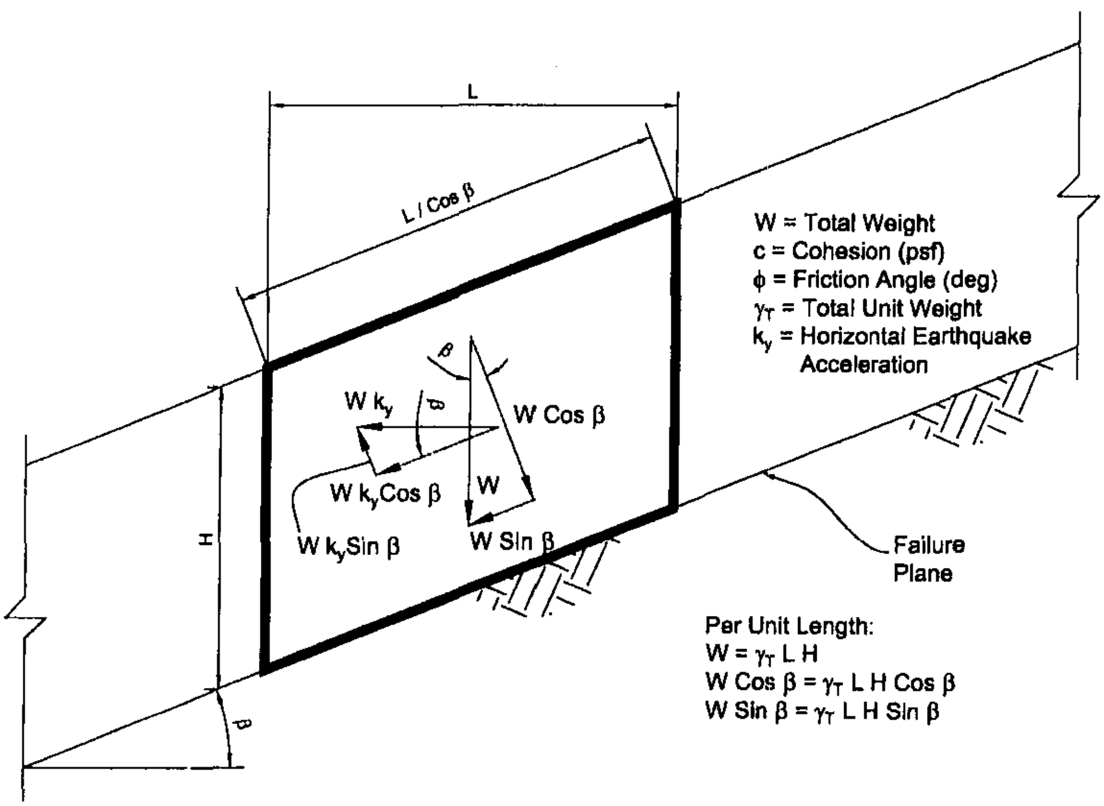


Figure 2. Equilibrium of Loads for a Unit Length of Cover

The safety factor against sliding can be evaluated using the following equation (Huang, 1983):

$$F.S. = \frac{c}{\gamma_T H \cos^2 \beta \tan \beta} + \frac{\tan \phi}{\tan \beta}$$

If $c = 0$, then: $F.S. = \dfrac{\tan \phi}{\tan \beta}$

Note: This analysis is conservative since the effect of finite slope length and passive resistance wedge at the toe of the slope is not included.

Long-Term Static Stability:
Based on the interface and material properties shown in Table 1, for Class I waste cover the weakest interface of the cover is the Geotextile / HDPE geomembrane interface. The following presents the infinite slope stability analysis performed for the Class I waste cover.

Static Stability for Geotextile / HDPE geomembrane interface:

$c = 0$ psf, $\phi = 25°$, $\beta = 14°$, $H = 2.5 / (\cos 14) = 2.58$ ft, $\gamma = 110$ pcf

$$F.S. = \frac{0}{110 \cdot 2.58 \cdot \cos^2 14 \cdot \tan 14} + \frac{\tan 25}{\tan 14} = 1.87 > 1.5 \text{ o.k.}$$

Construction Stage/Temporary Loading (Short-Term) Static Stability:
The stability of cover needs to be evaluated for the temporary condition during cover placement. It is assumed that the cover is placed from bottom to top (backfilling up slope). When the equipment weight is considered, the stability is evaluated for a finite length of the slope, usually the distance between two benches. The equilibrium of forces for a finite length of the slope is shown on Figure 3 (Qian, Koerner, Gray, 2002). Figure 3 illustrates the forces applied on the cover for this case. The following symbols are used in this figure:

W_A = total weight of the active wedge including additional weight of soil wedge from the upper bench (W_{A1} and W_{A2}) plus equipment weights on the slope and upper bench (W_{e1} and W_{e2});
W_{A1} = weight of soil cover on the slope (included in W_A);
W_{A2} = weight of soil wedge from the upper bench (included in W_A);
W_{e1} = weight of equipment on slope (included in W_A);
W_{e2} = weight of equipment on upper bench (included in W_A);
W_P = total weight of the passive wedge;
N_A = effective force normal to the failure plane of the active wedge;
N_P = effective force normal to the failure plane of the passive wedge;
γ = unit weight of the cover soil;

h = thickness of the cover;
L = length of the slope measured along the slip plane;
β = soil slope angle;
ϕ = friction angle of cover soil;
δ = interface friction angle;
C_a = adhesion force between cover soil of the active wedge and geo-membrane or foundation;
c_a = adhesion between cover soil of the active wedge and geo-membrane or foundation;
C = cohesion force along the failure plane of the passive wedge;
c = cohesion of the cover soil;
E_A = inter-wedge force acting on the active wedge from the passive wedge;
E_P = inter-wedge force acting on the passive wedge from the active wedge;
FS = factor of safety against cover soil sliding.

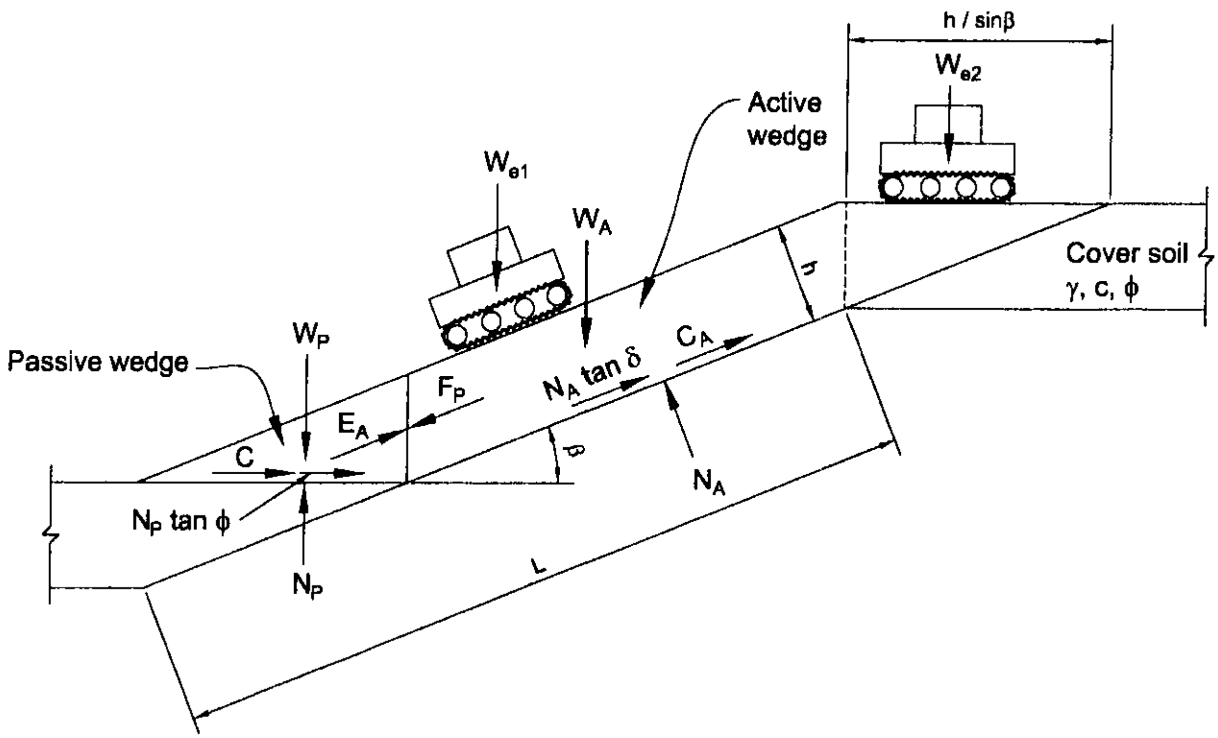


Figure 3. Equilibrium of Forces for a Finite Length Slope of a Uniformly Thick Cover Soil

For this condition the stability of the cover can be evaluated using the following equation:

$$FS = \frac{-b \pm \sqrt{b^2 - 4 \times a \times cc}}{2 \times a}$$

Where:

$a = (W_A - N_A \times \cos\beta) \times \cos\beta$

$b = -[(W_A - N_A \times \cos\beta) \times \sin\beta \times \tan\phi + (N_A \times \tan\delta + C_a) \times \sin\beta \times \cos\beta + (C + W_P \times \tan\phi) \times \sin\beta]$

$cc = (N_A \times \tan\delta + C_a) \times \sin^2\beta \times \tan\phi$

$W_A = W_{A1} + W_{A2} + W_{e1} + W_{e2}$

$W_{A1} = (\gamma \times h^2) \times [L/h - 1/\sin\beta - \tan(\beta/2)]$

$W_{A2} = (\gamma \times h^2) / (\sin 2\beta)$

$W_P = (\gamma \times h^2) / (\sin 2\beta)$

$N_A = W_A \times \cos\beta$

$C_a = c_a \times (L - h/\sin\beta)$

$C = (c \times h) / (\sin\beta)$

For the up slope backfilling, the dynamic force resulting from acceleration and braking of the construction equipment is not considered. The weight of the equipment is added to the weight of the cover soil.

The pressure at the potential slip interface can be calculated from the following equation:

Equivalent equipment force per unit width at slip plane interface: $W_e = q \times w \times I$

Where:

$q = W_b / (2 \times w \times b)$;
W_b = operating weight of equipment;
w = length of equipment track;
b = width of equipment track;
I = influence factor at slip plane interface.

The contact pressure for a CAT D6N LGP tractor is 4.8 psi, with an operating weight of 40,000 lbs. The track dimensions are length (w) = 122 in and width (b) = 34 in. The track gauge (distance between centers of tracks) is 85 inches.

The influence factor for cover thickness (h) of 2.5 ft can be calculated as:

$b / h = 34 / (2.5 \times 12) = 1.13 \rightarrow I = 0.92$

Using this influence factor, the equivalent pressure is evaluated below:

$q = 40{,}000 / (2 \times 122 \times 34) = 4.8$ psi = 695 psf

$h = 2.5$ ft $\rightarrow W_{e1} = 695 \times (122/12) \times 0.92 = 6{,}500$ lbs

We have also included additional surcharge of the construction equipment on the upper bench of the cover veneer. This load is estimated as a 500 psf uniform pressure acting on a length equal to h/sin β.

$\beta = 14° \rightarrow W_{e2} = 500 \times 2.5/\sin(14°) = 5{,}167$ lbs

Using these equipment weights, the safety factor for temporary stability of geotextile / HDPE interface is calculated below:

$\gamma = 110$ pcf;
$h = 2.5$ ft;
$L = 200$ ft (Section A-A');
$\beta = 14°$;
$\phi = 28°$;
$\delta = 25°$;
$c_a = 0$ psf;
$c = 100$ psf;
$W_e = 6{,}500 + 5{,}167 = 11{,}667$ lbs.

The following values are calculated using above parameters:

$W_A = 65{,}204$ lbs
$W_P = 1{,}464$ lbs
$N_A = 63{,}267$ lbs
$C_a = 0$ lbs
$C = 1{,}033.4$ lbs

$a = 3702.8$ lb/ft
$b = -7854.4$ lb/ft
$cc = 918.1$ lb/ft

These values result in a factor of safety of 2.00 for finite length cover slope. This value is higher than the factor of safety of 1.87 for infinite slope analysis without the construction equipment weight.

Seismic Stability:
For Class I waste cover, seismic stability is evaluated for a finite length of the slope, usually the distance between two benches. This provides a more realistic analytical model of the cover stability since it includes the effect of passive resistance wedge at the toe of the slope. For this case equipment forces shown in Figure 3 will be set equal to zero and seismic acceleration will be applied on the cover mass. For this condition the stability of the cover can be evaluated using the following equation:

$$FS = \frac{-b \pm \sqrt{b^2 - 4 \times a \times cc}}{2 \times a}$$

Where:

$a = (C_S \times W_A + N_A \times \sin\beta) \times \cos\beta + C_S \times W_P \times \cos\beta$

$b = -[(C_S \times W_A + N_A \times \sin\beta) \times \sin\beta \times \tan\phi + (N_A \times \tan\delta + C_a) \times \cos^2\beta + (C + W_P \times \tan\phi) \times \cos\beta]$

$cc = (N_A \times \tan\delta + C_a) \times \sin\beta \times \cos\beta \times \tan\phi$

C_S = Seismic Coefficient

W_A = total weight of the active wedge = $\gamma \times h^2 \times [L/h - 1/\sin\beta - \tan(\beta/2)] + (\gamma \times h^2) / (\sin 2\beta)$

$W_P = (\gamma \times h^2) / (\sin 2\beta)$

$N_A = W_A \times \cos\beta$

$C_a = c_a \times (L - h/\sin\beta)$

$C = (c \times h) / (\sin\beta)$

Using the above equations, the Yield Acceleration (k_y), corresponding to factor of safety of 1.0 was calculated for Geotextile / HDPE geomembrane interface (weakest interface in Class I waste cover):

L = 200 ft, h = 2.5 ft, γ = 110 pcf, c_a = 0 psf, c = 100 psf, β = 14°, ϕ = 28°, δ = 25°,
H = 2.5 / (cos 14) = 2.58 ft, *F.S.* = 1.0 ==> k_y = 0.24

The Newmark Displacement Correlations developed by Franklin and Chang (1977) were used to estimate the permanent seismic deformation of the cover system.

$$U_m = U_S \times \frac{V^2}{1800A}$$

Where:
- U_m = Unscaled Permanent Displacement (in.)
- U_s = Standardized Maximum Displacement (in.)
- A = Maximum Ground Acceleration (as fraction of g)
- V = Maximum Ground Velocity (in/s)

A conservative V/A ratio of 60 was used in the analyses, resulting in a maximum ground velocity of 34.2 in/s. U_s was obtained from standard displacement chart based on k_y/A ratio.

