



P. O. Drawer 571, Tyrone, New Mexico 88065 • (505) 538-5331

January 31, 2006

**Hand Delivered**

Mr. David Ohori  
Mining and Minerals Division  
Energy, Minerals and Natural Resources  
1220 South St. Francis Drive  
Santa Fe, New Mexico 87505

Dear Mr. Ohori:

**Re: Supplemental Borrow Materials Investigation Report, Condition L.5, Permit No. GR010RE**

Please find attached an Addendum to the Golder Associates report dated October 31, 2005, Preliminary Borrow Source Materials Investigation Leach Ore and Waste Rock Stockpiles. This addendum to that report finalizes the study as required under the above-referenced permit and condition.

Please contact Mr. Greg Schoen (505) 574-6359, if you have any questions or comments.

Very truly yours,

A handwritten signature in black ink that reads "Ned Hall". The signature is written in a cursive, slightly slanted style.

E. L. (Ned) Hall, Manager  
Environment, Land & Water  
New Mexico Operations

ELH:gs  
Attachment  
20060124-100

c Clint Marshall

**Golder Associates Inc.**

4910 Alameda Boulevard NE, Suite A  
Albuquerque, NM USA 87113  
Telephone (505) 821-3043  
Fax (505) 821-5273  
www.golder.com



**ADDENDUM TO  
PRELIMINARY BORROW  
SOURCE MATERIALS INVESTIGATION  
LEACH ORE AND WASTE ROCK STOCKPILES  
DP-1341 CONDITION 79**

*Submitted to:*

*Phelps Dodge Tyrone, Inc.  
P.O. Box 570  
Tyrone, NM 88065*

*Submitted by:*

*Golder Associates Inc.  
4910 Alameda Blvd. NE, Suite A  
Albuquerque, NM 87113*

Distribution:

8 Copies – Phelps Dodge Tyrone Inc.  
3 Copies - Golder Associates Inc., Albuquerque

January 30, 2006

053-2016



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## 1.0 TRANSMITTAL

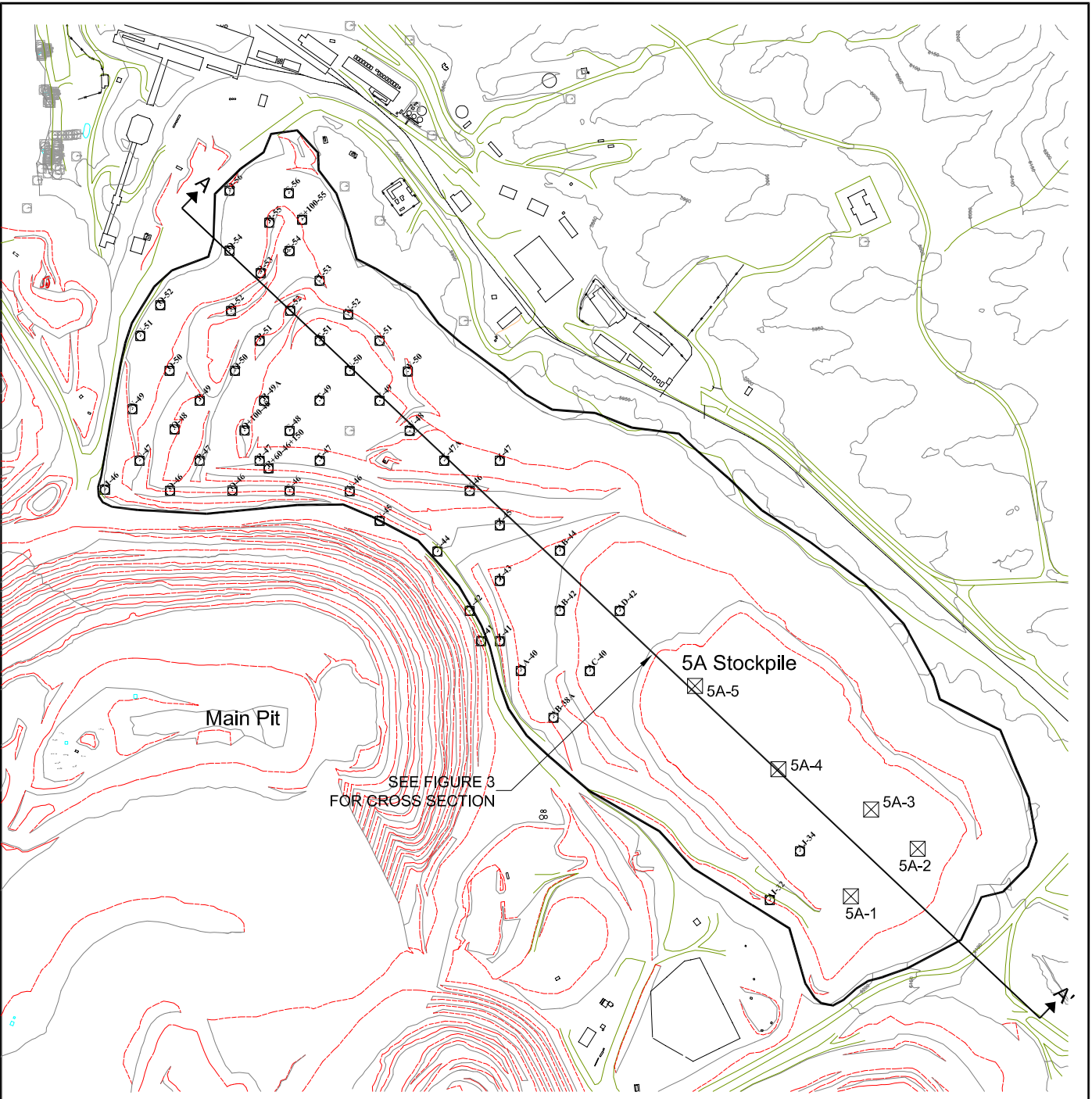
This document represents a transmittal of data that is intended to fill data gaps in the *Preliminary Borrow Source Materials Investigation Leach Ore and Waste Rock Stockpiles* (SMBI), which was submitted to the New Mexico Environment Department (NMED) and Mining and Minerals Division (MMD) in October 2005. The SBMI is intended to fulfill Condition 79 of DP-1341 and Condition L.5 of the Permit Revision 01-1 to Permit No. GR010RE. In the October 2005 SBMI report, Phelps Dodge Tyrone, Inc. (Tyrone) committed to providing additional drilling and soil hydraulic analyses by January 31, 2006. Specifically, this addendum provides:

- 1) Revised drill hole location map showing the actual location of the drill holes (Figure 2R),
- 2) Revised cross-sections for the 5A Stockpile based on newly acquired drilling and geologic descriptions (Figure 3R),
- 3) Drill logs prepared by the Tyrone geology staff (Appendix D) and ,
- 4) Additional soil hydraulic properties data (Appendix E).

These data are intended to augment the October 2005 SBMI. The supplemental drilling on the 5A stockpile indicates that materials with mixed character (Gila Conglomerate, leached cap, and sulfides) may occur within the stockpile. The far southern end of the stockpile appears to be relatively free of mixed materials and suggests that additional volume could be recovered in this area. However, because of the uncertainty of the exact distribution and character of the materials in the lower lifts of the 5A stockpile, Tyrone does not intend to modify the October 2005 estimates of the volume of cover materials at this time. The potential occurrence of mixed materials, which could be acid-forming, suggests that field monitoring should be implemented during the excavation of the 5A Stockpile for cover materials.



## FIGURES

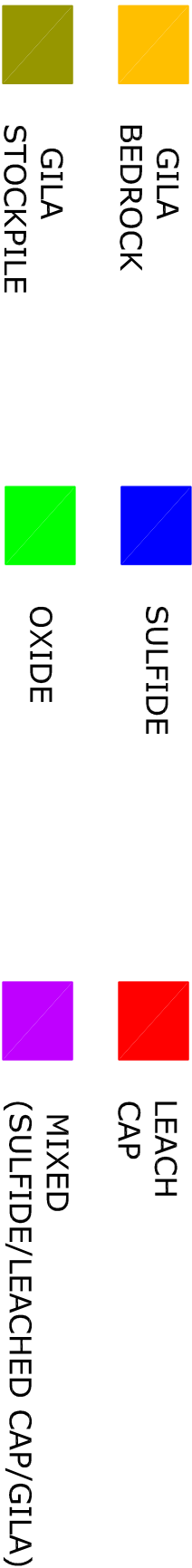
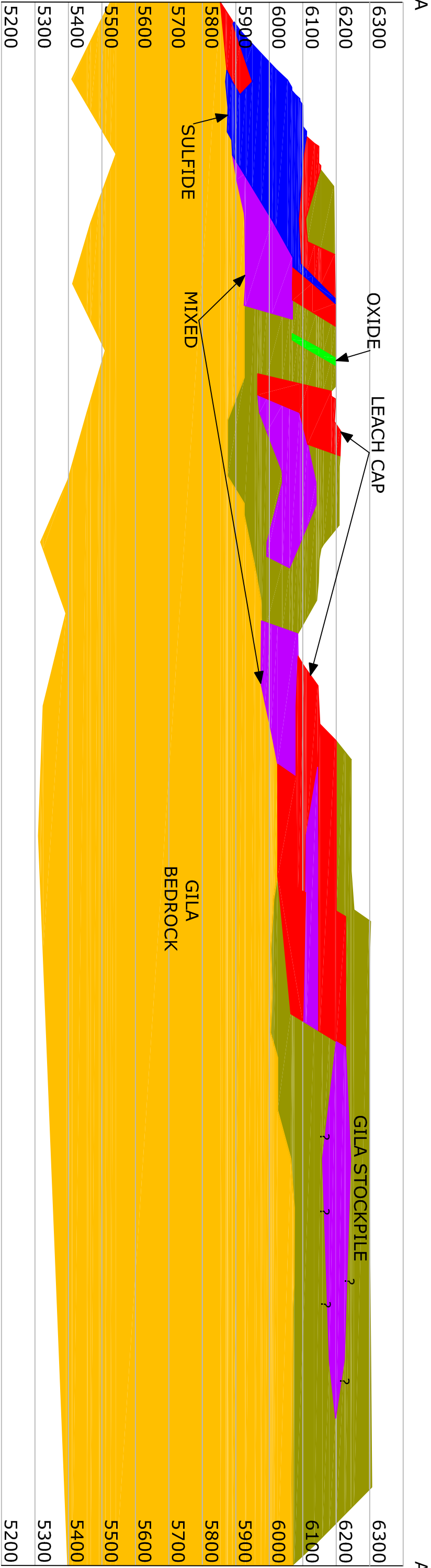
K:\2005 Projects\053-2016\DRILL PIT-1D\_5A.dwg CM 01/27/06



- ☒ ADDITIONAL DRILL LOCATIONS
- DRILL HOLE




PROJECT		 PHELPS DODGE TYRONE INC. GRANT COUNTY, NEW MEXICO				
TITLE		<b>EXPLORATION DRILLING LOCATIONS 5A (1D) STOCKPILE JANUARY 2006 AMENDMENT</b>				
 <b>Golder Associates</b> ALBUQUERQUE/NEW MEXICO		PROJECT No.	053-2016	FILE No.	DRILL PITs-1D_5A	
		DESIGN	LM	10/25/05	SCALE	SCALE
		CADD	CM	01/27/06	REV.	1
		CHECK	LM	01/27/06	<b>2R</b>	
		REVIEW	REVIEW	RVW_DATE		



SCALE: 1" = 300'

PROJECT




PHELPS DODGE TYRONE INC.  
GRANT COUNTY, NEW MEXICO

TITLE

5A STOCKPILE MATERIAL CROSS-SECTION  
JANUARY 2006 AMENDMENT

PROJECT No.		053-2016	FILE No.		5A-SECTION
DESIGN	RAW	10/25/05	SCALE	SCALE	REV. 1
CADD	CM	10/25/05			
CHECK	LM	10/25/05			
REVIEW	REVIEW	RAW DATE			



Golder Associates  
ALBUQUERQUE/NEW MEXICO

3R

## **APPENDIX D**

### **DRILL LOGS - 5A STOCKPILE**



Date Drilled: 11-08-05 Type: RC-DRY

Hole Depth: 250'

Orientation: - 90°

Logged by: RTW

[illegible]

Drill Hole Logging Form

Project:

Hole Number: 5A-1

Date Drilled: 11-08-05 Type:

Northing:

Hole Depth:

Easting:

Orientation:

C.E.:

Logged by: RJW

Analysis			Interval		Drill Log		Graphic Log		Graphic Log Notes		Alteration		Alteration						Mineralization (vol%)										Enrich	Notes				
Tcu	OxCu	QlT	Elev.	Ft.	H <sub>2</sub> O	Rock					Code	WC	YC	QS	Qtz	Ksp	Chl	FeOx	FeSt	CuOx	CuSt	Py	PySt	Cc	CcSt	Cpy	CpySt	Omin1	Omin2	Other	Oxide	(Rock Description, Alteration, Mineralization, Structure)		
				100						GILA CONG.	PALT:																						REDDISH-BROWN CLAY (BALLING)	
				110	DRY						SALT:																						W/MINOR SAND ALMOST NO PEBBLES	
				110	DRY						CLAY:																						NO VISIBLE SULFIDES CLAY CONTENT	
				120	DRY						LCAP:																						INCREASING W/ DEPTH.	
				120	DRY						PALT:																						REDDISH-BROWN LOOSE POWDERY CLAY	
				130	DRY						SALT:																						ANGULAR SAND-FEW PEBBLES ~ 15%	
				140	DRY						CLAY:																						CLAY-CLAY SLIGHTLY LESS THAN	
				150	DRY						LCAP:																						ABOVE. NO VISIBLE SULFIDES	
				160	DRY						PALT:																						MEDIUM-BROWN ANGULAR COARSE	
				170	DRY						SALT:																						SAND, CLAY (~10%) & PEBBLES NO	
				180	DRY						CLAY:																						MORE GRAVEL-UP TO 1/2" DIA VISIBLE	
				190	DRY						LCAP:																						ANGULAR FRAGMENTS, TRACE SULFIDES	
				200	DRY						PALT:																							BLACK OXIDE ON SOME PEBBLES.
				210	DRY						SALT:																							LIGHT BROWN LOOSE POWDERY
				220	DRY						CLAY:																							ANGULAR SAND, CLAY & GRAVEL
				230	DRY						LCAP:																							FRAGMENTS OF GD. NO VISIBLE
				240	DRY						PALT:																							SULFIDES-NO SECONDARY MINERALS.
				250	DRY						SALT:																							~10% CLAY
				260	DRY						CLAY:																							MEDIUM BROWN COARSE ANGULAR
				270	DRY						LCAP:																							SAND MINOR CLAY; ANGULAR
				280	DRY						PALT:																							GRAVEL-GD NO VISIBLE SULFIDES
				290	DRY						SALT:																							OR SECONDARY MINERALIZATION
				300	DRY						CLAY:																							LIGHT BROWN COARSE ANGULAR
				310	DRY						LCAP:																							SAND, MINOR CLAY; GRAVEL UP TO 1/2"
				320	DRY						PALT:																							DIA. FRAGMENTS OF GD & MP
				330	DRY						SALT:																							SCATTERED GRAINS OF PYRITE IN MP
				340	DRY						CLAY:																							FRAGMENTS.
				350	DRY						LCAP:																							MEDIUM BROWN ANGULAR COARSE
				360	DRY						PALT:																							SAND MINOR CLAY & GRAVEL FRAGMENTS
				370	DRY						SALT:																							OF GD & MP TRACES OF BLACK OXIDE
				380	DRY						CLAY:																							ON 1/4" FRAGMENTS
				390	DRY						LCAP:																							NO VISIBLE SULFIDES
				400	DRY						PALT:																							LIGHT TO MEDIUM BROWN ANGULAR
				410	DRY						SALT:																							COARSE SAND MINOR CLAY; SCATTERED
				420	DRY						CLAY:																							GRAVEL FRAGMENTS-TRACES OF
				430	DRY						LCAP:																							ENRICHED PYRITE.
				440	DRY						PALT:																							MEDIUM BROWN ANGULAR COARSE
				450	DRY						SALT:																							SAND, MINOR CLAY & GRAVEL-SOME
				460	DRY						CLAY:																							FRAGMENTS W/ BLACK OXIDES ON SURFACES
				470	DRY						LCAP:																							NO VISIBLE SULFIDES
				480	DRY						PALT:																							MEDIUM BROWN ANGULAR COARSE
				490	DRY						SALT:																							SAND, MINOR CLAY & GRAVEL
				500	DRY						CLAY:																							FRAGMENTS MINUTE TRACE OF
				510	DRY						LCAP:																							ENRICHED PYRITE ON FRAGMENT OF GD

Project: 5A STOCKPILE COVER MATERIAL

Hole Number: 5A-1

Hole Number: 5A-1  
Date Drilled: 11-08-05 Type: RC-DRY

Nothing:

Easting:

C.E.:

Logged by: RTW

Hole Depth: \_\_\_\_\_

**Orientation:**

[illegible]

Hole Number: SA-2 North: 100°  
Date Drilled: 11-09-05 Type: RC-DRY Hole Depth: 250

C.E.: 6297.334

Logged by: RJW

Analysis			Interval		Drill Log		Graphic Log		Graphic Log Notes		Alteration		Alteration		Mineralization (vol%)														Enrich	Notes		
Tcu	OxCu	QLT	Elev.	Fl.	H <sub>2</sub> O	Rock				Code	WC	YC	QS	Qtz	Ksp	Chl	FeOx	FeSt	CuOx	CuSt	Py	PySt	Cc	CcSt	Cpy	CpySt	Omin1	Omin2	Other	Oxide	(Rock Description, Alteration, Mineralization, Structure)	
				0						PALT:																					COARSE ANGULAR SAND & GRAVEL < 5% CLAY MEDIUM BROWN COLOR NO VISIBLE SULFIDES - MINUTE TRACES OF BLACK OXIDES ON GRAVEL FRAGMENTS GD & MP.	
				10						SALT:																						
				10						CLAY:																						
				20						LCAP:																						
				10						PALT:																						MEDIUM BROWN ANGULAR COARSE SAND & GRAVEL UP TO 1" DIA FRAGMENTS OF GD NO VISIBLE SULFIDES VERY MINUTE TRACE OF BLACK OXIDE COATINGS.
				20						SALT:																						
				20						CLAY:																						
				30						LCAP:																						
				20						PALT:																						MEDIUM BROWN ANGULAR COARSE SAND, GRAVEL & MINOR CLAY ~ 5% VERY MINUTE TRACE OF PYRITE & BLACK OXIDE COATING ON GD FRAGMENTS.
				30						SALT:																						
				30						CLAY:																						
				40						LCAP:																						
				30						PALT:																						LIGHT BROWN ANGULAR COARSE SAND GRAVEL & < 5% CLAY VERY MINUTE TRACES OF BLACK OXIDES NO VISIBLE SULFIDES GD FRAGMENTS UP TO 1" IN DIA.
				40						SALT:																						
				40						CLAY:																						
				50						LCAP:																						
				40						PALT:																						MEDIUM BROWN ANGULAR COARSE SAND GRAVEL & < 5% CLAY NO VISIBLE SULFIDES GD FRAGMENTS UP TO 3/4" IN DIA.
				50						SALT:																						
				50						CLAY:																						
				50						LCAP:																						
Composite:																																
				50						PALT:																						LIGHT BROWN ANGULAR COARSE SAND, GRAVEL & < 5% CLAY. GD FRAGMENTS. NO VISIBLE SULFIDES
				60						SALT:																						
				60						CLAY:																						
				70						LCAP:																						
				60						PALT:																						LIGHT REDDISH BROWN ANGULAR SAND & GRAVEL W/ VERY MINOR CLAY NO VISIBLE SULFIDES. LARGE FRAGMENTS ARE GD FINER SAND & FEWER GRAVEL FRAGMENTS.
				70						SALT:																						
				70						CLAY:																						
				80						LCAP:																						
				70						PALT:																						LIGHT REDDISH BROWN ANGULAR FINE TO COARSE SAND, CLAY & MINOR GRAVEL. LOOSE, POWDERY ~ 10% TO 15% CLAY NO VISIBLE SULFIDES.
				80						SALT:																						
				80						CLAY:																						
				90						LCAP:																						
				80						PALT:																						LIGHT BROWN LOOSE POWDERY FINE TO COARSE SAND, ~ 10% CLAY & MINOR GRAVEL. TRACE OF PYRITE ON OCCASIONAL FRAGMENTS
				90						SALT:																						
				90						CLAY:																						
				100						LCAP:																						
Composite:																																
				90						PALT:																						LIGHT REDDISH BROWN LOOSE POWDERY FINE TO COARSE SAND, MINOR CLAY ~ 5% & SOME GRAVEL. MINUTE TRACES OF PYRITE GD FRAGMENTS.
				100						SALT:																						
				100						CLAY:																						
				100						LCAP:																						

