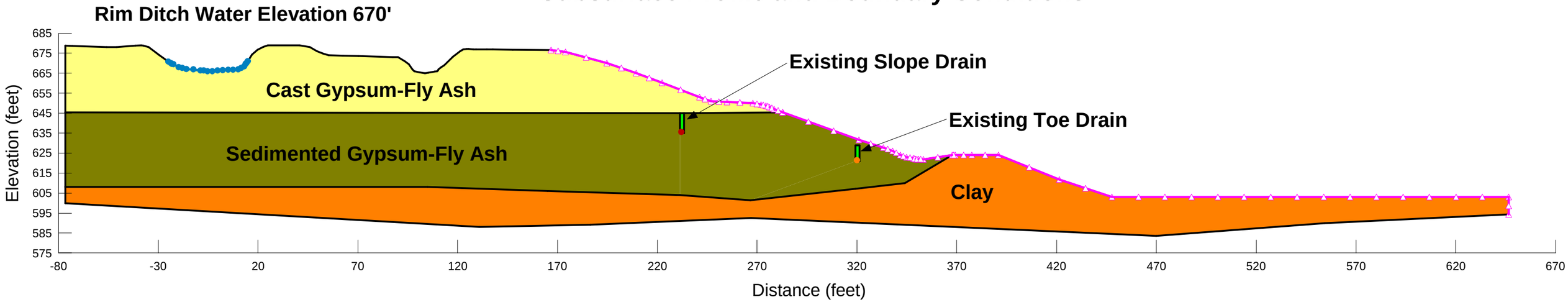
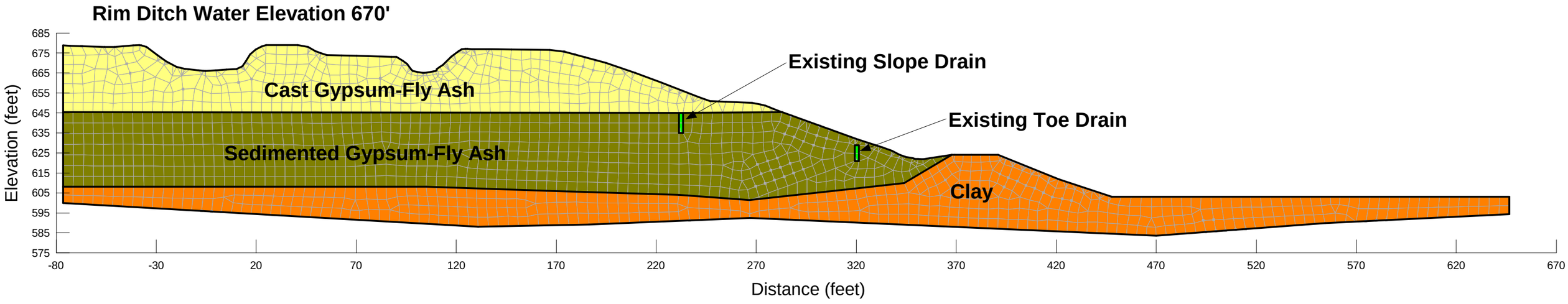
Widows Creeek Fossil Plant

Gypsum Stack - Section A with Drains
Subsurface Profile and Boundary Conditions



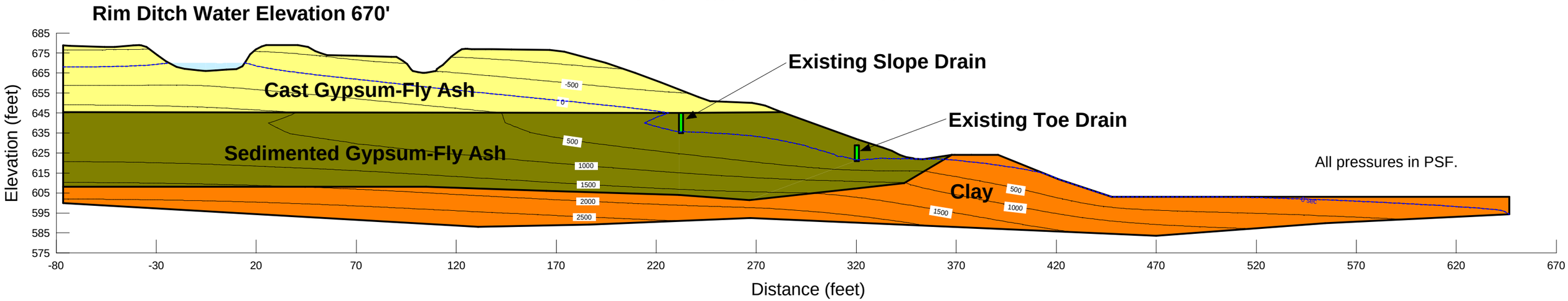
Widows Creeek Fossil Plant

Gypsum Stack - Section A with Drains
Finite Element Mesh



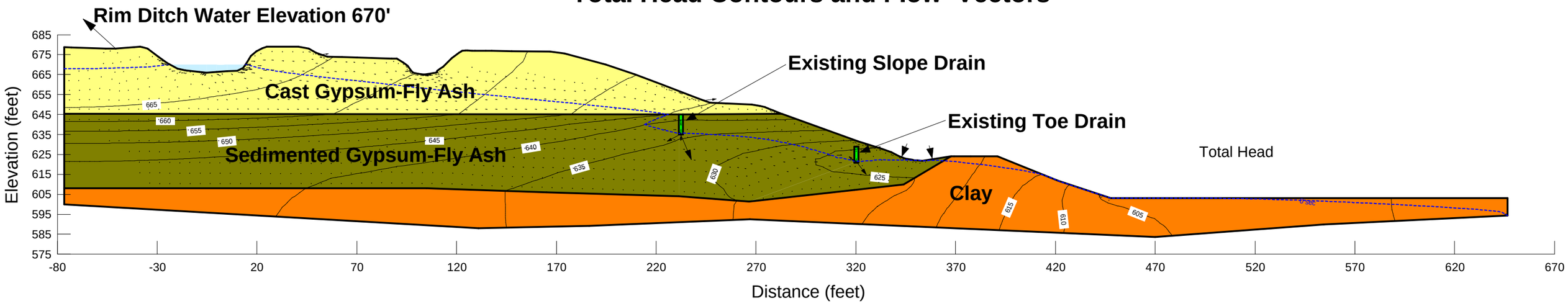
Widows Creeek Fossil Plant

Gypsum Stack - Section A with Drains
Pore-Water Pressure Contours



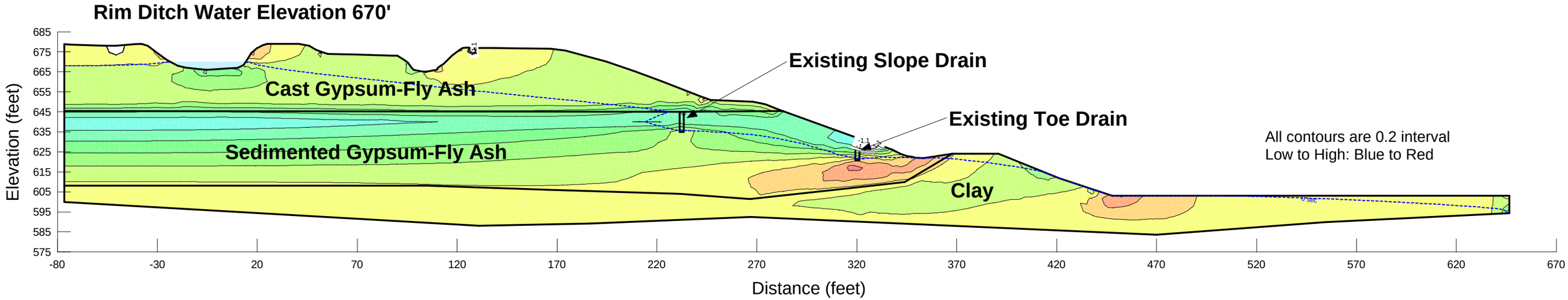
Widows Creeek Fossil Plant

Gypsum Stack - Section A with Drains
Total Head Contours and Flow Vectors

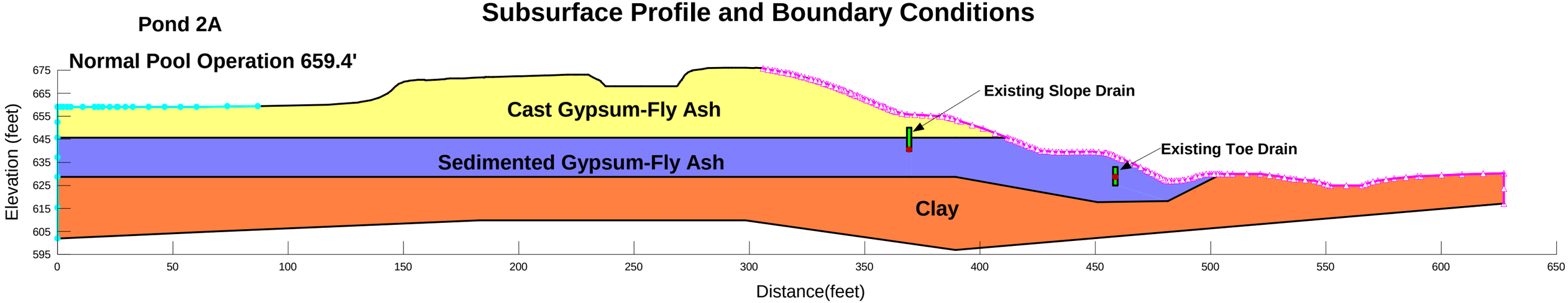


Widows Creeek Fossil Plant

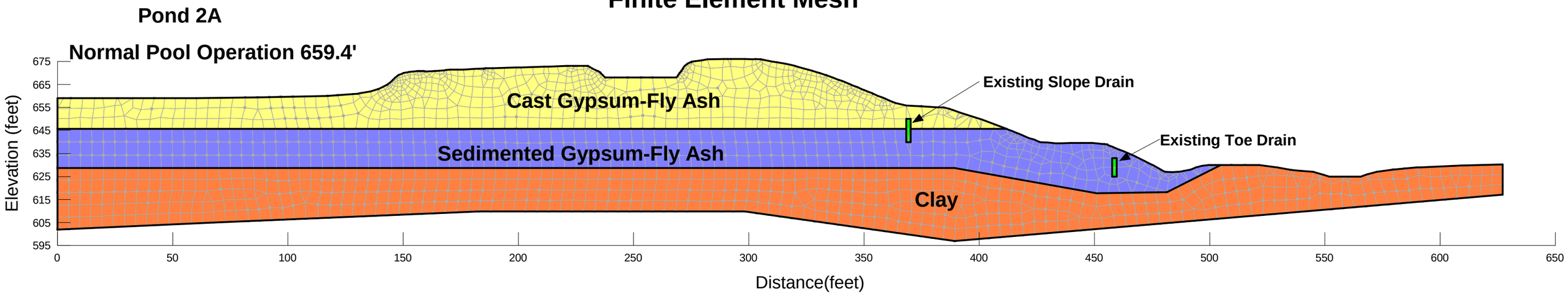
Gypsum Stack - Section A with Drains
Vertical Gradient Contours



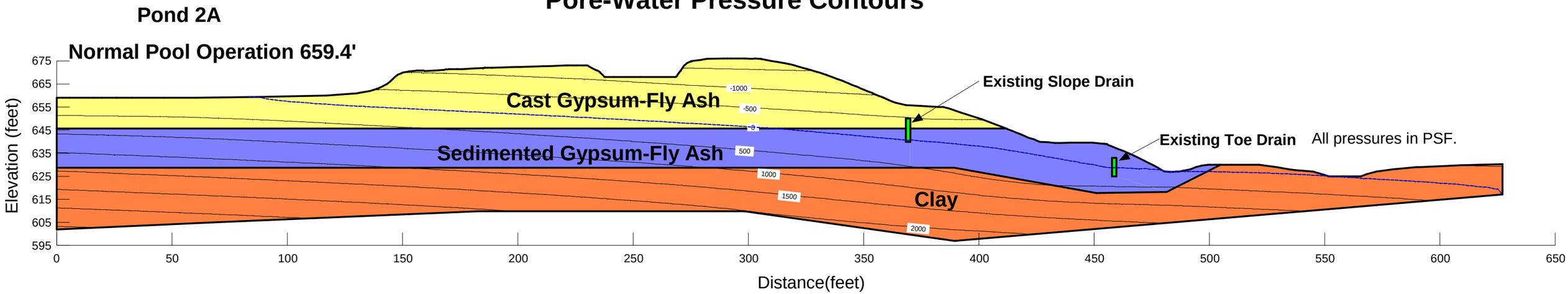
Widows Creek Fossil Plant
Gypsum Stack - Section D with Drains
Subsurface Profile and Boundary Conditions



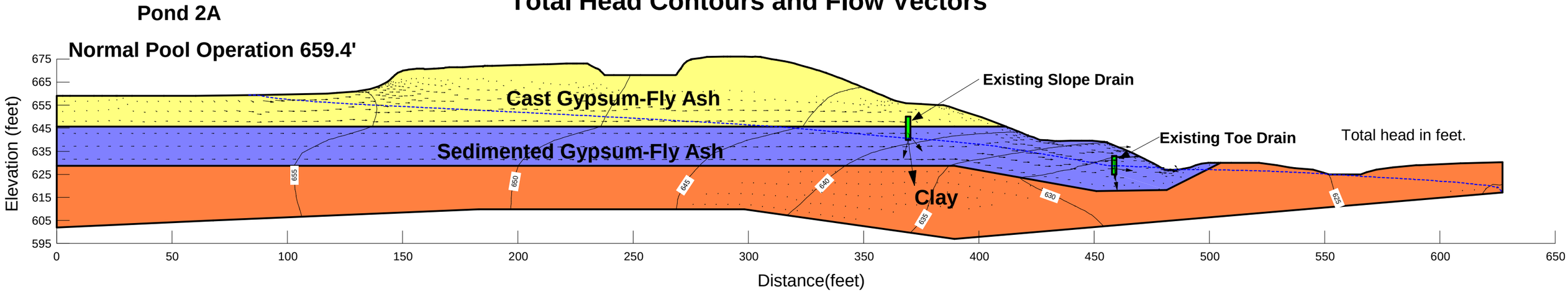
Widows Creek Fossil Plant
Gypsum Stack - Section D with Drains
Finite Element Mesh



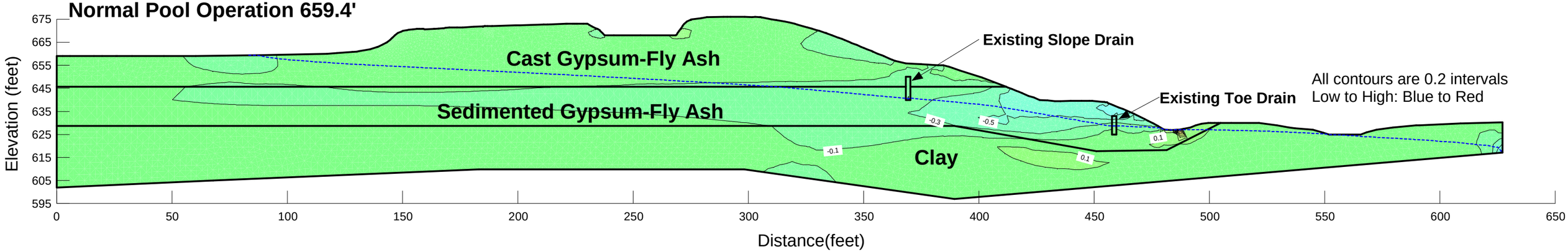
Widows Creek Fossil Plant
Gypsum Stack - Section D with Drains
Pore-Water Pressure Contours



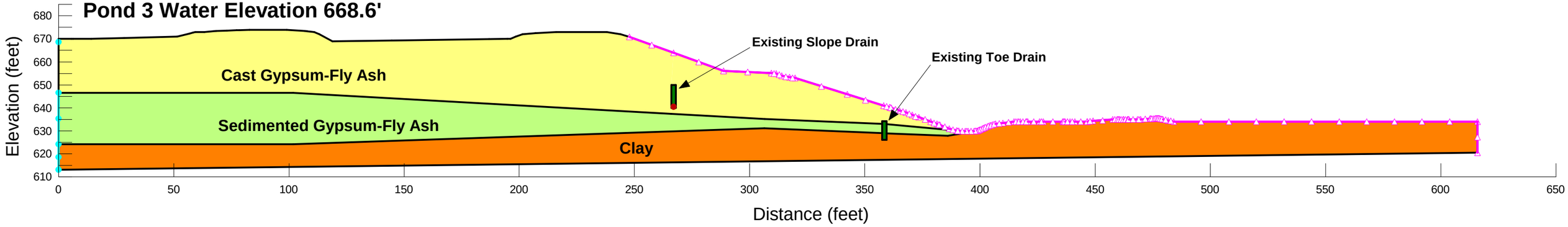
Widows Creek Fossil Plant
Gypsum Stack - Section D with Drains
Total Head Contours and Flow Vectors



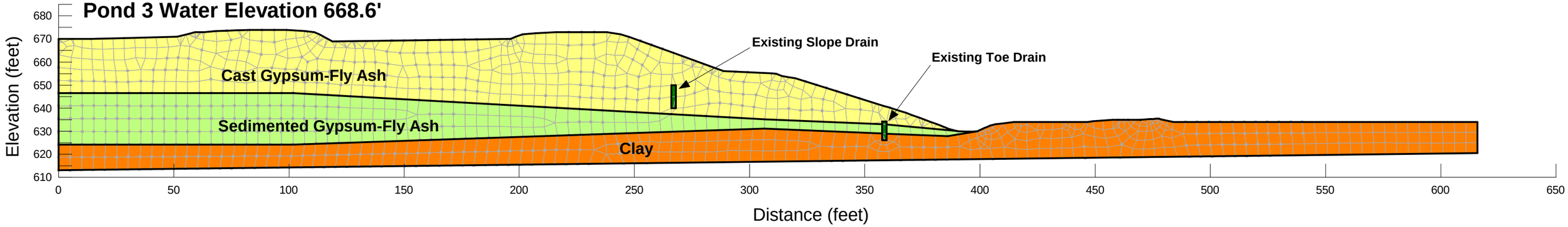
Widows Creek Fossil Plant
Gypsum Stack - Section D with Drains
Vertical Gradient Contours



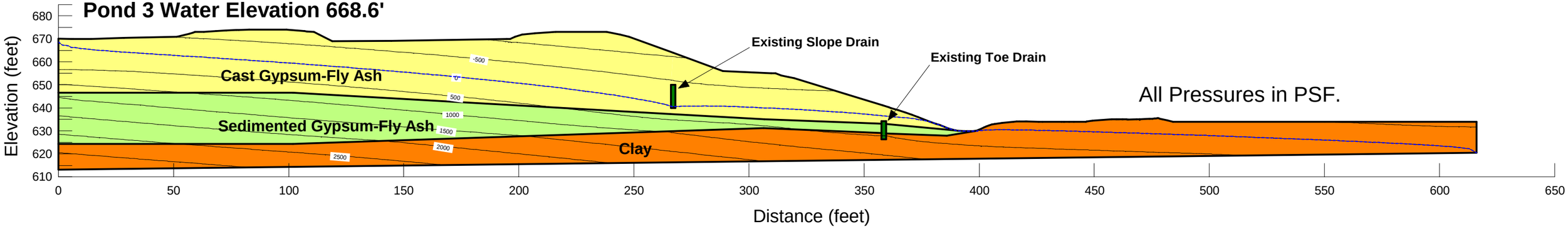
Widows Creek Fossil Plant
Gypsum Stack - Section F with Drains
Subsurface Profile and Boundary Conditions



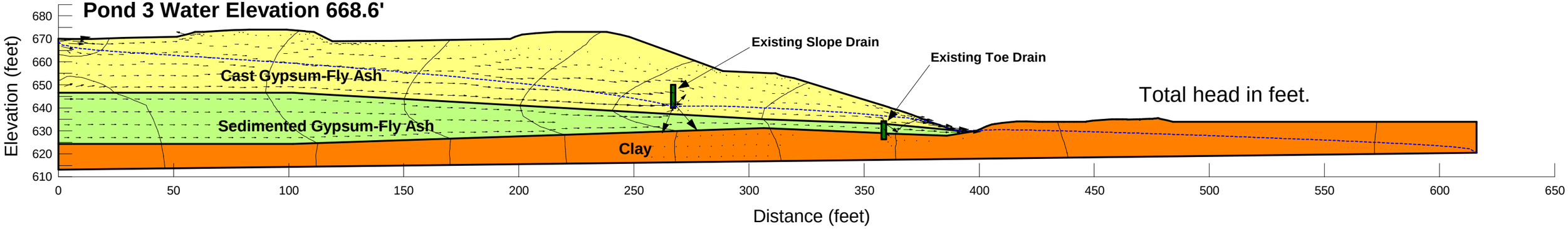
Widows Creek Fossil Plant
Gypsum Stack - Section F with Drains
Finite Element Mesh



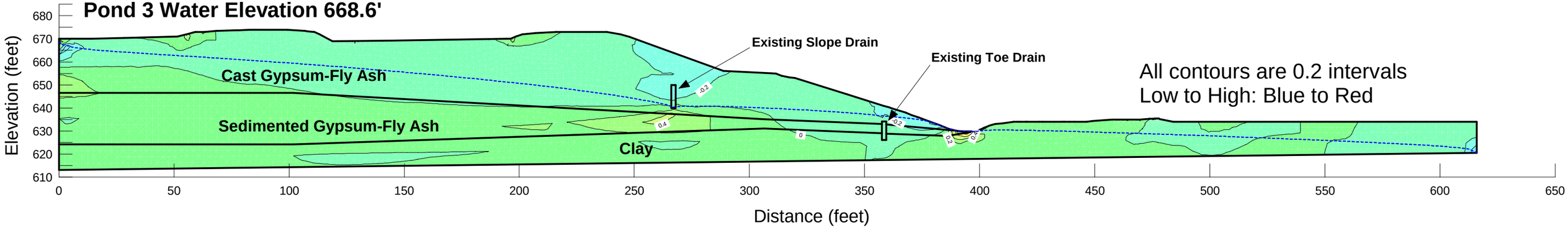
Widows Creek Fossil Plant
Gypsum Stack - Section F with Drains
Pore-Water Pressure Contours



Widows Creek Fossil Plant
Gypsum Stack - Section F with Drains
Total Head Contours and Flow Vectors



Widows Creek Fossil Plant
Gypsum Stack - Section F with Drains
Vertical Gradient Contours

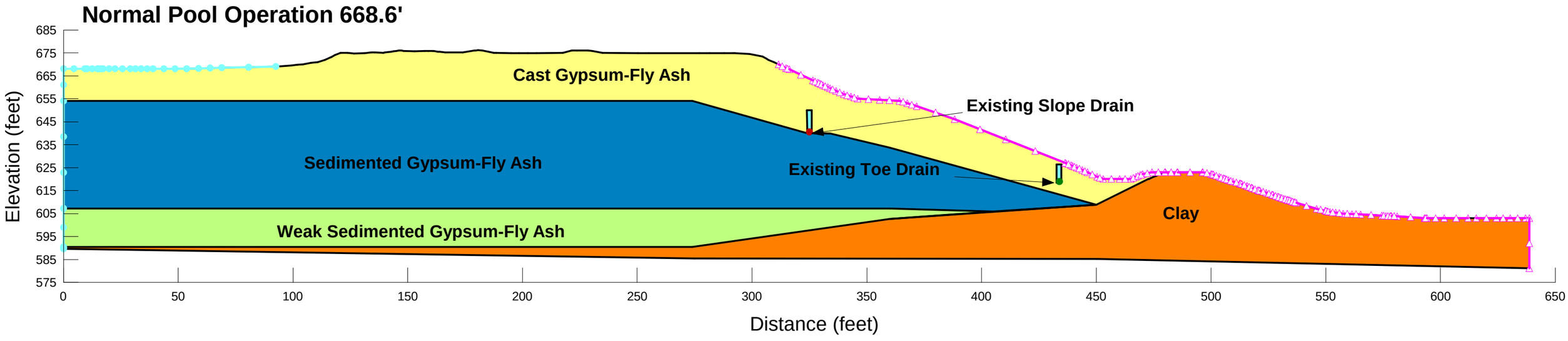


Widows Creek Fossil Plant

Gypsum Stack - Section H with Drains

Subsurface Profile and Boundary Conditions

Pond 3

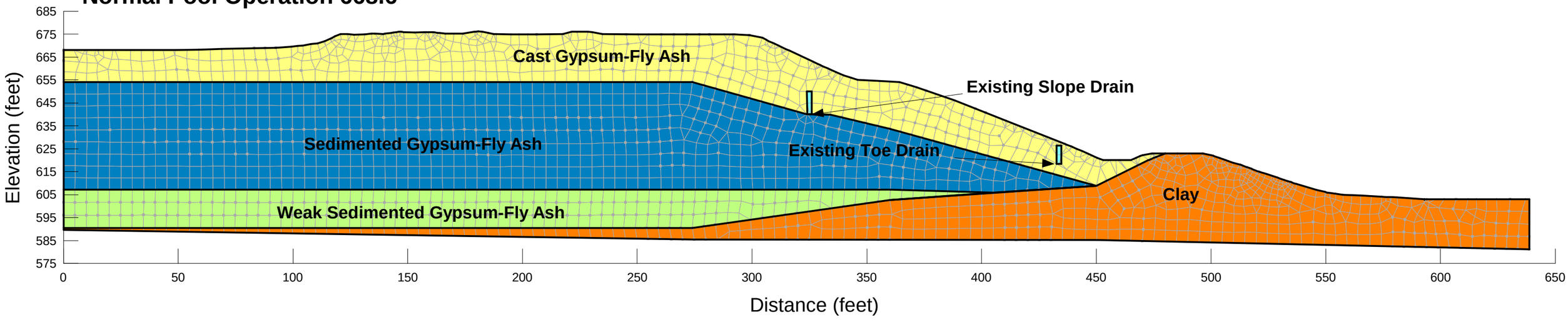


Widows Creek Fossil Plant

Gypsum Stack - Section H with Drains
Finite Element Mesh

Pond 3

Normal Pool Operation 668.6'