Based on these assumptions, the seismic displacement value in Table 2 was obtained for Class I waste landfill cover system. Based on our calculation it appears that the permanent seismic displacement is in the allowable range for the weakest interface of the cover, therefore the cover system meets the static and seismic stability criteria.

Table 2. Permanent Seismic Displacement Evaluation for Class I Waste Cover

Interface	k_y* (g)	A (g)	V (in/s)	k_y/A	U_s (in)	U_m (in)
Geotextile / HDPE*	0.24	0.57	34.2	0.42	~ 10	~ 11

References:

Huang, Y. H. (1983), "Stability Analysis of Earth Slopes".

Franklin, A. G. and Chang, F. K. (1977), "Permanent Displacements of Earth Embankments by Newmark Sliding Block Analysis", Report 5, Miscellaneous Papers S-71-17, U.S. Army Corps of Engineers Waterway Experiment Station, Vicksburg, Mississippi.

Qian, X., Koerner, R. M., Gray, D. H. (2002), "Geotechnical Aspects of Landfill Design and Construction

Subject: Cover Slope Stability | **Project Name:**
By: A.Z. **Date:** 5/12606 **Project No:**
Checked By: B.H. **Date:** 5/26/06 **Sheet:** 1 of 7

CLASS II/III / BIOREACTOR WASTE FINAL COVER STABILITY

Objective:
Evaluate static and seismic stability (long term condition) and temporary stability (during construction) of the final cover for Class II/III (MSW) and bioreactor waste at Kettleman Hills Facility Landfill Unit B-19.

Performance Criteria:
- Static Loading: Minimum Factor of Safety of 1.5.
- Dynamic Loading: Allowable seismic displacements up to 12 inches.
- Temporary Loading Case during Construction: Minimum Factor of Safety 1.25.

Geometry:
The typical cover system for Class II/III and bioreactor waste is shown on Figure 1.

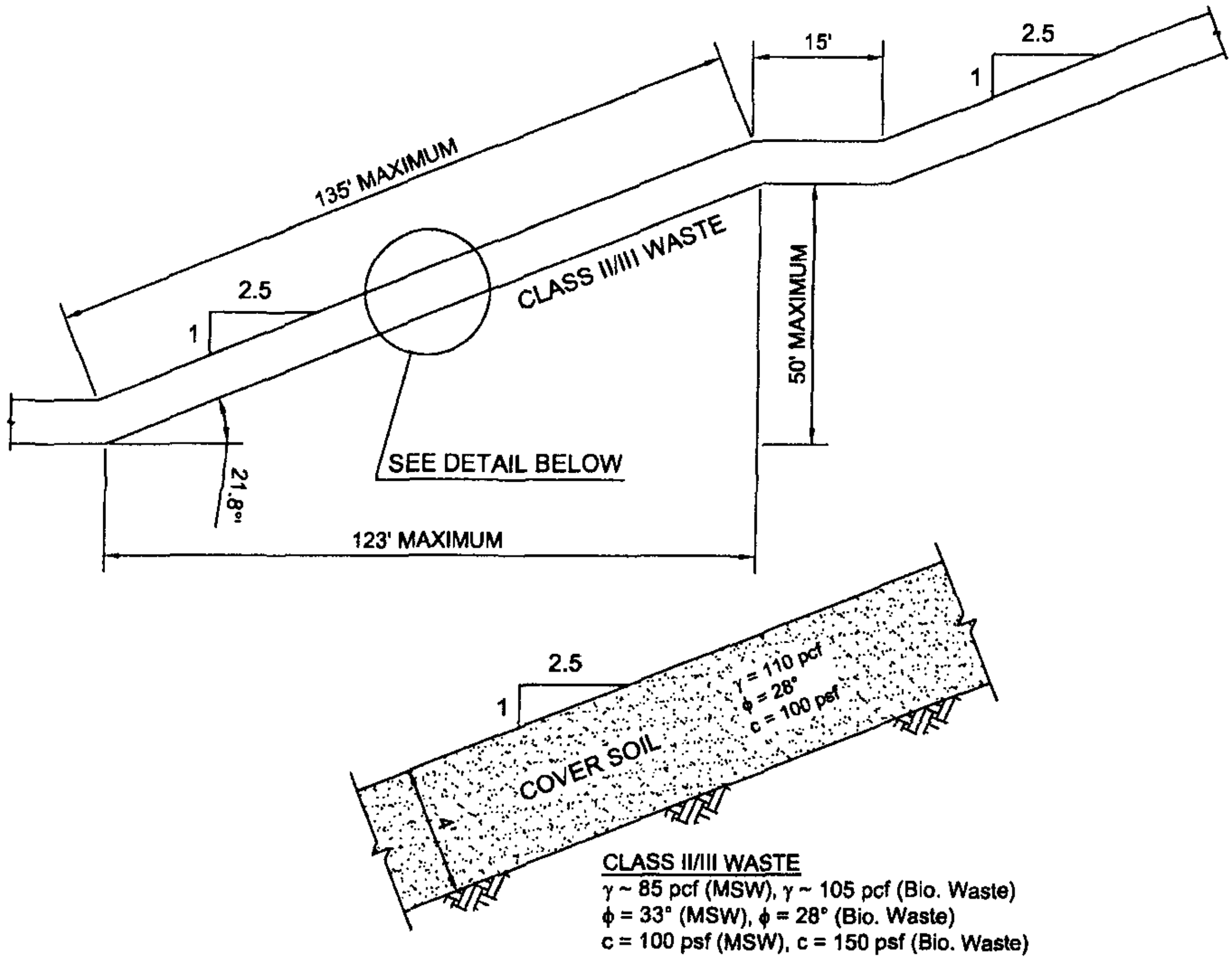


Figure 1. Cover Geometry for Class II/III Waste.

The assumed strength parameters for the weakest interface of the cover are shown in Table 1. The site-specific values of these parameters should be verified prior to the construction of the cover.

Table 1. Cover Interface Shear Strength Properties

INTERFACE	STRENGTH PARAMETERS		
	γ (pcf)	c (psf)	ϕ (degrees)
Cover Soil / Class II/III Waste	110	100	28

Design Theory:
The stability analysis for static and seismic cases is based on the infinite slope model, which is shown on Figure 2.

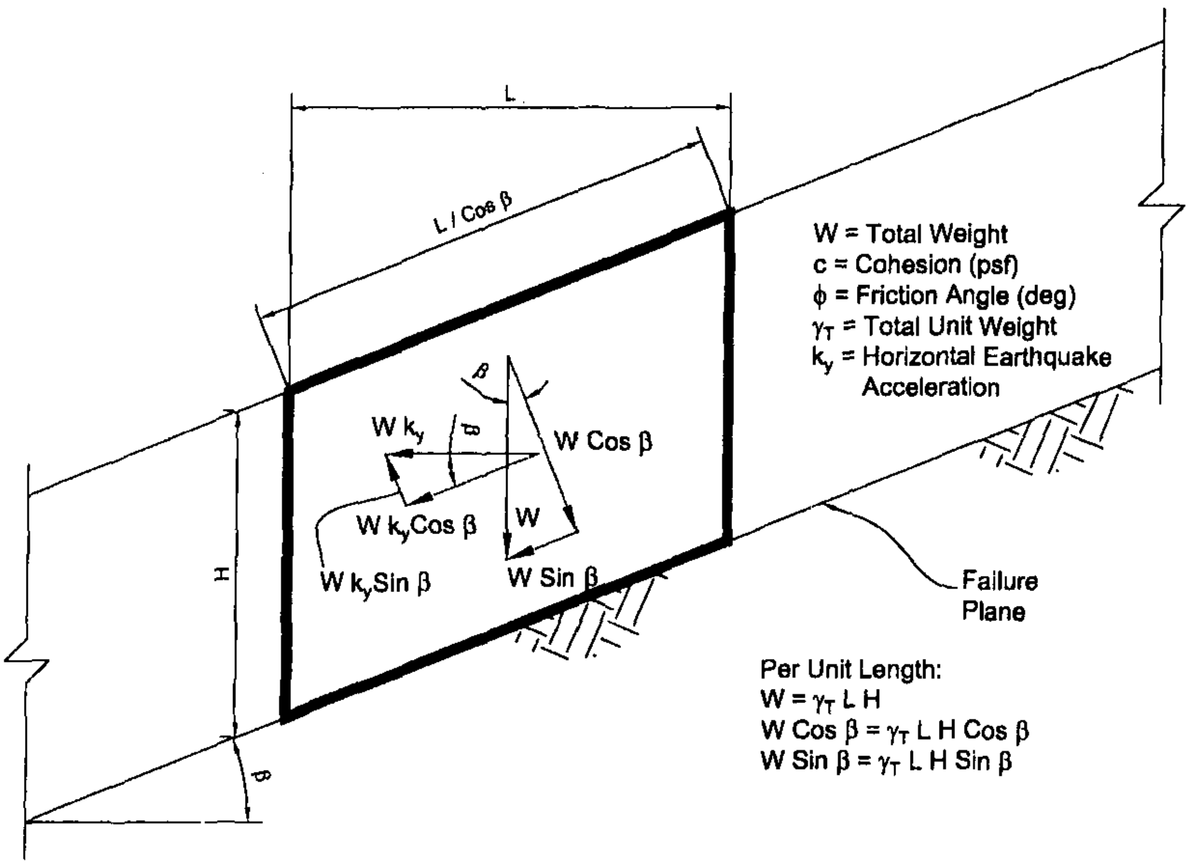


Figure 2. Equilibrium of Loads for a Unit Length of Cover.

The safety factors against sliding can be evaluated using the following equations (Huang, 1983):

For static case:

$$F.S. = \frac{c}{\gamma_T H \cos^2\beta \tan\beta} + \frac{\tan\phi}{\tan\beta}$$

If $c = 0$, then: $F.S. = \frac{\tan\phi}{\tan\beta}$

For seismic case ($k_y > 0$):

$$F.S. = \frac{c(L/\cos\beta) + \gamma_T LH\cos\beta\tan\phi - k_y\gamma_T LH\sin\beta\tan\phi}{\gamma_T LH\sin\beta + k_y\gamma_T LH\cos\beta}$$

Note: This analysis is conservative since the effect of finite slope length and passive resistance wedge at the toe of the slope is not included.

Static Stability:
Static stability for cover soil / Class II/III waste interface properties (Table 1) was calculated.

c = 100 psf, ϕ = 28°, β = 21.8°, H = 4.0 / (cos 21.8) = 4.31 ft, γ = 110 pcf

$$F.S. = \frac{100}{110\cdot 4.31\cdot\cos^2 21.8\cdot\tan 21.8} + \frac{\tan 28}{\tan 21.8} = 1.94 > 1.5 \text{ o.k.}$$

Seismic Stability:
Using seismic case equation, the Yield Acceleration (k_y), corresponding to factor of safety of 1.0 was calculated for the cover soil / Class II/III waste interface:

c = 100 psf, ϕ = 28°, β = 21.8°, H = 4.0 / (cos 21.8) = 4.31 ft, γ = 110 pcf

$F.S. =$ 1.0 ==> k_y = 0.311

The Newmark Displacement Correlations developed by Franklin and Chang (1977) were used to estimate the permanent seismic deformation of the cover system.

$$U_m = U_S \times \frac{V^2}{1800A}$$

Where: U_m = Unscaled Permanent Displacement (in.)
U_s = Standardized Maximum Displacement (in.)
A = Maximum Ground Acceleration (as fraction of g)
V = Maximum Ground Velocity (in/s)

A conservative V/A ratio of 60 was used in the analyses, resulting in a maximum ground velocity of 34.2 in/s. U_s was obtained from standard displacement chart based on k_y/A ratio.

Based on these assumptions, the seismic displacement in Table 2 was obtained for MSW/bioreactor waste landfill cover system. Based on our calculations, it appears that the permanent seismic displacement is in the allowable range for all interfaces, therefore the cover system meets the static and seismic stability criteria.