Date Drilled: \_\_\_\_\_ Type: **RC-DRY** Hole Depth: \_\_\_\_\_

Logged by: RTW

Analysis			Interval				Drill Log		Graphic Log		Graphic Log Notes		Alteration		Mineralization (vol%)														Enrich	Notes				
Tcu	OxCu	QLT	Elev.	Fl.	H <sub>2</sub> O	Rock				Code	WC	YC	QS	Qtz	Ksp	Chl	FeOx	FeSt	CuOx	CuSt	Py	PySt	Cc	CcSt	Cpy	CpySt	Omin1	Omin2	Other	Oxide	(Rock Description, Alteration, Mineralization, Structure)			
				100						PALT:																					MEDIUM REDDISH BROWN LOOSE POWDERY FINE TO COARSE SAND MINOR CLAY			
				110	DRY					SALT:																					SOME GRAVEL FRAGMENTS - MINUTE			
				110						CLAY:																						TRACE OF SULFIDE - CC - ON FRAGMENT		
				120	DRY					LCAP:																								
				120						PALT:																								
				120						SALT:																								
				130	DRY					CLAY:																								
				130						LCAP:																								
				130						PALT:																								
				140	DRY					SALT:																								
				140						CLAY:																								
				140						LCAP:																								
				150	DRY					PALT:																								
				150						SALT:																								
				150						CLAY:																								
				150						LCAP:																								
				150						PALT:																								
				160	DRY					SALT:																								
				160						CLAY:																								
				170	DRY					LCAP:																								
				170						PALT:																								
				180						SALT:																								
				180						CLAY:																								
				190	DRY					LCAP:																								
				190						PALT:																								
				200	DRY					SALT:																								
				200						CLAY:																								
				200						LCAP:																								
Composite:																																		
Composite:																																		





Logged by: RTW

Analysis			Interval		Drill Log		Graphic Log		Graphic Log Notes		Alteration		Mineralization (vol%)														Enrich		Notes				
Tcu	OxCu	QLT	Elev.	Ft.	H <sub>2</sub> O	Rock					Code	WC	YC	QS	Qtz	Ksp	Chl	FeOx	FeSt	CuOx	CuSt	Py	PySt	Cc	CcSt	Cpy	CpySt	Omin1	Omin2	Other	Oxide	(Rock Description, Alteration, Mineralization, Structure)	
				0	MOIST					GILA CONG.	PALT:																						MEDIUM TO DARK BROWN GRAVEL, COARSE TO MEDIUM SAND-VERY MINOR TRACES OF BLACK OXIDE NO VISIBLE SULFIDES. GILA CONGL.
				10	MOIST						SALT:																						
				10	MOIST						CLAY:																						
				20	MOIST						LCAP:																						
				20	MOIST						PALT:																						
				20	MOIST						SALT:																						
				20	MOIST						CLAY:																						
				30	MOIST						LCAP:																						
				30	MOIST						PALT:																						
				30	MOIST						SALT:																						
				40	MOIST						CLAY:																						
				40	MOIST						LCAP:																						
				40	MOIST						PALT:																						
				40	MOIST						SALT:																						
				40	MOIST						CLAY:																						
				50	MOIST						LCAP:																						
Composite:																																	
				50	DRY						PALT:																						
				60	DRY						SALT:																						
				60	DRY						CLAY:																						
				70	DRY						LCAP:																						
				70	DRY						PALT:																						
				80	DRY					GILA CONG	SALT:																						
				80	DRY						CLAY:																						
				80	DRY						LCAP:																						
				90	DRY					TRACE SULFIDES	PALT:																						
				90	DRY						SALT:																						
				90	DRY						CLAY:																						
				100	DRY					TRACE SULFIDES	PALT:																						
				100	DRY						SALT:																						
				100	DRY						CLAY:																						
Composite:																																	

Drill Hole Logging Form

Project: 5A DUMP CHARACTERIZATION

Hole Number: 5A-3

Northing:

Date Drilled:

Type: RC-DRY

Hole Depth: 250'

Easting:

Orientation: -90°

C.E.:

Logged by: RJW

Analysis			Interval		Drill Log		Graphic Log		Graphic Log Notes		Alteration		Mineralization (vol%)										Enrich		Notes											
Tcu	OxCu	QLT	Elev.	Fl.	H <sub>2</sub> O	Rock				Code	WC	YC	QS	Qtz	Ksp	Chl	FeOx	FeSt	CuOx	CuSt	Py	PySt	Cc	CcSt	Cpy	CpySt	Omin1	Omin2	Other	Oxide	(Rock Description, Alteration, Mineralization, Structure)					
				100						PALT:																						MEDIUM TAN COARSE TO FINE ANGULAR SAND ~5% TO 10% CLAY MINOR GRAVEL VERY SPARSE DISSEMINATED TINY GRAINS OF PYRITE ON SOME LARGER FRAGMENTS OF GD.				
				110	DRY				TRACE SULFIDES	SALT:																										
										CLAY:																										
										LCAP:																										
				110						PALT:																										
				120	DRY				TRACE SULFIDES	SALT:																										
										CLAY:																										
										LCAP:																										
				120						PALT:																										
				130	DRY				GILA CONG	SALT:																										
										CLAY:																										
										LCAP:																										
				130						PALT:																										
				140	DRY					SALT:																										
										CLAY:																										
										LCAP:																										
				140						PALT:																										
				150	DRY					SALT:																										
										CLAY:																										
										LCAP:																										
Composite:																																				
				150						PALT:																										
				160	DRY					SALT:																										
										CLAY:																										
										LCAP:																										
				160						PALT:																										
				170	DRY					SALT:																										
										CLAY:																										
										LCAP:																										
				170						PALT:																										
				180	DRY					SALT:																										
										CLAY:																										
										LCAP:																										
				180						PALT:																										
				190	DRY					SALT:																										
										CLAY:																										
										LCAP:																										
				190						PALT:																										
				200	DRY				GILA CONG.	SALT:																										
										CLAY:																										
										LCAP:																										
Composite:																																				



Project: 5A DUMP CHARACTERIZATION

Hole Number: 5A-3      Northing:

Hole Number: 5A-3      Northing:

Type: RC-DRY

Hole Depth: 250'

Orientation:  $-90^\circ$

Logged by:

[illegible]

## Drill Hole Logging Form

Project:

Hole Number: 5A-4  
Date Drilled: 11-13-05 Type: RC-DRY

Northing: 13746.329N  
 Hole Depth: 250'

Easting: 16254.615  
Orientation: -90°

C.E.: 6299.719  
Logged by: RJ WAIDLER

Analysis			Interval		Drill Log		Graphic Log		Graphic Log Notes		Alteration		Alteration		Mineralization (vol%)																Enrich	Notes
Tcu	OxCu	QLT	Elev.	Ft.	H <sub>2</sub> O	Rock					Code	WC	YC	QS	Qtz	Ksp	Chl	FeOx	FeSt	CuOx	CuSt	Py	PySt	Cc	CcSt	Cpy	CpySt	Omin1	Omin2	Other	Oxide	(Rock Description, Alteration, Mineralization, Structure)
				0					GILA CONG.	PALT:																						MEDIUM BROWN MIXED COARSE TO FINE SAND GRAVEL AND TRACE CLAY FRAGMENTS CONSIST OF GD. NO VISIBLE SULFIDES OR SECONDARY CU MINERALS. GILA
				10		DRY				SALT:																						
				10		DRY				CLAY:																						
				20		DRY				LCAP:																						
				20		DRY				PALT:																						MEDIUM BROWN MIXED COARSE TO FINE ANGULAR SAND GRAVEL TRACE CLAY. TRACES OF CC & BLACK OXIDES ON LARGER FRAGMENTS. NO VISIBLE PYRITE. GILA
				30		DRY				SALT:																						
				30		DRY				CLAY:																						
				40		DRY				LCAP:																						
				40		DRY				PALT:																						MEDIUM BROWN MIXED COARSE TO FINE ANGULAR SAND OCCASIONAL GRAVEL FRAGMENTS MINOR CLAY. TRACES OF PYRITE GRAINS; VERY MINUTE TRACES OF BLACK OXIDE. GILA
				50		DRY				SALT:																						
				50		DRY				CLAY:																						
				50		DRY				LCAP:																						
Composite:																																
				50		DRY			GILA CONG.	PALT:																						LIGHT TO MEDIUM BROWN COARSE TO FINE ANGULAR SAND; SOME GRAVEL FRAGMENTS MINOR CLAY BIOTITE FLAKES VERY MINUTE-MINOR TRACES OF BLACK OXIDE GILA.
				60		DRY				SALT:																						
				60		DRY			TRACE SULFIDE	CLAY:																						
				70		DRY				LCAP:																						
				70		DRY			TRACE SULFIDE	PALT:																						LIGHT REDDISH BROWN FINE TO COARSE SAND; OCCASIONAL GRAVEL FRAGMENTS ~5% TO 10% CLAY WIDELY SCATTERED GRAINS OF PYRITE.
				80		DRY				SALT:																						
				80		DRY			TRACE SULFIDE	CLAY:																						
				90		DRY				LCAP:																						
				90		DRY			TRACE SULFIDE	PALT:																						MEDIUM TO LIGHT SLIGHTLY REDDISH BROWN FINE TO COARSE SAND ~5%

Logged by: RSW

[illegible]

Project: \_\_\_\_\_  
Hole Number: 5A-4      Northing: \_\_\_\_\_      Easting: \_\_\_\_\_      C.E.: \_\_\_\_\_  
Date Drilled: \_\_\_\_\_      Type: \_\_\_\_\_      Hole Depth: 250'      Orientation: \_\_\_\_\_      Logged by: RTW

Analysis			Interval		Drill Log		Graphic Log		Graphic Log Notes		Alteration		Alteration		Mineralization (vol%)														Enrich	Notes				
Tcu	OxCu	QLT	Elev.	Fl.	H <sub>2</sub> O	Rock				Code	WC	YC	QS	Qtz	Ksp	Chl	FeOx	FeSt	CuOx	CuSt	Py	PySt	Cc	CcSt	Cpy	CpySt	Omin1	Omin2	Other	Oxide	(Rock Description, Alteration, Mineralization, Structure)			
				200						PALT:																						MEDIUM TO LIGHT BROWN COARSE TO FINE SAND (ANGULAR) 5% TO 10% CLAY SOME GRAVEL. EXTREMELY SPARSE SCATTERED TINY GRAINS OF PYRITE; NO SECONDARY CU MINERALS.		
				210	DRY					SALT:																								
										CLAY:																								
										LCAP:																								
				210						PALT:																								LIGHT TAN COARSE TO FINE SAND; 5% TO 10% CLAY SOME GRAVEL; TINY DISSEMINATED GRAINS OF PYRITE IN FRAGMENTS AND SAND NO SECONDARY CU MINERALS.
				220	DRY					SALT:																								
										CLAY:																								
										LCAP:																								
				220						PALT:																								LIGHT TANNISH GRAY COARSE TO FINE SAND; 5% TO 10% CLAY; SOME GRAVEL TINY DISSEMINATED GRAINS OF PYRITE IN FRAGMENTS & SAND; NO VISIBLE SECONDARY CU MINERALS.
				230	DRY					SALT:																								
										CLAY:																								
										LCAP:																								
				230						PALT:																								MEDIUM TO DARK BROWN COARSE TO FINE SAND; 15% TO 20% CLAY SOME GRAVEL. NO VISIBLE SULFIDES OR SECONDARY CU MINERALIZATION
				240	DRY					SALT:																								
										CLAY:																								
										LCAP:																								
				240						PALT:																								MEDIUM BROWN COARSE TO FINE SAND 5% TO 10% CLAY SOME GRAVEL NO VISIBLE SULFIDES OR SECONDARY CU MINERALS FLAKES OF BIOTITE E.O.H.
				250	DRY					SALT:																								
										CLAY:																								
										LCAP:																								
Composite:										PALT:																								
										SALT:																								
										CLAY:																								
										LCAP:																								
										PALT:																								
										SALT:																								
										CLAY:																								
										LCAP:																								
										PALT:																								
										SALT:																								
										CLAY:																								
										LCAP:																								
										PALT:																								
										SALT:																								
										CLAY:																								
										LCAP:																								
Composite:										PALT:																								
										SALT:																								
										CLAY:																								
										LCAP:																								

Project:

Hole Number: 5A-5

Date Drilled: 11-13-05 Type: RC-DRY

Northing: 14300.878  
 Hole Depth: 250'

Easting: 15700.451  
Orientation: -90°

C.E.: 6295.904  
Logged by: RJW 12-13-05

[illegible]



Project:

Hole Number: 5A-5

Date Drilled:

Type: RC-DRY

Nothing:

Easting:

C.E.:

Orientation:

Logged by: KJW 12-13-05

Analysis			Interval		Drill Log		Graphic Log		Graphic Log Notes		Alteration		Mineralization (vol%)																Enrich	Notes		
Tcu	OxCu	QLT	Elev.	Ft.	H <sub>2</sub> O	Rock				Code	WC	YC	QS	Qtz	Ksp	Chl	FeOx	FeSt	CuOx	CuSt	Py	PySt	Cc	CcSt	Cpy	CpySt	Omin1	Omin2	Other	Oxide	(Rock Description, Alteration, Mineralization, Structure)	
				100					LEACH CAP DUMP MATERIAL	PALT:																					LIGHT TO MEDIUM REDDISH BROWN	
				110		DRY				SALT:																					COARSE TO FINE SUB-ANGULAR SAND & GRAVEL 5 TO 10% CLAY. WIDELY	
										CLAY:																					SCATTERED GRAINS OF PYRITE & ENRICHED	
										LCAP:																						PYRITE TRACES OF BLACK OXIDES
				110		DRY			LEACH CAP DUMP MATERIAL	PALT:																						MEDIUM REDDISH BROWN COARSE TO
				120						SALT:																						FINE SUB-ANGULAR SAND & GRAVEL
										CLAY:																						5 TO 10% CLAY WIDELY SCATTERED
										LCAP:																						GRAINS OF PYRITE, ENRICHED PYRITE
				120		DRY				PALT:																						TRACES BLACK OXIDES.
				130		DRY			LEACH CAP DUMP MATERIAL	SALT:																						MEDIUM REDDISH BROWN COARSE TO
										CLAY:																						FINE SUB-ANGULAR SAND & GRAVEL 5
				130		DRY				LCAP:																						TO 10% CLAY. SPARSE WIDELY SCATTERED
										PALT:																						GRAINS OF PYRITE-ENRICHED PYRITE
				140		DRY			LEACH CAP DUMP MATERIAL	SALT:																						TRACES BLACK OXIDE.
										CLAY:																						LIGHT REDDISH BROWN COARSE TO
				140		DRY				LCAP:																						FINE SUB-ANGULAR SAND & GRAVEL
										PALT:																						5 TO 10% CLAY VERY WIDELY SCATTERED
				150		DRY			LEACH CAP DUMP MATERIAL	SALT:																						GRAINS OF PYRITE TRACES OF BLACK
										CLAY:																						OXIDES.
										LCAP:																						LIGHT TAN-BROWN COARSE TO FINE
				150		DRY			VERY WEAK SULFIDE DUMP MATERIAL	PALT:																						SUB-ANGULAR SAND & GRAVEL 5 TO
										SALT:																						10% CLAY WIDELY SCATTERED GRAINS
				160		DRY				CLAY:																						OF PYRITE & ENRICHED PYRITE TRACES
										LCAP:																						OF BLACK OXIDES
				160		DRY			VERY WEAK SULFIDE	PALT:																						LIGHT MEDIUM BROWN COARSE TO
										SALT:																						FINE SUB-ANGULAR SAND & GRAVEL
				170		DRY				CLAY:																						5 TO 10% CLAY. WIDELY SCATTERED
										LCAP:																						GRAINS OF PYRITE, ENRICHED PYRITE
				170		DRY			VERY WEAK SULFIDE	PALT:																						NO VISIBLE BLACK OXIDES.
										SALT:																						LIGHT TAN-BROWN COARSE TO FINE
				180		DRY				CLAY:																						SUB-ANGULAR SAND & GRAVEL
										LCAP:																						~ 5% CLAY WIDELY SCATTERED GRAINS
				190		DRY			VERY WEAK SULFIDE	PALT:																						OF PYRITE, ENRICHED PYRITE. NO VISIBLE
										SALT:																						BLACK OXIDES.
				190		DRY				CLAY:																						LIGHT MEDIUM BROWN COARSE TO
										LCAP:																						FINE SUBANGULAR SAND & GRAVEL
				200		DRY			VERY WEAK SULFIDE	PALT:																						~ 5% CLAY. WIDELY SCATTERED
										SALT:																						GRAINS OF PYRITE, ENRICHED PYRITE
										CLAY:																						NO VISIBLE BLACK OXIDES.
				200		DRY				LCAP:																						LIGHT BROWN COARSE TO FINE
										PALT:																						SUB-ANGULAR SAND & GRAVEL ~ 5%
										SALT:																						CLAY SCATTERED GRAINS OF PYRITE,
										CLAY:																						ENRICHED PYRITE NO VISIBLE BLACK
										LCAP:																						OXIDES.
Composite:																																

Project:

Nothing:

Easting:

C.E.:

Logged by: RSW

Hole Depth: 250

Orientation:

[illegible]

## **APPENDIX E**

### **SOIL HYDRAULIC PROPERTIES LABORATORY REPORT**



# **Laboratory Report for Golder Associates, Inc.**

**Project # 053-2016**

**Tyrone Supp. Borrow Mat. Investigation**

**December 31, 2005**



***Daniel B. Stephens & Associates, Inc.***

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109



December 31, 2005

Mr. Doug Romig  
Golder Associates, Inc.  
4910- A Alameda Blvd. NE  
Albuquerque, NM 87113

Re: DBS&A Laboratory Report for Golder Associates, Inc.  
Project # 053-2016; Tyrone Supp. Borrow Mat. Investigation

Dear Mr. Romig:

Enclosed is the final report for the Golder Associates, Inc., Project # 053-2016; Tyrone Supp. Borrow Mat. Investigation samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed final report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the final report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to Golder Associates, Inc. and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.  
LABORATORY / TESTING FACILITY

