

2014 Soil Survey of Palmer Lake Field Geological Engineering Report

March 12th, 2014

Field Results:

A field investigation was conducted in and around the former Palmer Lake in Palmer Lake, Colorado. This occurred on January 27, 2014 and results from the field investigation are summarized below. The investigation included: Visual examination, Geo-Probe direct push drilling, photographic logging, and conducting interviews with local witnesses for documenting the changing conditions over a significant period following the lakes regression. Field procedures were investigating why Palmer Lake reverted back into a dry state.

Through field examination similar distinct layers were noticed in most of the boring locations indicating a common stratigraphy across the entire lake bed. It also seems reasonable to believe that the sidewalls had some amount of overburden based on walking upslope around the lake perimeter. When the bank locations reached approximately the same elevation height as the lake bed borings, the layers of analyzed soil seemed fairly consistent with the same soil stratigraphy noticed in the lake bed itself. This will have to be confirmed or denied with soil and groundwater modeling. These initial results should be verified by analyzing the collected data and plotting the soil types at the differing elevations. JDS-Hydro Consultants (JDS) was on site and collected GPS data that could be used in conjunction here. An inclusive figure showing all of the collected locations is also attached within this report.

Field Data Collected:

11 soil boring logs are included in this report. Data was collected by Patrick DUBY an independent Geo-Environmental Engineer who also authored this report. The soil drilling company was Resource Geoscience, Inc. Also collecting data on site was JDS as mentioned above. These corresponding soil boring logs are to be analyzed for soil stratigraphy and soil classification. Analyzing these geologic patterns may show an anomaly or unknown that could affect the flow of water into and out of Palmer Lake as well the ability for the lake bed to continue to hold and maintain water.

Where Further Study is Needed:

A second day of field investigation was scheduled to occur and was called off due to weather. The Geo-Environmental Engineer doing the field study recommends collecting that second phase of field data before final conclusions are reached. Through previous emails and discussions the recommendation of JDS Hydro Engineering is to include laboratory material testing and this study agrees that a limited material testing investigation of should be included. This transition is between 5-11 feet below ground surface (BGS) in the lake bed itself and between 8-15 feet BGS around the perimeter edges and outside the lake bed. Recommend conducting material testing for Atterberg Limits, moisture content, and gradation (grain size sieve analysis). Recommend collecting 2 samples per soil boring at approximately 3-5 locations at the transition locations between the native sandy material and the clay bottom confining layer.

Immediate Concerns and Recommendations:

An immediate recommendation is to finish capping off the groundwater monitoring wells, file the mandated paperwork for the well information with the state, and begin taking water level readings on a monthly basis to record static water levels during different seasonal periods of the year.

Recommend collecting two years of monthly water level data. Recommend requesting the city water department or another vested city agency or local resource to familiarize with water level monitoring and conduct the monthly level readings to save costs for the city and overall project.

Geological Conclusions:

Over time it seems that sediment has built up on the lake bed. This sediment has hardened as the Lake has dried. It is a reasonable conclusion to reach, that if a significant portion of the non-native sediment was removed from the lake bed, the basin would be much more suited to contain and hold water. In addition it is possible that this hardened sediment could be acting as an upper confining layer causing pressure downward which could be forcing the static water level lower. In addition there does seem to be an extensive amount of clay found deeper in borings as a confining layer which seems to debunk the rumor that the lake is leaking. Additional information was further derived by noting that in local interviews it was described as natural springs surfacing in lower areas where the clay sediment was less thick. This was later confirmed by visual examination. It seems to indicate that the lake bed could be carefully altered removing overburden to revert back to a former soil level that would still be above the water table but closer to a workable elevation for maintaining water.

Altered Historic Conditions:

There is a historically changed condition by the height and directional flow of the railroad ditch that seems to be interrupting the surface flow to Palmer Lake from the alluvial fan coming out of the mountains. This can be easily noted during any rain storm with significant precipitation. There does seem to be a correlation between the railroads directional drainage changes impacting the surface water to the lake and near subsurface water entering the lake bed itself. This, in turn, negatively effecting the long term stability of the lake and may have been a significant factor in its demise.