Table 2. Permanent Seismic Displacement Evaluation for Cover Interfaces

Interface	k_y (g)	A (g)	V (in/s)	k_y/A	U_s (in)	U_m (in)
Cover Soil / Class II/III Waste	0.311	0.57	34.2	0.55	~ 5	~ 6

Cover Stability for Temporary (Construction Stage) Loading:
The stability of cover needs to be evaluated for the temporary condition during cover placement. It is assumed that the cover is placed from bottom to top (backfilling up slope). When the equipment weight is considered, the stability is evaluated for a finite length of the slope, usually the distance between two benches. The equilibrium of forces for a finite length of the slope is shown on Figure 3 (Qian, Koerner, Gray, 2002). Figure 3 illustrates the forces applied on the cover for this case. The following symbols are used in this figure:

W_A = total weight of the active wedge including additional weight of soil wedge from the upper bench (W_{A1} and W_{A2}) plus equipment weights on the slope and upper bench (W_{e1} and W_{e2});
W_{A1} = weight of soil cover on the slope (included in W_A);
W_{A2} = weight of soil wedge from the upper bench (included in W_A);
W_P = total weight of the passive wedge;
W_{e1} = weight of equipment on slope (included in W_A);
W_{e2} = weight of equipment on upper bench (included in W_A);
N_A = effective force normal to the failure plane of the active wedge;
N_P = effective force normal to the failure plane of the passive wedge;
γ = unit weight of the cover soil;
h = thickness of the cover;
L = length of the slope measured along the slip plane;
β = soil slope angle;
ϕ = friction angle of cover soil;

δ = interface friction angle;
C_a = adhesion force between cover soil of the active wedge and geo-membrane or foundation;
c_a = adhesion between cover soil of the active wedge and geo-membrane or foundation;
C = cohesion force along the failure plane of the passive wedge;
c = cohesion of the cover soil;
E_A = inter-wedge force acting on the active wedge from the passive wedge;
E_P = inter-wedge force acting on the passive wedge from the active wedge;
FS = factor of safety against cover soil sliding.

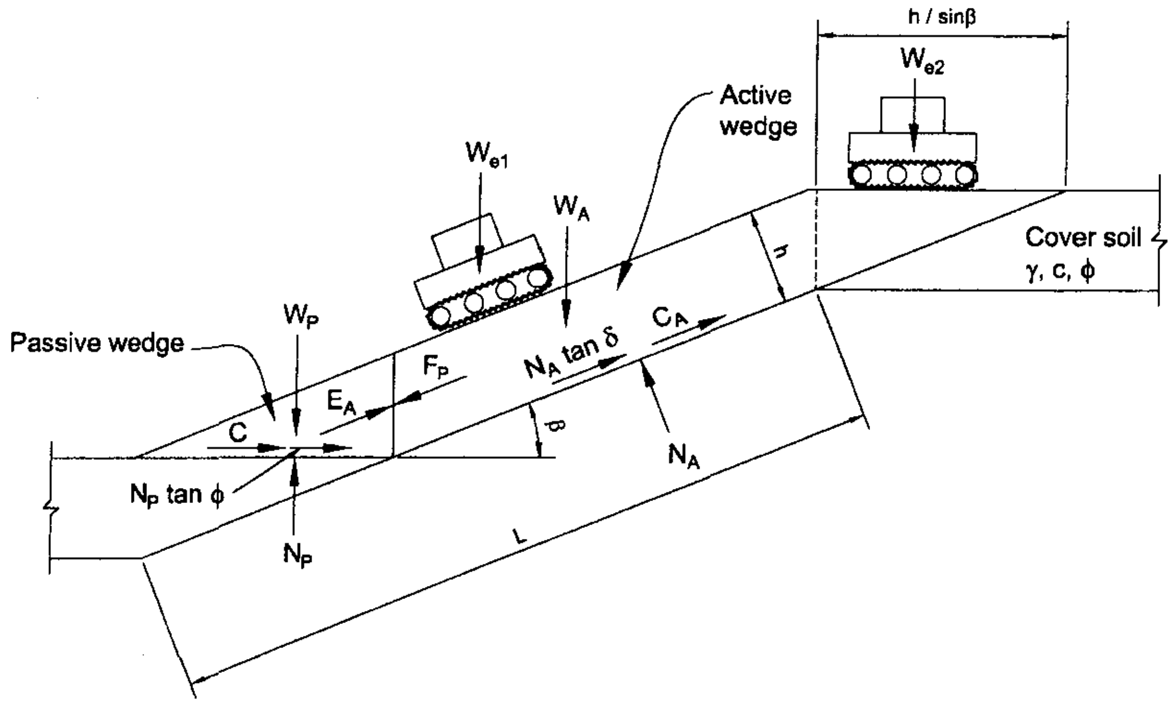


Figure 3. Equilibrium of Forces for a Finite Length Slope of a Uniformly Thick Cover Soil

For this condition the stability of the cover can be evaluated using the following equation:

$$FS = \frac{-b \pm \sqrt{b^2 - 4 \times a \times cc}}{2 \times a}$$

Where:

$a = (W_A - N_A \times \cos\beta) \times \cos\beta$

$b = -[(W_A - N_A \times \cos\beta) \times \sin\beta \times \tan\phi + (N_A \times \tan\delta + C_a) \times \sin\beta \times \cos\beta + (C + W_P \times \tan\phi) \times \sin\beta]$

$cc = (N_A \times \tan\delta + C_a) \times \sin^2\beta \times \tan\phi$

$W_A = W_{A1} + W_{A2} + W_{e1} + W_{e2}$
$W_{A1} = (\gamma \times h^2) \times [L/h - 1/\sin\beta - \tan(\beta/2)]$
$W_{A2} = (\gamma \times h^2) / (\sin 2\beta)$
$W_P = (\gamma \times h^2) / (\sin 2\beta)$
$N_A = W_A \times \cos\beta$
$C_a = c_a \times (L - h/\sin\beta)$
$C = (c \times h) / (\sin\beta)$

For the up slope backfilling, the dynamic force resulting from acceleration and braking of the construction equipment is not considered. The weight of the equipment is added to the weight of the cover soil.

The equipment pressure at the potential slip interface can be calculated from the following equation:

Equivalent equipment force per unit width at slip plane interface: $W_e = q \times w \times I$

Where:

$q = W_b / (2 \times w \times b)$;
W_b = operating weight of equipment;
w = length of equipment track;
b = width of equipment track;
I = influence factor at slip plane interface.

The contact pressure for a CAT D6N LGP tractor is 4.8 psi, with an operating weight of 40,000 lbs. The track dimensions are length (w) = 122 in and width (b) = 34 in. The track gauge (distance between centers of tracks) is 85 inches.

The influence factor for cover thickness (h) of 4 ft can be calculated as:

$b / h = 34 / (4 \times 12) = 0.71 \rightarrow I = 0.85$

Using this influence factor, the equivalent pressure is evaluated below:

$q = 40{,}000 / (2 \times 122 \times 34) = 4.8 \text{ psi} = 695 \text{ psf}$
$h = 4.0 \text{ ft} \rightarrow W_{e1} = 695 \times (122/12) \times 0.85 = 6{,}005 \text{ lbs}$

We have also included additional surcharge of the construction equipment on the upper bench of the cover veneer. This load is estimated as a 500 psf uniform pressure acting on a length equal to h/sin β:

$\beta = 21.8° \rightarrow W_{e2} = 500 \times 4/\sin(21.8°) = 5{,}385 \text{ lbs}$

Using these equipment weights, the safety factor for temporary stability of the cover soil / Class II/III waste interface is calculated below:

$\gamma = 110$ pcf;
$h = 4$ ft;
$L = 135$ ft;
$\beta = 21.8°$;
$\phi = 28°$;
$\delta = 28°$;
$c_a = 100$ psf;
$c = 100$ psf;
$W_e = 6{,}005 + 5{,}385 = 11{,}390$ lbs.

The above parameters result in the following values:

$W_A = 66{,}064$ lbs
$W_P = 2{,}552$ lbs
$N_A = 61{,}339$ lbs
$C_a = 11{,}923$ lbs
$C = 1{,}077$ lbs

$a = 8459.6$ lb/ft
$b = -18060.1$ lb/ft
$cc = 3266.0$ lb/ft

These values result in a factor of safety of 1.94 for finite length cover slope. This value is identical to the factor of safety of 1.94 for infinite slope analysis without the construction equipment weight.

References:

Franklin, A. G. and Chang, F. K. (1977), "Permanent Displacements of Earth Embankments by Newmark Sliding Block Analysis", Report 5, Miscellaneous Papers S-71-17, U.S. Army Corps of Engineers Waterway Experiment Station, Vicksburg, Mississippi.

Huang, Y. H. (1983), "Stability Analysis of Earth Slopes".

Qian, X., Koerner, R. M., Gray, D. H. (2002), "Geotechnical Aspects of Landfill Design and Construction".

APPENDIX D

CONSTRUCTION QUALITY ASSURANCE PLAN AND TECHNICAL SPECIFICATIONS

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Irvine, California 92602
Telephone (714) 508-4400
Fax (714) 508-4401

CONSTRUCTION QUALITY ASSURANCE FOR THE FINAL CLOSURE CONSTRUCTION OF LANDFILL B19 KETTLEMAN HILLS FACILITY

Prepared for:

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Prepared by:

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230 Commerce, Suite 200
Irvine, California 92602

April 2006
(Revised October 2006)

Project No. 053-1910

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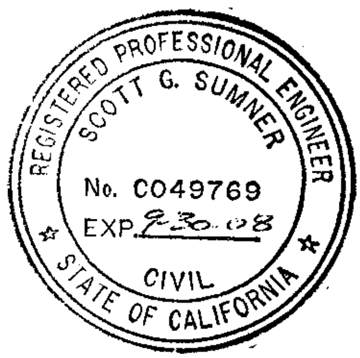
CERTIFICATION

In accordance with the requirements of California Code of Regulations (CCR) Title 22 Section 66264.19, this Construction Quality Assurance (CQA) Plan has been developed under the direction of a Civil engineer registered in the State of California.

I hereby certify that this plan was developed under my supervision.

______________________ 12-3-06
Scott G. Sumner, P.E. Date
C49769 Expires: 09-30-2008



1. INTRODUCTION

1.1 Purpose

The purpose of this manual is to describe the Construction Quality Assurance (CQA) procedures required during the final closure construction of Landfill B-19 at the Kettleman Hills Facility outside of Kettleman City, California. This CQA Plan establishes procedures to document that construction is in accordance with the approved engineering standards and specifications, meets the appropriate regulatory requirements (i.e., California Code of Regulations (CCR) Title 22 §66264.19 and Title 27 §20323 and §20324), and develops the necessary documentation for submittal to the regulatory agency. The CQA plan shall be implemented under the direction of a CQA officer who is a California State registered professional Civil engineer.

The CQA manual is a guidance document that contains general and specific work element requirements for monitoring construction. General requirements include the organization and responsibilities of CQA personnel, documentation control, and reporting procedures. Specific work elements include the following:

- ❑ Clearing, Grubbing, and Stripping
- ❑ Excavating
- ❑ Earthfill
- ❑ Subgrade Preparation
- ❑ Geomembranes
- ❑ Geotextiles
- ❑ HDPE Pipe
- ❑ Culverts / Drainage Channels

The CQA organization will prepare a final CQA report (FCR) upon completion of construction. The FCR will include information generated through the CQA program and will document the extent to which construction was performed in accordance with the intent of the contract documents and design. The CQA organization will be required to submit the FCR within one week of substantial completion of construction.

1.2 CQA Organization

The CQA organization has the primary responsibility of implementing and managing the CQA program described in this manual and will document to the appropriate regulatory agencies that construction of the facility was performed in accordance with the design and the contract documents. Specific responsibilities for the CQA organization site personnel are presented in Section 2.2, Responsibilities of Construction Quality Assurance Staff.

1.3 Project Organization

The project will be completed by Contractors performing earthworks construction, geosytnthetic materials installation and associated ancillary facilities. As shown on Figure 1-1 the CQA officer and CQA monitors are independent of the Contractors and report directly to the Owner's Project Manager.

1.4 Reference Documents

The following reference documents provide background information and support this CQA manual for construction:

> *American Society for Testing and Materials (ASTM) Annual Book of ASTM Standards. Section 4 Construction, Volume 04.02 Concrete and Aggregates.*
>
> *American Society for Testing and Materials (ASTM) Annual Book of ASTM Standards. Section 4 Construction, Volume 04.08 Soil and Rock(I), and Volume 04.09 Soil and Rock (II); Geosynthetics*
>
> *American Society for Testing and Materials (ASTM) Annual Book of ASTM Standards. Section 8 Plastics, Volumes 08.01 Plastics (I), 08.02 Plastics (II), and 08.03 Plastics (III).*

1.5 Definitions

Whenever the terms listed below are used, the intent and meaning shall be interpreted as indicated.

ACI. American Concrete Institute

AISC. American Institute of Steel Construction.

ASTM. American Society for Testing and Materials.

Construction Manager. The individual or firm responsible for administering the construction contract and providing overall construction management for the project. The Construction Manager is the primary contact on the project site representing the owner.

Construction Quality Assurance. A planned and systematic pattern of procedures and documentation designed to provide confidence that items of work or services meet the requirements of the contract documents. Construction quality assurance includes verifying that the Contractor is performing quality control requirements of the specifications.

CQA Manager. Authorized representative of the CQA organization responsible for managing the CQA program.

CQA Monitors. Authorized representative of the CQA organization, responsible for observing and documenting activities related to CQA during construction.

CQA Officer. Authorized representative of the CQA organization and professional engineer registered in state of California responsible for certifying that construction was performed in accordance with the intent of the contract documents and design.

Construction Quality Control. Those actions which provide a means to measure and regulate the characteristics of an item or service to comply with the requirements of the contract documents. Quality control will be performed by the Contractor, except where designated in the Specifications.

Contract Drawings. The official plans, profiles, typical cross-sections, elevations, and details, as well as their amendments and supplemental drawings, which show the locations, character, dimensions, and details of the work to be performed. Contract drawing are also referred to as the "plans."

Contract Documents. The official set of documents issued by the owner, which includes bidding requirements, contract forms, contract conditions, specifications, contract drawings, addenda, and contract modifications.