Joleen Hines  
Laboratory Supervising Manager

Enclosure

*Daniel B. Stephens & Associates, Inc.*

6020 Academy NE, Suite 100

505-822-9400

Albuquerque, NM 87109

FAX 505-822-8877

## **Summaries**



*Daniel B. Stephens & Associates, Inc.*

## Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties <sup>1</sup> ( $\theta$ , $\rho_s$ , $\phi$ )	Saturated Hydraulic Conductivity <sup>2</sup>		Moisture Characteristics <sup>3</sup>				Unsaturated Hydraulic Conductivity	Particle Size <sup>4</sup>		Effective Porosity	Particle Density	Air Permeability	1/3, 15 Bar Points and Water Holding Capacity	Atterberg Limits	Proctor Compaction
		CH	FH	HC	PP	TH	WP	RH	DS	WS						
TP5A7	X	X		X	X	X	X	X	X							
TP5A8	X	X		X	X	X	X	X	X							
TP5A21	X	X		X	X	X	X	X	X							

<sup>1</sup>  $\theta$  = Initial moisture content,  $\rho_s$  = Dry bulk density,  $\phi$  = Calculated porosity

<sup>2</sup> CH = Constant head, FH = falling head

<sup>3</sup> HC = Hanging column, PP = Pressure plate, TH = Thermocouple psychrometer, WP = Water activity meter, RH = Relative humidity box

<sup>4</sup> DS = Dry sieve, WS = Wet sieve, H = Hydrometer



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*Daniel B. Stephens & Associates, Inc.*

### Summary of Sample Preparation

Sample Number	Target Remold Densities	Actual Remold Data		
	Maximum Dry Bulk Density (g/cm <sup>3</sup> )	Gravimetric Moisture Content (%, g/g)	Dry Bulk Density (g/cm <sup>3</sup> )	Percent of Target Dry Bulk Density (%)
TP5A7	1.40	10.9	1.39	99.3%
TP5A8	1.40	10.5	1.39	99.5%
TP5A21	1.40	10.3	1.40	100%



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*Daniel B. Stephens & Associates, Inc.*

**Summary of Initial Moisture Content, Dry Bulk Density  
Wet Bulk Density and Calculated Porosity**

Sample Number	Initial Moisture Content		Dry Bulk Density (g/cm <sup>3</sup> )	Wet Bulk Density (g/cm <sup>3</sup> )	Calculated Porosity (%)
	Gravimetric (%, g/g)	Volumetric (%, cm <sup>3</sup> /cm <sup>3</sup> )			
TP5A7	10.9	15.2	1.39	1.54	47.5
TP5A8	10.5	14.6	1.39	1.54	47.4
TP5A21	10.3	14.4	1.40	1.54	47.3

---

NA = Not analyzed



*Daniel B. Stephens & Associates, Inc.*

### Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K <sub>sat</sub> (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
TP5A7	3.4E-03	X	
TP5A8	1.8E-02	X	
TP5A21	2.2E-02	X	



---

*Daniel B. Stephens & Associates, Inc.*

### Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	$\alpha$ (cm <sup>-1</sup> )	N (dimensionless)	$\theta_r$	$\theta_s$
TP5A7	0.0765	1.2400	0.0000	0.3119
TP5A8	0.1113	1.2416	0.0000	0.3388
TP5A21	0.5936	1.2010	0.0000	0.4190





*Daniel B. Stephens & Associates, Inc.*

**Summary of Calculated Unsaturated Hydraulic Properties with Gravel  
Corrections**

Sample Number	Ksat	$\theta_i$	$\theta_s$	$\theta_r$
TP5A7	1.8E-03	0.0811	0.1663	0.0000
TP5A8	8.5E-03	0.0693	0.1609	0.0000
TP5A21	9.8E-03	0.0641	0.1865	0.0000



---

*Daniel B. Stephens & Associates, Inc.*

**Summary of Moisture Characteristics  
of the Initial Drainage Curve**

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm <sup>3</sup> /cm <sup>3</sup> )
TP5A7	0	31.2
	11	28.0
	41	22.2
	82	19.8
	510	13.5
	7547	6.5
	851293	1.9
TP5A8	0	33.4
	9	30.8
	42	21.5
	82	19.4
	510	13.4
	7750	6.6
	851293	2.1
TP5A21	0	41.9
	9	29.4
	42	21.4
	82	19.0
	510	14.6
	8464	7.0
	851293	2.5

---

## **Laboratory Data and Graphical Plots**

## **Initial Properties**



*Daniel B. Stephens & Associates, Inc.*

**Summary of Initial Moisture Content, Dry Bulk Density  
Wet Bulk Density and Calculated Porosity**

Sample Number	Initial Moisture Content		Dry Bulk Density (g/cm <sup>3</sup> )	Wet Bulk Density (g/cm <sup>3</sup> )	Calculated Porosity (%)
	Gravimetric (%, g/g)	Volumetric (%, cm <sup>3</sup> /cm <sup>3</sup> )			
TP5A7	10.9	15.2	1.39	1.54	47.5
TP5A8	10.5	14.6	1.39	1.54	47.4
TP5A21	10.3	14.4	1.40	1.54	47.3

---

NA = Not analyzed



---

*Daniel B. Stephens & Associates, Inc.*

**Data for Initial Moisture Content,  
Bulk Density, Porosity, and Percent Saturation**

*Job Name:* Golder Associates, Inc.  
*Job Number:* LB05.0243.00  
*Sample Number:* TP5A7  
*Ring Number:* NA  
*Depth:* NA

*Test Date:* 24-Oct-05

*Field weight\* of sample (g):* 333.94  
*Tare weight, ring (g):* 116.03  
*Tare weight, cap/plate/epoxy (g):* 0.00

*Dry weight of sample (g):* 196.46  
*Sample volume (cm<sup>3</sup>):* 141.33  
*Assumed particle density:* 2.65

---

*Initial Volumetric Moisture Content (% vol):* 15.2  
*Initial Gravimetric Moisture Content (% g/g):* 10.9  
*Dry bulk density (g/cm<sup>3</sup>):* 1.39  
*Wet bulk density (g/cm<sup>3</sup>):* 1.54  
*Calculated Porosity (% vol):* 47.5  
*Percent Saturation:* 31.9

---

*Comments:*

\* Weight including tares  
NA = Not analyzed

*Laboratory analysis by:* D. O'Dowd  
*Data entered by:* T. Bowekaty  
*Checked by:* J. Hines



---

*Daniel B. Stephens & Associates, Inc.*

**Data for Initial Moisture Content,  
Bulk Density, Porosity, and Percent Saturation**

*Job Name:* Golder Associates, Inc.  
*Job Number:* LB05.0243.00  
*Sample Number:* TP5A8  
*Ring Number:* NA  
*Depth:* NA

*Test Date:* 24-Oct-05

*Field weight\* of sample (g):* 337.90  
*Tare weight, ring (g):* 121.52  
*Tare weight, cap/plate/epoxy (g):* 0.00

*Dry weight of sample (g):* 195.82  
*Sample volume (cm<sup>3</sup>):* 140.52  
*Assumed particle density:* 2.65

---

*Initial Volumetric Moisture Content (% vol):* 14.6  
*Initial Gravimetric Moisture Content (% g/g):* 10.5  
*Dry bulk density (g/cm<sup>3</sup>):* 1.39  
*Wet bulk density (g/cm<sup>3</sup>):* 1.54  
*Calculated Porosity (% vol):* 47.4  
*Percent Saturation:* 30.9

---

*Comments:*

\* Weight including tares  
NA = Not analyzed

*Laboratory analysis by:* D. O'Dowd  
*Data entered by:* T. Bowekaty  
*Checked by:* J. Hines



---

*Daniel B. Stephens & Associates, Inc.*

**Data for Initial Moisture Content,  
Bulk Density, Porosity, and Percent Saturation**

*Job Name:* Golder Associates, Inc.  
*Job Number:* LB05.0243.00  
*Sample Number:* TP5A21  
*Ring Number:* NA  
*Depth:* NA

*Test Date:* 24-Oct-05

*Field weight\* of sample (g):* 339.45  
*Tare weight, ring (g):* 121.92  
*Tare weight, cap/plate/epoxy (g):* 0.00

*Dry weight of sample (g):* 197.20  
*Sample volume (cm<sup>3</sup>):* 141.12  
*Assumed particle density:* 2.65

---

*Initial Volumetric Moisture Content (% vol):* 14.4  
*Initial Gravimetric Moisture Content (% g/g):* 10.3  
*Dry bulk density (g/cm<sup>3</sup>):* 1.40  
*Wet bulk density (g/cm<sup>3</sup>):* 1.54  
*Calculated Porosity (% vol):* 47.3  
*Percent Saturation:* 30.5

---

**Comments:**

\* Weight including tares  
NA = Not analyzed

*Laboratory analysis by:* D. O'Dowd  
*Data entered by:* T. Bowekaty  
*Checked by:* J. Hines



## **Saturated Hydraulic Conductivity**



---

*Daniel B. Stephens & Associates, Inc.*

### Summary of Saturated Hydraulic Conductivity Tests

Sample Number	$K_{sat}$ (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
TP5A7	3.4E-03	X	
TP5A8	1.8E-02	X	
TP5A21	2.2E-02	X	

---



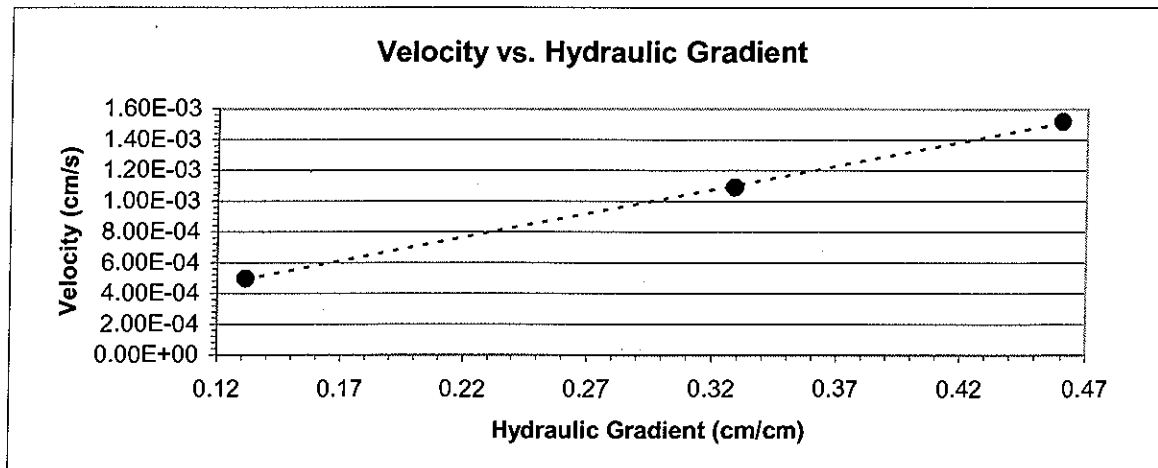
Daniel B. Stephens & Associates, Inc.

### Saturated Hydraulic Conductivity Constant Head Method

Job name: Golder Associates, Inc.	Type of water used: TAP
Job number: LB05.0243.00	Collection vessel tare (g): 4.62
Sample number: TP5A7	Sample length (cm): 7.61
Ring Number: NA	Sample diameter (cm): 4.86
Depth: NA	Sample x-sectional area (cm <sup>2</sup> ): 18.57

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm <sup>3</sup> )	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
02-Nov-05	09:23:44	20.5	3.5	6.3	1.7	60	3.3E-03	3.3E-03
02-Nov-05	09:24:44							
Test # 2:								
04-Nov-05	13:53:21	21.0	1.0	10.0	5.4	588	3.8E-03	3.7E-03
04-Nov-05	14:03:09							
Test # 3:								
06-Nov-05	14:48:33	21.0	2.5	8.2	3.6	176	3.3E-03	3.2E-03
06-Nov-05	14:51:29							

Average Ksat (cm/sec): 3.4E-03



Comments:

Laboratory analysis by: M. Carrillo  
Data entered by: M. Carrillo  
Checked by: J. Hines



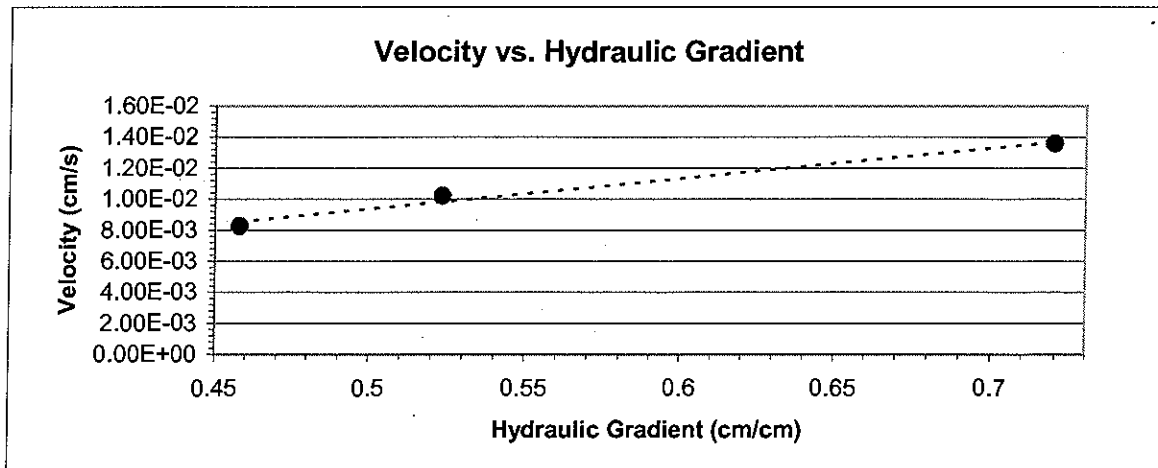
*Daniel B. Stephens & Associates, Inc.*

### Saturated Hydraulic Conductivity Constant Head Method

Job name: Golder Associates, Inc.	Type of water used: TAP
Job number: LB05.0243.00	Collection vessel tare (g): 11.54
Sample number: TP5A8	Sample length (cm): 7.64
Ring Number: NA	Sample diameter (cm): 4.84
Depth: NA	Sample x-sectional area (cm <sup>2</sup> ): 18.39

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm <sup>3</sup> )	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
03-Nov-05	12:21:18	21.0	4.0	32.8	21.2	113	1.9E-02	1.9E-02
03-Nov-05	12:23:11							
Test # 2:								
04-Nov-05	09:19:49	20.5	5.5	20.5	9.0	36	1.9E-02	1.9E-02
04-Nov-05	09:20:25							
Test # 3:								
04-Nov-05	13:55:28	21.0	3.5	20.2	8.7	57	1.8E-02	1.8E-02
04-Nov-05	13:56:25							

**Average Ksat (cm/sec): 1.8E-02**



*Comments:*

Laboratory analysis by: M. Carrillo  
Data entered by: M. Carrillo  
Checked by: J. Hines



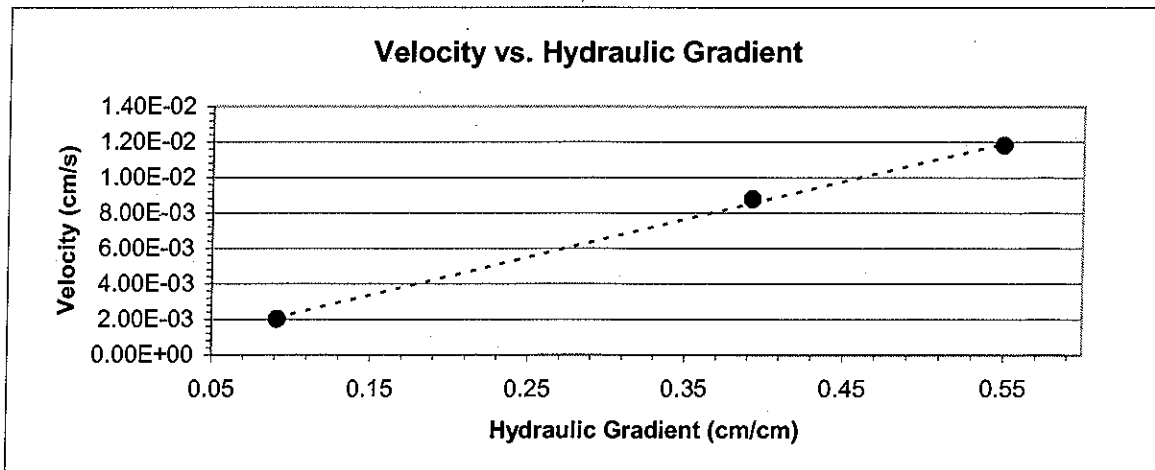
Daniel B. Stephens & Associates, Inc.

### Saturated Hydraulic Conductivity Constant Head Method

Job name: Golder Associates, Inc.	Type of water used: TAP
Job number: LB05.0243.00	Collection vessel tare (g): 11.30
Sample number: TP5A21	Sample length (cm): 7.65
Ring Number: NA	Sample diameter (cm): 4.85
Depth: NA	Sample x-sectional area (cm <sup>2</sup> ): 18.46

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm <sup>3</sup> )	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
03-Nov-05	12:24:05	21.0	4.2	33.1	21.8	100	2.1E-02	2.1E-02
03-Nov-05	12:25:45							
Test # 2:								
03-Nov-05	16:12:10	21.0	3.0	25.9	14.6	90	2.2E-02	2.2E-02
03-Nov-05	16:13:40							
Test # 3:								
04-Nov-05	09:21:15	20.5	0.7	20.9	9.6	257	2.2E-02	2.2E-02
04-Nov-05	09:25:32							

Average Ksat (cm/sec): 2.2E-02



Comments:

Laboratory analysis by: M. Carrillo  
Data entered by: M. Carrillo  
Checked by: J. Hines

## **Unsaturated Hydraulic Conductivity**



---

*Daniel B. Stephens & Associates, Inc.*

### **Summary of Calculated Unsaturated Hydraulic Properties**

Sample Number	$\alpha$ (cm <sup>-1</sup> )	N (dimensionless)	$\theta_r$	$\theta_s$
TP5A7	0.0765	1.2400	0.0000	0.3119
TP5A8	0.1113	1.2416	0.0000	0.3388
TP5A21	0.5936	1.2010	0.0000	0.4190

---



*Daniel B. Stephens & Associates, Inc.*

**Summary of Calculated Unsaturated Hydraulic Properties with Gravel  
Corrections**

Sample Number	Ksat	$\theta_i$	$\theta_s$	$\theta_r$
TP5A7	1.8E-03	0.0811	0.1663	0.0000
TP5A8	8.5E-03	0.0693	0.1609	0.0000
TP5A21	9.8E-03	0.0641	0.1865	0.0000





---

*Daniel B. Stephens & Associates, Inc.*

**Summary of Moisture Characteristics  
of the Initial Drainage Curve**

Sample Number	Pressure Head (-cm water)	Moisture Content (%, $\text{cm}^3/\text{cm}^3$ )
TP5A7	0	31.2
	11	28.0
	41	22.2
	82	19.8
	510	13.5
	7547	6.5
	851293	1.9
TP5A8	0	33.4
	9	30.8
	42	21.5
	82	19.4
	510	13.4
	7750	6.6
	851293	2.1
TP5A21	0	41.9
	9	29.4
	42	21.4
	82	19.0
	510	14.6
	8464	7.0
	851293	2.5

---



Daniel B. Stephens & Associates, Inc.