There seems to be no doubt that some surface water and part of the shallow groundwater table has been affected by changes to the drainage trench running alongside the railroad tracks. It was noted that the directional flow of the water in the ditch was changed during previous excavation along with changes to a culvert now impede the natural water flow into the lake with the water now traveling in a northward direction away from the lake. Further study would be needed to determine if this was the entirety of the cause of the changing situation and problems for the lake or whether it was just a contributing factor.

Environmental and Ecological Impact:

It should be noted that the above referenced conditions have ecological impact that is devastating for the bird life, plant life, and animal life in general. They were all unnaturally altered. Although obvious it should be noted that above all the fish life is completely destroyed due to the conditions that have removed all traces of water from Palmer Lake itself. This altered condition could be results of the railroad changing the drainage conditions, sediment buildup within the lake bed bottom itself, construction/development in the area, or from changing climate conditions that would have to be determined under a different scope of study. If it is determined that an outside party is responsible for the ecological destruction of Palmer Lake then recommend seeking a federal government agency such as the US Army Corps of Engineers (USACE) or the US Geological Survey (USGS), or a state agency such as the Colorado Department of Public Health and Environment. The USACE has an area office in Colorado Springs.

Additional Recommendation:

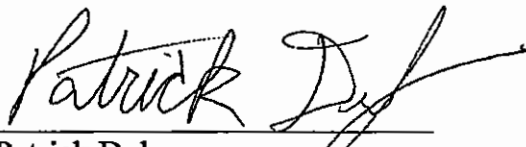
Soil stripping which in this case would remove the hardened sediment down to native soil, likely leaving a sandier bottom good for human and animal life. This soil stripping should not interfere with the groundwater table but removes a non-natural sediment upper confining layer allowing water to expose itself in higher rain periods. Results indicate that there is a deeper clay layer that would act as a bottom confining layer. This bottom confining layer would not be harmed by removing overburden. If the dry hardened clay overburden sediment and the top few feet of the clayey sand layer were stripped back, the results could lessen the cost impact for filling and maintaining water and could reduce the necessity to purchase water credits for the lake. This would be accomplished using excavators or other large equipment to strip or pull back the overburden and place it in berms or placing in areas around the lake as needed. Noting the thickness of the sand and the overburden it seems that removing about 8 feet of material could dramatically change the condition of the lake and even removing 3-5 feet of overburden could help the long term stability of Palmer Lake.

Optional Investigations:

Geo-Physics is an accurate method if a greater overall picture of the lake bed and surrounding area is required. An Electromagnetic Survey (EM-31) should then be conducted, followed by Ground Penetrating Radar (GPR). This EM-31 in conjunction with a GPR survey would be the Geo-Physics techniques required that would give a highly detailed picture of the soil, water, metal, rock layers, and overall structure of the entire region. While more expensive than many field methods the data logger takes nearly continuous field results and plots figures that are impressive and highly detailed which would provide a clearer picture of the current geological conditions. At the moment, recommend restraint and holding off on the Geo-Physics until it is known if that option is needed.

Final Summary and Recommendations:

- A field investigation of the dry former Palmer Lake in Palmer Lake, Colorado occurred on January 27, 2014. The results are summarized in this report and the investigation including 11 soil boring logs.
- Groundwater monitoring wells should be capped and water level data should be collected on a monthly basis for a period of 2 years. This should be completed with a water level meter and could be collected by the local water department or another vested local city resource.
- Recommend 5-7 additional soil boring locations to a depth of 25' to collect soil stratigraphy and log soils to complete the second phase of the field investigation.
- Recommend a limited material testing investigation at the transition layer between native sandy material and the clay layer believed to be a confining layer. Recommend collecting 2 samples per soil boring at approximately 4 locations at this transition which appear located between 5-11 feet below ground surface (BGS) in the lake bed itself and between 8-15 feet BGS around the perimeter edges and outside the lake bed. Recommend conducting material testing for Atterberg Limits, moisture content, and gradation (grain size sieve analysis).
- Determine the lake soil structure through soil and groundwater modeling and classification using the borings attached within this document.
- Determine if stripping off the non-native dried sediment layer may have a positive long term impact for the lake. The dried clay surface layer seems to be overburden that could be removed while the lake bed is dry. This could open up a natural source for spring water to collect, hold rain water longer, be closer to the water table, and possibly may lower the long term costs of maintaining the lake once restored.
- At the moment, recommend restraint and holding off on the Geo-Physics survey until it is known if that option is needed. If proceeding use an Electromagnetic Survey (EM-31) followed by Ground Penetrating Radar (GPR). This EM-31 in conjunction with a GPR survey would be the Geo-Physics techniques collecting nearly continuous field results that would give a highly detailed picture of the soil, water, metal, rock layers, and overall structure of the entire region.