Contractor. The person or persons, firm, partnership, corporation, or any combination, or any combination, private, municipal, or public, who as an independent Contractor, has entered into a contract with the owner, and who is referred to throughout the contract documents by singular number and masculine gender.

Contract Specifications. The qualitative requirements for products, materials, and workmanship upon which the contract is based.

Design Engineer. The individuals or firms responsible for the design and preparation of the project construction drawings and specifications. Also referred to as " designer" or "engineer". The Design Engineer is Golder Associates Inc., Irvine, California.

Earthwork. A construction activity involving the use of soil materials as defined in the construction specifications and Section 3 of this manual.

Flexible Membrane Liner (FML). A synthetic lining material, also referred to as geomembrane, membrane, liner, or sheet.

Geosynthetics Contractor. The person or firm responsible for geosynthetic construction. This definition applies to any party installing geomembrane, geotextile, geonet, or other geosynthetic material, even if not his primary function.

GRI. Geosynthetics Research Institute

Non-Conformance. A deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate. Examples of non-conformance include, but are not limited to, physical defects, test failures, and inadequate documentation.

Owner. Kettleman Hills Facility.

Owner's Project Manager. Authorized representative of the owner responsible for planning, organizing, and control of the design and construction activities. Responsibility includes scheduling, cost control, engineering, procurement, and contracting functions. Referred to as "project manager" in this manual.

Panel. A unit area of the FML which will be seamed in the field or in the fabricator's plant.

Procedure. A document that specifies or describes how an activity is to be performed.

Project Documents. Contractor submittals, construction drawing, record drawings, specifications, shop drawings, construction quality control and quality assurance plans, health and safety plan, and project schedule.

Record Drawings. Drawing recording the constructed dimensions, details, and coordinates of the project. Also referred to as "as-builts."

SSPWC. Standard Specifications for Public Works Construction.

Testing. Verification that an item meets specified requirements by subjecting that item to a set of physical, chemical, environmental, or operating conditions.

Testing Laboratory. A laboratory capable of conducting the tests required by this CQA manual and the specifications.

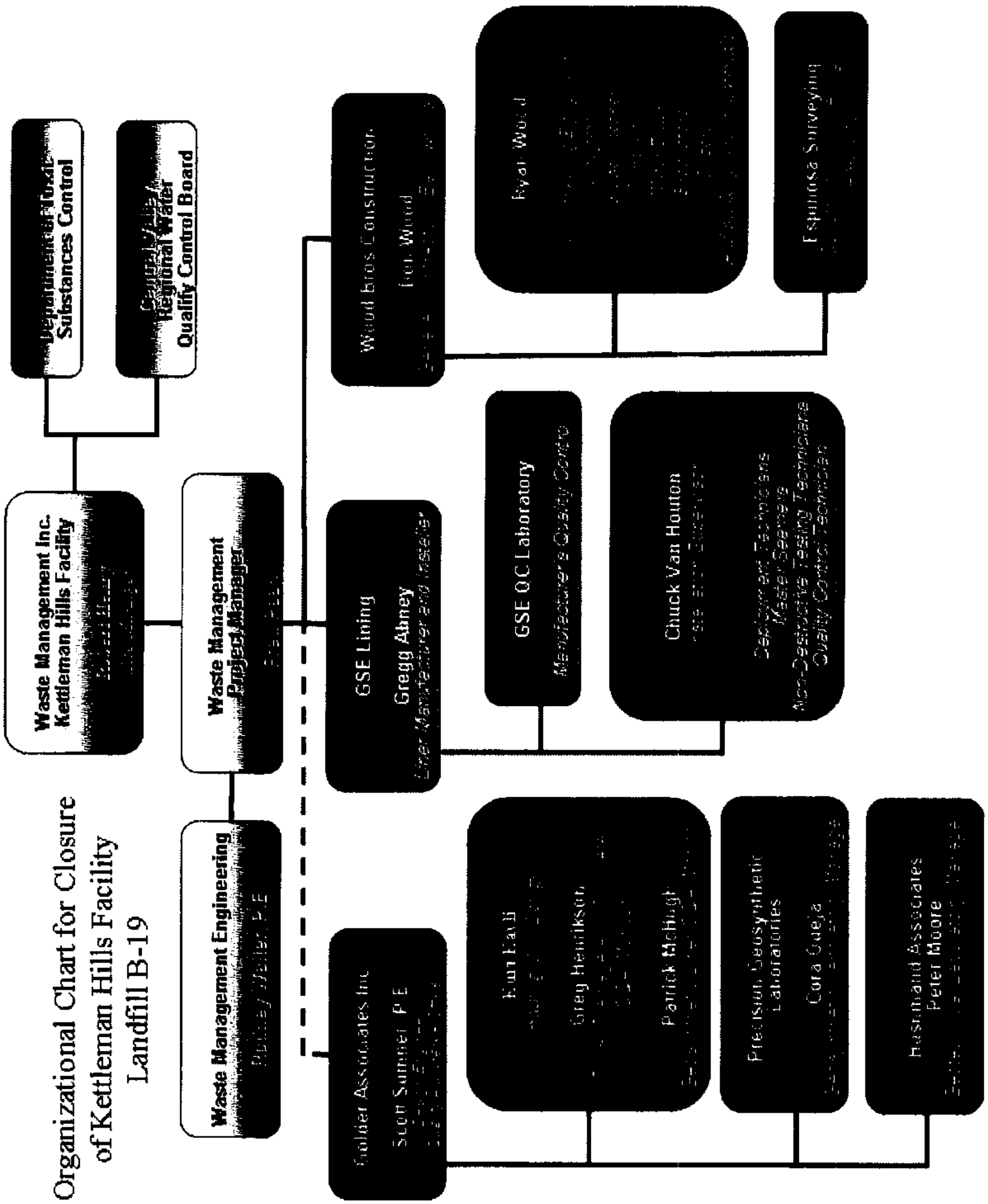


FIGURE **1-1**
ORGANIZATIONAL CHART

2. GENERAL REQUIREMENTS

2.1 Meetings

In order to facilitate construction and to clearly define construction goals and activities, close coordination between the owner, Design Engineers, CQA organization, and Contractors is essential. To meet this objective, pre-construction and progress meetings will be held.

2.1.1 Pre-Construction Meeting

Following bid award a pre-construction meeting will be held at the site. The purpose of this meeting, attended by the owner, Contractor, Design Engineers, CQA organization, agencies, and others designated by the owner, will be to:

- ❑ Review the construction drawings, specifications, CQA plan, work area security, health and safety procedures, and related issues.
- ❑ Provide all parties with relevant project documents.
- ❑ Review responsibilities and qualifications of each party.
- ❑ Define lines of communication and authority.
- ❑ Establish reporting and documenting procedures.
- ❑ Review procedures for handling submittals.
- ❑ Review testing equipment and procedures.
- ❑ Review procedures for field directives and change orders.
- ❑ Establish testing protocols and procedures for correcting and documenting construction or non-conformance.
- ❑ Establish weekly meeting schedule.
- ❑ Conduct a site inspection to discuss work areas, stockpile areas, lay down areas, access roads, haul roads, and related items.
- ❑ Review the project schedule and critical path items.
- ❑ Review Contractor's work plan.

The meeting will be documented by the CQA manager. Copies of the minutes and relevant documents will be prepared and provided to all parties.

2.1.2 Progress Meeting

Informal progress meetings will be held each morning before the start of work. At a minimum, this meeting will be attended by the CQA manager and Contractor. The purpose of this meeting is to:

- ❑ Discuss problems and resolutions.
- ❑ Review test data.
- ❑ Discuss the Contractor's personnel and equipment assignments for the day.
- ❑ Review the previous day's activities and accomplishments.
- ❑ Resolve any outstanding problems or disputes.

2.1.3 Weekly Meeting

Weekly scheduled meetings will be held. The project manager, Construction Manager, CQA manager, and Contractor will be present. The meetings will be held to discuss progress, problems, construction schedule, changes, test data, safety, environmental issues, and any other issues necessary. The project manager will prepare the agenda for each meeting and prepare meeting minutes for distribution to all parties.

2.1.4 Other Meetings

As required, special meetings will be held to plan work items and to discuss problems or non-conformance. These meetings will be attended by parties as directed by the owner. If the problem requires a design modification and subsequent change order, the engineering project managers should also be present. The meeting will be documented as directed by the project manager.

2.2 Responsibilities of Construction Quality Assurance Staff

2.2.1 Communications with the Contractor

Only the individuals assigned to this project, as defined in this manual, can communicate with the Contractor. Communications of an official nature must be clear, direct, and professional. When written communications are required, they must be documented on the appropriate forms. Formal letters to the Contractor should normally be signed by the CQA manager and reviewed by the owner.

2.2.2 Communications with the Owner

Only those individuals assigned to this project, as defined in this manual, can communicate with representatives of the owner. All communications must be through proper channels as defined in the project organization chart. Communications of an official nature must be written, clear, direct, and professional.

2.2.3 Responsibilities of the CQA Manager

The CQA manager administers the construction quality assurance program. CQA procedures and reports must be reviewed by the CQA manager for compliance with the project CQA manual. The CQA manager acts as an auditor to monitor and document the proper and complete implementation of the CQA program. The CQA manager has authority to identify deficiencies and implement corrective action to the CQA program. The CQA manager collects, distributes, and addresses disposition of Contractor submittals approved by the Design Engineers. The CQA manager coordinates testing with independent testing laboratories and maintains record drawings. The CQA manager reports directly to the Construction Manager. The CQA manager will write the final CQA report (FCR) under the direction of the CQA officer.

2.2.4 Responsibilities of the CQA Officer

The CQA officer is responsible for documenting and certifying to the Department of Toxic Substances Control (DTSC) and the Regional Water Quality Control Board (RWQCB) that construction was performed in accordance with the intent of the design and the contract documents. The CQA Officer may also be the CQA manager.

2.2.5 Responsibilities of the Design Engineers

The Design Engineers represent their organizations and are responsible for site engineering services related to their design. Those services include reviewing Contractor submittals, resolving technical issues related to construction, providing interpretation of the drawings and specifications and approving substantial design modifications and technical revisions.

2.2.6 Responsibilities of the CQA Monitors

The CQA monitors implement the CQA program under the direction of the CQA manager. The CQA monitors perform all construction monitoring and construction materials testing. The CQA monitors maintain all documentation and test data summaries related to construction monitoring and construction material testing. The CQA monitors report directly to the CQA manager.

2.3 Control of Documents, Records, and Forms

2.3.1 Project Control of Contract Documents

Contract documents, including specifications, drawings, and change orders, are controlled by the Construction Manager. The Construction Manager maintains one or more copies of the most current set of contract documents for use by the CQA organization. Upon issuance of new copies or revisions, it is the responsibility of the Construction Manager to notify the Contractor of the revisions, provide revised contract documents, and order the recall of all unrevised copies of the contract documents. The Construction Manager also provides the latest revised set of contract documents to the CQA organization.

2.3.2 Project Control of As-Built Information

As-built information generated by the Contractor and CQA organization is controlled by the CQA manager. During the progress of the work, the CQA manager obtains as-built information provided from the CQA monitors, Contractor, surveyors, or others and compiles all as-built data onto one set of drawings. At the completion of the project, this information is presented to the Design Engineers for use in preparing final drawings for the final CQA report. The as-built drawing set must be maintained on site and be clearly marked as Record Drawings.

2.3.3 Project Control of Forms

Daily report forms, test report forms, and other project forms are controlled by the CQA manager who maintains a master of each form for copies. Upon issuance of a new form, the CQA manager must recall and remove all superseded copies along with the master, notify the CQA monitors, and provide new copies for their use.

2.3.4 Processing Daily Reports

The CQA manager and CQA monitors write a daily record of work progress. The daily reports are reviewed by the CQA manager for legibility, clarity, traceability, and completeness. The review must be evidenced by signature. Daily reports are submitted to the Construction Manager on a daily basis and are maintained at the site. A weekly summary construction report will be prepared by the CQA manager and submitted to the Construction Manager.

2.3.5 Processing Test Reports

A test report must be completed by the CQA monitors whenever testing is performed. The test reports must be reviewed by the CQA manager. The review includes a check for mathematical accuracy, conformance to test requirements, conformance to specifications, and for clarity, legibility, traceability, and completeness. The review must be evidenced by a signature of the reviewer. Test reports (or summaries) from independent testing laboratories will also be transmitted to the CQA manager for review.

2.3.6 Processing Project Records

Project records are completed as needed. Use of the project records is limited to the scope for which they are intended. The record must be completed by filling in all of the blanks provided on the form, followed by the signature of the individual completing the form. All project records must be maintained at the site.

2.4 Documentation and Control of Non-Conformance

2.4.1 Observation of Non-Conformance

Whenever a non-conformance is discovered or observed in the construction process, product, job related materials, documentation, or elsewhere, the CQA manager and CQA monitors should first notify the foreman or superintendent supervising the work in question. The CQA manager should then notify the Construction Manager.

2.4.2 Determining Extent of Non-Conformance

Whenever a non-conformance is discovered or observed in the construction process, product, job-related materials, documentation, or elsewhere, the CQA organization will determine the extent of the non-conformance. The extent of the deficiency may be determined by additional sampling, testing, observations, review of records, or any other means deemed appropriate.

2.4.3 Documenting Non-Conformance

All non-conformance must be documented in writing on the daily records, logs, and elsewhere, as appropriate. The documentation must occur immediately upon determining the extent of the non-conformance. For a non-conformance which is considered serious or complex in nature, or which requires an engineering evaluation, a Non-conformance Report will be prepared and issued to the Construction Manager and Contractor.