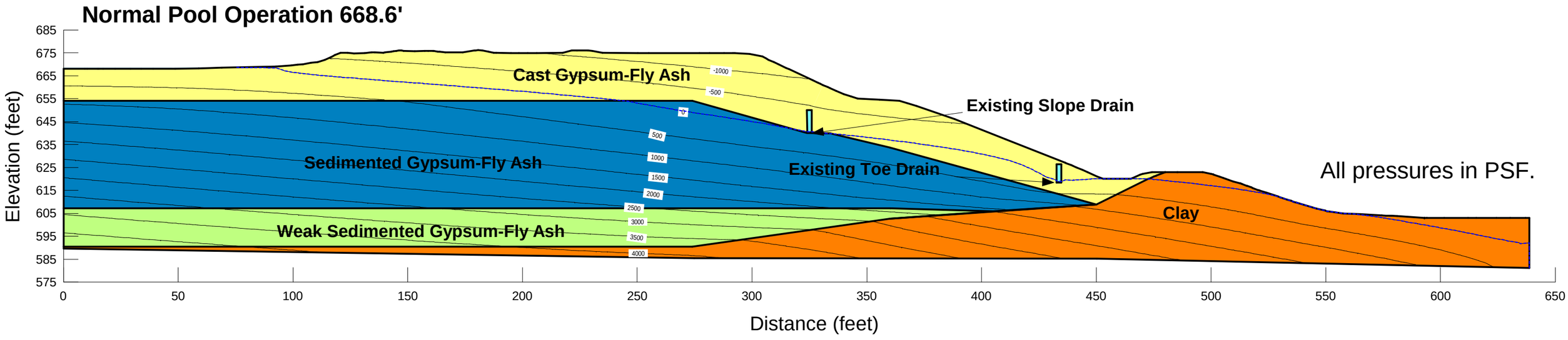


Widows Creek Fossil Plant

Gypsum Stack - Section H with Drains

Pore-Water Pressure Contours

Pond 3

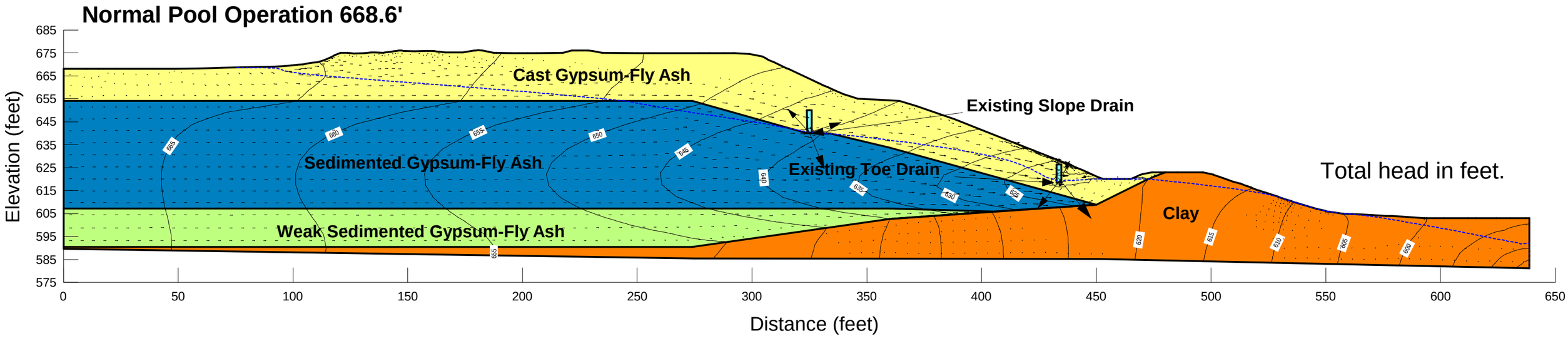


Widows Creek Fossil Plant

Gypsum Stack - Section H with Drains

Total Head Contours and Flow Vectors

Pond 3

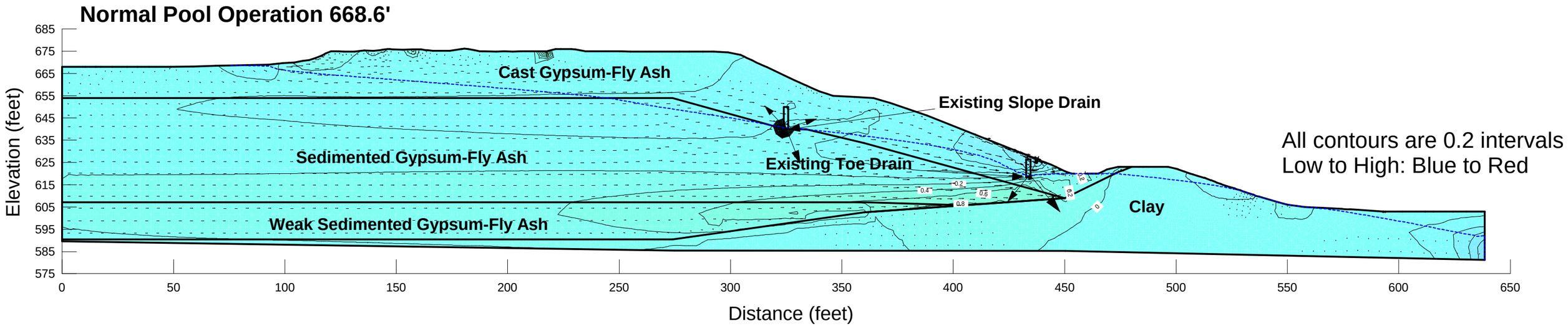


Widows Creek Fossil Plant

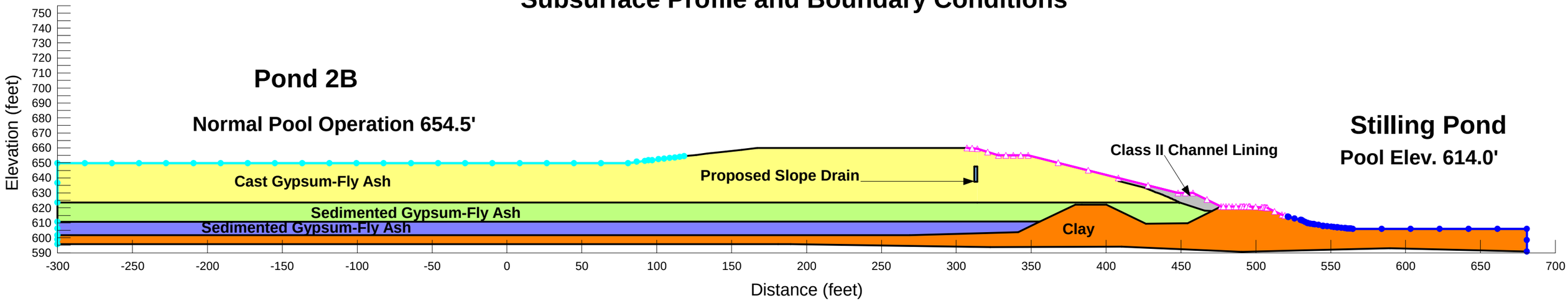
Gypsum Stack - Section H with Drains

Vertical Gradient Contours

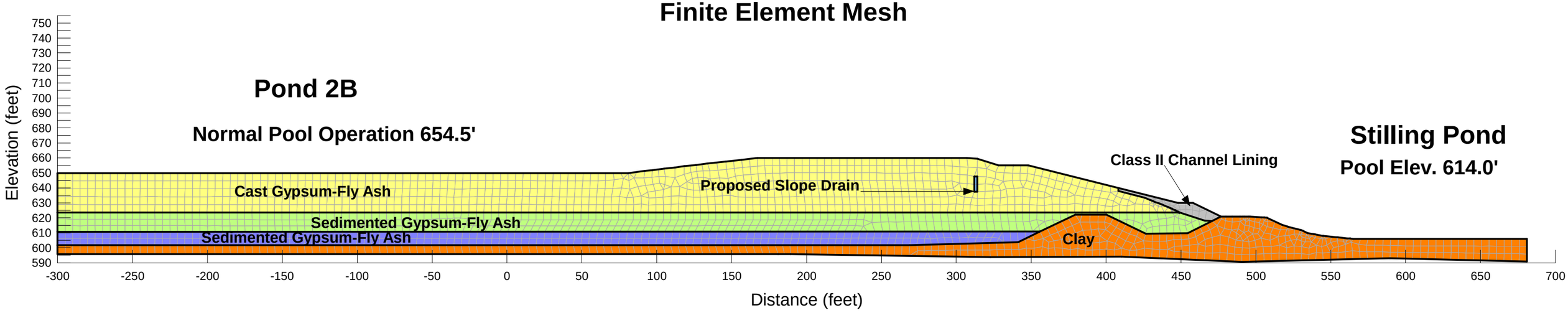
Pond 3



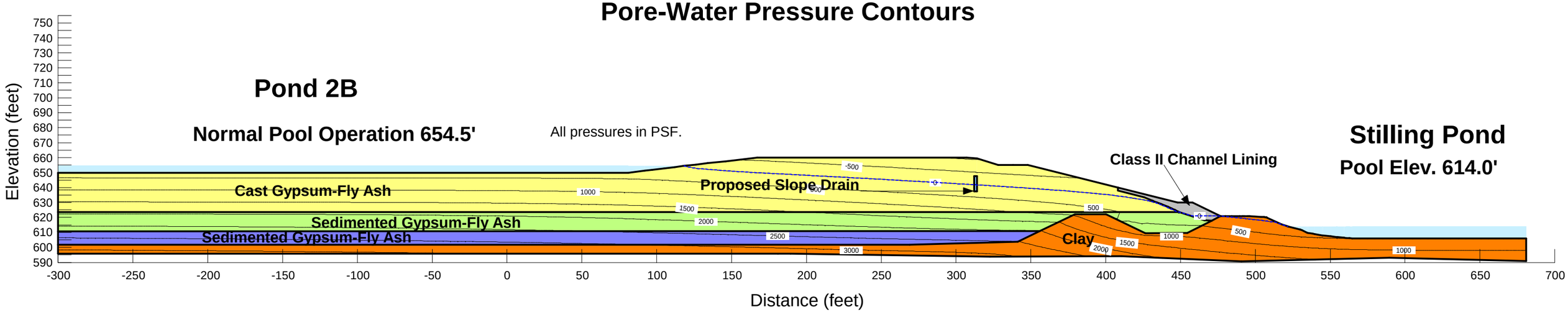
Widows Creek Fossil Plant
Gypsum Stack - Section K
Subsurface Profile and Boundary Conditions



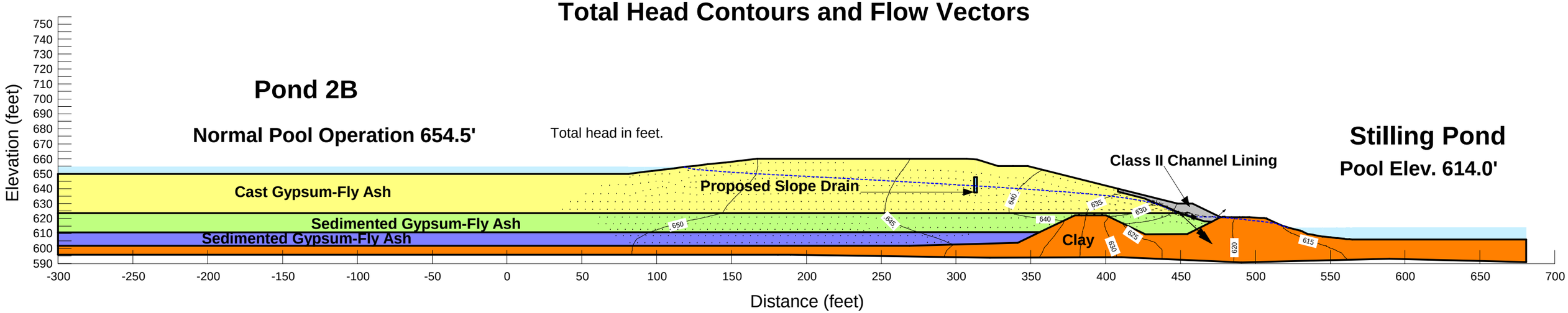
Widows Creek Fossil Plant
Gypsum Stack - Section K
Finite Element Mesh



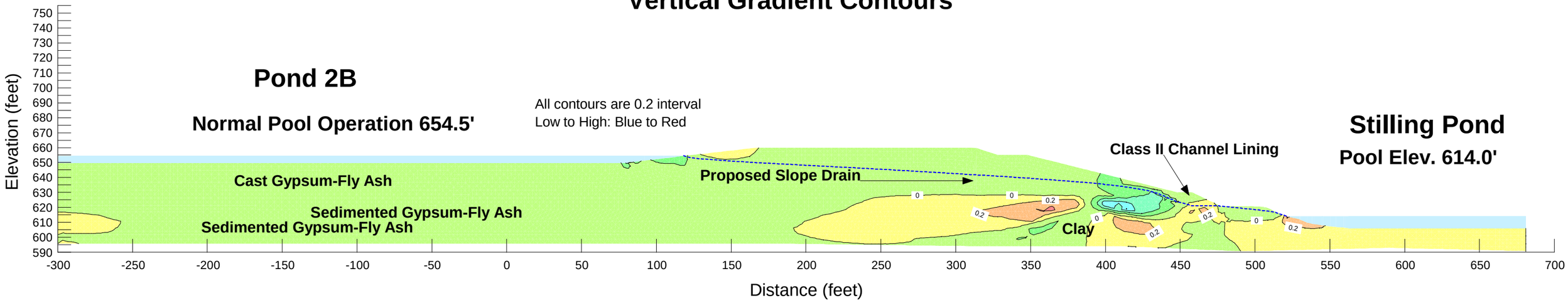
Widows Creek Fossil Plant
Gypsum Stack - Section K
Pore-Water Pressure Contours



Widows Creek Fossil Plant
Gypsum Stack - Section K
Total Head Contours and Flow Vectors



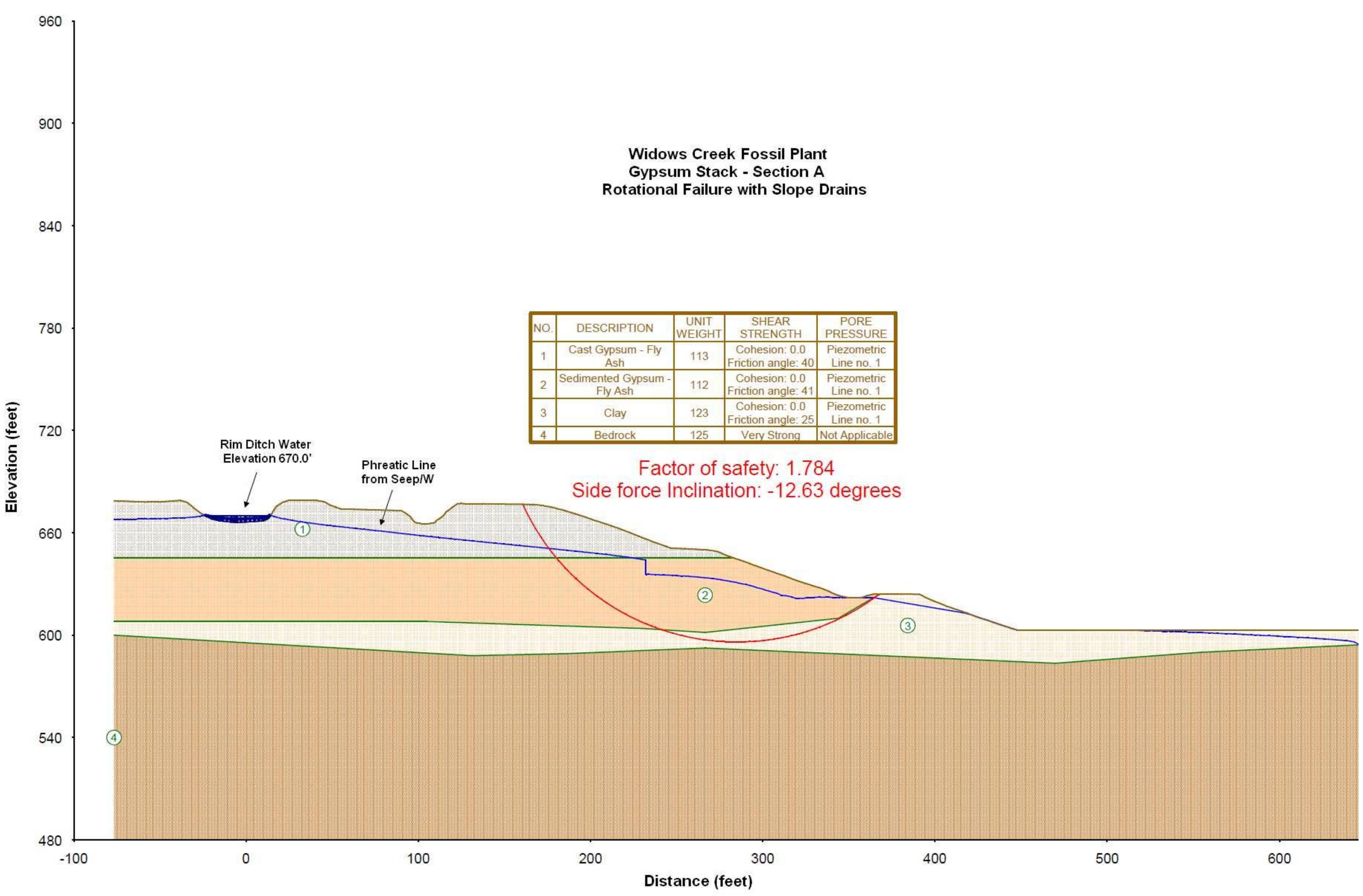
Widows Creek Fossil Plant
Gypsum Stack - Section K
Vertical Gradient Contours



Widows Creek Fossil Plant
Gypsum Stack - Section A
Rotational Failure with Slope Drains

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Cast Gypsum - Fly Ash	113	Cohesion: 0.0 Friction angle: 40	Piezometric Line no. 1
2	Sedimented Gypsum - Fly Ash	112	Cohesion: 0.0 Friction angle: 41	Piezometric Line no. 1
3	Clay	123	Cohesion: 0.0 Friction angle: 25	Piezometric Line no. 1
4	Bedrock	125	Very Strong	Not Applicable

Factor of safety: 1.784
Side force Inclination: -12.63 degrees



Widows Creek Fossil Plant
Gypsum Stack - Section D
Rotational Failure with Slope Drains

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Cast Gypsum - Fly Ash	113	Cohesion: 0.0 Friction angle: 40	Piezometric Line no. 1
2	Sedimented Gypsum - Fly Ash	112	Cohesion: 0.0 Friction angle: 41	Piezometric Line no. 1
3	Clay	123	Cohesion: 0.0 Friction angle: 25	Piezometric Line no. 1
4	Bedrock	125	Very Strong	Not Applicable

Factor of safety: 2.287
Side force Inclination: -11.58 degrees

Pond 2A Water Elevation 654.5

Phreatic Line from Seep/W

Elevation (feet)

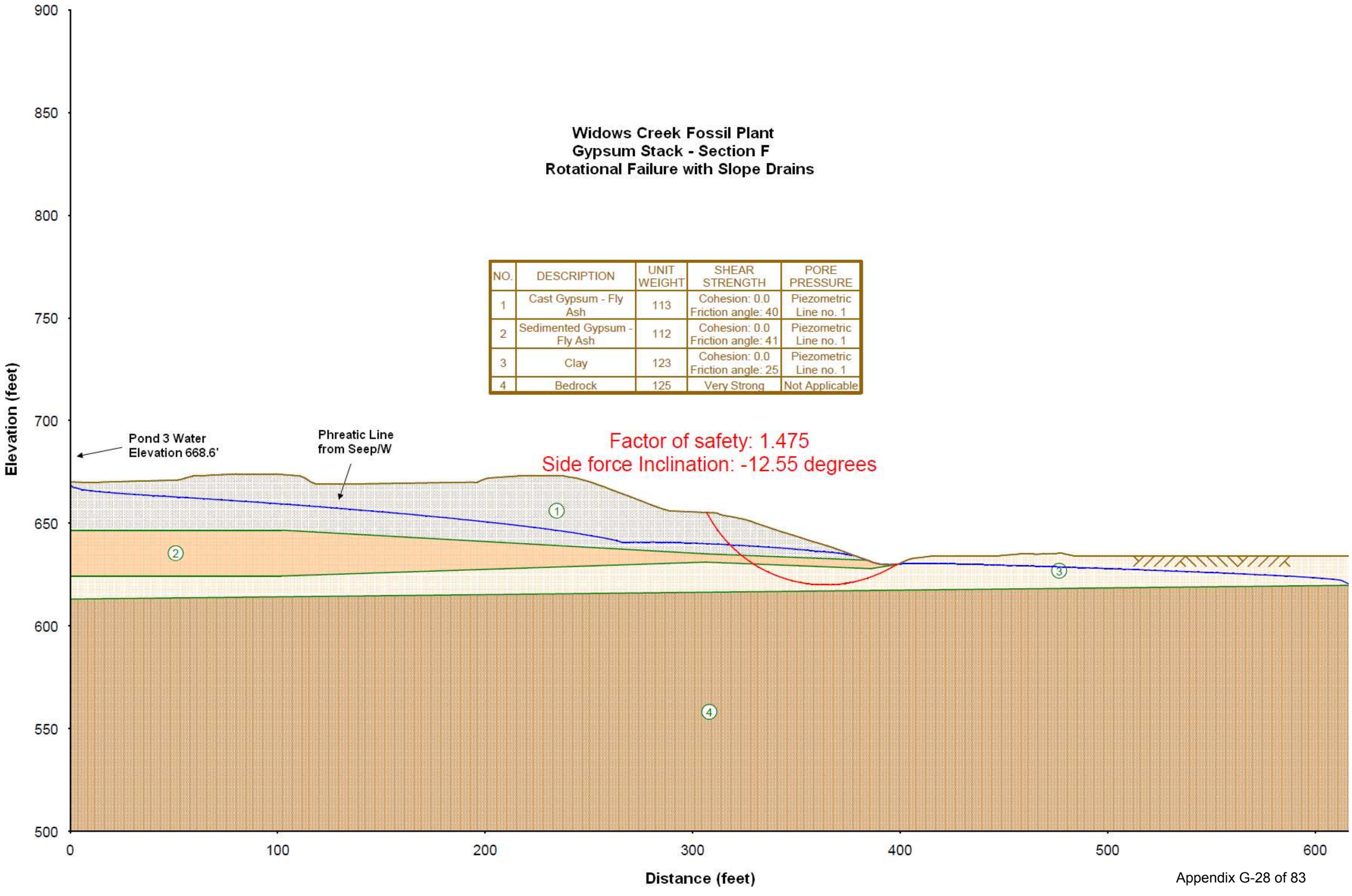
900
850
800
750
700
650
600
550
500

0
100
200
300
400
500
600

Distance (feet)

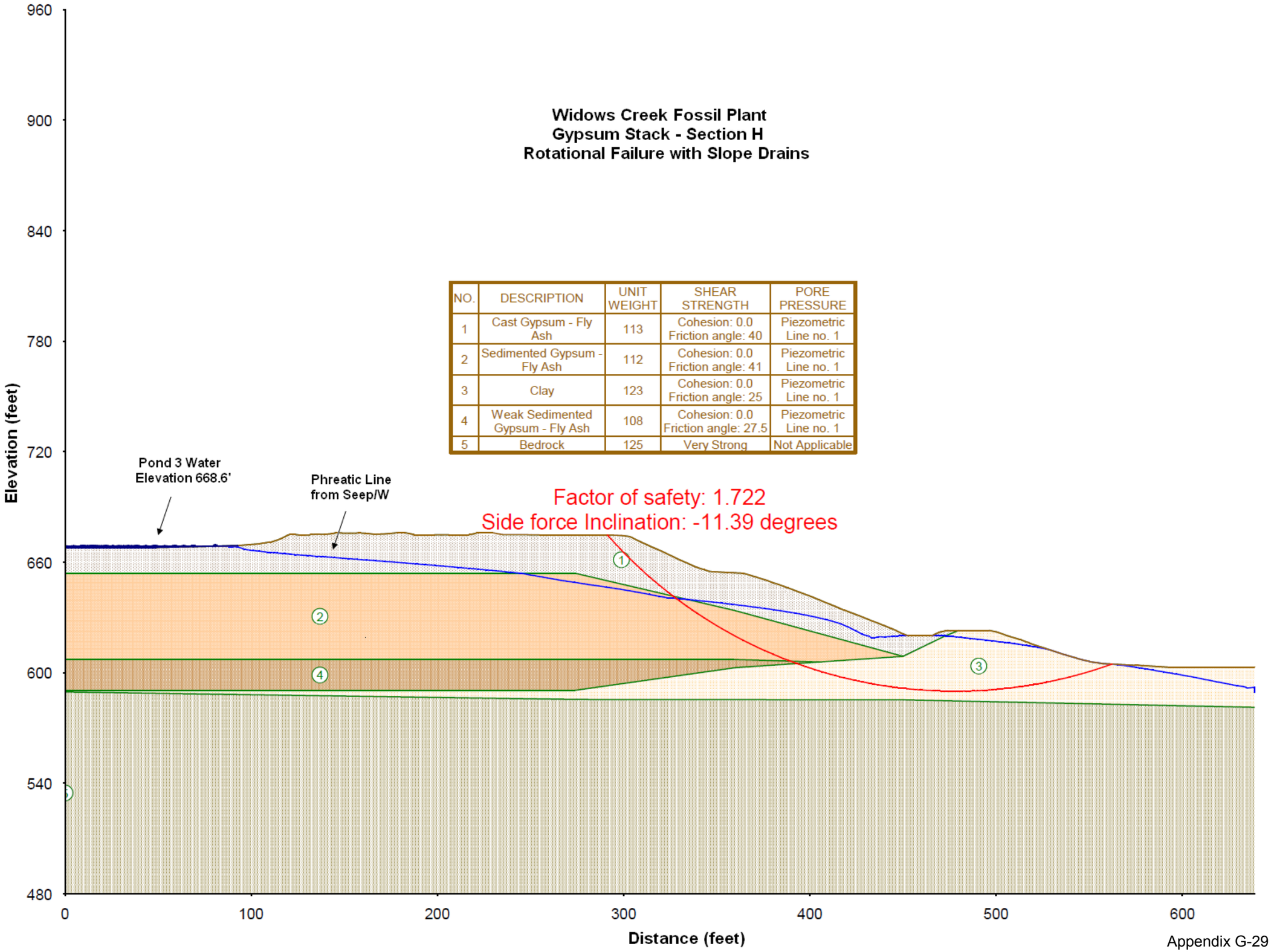
Widows Creek Fossil Plant
Gypsum Stack - Section F
Rotational Failure with Slope Drains

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Cast Gypsum - Fly Ash	113	Cohesion: 0.0 Friction angle: 40	Piezometric Line no. 1
2	Sedimented Gypsum - Fly Ash	112	Cohesion: 0.0 Friction angle: 41	Piezometric Line no. 1
3	Clay	123	Cohesion: 0.0 Friction angle: 25	Piezometric Line no. 1
4	Bedrock	125	Very Strong	Not Applicable



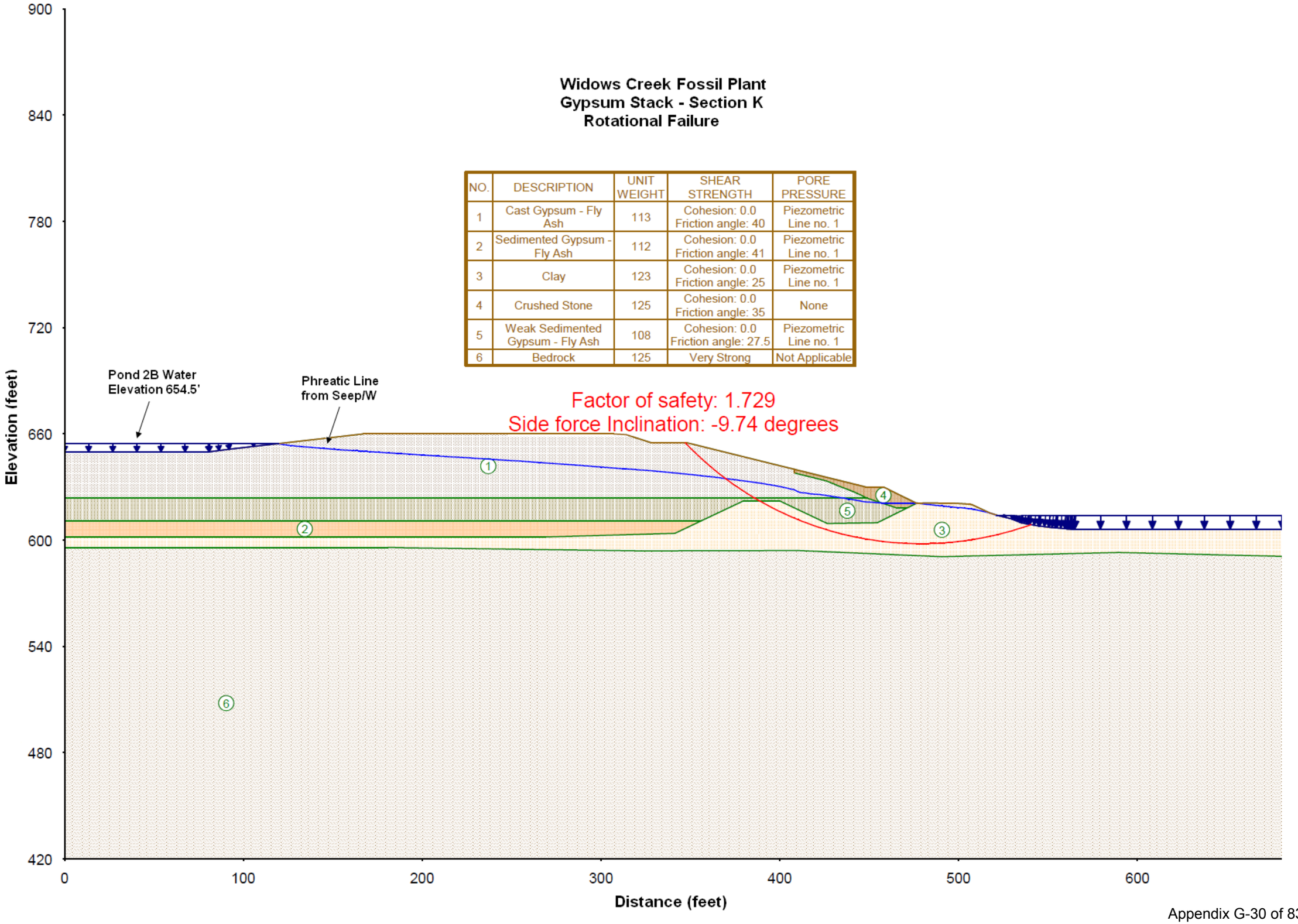
Widows Creek Fossil Plant
Gypsum Stack - Section H
Rotational Failure with Slope Drains

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Cast Gypsum - Fly Ash	113	Cohesion: 0.0 Friction angle: 40	Piezometric Line no. 1
2	Sedimented Gypsum - Fly Ash	112	Cohesion: 0.0 Friction angle: 41	Piezometric Line no. 1
3	Clay	123	Cohesion: 0.0 Friction angle: 25	Piezometric Line no. 1
4	Weak Sedimented Gypsum - Fly Ash	108	Cohesion: 0.0 Friction angle: 27.5	Piezometric Line no. 1
5	Bedrock	125	Very Strong	Not Applicable



Widows Creek Fossil Plant
Gypsum Stack - Section K
Rotational Failure

NO.	DESCRIPTION	UNIT WEIGHT	SHEAR STRENGTH	PORE PRESSURE
1	Cast Gypsum - Fly Ash	113	Cohesion: 0.0 Friction angle: 40	Piezometric Line no. 1
2	Sedimented Gypsum - Fly Ash	112	Cohesion: 0.0 Friction angle: 41	Piezometric Line no. 1
3	Clay	123	Cohesion: 0.0 Friction angle: 25	Piezometric Line no. 1
4	Crushed Stone	125	Cohesion: 0.0 Friction angle: 35	None
5	Weak Sedimented Gypsum - Fly Ash	108	Cohesion: 0.0 Friction angle: 27.5	Piezometric Line no. 1
6	Bedrock	125	Very Strong	Not Applicable



CPT Data Analysis Summary

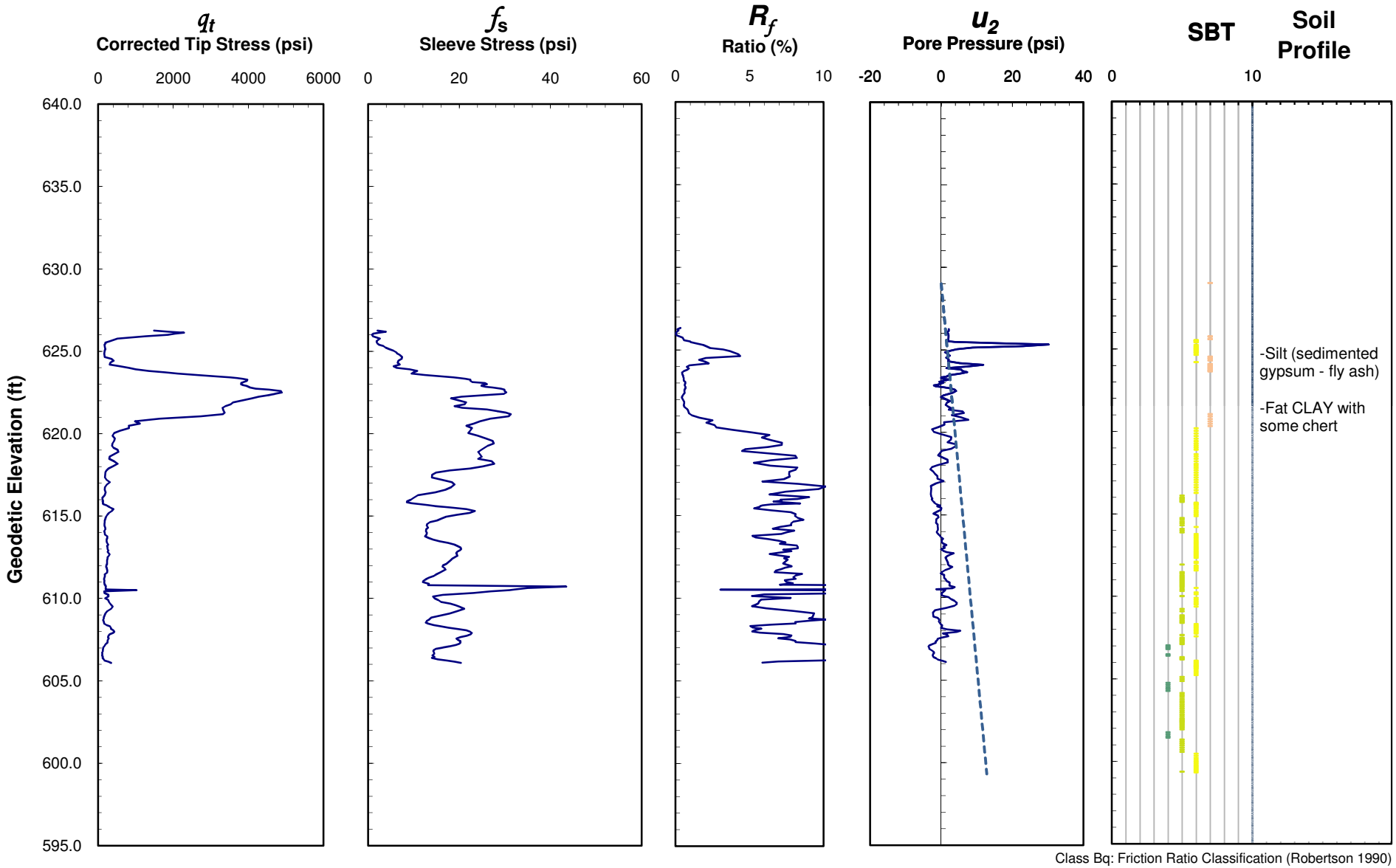
The coefficient of consolidation in the horizontal direction (c_h) was determined using the chart proposed by Roberston et al. (1992). Robertson et al. (1992) had reviewed dissipation data from piezocone tests and compared these with values obtained in the lab or field. In order to use the chart proposed by Robertson et al. (1992) the time to reach U_{50} is determined in minutes. This value is a function of the pore pressure measured at the start of the dissipation test (Push pore pressure) and the location of the static groundwater table (hydrostatic pressure). In order to accurately predict the static groundwater level, piezometer data taken from the nearest piezometers was used. In some cases, the dissipation tests were run long enough for the to reach hydrostatic pressure. When this occurred, the depth to the groundwater table was determined using the hydrostatic pressure measured during the dissipation test. The time to reach U_{50} (t_{50}) was then determined and used to determine c_h. It should be noted that the chart provided by Robertson et al. (1992) provides an upper and lower bound for c_h values. As such the c_h value presented on the graph is the average of the upper and lower bound c_h values determined using the chart.