Patrick Duby
Geo-Environmental Engineer



NOTES:
 1. SB-1 & SB-2 PREPARED BY GRI,
 OCT. 2012
 2. SB-3 THROUGH SB-10
 & MW-1 THROUGH MW-3
 PREPARED BY GRI,
 FEB. 2014



1

Project No.	2422
Scale	AS SHOWN
Date	03/07/14
Drawn By	SDC
Checked By	JAD
Drawn Date	03/07/14
Checked Date	03/07/14
Drawn By	SDC
Checked By	JAD
Drawn Date	03/07/14
Checked Date	03/07/14

TOWN OF PALMER LAKE — AWAKE THE LAKE
 PALMER LAKE PRELIMINARY RESTORATION STUDY
 GEOTECHNICAL INVESTIGATIONS

IDS-HYDRO CONSULTANTS, INC.
 545 East Pikes Peak Avenue, Suite 300
 Colorado Springs, Colorado 80903
 (719) 227-0072

**RESOURCE
GEOSCIENCE,
INC.**

3740 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Consulting Environmental Engineers and Earth Scientists

Location Map:



BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: SB-1 / MW-1	Project: Awake Palmer Lake
Date: January 27, 2014	Project Number:
Drilled By: Resource Geoscience	Logged By: Patrick Duby
Drilling Method: Direct Push	Sampling Method: 5' plastic liners
Casing Type: PVC	Diameter: 1" Length: 10' Hole Diameter: >1" Depth to Water:
Screen Type: PVC slotted	Diameter: 1" Length: 10' Boring Depth: 20' Depth Completed: 20'

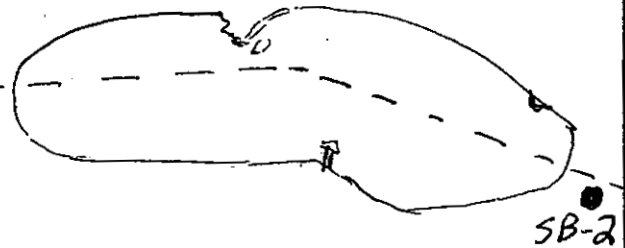
Penetration Resistance	Sample #	Moisture Content	Sample Run Recovered	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	MW-1 Well Completion			
				0		SB-1 / MW-1 outside lake bed, closer to railroad tracks				
				1		surface: light brown sandy gravel, dry	0			
loose	1	↑ Dry	4 1/5 recovery	2				2		
				3					1.5-8.5 clayey gravelly sand, reddish to brown	
				4						4
				5						
				6		well riser benzene				
loose	2	← Moist	4.25' / 5'	7			8			
				8				- moisture at 8.75' BGS		
				9					8.5'-13' solid mottled clay, dk grey, native, moist	
				10						10
				11		12				
mid level tightness	3	→ Moist	5' / 5'	12			- saturated			
				13				13'-18' clayey sand, brown, saturated		
				14					14	
				15						well screen sand pack
				16		16				
mid level tightness	4	← Saturated	5' / 5'	17			18-20' clay, trace silt, consistent			
				18				18		
				19					20	
				20						End of Boring 20' BGS
				21		21				
				22			well cap 20' BGS			
				23				22		
				24					24	
				25						26
				26		26				
				27			28			
				28				28		
				29					30	
				30						30
				31		31				

**RESOURCE
GEOSCIENCE,
INC.**

3740 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Consulting Environmental Engineers and Earth Scientists

Location Map:



BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: **SB-2** Project: **Awake Palmer Lake**

Date: **January 27, 2014** Project Number:

Drilled By: **Resource Geoscience** Logged By: **Patrick Duby**

Drilling Method: **Direct Push** Sampling Method: **5' plastic liners**

Casing Type: Diameter: Length: Hole Diameter: **1 1/4"** Depth to Water:

Screen Type: Diameter: Length: Boring Depth: Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Sample Pen Recovery	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	NO Well Completion
						SB-2	
				0		surface: Tree area outside of Northedge	0
loose	1	Dry	8.5'/5' recovered	1		0-3.5' Brn sand + gravel, dry, roots	1
				2			2
				3			3
				4			4
				5			5
				6		8'-12' clayey sand, lt brown, dry	6
tight	2	Dry	4'/5'	7			7
				8			8
				9			9
				10			10
tight	3	Dry	5'/5'	11		12'-18' Hard Clay, mottled, grey, dry, tight, consistent	11
				12			12
				13			13
				14			14
				15			15
tight	4	Dry	5'/5'	16		18'-25' Sandy, gravelly Clay, dry, mottled, lt brn and mixed colors	16
				17			17
				18			18
				19			19
				20			20
tight	5	Dry	5'/5'	21		End of Boring 25' No water level noted	21
				22			22
				23			23
				24			24
				25			25
				26			26
				27			27
				28			28
				29			29
				30			30
				31			31

Backfilled Boring



**RESOURCE
GEOSCIENCE,
INC.**

3748 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Consulting Environmental Engineers and Earth Scientists

Location Map:



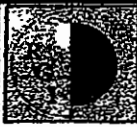
BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: **SB-3** Project: **Awake Palmer Lake**
 Date: **January 27, 2014** Project Number:
 Drilled By: **Resource Geoscience** Logged By: **Patrick Duby**
 Drilling Method: **Direct Push** Sampling Method: **5' plastic liners**

Casing Type: Diameter: Length: Hole Diameter: Depth to Water:
 Screen Type: Diameter: Length: Boring Depth: Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Sample Run Recovery	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	NO Well Completion
				0		Surface: Lake Bed near slope	
				1			
medium tightness	1		3.5/5 recovery	2		0.75' Dark sand and gravel	
		Dry		3			
				4		0.75'-6' Clayey sand, lt gray, dry	
				5			
tight	2		4.5/5	6		6'-8.5' Hard clay, tan, dry - Mottled, native	
				7			
				8		8.5-9.5: Sandy clay	
				9		- 9.5' Saturated	
		wet		10			
				11			
tight to medium tightness	3		4/5	12		9.5'-20' Brown Clay w/silt, trace gravel	
				13			
				14		Low recovery in last 5'	
				15			
unknown saturated	4		~1/5'	16			
				17			
				18			
				19			
				20			
				21		EOB 20', meaningful to 15' soils	
				22			
				23			
				24			
				25			
				26			
				27			
				28			
				29			
				30			
				31			

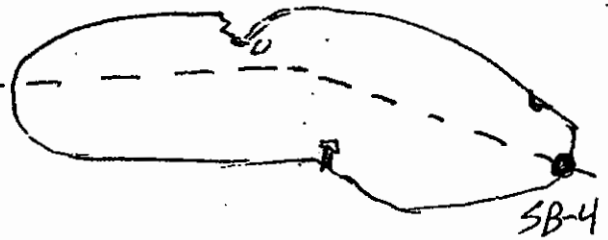
Back-filled Boring



**RESOURCE
GEOSCIENCE,
INC.**

3740 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Location Map:



BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: **SB-4** Project: **Awake Palmer Lake**
 Date: **January 27, 2014** Project Number:
 Drilled By: **Resource Geoscience** Logged By: **Patrick Duby**
 Drilling Method: **Direct Push** Sampling Method: **5' plastic liners**