2.4.4 Corrective Measures

For a simple or routine non-conformance, corrective measures will be determined by specification direction, or if none exists, the Construction Manager, CQA manager and Contractor will discuss standard construction methods to correct the deficiency. For Non-conformance Reports which require a engineering evaluation, the Design Engineers must determine corrective measures. A copy of the Non-conformance Report, with the Design Engineer's corrective measure determination, will be forwarded to the Construction Manager, CQA manager, and Contractor for implementation of the corrective action.

2.4.5 Verification of Corrective Measures

Upon notification by the Contractor that a corrective measure is complete, the CQA manager will verify its completion. The verification must be accomplished by observations or retesting and documented photographically. Written documentation of the corrective measures must be made by the CQA manager on daily reports, logs, and forms, and, if applicable, the Non-conformance Report. Verification of corrective measures will be reviewed by the Construction Manager. Corrective action measures that require an engineering evaluation will be reviewed and verified by the Design Engineers.

2.5 Construction Monitoring

2.5.1 Monitoring Priorities

Before commencement of construction, the CQA manager will establish a list of monitoring priorities. The list includes the various construction activities and the monitoring priority of those activities. The monitoring priorities may change during construction, based upon Contractor performance and owner request. Changes in the monitoring priorities must be approved by the CQA manager.

2.5.2 Discrepancies

CQA testing must be conducted in accordance with this CQA manual, the document that requires the most frequent tests or has more stringent test requirements will govern, unless otherwise specified by the CQA manager.

2.6 Materials Quality Verification

2.6.1 General

Material sources will be identified and samples tested to determine if the material meets project specifications for specific work elements. Definitions and requirements of materials are provided in the technical specifications. Test samples will be obtained in accordance with applicable ASTM and GRI standards. Archive samples and test results of the test samples will be maintained and stored at the project site. The CQA monitors will establish and maintain a materials quality verification list. The list will include material sources, sample locations, testing requirements, test results, and verification action items.

2.6.2 Materials Submittals

Material submittals may be used by the CQA organization to establish the acceptability of materials. When sample submittals are required, they will be made available to the CQA organization by the Contractor. Acceptance and proper review of submittals are the responsibility of the CQA manager.

2.6.3 Certificates of Compliance and Conformance

Certificates of compliance and conformance may be used by the CQA manager to establish the acceptability of materials. Those certificates generally state that the material is in compliance or conformance with a particular code, standard, or specification. The certificate may be used for acceptance of a product before or in lieu of testing, if allowed by the specifications.

2.7 Equipment Control

2.7.1 Equipment List

Before the start of construction, the CQA manager will complete a list of all measuring, sampling, and testing equipment being used at the site. As new equipment becomes available during the course of the project, it must be added to the list. When more than one type of equipment is available, a unique number will be affixed to each piece to maintain identity. The equipment list is maintained in the project files and contain the following information:

- ❑ Type of equipment
- ❑ Serial number or identifying number
- ❑ Date item received at site
- ❑ Use of the equipment
- ❑ Date removed from service

2.7.2 Calibration of Equipment and Materials

Before placing a piece of testing equipment into service, its accuracy must be established and calibrated by the CQA manager. Types of equipment requiring calibration include: nuclear gauges, sand cone devices, sand to be used in sand cones, and scales. The calibration procedures and frequencies must be as per manufacturer's instructions or ASTM standards. Whenever the equipment is suspect or is producing questionable results, it must be removed from service immediately and re-calibrated.

3. CONSTRUCTION QUALITY ASSURANCE FOR EARTHWORK

3.1 Introduction

This section describes the CQA procedures for earthwork operations. The scope of earthwork and related CQA includes the following elements:

- Clearing, Grubbing, and Stripping
- Borrow Excavation
- Structural Fill
- Vegetative Cover
- Trench Excavation and Backfill

3.2 Earthwork Construction Testing

3.2.1 Test Standards

The latest editions of the following test standards apply as called out in this manual or the technical specifications:

Standard	Test Description
ASTM D422	Standard Test Method for Particle Size Analysis of Soils
ASTM D1140	Standard Test Method for Amount of Material in Soils Finer Than the No. 200 Sieve
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method
ASTM D1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
ASTM D2216	Standard Test Method of Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D2937	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method

ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

3.2.2 Test Frequencies

Tables 3-1 and 3-2 establish the test frequencies for earthwork CQA. The test frequencies listed establish a minimum number of required tests. Extra testing must be conducted whenever work or materials are suspect, marginal, or of poor quality. Extra testing may also be performed to provide additional data for engineering evaluation. Any re-tests performed as a result of a failing test do not contribute to the total number of tests performed in satisfying the minimum test frequency.

The final CQA report shall include tables similar to Table 3-1 and 3-2 documenting compliance with the testing frequencies and results documenting compliance with the project specifications.

TABLE 3-1
STRUCTURAL FILL AND FOUNDATION LAYER CONFORMANCE TESTING

ASTM Test Method	ASTM Designation	Frequency (Structural Fill)	Frequency (Bench Fill/Trench)
Moisture-Density[1]	D1557	1 Per 10,000 CY or Each Material Type (minimum of 2)	1 Per Material Type
Nuclear Density[2]	D2922	1 Per 1,000 CY per 1.5 Vertical Feet	1 Per Lift Per 200 Linear Feet
Nuclear Water Content	D3017	1 Per 1,000 CY per 1.5 Vertical Feet	1 Per Lift Per 200 Linear Feet
Sand Cone Test, or Drive Cylinder Test[3]	D1556 D2937	1 Per 20 Nuclear Density Tests	1 Per 10 Nuclear Density Tests
Gradation Analysis	D422	1 Per 30,000 CY	-
Atterberg Limits	D4318	1 Per 30,000 CY	-
Direct Shear	D3080	3 Point Test Per 30,000 CY (minimum of 2)[4]	-
Test Pit to Confirm Cover Thickness (For Existing Cover Only)	-	1 Per 100,000 sf	-
Hydraulic Conductivity (Foundation Layer Only)[5]	D5084	1 Per 100,000 sf	-

Notes to Table 3-1:

1. Perform a Check Point (One-Point selected at near optimum and compared to the ASTM D1557 curve) at least once for every 10,000 cubic yards of material placed.
2. Tests shall be performed on an even grid to provide adequate testing coverage. For large fills in small areas, the testing frequency shall be increased as necessary to ensure testing for each lift of soil placed.
3. Drive cylinder test may be performed on fine-grained clay or silt samples only.
4. Tests shall be conducted at confining pressures similar to those expected at completion of the buttress fill.
5. Hydraulic Conductivity tests shall be conducted on relatively undisturbed samples obtained using a thin-walled sampler (Shelby tube) with a minimum 3-inch diameter.

TABLE 3-2
VEGETATIVE COVER CONFORMANCE TESTING

ASTM Test Method	ASTM Designation	Frequency (Structural Fill)	Frequency (Bench Fill/Trench)
Moisture-Density[1]	D1557	1 Per 10,000 CY or Each Material Type (minimum of 2)	1 Per Material Type
Nuclear Density[2]	D2922	1 Per 1,000 CY per 1.5 Vertical Feet	1 Per Lift Per 200 Linear Feet
Nuclear Water Content	D3017	1 Per 1,000 CY per 1.5 Vertical Feet	1 Per Lift Per 200 Linear Feet
Direct Shear	D3080	3 Point Test Per 30,000 CY (minimum of 2)[4]	-
Sand Cone Test, or Drive Cylinder Test[3]	D1556 D2937	1 Per 20 Nuclear Density Tests	1 Per 10 Nuclear Density Tests

Notes to Table 3-2:

1. Perform a Check Point (One-Point selected at near optimum and compared to the ASTM D1557 curve) at least once for every 10,000 cubic yards of material placed.
2. Tests shall be performed on an even grid to provide adequate testing coverage. For large fills in small areas, the testing frequency shall be increased as necessary to ensure testing for each lift of soil placed.
3. Drive cylinder test may be performed on fine-grained clay or silt samples only.
4. Tests shall be conducted on materials placed in direct contact with geosynthetic materials.

3.2.3 Soil Sample Numbering

The CQA monitor maintains soil sample numbers in a master log maintained at the site. Sample numbers begin with (001) and proceed upward. No sample number can be repeated, and re-tests of a failing sample are given the original number with a letter suffix (i.e., re-tests for a failing sample 021 would be 021A, 021B, etc.). Information contained in the master log of test samples includes:

- Sample number
- Test(s) to be performed
- Dated sampled
- Monitor obtaining sample
- Location sampled
- Location to testing (site vs. off site)
- Date sample sent off site
- Date test results received
- Site testing monitor
- Date testing completed at site
- Test results and remarks

3.2.4 Soil Sample Tagging

The CQA monitor is responsible for maintaining sample identification for all soil samples while on site, from time of sampling through completion of testing. The CQA monitor must place a sample tag on the soil sample container immediately upon sampling. The tag must remain with the soil sample throughout processing. The tag contains the following information:

- Sample number
- Material type
- Project name and project number
- Sampling monitor
- Date sampled
- Test(s) to be performed

3.2.5 Soil Sample Processing

The CQA monitor is responsible for the timely processing of soil test samples. The CQA manager also determines which samples are tested on site and which are tested off site. The determination is made based on manpower available, equipment available, complexity of test, and time available for results. For expediency, samples to be tested off site should be shipped the same day as they are obtained.

3.3 Field Density Tests

3.3.1 Test Numbering

The CQA monitor is responsible for maintaining test numbers and results for field density tests performed by the nuclear moisture density (ASTM D2922), sand cone (ASTM D1556), and drive cylinder (ASTM D2937). All other testing is identified through the sample number (Section 3.2.3). The CQA monitors will maintain field books that identify soil segments, data tested, CQA monitor performing the test, and sequential test number. Each soil segment will have a unique series of numbers. No test number can be repeated for a given soil segment, and re-tests of failing tests must be given a letter suffix along with the original test number (i.e., re-tests for a failing Test #1201 would be 1201A, 1201B, etc.). Test data and results must be filled out on the field density test form.

3.3.2 Test Locations

The intention of the CQA program is to provide confidence that the earthwork materials and work conform to the technical specifications. To meet this intent, the CQA monitor will perform density tests of earthfills and compacted soil liner during construction. Density tests must be located at various elevations and uniformly dispersed throughout the entire plan dimensions of the fill. Density test locations must be chosen without bias; however, additional testing can be performed in any areas that are suspect, marginal, or appear to be of poor quality. During the progress of the work, density test locations will be plotted on a drawing by the CQA monitor to document that no significant areas are untested. The drawing becomes part of the FCR.

3.4 Monitoring and Testing Requirements

Earthwork components of the construction are summarized in Paragraph 3.1 of this section. Each component has specific construction requirements that must be monitored. The following sections list monitoring requirements for each type of earthwork.

3.4.1 Clearing, Grubbing, and Stripping

- ❑ Document that erosion and sediment control silt fences, straw bale barriers, and other measures are securely in place prior to initiating clearing, grubbing, and stripping operations in any area.
- ❑ Document that existing plant life designated to remain is protected against damage during construction.
- ❑ Document that clearing and stripping in areas required for site access and execution of the work is complete.
- ❑ Document that vegetation, roots, and highly organic soil within marked areas are removed to a minimum depth of 6 inches below the existing ground surface.

3.4.2 Excavations

- ❑ Document that construction staking is performed before work and that survey bench marks with elevations are secured outside the work area.
- ❑ If applicable, document that the Contractor has notified the Underground Service Alert to identify and locate underground utilities.
- ❑ Document that excavated materials are segregated into proper stockpiles.
- ❑ Coordinate with the Contractor to perform excavation verification surveys upon completion of excavating operations. Verify corrective action measures as determine by verification surveys. Verification surveys will also be used to determine limits of excavation for measurement and payment applications. Submit copy of verification surveys to the Construction Manager.

3.4.3 Structural Fill

- ❑ Monitor that construction staking is performed before work and that survey bench marks with elevations are secured outside the work area.
- ❑ Perform visual and manual soil classifications (ASTM D2488) to verify that material source is suitable for Structural Fill. Verify that the material is free of organic and oversized materials and perform classifications continually during excavation of borrow materials.
- ❑ Perform moisture-density relationship testing (ASTM D1557) to determine the maximum dry density and optimum moisture content for Structural Fill materials. Perform Direct Shear tests to confirm design shear strength is equivalent to 33 degrees friction angle and

100 psf cohesion at the anticipated overburden pressures. Perform tests at testing frequencies specified in Table 3-1.

- ❑ Monitor that Structural Fill materials are placed loose lifts not to exceed 8-inches thick and compacted.

- ❑ Perform nuclear density-moisture tests (ASTM D2922 and ASTM D3017) to document that each lift is compacted to a minimum of 90 percent of the maximum dry density and -3 to +3 percent of optimum moisture content as determined by ASTM D1557. Perform tests at testing frequencies specified in Table 3-1.

- ❑ Monitor that soil materials are kept within the specified moisture content range listed in the Specifications. Monitor that soil materials that exceed the specified moisture content are properly aerated and processed to bring the moisture content of the material into the acceptable range. Monitor that Structural Fill soils that are below the specified moisture content are properly moisture conditioned and processed to bring the moisture content into the acceptable range.

- ❑ Monitor that desiccated Structural Fill are properly repaired or removed before placing subsequent lifts.

- ❑ Monitor that final Structural Fill surfaces are free of ruts, gouges, and other features that might contribute to erosion and sediment run-off.

- ❑ During Structural Fill operations field verify lines, grades, and dimensions using hand-held levels, range poles and measuring tapes.