The hydraulic conductivity in the horizontal direction (k_h) is determined in a similar fashion using the chart proposed by Robertson et al. (1992). Once again, a lower and upper value of k_h is determined using t_{50}, and an average k_h value is presented. In this case, the relationship between k_h values in laboratory and field tests, and t50 is not as good as that observed between c_h and t_{50}. This is reflected in the difference in k_h estimates (which is approximately 1.5 orders of magnitude). As such it is typically recommended that the k_h values obtained from dissipation tests be only used as a guide.

Soil parameters (angle of friction, N60, and s_u) were determined using empirical correlations provided in the literature (and as presented by Lunne et al. 1997). These empirical relationships were determined using various natural soils. It should be noted that bottom ash and fly ash were not part of the data sets used to determine these relationships. As such these values should be used as a guide until enough empirical data can be used to very that these relationships apply for bottom ash and fly ash.

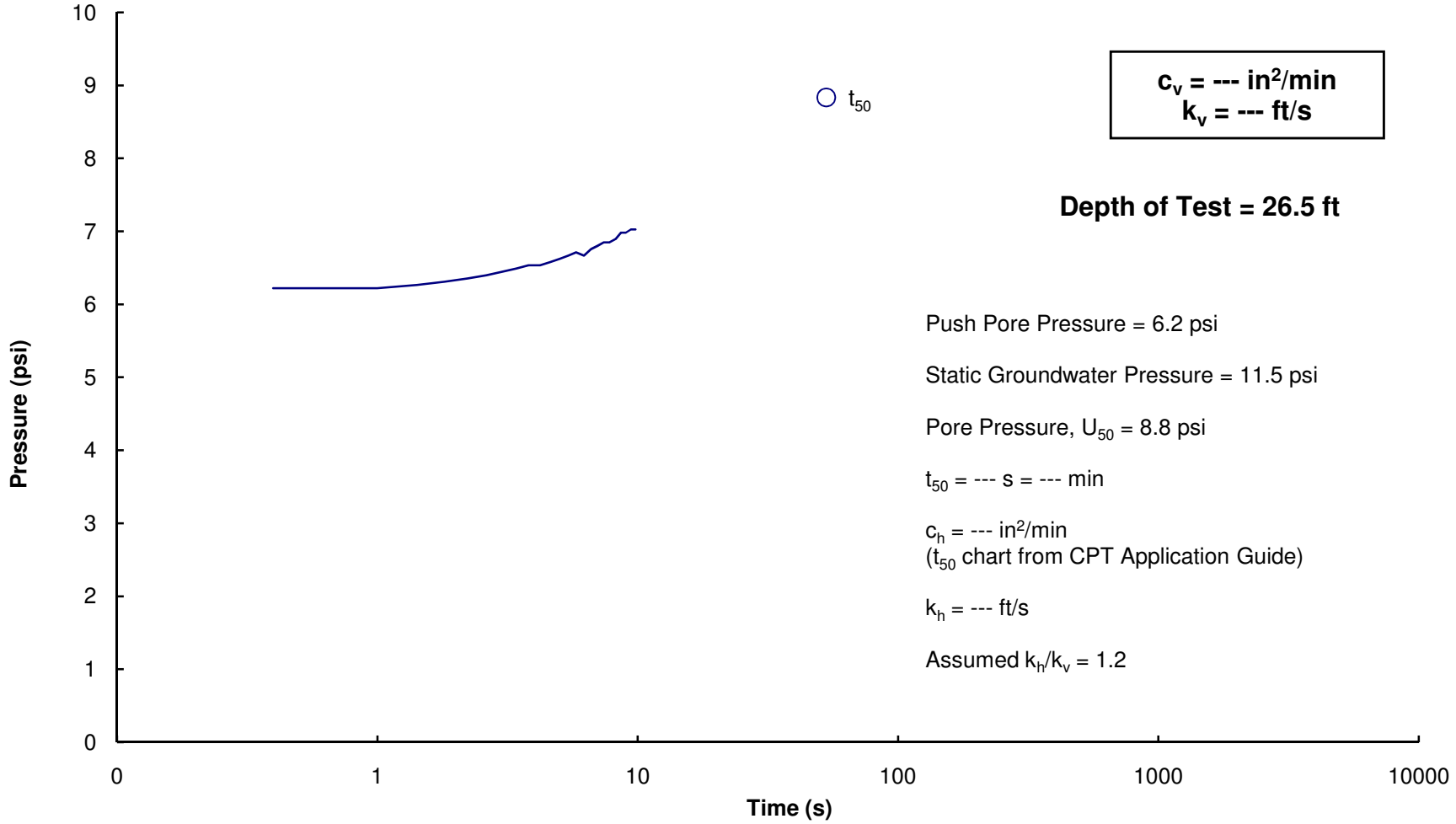
Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne. T., Powell, J.J.M., and Gillespie, D.G. (1992b) “Estimating coefficient of consolidation from piezocone tests” Canadian Geotechnical Journal, 29 (4), 551-557
Robertson, P.K., Woeller, D.J., and Finn, W.D.L. (1992) “Seismic cone penetration test for evaluating liquefaction potential under cyclic loading” Canadian Geotechnical Journal, 29 (4), 686-695
Lunne, T., Robertson, P.K., and Powell, J.J.M. (1997) “Cone Penetration Testing in Geotechnical Engineering”, E&FN Spon, New York, NY

Stantec Consulting Inc.	Elevation: 629.00 ft SCPTu Start Elevation: 626.50 ft Groundwater Elevation: 629.00 ft	Test Date: July 30, 2009 Project No. 175569036	CPT10
	Client: TVA Project: Widows Creek Main Gypsum Stack		



Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = --- in²/min
k_v = --- ft/s

Depth of Test = 26.5 ft

Push Pore Pressure = 6.2 psi

Static Groundwater Pressure = 11.5 psi

Pore Pressure, U_{50} = 8.8 psi

t_{50} = --- s = --- min

c_h = --- in²/min
(t_{50} chart from CPT Application Guide)

k_h = --- ft/s

Assumed k_h/k_v = 1.2

Project No. 175569036
CPT10

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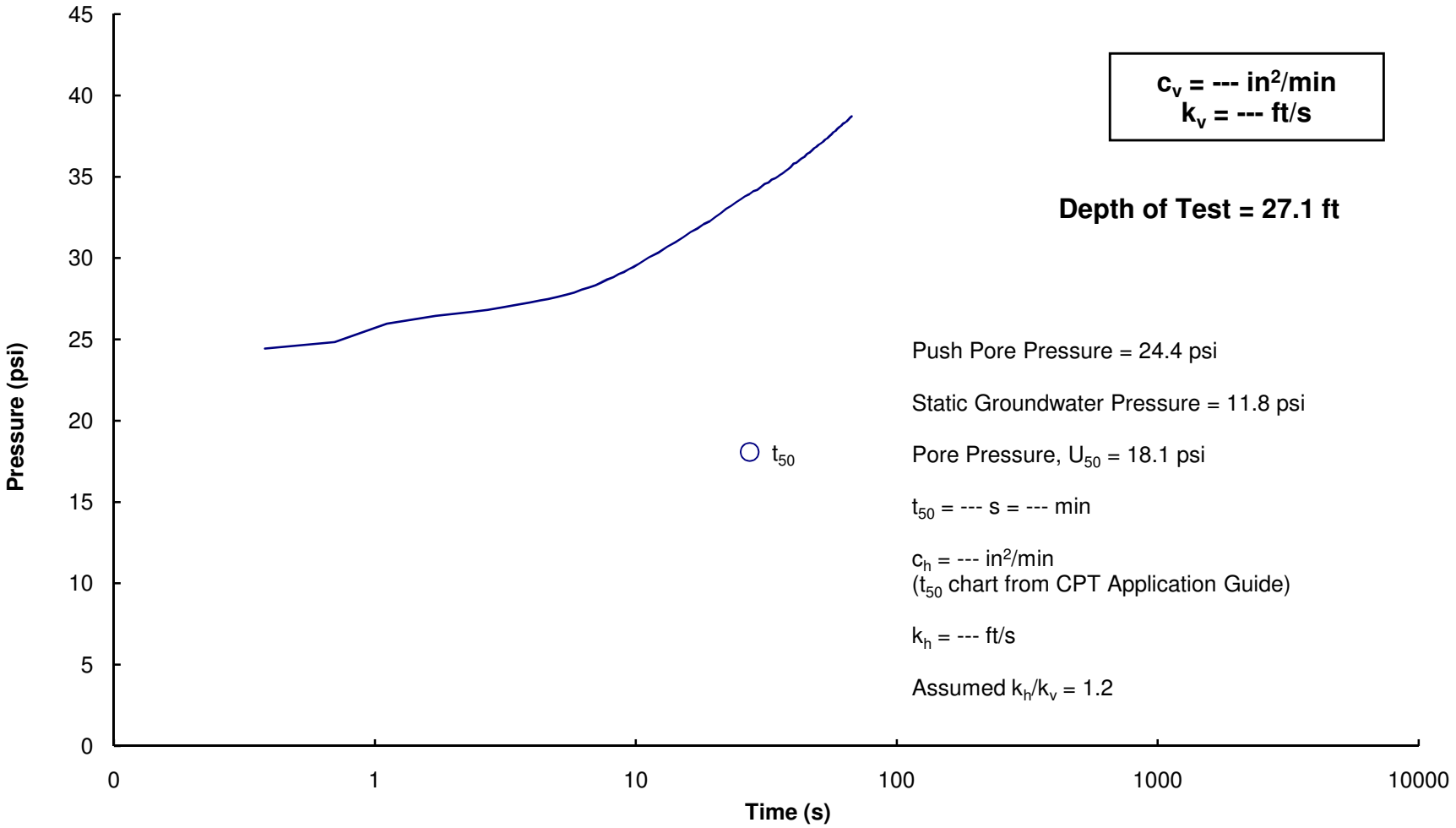
Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = --- in²/min
k_v = --- ft/s

Depth of Test = 27.1 ft

Push Pore Pressure = 24.4 psi

Static Groundwater Pressure = 11.8 psi

Pore Pressure, U_{50} = 18.1 psi

t_{50} = --- s = --- min

c_h = --- in²/min
(t_{50} chart from CPT Application Guide)

k_h = --- ft/s

Assumed k_h/k_v = 1.2

Project No. 175569036
CPT10

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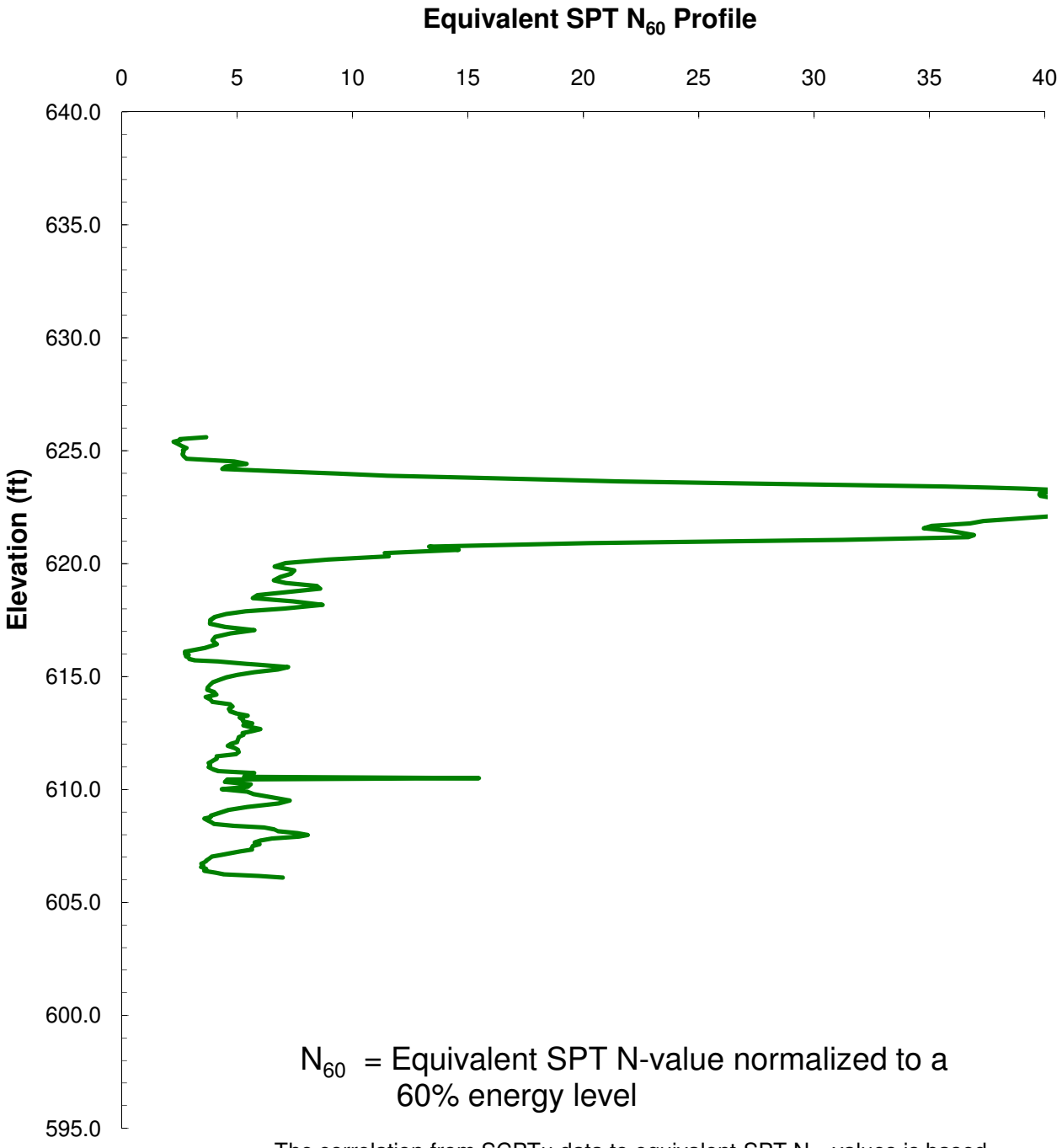
SCPTu Results

SCPTu N_{60} Values



N_{60} = Equivalent SPT N-value normalized to a 60% energy level

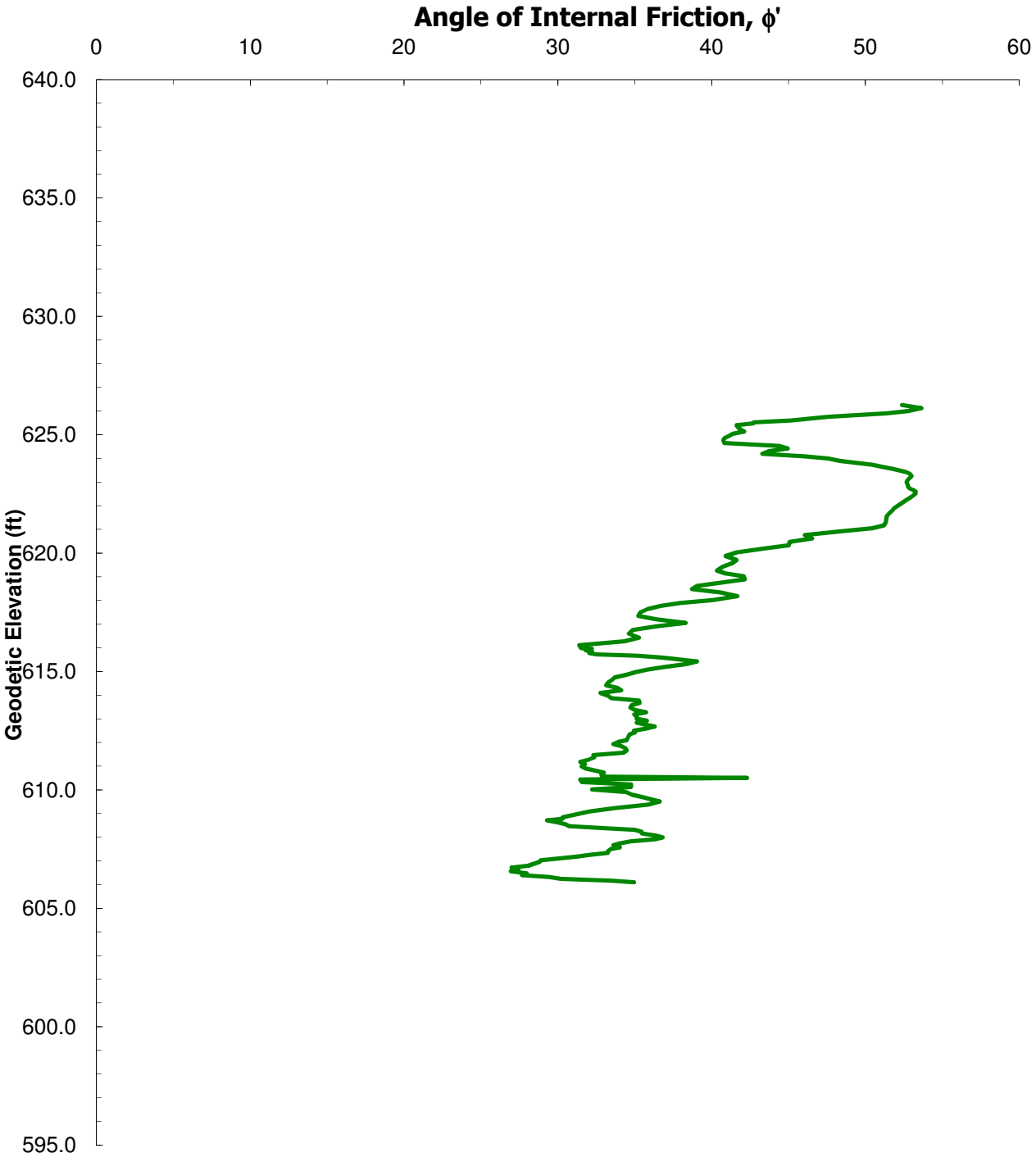
The correlation from SCPTu data to equivalent SPT N_{60} values is based on the Jefferies and Davies (1993) approach.

Project No. 175569036

CPT10

SCPTu RESULTS

Effective Angle of Internal Friction

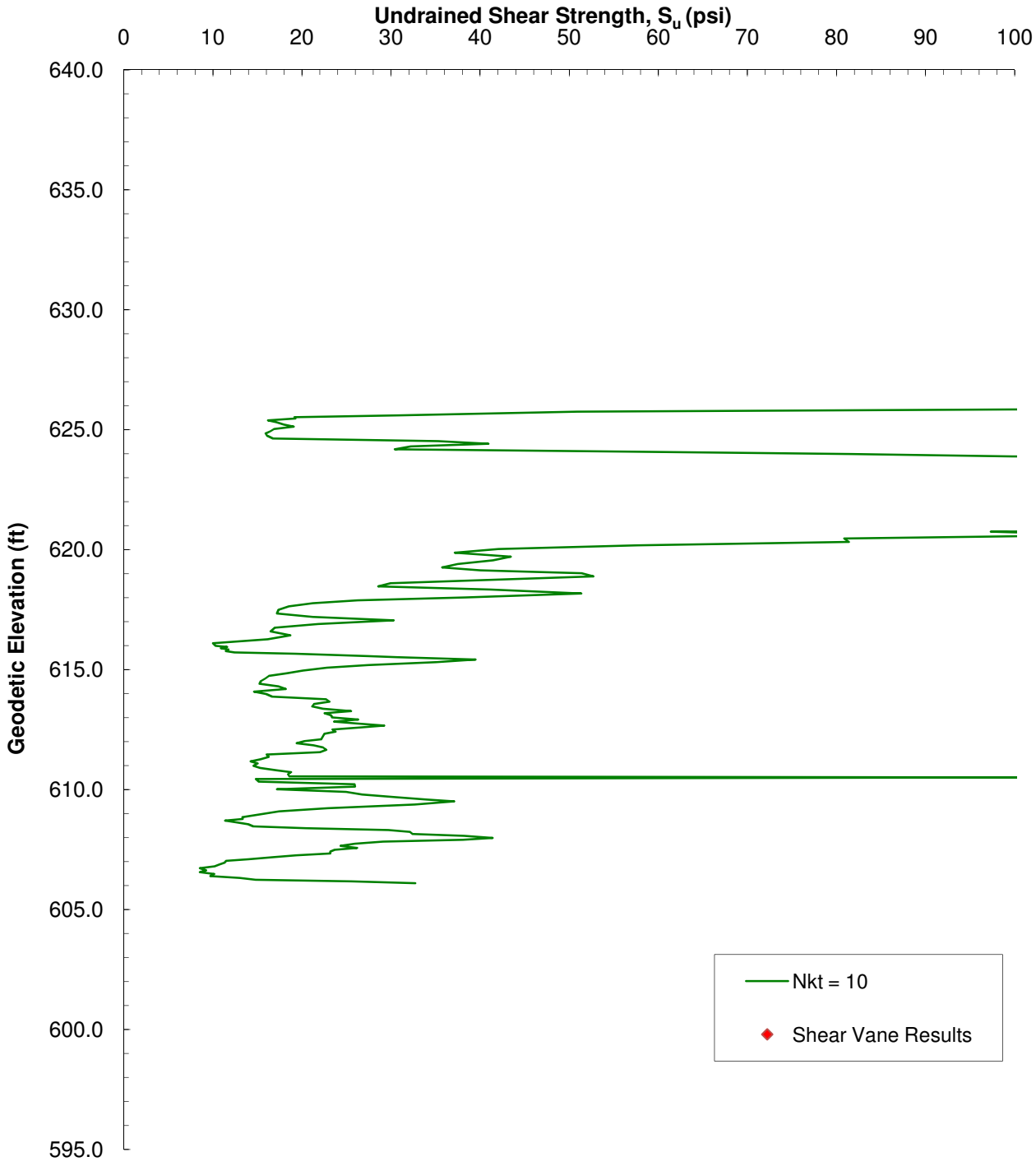


Project No. 175569036

CPT10

SCPTu RESULTS

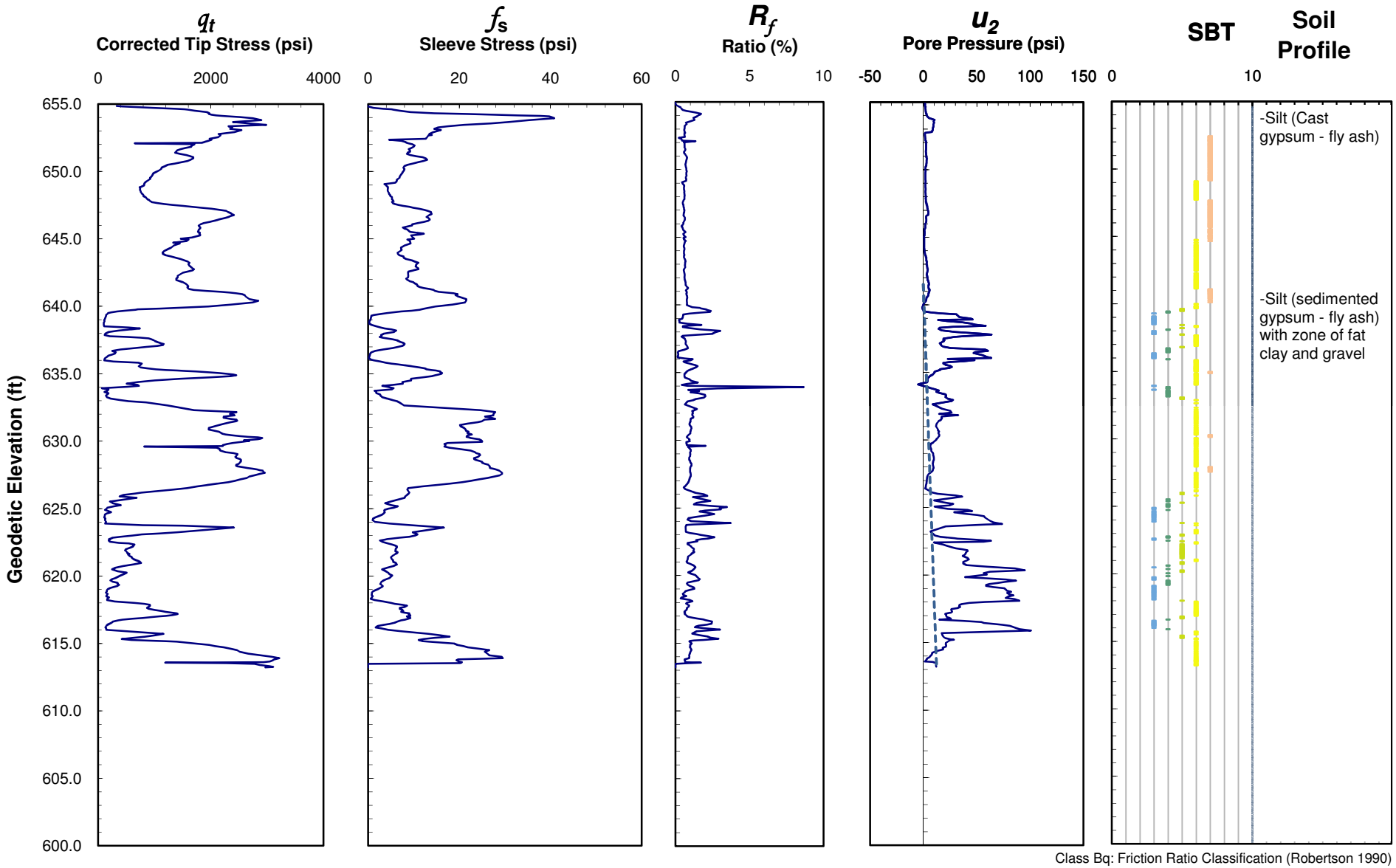
Undrained Shear Strength, S_u



Project No. 175569036

CPT10

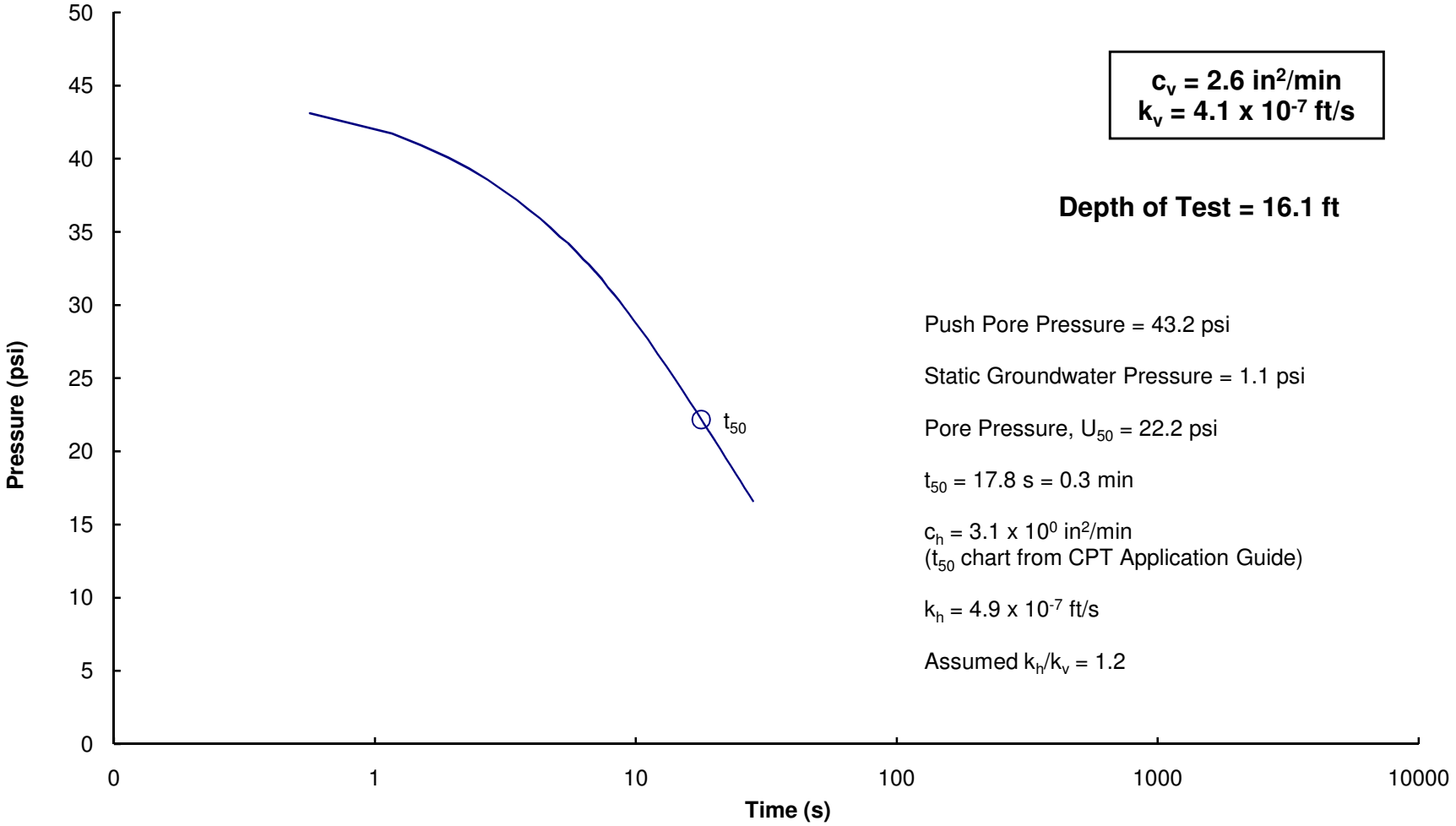
Stantec Consulting Inc.	Elevation: 655.00 ft SCPTu Start Elevation: 655.00 ft Groundwater Elevation: 641.50 ft	Test Date: July 30, 2009 Project No. 175569036	CPT11
	Client: TVA Project: Widows Creek Main Gypsum Stack		