**Moisture Retention Data**  
**Hanging Column/Pressure Plate/Thermocouple**  
(Main Drainage Curve)

Job Name: Golder Associates, Inc.	Dry wt. of sample (g): 196.46
Job Number: LB05.0243.00	Tare wt., screen & clamp (g): 25.33
Sample Number: TP5A7	Tare wt., ring (g): 116.03
Ring Number: NA	Tare wt., epoxy (g): 0.00
Depth: NA	Sample volume (cm <sup>3</sup> ): 141.33

Saturated weight\* at 0 cm tension (g): 381.87  
Volume of water<sup>†</sup> in saturated sample (cm<sup>3</sup>): 44.05  
Saturated moisture content (% vol): 31.17  
Sample bulk density (g/cm<sup>3</sup>): 1.39

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content <sup>†</sup> (% vol)
Hanging column:	07-Nov-05 / 16:30	381.87	0.00	31.17
	14-Nov-05 / 10:30	377.34	10.50	27.96
	21-Nov-05 / 14:50	369.26	40.50	22.25
	28-Nov-05 / 14:40	365.86	81.50	19.84
Pressure plate:	04-Dec-05 / 10:00	356.83	509.90	13.45

**Sample Settling Information<sup>Note</sup>**

Matric Potential (-cm water)	Percent Settled (%)	Settled Bulk Density (g/cm <sup>3</sup> )
0.00	12.9%	1.57
10.50	NM	NM
40.50	14.5%	1.59
81.50	17.9%	1.64
509.90	17.9%	1.64

**Note:**

Sample settling was measured periodically following hanging column and pressure plate moisture retention points. These values were obtained by averaging several measurements of loss in sample length, measured with a hand caliper. Due to the uneven nature of samples as settling occurs, these values should be considered as estimates.

NS=No Settling

NM=Not Measured

\* Weight including tares

<sup>†</sup> Assumed density of water is 1.0 g/cm<sup>3</sup>

Laboratory analysis by: M. Carrillo  
Data entered by: T. Bowekaty  
Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

**Moisture Retention Data**  
**Water Activity Meter/Relative Humidity Box**  
(Main Drainage Curve)

Job Name: Golder Associates, Inc.  
Job Number: LB05.0243.00  
Sample Number: TP5A7  
Ring Number: NA  
Depth: NA

Dry weight\* of water activity meter sample (g): 243.48  
Tare weight, jar (g): 198.78  
Sample bulk density (g/cm<sup>3</sup>): 1.39

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content <sup>†</sup> (% vol)
Water Activity Meter:	07-Nov-05 / 13:57	245.56	7546.5	6.47

-----

Dry weight\* of relative humidity box sample (g): 67.16  
Tare weight (g): 39.93  
Sample bulk density (g/cm<sup>3</sup>): 1.39

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content <sup>†</sup> (% vol)
Relative humidity box:	08-Nov-05 / 12:20	67.54	851293	1.95

**Comments:**

\* Weight including tares

<sup>†</sup> Assumed density of water is 1.0 g/cm<sup>3</sup>

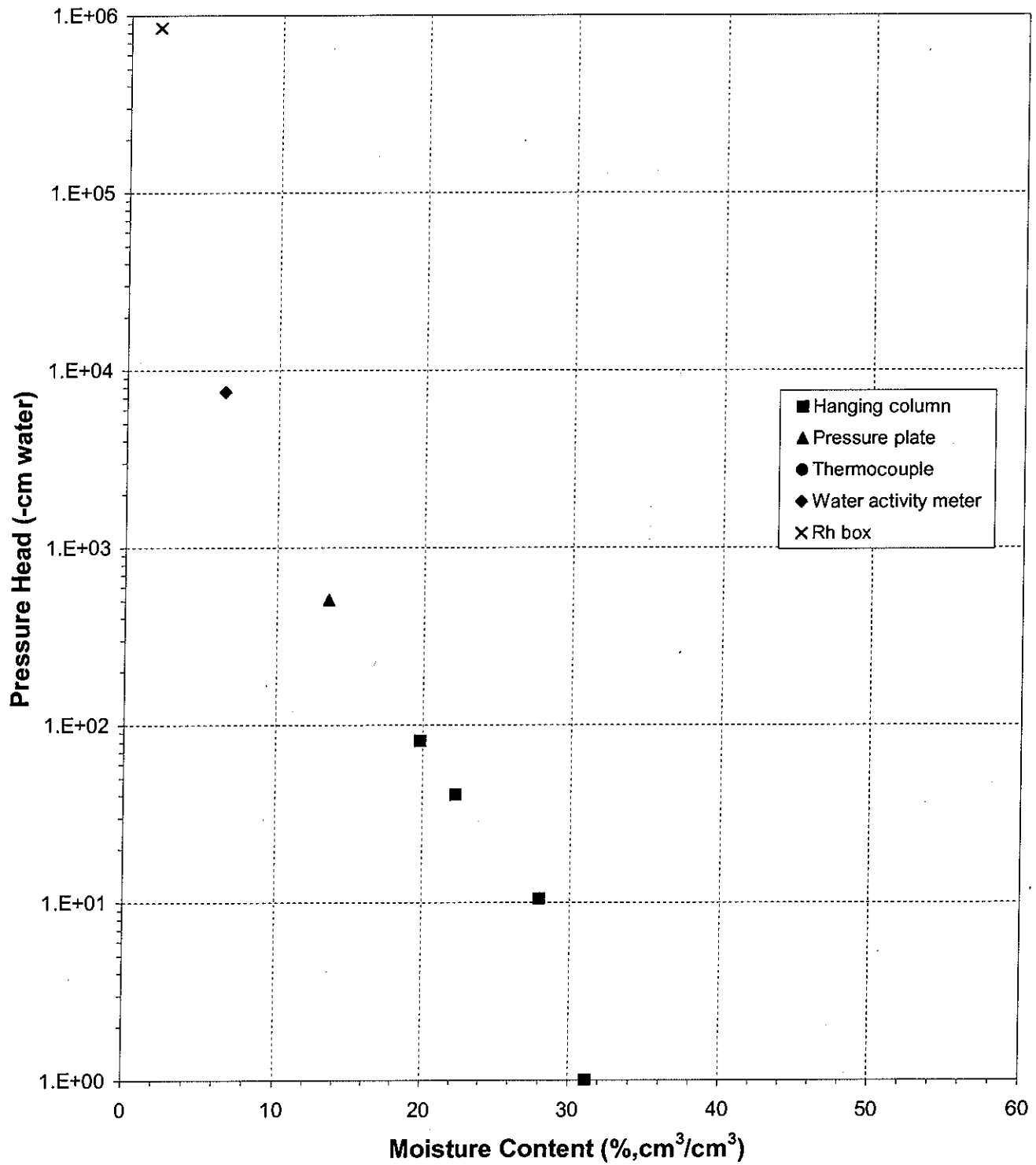
Laboratory analysis by: M. Carrillo/D. O'Dowd  
Data entered by: T. Bowekaty  
Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

### Water Retention Data Points

Sample Number: TP5A7

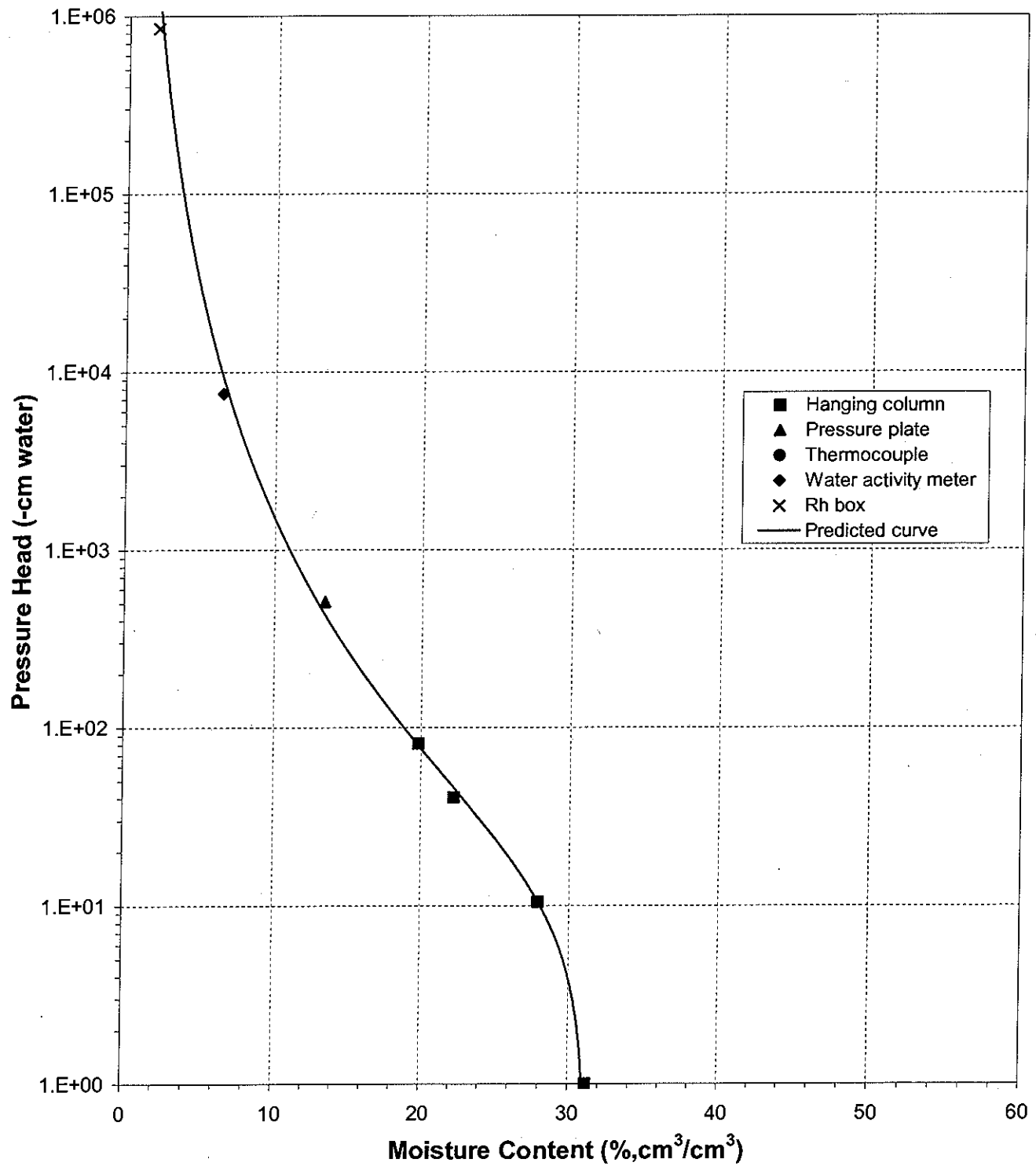




Daniel B. Stephens & Associates, Inc.

### Predicted Water Retention Curve and Data Points

Sample Number: TP5A7

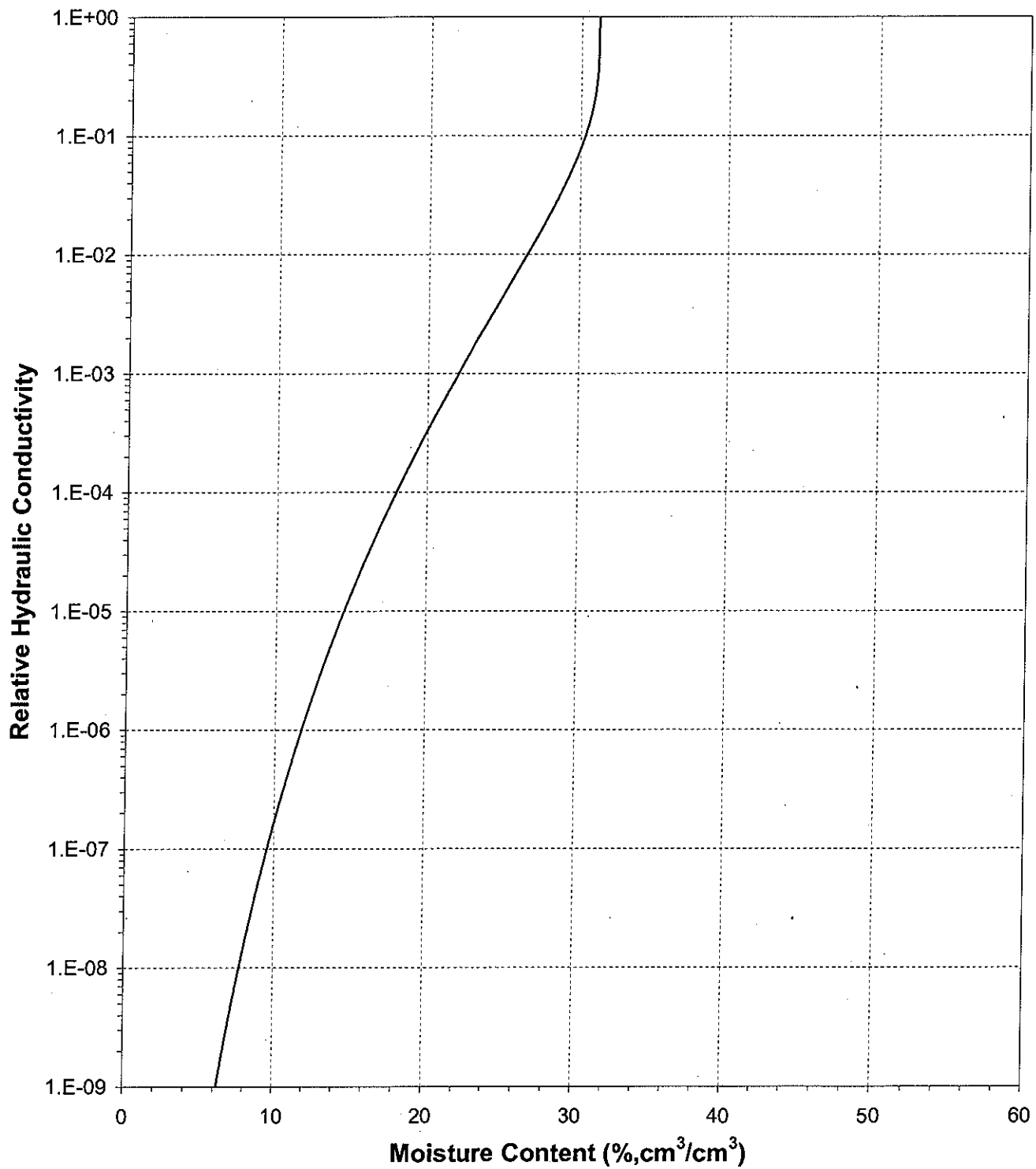




Daniel B. Stephens & Associates, Inc.

### Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: TP5A7

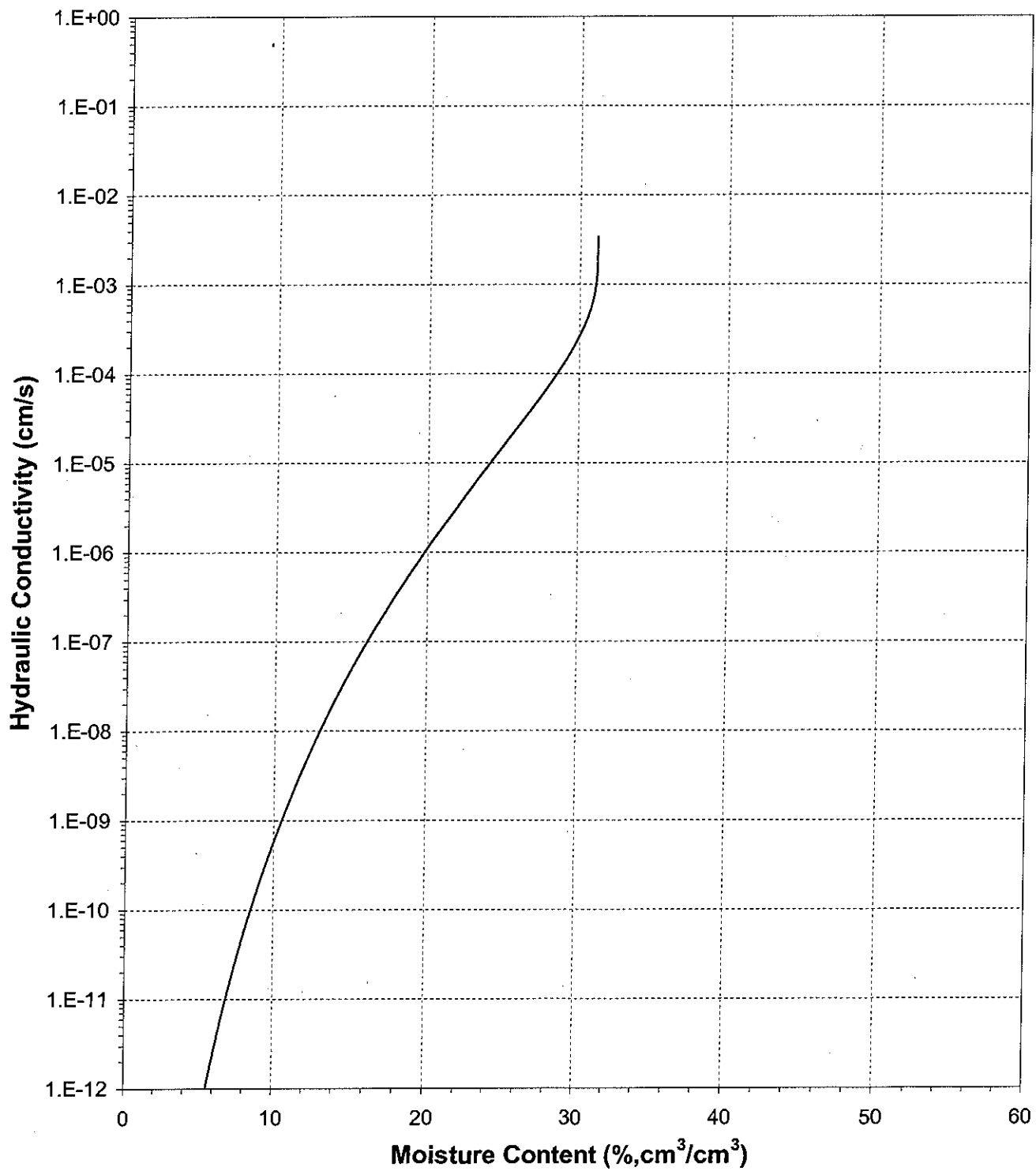




Daniel B. Stephens & Associates, Inc.

### Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: TP5A7

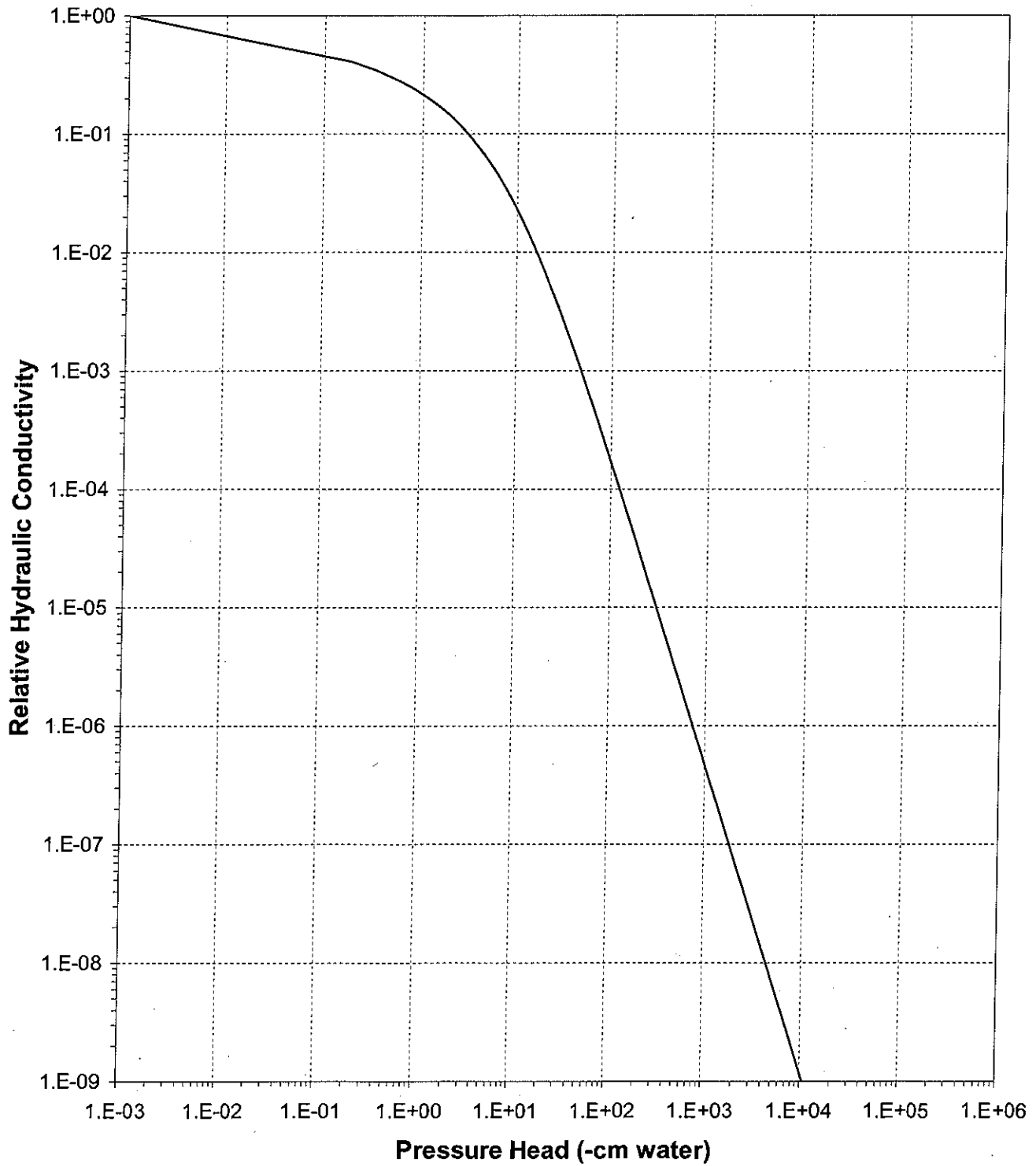




Daniel B. Stephens & Associates, Inc.

### Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: TP5A7



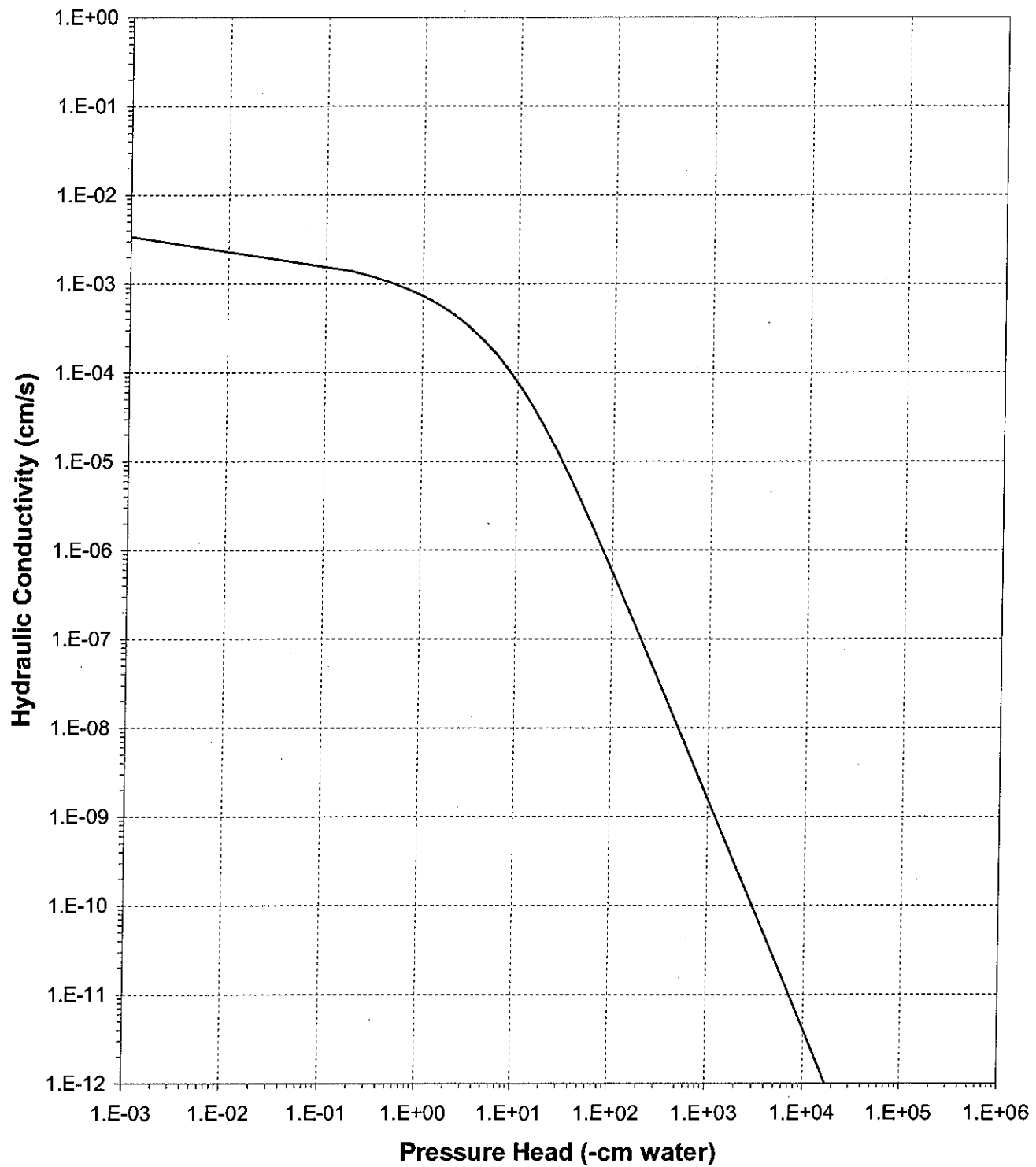




Daniel B. Stephens & Associates, Inc.

### Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: TP5A7





*Daniel B. Stephens & Associates, Inc.*

### Gravel Correction Data Sheet

Job Name: Golder Associates, Inc.  
Job Number: LB05.0243.00  
Sample Number: TP5A7 (Gravel Corrected)  
Ring Number: NA  
Depth: NA  
Split: #10 (2.00 mm)

---

Uncorrected input values	Corrected Values
Mass (coarse)(g): 3475	
Mass (fines)(g): 2083	
Dry bulk density (fines)(g/cm <sup>3</sup> ): 1.39	Density (composite)(g/cm <sup>3</sup> ): 1.98
*Density (coarse)(g/cm <sup>3</sup> ): 2.65	
Ksat value (fines)(cm/sec): 3.4E-03	Ksat composite(cm/sec): 1.8E-03
Theta initial (fines): 0.1520	Theta initial composite: 0.0811
Theta saturated (fines): 0.3119	Theta saturated composite: 0.1663
Theta residual (fines): 0.0000	Theta residual composite: 0.0000
*Theta initial (coarse): 0	
*Theta saturated (coarse): 0	
*Theta residual (coarse): 0	
*Volume (coarse voids)(cm <sup>3</sup> ): 0	

---

Volumetric fraction of fines in composite: 0.533  
Volumetric fraction of coarse in composite: 0.467  
Volumetric fraction of voids in composite: 0.000  
Volume (fines)(cm<sup>3</sup>): 1498.56  
Volume (coarse)(cm<sup>3</sup>): 1311.32  
Volume (composite)(cm<sup>3</sup>): 2809.88

**Comments:**

- \*Assumed to be 2.65, unless measured.
- \*Values will be zero if the coarse fraction is assumed to hold no water in pores.

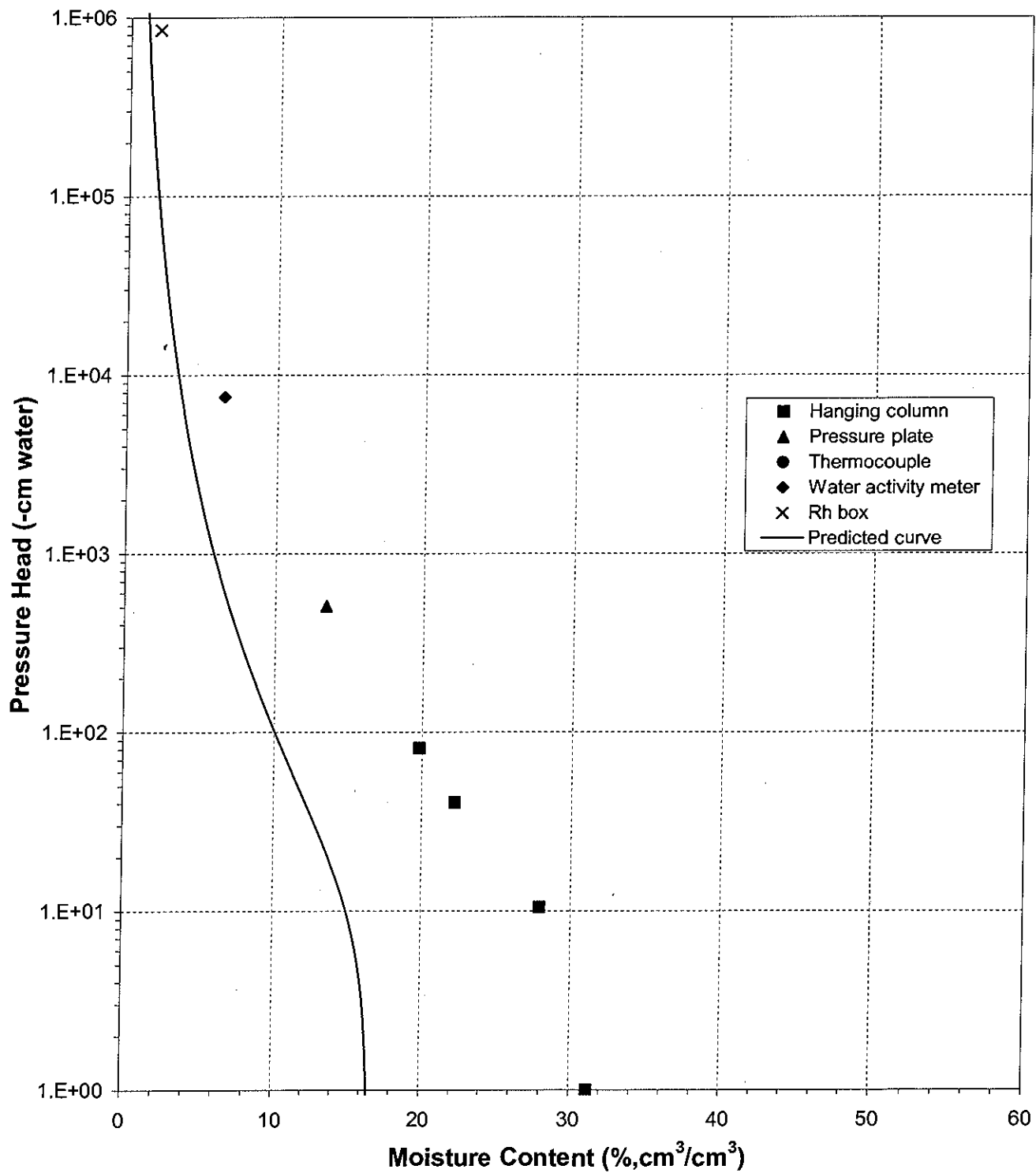
Date: 30-Dec-05  
Data entered by: D. O'Dowd  
Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

### Predicted Water Retention Curve and Data Points

Sample Number: TP5A7 (Gravel Corrected)





Daniel B. Stephens & Associates, Inc.

**Moisture Retention Data**  
**Hanging Column/Pressure Plate/Thermocouple**  
(Main Drainage Curve)

Job Name: Golder Associates, Inc.      Dry wt. of sample (g): 195.82  
Job Number: LB05.0243.00      Tare wt., screen & clamp (g): 25.82  
Sample Number: TP5A8      Tare wt., ring (g): 121.52  
Ring Number: NA      Tare wt., epoxy (g): 0.00  
Depth: NA      Sample volume (cm<sup>3</sup>): 140.52

Saturated weight\* at 0 cm tension (g): 390.15  
Volume of water<sup>†</sup> in saturated sample (cm<sup>3</sup>): 46.99  
Saturated moisture content (% vol): 33.44  
Sample bulk density (g/cm<sup>3</sup>): 1.39

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content <sup>†</sup> (% vol)
Hanging column:	04-Nov-05 / 17:25	390.15	0.00	33.44
	11-Nov-05 / 16:55	386.51	9.00	30.85
	18-Nov-05 / 15:40	373.44	41.50	21.55
	28-Nov-05 / 14:30	370.44	81.50	19.41
Pressure plate:	04-Dec-05 / 10:00	362.03	509.90	13.43

**Sample Settling Information<sup>Note</sup>**

Matric Potential (-cm water)	Percent Settled (%)	Settled Bulk Density (g/cm <sup>3</sup> )
0.00	8.6%	1.51
9.00	11.0%	1.55
41.50	17.4%	1.64
81.50	18.2%	1.65
509.90	18.2%	1.65

**Note:**

Sample settling was measured periodically following hanging column and pressure plate moisture retention points. These values were obtained by averaging several measurements of loss in sample length, measured with a hand caliper. Due to the uneven nature of samples as settling occurs, these values should be considered as estimates.

NS=No Settling

NM=Not Measured

\* Weight including tares

<sup>†</sup> Assumed density of water is 1.0 g/cm<sup>3</sup>

Laboratory analysis by: M. Carrillo  
Data entered by: T. Bowekaty  
Checked by: J. Hines



*Daniel B. Stephens & Associates, Inc.*

**Moisture Retention Data**  
**Water Activity Meter/Relative Humidity Box**  
(Main Drainage Curve)

*Job Name:* Golder Associates, Inc.  
*Job Number:* LB05.0243.00  
*Sample Number:* TP5A8  
*Ring Number:* NA  
*Depth:* NA

*Dry weight\* of water activity meter sample (g):* 257.77  
*Tare weight, jar (g):* 197.28  
*Sample bulk density (g/cm<sup>3</sup>):* 1.39

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content <sup>†</sup> (% vol)
<i>Water Activity Meter:</i>	07-Nov-05 / 12:40	260.65	7750.5	6.63

-----  
*Dry weight\* of relative humidity box sample (g):* 70.83  
*Tare weight (g):* 41.09  
*Sample bulk density (g/cm<sup>3</sup>):* 1.39

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content <sup>†</sup> (% vol)
<i>Relative humidity box:</i>	08-Nov-05 / 12:20	71.28	851293	2.12

*Comments:*

\* Weight including tares

<sup>†</sup> Assumed density of water is 1.0 g/cm<sup>3</sup>

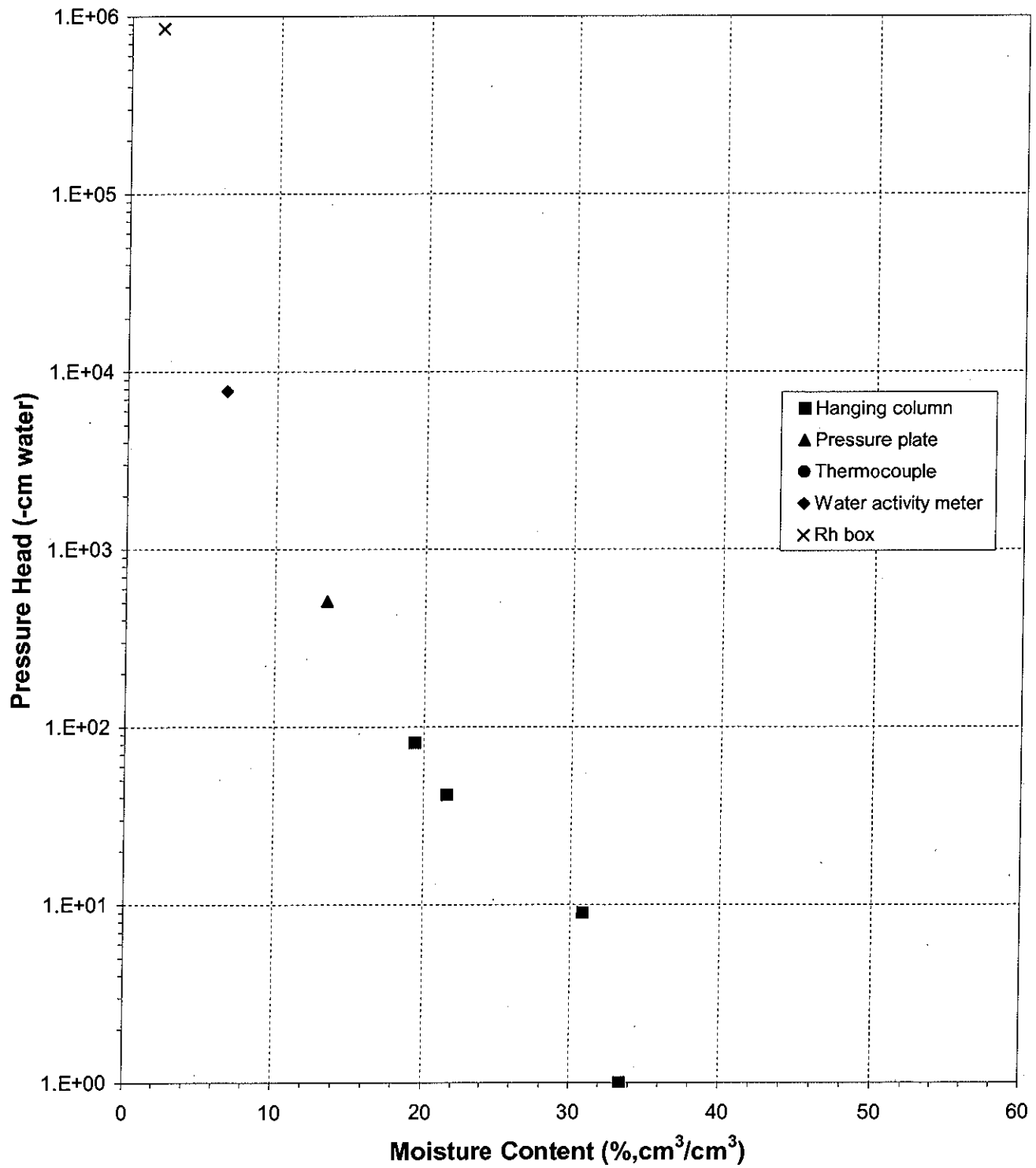
*Laboratory analysis by:* M. Carrillo/D. O'Dowd  
*Data entered by:* T. Bowekaty  
*Checked by:* J. Hines



Daniel B. Stephens & Associates, Inc.