- ❑ Coordinate with the Contractor to perform verification surveys at the completion of Structural Fill operations. Verify corrective action measures as determined by verification surveys. Verification surveys will also be used to determine the limits of Structural Fill for measurement and payment applications. Submit copy of verification surveys to the Construction Manager.

3.4.4 Geosynthetics Subgrade Preparation

- ❑ Monitor that material source is suitable for the subgrade, is free of organic and oversized materials, and meets the grading requirements of the technical specifications.

- ❑ Monitor that grade control construction staking is performed prior to work.

- ❑ Perform moisture-density relationship testing (ASTM D1557) to determine the maximum dry density and optimum moisture content of subgrade materials.

- ❑ Monitor that angular or sharp rocks, rocks that protrude more than 0.5-inches, and other debris that could damage the geomembrane are removed from the surface of the subgrade. Verify that the subgrade is free of irregularities and is steel drum rolled smooth prior to geomembrane placement.

- ❑ Monitor that the final surface provides continuous and intimate contact with the overlying geomembrane.

- ❑ Coordinate with the Contractor to perform subgrade verification surveys upon completion of the subgrade preparation. Verify corrective action measures as determined by the verification surveys. Verification surveys will also be used to determine the limits of the subgrade preparation for measurement and payment applications. Submit copy of verification surveys to the Construction Manager.

3.4.5 Vegetative Cover Layer

- ❑ Monitor that material source is suitable for the operations layer. free of organic or other deleterious materials. and free of particles greater than 3 inches in diameter or 0.5 inches in diameter in the select fill zone above geosynthetics.

- ❑ Monitor that grade control construction staking is performed before work.

- ❑ Verify that the operations layer is placed in a manner that does not damage underlying geosynthetic installations.

- ❑ Coordinate with the Contractor to perform operations layer verification surveys upon completion of placement operations. Verify corrective action measures as determined by the verification surveys. Verification surveys will also be used to determine the limits of the operations layer for measurement and payment applications. Submit copy of verification surveys to the Construction Manager.

3.4.6 Trenching and Backfilling

- ❑ Monitor that construction staking is performed before work and that survey bench marks with elevations are secured outside the work area.

- ❑ Monitor that trenches are excavated in accordance with the dimensional cross-sections and design elevations shown on the drawings.

- ❑ Monitor profile surveys conducted by the Contractor during trenching operations.

- ❑ Perform moisture-density relationship testing (ASTM D1557) to determine the maximum dry density and optimum moisture content of earthfill materials that will be used as backfill.

- ❑ Perform nuclear density-moisture tests (ASTM D2922 and ASTM D3017) to verify that backfill materials are moisture conditioned and compacted to a minimum of 90 percent maximum dry density and that the moisture content is within 4 percentage points of the optimum moisture content as determined by ASTM D1557.

4. CONSTRUCTION QUALITY ASSURANCE FOR GEOSYNTHETICS

4.1 General

The objectives of the geosynthetics CQA program are to: (i) assure that proper construction techniques and procedures are used: (ii) that the project is completed in accordance with the project construction drawings and technical specifications. The intents of the CQA program are to: (i) identify and define problems that may occur during construction: (ii) document that these problems are corrected before construction is complete.

This section describes CQA procedures for the installation of geosynthetic components. The following types of geosynthetics will be utilized for this project:

- ❑ 40 mil double-sided textured HDPE geomembrane
- ❑ 60-mil double-sided textured HDPE geomembrane
- ❑ Non-woven geotextile

CQA for the geosynthetics installations will be performed to monitor that geosynthetics are installed in accordance with the design. Construction must be conducted in accordance with the project construction drawings and specifications. To monitor compliance, the CQA Site Manager will: (i) review the Contractor's quality control submittals; (ii) perform material conformance testing; (iii) monitor construction testing: and (iv) monitor installations. Conformance testing refers to activities that take place before geosynthetics installation. Construction testing includes activities that occur during geosynthetics installation.

All CQA testing will be conducted in accordance with this CQA manual. and the project construction drawings and specifications. If a discrepancy exists in the testing requirements, the document that requires the most stringent testing will govern.

4.2 Geomembrane

4.2.1 Delivery

Upon delivery of geomembrane, the CQA monitor will:

- ❑ Observe geomembrane rolls for damage during shipping and handling. Identify damaged materials and document that damaged materials are set aside.
- ❑ Observe that the geomembrane is stored in accordance with the specifications and is protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, direct sunlight, and other damage.
- ❑ Document that all manufacturing documentation required by the specifications has been received.
- ❑ Complete the geosynthetics receipt log form for all geomembrane materials received.

Damaged geomembrane may be rejected. If rejected, document that material is removed from the site or stored at a location, separate from accepted geomembrane. Geomembrane that does

not have proper manufacturer's documentation must be stored at a separate location, until all documentation has been received, reviewed and accepted.

4.2.2 Conformance Testing

Geomembrane Material Tests. Geomembrane samples will be obtained for conformance testing in accordance with Table 4-1. The material will be sampled at the site by the CQA monitors or at the manufacturing plant by an independent third party under the direction of the CQA organization. The samples will be forwarded to an independent testing laboratory for the conformance tests identified in Table 4-1.

The CQA manager will review all conformance test results and report any non-conformance to the Construction Manager and Contractor.

The final CQA report shall include tables similar to Table 4-1 documenting compliance with the testing frequencies and results documenting compliance with the project specifications.

Sampling Procedure. Samples will be taken across the entire roll width. Samples may be cut for shipping purposes, but a minimum of five square feet must be sent to the testing laboratory. Samplers must mark the machine direction and the manufacturer's roll identification number on the sample (each piece). Samplers will also assign a conformance test number to the sample and mark the sample with that number.

4.2.3 Geomembrane Installation

Surface Preparation. The soil surface must be prepared in accordance with the technical specifications. Before geomembrane installation, the subgrade will be inspected by the CQA monitor and geosynthetics Contractor. The CQA monitor must monitor the following:

- ❑ All lines and grades for soil surface have been verified by the Contractor.
- ❑ The soil surface has been rolled and compacted to be free of surface irregularities, loose soil, and protrusions.
- ❑ The soil surface is firm and does not contain stones or other objects that could damage the geomembrane.
- ❑ The anchor trench dimensions have been checked, and the trenches are free of sharp objects and stones.
- ❑ There are no excessively soft areas.
- ❑ The soil surface is not saturated, and no standing water is present.
- ❑ The soil surface has not desiccated.
- ❑ All construction stakes have been removed and there is no debris, rocks, or any other objects in or on the soil surface.
- ❑ The geosynthetics Contractor has certified in writing that the surface on which the geomembrane will be installed is acceptable.

TABLE 4-1
HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE – TEXTURED CONFORMANCE TESTING

Properties	Test Method	Conformance QA Test Frequency(7)
Thickness (min. ave.) • Lowest individual for 8 out of 10 values • Lowest individual for any of the 10 values	ASTM D5994	1 per 250,000 sf
Asperity Height (min. ave.)(1)(2)	GM 12	1 per 250,000 sf
Melt Flow Index	ASTM 1238	1 per 250,000 sf
Sheet Density (min ave.)	ASTM D792 or ASTM D1505	1 per 250,000 sf
Tensile Properties(3) (min. ave.) • Yield strength • Break strength • Yield elongation • Break elongation	ASTM D6693 Type IV	1 per 250,000 sf
Tear Resistance (min. ave.)	ASTM D1004 Die C	N/A
Puncture Resistance (min. ave.)	ASTM D4833	1 per 250,000 sf
Stress Crack Resistance(4)	ASTM D5397 (App.)	N/A
Carbon Black Content (range)	ASTM D1603(5)	1 per 250,000 sf
Carbon Black Dispersion(6)	ASTM D2663 ASTM D5596	1 per 250,000 sf
Oxidative Induction Time (OIT) (min. ave.) • Std. OIT, or • High Pressure OIT	ASTM D3895 ASTM D5885	N/A
Interface Shear Strength (cover soil, geotextile, geomembrane)	ASTM D5321	1 per 250,000 sf
Oven Aging at 85°C • Std. OIT (min. ave.), % retained after 90 days, or • High Pressure OIT (min. ave.), % retained after 90 days	ASTM D5721 ASTM D3895 ASTM D5885	N/A
UV Resistance • Std. OIT (min. ave.), or • High Pressure OIT (min. ave.) % retained after 1600 hrs	GM 11 ASTM D3895 ASTM D5885	N/A

Notes:

(1) Of 10 readings: 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils.
(2) Alternate the measurement side for double sided textured sheet.
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Yield elongation is calculated using a gage length of 1.3 inches.
- Break elongation is calculated using a gage length of 2.0 inches.

(4) The P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
(5) Other methods such as D 4218 (muffle furnace)
(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in categories 1 or 2, and
- 1 in category 3.

(7) Minimum testing frequency shall be one sample per lot.

Panel Placement. Before installing any of the geomembrane, the Contractor must submit drawings in accordance with the technical specifications. The drawings will show the proposed layout of the panels, including panel identification numbers, field seams, and any other details that do not conform to the construction drawings.

The CQA monitors will maintain an up to date panel layout drawing that shows the following: (i) roll numbers; (ii) panel numbers; (iii) seam numbers; (iv) test locations; (v) repair locations; and, (vi) non-destructive testing information.

During panel placement operations, the CQA monitor will:

- ❑ Record panel numbers and dimensions on the panel/seam log.
- ❑ Observe the panel surface as it is deployed and record all panel defects and defect corrective actions (panel rejected, patch installed, extrudate placed over the defect, etc.) on the repair sheet. Verify that corrective actions are made in accordance with the specifications.
- ❑ Monitor that equipment used during deployment operations does not damage the geomembrane. Verify that equipment used on the geomembrane does not leak hydrocarbons onto the geomembrane or that corrective measures are taken to prevent leakage.
- ❑ Observe that the surface beneath the geomembrane has not deteriorated since previous acceptance. Verify that no stones, construction debris, or other items are beneath the geomembrane that could damage the geomembrane.
- ❑ Monitor that the geomembrane is not dragged across an unprotected surface. If the geomembrane is dragged across an unprotected surface, the geomembrane must be inspected for scratches and repaired or rejected, if necessary.
- ❑ Record weather conditions including temperature, wind speed and direction, and humidity. Verify that the geomembrane is not deployed in the presence of excess moisture (fog, dew, mist, etc.). In addition, verify that the geomembrane is not placed when the air temperature is less than 40^0 F, or when standing water of frost is on the ground.
- ❑ Monitor that crews working on the geomembrane do not smoke, wear shoes that could damage the liner, or engage in activities that could damage the geomembrane.
- ❑ Monitor that methods used to deploy the geomembrane minimize wrinkles and that panels are anchored to prevent movement by the wind. Verify that the Contractor corrects any damage resulting to or from windblown geomembrane.
- ❑ Monitor that no more panels are deployed than can be seamed on the same day.
- ❑ The CQA monitor must inform both the Contractor and the CQA manager if any of the above conditions are not met.

Field Seaming. Before the start of geomembrane welding and during welding operations, each welder and welding apparatus will be tested in accordance with the specifications to verify that the equipment is functioning properly. One trial weld will be taken before the start of work and one at mid-shift. The trial weld sample will be 42-inches-long and 12-inches-wide, with the seam centered lengthwise. The CQA monitor will observe all welding operations and verify that the Contractor quantitatively test each trial weld for peel adhesion and bonded seam strength (ASTM D 4437). (Peel adhesion tests will be referred to as "peel" and bonded seam strength tests will be referred to as "shear" in this manual.) The purpose of peel and shear tests is to evaluate seam strength and to evaluate long-term performance. Shear strength measures the continuity of tensile strength through the seam and into the parent material. Peel adhesion measures the strength of the bond created by the welding process. The results of the peel and shear tests will be recorded on the trial weld form. Trial welds must be completed under conditions similar to those under which the panels will be welded. Trial welds must meet specified requirements for peel and shear and the failure must be ductile or a film tearing bond (FTB) for a wedge weld. An FTB means the test specimen breaks at the edge of the outside of the seam, but not in the same seam. If at any time the CQA monitor believes that welding apparatus is not functioning properly, a trial weld must be performed. If there are wide changes in temperature (> 30^0 F), humidity, or wind speed, another trial weld must be performed. The trial weld must be allowed to cool to ambient temperature before it is tested.

During geomembrane welding operations, the CQA monitor will:

- ❑ Monitor that the Contractor has the number of welding apparatuses and spare parts necessary to perform the work.
- ❑ Monitor that equipment used for welding will not damage the geomembrane.
- ❑ Monitor that extrusion welders are purged before beginning a weld so that all heat-degraded extrudate is removed from the nozzle of the welder.
- ❑ Monitor that seam grinding is completed less than 1 hour before seam welding, and the upper sheet is beveled (extrusion welding only).
- ❑ Monitor that ambient temperature measured 6-inches above the geomembrane surface is between 40^0 and 110^0 Fahrenheit.
- ❑ Monitor that ends of extrusion welds that are more than 5 minutes old, are ground to expose new material before restarting a weld.
- ❑ Monitor that contact surfaces of the panels are clean, and free of dust, grease, dirt, debris and moisture before welding.
- ❑ Monitor that welds are free of dust, rocks and other debris.
- ❑ Monitor that cross seams are ground to a smooth incline before welding (fusion welding only).
- ❑ Monitor that all seams are overlapped a minimum of 3 inches or in accordance with manufacturer's recommendations, whichever is more stringent.
- ❑ Monitor that solvents or adhesives are not present in the seam area.
- ❑ Monitor that procedures used to temporarily hold the panels together do not damage the panels and do not preclude CQA testing.