Class Bq: Friction Ratio Classification (Robertson 1990)

Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = 2.6 in^2/min
k_v = 4.1 x 10^{-7} ft/s

Depth of Test = 16.1 ft

Push Pore Pressure = 43.2 psi

Static Groundwater Pressure = 1.1 psi

Pore Pressure, U_{50} = 22.2 psi

t_{50} = 17.8 s = 0.3 min

c_h = 3.1 x 10^0 in^2/min
(t_{50} chart from CPT Application Guide)

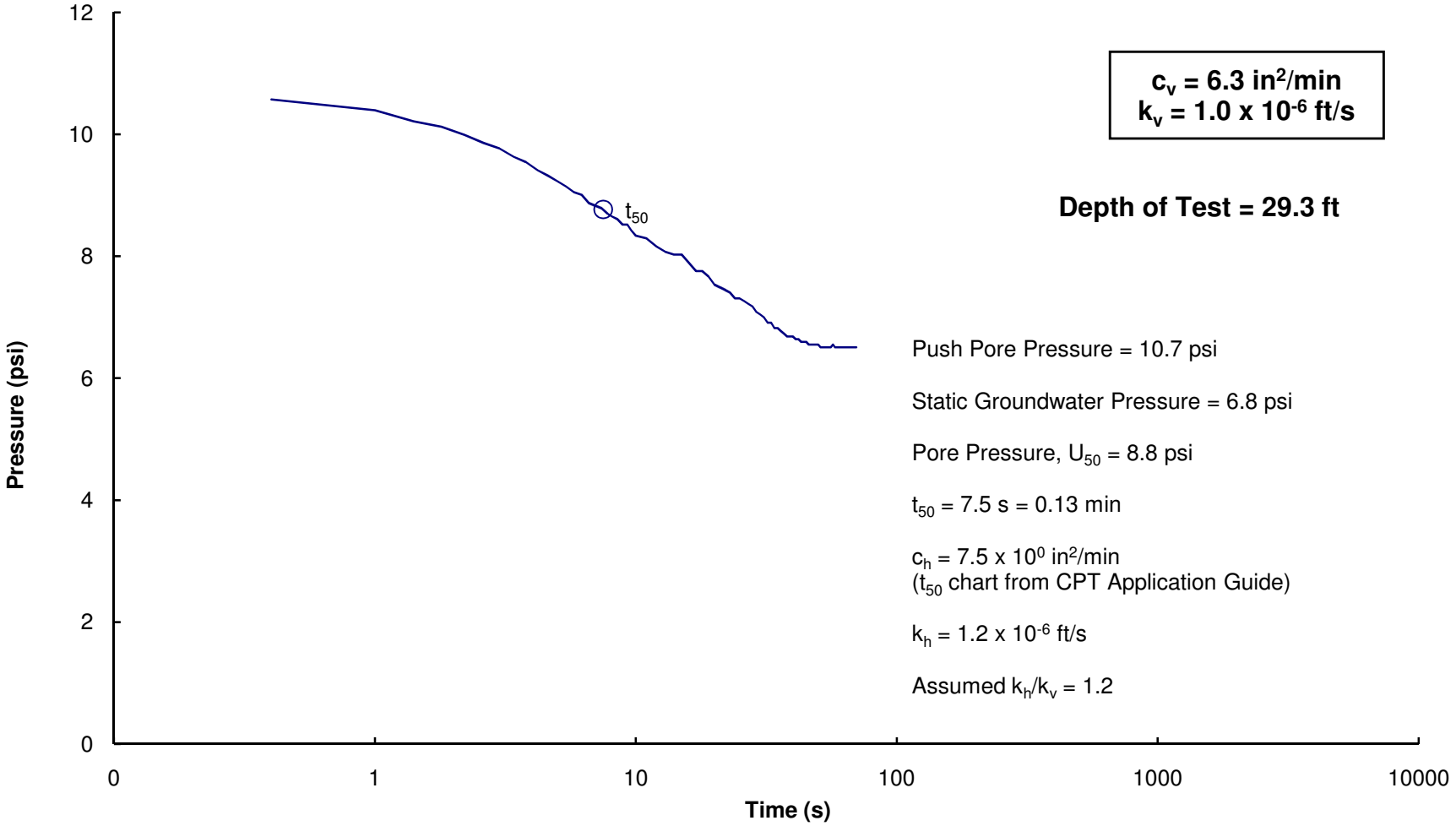
k_h = 4.9 x 10^{-7} ft/s

Assumed k_h/k_v = 1.2

Project No. 175569036
CPT11

Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = 6.3 in^2/min
k_v = 1.0 x 10^{-6} ft/s

Depth of Test = 29.3 ft

Push Pore Pressure = 10.7 psi

Static Groundwater Pressure = 6.8 psi

Pore Pressure, U_{50} = 8.8 psi

t_{50} = 7.5 s = 0.13 min

c_h = 7.5 x 10^0 in^2/min
(t_{50} chart from CPT Application Guide)

k_h = 1.2 x 10^{-6} ft/s

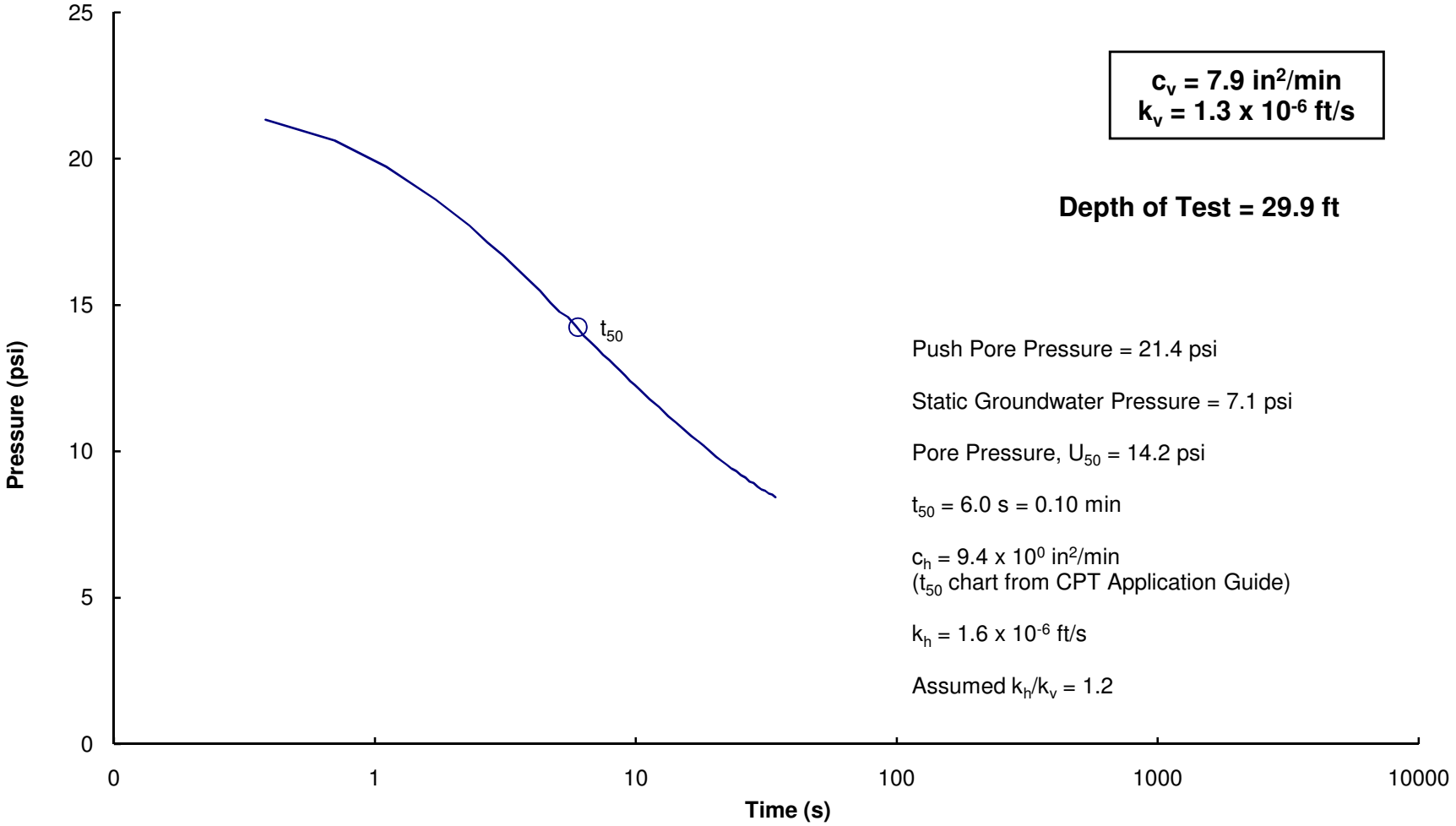
Assumed k_h/k_v = 1.2

Project No. 175569036
CPT11

C:\anderson\CPT11.xlsm

Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = 7.9 in^2/min
k_v = 1.3 x 10^{-6} ft/s

Depth of Test = 29.9 ft

Push Pore Pressure = 21.4 psi

Static Groundwater Pressure = 7.1 psi

Pore Pressure, U_{50} = 14.2 psi

t_{50} = 6.0 s = 0.10 min

c_h = 9.4 x 10^0 in^2/min
(t_{50} chart from CPT Application Guide)

k_h = 1.6 x 10^{-6} ft/s

Assumed k_h/k_v = 1.2

Project No. 175569036
CPT11

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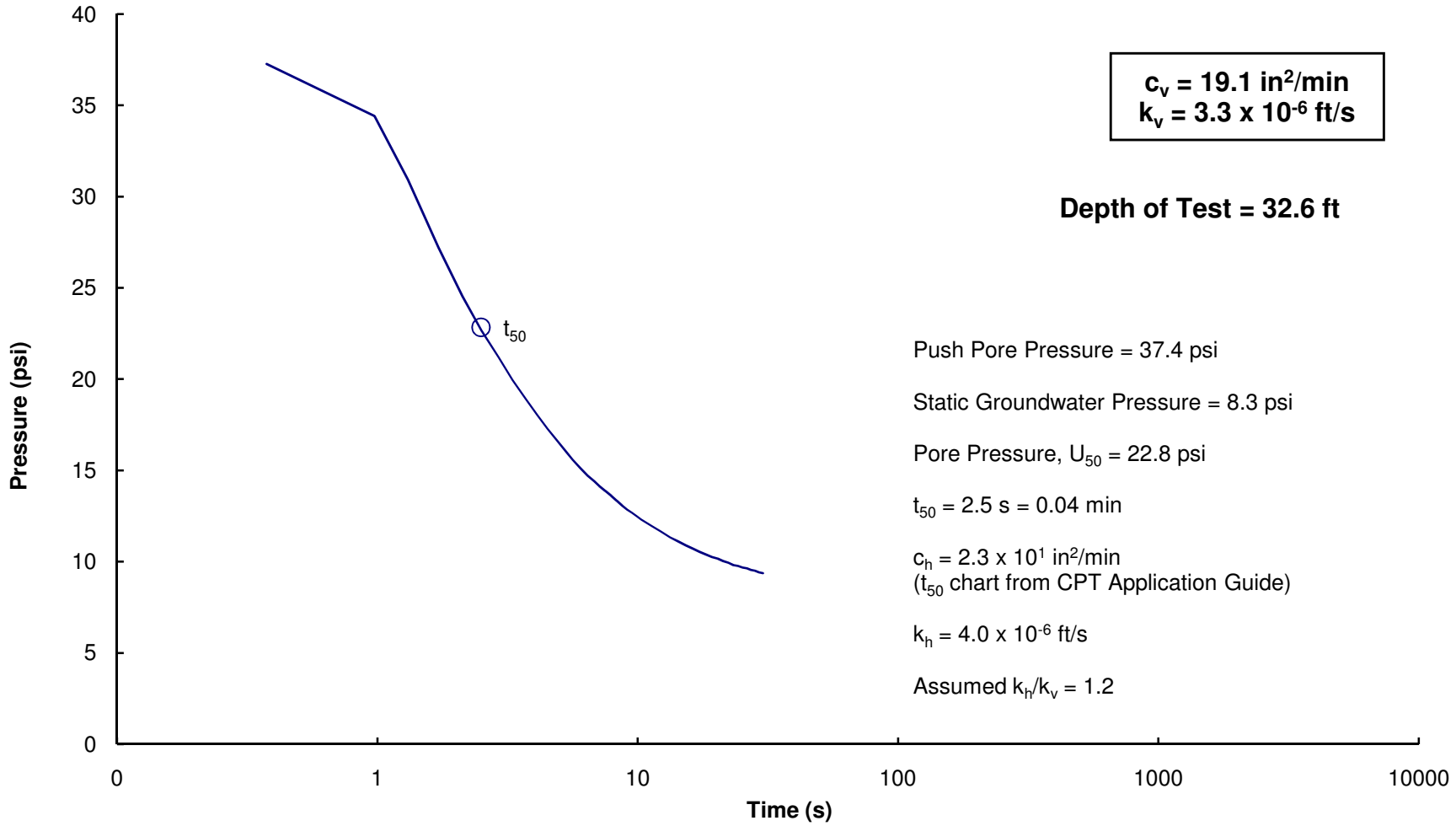
Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = 19.1 in^2/min
k_v = 3.3 x 10^{-6} ft/s

Depth of Test = 32.6 ft

Push Pore Pressure = 37.4 psi

Static Groundwater Pressure = 8.3 psi

Pore Pressure, U_{50} = 22.8 psi

t_{50} = 2.5 s = 0.04 min

c_h = 2.3 x 10^1 in^2/min
(t_{50} chart from CPT Application Guide)

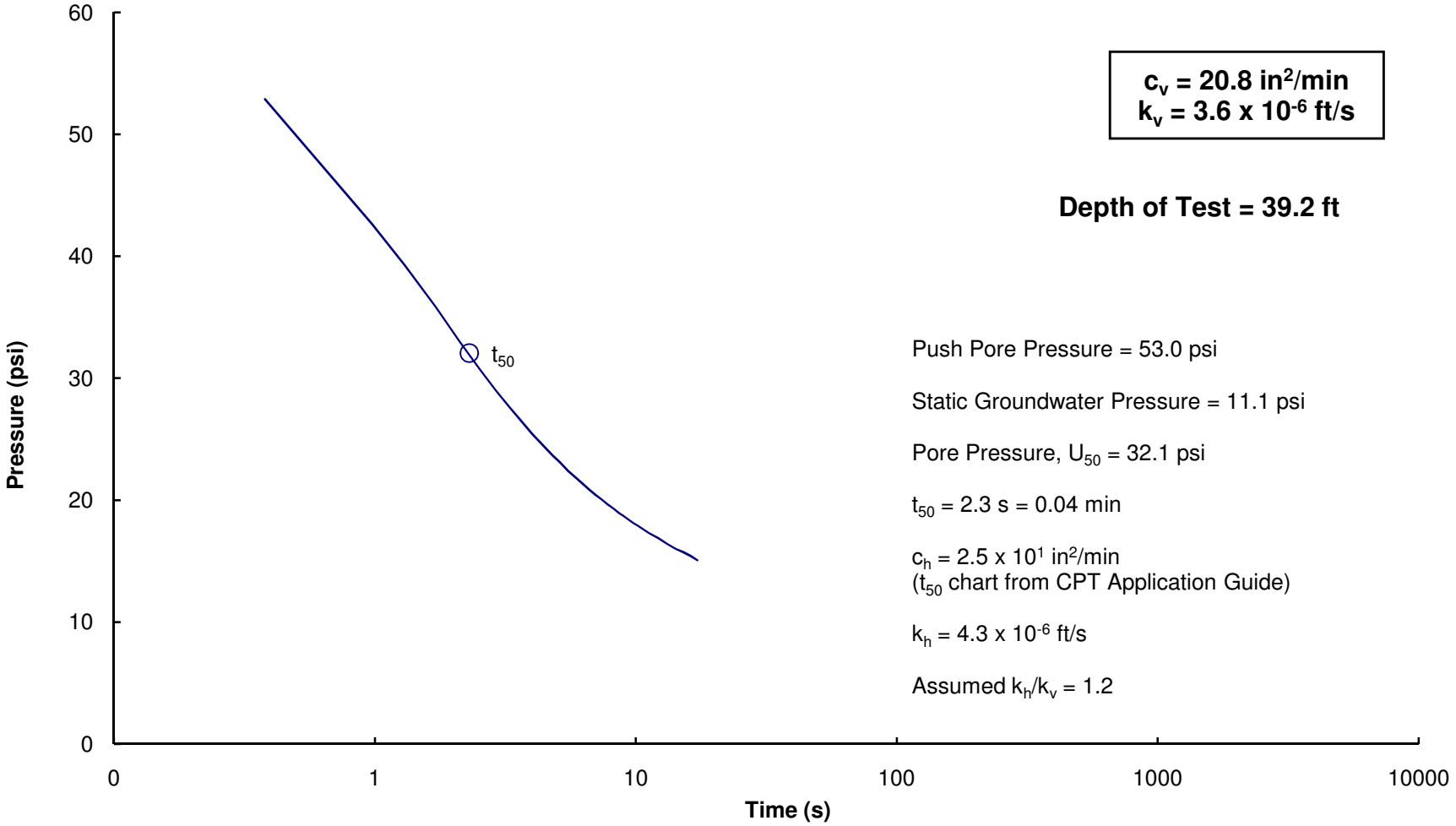
k_h = 4.0 x 10^{-6} ft/s

Assumed k_h/k_v = 1.2

Project No. 175569036
CPT11

Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = 20.8 in^2/min
k_v = 3.6 x 10^{-6} ft/s

Depth of Test = 39.2 ft

Push Pore Pressure = 53.0 psi

Static Groundwater Pressure = 11.1 psi

Pore Pressure, U_{50} = 32.1 psi

t_{50} = 2.3 s = 0.04 min

c_h = 2.5 x 10^1 in^2/min
(t_{50} chart from CPT Application Guide)

k_h = 4.3 x 10^{-6} ft/s

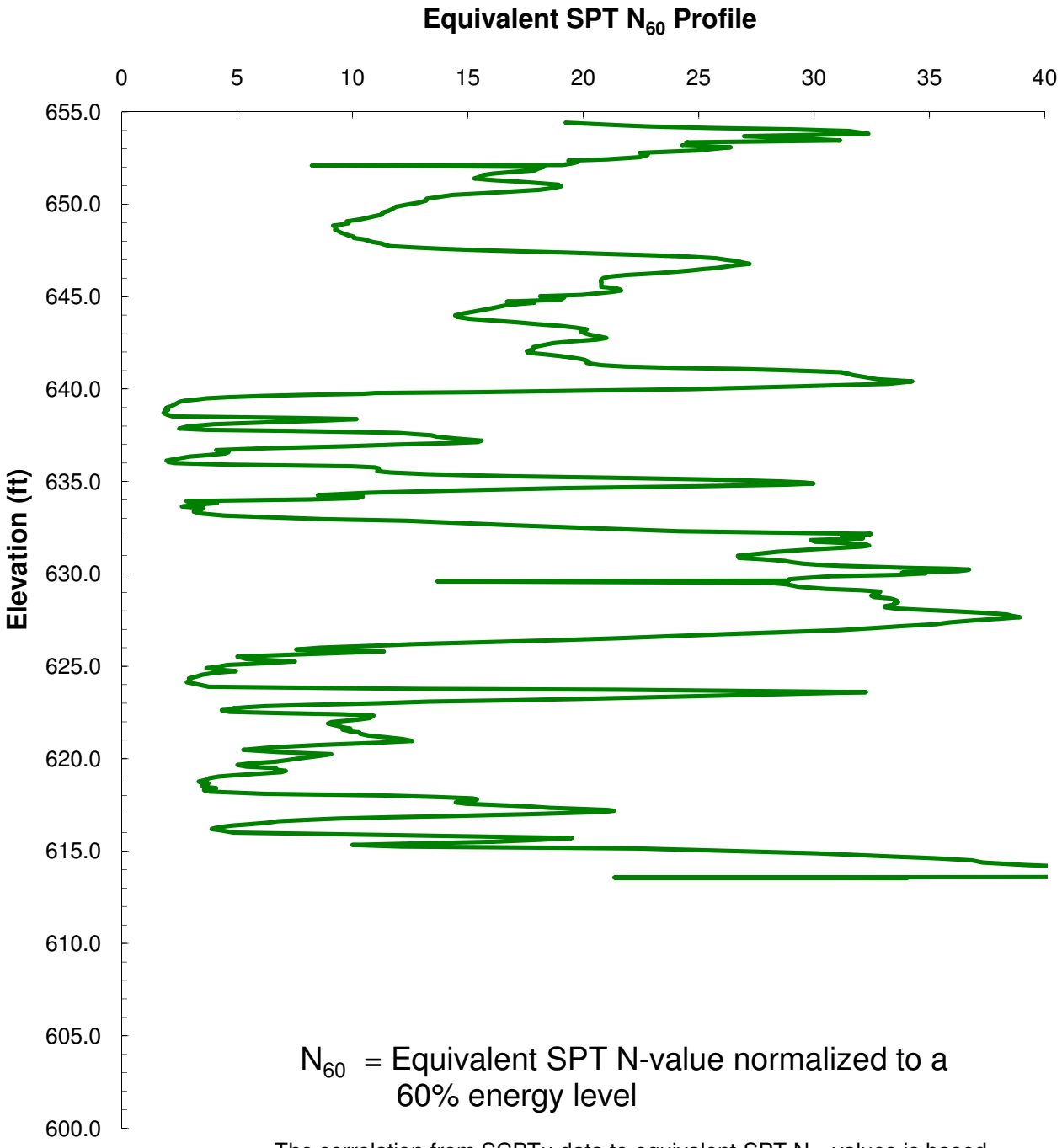
Assumed k_h/k_v = 1.2

Project No. 175569036
CPT11

C:\anderson\CPT11.xlsm

SCPTu Results

SCPTu N_{60} Values



N_{60} = Equivalent SPT N-value normalized to a 60% energy level

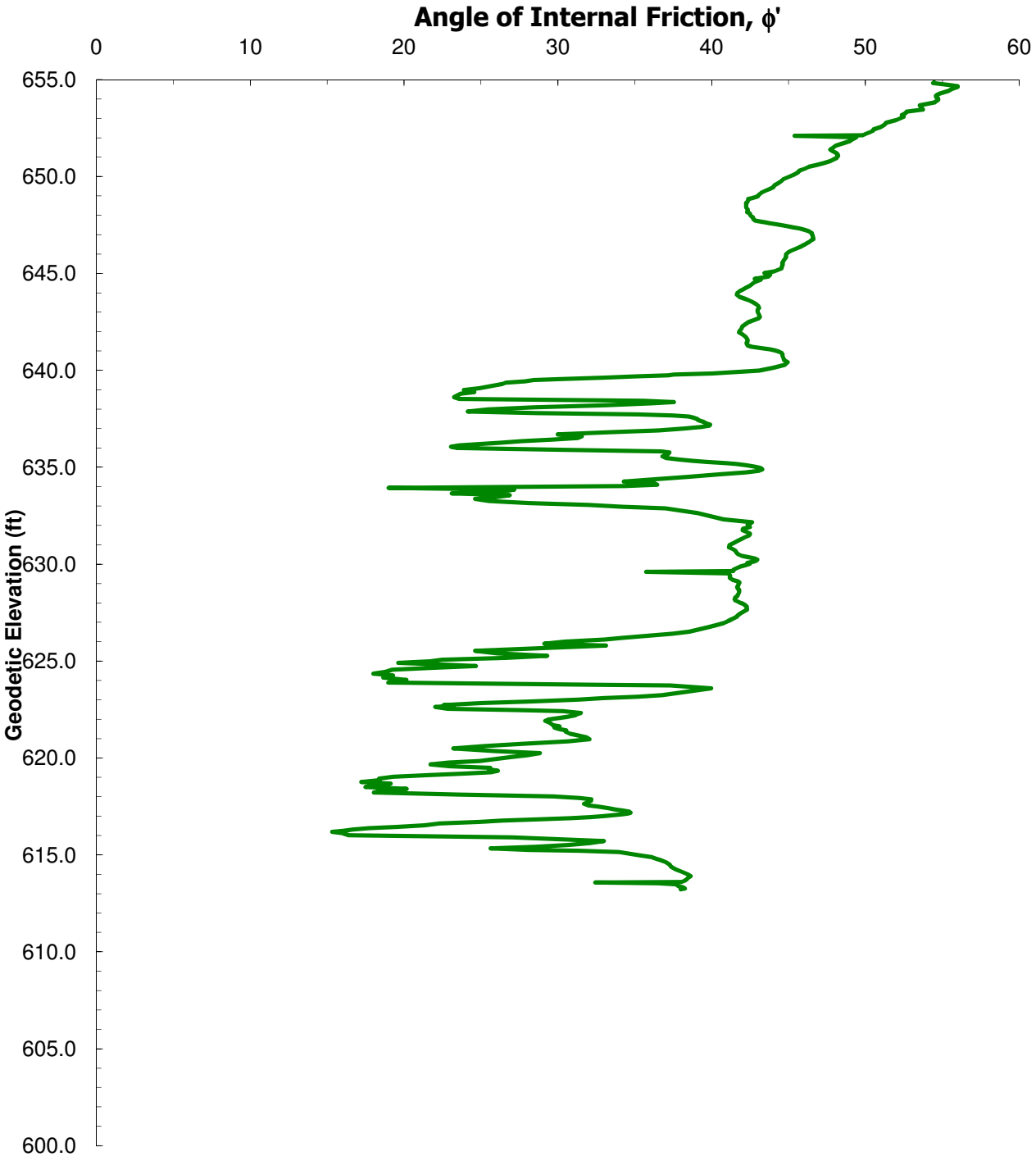
The correlation from SCPTu data to equivalent SPT N_{60} values is based on the Jefferies and Davies (1993) approach.