Casing Type: Diameter: Length: Hole Diameter: Depth to Water:
 Screen Type: Diameter: Length: Boring Depth: Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Recovery Sample Point	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	NO Well Completion
				0		surface: Lake Bed slope transition to bank	Backfilled Boring
medium consistency	1	↑ DRY	3' / 5' recovery	1		0-3' Gravely Black topsoil	
				2			
				3			
				4			
				5			
tight	2	↑ Moist	3' / 5'	6		5'-11' grey Mottled Clay, some silt, moist	
				7			
				8			
				9			
				10			
tight	3	← Moist	3.5' / 5'	11		11-20 clayey sand - 11'-15' grey, moist	
				12			
				13			
				14			
				15			
tight	4	saturated from above	5' / 5'	16		- 15'-20' brn, saturated	
				17			
				18			
				19			
				20			
				21		End of Boring 20' BGS	
				22			
				23			
				24			
				25			
				26			
				27			
				28			
				29			
				30			
				31			



**RESOURCE
GEOSCIENCE,
INC.**

3740 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Location Map:



BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: SB-5 Project: Awake Palmer Lake
 Date: January 27, 2014 Project Number:
 Drilled By: Resource Geoscience Logged By: Patrick Duby
 Drilling Method: Direct Push Sampling Method: 5' plastic liners

Casing Type: Diameter: Length: Hole Diameter: Depth to Water:
 Screen Type: Diameter: Length: Boring Depth: Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Recovery Sample Return	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	NO Well Completion
				0		Surface: Lake Bed to bank transition/slope	
medium tightness	1	dry	3' / 5' recovery	1		0-4' Clayey sand, black, dry	
				2			
				3			
				4			
				5		4-9' Rocky sand, trace clay, Red stones low recovery, loose, dry	
very loose	2	moist	1.5' / 5'	6			
				7			
				8			
				9		9-15' silty, clayey sand, wet	
				10			
				11		- saturated at 11'	
tight	3	↑	5' / 5'	12			
				13			
				14			
				15			
				16		15'-16.5' - Tight clay, confining, grey	
tight	4	↓	5' / 5'	17			
				18			
				19		16.5-25' - Clayey sand to sandy clay some gravel, wet	
				20			
				21			
tight	5	↓	5' / 5'	22			
				23			
				24			
				25			
				26		End of Boring 25'	
				27			
				28			
				29			
				30			
				31			

Backfilled Boring

RESOURCE GEOSCIENCE, INC.

3740 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Consulting Environmental Engineers and Earth Scientists

Location Map:



BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: **SB-6** Project: **Awake Palmer Lake**

Date: **January 27, 2014** Project Number:

Drilled By: **Resource Geoscience** Logged By: **Patrick Duby**

Drilling Method: **Direct Push** Sampling Method: **5' plastic liners**

Casing Type: Diameter: Length: Hole Diameter: Depth to Water:

Barren Type: Diameter: Length: Boring Depth: Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Sample Run	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	NO Well Completion	
				0		SB-6 Lake bed		
				1		surface: 0'-6.5' Black Clay, consistent, hard, overburden, dry		
	1	dry ↑	5' / 5' recovery	2				
tight				3				
				4				
				5				
				6		6.5'-10' silty clay ⇒ 6.5'-8'-grey dry 8'-10'-reddish brown moist — water line at 7.5' moist below		
tight	2	wet ↓	5' / 5'	7				
				8				
				9				
				10				
				11		End of Boring 10' BGS	Backfilled Boring	
				12				
				13				
				14				
				15				
				16				
				17				
				18				
				19				
				20				
				21				
				22				
				23				
				24				
				25				
				26				
				27				
				28				
				29				
				30				
				31				

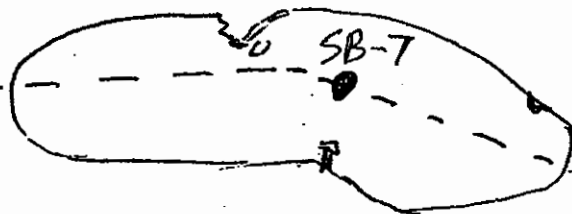


**RESOURCE
GEOSCIENCE,
INC.**

3740 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Consulting, Environmental Engineers and Earth Scientists

Location Map:



BORING LOG / MONITORING WELL COMPLETION

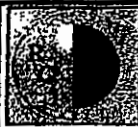
Boring / Well Number: **SB-7** Project: **Awake Palmer Lake**
 Date: **January 27, 2014** Project Number:
 Drilled By: **Resource Geoscience** Logged By: **Patrick Duby**
 Drilling Method: **Direct Push** Sampling Method: **5' plastic liners**