### Water Retention Data Points

Sample Number: TP5A8

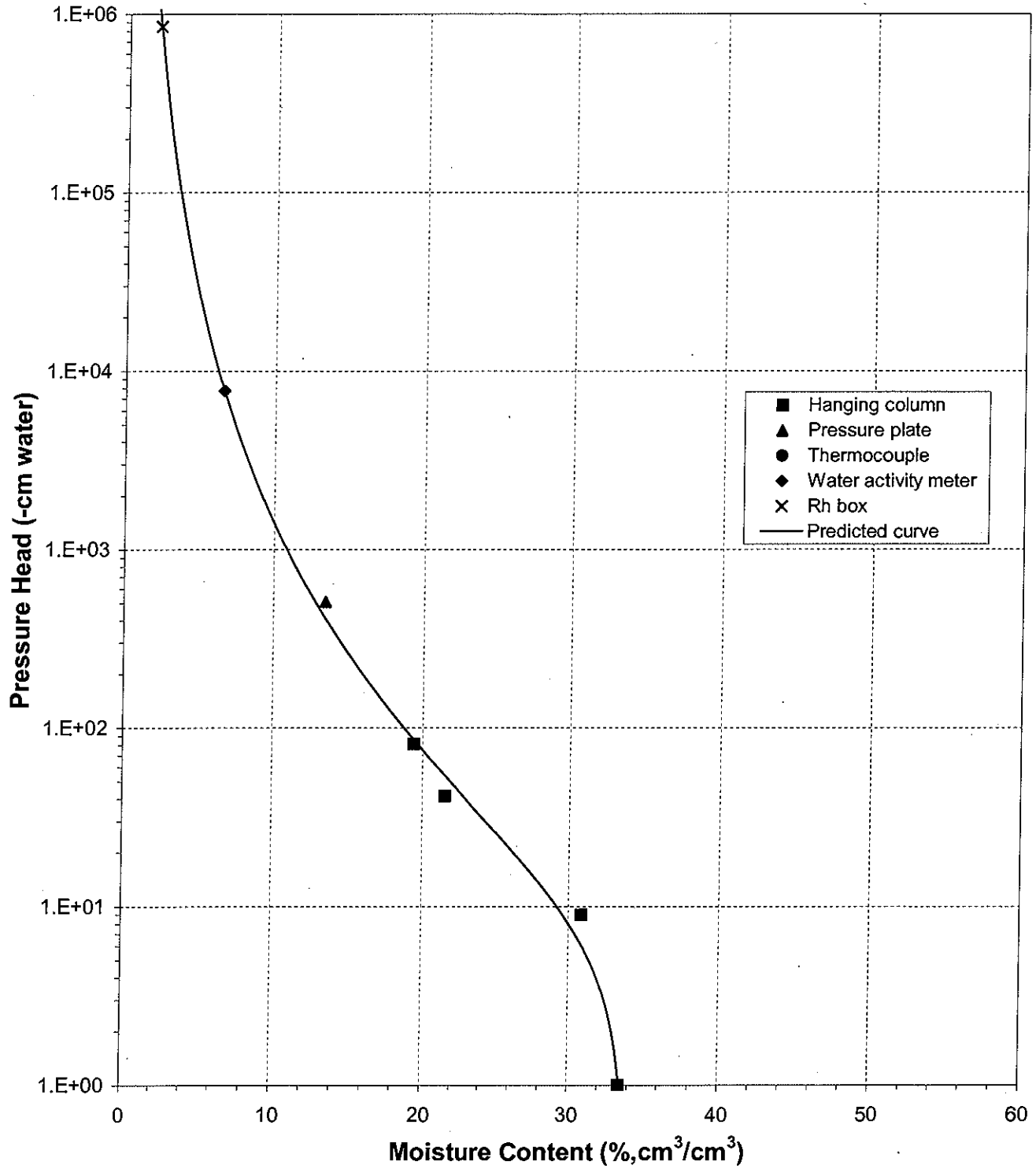




Daniel B. Stephens & Associates, Inc.

### Predicted Water Retention Curve and Data Points

Sample Number: TP5A8

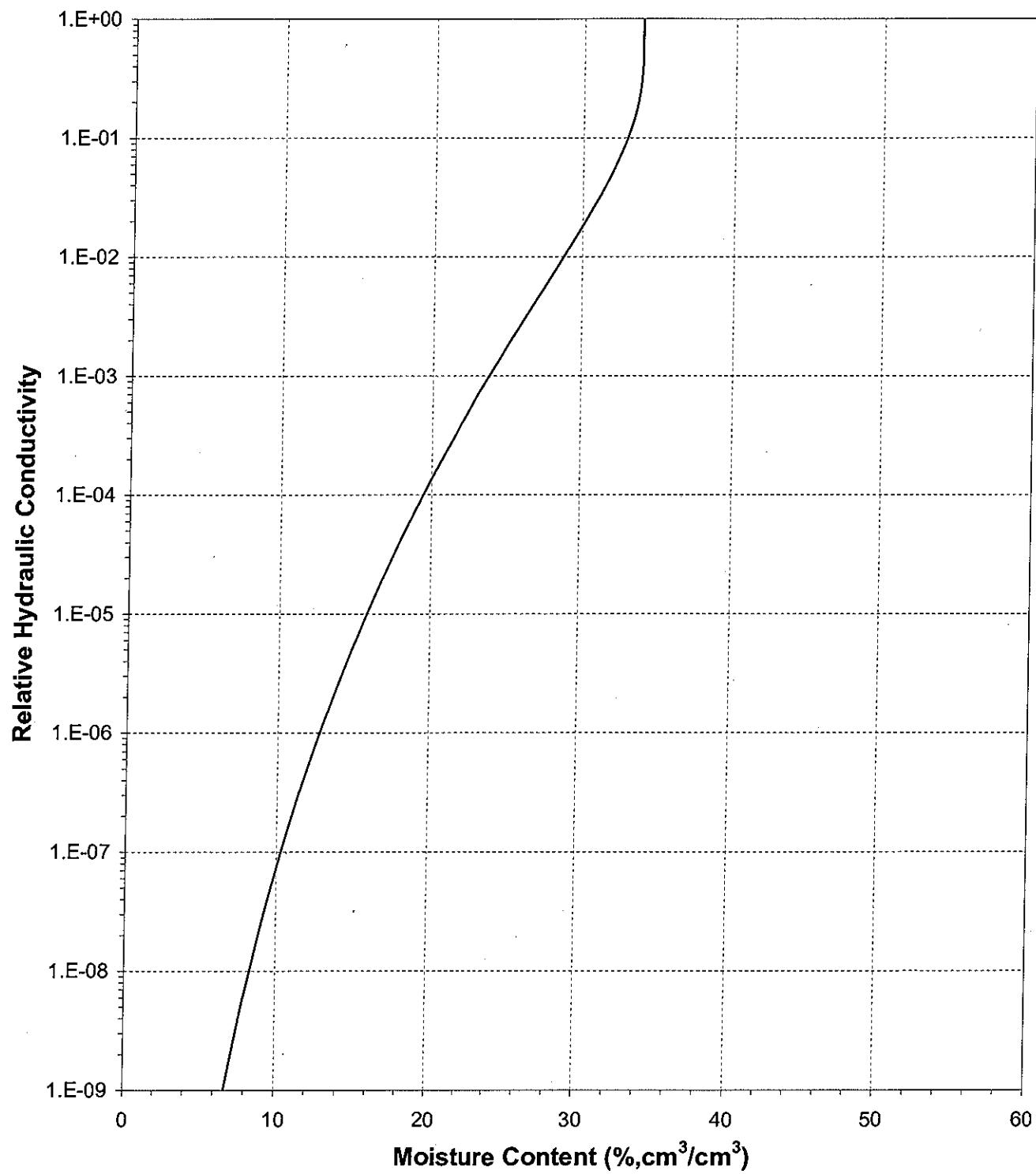




Daniel B. Stephens & Associates, Inc.

Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: TP5A8



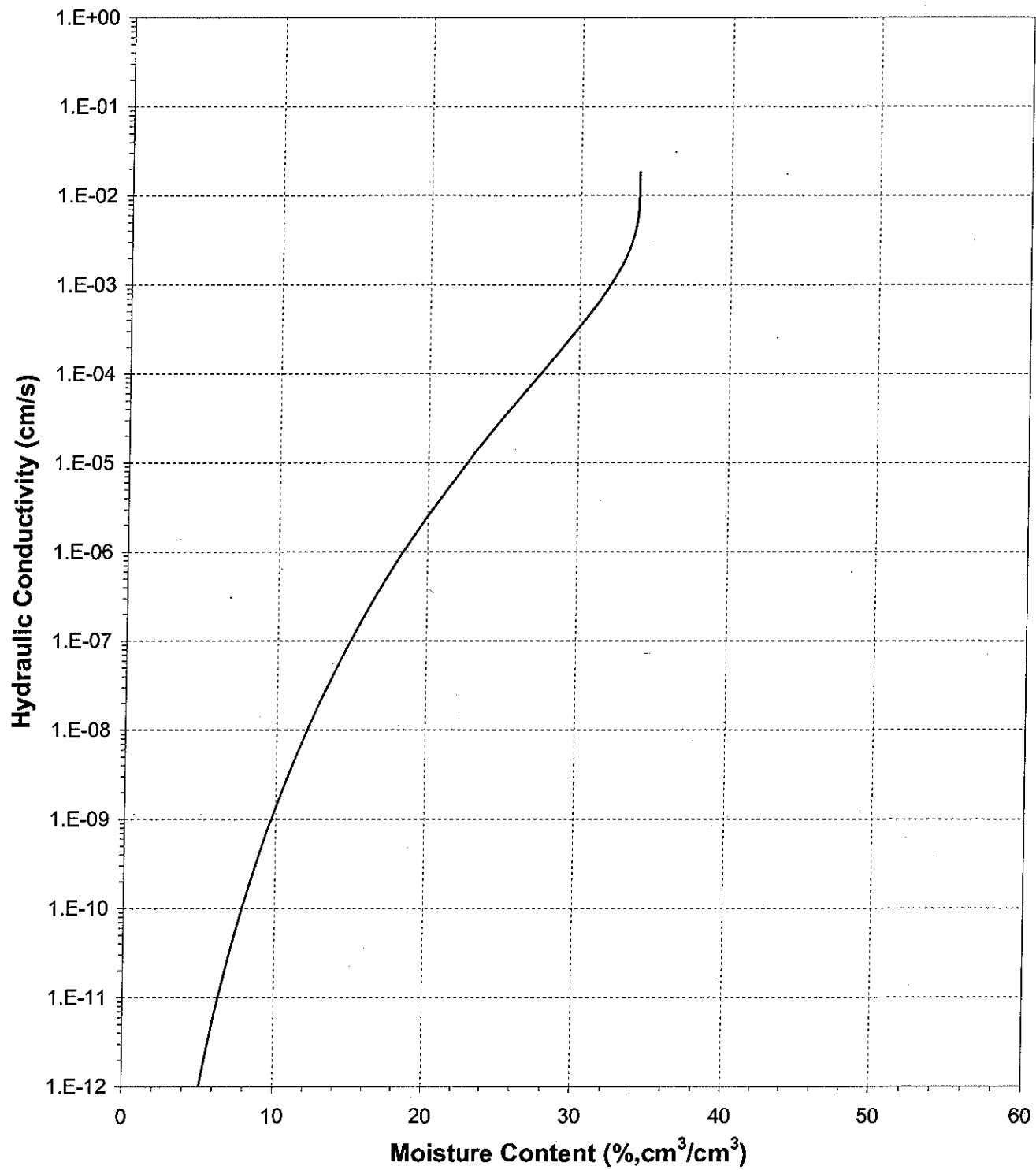




Daniel B. Stephens & Associates, Inc.

### Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: TP5A8

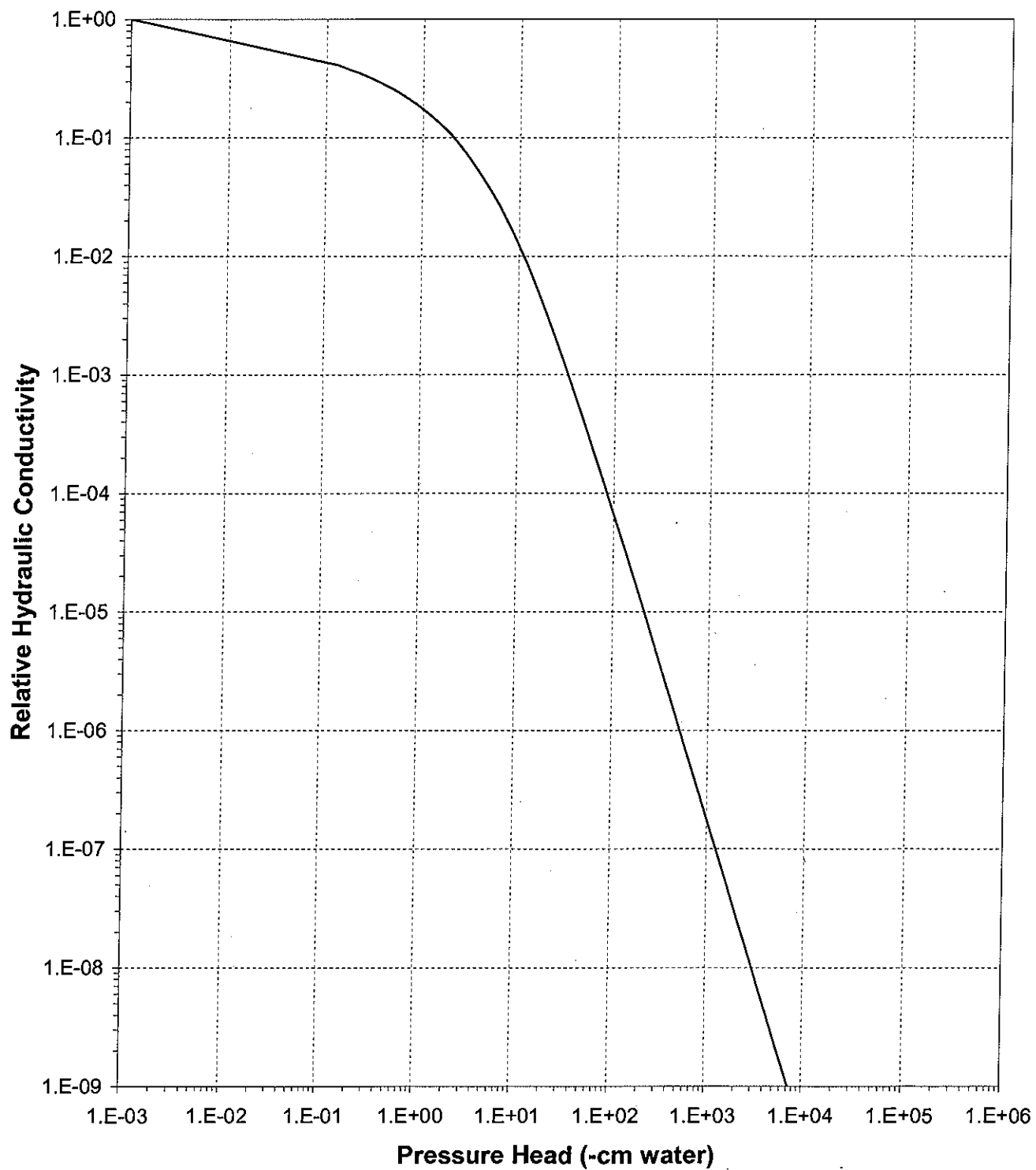




Daniel B. Stephens & Associates, Inc.

### Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: TP5A8

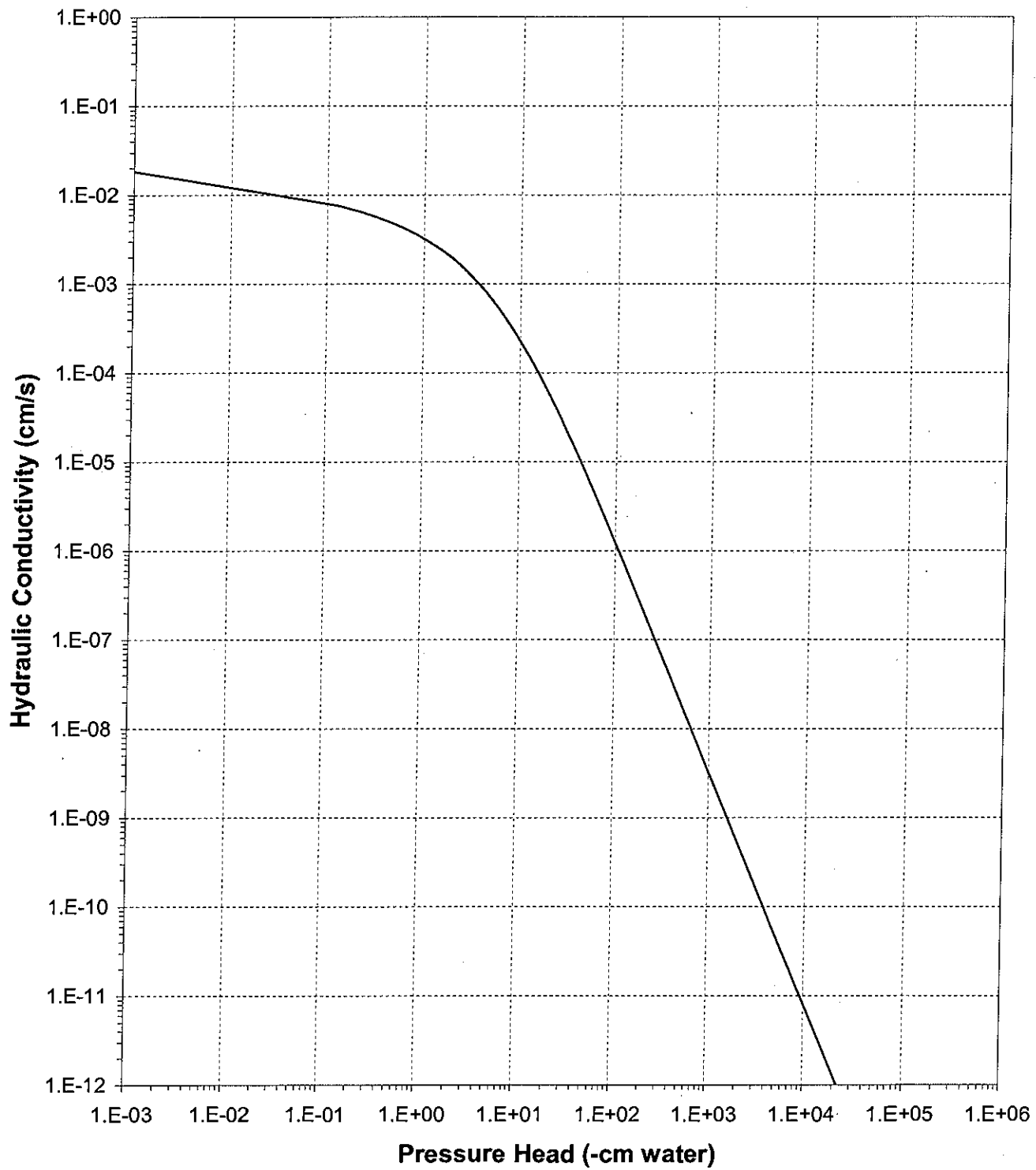




Daniel B. Stephens & Associates, Inc.

### Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: TP5A8





*Daniel B. Stephens & Associates, Inc.*

### Gravel Correction Data Sheet

Job Name: Golder Associates, Inc.  
Job Number: LB05.0243.00  
Sample Number: TP5A8 (Gravel Corrected)  
Ring Number: NA  
Depth: NA  
Split: #10 (2.00 mm)

---

Uncorrected input values	Corrected Values
Mass (coarse)(g): 3571	
Mass (fines)(g): 1694	
Dry bulk density (fines)(g/cm <sup>3</sup> ): 1.39	Density (composite)(g/cm <sup>3</sup> ): 2.05
*Density (coarse)(g/cm <sup>3</sup> ): 2.65	
Ksat value (fines)(cm/sec): 1.8E-02	Ksat composite(cm/sec): 8.5E-03
Theta initial (fines): 0.1460	Theta initial composite: 0.0693
Theta saturated (fines): 0.3388	Theta saturated composite: 0.1609
Theta residual (fines): 0.0000	Theta residual composite: 0.0000
*Theta initial (coarse): 0	
*Theta saturated (coarse): 0	
*Theta residual (coarse): 0	
*Volume (coarse voids)(cm <sup>3</sup> ): 0	

---

Volumetric fraction of fines in composite: 0.475
Volumetric fraction of coarse in composite: 0.525
Volumetric fraction of voids in composite: 0.000
Volume (fines)(cm <sup>3</sup> ): 1218.71
Volume (coarse)(cm <sup>3</sup> ): 1347.55
Volume (composite)(cm <sup>3</sup> ): 2566.25

**Comments:**

\*Assumed to be 2.65, unless measured.

\*Values will be zero if the coarse fraction is assumed to hold no water in pores.

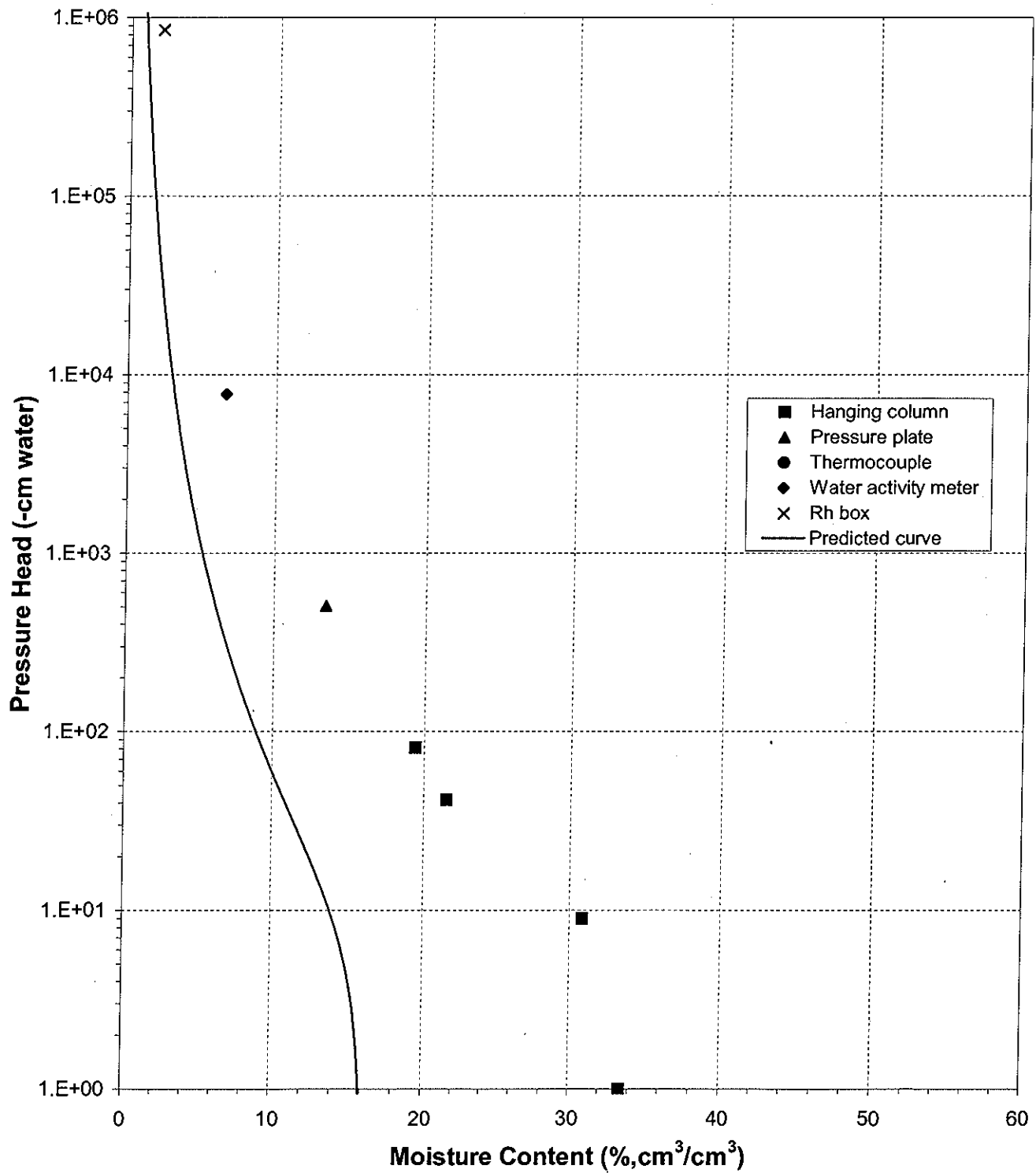
Date: 30-Dec-05  
Data entered by: D. O'Dowd  
Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

### Predicted Water Retention Curve and Data Points

Sample Number: TP5A8 (Gravel Corrected)





Daniel B. Stephens & Associates, Inc.

**Moisture Retention Data**  
**Hanging Column/Pressure Plate/Thermocouple**  
(Main Drainage Curve)

Job Name: Golder Associates, Inc.      Dry wt. of sample (g): 197.20  
Job Number: LB05.0243.00      Tare wt., screen & clamp (g): 23.23  
Sample Number: TP5A21      Tare wt., ring (g): 121.92  
Ring Number: NA      Tare wt., epoxy (g): 0.00  
Depth: NA      Sample volume (cm<sup>3</sup>): 141.12

Saturated weight\* at 0 cm tension (g): 401.48  
Volume of water<sup>†</sup> in saturated sample (cm<sup>3</sup>): 59.13  
Saturated moisture content (% vol): 41.90  
Sample bulk density (g/cm<sup>3</sup>): 1.40

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content <sup>†</sup> (% vol)
Hanging column:	04-Nov-05 / 11:30	401.48	0.00	41.90
	11-Nov-05 / 16:55	383.82	9.00	29.39
	18-Nov-05 / 15:40	372.51	41.50	21.37
	28-Nov-05 / 14:25	369.17	81.50	19.00
Pressure plate:	04-Dec-05 / 10:00	362.93	509.90	14.58

**Sample Settling Information<sup>Note</sup>**

Matric Potential (-cm water)	Percent Settled (%)	Settled Bulk Density (g/cm <sup>3</sup> )
0.00	7.6%	1.50
9.00	NM	NM
41.50	10.3%	1.54
81.50	10.9%	1.55
509.90	10.9%	1.55

**Note:**

Sample settling was measured periodically following hanging column and pressure plate moisture retention points. These values were obtained by averaging several measurements of loss in sample length, measured with a hand caliper. Due to the uneven nature of samples as settling occurs, these values should be considered as estimates.

NS=No Settling

NM=Not Measured

\* Weight including tares

<sup>†</sup> Assumed density of water is 1.0 g/cm<sup>3</sup>

Laboratory analysis by: M. Carrillo  
Data entered by: T. Bowekaty  
Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

**Moisture Retention Data**  
**Water Activity Meter/Relative Humidity Box**  
(Main Drainage Curve)

Job Name: Golder Associates, Inc.  
Job Number: LB05.0243.00  
Sample Number: TP5A21  
Ring Number: NA  
Depth: NA

Dry weight\* of water activity meter sample (g): 259.28  
Tare weight, jar (g): 197.68  
Sample bulk density (g/cm<sup>3</sup>): 1.40

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content <sup>†</sup> (% vol)
Water Activity Meter:	08-Nov-05 / 14:30	262.38	8464.3	7.03

Dry weight\* of relative humidity box sample (g): 74.51  
Tare weight (g): 37.74  
Sample bulk density (g/cm<sup>3</sup>): 1.40

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content <sup>†</sup> (% vol)
Relative humidity box:	08-Nov-05 / 12:20	75.16	851293	2.45

**Comments:**

\* Weight including tares

<sup>†</sup> Assumed density of water is 1.0 g/cm<sup>3</sup>

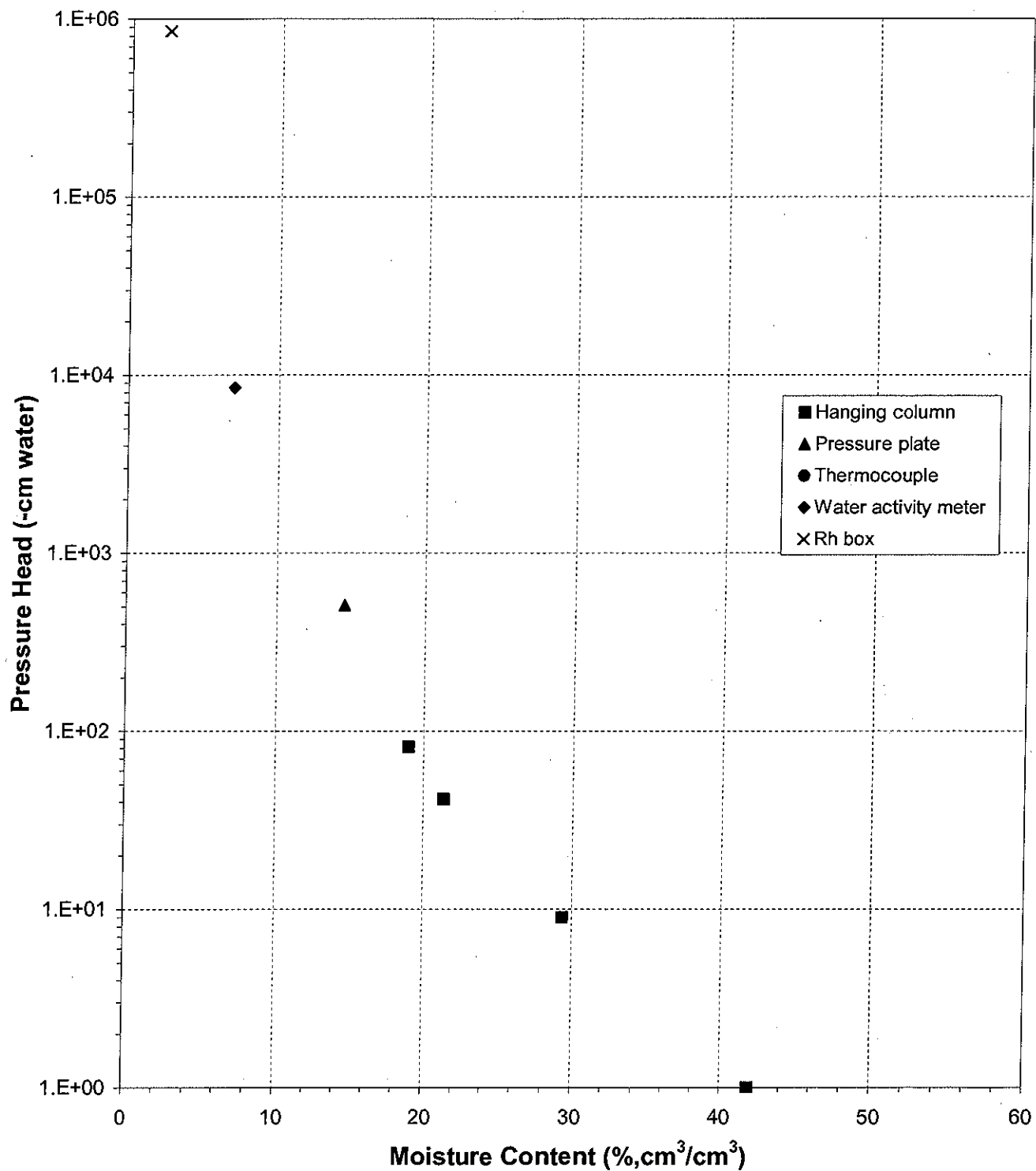
Laboratory analysis by: M. Carrillo/D. O'Dowd  
Data entered by: T. Bowekaty  
Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

### Water Retention Data Points

Sample Number: TP5A21



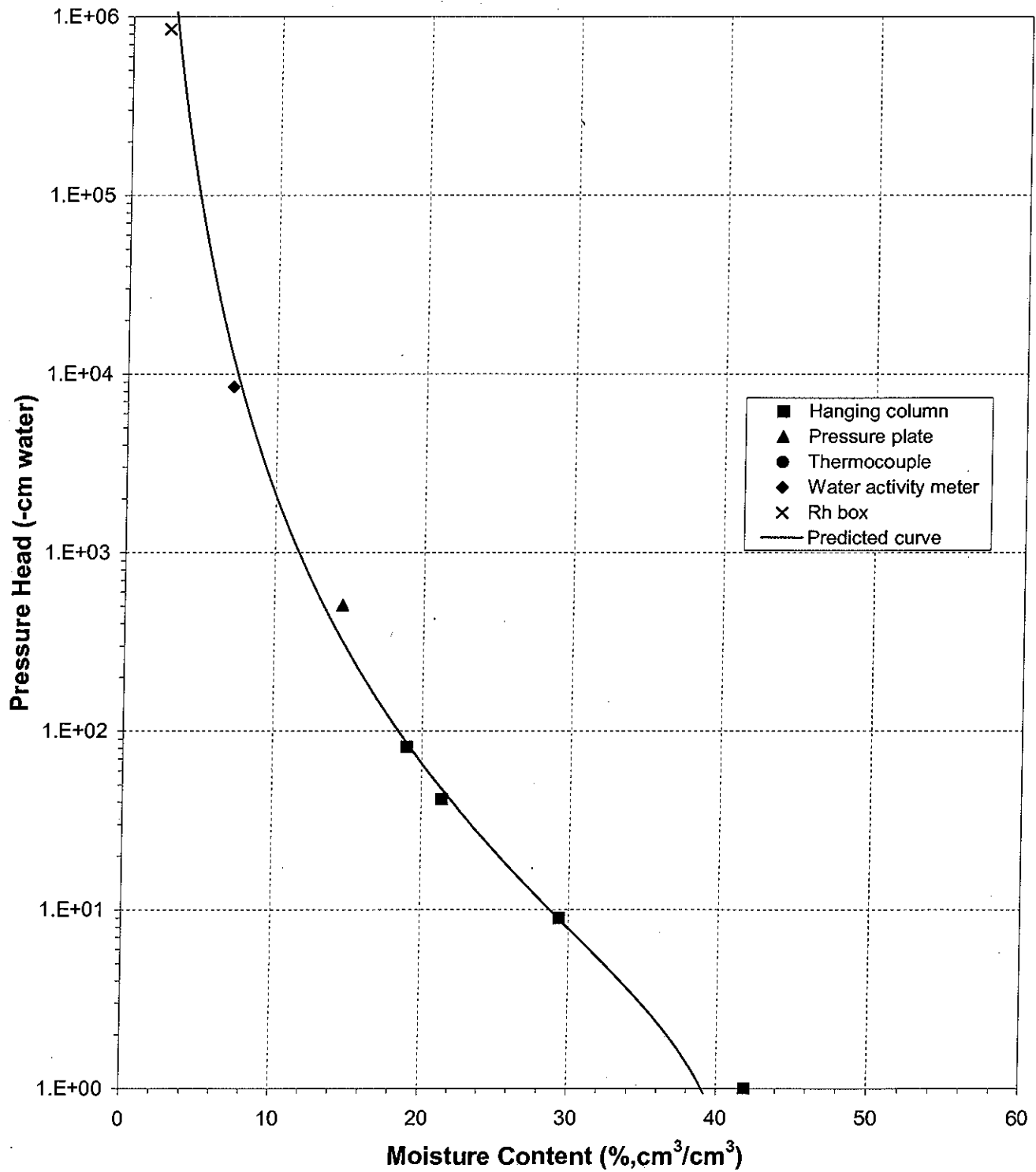




Daniel B. Stephens & Associates, Inc.

### Predicted Water Retention Curve and Data Points

Sample Number: TP5A21

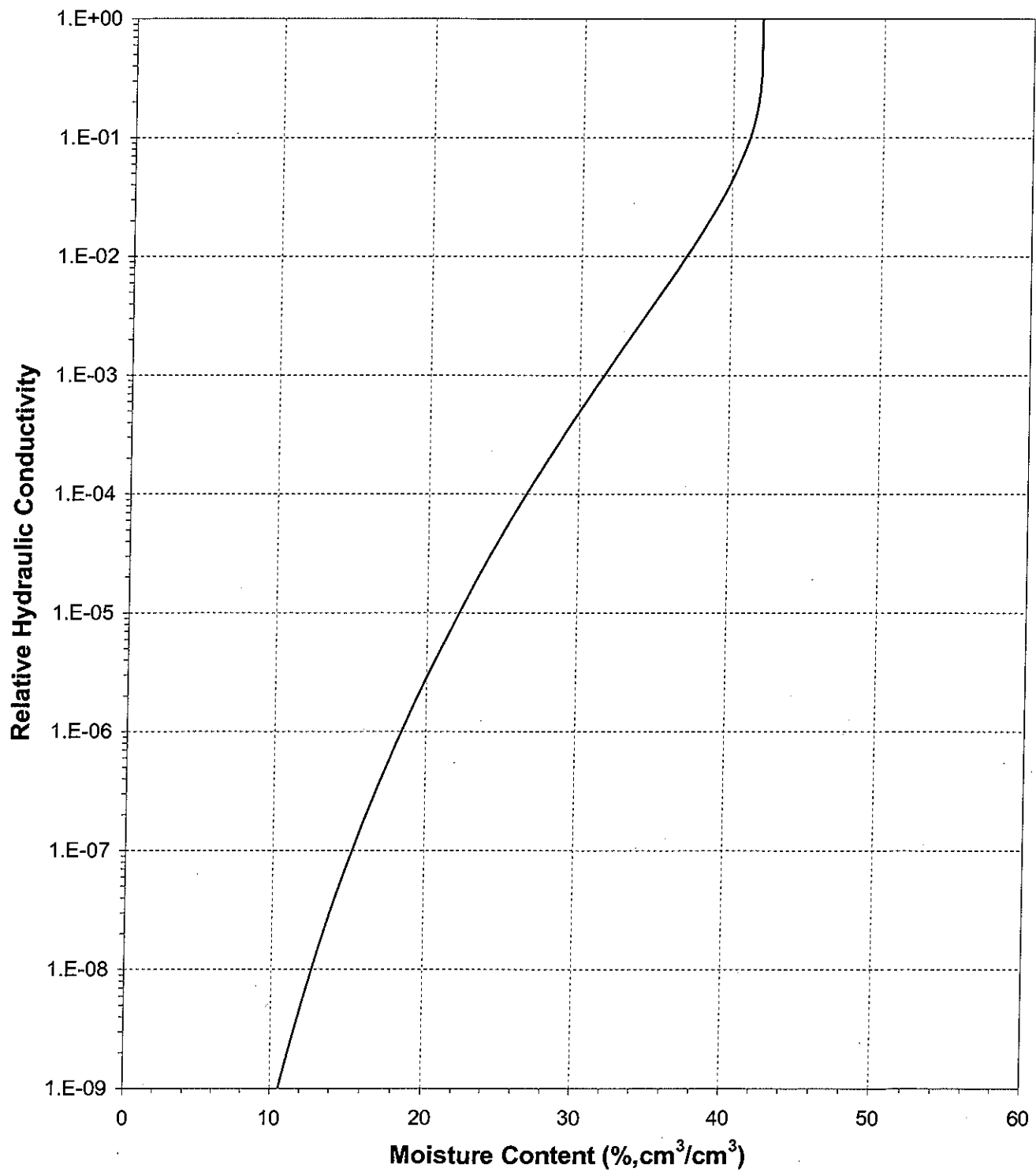




Daniel B. Stephens & Associates, Inc.

### Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: TP5A21

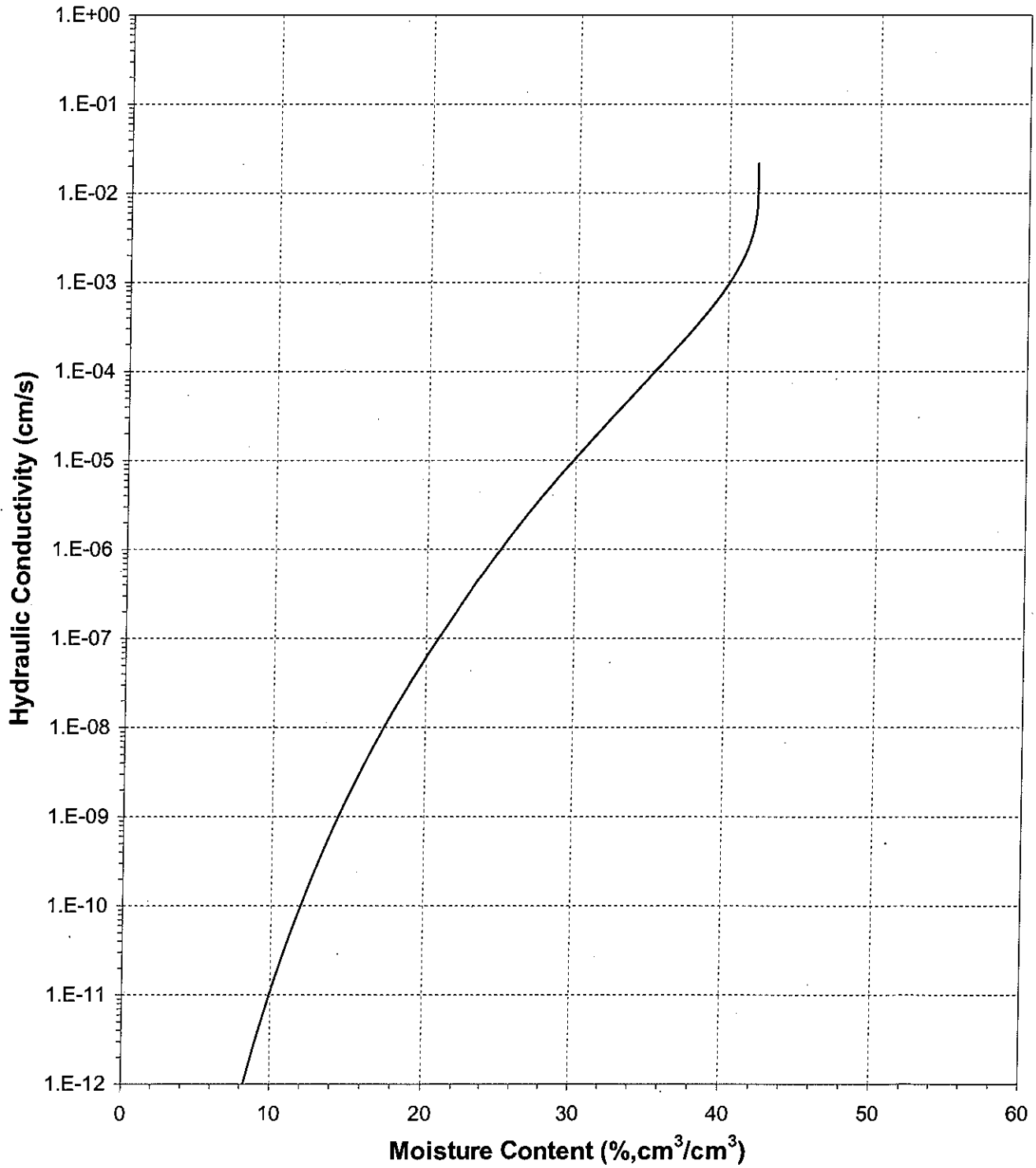




Daniel B. Stephens & Associates, Inc.

### Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: TP5A21

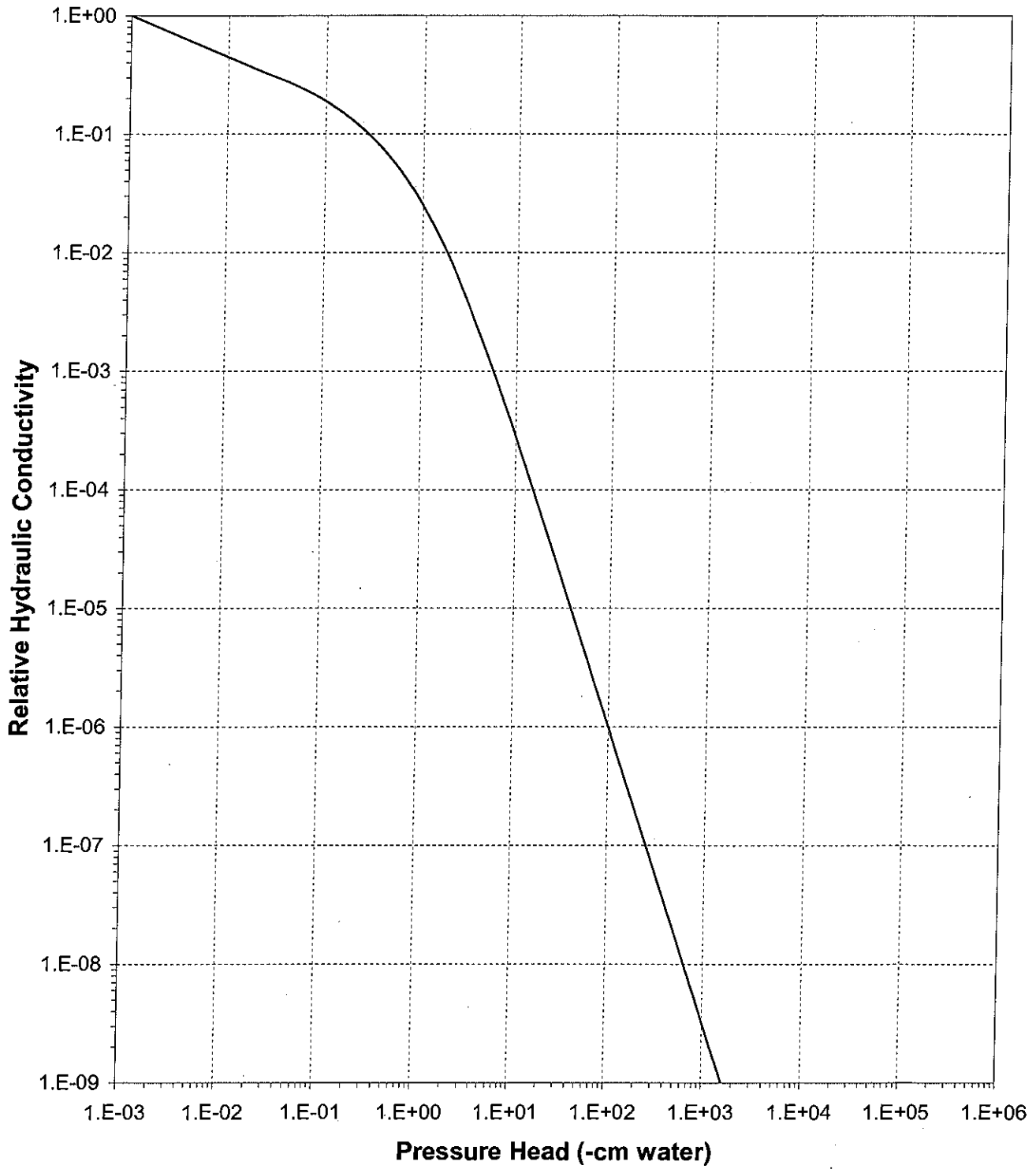




Daniel B. Stephens & Associates, Inc.

### Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: TP5A21

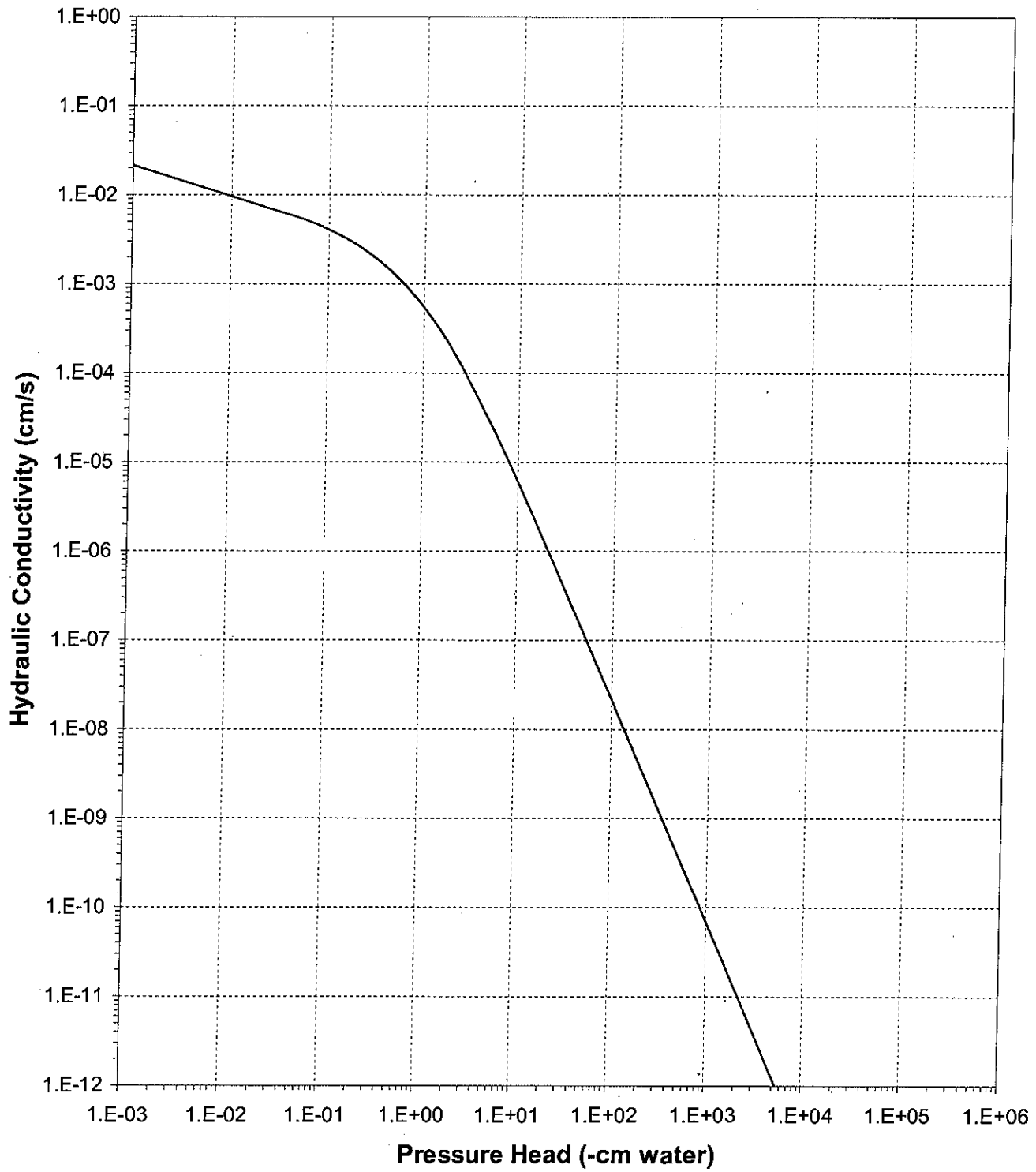




Daniel B. Stephens & Associates, Inc.

### Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: TP5A21





Daniel B. Stephens & Associates, Inc.

### Gravel Correction Data Sheet

Job Name: Golder Associates, Inc.  
Job Number: LB05.0243.00  
Sample Number: TP5A21 (Gravel Corrected)  
Ring Number: NA  
Depth: NA  
Split: #10 (2.00 mm)

---

Uncorrected input values	Corrected Values
Mass (coarse)(g): 4253	
Mass (fines)(g): 1802	
Dry bulk density (fines)(g/cm <sup>3</sup> ): 1.4	Density (composite)(g/cm <sup>3</sup> ): 2.09
*Density (coarse)(g/cm <sup>3</sup> ): 2.65	
Ksat value (fines)(cm/sec): 2.2E-02	Ksat composite(cm/sec): 9.8E-03
Theta initial (fines): 0.1440	Theta initial composite: 0.0641
Theta saturated (fines): 0.4190	Theta saturated composite: 0.1865
Theta residual (fines): 0.0000	Theta residual composite: 0.0000
*Theta initial (coarse): 0	
*Theta saturated (coarse): 0	
*Theta residual (coarse): 0	
*Volume (coarse voids)(cm <sup>3</sup> ): 0	

---

Volumetric fraction of fines in composite: 0.445

Volumetric fraction of coarse in composite: 0.555

Volumetric fraction of voids in composite: 0.000

Volume (fines)(cm<sup>3</sup>): 1287.14

Volume (coarse)(cm<sup>3</sup>): 1604.91

Volume (composite)(cm<sup>3</sup>): 2892.05

#### Comments:

\*Assumed to be 2.65, unless measured.

\*Values will be zero if the coarse fraction is assumed to hold no water in pores.

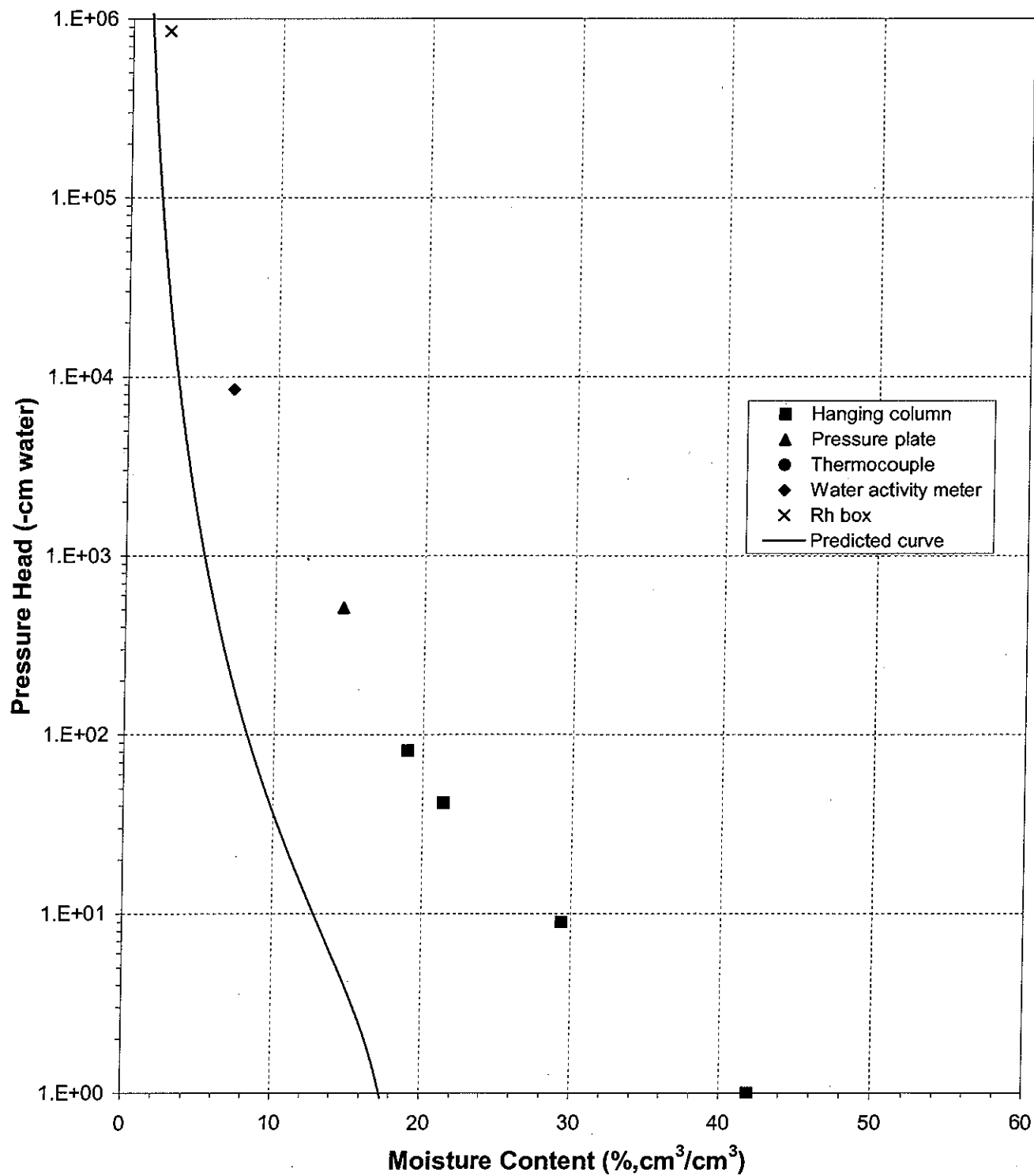
Date: 30-Dec-05  
Data entered by: D. O'Dowd  
Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

### Predicted Water Retention Curve and Data Points

Sample Number: TP5A21 (Gravel Corrected)



## **Laboratory Tests and Methods**





*Daniel B. Stephens & Associates, Inc.*

## **Tests and Methods**

Dry Bulk Density:	ASTM D4531; ASTM D6836
Moisture Content:	ASTM D2216; ASTM D6836
Calculated Porosity:	Klute, A. 1986. Porosity. Chp.18-2.1, pp. 444-445, in A. Klute (ed.), Methods of Soil Analysis, American Society of Agronomy, Madison, WI
Saturated K:	
Constant Head:	ASTM D 2434 (modified apparatus)
Hanging Column Method:	ASTM D6836; Klute, A. 1986. Porosity. Chp.26, in A. Klute (ed.), Methods of Soil Analysis, American Society of Agronomy, Madison, WI
Pressure Plate Method:	ASTM D6836; ASTM D2325
Water Potential Method:	ASTM D6836; Rawlins, S.L. and G.S. Campbell, 1986. Water Potential: Thermocouple Psychrometry. Chp. 24, pp. 597-619, in A. Klute (ed.), Methods of Soil Analysis, Part 1. American Society of Agronomy, Madison, WI.
Relative Humidity Box:	Karathanasis & Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil Clays. SSA Journal 46:1321-1325
Calc. Kunsat:	ASTM D6836; Soil Sci. Soc. Am. J. 1980 44:892-898
Course Fraction (Gravel) Correction (calc):	ASTM D4718; Bouwer, H. and Rice, R.C. 1984. Hydraulic Properties of Stony Vadose Zones. Groundwater Vol. 22, No. 6