Project No. 175569036

CPT11

SCPTu RESULTS

Effective Angle of Internal Friction

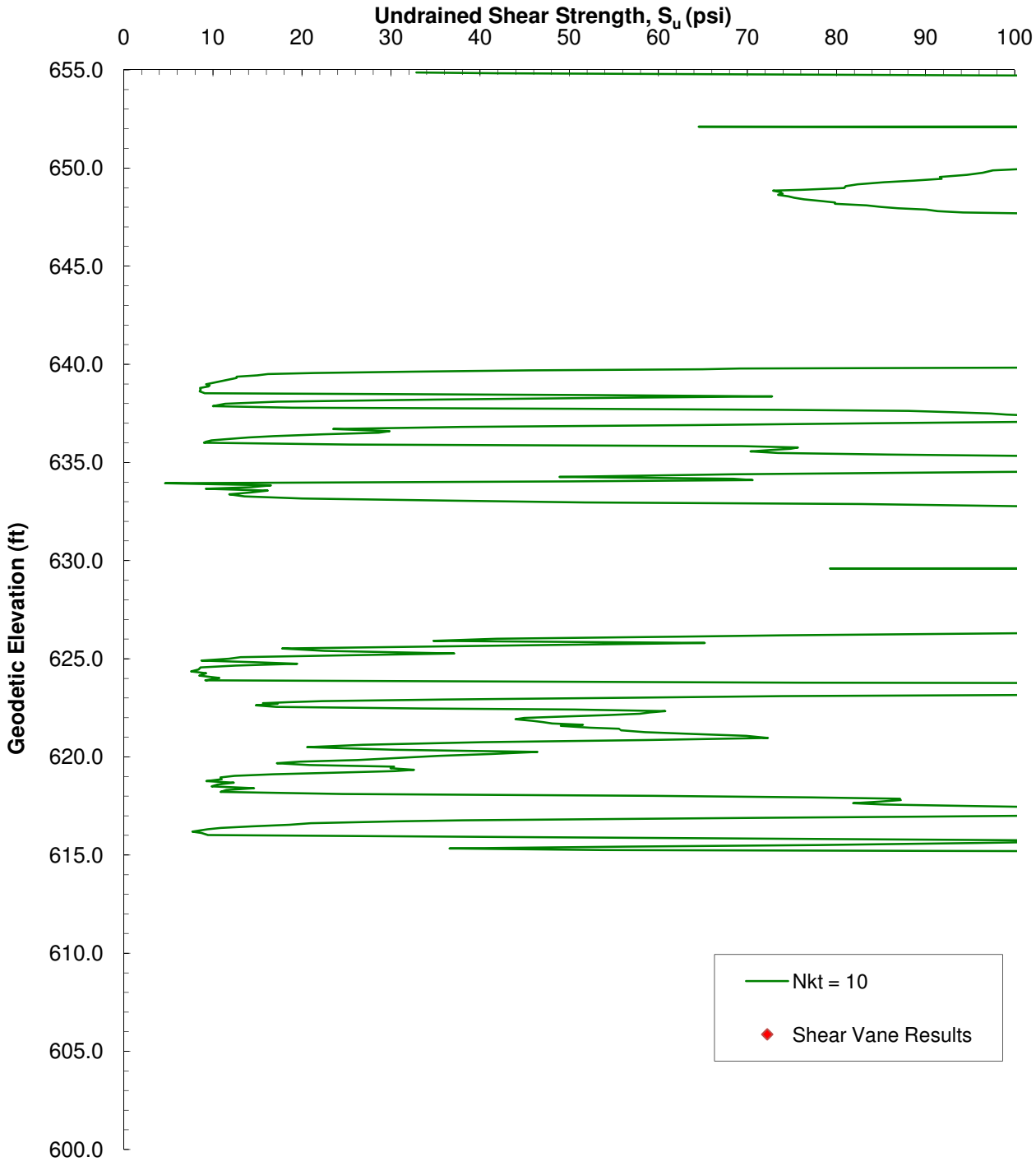


Project No. 175569036

CPT11

SCPTu RESULTS

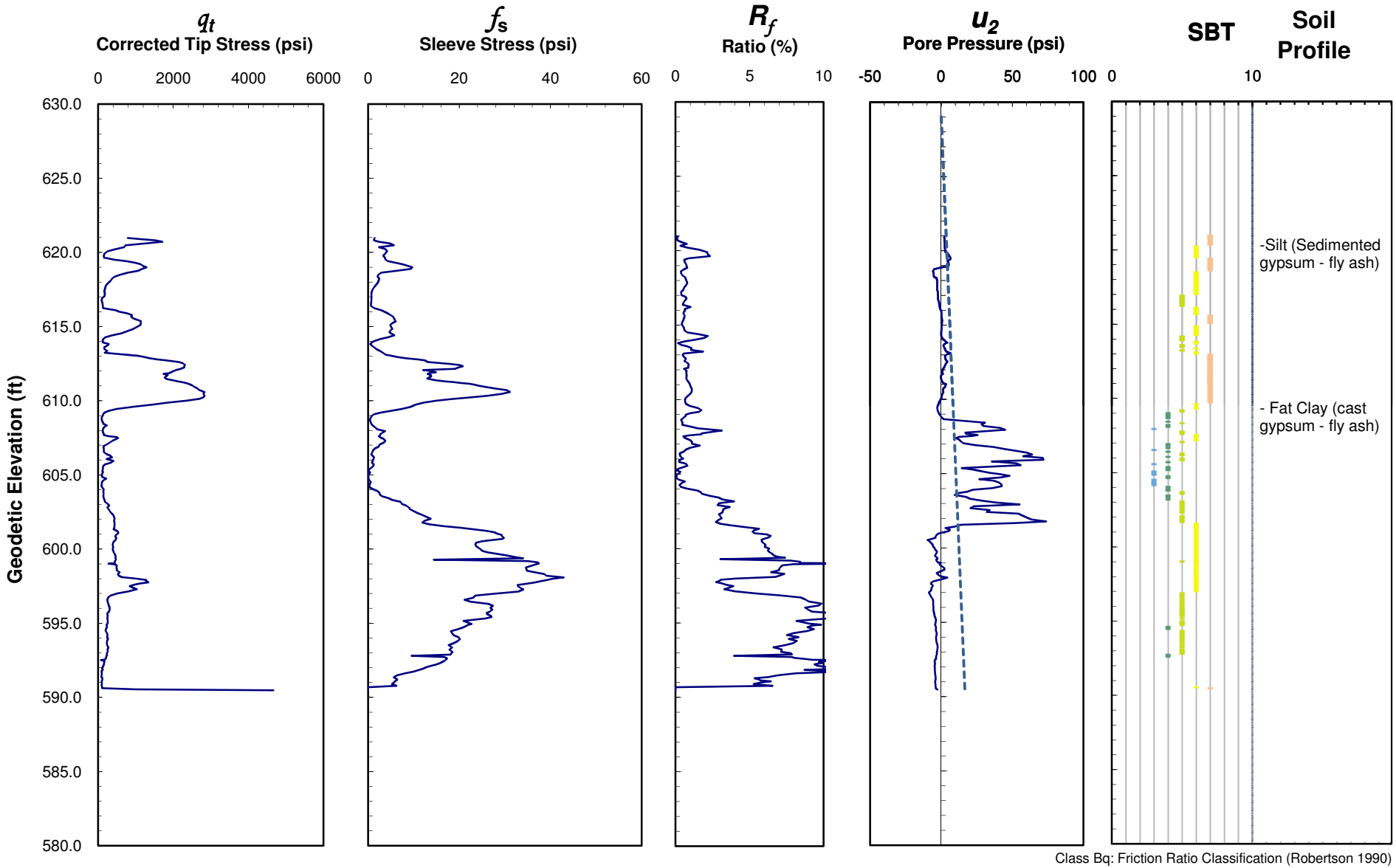
Undrained Shear Strength, S_u



Project No. 175569036

CPT11

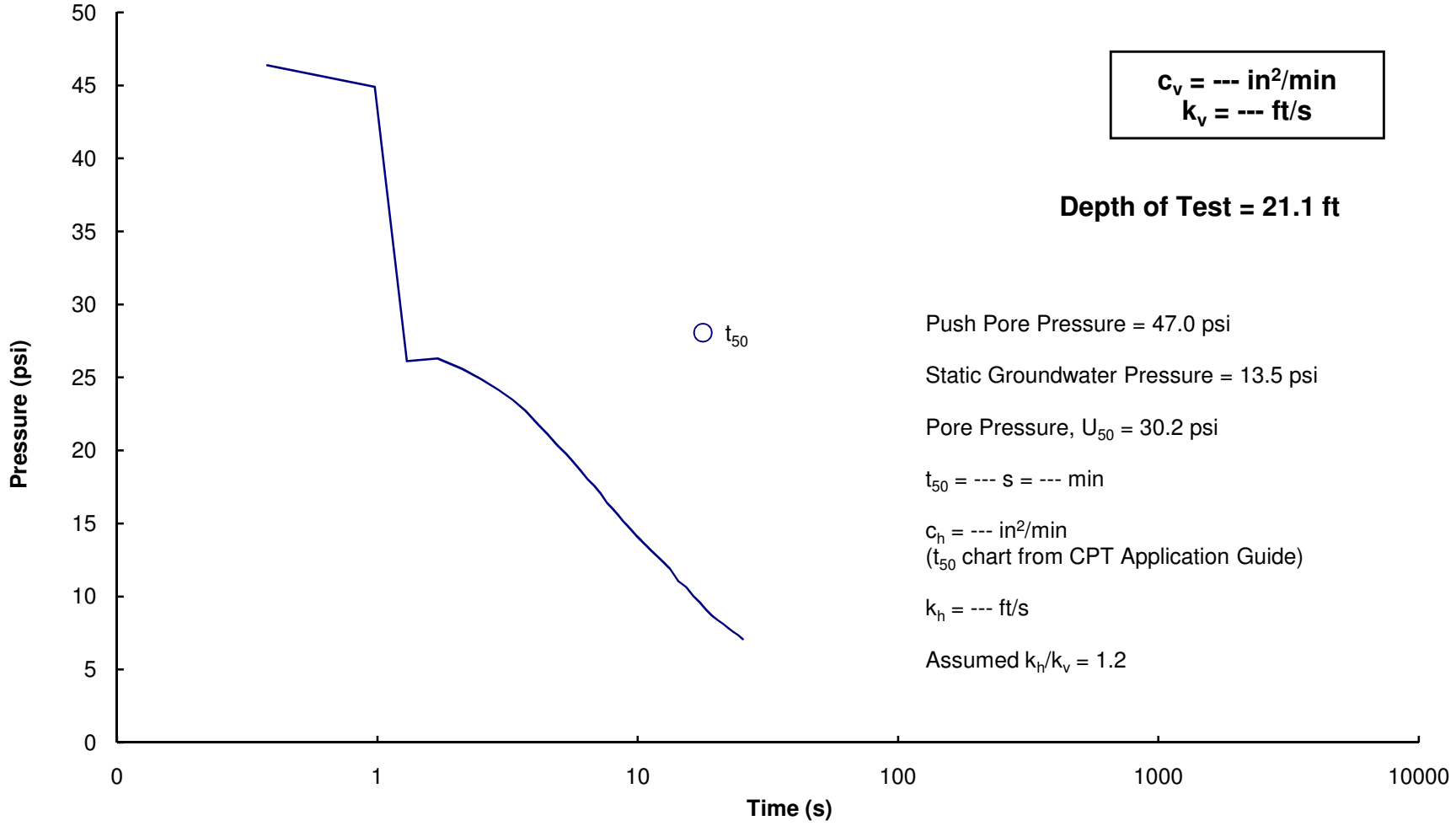
Stantec Consulting Inc.	Elevation: 629.00 ft SCPTu Start Elevation: 621.00 ft Groundwater Elevation: 629.00 ft	Test Date: July 30, 2009 Project No. 175569036	CPT12
	Client: TVA Project: Widows Creek Main Gypsum Stack		



Class Bq: Friction Ratio Classification (Robertson 1990)

Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = --- in²/min
k_v = --- ft/s

Depth of Test = 21.1 ft

Push Pore Pressure = 47.0 psi

Static Groundwater Pressure = 13.5 psi

Pore Pressure, U_{50} = 30.2 psi

t_{50} = --- s = --- min

c_h = --- in²/min
(t_{50} chart from CPT Application Guide)

k_h = --- ft/s

Assumed k_h/k_v = 1.2

Project No. 175569036
CPT12

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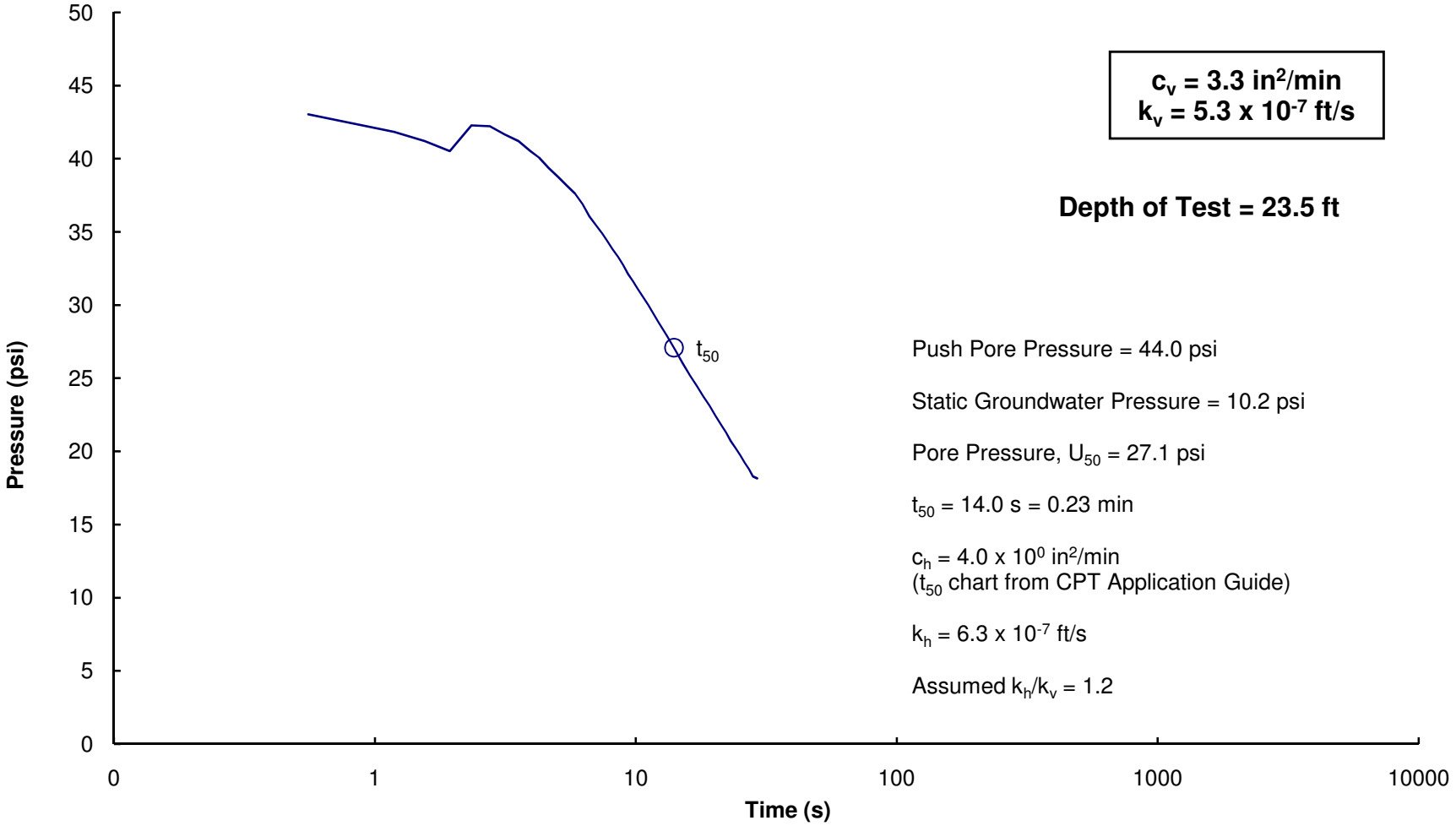
Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = 3.3 in^2/min
k_v = 5.3 x 10^{-7} ft/s

Depth of Test = 23.5 ft

Push Pore Pressure = 44.0 psi

Static Groundwater Pressure = 10.2 psi

Pore Pressure, U_{50} = 27.1 psi

t_{50} = 14.0 s = 0.23 min

c_h = 4.0 x 10^0 in^2/min
(t_{50} chart from CPT Application Guide)

k_h = 6.3 x 10^{-7} ft/s

Assumed k_h/k_v = 1.2

Project No. 175569036
CPT12

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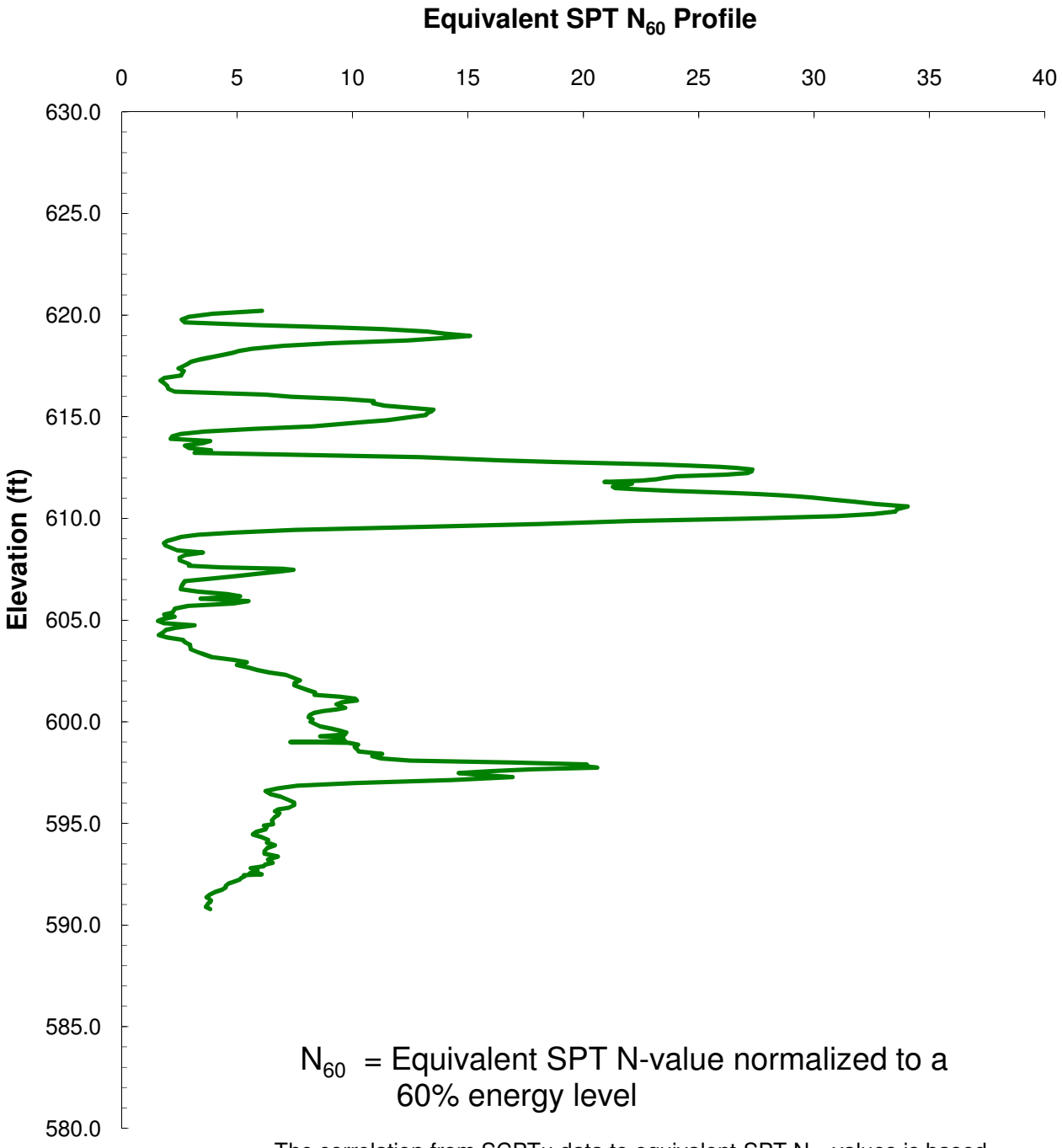
SCPTu Results

SCPTu N_{60} Values



N_{60} = Equivalent SPT N-value normalized to a 60% energy level

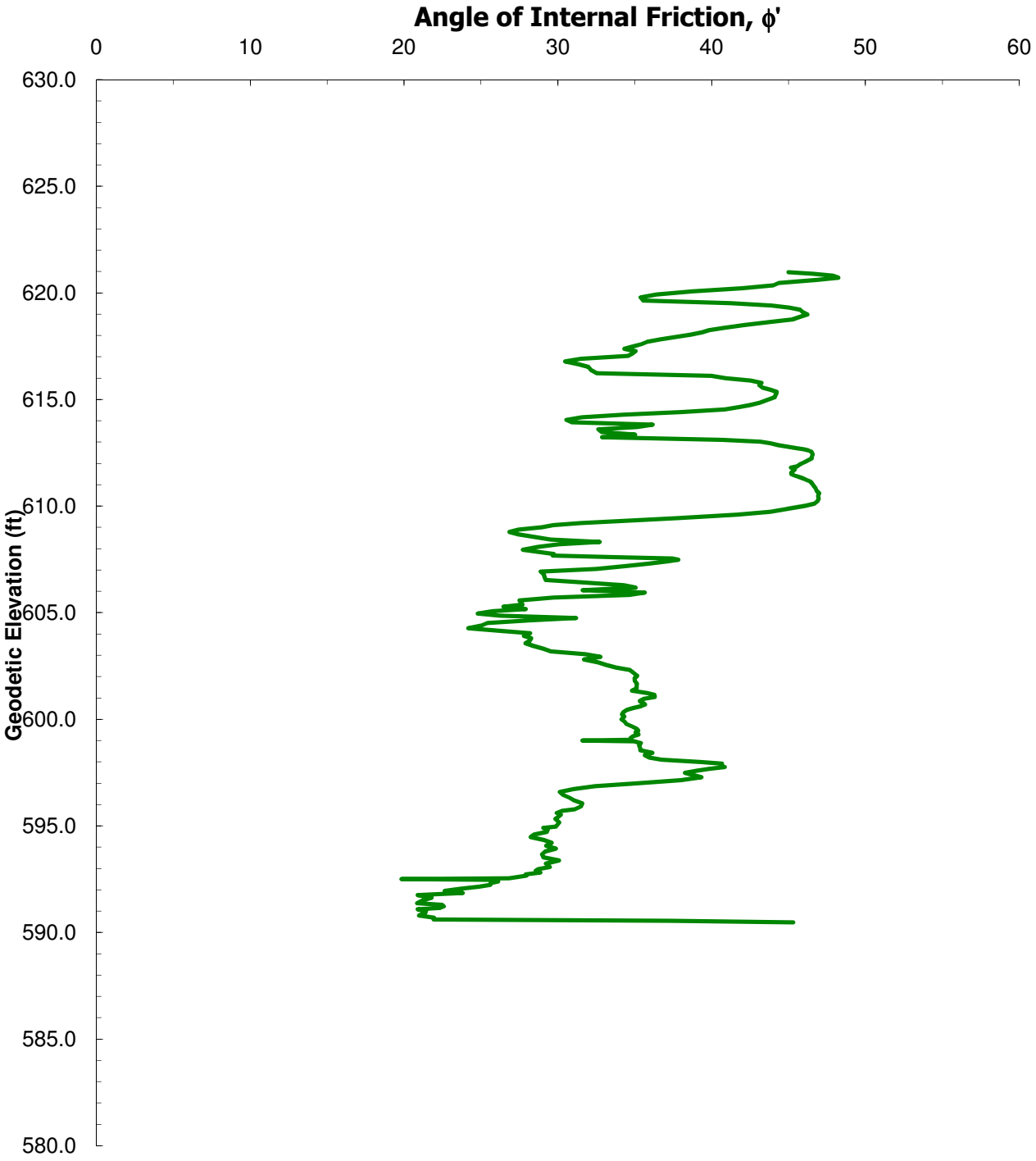
The correlation from SCPTu data to equivalent SPT N_{60} values is based on the Jefferies and Davies (1993) approach.