Casing Type: Diameter: Length: Hole Diameter: Depth to Water:
 Screen Type: Diameter: Length: Boring Depth: Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Recovery Sample Return	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	NO Well Completion	
				0		Surface: Dry Black Clay		
Tight	1	dry to damp	4' / 5' recovery	1		1'-7' Greenish grey Clay, hard, dry		
				2				
				3				
				4				
				5				
Tight	2	dry to damp	5' / 5'	6		7'-9' - Reddish Clay, trace silt, dry		
				7				
				8				
				9			9'-11' Greenish Clay, thick, moist	
				10				
Tight	3	saturated	5' / 5'	11		— water line		
				12			11'-16' Gravely sand, saturated	
				13				
				14				
				15				
		16						
Tight	4	saturated	5' / 5'	17		16-20' Consistent brown Clay, thick confining, tight		
				18				
				19				
				20				
				21				
				22		End of Boring 20' BGS		
				23				
				24				
				25				
				26				
				27				
				28				
				29				
				30				
				31				

* Notes - Lakebed bottom sample with 4' of solid confining layer 16'-20' below ground surface

Backfilled Boring

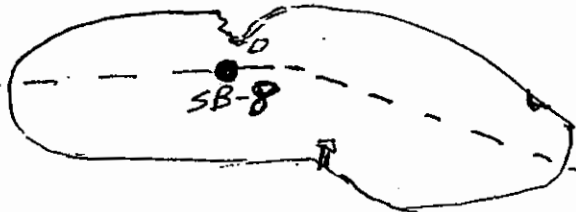


**RESOURCE
GEOSCIENCE,
INC.**

3740 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Consulting, Environmental Engineers and Earth Scientists

Location Map:



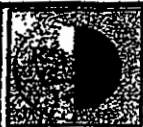
BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: SB-8	Project: Awake Palmer Lake
Date: January 27, 2014	Project Number:
Drilled By: Resource Geoscience	Logged By: Patrick Duby
Drilling Method: Direct Push	Sampling Method: 5' plastic liners

Casing Type:	Diameter:	Length:	Hole Diameter:	Depth to Water:
Screen Type:	Diameter:	Length:	Boring Depth:	Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Sample Run Recovered	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	NO Well Completion
				0		surface:	
tight	1	↑	5'/5' recovery	1		0'-4' Dry greenish grey clay sediment	
				2			
				3			
fairly tight		← Dry		4		4'-6' Gravely sand, dry, reddish	
				5			
	2	← wet	5'/5'	6		—moisture at 6' BGS	
				7		6'-8' clayey sand, reddish, wet	
tight				8			
				9		8'-10' clay, trace fines, reddish brown	
				10			
				11		End of Boring (EOB) at 10' BGS	
				12			
				13			
				14			
				15			
				16			
				17			
				18			
				19			
				20			
				21			
				22			
				23			
				24			
				25			
				26			
				27			
				28			
				29			
				30			
				31			

Backfilled Boring



**RESOURCE
GEOSCIENCE,
INC.**

3740 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Consulting Environmental Engineers and Earth Scientists

Location Map:



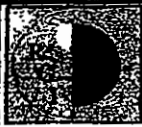
BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: **SB-9** Project: **Awake Palmer Lake**
 Date: **January 27, 2014** Project Number:
 Drilled By: **Resource Geoscience** Logged By: **Patrick Dwy**
 Drilling Method: **Direct Push** Sampling Method: **5' plastic liners**

Casing Type: Diameter: Length: Hole Diameter: Depth to Water:
 Screen Type: Diameter: Length: Boring Depth: Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Recovery Sample Feet	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	NO Well Completion
				0		SB-9 Lake bed	
				1			
medium to fairly tight	1	↑ Dry - No water found	3 1/5' recovery	2		surface: 6" Gravely sand	
				3		0.5'-3' Greenish Clay, hard, dry, sediment overburden	
				4		3'-7.5' Clayey sand, dry, brownish	
				5			
				6			
tight	2		4 1/5'	7			
				8		7.5'-18' Mottled Clay, brown, dry	
				9		consistent, native	
				10			
tight	3		5 1/5'	11			
				12			
				13			
				14			
				15			
tight	4		5 1/5'	16			
				17			
				18		18'-20' Gravely Sandy Clay, tans/reds	
				19			
				20			
				21		EQB at 20' BGS - No water found	
				22			
				23			
				24			
				25			
				26			
				27			
				28			
				29			
				30			
				31			