- Monitor that strips of geomembrane, wide enough and long enough to protect the hot wedge welder from running on the subgrade, are placed below the geomembrane. These strips may be as long as the seam itself or shorter and moved with the seaming equipment. If necessary, a firm material such as a flat board or similar hard surface may be placed directly under the weld overlap to achieve firm support.

- Monitor that panels are being welded in accordance with the plans and specifications.

- Monitor that there is no free moisture in the weld area.

- Measure surface temperature of the panels every 2 hours.

4.2.4 Construction Testing

Nondestructive Seam Testing. The purpose of nondestructive geomembrane testing is to detect discontinuities or holes in the seams. Nondestructive geomembrane tests include vacuum and air pressure testing. Nondestructive testing must be performed over the entire length of the seam.

It is the Contractor's responsibility to perform all nondestructive testing as part of his quality control (QC) program. The CQA monitor's responsibility is to observe and document that the Contractors QC testing is in compliance with the specifications and to document seam defects and repairs.

Nondestructive testing procedures are described below:

- For welds tested by vacuum method, the weld is placed under suction utilizing a vacuum box constructed with rigid sides, a transparent top for viewing the seams, a neoprene rubber gasket attached to the bottom of the rigid sides, a vacuum gauge on the inside, and a valve assembly attached to a vacuum hose connection. The box is placed over a seam section which has been thoroughly saturated with a soapy water solution (1 oz. soap to 1 gallon water). The rubber gasket on the bottom of the box must fit snugly against the soaped seam section of the panel, to ensure a leak-tight seal.

- *A vacuum pump is energized and the vacuum box pressure reduced to approximately* 5 psi gauge. Any pinholes, porosity or non-bonded areas are detected by the appearance of soap bubbles in the vicinity of the defect. Dwell time must not be less than 10 seconds.

- Air pressure testing is used to test double seams that have enclosed air space between them. Both ends of the air channel must be sealed. A pressure feed device, usually a needle equipped with a pressure gauge, is inserted into one end of the channel. Air is then pumped into the channel to a minimum pressure of 25 to 30 psi. The air chamber must sustain the pressure for a further 5 minutes without losing more than 2 psi. Following a passed pressure test, the opposite end of the tested seam must be punctured to release the air. The pressure gauge must return to zero, if not, a blockage is likely in the seam channel. Locate the blockage and test the seam on both sides of the blockage. The penetration holes must be sealed after testing.

During nondestructive testing, the CQA monitor will:

- Review technical specifications regarding test procedures.

- ❑ Monitor that equipment operators are fully trained and qualified to perform their work.
- ❑ Monitor that test equipment meets project specifications.
- ❑ Monitor the entire length of each seam is tested in accordance with the specifications.
- ❑ Observe all continuity testing and record results on the panel/seam log. and the panel layout drawing.
- ❑ Monitor that all testing is completed in accordance with the project specifications.
- ❑ Identify any failed areas. by marking the area with a waterproof marker compatible with geomembrane. inform the Contractor of any required repairs. and record the repair on the panel/seam log.
- ❑ Monitor that all repairs are completed and tested in accordance with the project specifications.
- ❑ Record all completed and tested repairs on a repair sheet, and the panel layout drawing.

Destructive Seam Sampling Procedures and Field Testing. Destructive seam samples will be taken at intervals of at least one test per 500 lineal feet of geomembrane seam. However, additional samples will be taken if the CQA monitor suspects that a seam does not meet the specification requirements. Reasons for taking additional samples may include. but are not limited to:

1. Wrinkling in seam area.
2. Excess crystallinity.
3. Suspect seaming equipment or techniques.
4. Weld contamination.
5. Insufficient overlap
6. Adverse weather conditions.
7. Failing tests.

The CQA monitor selects the locations from where seam samples will be cut for destructive laboratory testing as follows:

- ❑ A minimum of one test per 500 feet of seam length. This is an average frequency for the entire installation: individual samples may be taken at greater or lesser intervals. The testing frequency will be increased if welding operations were conducted in temperatures below 40^0 F. This increase will be agreed upon by the Construction Manager, CQA manager, and Contractor.
- ❑ A maximum frequency must be agreed to by the Construction Manager. CQA manager, and Contractor at the pre-construction meeting. However, if the number of failed samples exceeds 5 percent of the tested samples, this frequency may be increased at the discretion of the CQA manager. Samples taken as the result of failed tests do not count toward the total number of required tests.

The CQA monitor will not inform the Contractor in advance of selecting the destructive sample locations.

The Contractor will remove specimens and samples at locations identified by the CQA monitor and field test the specimens for peel and shear before the samples are shipped off-site for laboratory testing. During sampling procedures the CQA monitor will:

- ❑ Observe sample cutting.
- ❑ Mark each specimen and sample with an identifying number which contains the seam number, destructive sample test number, welder, and date and time welded.
- ❑ Record sample locations on the panel layout drawing and panel-seam logs.
- ❑ Record the sample locations, weather conditions, and reasons samples were taken (e.g., random sample, visual appearance, result of a previous failure, etc.) In the destructive seam test form.

At each location, obtain two seam specimens that are 44-inches apart. The specimens should be 1-inch wide and 12-inches long with the weld centered across the length of the specimen. The Contractor must test these samples to failure in the field using a tensiometer capable of quantitatively measuring shear and peel strengths. For double wedge welding, the Contractor must test both welds. The CQA monitor will observe the tests. Geomembrane seam specimens pass when the break is a ductile FTB. A film tearing bond means the test specimen breaks at the edge of the outside of the seam, but not in the seam. In addition, the seam strength must meet the specified values.

If one or both of the 1-inch specimens fails in either peel or shear, the Contractor can, at his discretion: (1) reconstruct the entire seam between passed test locations; or (2) take another test sample 10 feet from the point of the failed test and repeat this procedure. If the second test passes, the Contractor can either reconstruct or cap strip the seam between the two passed test locations. If subsequent tests fail, the sampling and testing procedure is repeated, until the length of the poor quality seam is established. Repeated failures indicate that either the seaming equipment or operator is not performing properly, and appropriate corrective action must be taken immediately.

Once the field tests specimens have passed a sample must be recovered for laboratory testing from between the passing field specimen locations. The sample must be 42-inches long and 12-inches wide, with the weld centered along the length of the sample. The sample must be divided into three sections: one 12-inch by 12-inch section for the Contractor, one 12-inch by 18-inch section for laboratory testing, and one 12-inch by 12-inch for the owner to archive. Record the results of field testing on the destructive seam tests form, and the panel/seam log.

Third Party Laboratory Testing. All CQA destructive samples must be shipped to the testing laboratory to verify seam quality. The laboratory will test five specimens from each sample in each method used. Minimum test values are presented in the specifications. The testing laboratory must provide verbal test results within 24 hours to the CQA manager, written certified test results are to be provided within 5 days.

The CQA manager must immediately notify the Construction Manager and Contractor in the event of failed test results.

If the laboratory test fails in either peel or shear, The Contractor must either reconstruct the entire seam, or recover additional samples at least 10 feet on either side of the failed sample for retesting. This process is repeated until passed tests bracket the failed seam section. All seams must be bounded by locations from which passing laboratory tests have been taken. Laboratory testing governs seam acceptance. In no case can field testing of repaired seams be used for final acceptance.

4.2.5 Repairs

Portions of geomembrane panels and seams that contain: (1) a flaw; (2) a destructive test; or (3) nondestructive test cuts of holes, must be repaired in accordance with the specifications. The CQA monitor must locate and record all repairs on the repair sheet and panel layout drawing. Acceptable repair techniques include the following:

- ❑ Patching: used to repair large holes, tears, large panel defects, undispersed raw materials, welds, contamination by foreign matter, and destructive sample locations.
- ❑ Extrusion: used to repair small defects in the panels and seams. In general, this procedure should be used for defects less than 2-inch in the largest dimension.
- ❑ Capping: used to repair failed welds or to cover seams where welds cannot be nondestructively tested.
- ❑ Removal: used to replace area with large defects where preceding methods are not appropriate. Also used to remove excess material (wrinkles, fishmouths, intersections, etc.) from the installed geomembrane. Areas of removal shall be patched or capped.

Repair procedures include the following:

- ❑ Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than 1 hour before the repair.
- ❑ Clean and dry all surfaces at the time of repair.
- ❑ Monitor acceptance of the repair procedures, materials and techniques by the CQA monitor in advance of the specific repair.
- ❑ Extend patches or caps at least 6 inches beyond the edge of the defect, and round all corners of material to be patched and the patches to a radius of at least 3 inches. Bevel the top edges of patches before extrusion welding.

4.2.6 Folded Material

All folded geomembrane must be removed.

4.2.7 Geomembrane Anchor Trench

The geomembrane anchor trench should be left open until seaming is completed. Expansion and contraction of the geomembrane should be accounted for in the liner placement. The anchor trench should be filled in the morning when temperatures are coolest to reduce bridging of the geomembrane.

4.2.8 Geomembrane Acceptance

The Contractor retains all ownership and responsibility for the geomembrane until acceptance by the owner. In the event the Contractor is responsible for placing cover over the geomembrane, the Contractor retains all ownership and responsibility for the geomembrane until all required documentation is complete and the cover material is placed. After panels are placed, seamed, tested successfully and repairs made, the completed installation will be walked by the CQA monitor and Contractor. Any damage or defect found during this inspection will be repaired properly by the Contractor. The installation will not be accepted until it meets the requirements of both parties. In addition, the geomembrane will be recommended for acceptance by the CQA monitor only when the following have been completed:

- ❑ The installation is finished.
- ❑ All seams have been inspected an verified to be acceptable, and that all required laboratory and field tests have been completed and reviewed.
- ❑ All required Contractor-supplied documentation has been received and reviewed.
- ❑ All as-built record drawings have been completed and verified by the CQA monitor to show the true panel dimensions, the locations of all seams, trenches, pipes, appurtenances, and repairs.

4.2.9 Qualifications

Installer Experience and Qualifications. Proper layout, seaming, and testing of the geomembrane requires skill and experience. As such, the integrity of the geomembrane is dependent upon the installers. In order to assure a minimum level of experience and expertise, the following experience standards which are presented have been established in the specifications.

Manufacturer/Fabricator/Installer. The specifications list prequalified manufacturer/ fabricator/ installer companies for each geomembrane type. Substitutions to the prequalified list will be considered, however, substitutions must be submitted in accordance with the construction contract. The CQA manager must verify qualifications of the manufacturer, fabricator, and installer through review of engineer approved project submittal.

Installation Superintendent. The installation field superintendent must have been responsible for the completed installation of a minimum of 5,000,000 square feet of polyethylene geomembrane in the past 5 years, utilizing the type of seaming techniques and apparatus proposed for use on this project. A resume with references and phone numbers of satisfactory installations is required. Any superintendent proposed for this project must be present whenever geomembrane is installed.

Welders. Welders must have demonstrated expertise on previous geomembrane installations. Each welder must have successfully welded a minimum of 1,000,000 square feet of polyethylene geomembrane within the past 3 years. A resume for this work, with references and phone numbers, is required.

CQA Manager Qualifications. The CQA manager must have provided CQA services on a minimum of 1,000,000 square feet of polyethylene installations or be level II certified in geosynthetics installations by National Institute for Certification in Engineering Technologies

(NICET). They must provide verification of this experience by reference in a current resume presented at the pre-construction meeting.

4.3 Geotextiles

4.3.1 Delivery

During delivery of geotextiles the CQA monitor will:

- ❑ Monitor that equipment used to unload the rolls does not damage the geotextile.
- ❑ Monitor that rolls are wrapped in impermeable and opaque protective covers.
- ❑ Monitor that care is used to unload the rolls.
- ❑ Monitor that all documentation required by the specifications has been received.
- ❑ Monitor that each roll is marked or tagged with the following information: manufacturer's name; project identification; lot number; roll number; roll dimensions. Log this information on the geosynthetic receipt form.
- ❑ Monitor that the geosynthetic receipt form is completed.
- ❑ Monitor that materials are stored in a location that will protect the rolls from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

Any damaged rolls may be rejected. Monitor that rejected material is removed from the site and stored at a location separate from accepted rolls. Geotextile rolls which do not have proper manufacturer's documentation must also be stored at a separate location, until all documentation has been received and approved.

4.3.2 Conformance Testing

Tests. After delivery, the CQA monitor will obtain geotextile conformance test samples for every 250,000 square feet of material delivered to the site or as indicated on Table 4-2. The CQA monitor will forward the samples to the testing laboratory for the following conformance tests:

TABLE 4-2
NONWOVEN GEOTEXTILE CONFORMANCE TESTING

Properties	Test Method	Conformance QA Test Frequency(3)
Mass/Unit Area (min. ave.)	ASTM D5261	1 per 250,000 sf
Apparent Opening Size (max.)	ASTM D4751	1 per project(1)
Grab Strength (min. ave.)	ASTM D4632	1 per 250,000 sf
Permittivity (min.)	ASTM D4491	1 per project(1)
Puncture Strength (min. ave.)	ASTM D4833	1 per 250,000 sf
UV Resistance(2)	ASTM D4355	N/A

Notes:
(1) AOS and Permittivity shall only be tested for geotextiles used in filter applications.
(2) After 500 hours of exposure.
(3) Minimum testing frequency shall be one sample per lot.

The CQA manager will review all test results and report any non-conformance to the Construction Manager.

The final CQA report shall include tables similar to Table 4-2 documenting compliance with the testing frequencies and results documenting compliance with the project specifications.

Sampling Procedure. Samples will be obtained across the entire roll width and will be 3-feet long. Samplers must mark the manufacturer's roll identification number, and the machine direction, on the sample. Samplers will also assign a conformance test number to the sample and mark the sample with that number.