Project No. 175569036

CPT12

SCPTu RESULTS

Effective Angle of Internal Friction

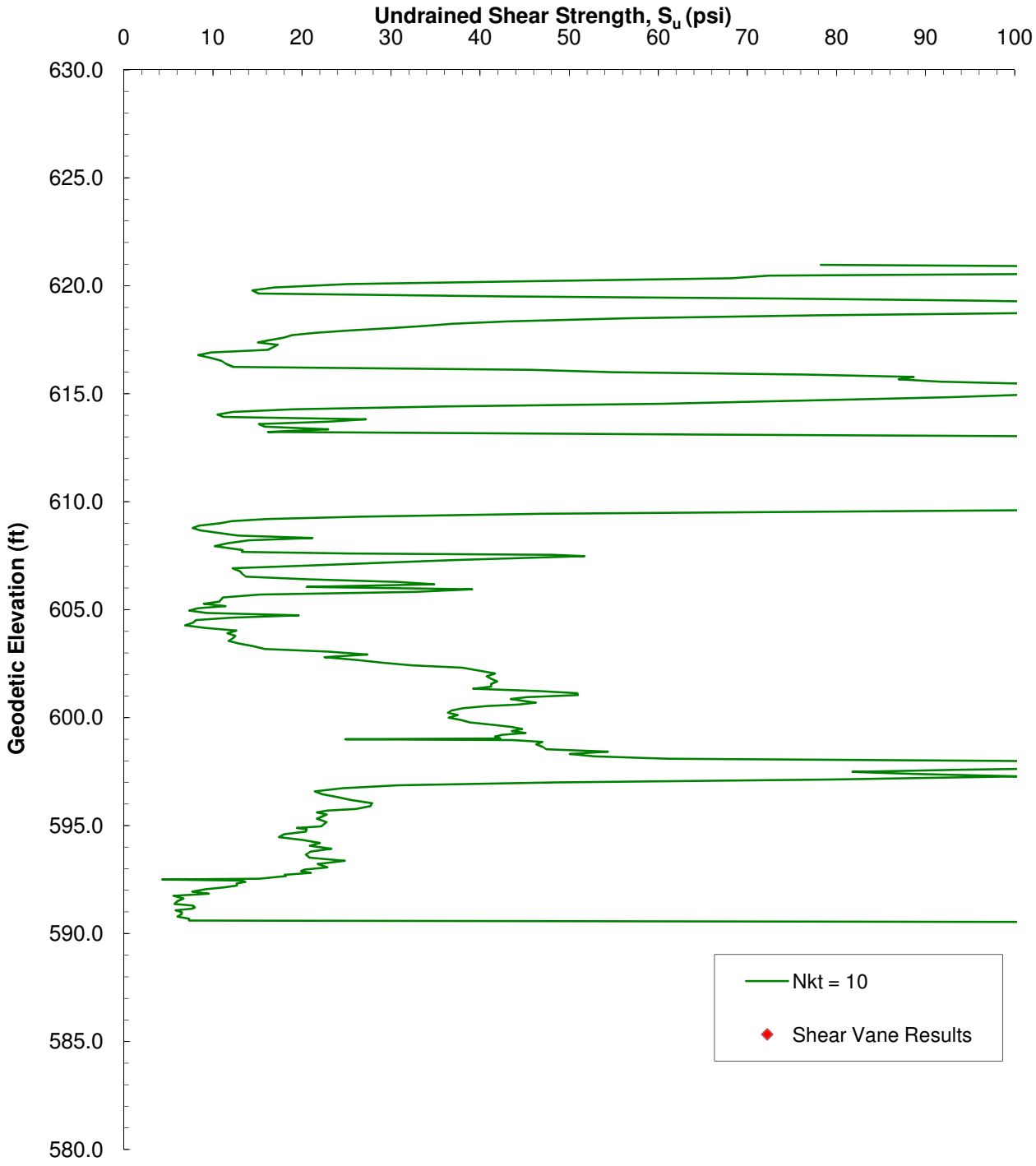


Project No. 175569036

CPT12

SCPTu RESULTS

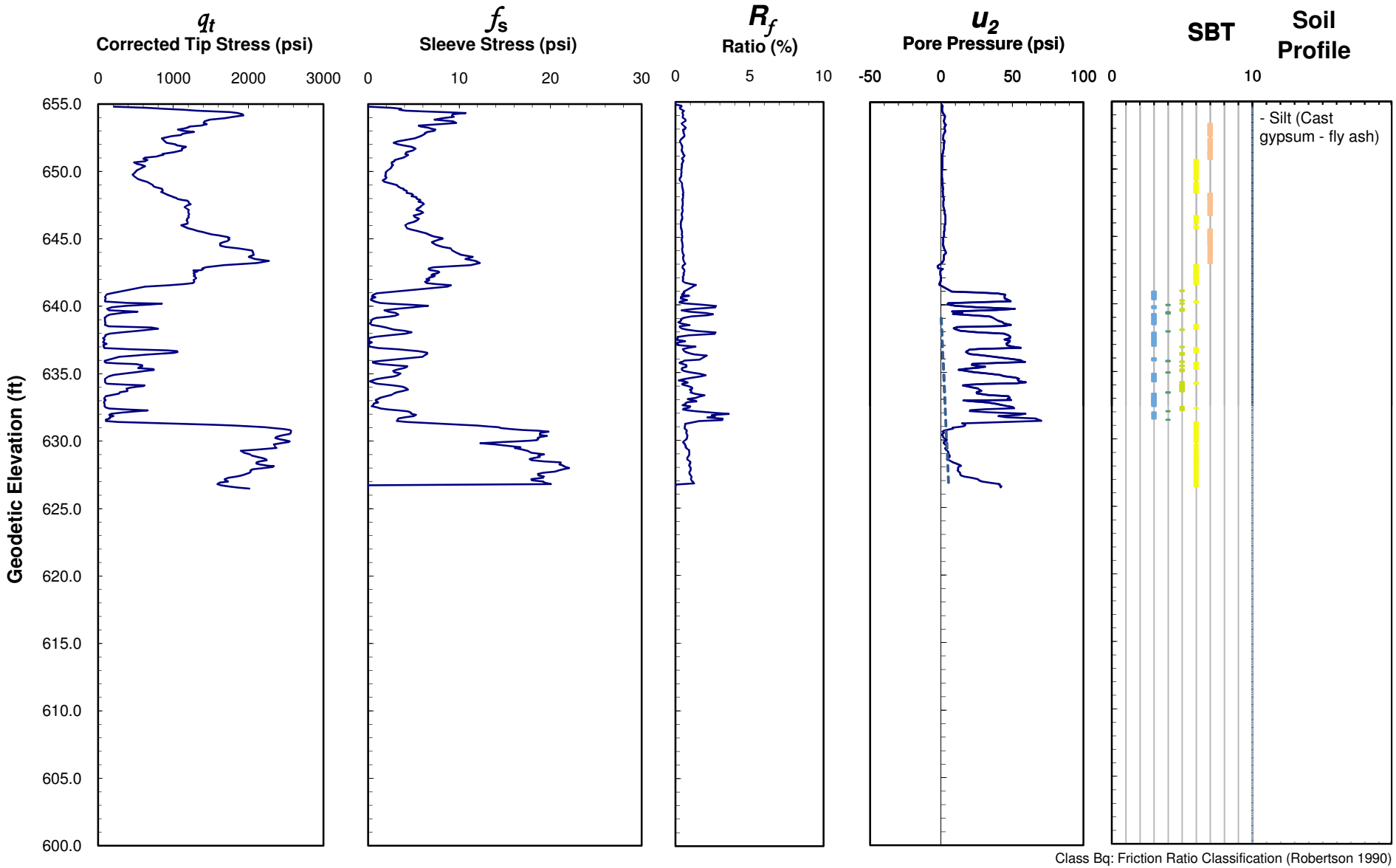
Undrained Shear Strength, S_u



Project No. 175569036

CPT12

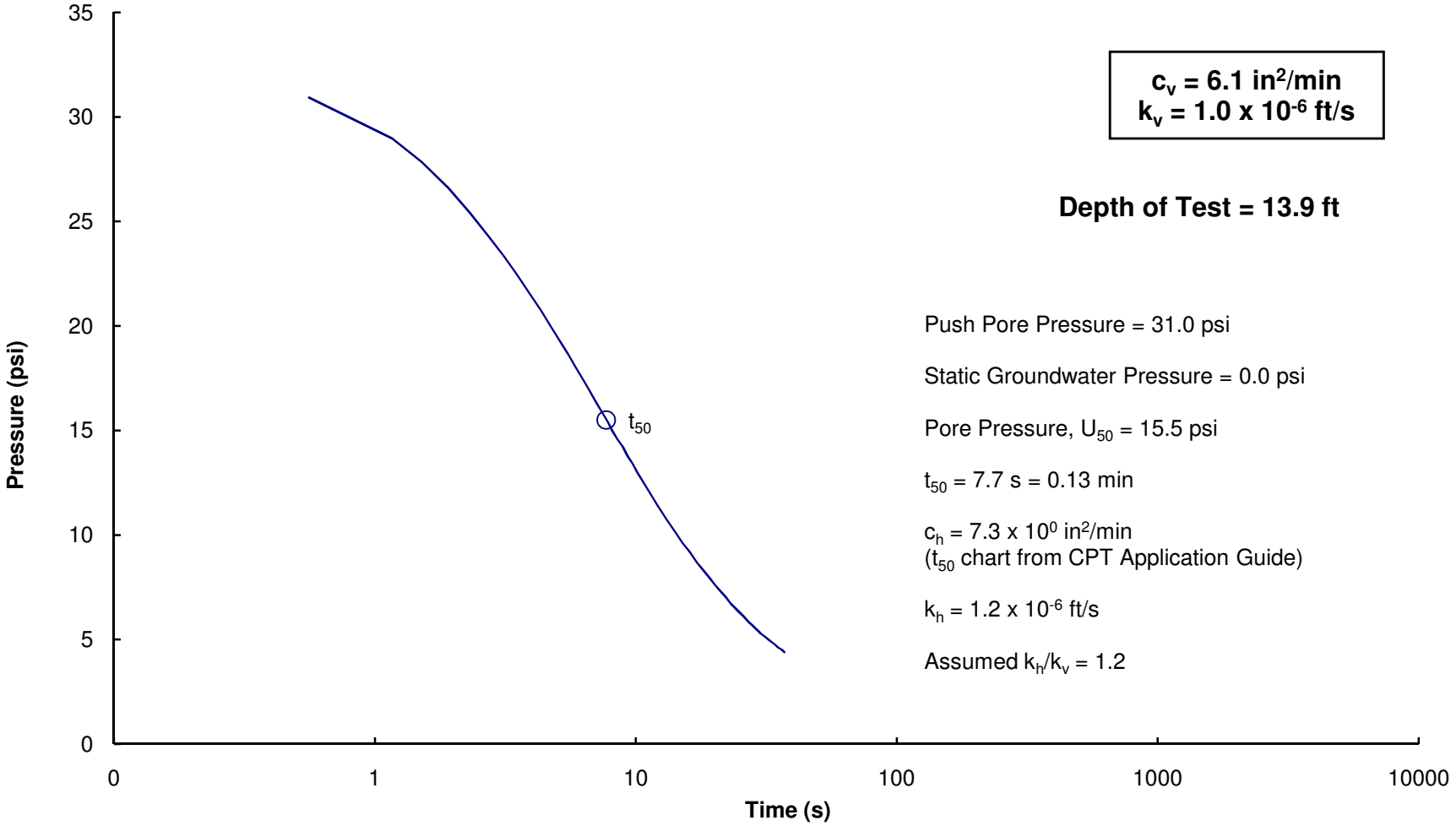
Stantec Consulting Inc.	Elevation: 655.00 ft SCPTu Start Elevation: 655.00 ft Groundwater Elevation: 639.00 ft	Test Date: July 30, 2009 Project No. 175569036	CPT13
	Client: TVA Project: Widows Creek Main Gypsum Stack		



Class Bq: Friction Ratio Classification (Robertson 1990)

Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = 6.1 in^2/min
k_v = 1.0 x 10^{-6} ft/s

Depth of Test = 13.9 ft

Push Pore Pressure = 31.0 psi

Static Groundwater Pressure = 0.0 psi

Pore Pressure, U_{50} = 15.5 psi

t_{50} = 7.7 s = 0.13 min

c_h = 7.3 x 10^0 in^2/min
(t_{50} chart from CPT Application Guide)

k_h = 1.2 x 10^{-6} ft/s

Assumed k_h/k_v = 1.2

Project No. 175569036
CPT13

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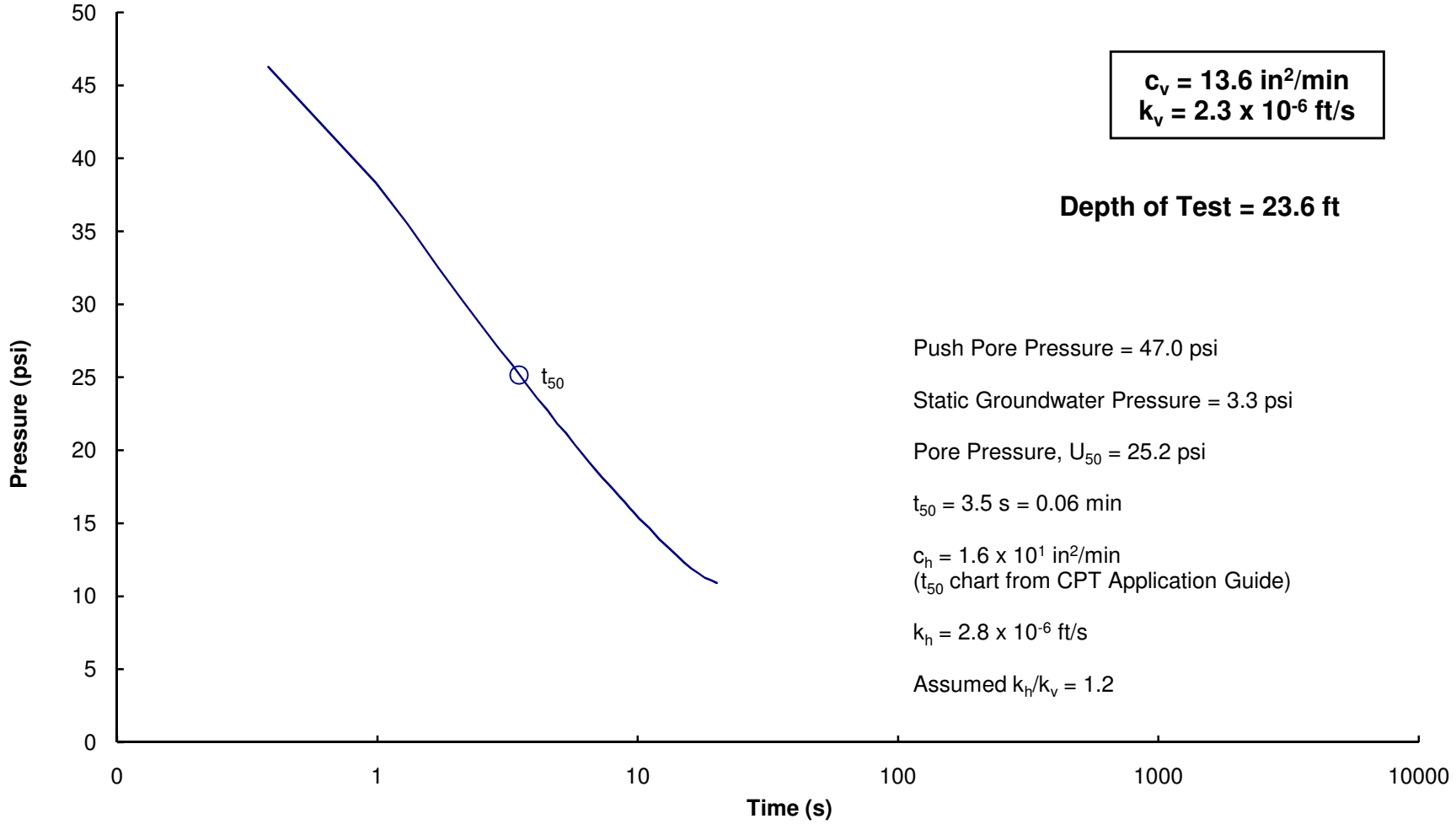
Stantec Consulting Inc.

SCPTu DISSIPATION RESULTS
Coefficient of Consolidation



c_v = 13.6 in^2/min
k_v = 2.3 x 10^{-6} ft/s

Depth of Test = 23.6 ft

Push Pore Pressure = 47.0 psi

Static Groundwater Pressure = 3.3 psi

Pore Pressure, U_{50} = 25.2 psi

t_{50} = 3.5 s = 0.06 min

c_h = 1.6 x 10^1 in^2/min
(t_{50} chart from CPT Application Guide)

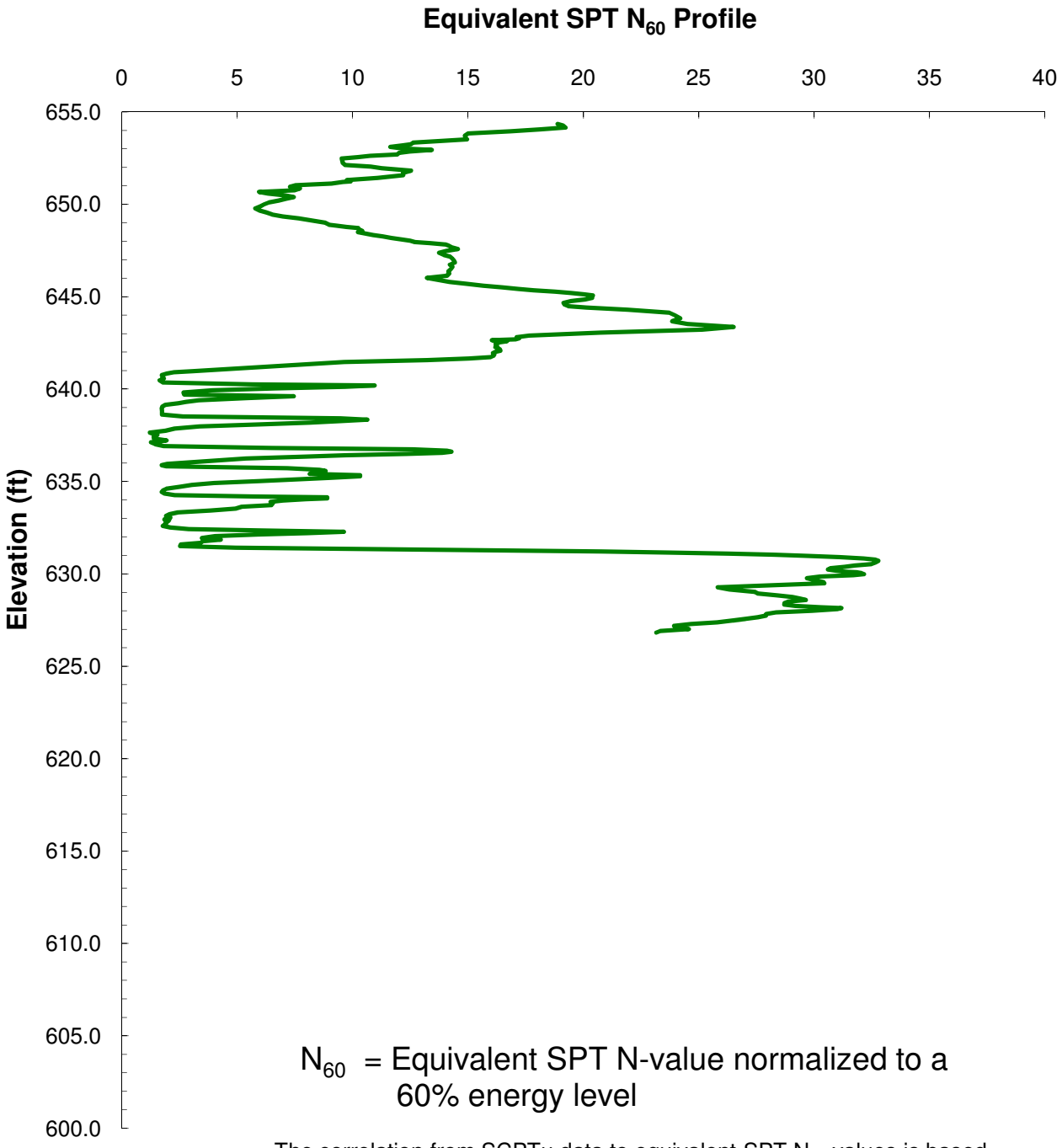
k_h = 2.8 x 10^{-6} ft/s

Assumed k_h/k_v = 1.2

Project No. 175569036
CPT13

SCPTu Results

SCPTu N_{60} Values



N_{60} = Equivalent SPT N-value normalized to a 60% energy level

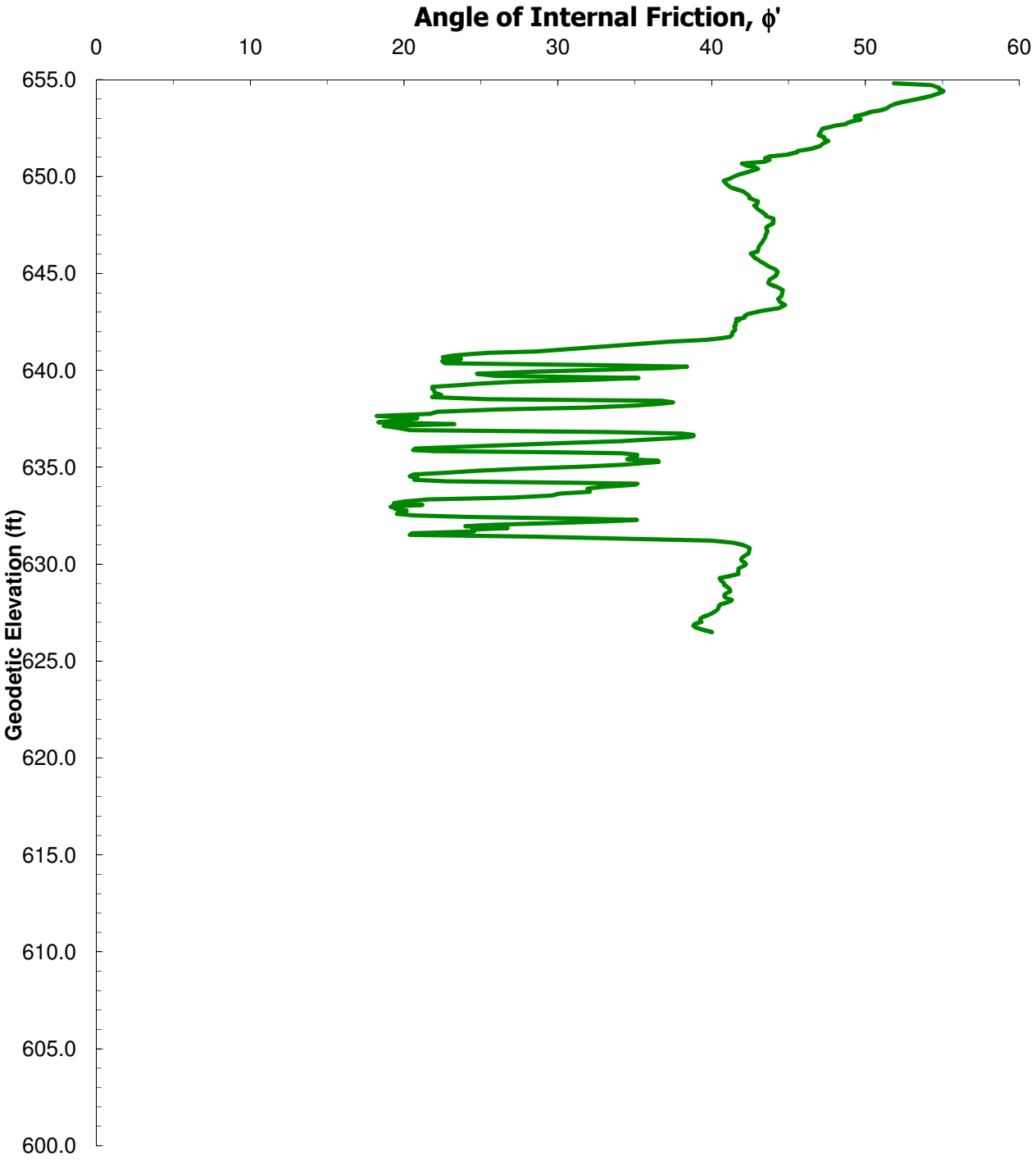
The correlation from SCPTu data to equivalent SPT N_{60} values is based on the Jefferies and Davies (1993) approach.

Project No. 175569036

CPT13

SCPTu RESULTS

Effective Angle of Internal Friction

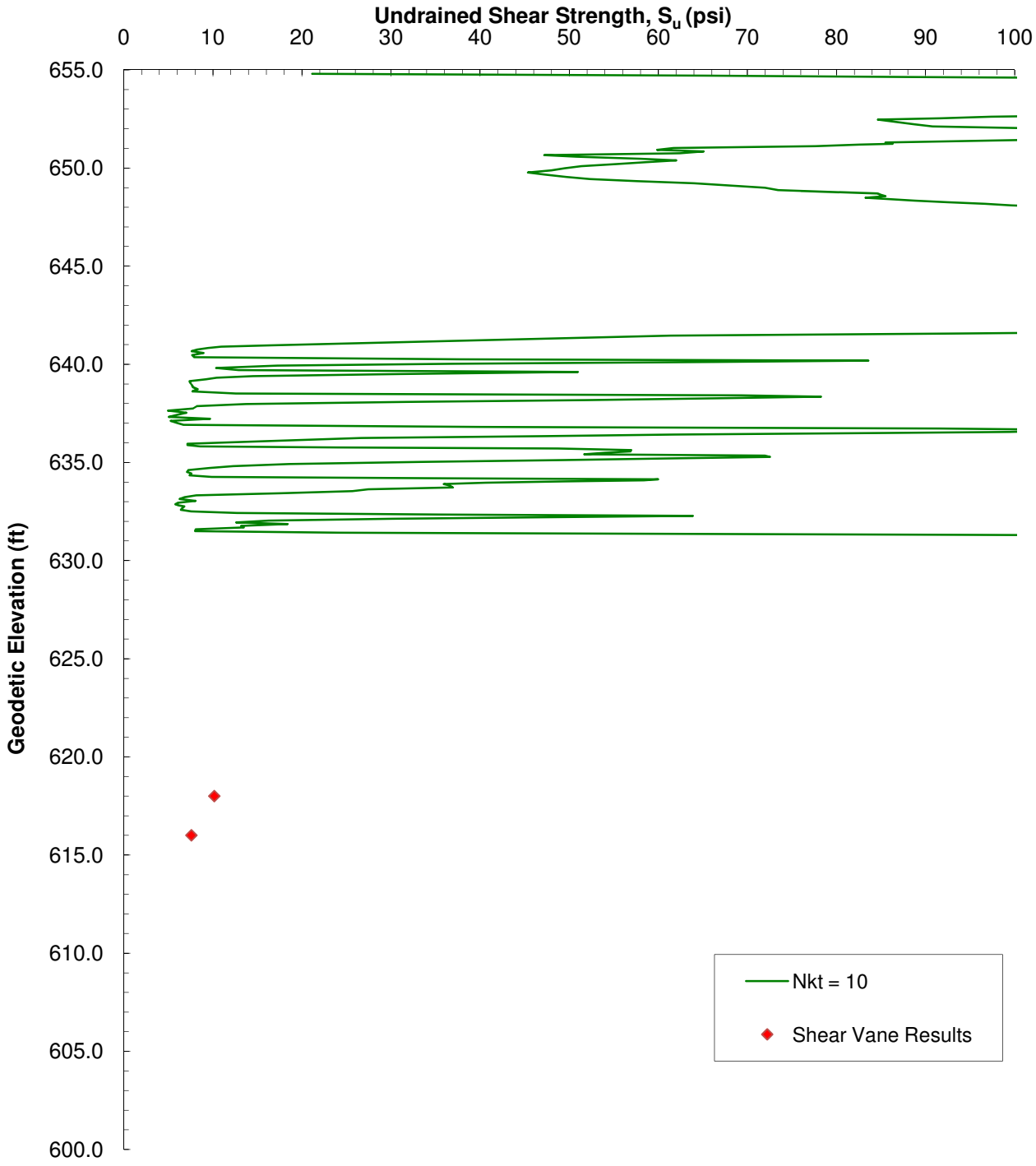


Project No. 175569036

CPT13

SCPTu RESULTS

Undrained Shear Strength, S_u



Project No. 175569036

CPT13

175569039

WCF - Gypsum Stack

Review of Slug Test Data (K_H) vs Laboratory K_V values for Cast Gypsum

K_V from laboratory Falling Head Tests (Cast Gypsum)

*	STN-44	22-24	bgs	$K_V = 3.22 \times 10^{-5}$ cm/s
*	STN-47	35-37	bgs	$K_V = 2.68 \times 10^{-6}$ cm/s

Avg $K_V = 1.74 \times 10^{-5}$ cm/s

K_H values from In-Situ Slug Tests (Cast Gypsum)

	STN-29	$K_H = 1.482\ E-4$ cm/s
	STN-35	$K_H = 4961\ E-4$ cm/s
*	STN-45U	$K_H = 1.977\ E-4$ cm/s
*	STN-48U	$K_H = 1.313\ E-4$ cm/s
*	STN-48L	$K_H = 3.062\ E-4$ cm/s

Avg $K_H = 2.559\ E-4$ cm/s

* Avg $K_H = 2.117\ E-4$ cm/s

Assumes ① & ② from Sedimental Gypsum Calculations

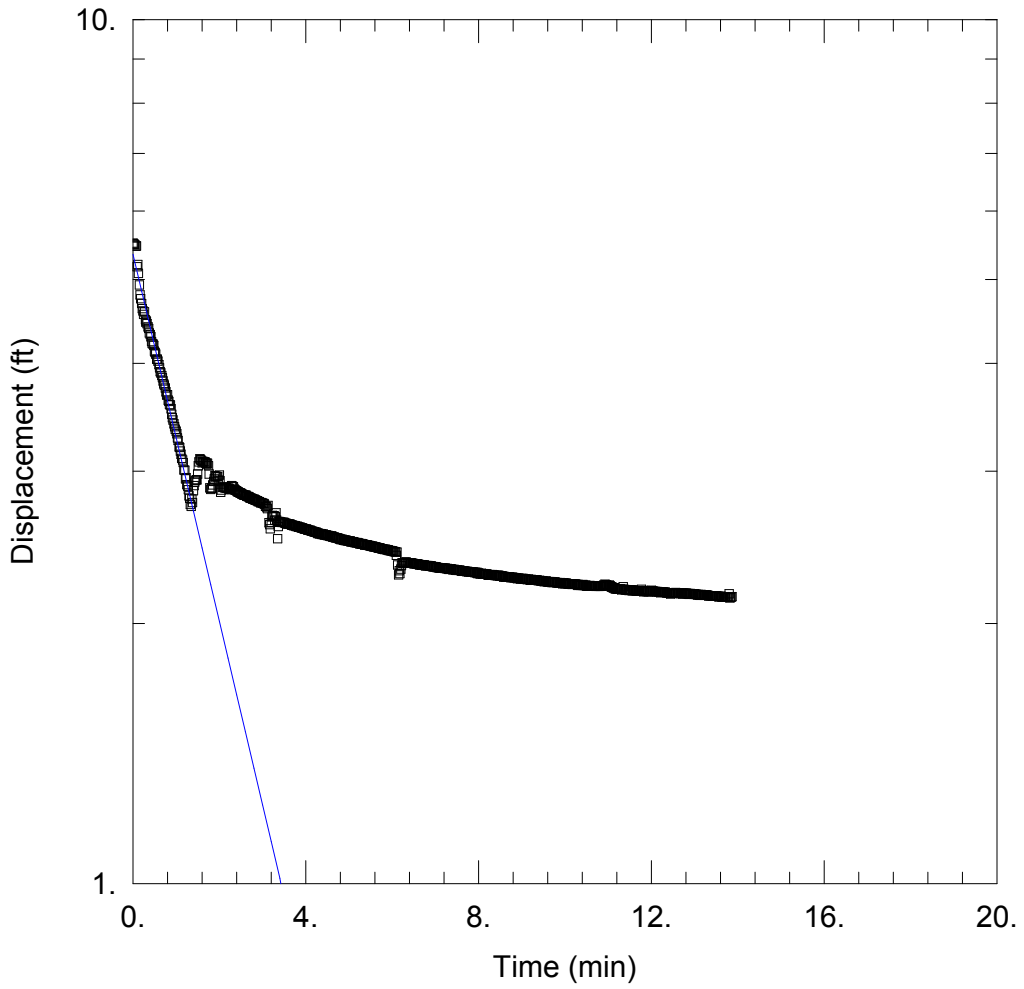
* Denotes borings along west embankment near Section K

If we look at K_H/K_V for west Embankment only

$$K_H/K_V = \frac{2.117\ E-4}{1.74\ E-5} = 12 \qquad \text{New Total, } \frac{2.559\ E-4}{1.74\ E-5} = 14.7$$

∴ Use $K_H/K_V = 15$ for cast Gypsum

Designed by: KA 7/14/09 Checked by: CJ 7/23/09



SLUG TEST SB-29

Data Set: V:\...\SB-29_1.aqt
Date: 10/21/09 Time: 10:39:15

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-29
Test Date: 3/10/09

AQUIFER DATA

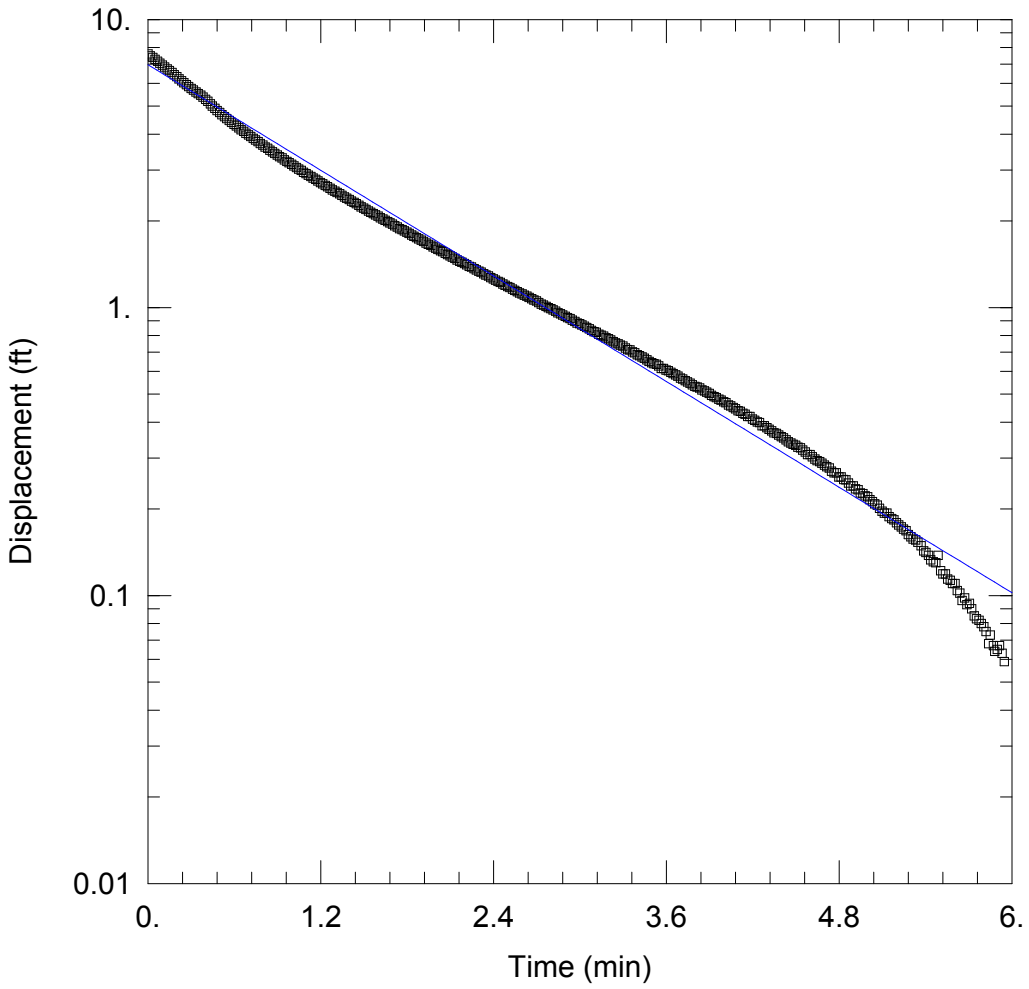
Saturated Thickness: 9.88 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (SB-29)