Backfilled Boring



**RESOURCE
GEOSCIENCE,
INC.**

3740 Wabash Street
Colorado Springs, CO 80906
(719) 635-0229

Location Map:

SB-10



Consulting, Environmental Engineers and Earth Scientists

BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: **SB-10** Project: **Awake Palmer Lake**

Date: **January 27, 2014** Project Number:

Drilled By: **Resource Geoscience** Logged By: **Patrick Duly**

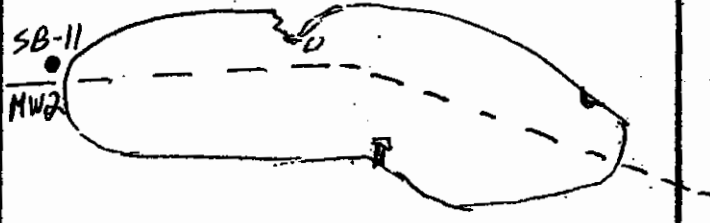
Drilling Method: **Direct Push** Sampling Method: **5' plastic liners**

Casing Type: Diameter: Length: Hole Diameter: Depth to Water:

Screen Type: Diameter: Length: Boring Depth: Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Recovery Sample Rate	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	NO Well Completion
				0	SB-10	Surface: Lake Bed to bank transition	
medium tightness	1	↑	3.5' / 5'	1		0.5'-8' Sandy Clay, gravel, reddish brown	
		← DRY		2			
				3			
				4			
				5			
tight	2	←	4' / 5'	6		— moisture at 7'	
				7		8'-15' Hard Mottled Clay, reddish brown, most native	
				8			
				9			
				10		11'-12' lens of softer sandy clay, moist	
tight	3	Moist	4.5' / 5.0'	11			
				12			
				13			
				14		— saturated at 15'	
				15			
tight	4	wet	5' / 5'	16		15'-18' siltstone, gravel, some sand, wet	
				17			
				18		18'-20' silty clay, moist from above	
				19			
				20			
				21		EOB at 20' BGS	
				22		(End of Boring) (Below ground surface)	
				23			
				24			
				25			
				26			
				27			
				28			
				29			
				30			
				31			

Backfilled Boring



BORING LOG / MONITORING WELL COMPLETION

Boring / Well Number: SB-11 / MW-2	Project: Awake Palmer Lake		
Date: January 27, 2014	Project Number:		
Drilled By: Resource Geoscience	Logged By: Patrick Duby		
Drilling Method: Direct Push	Sampling Method: 5' plastic liners		
Casing Type: R/C	Diameter: 1" Length: 8' riser	Hole Diameter:	Depth to Water: 9' BGS
Screen Type: PVC slotted	Diameter: 1" Length: 5' screen	Boring Depth: 12.5'	Depth Completed:

Penetration Resistance	Sample #	Moisture Content	Sample Run Recovered	Depth (feet bgs)	USCS Symbol	Lithology / Remarks	MW-2 Well Completion	
				0		Surface: clayey topsoil frozen		
Tight	1	↑	4' 1/5' recovery	1		0.5-5' Hard Brown Sandy Clay		
				2				
				3				
				4				
				5				
				6		5'-9' Hard Mottled Clay, Brownish, native	well riser bentonite	
Tight	2	← dry	5' 1/5'	7				
				8				
				9				
				10				
				11				
tight	3	← wet	overdrill NO sample	12		- wet ~ 9' 9-10' Clayey sand, (ouch gravel)	well screen sand	
				13				
				14				
				15				
				16				
				17		FOB 10' BGS 12.5' BGS. overdrill well set to 12.5' BGS *Notes - Weather conditions became too severe and this was last soil boring and well for the day	well cap	
				18				
				19				
				20				
				21				
				22				
				23				
				24				
				25				
				26				
				27				
				28				
				29				
				30				
				31				