4.3.3 Geotextile Installation

Surface Preparation. Before geotextile installation, the CQA monitor will:

- ❑ Monitor that all lines and grades have been verified by the Contractor.
- ❑ Monitor that the subgrade has been prepared in accordance with the earthwork specifications, and, if placed over a geomembrane, the geomembrane installation, and all associated documentation, has been completed.
- ❑ Monitor that soil or geomembrane surfaces do not contain stones that could damage the geotextile, or any overlying geomembrane.
- ❑ Monitor that there are no excessively soft areas in soil surfaces that could damage that geotextile, or any overlying geomembrane.
- ❑ All construction stakes have been removed.

Geotextile Placement and Seaming. During geotextile placement and seaming operations, the CQA monitor will:

- ❑ Observe the geotextile as it is deployed and record all defects and defect corrective actions (panel rejected, patch installed, etc.). Verify that corrective actions are performed in accordance with the specifications.
- ❑ Monitor that equipment used does not damage the geotextile by handling, equipment transit, leakage of hydrocarbons, or other means.
- ❑ Monitor that crews working on the geotextile do not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.
- ❑ Monitor that the geotextile is securely anchored in an anchor trench and is temporarily anchored to prevent movement by the wind.

- Monitor that adjacent panels are overlapped and seamed in accordance with the specifications.
- Monitor that the geotextile was not exposed to direct sunlight for more than 5 days.
- Examine the geotextile after installation to ensure that no potentially harmful foreign objects are present.
- The CQA monitor must inform both the CQA manager and Contractor if the above conditions are not met.

4.3.4 Repairs

Repair procedures include:

- Patching: used to repair large holes, tears, and small defective areas.
- Removal: used to replace large defective areas where the preceding method is not appropriate.

5. QUALITY ASSURANCE FOR HDPE PIPE

5.1 Introduction

This section describes CQA procedures for high density polyethylene (HDPE) pipe installations. Solid HDPE pipe will be utilized to extend the side-slope and vertical LCRS risers.

CQA for the HDPE pipe installations will be performed to verify that HDPE pipe systems are installed in accordance with the design. Construction must be conducted in accordance with the project construction drawings and specifications. To monitor compliance, the CQA program will: (1) review the Contractor's quality control submittals: (2) monitor construction testing; and (3) monitor installations.

All construction testing will be conducted in accordance with the project technical specifications.

5.2 Construction Monitoring

The following sections list monitoring requirements during HDPE pipe operations.

5.2.1 Delivery, Handling, and Storage

- ❑ Monitor that chains, end hooks, cable slings, or any other devices that may scar the pipe are not used to handle pipe. Wide nylon web slings are recommended to handle the pipe.
- ❑ Monitor that the pipe is not damaged during handling operations and that damaged pipe is separated from accepted pipe.
- ❑ Monitor that pipe out-of-roundness will not occur due to excessive stacking heights when the pipe is stored at the site.
- ❑ Monitor that the pipe is not damaged by sharp rocks or excessive abrasion when the pipe is pulled into place during fusion welding and installation operations.

5.2.2 Fusion Welding

- ❑ Before pipe fusion welding operations and installations verify that solid walled pipe, perforated pipe, fittings, and flanged couplings comply with product requirements of the technical specifications.
- ❑ Monitor that certified fusion welding operators will be performing the welding.
- ❑ Monitor that caution is taken to prevent water from coming in contact with the pipe and heater plates during welding operations. A shelter may be required for the fusion welding machine to allow operations to continue in adverse weather conditions.
- ❑ Monitor that heater plate surface temperatures are maintained between 375°F and 400°F for both coated plates and uncoated plates. Monitor that operator checks heater plate surface temperatures with pyrometer.
- ❑ Monitor that inside and outside of pipe ends are cleaned to remove dirt, water, grease, and other foreign material.

- ❑ Monitor that pipe ends are squarely faced with the facing tool of the fusion welding machine.

- ❑ Monitor that pipe ends line up in the fusion welding machine and that the pipe ends meet squarely and completely over the entire surface to be welded. Monitor at this point that the pipe is securely clamped into place so that the pipe does not move during the fusion welding process.

- ❑ Monitor that the heater plate is clean and maintains the appropriate temperature. Monitor that the heater plate is inserted between the aligned pipe ends and that the pipe ends are firmly brought into contact with the heater plate. NO PRESSURE should be applied to achieve the melt pattern.

- ❑ Monitor that the pipe ends are allowed to heat and soften. As the pipe heats and softens a melt bead begins to roll back from the contact point of the heater plate and the pipe ends.

- ❑ Monitor that the heater plate is removed quickly and cleanly when the appropriate melt bead is achieved and that no melted pipe material sticks to the heater plate. If melted material sticks to the heater plate, Monitor that this joint is discontinued, the heater plate is cleaned, the pipe ends are re-faced, and that the joint is re-started.

- ❑ Monitor that the melted pipe ends are rapidly joined together and that enough pressure is applied to the joint to form a melt bead 1/8-inch to 3/16-inch in diameter around the entire circumference of the pipe. Pressure is critical to cause the heated material of each pipe end to flow together.

- ❑ Monitor that the joint is allowed to cool and solidify properly before the pipe is released from the fusion welding machine. Cooling and solidification is completed when your finger can remain comfortably on the bead.

- ❑ Examine the joint when the pipe is released from the fusion welding machine to verify that the weld is completely around the entire circumference of the pipe.

5.2.3 Slip Joints

- ❑ Monitor that all joints extend to the minimum overlap and comply with the requirements of the Specifications.

Monitor that there is a snug fit with zero air gaps surrounding the connection.

6. QUALITY ASSURANCE FOR EROSION CONTROL

6.1 Introduction

This section describes CQA procedures for temporary and permanent erosion control installations.

CQA for the temporary and permanent erosion control measures will be performed to verify that the CONTRACTOR is complying with the requirements of the SWPPP and that the permanent erosion control measures are installed in accordance with the design. Construction must be conducted in accordance with the project construction drawings and specifications. To monitor compliance, the CQA program will: (1) review the Contractor's quality control submittals and (2) monitor installations.

6.2 Construction Monitoring

6.2.1 Temporary Erosion Control

- ❑ Monitor that the Contractor is implementing temporary erosion control measures in compliance with the SWPPP.

6.2.2 Permanent Erosion Control Measures

Straw Wattles

- ❑ Review the Contractor's submittals for the straw wattles and verify that the material complies with the manufacturer's specifications and the Specifications.
- ❑ Monitor that the Contractor installs the straw wattles at the locations indicated on the Drawing.
- ❑ Monitor that the Contractor installs the straw wattles prior to revegetation of the monolithic cover.
- ❑ Monitor that the Contractor installs the straw wattles in accordance with the manufacturer's recommendations.

Revegetation

- ❑ Review the Contractor's submittals for the hydroseed mixture and straw mulch for compliance with the Specifications.
- ❑ Monitor that the Contractor evenly and uniformly distributes the hydroseed mixture over the monolithic cover and that there are no bare spots.
- ❑ Monitor that the Contractor evenly and uniformly distributes the straw mulch in accordance with the Specifications.
- ❑ Monitor that the Contractor irrigates the revegetated areas during construction.

7. QUALITY ASSURANCE FOR DRAINAGE FACILITIES

7.1 Introduction

This section describes CQA procedures for the drainage facilities installations. The drainage facilities at the Kettleman Hills Facility comprise various types of drainage channels, drop inlets, downdrains, riprap apron, and diversion berms.

CQA for the erosion control mats installation will be performed to verify that the material is installed in accordance with the design. Construction must be conducted in accordance with the project construction drawings and specifications. To monitor compliance, the CQA program will: (1) review the Contractor's quality control submittals: (2) monitor construction testing; and (3) monitor installations.

All construction testing will be conducted in accordance with the project technical specifications.

7.2 Construction Monitoring

7.2.1 Drainage Channels

- ❑ Monitor that the drainage channel is constructed in accordance with the Drawings and Specifications.
- ❑ Review the Contractor's submittals for the erosion control-lining for compliance with the Specifications.
- ❑ Monitor that the drainage channel subgrade is dry, firm and unyielding, and does not have loose or extraneous material.
- ❑ Monitor that the erosion control blanket or rip-rap is placed to the extents and thickness indicated on the Drawings.

7.2.2 Drop Inlets and Downdrains

- ❑ Review the Contractor's submittals for the piping for compliance with the Specifications.
- ❑ Monitor that the Contractor has excavated to the proper depth.
- ❑ Monitor that the Contractor has graded the slope to uniform gradient.
- ❑ Monitor that the downdrain subgrade is dry, firm and unyielding, and does not have loose or extraneous material.
- ❑ Monitor that the piping is placed to the extents, and dimensions indicated on the Drawings.

7.2.3 Riprap Apron

- ❑ Review the Contractor's submittals for the riprap for compliance with the Specifications.

- ❑ Monitor that the subgrade is firm and unyielding prior to the installation of the geotextile filter.

- ❑ Monitor that the geotextile is installed in accordance with the Drawings and Specifications.

- ❑ Monitor the riprap rock size for compliance with the Specifications.

- ❑ Monitor that the riprap is installed in accordance with the Drawings and Specifications.

- ❑ Monitor that the riprap is installed to the design thickness.

- ❑ Monitor that the riprap is installed to the limits shown on the Drawings.

7.2.4 Diversion Berms

- ❑ Monitor that the material used to construct the diversion berms complies with the Specifications for Structural Fill.

- ❑ Monitor that the diversion berms are constructed in accordance with the design and Specifications for Structural Fill (where applicable).

- ❑ Refer to Section 3 of this CQA Plan for CQA monitoring requirements for Structural Fill.

8. DOCUMENTATION

The quality assurance plan depends on thorough monitoring and documentation of all construction activities. Therefore, the CQA manager will document that all quality assurance requirements have been addressed and satisfied. Documentation will consist of daily record keeping, testing and installation reports, non-conformance reports (if necessary), progress reports, photographic records, design and specification revisions, and a construction report.

8.1 Daily Record Keeping

At a minimum, daily records will consist of a daily record of construction progress, daily construction report, observation and test data sheets, and, as needed, non-conformance/corrective measure reports. All forms will have peer review.

8.1.1 Daily Record of Construction Progress

The daily field report will summarize ongoing construction and discussions with the Contractor and will be prepared by the CQA manager and CQA monitors. At a minimum, the report will include the following:

1. Date, project name, project number, and location.
2. A unique number for cross-referencing and document control.
3. Weather data.
4. A description of ongoing construction for the day in the area of the monitor's responsibility.
5. An inventory of equipment utilized by the Contractor.
6. Items of discussion and names of parties involved in discussions.
7. A brief description of tests and observations, identified as passing or failing, or, in the event of failure, a retest.
8. Areas of non-conformance/corrective actions, if any, (non-conformance/corrective action form to be attached).
9. Summary of materials received and quality documentation.
10. Follow-up information on previously reported problems or deficiencies.
11. Record of any site visitors.
12. Signature of CQA manager or CQA monitor.
13. Signature of the peer reviewer.

8.1.2 Observation and Test Data Sheets

Observation and test data sheets should include the following information as is appropriate for the form being used.

1. Date, Project name, and location.

2. A unique number for cross-referencing and document control.

3. Weather data, as applicable.

4. A reduced scale site plan showing sample and test locations.

5. Test equipment calibrations, if applicable.

6. A summary of test results identified as passing, failing, or, in the event of a failed test, retest.

7. Completed calculations.

8. Signature of the CQA manager or CQA monitor.

9. Signature of the peer reviewer.

8.1.3 Non-Conformance Reports

In the event of a non-conformance event, a non-conformance verification report form will be included with the daily report. Procedures for implementing and resolving any non-conformities to the contract are outlined in Section 2.4 of this CQA manual.

8.2 Weekly Progress Reports

The CQA manager will prepare weekly progress reports summarizing construction and quality assurance activities. The reports will contain, at a minimum, the following information:

- The date, project name, and location.
- A summary of work activities completed in the last week, and those expected to be performed in the next week.
- A summary of deficiencies and/or defects, and resolutions.
- Ongoing summary of changed and/or change orders to the work.
- The signature of the CQA manager.
- On fourth week of each month the report will include a summary on-site and third party laboratory test results.

8.3 Photographs

Construction activities will be photographed. Photographs will include any significant problems encountered and corrective actions, and will document construction progress. The photographs will be identified by number, location, time, date, and photographer. The photographer should document the subject or the photograph, either on the back of the picture, or in a photograph log.

8.4 Design and Specification Changes

Design and specification changes may be required during construction. Design and specification changes will only be made with written agreement of the Design Engineer, owner, and Contractor. These changes will be made by change order to the contract. When change orders are issued, they will be prepared by the Construction Manager. The Construction Manager will distribute change orders for signature and execution to the required parties.

8.5 Construction Report

At the completion of the project, the CQA manager and CQA officer will submit a final construction report. This report will document that the work has been performed in compliance with the construction drawings and specifications.

At a minimum, the report will contain:

- A summary of all construction activities.
- A summary of all laboratory and field test results.
- Sampling and testing location drawings
- A description of significant construction problems and the resolution of these problems.
- A list of changes from the construction drawings and specifications and the justifications for these changes.
- As-built record drawings.
- A statement of compliance with the construction contract documents and design intent signed and stamped by the CQA officer, a professional Civil engineer registered in the state of California.

The as-built record drawings will accurately locate the constructed location of all work items, including the location of piping, anchor trenches, etc. All surveying and base maps required for the development of the record drawings will be prepared by the Contractor. The CQA manager must review and verify that as-builts are correct. As-builts will be included in the final construction report.