Initial Displacement: 5.513 ft
Total Well Penetration Depth: 2.38 ft
Casing Radius: 0.03125 ft
Static Water Column Height: 2.38 ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001482 cm/sec
y0 = 5.348 ft



SLUG TEST SB-35

Data Set: V:\...\SB-35_1.aqt
Date: 10/21/09 Time: 10:39:23

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-35
Test Date: 3/10/09

AQUIFER DATA

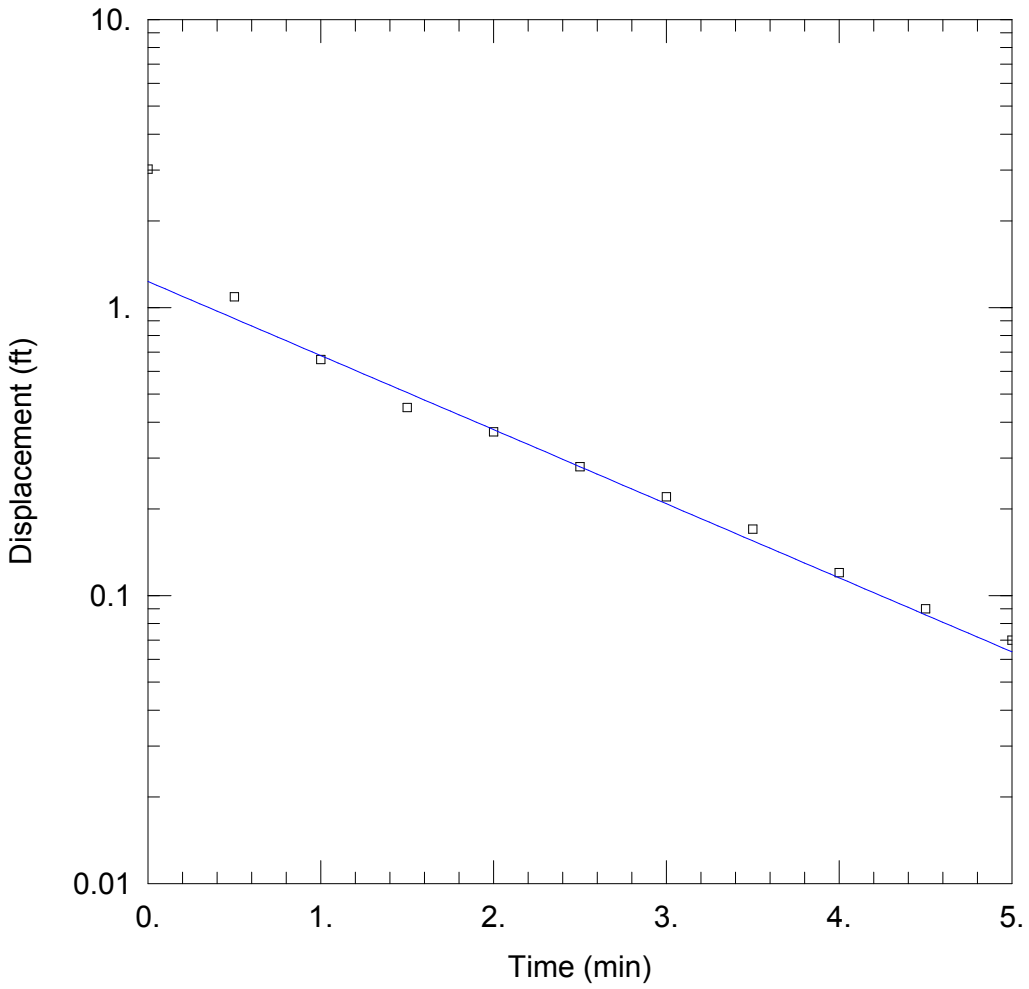
Saturated Thickness: 11.18 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (SB-35)

Initial Displacement: 7.59 ft
Total Well Penetration Depth: 10.48 ft
Casing Radius: 0.0417 ft
Static Water Column Height: 8.48 ft
Screen Length: 2. ft
Well Radius: 0.0417 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0004961 cm/sec
y0 = 6.968 ft



SLUG TEST SB-45U

Data Set: V:\...\SB-45U_1.aqt
Date: 10/21/09 Time: 10:39:48

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-45U
Test Date: 3/9/09

AQUIFER DATA

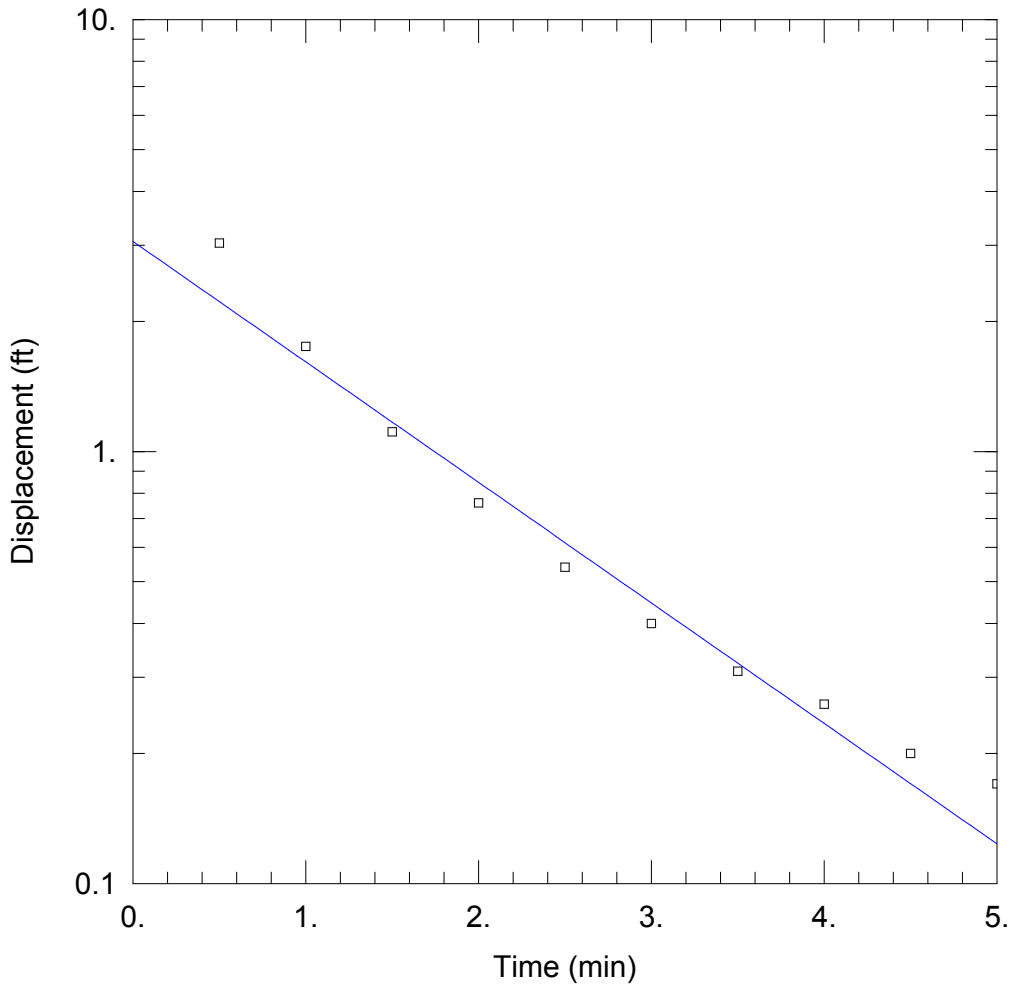
Saturated Thickness: 26.3 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 3.02 ft
Total Well Penetration Depth: 2. ft
Casing Radius: 0.03125 ft
Static Water Column Height: 0. ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001977 cm/sec
y0 = 1.231 ft



SLUG TEST SB-48L

Data Set: V:\...\SB-48L_1.aqt
Date: 10/21/09 Time: 10:40:17

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-48L
Test Date: 3/9/09

AQUIFER DATA

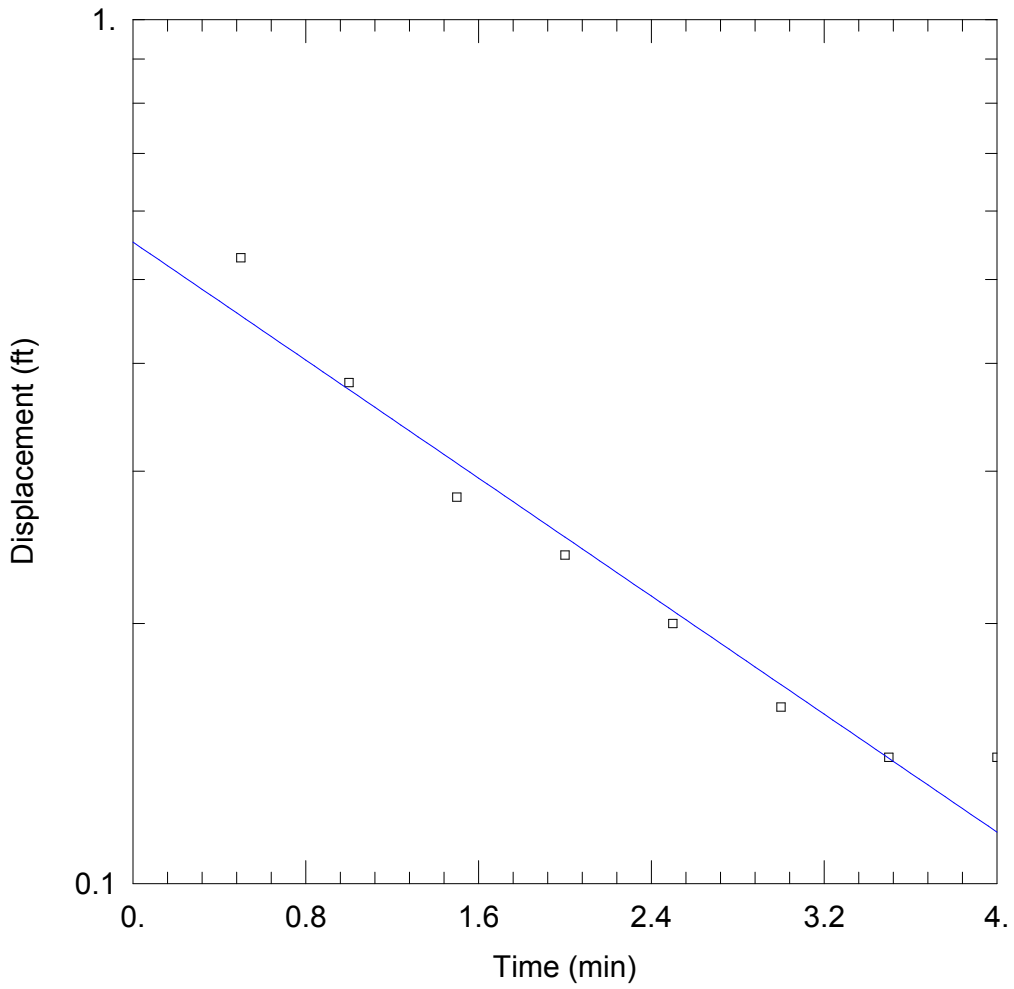
Saturated Thickness: 30.44 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (SB-48L)

Initial Displacement: 14.72 ft
Total Well Penetration Depth: 26.44 ft
Casing Radius: 0.03125 ft
Static Water Column Height: 26.44 ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0003062 cm/sec
y0 = 3.064 ft



SLUG TEST SB-48U

Data Set: V:\...\SB-48U_1.aqt
Date: 10/21/09 Time: 10:39:55

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-48U
Test Date: 3/9/09

AQUIFER DATA

Saturated Thickness: 36.5 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 1.22 ft
Total Well Penetration Depth: 2. ft
Casing Radius: 0.03125 ft
Static Water Column Height: 0. ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001313 cm/sec
y0 = 0.5525 ft

Stantec

175569039
WCF - Gypsum Stack
Review of Slug Test Data (K_H) vs. Laboratory K_V Values
For Sedimented Gypsum - Flyash

K_V from laboratory Falling Head Tests (Sedimented Gypsum)

B-28	39.5' - 41.5' bgs	K_V = 4.47E-5 cm/s
* B-44	52.0' - 54.0' bgs	K_V = 2.02E-6 cm/s

Avg K_V = 2.336E-5 cm/s

K_H values from In-Situ Slug Tests (Sedimented Gypsum)

Notes: ① K_z/K_r or K_V/K_H set to 1

② Slug of water flow into aquifer happens so quick that very little log occurs until the static water level is reached. Therefore, it is assumed the values obtained from the slug test data is representative of K_H and K_V has relatively minor effects.

B-28	K_H = 2.02 E-4 cm/s	
B-32	K_H = 5.11 E-4 cm/s	
B-33	K_H = 2.19 E-4 cm/s	
B-39	K_H = 3.03 E-5 cm/s	Avg. K_H = 2.029 E-4 cm/s
* B-42	K_H = 1.84 E-4 cm/s	
B-43	K_H = 1.02 E-4 cm/s	Avg. K_H
* B-45L	K_H = 3.08 E-4 cm/s	Along West Emb. = 1.905 E-4 cm/s
* B-49	K_H = 1.53 E-4 cm/s	
* B-50L	K_H = 1.17 E-4 cm/s	

* Denotes borings along west embankment near Section K

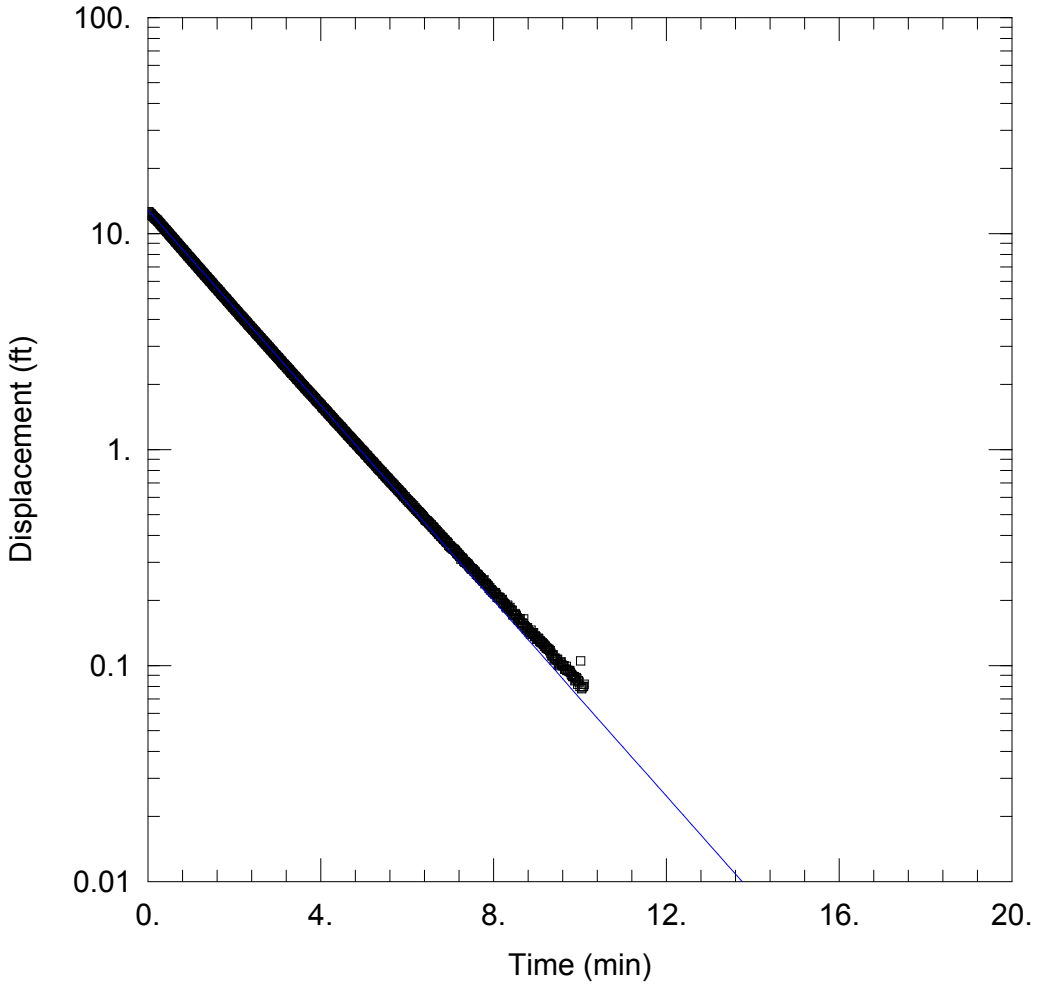
If we look at K_H/K_V for west Embankment only

$$K_H/K_V = \frac{1.905\text{E-}4}{2.02\text{E-}6} = 94.3$$ Now Total Avg: $\frac{2.029\text{E-}4}{2.336\text{E-}5} = 8.6$

Designed by: KA Checked by: 5/14/09

∴ Use K_H/K_V = 100 Sedimented Gypsum

Wells w/in very weak sedimented Gypsum i.e N= WOH



SLUG TEST SB-28

Data Set: V:\...\SB-28_1.aqt
Date: 10/21/09 Time: 10:31:42

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-28
Test Date: 3/10/09

AQUIFER DATA

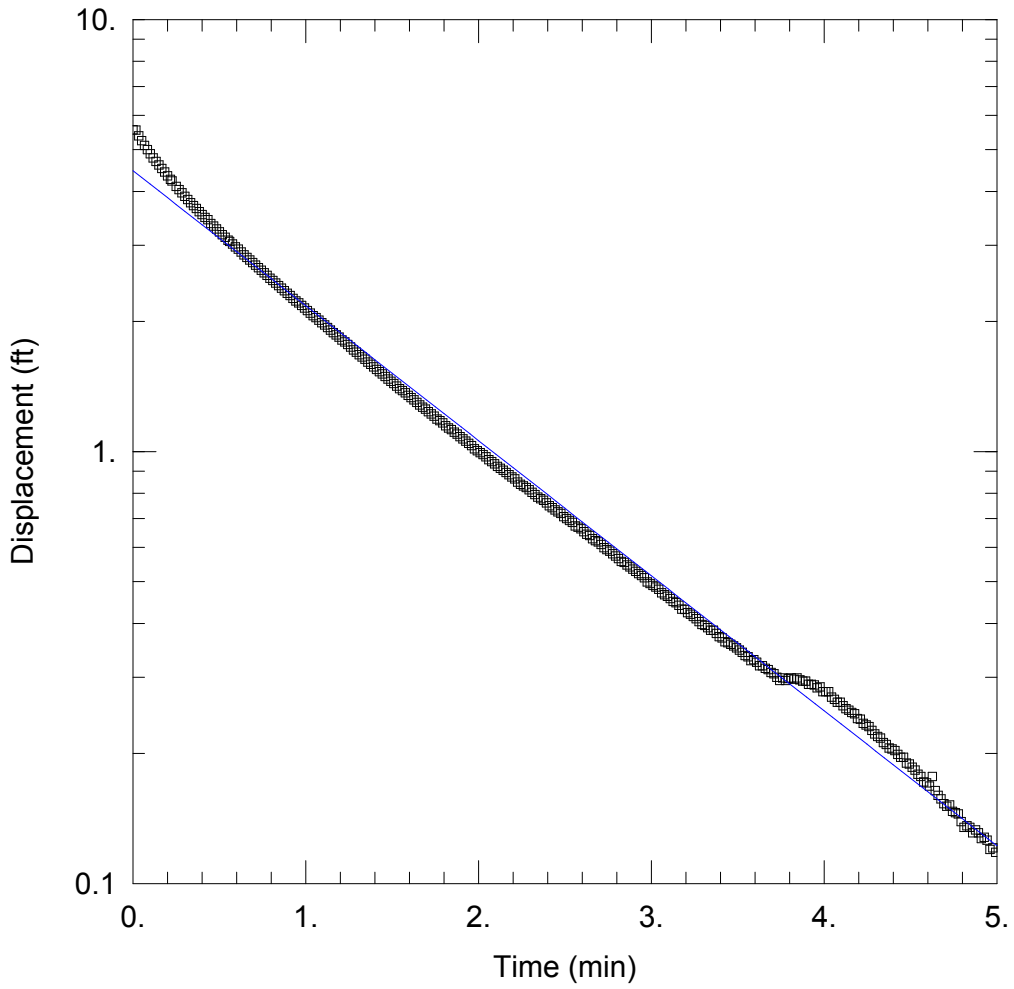
Saturated Thickness: 32.54 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (SB-28)

Initial Displacement: 12.59 ft
Total Well Penetration Depth: 19.44 ft
Casing Radius: 0.03125 ft
Static Water Column Height: 19.44 ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0002021 cm/sec
y0 = 12.81 ft



SLUG TEST SB-32

Data Set: V:\...\SB-32.aqt
Date: 10/21/09 Time: 10:32:28

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-32
Test Date: 3/10/09

AQUIFER DATA

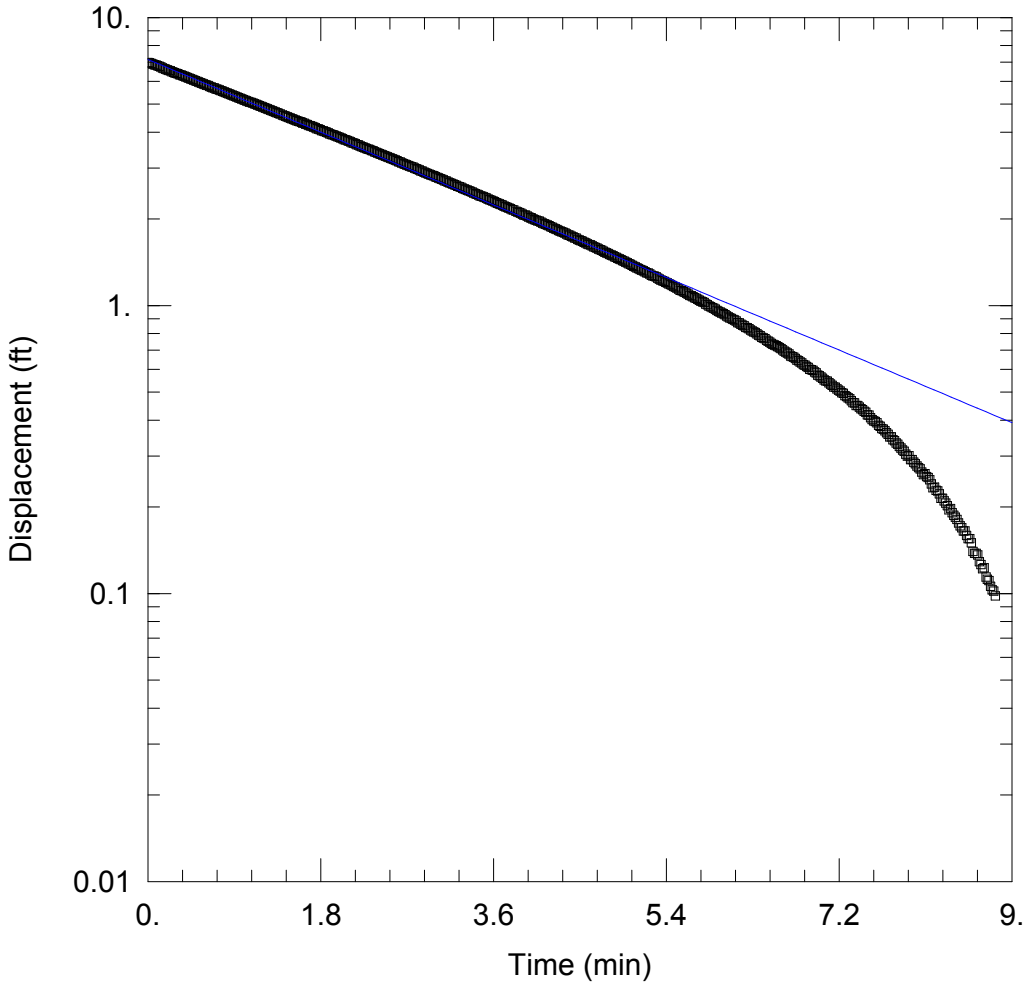
Saturated Thickness: 13.85 ft Anisotropy Ratio (Kz/Kr): 0.33

WELL DATA (SB-32)

Initial Displacement: 5.553 ft
Total Well Penetration Depth: 6.85 ft
Casing Radius: 0.0417 ft
Static Water Column Height: 4.85 ft
Screen Length: 2. ft
Well Radius: 0.0417 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0005141 cm/sec
y0 = 4.466 ft



SLUG TEST SB-33

Data Set: V:\...\SB-33.aqt
Date: 10/21/09 Time: 10:33:02

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-33
Test Date: 3/10/09

AQUIFER DATA

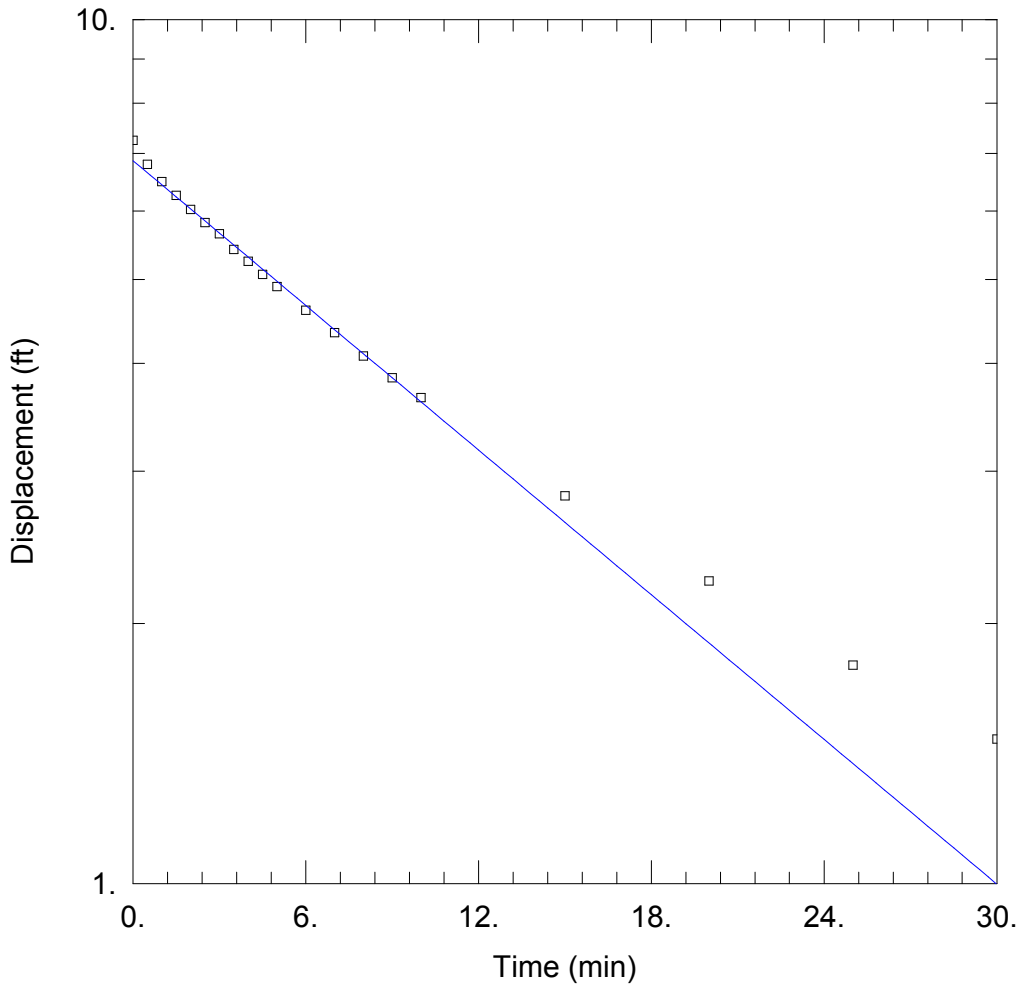
Saturated Thickness: 11.24 ft Anisotropy Ratio (Kz/Kr): 0.33

WELL DATA (SB-33)

Initial Displacement: 6.979 ft
Total Well Penetration Depth: 9.74 ft
Casing Radius: 0.0417 ft
Static Water Column Height: 9.74 ft
Screen Length: 2. ft
Well Radius: 0.0417 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0002509 cm/sec
y0 = 7.148 ft



SLUG TEST SB-39

Data Set: V:\...\SB-39.aqt
Date: 10/21/09 Time: 10:33:28

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-39
Test Date: 3/9/09

AQUIFER DATA

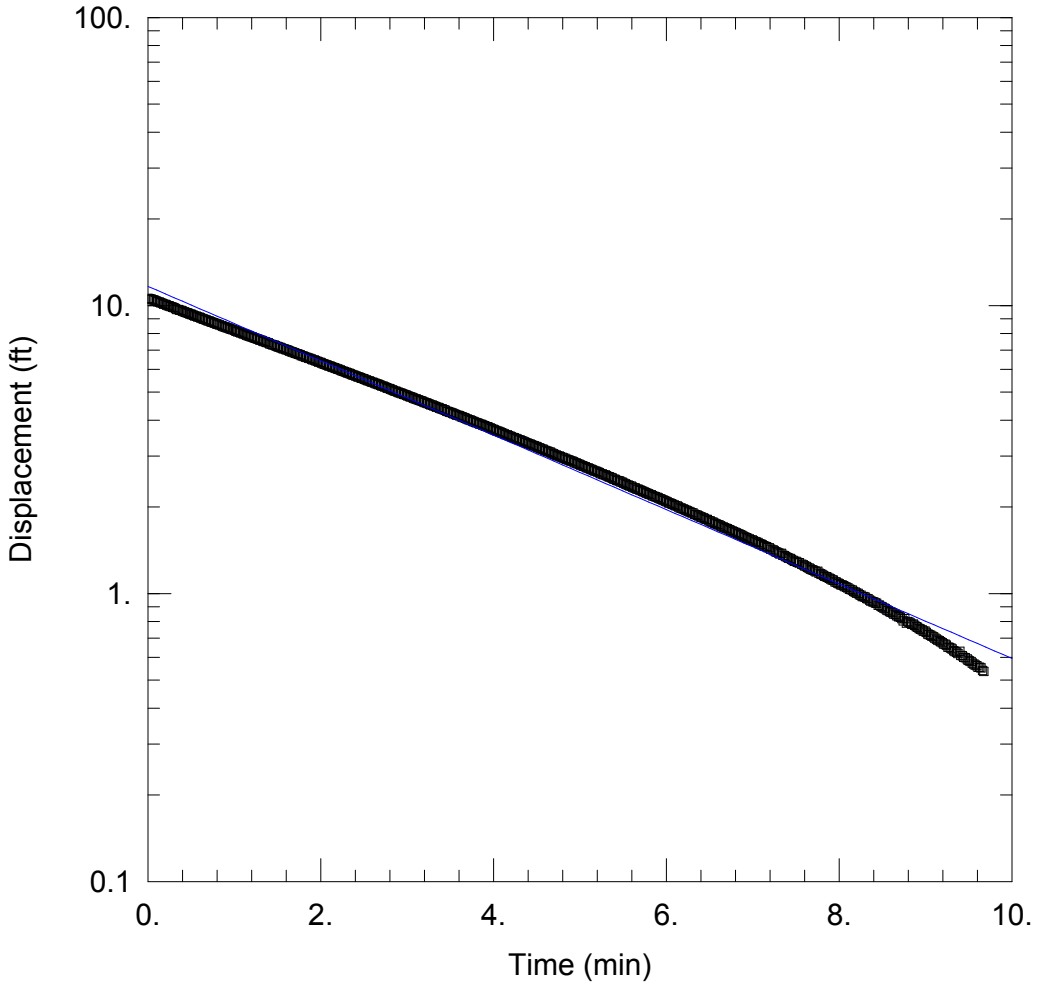
Saturated Thickness: 29.38 ft Anisotropy Ratio (Kz/Kr): 0.33

WELL DATA (SB-39)

Initial Displacement: 7.25 ft
Total Well Penetration Depth: 24.68 ft
Casing Radius: 0.03125 ft
Static Water Column Height: 24.68 ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.426E-5 cm/sec
y0 = 6.865 ft



SLUG TEST SB-42

Data Set: V:\...\SB-42.aqt
Date: 10/21/09 Time: 10:33:43

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-42
Test Date: 3/9/09

AQUIFER DATA

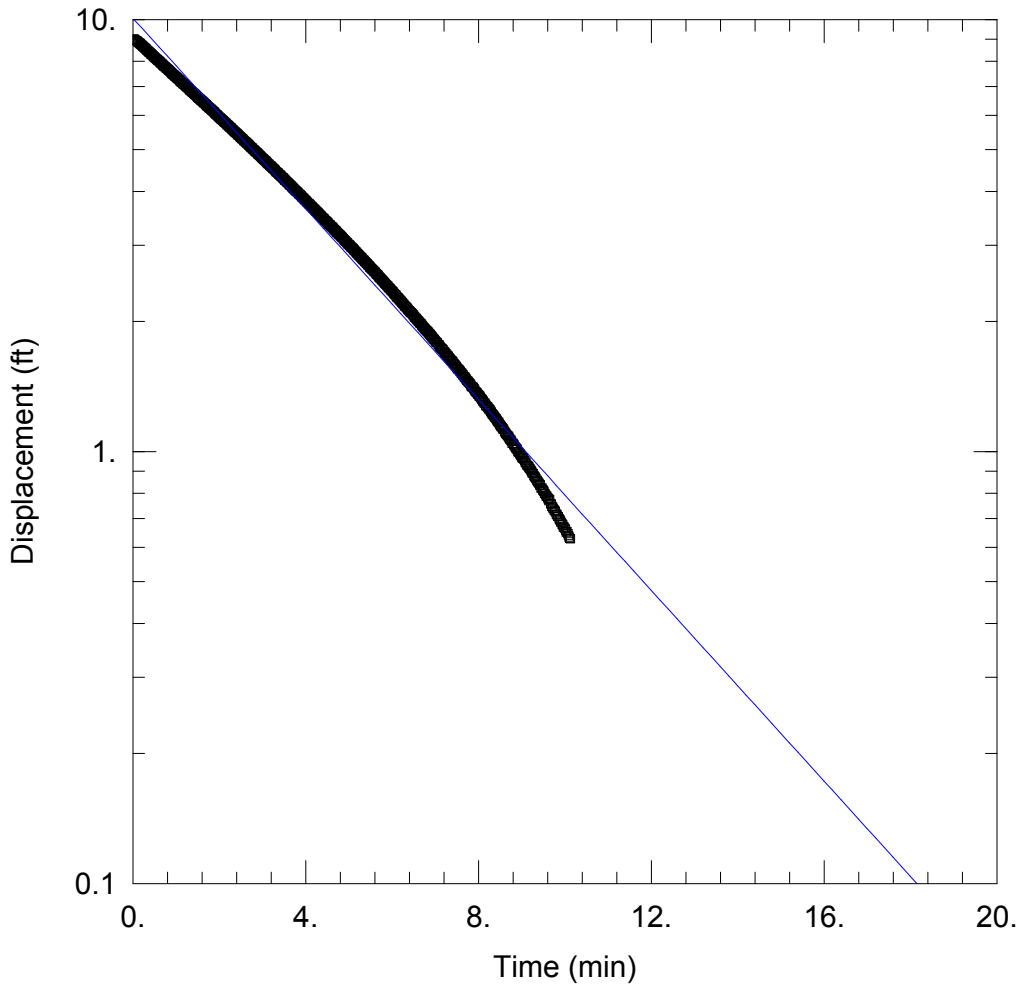
Saturated Thickness: 36.93 ft Anisotropy Ratio (Kz/Kr): 0.33

WELL DATA (SB-42)

Initial Displacement: 10.59 ft
Total Well Penetration Depth: 18.43 ft
Casing Radius: 0.0417 ft
Static Water Column Height: 18.43 ft
Screen Length: 2. ft
Well Radius: 0.0417 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0002341 cm/sec
y0 = 11.65 ft



SLUG TEST SB-43

Data Set: V:\...\SB-43.aqt
Date: 10/21/09 Time: 10:34:08

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-43
Test Date: 3/9/09

AQUIFER DATA

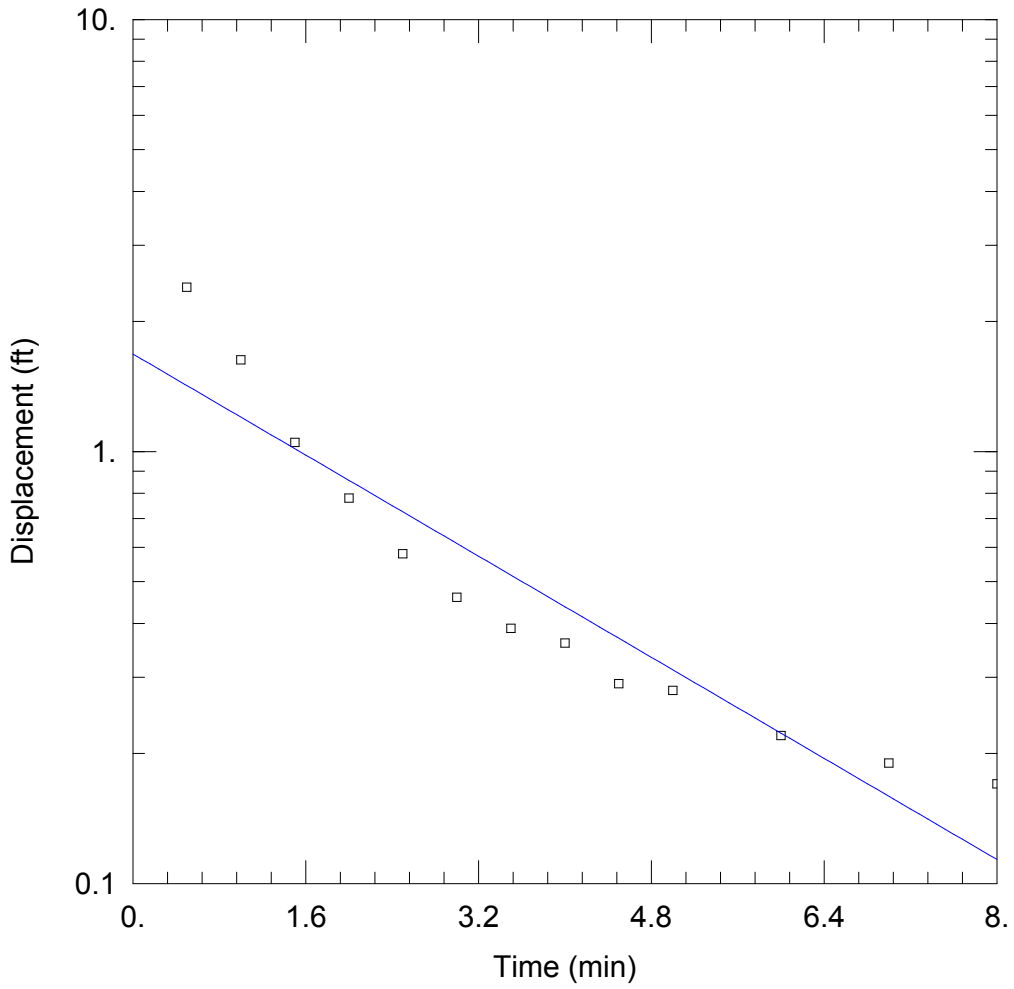
Saturated Thickness: 31.22 ft Anisotropy Ratio (Kz/Kr): 0.33

WELL DATA (SB-43)

Initial Displacement: 9.006 ft
Total Well Penetration Depth: 30.22 ft
Casing Radius: 0.03125 ft
Static Water Column Height: 30.22 ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001259 cm/sec
y0 = 10.07 ft



SLUG TEST SB-45L

Data Set: V:\...\SB-45L.aqt
Date: 10/21/09 Time: 10:34:22

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-45L
Test Date: 3/9/09

AQUIFER DATA

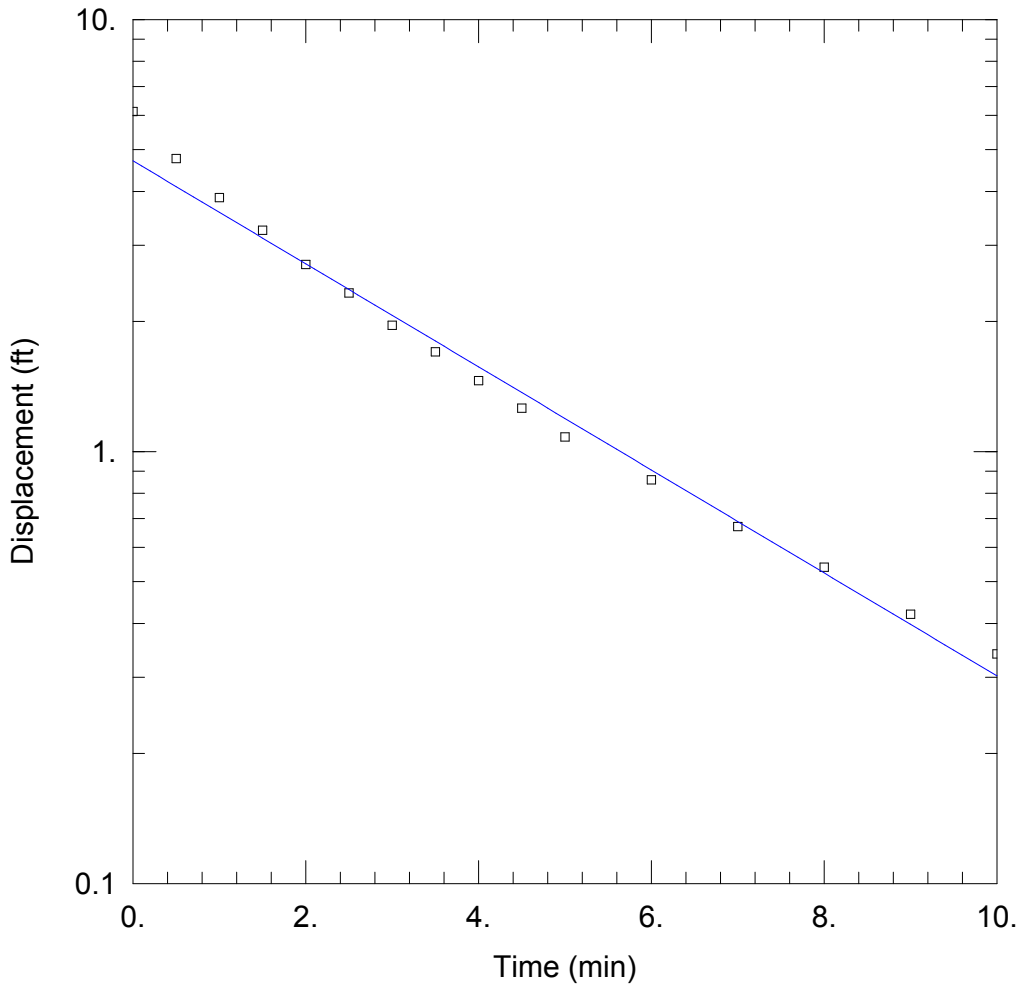
Saturated Thickness: 22.5 ft Anisotropy Ratio (Kz/Kr): 0.33

WELL DATA (SB-45L)

Initial Displacement: 13.82 ft
Total Well Penetration Depth: 21.2 ft
Casing Radius: 0.03125 ft
Static Water Column Height: 21.2 ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.000184 cm/sec
y0 = 1.682 ft



SLUG TEST SB-49

Data Set: V:\...\SB-49.aqt
Date: 10/21/09 Time: 10:34:43

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-49
Test Date: 3/9/09

AQUIFER DATA

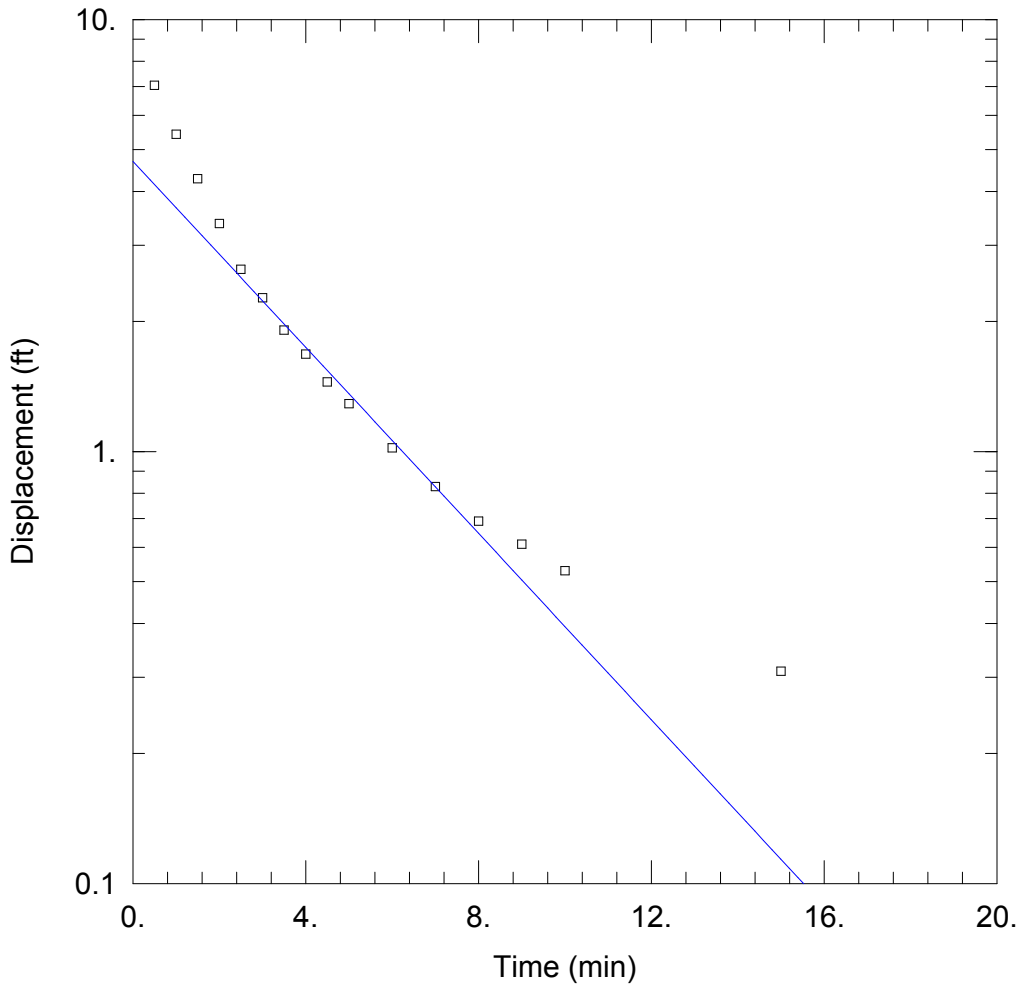
Saturated Thickness: 24.21 ft Anisotropy Ratio (Kz/Kr): 0.33

WELL DATA (SB-49)

Initial Displacement: 6.12 ft
Total Well Penetration Depth: 21.71 ft
Casing Radius: 0.03125 ft
Static Water Column Height: 21.71 ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001473 cm/sec
y0 = 4.708 ft



SLUG TEST SB-50L

Data Set: V:\...\SB-50L.aqt
Date: 10/21/09 Time: 10:35:09

PROJECT INFORMATION

Company: Stantec
Client: TVA
Project: 171468118
Location: Widows Creek
Test Well: SB-50L
Test Date: 3/9/09

AQUIFER DATA

Saturated Thickness: 20.9 ft Anisotropy Ratio (Kz/Kr): 0.33

WELL DATA (New Well)

Initial Displacement: 10.26 ft
Total Well Penetration Depth: 18.9 ft
Casing Radius: 0.03125 ft
Static Water Column Height: 18.9 ft
Screen Length: 2. ft
Well Radius: 0.03125 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001322 cm/sec
y0 = 4.696 ft

Stantec

175569039

GYPSUM STACK - WCF

FINAL SEEPAGE PARAMETERS (9-16-09)

HYDRAULIC CONDUCTIVITY PARAMETERS

CAST GYPSUM $K_H/K_V = 15$

*** $K_V = 1.74 \times 10^{-5}$ cm/s → 5.71×10^{-7} ft/s

$K_{SAT} = K_H = 8.57 \times 10^{-6}$ ft/s

- K_H/K_V, SEE NOTE BELOW

$K_V/K_H = 6.67 \times 10^{-2}$

WEAK SEDIMENTED GYPSUM

$K_H/K_V = 100$

*** $K_V = 2.02 \times 10^{-6}$ cm/s → 6.27×10^{-8} ft/s

- K_H/K_V, SEE NOTE BELOW $K_V/K_H = 0.01$

$K_{SAT} = K_H = 6.27 \times 10^{-6}$ ft/s

SEDIMENTED GYPSUM

$K_H/K_V = 100$

*** $K_V = 2.02 \times 10^{-6}$ cm/s → 6.27×10^{-8} ft/s

- K_H/K_V BASED ON REVIEW OF FHP & IN-SITU SLUG TESTS

$K_{SAT} = K_H = 6.27 \times 10^{-6}$ ft/s

$K_V/K_H = 0.01$

CLAY $K_H/K_V = 9$

** $K_V = 6.23 \times 10^{-7}$ cm/s → 2.04×10^{-8} ft/s

K_H/K_V, ASSUMED FROM PAST ARDAMAN REPORTS

*$K_{SAT} = K_H = 1.836 \times 10^{-7}$ ft/s

$K_V/K_H = 0.11$

* FROM SLUG TEST DATA

** BACK CALCULATION

*** FROM FHP LAB TESTS

M_V FOR CAST GYPSUM

$M_V = 1.759 \times 10^{-6}$ 1/psf PREVIOUS FROM STN-44

USE STN-34 SINCE $\phi' = 40.7$ CLOSEST TO AVERAGE $\phi' = 40.4$

$M_V = \frac{a_V}{1+e_0}$ $a_V = \frac{e_1 - e_2}{\sigma'_2 - \sigma'_1}$ $a_V = \frac{0.953 - 0.942}{11.453 - 0} = 7.8786 \times 10^{-2}$ 1/psf

$a_V = 3.9393 \times 10^{-5}$ 1/psf

$M_V = \frac{3.9393 \times 10^{-5}}{1 + 0.953} = \boxed{2.02 \times 10^{-5}\ 1/psf}$

Designed by: KA 7/21/09 Checked by: CJ 7/29/09

M_V FOR SEDIMENTED AND WEAK SEDIMENTED GYPSUM

$M_V = 2.41 \times 10^{-6}$ 1/psf PREVIOUS FROM STN-42

STN-42 $\phi' = 41.7$ IS CLOSEST TO AVERAGE $\phi' = 41.3$ ∴

LOOK AT 2ND CLOSEST TO AVERAGE FOR COMPARISON

STN 33 $\phi' = 40.6$

$$M_V = \frac{a_V}{1+e_0} \qquad a_V = \frac{0.973 - 0.845}{12.45 - 0} \qquad a_V = 1.028 \times 10^{-2} \text{ 1/tsf} = 5.14 \times 10^{-6} \text{ 1/psf}$$

$M_V = 2.605 \times 10^{-6}$ 1/psf FOR STN 33 $M_V = 2.41 \times 10^{-6}$ FOR STN-42

USE $\boxed{M_V = 2.5 \times 10^{-6} \text{ 1/psf}}$

NOTE! SEEPAGE SECTION IS CONTROLLED BY CLAY STARTER DIKES AND VERY LITTLE DIFFERENCE BETWEEN K_V LAB TESTS FOR GYPSUM SAMPLES

∴ SED GYPSUM AND WEAK SED GYPSUM MODELED WITH SAME K_H/K_V PARAMETERS

M_V FOR CLAY SOILS

$$a_V = \frac{0.7593 - 0.606}{3.758 - 0} = 1.9505 \text{ 1/tsf} = 9.7525 \times 10^{-6} \text{ 1/psf}$$

$$\boxed{M_V = \frac{a_V}{1+e_0} = 5.5434 \times 10^{-6} \text{ 1/psf}}$$

Designed by: KA 7/21/09 Checked by: CJ 7/24/09

CRUSHED STONE (ASSUMED)

NAVFAC TABLE 1, 7.2-39

$GW = K_V = 5 \times 10^{-2}$ ft/min $= 8.33 \times 10^{-4}$ ft/s

$\theta_W = 0.5$ ASSUMED

M_V = 1/MODULUS OF ELASTICITY

$M_V = \frac{1}{1500 \text{ ksf}} = 6.67 \times 10^{-7} \frac{1}{\text{psf}}$

p. 438 SOIL MECHANICS

SAND FILTER (ASSUMED)

SLOPE DRAIN AND TOE DRAIN

SP OR SW - WELL OR POORLY GRADED SANDS

$K_V = 5 \times 10^{-2}$ ft/min $= 8.33 \times 10^{-5}$ ft/s

$\theta_W = 0.5$ ASSUMED

M_V = 1/MODULUS OF ELASTICITY

$M_V = \frac{1}{500 \text{ ksf}} = 2 \times 10^{-6} \frac{1}{\text{psf}}$

SAND LOOSE p. 438 SOIL MECHANICS

Designed by: KA 7/21/09 Checked by: CJ 7-24-09

Soil Type	* Saturated Water Content (%)	** Residual Water Content (%)
Sedimental Gypsum-Flyash	38.0	2
Cast-Gypsum Flyash	34.6	2
Fat Clay	24.8	3
Weak Sed. Gypsum-Flyash	47.0	2

* From Lab Data

** Assumed Typical Values

Designed by: KA 8/13/09 Checked by: CJ 9-16-09

Moisture Content Summary

Boring	Moisture Content			- 200 (%)	+ 200 (%)	Gypsum (%)	Non-Gypsum Component * (%)
	W_{40} (%)	W_{200} (%)	D_{WC} (%)				
STN-28	22.0	37.3	15.3	93.7	6.3	73.0	27.0
STN-29	20.5	35.8	15.3			73.3	26.7
STN-32	19.8	34.0	14.3	76.5	23.5	68.3	31.7
STN-33	19.5	33.5	14.0			66.8	33.2
STN-34	22.8	39.3	16.5			78.9	21.1
STN-35	20.6	37.0	16.5			78.8	21.2
STN-37	17.0	41.0	24.0			114.9	-14.9
STN-38	24.1	40.1	16.0	90.9	9.1	76.6	23.4
STN-39	20.9	34.7	13.8			66.2	33.8
STN-40	22.1	39.2	17.1			81.6	18.4
STN-42	24.1	38.1	14.0			66.9	33.1
STN-45	22.5	NA	NA			NA	NA
STN-46	17.3	32.5	15.1			72.5	27.5
STN-48	24.5	NA	NA			NA	NA
STN-49	22.8	NA	NA			NA	NA
STN-50	22.4	NA	NA			NA	NA

Soil Type Average

Boring	Moisture Content			Gypsum (%)	Non-Gypsum Component * (%)
	W_{40} (%)	W_{200} (%)	D_{WC} (%)		
Sedimented Gypsum	24.9	38.0	14.6	70.0	30.0
Cast Gypsum	19.9	34.6	15.4	73.8	26.2
Fat Clay	24.8	NA	NA	NA	NA
Weak Sedimented Gypsum	35.3	47.0	12.4	59.2	40.8

SATURATED MOISTURE CONTENT

IA 8/13/09

CJ 9/15/09

Stantec

175569039
Review Sieve Analysis
FINAL SEEPAGE PARAMETERS

Gypsum Stack
175569039

Boring No.	Depth	Dia (mm) at 10% passing	Dia (mm) at 60% passing	Liquid Limit (%)	Soil Type
STN -28	7.5-10.5	0.012	0.026	—	Sed-Gypsum
STN-32	21.5-24.5	0.015	0.04	—	Sed-Gypsum
STN-32	4.5-6	0.015	0.041	—	Cast Gypsum
STN-33	4-5.5				
STN-38	14-17	0.015	0.038	—	Cast Gypsum
STN-36	59.5-66	0.016	0.038	—	Sed-Gypsum
STN-45	16.5-19.5	0.015	0.035	—	Cast Gypsum
? STN-45	16.5-19.5	~~0.035~~	~~0.05~~	—	Cast Gypsum
STN-45	31.5-34.5	0.011	0.033	—	Weak Sed. Gypsum
STN-49	31.5-34.5	0.012	0.03	—	Weak Sed. Gypsum

Average Values Per Soil Type

	Dia (mm) @ 10%	Dia (mm) @ 60%
Cast Gypsum-Flyash	0.015	0.038
Weak Sedimented Gypsum-Flyash	0.0115	0.0315
Sedimented Gypsum Flyash	0.014	0.035

Designed by: KA 8/13/09 Checked by: CJ 9/15/09

Stantec

Review of Foundation Soils
1755 69036 Ash Pond
FINAL SEEPAGE PARAMETERS

Boring No.	Depth	Dia (mm) @ 10% passing	Dia (mm) at 60% passing	Liquid Limit (%)	Soil Type
STN-105	13-16	0.001	0.01	55	CH
STN-107	35-39.5	0.001	0.015	36	CL
STN-96	43-46	0.015	0.15	29	CL
STN-99	38.5-43.5	0.001	0.0085	43	CL
STN-97	32.5-37	0.001	0.0085	52	CH
STN-75	7.5-12	0.001	0.015	55	CH
STN-74	4.5-9.0	0.001	0.0055	59	CH
STN-110	13-15	0.001	0.008	50	CH/CL
STN-71	32-35	0.001	0.036	69	CH
STN-76	42-48	0.001	0.015	48	CL
STN-80	6-10.5	0.001	0.0028	65	CH
STN-81	32-36	0.001	0.05	38	CL
STN-85	12.5-22	0.001	0.0013	73	CH
STN-64	7-12	0.001	0.004	65	CH
STN-84	35-39	0.001	0.012	60	CH
Average Values		0.0019	0.0228	53	

Designed by: KA 8/13/09 Checked by: CJ 9/15/09

Stantec

Seepage Exit Gradients
1755 69039 TVA-WCF
Gypsum Stack (All with Drains Modeled except Section K)
Seep W

Section	$i = \frac{\Delta \text{ Total Head}}{L}$	Δi
A	$i = \frac{622.8351 - 621.8791}{621.8791 - 619.24222}$	0.36 − 0.35

$i = 0.363$, in Sedimented Gypsum - Flyash at Perimeter Ditch

D	$i = \frac{627.53886 - 626.99366}{626.9945 - 624.99315}$	2.04 − 0.22

$i = 0.272$, same location & Material as above
or if we look at Region $i_y = 0.328$

F	$i = \frac{630.52781 - 629.8305}{629.8305 - 629.3}$	1.31 − 0.924

$i = 1.31$, same location & Material as above
or, if we look at Region $i_y = 1.28$

H	$i = \frac{621.184144 - 619.99469}{619.9918 - 613.34}$	0.38 − 0.13

$i = 0.18$, Cast Gypsum-Flyash, @ Perimeter Dtch

K	$i = \frac{615.027448 - 614}{613.9999 - 612.079774}$	0.45 - 0.34

$i = 0.54$ or 0.46 in the clay just above Sl.ty Sand Normal Pool

Designed by: KA 8/24/09 Checked by: CJ 9-1-09

Stantec

SECTION F EXIT GRADIENTS

RECALCULATED

1755 69039 - GYPSUM STACK

NODE 942:

$$i = \frac{631.552 - 629.831}{629.831 - 625.948} = .443$$

$$FS = \frac{0.847}{.443} = 1.91$$

Designed by: CJ 10-15-09 Checked by: KA 10/15/09