Design Report
Swede Lake Dam Rehabilitation
Boulder County, Colorado

Water Division 1, Water District 5, C-2064
DAMID:050304

Prepared for:

Boulder Country Parks and Open Space
5201 St Vrain Road
Longmont, Colorado 80503

Prepared by:

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Project No. 110480

April 24, 2018

EXECUTIVE SUMMARY

Construction for the Swede Lake Dam Rehabilitation project began in August 2017. The scope of work included: 1) Mitigate seepage through embankment. 2) Repair primary outlet structure. 3) Repair irrigation outlet structure. 4) Repair and replace embankment erosion. 5) Remove sediment from Swede Lake. 6) Repair emergency spillway. 7) Repair spillway ditch. 8) Add erosion control where damaged or missing. 9) Revegetate disturbed areas.

Construction experienced delays from a necessary change in scope of work. After excavation and further examination of the existing embankment, EA observed that the conditions of the existing embankment were unacceptable due to volume of roots and, in some locations, poor soil condition. It was determined that the embankment should be completely removed and replaced, rather than repaired. Apart from this change, only minor field adjustments were needed. Work was substantially completed in March 2018.

Based on our observation and testing throughout the project, the work was conducted in accordance with the approved plans and specifications. Changes to the original plans and issues addressed during construction are described in this report and are shown on the "As-Constructed" drawings.

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LIST OF APPENDICES

1.0 INTRODUCTION

Swede Lake is located in Section 14, Township 2 North, Range 70 West of the 6th Principal Meridian, in Boulder County, Colorado. The project site is located approximately one mile west of the intersection of Pike Road and North 75th Street in rural Boulder County, Colorado. Swede Lake is the largest of three small reservoirs north of Pike Road and northwest of Lagerman Reservoir in unincorporated Boulder County, Colorado. The dam and reservoir lie within an ephemeral drainage with a small drainage area. The reservoir is filled by local irrigation ditches.

Swede Lake has a maximum vertical height of 14.2 feet, a crest length of 1,506 feet, and a crest width of approximately 12 feet. The upstream slope is 2.5H:1V, and the downstream slope is 2.5H:1V.

The proposed scope of work included: 1) Mitigate seepage through embankment. 2) Repair primary outlet structure. 3) Repair irrigation outlet structure. 4) Repair and replace embankment erosion. 5) Remove sediment from Swede Lake. 6) Repair emergency spillway. 7) Repair spillway ditch. 8) Add erosion control where damaged or missing. 9) Revegetate disturbed areas.

This report summarizes the design changes, construction observations, and field testing results for the project.

2.0 DESIGN CHANGES

One change order was submitted to the SEO requesting the complete replacement of the dam embankment. It was determined that the existing embankment was inadequate due to the extent of roots through the embankment and the damage caused by the roots. Also, the sand blanket was removed from the design. The only reason the blanket was included in the original design was due to the uncertainty of potential roots in the embankment, which is now removed. The Change Order Requested dated October 4, 2017 outlines the changes to the original Construction Drawings. No changes to the Construction Specifications were required.

3.0 CONSTRUCTION

The contractor for this project was CAP Excavating and Demolition, out of Lyons, Colorado. Engineering Analytics, Inc. (EA) provided construction oversight throughout the construction phase of the project and provided oversite testing for backfill, bedding, and concrete. Construction at Swede Lake Dam began in August 2017 and was completed in March 2018. The construction progressed without major delays. After the decision was made to completely replace the dam embankment, the construction schedule was revised to construct the outlet works while the new embankment was being designed and approved. There were only a couple of weeks during this process where the contractor was slow on work. The weather conditions for the site during the construction phase are summarized in Appendix A.

The construction milestones are summarized in the following paragraphs. The construction photographs are presented in Appendix B.

3.1 Clay Excavation

The clay material used for the Swede Lake Dam embankment was excavated from the reservoir, 200 feet away from the toe of the dam. Prior to excavation, a dozer was used to strip the top 1 to 2 feet to access usable clay material. Clay was excavated using a loader and two haul trucks. The clay material was stockpiled at the original stock pile location just west of the staging area. Photo 1 shows the excavation of clay in the reservoir bottom.

3.2 Tree Removal and Root Chasing

Over 80 trees were removed from the dam or the immediate area surrounding the dam. Some trees were salvaged and used on another project. The trees were removed down to their root ball, and any remaining roots were chased down to ½ inch in diameter. As can be seen in the photos in Appendix B, there was a large volume of roots within the embankment. Also, some large roots (2 inches or greater) went all the way through the dam embankment. Photos 2-4 show the roots within the existing embankment.

3.3 Outlet Excavation and Installation

The two outlet locations were excavated according to the excavation detail on the drawings. The foundation of the outlet was excavated until good material was found, and then was filled with clay and compacted to meet grade, in accordance to the specifications. Photo 5 shows the excavation for the primary outlet pipe.

The base of the outlet easements and the outlet structures were formed and poured first. Then the two outlet pipes were place and anchored to the base using metal belts and spacers between the pipe and base. The remainder of the outlet pipe encasement was formed and poured with battered sides. After the concrete set, the excavation was backfilled with compacted clay and the pipes were pressure tested. Both the primary outlet and the irrigation outlet passed the pressure tests. Photo 6 shows the formwork for the base of the outlet pipe encasement. Photos 9 and 10 show the outlet pipes strapped to the base of the encasement. Photo 11 shows the formwork of the irrigation outlet pipe before the remainder of the encasement was poured.

3.4 Emergency Spillway

The cutoff wall was constructed per the drawings and specifications. Both sides of the cutoff wall were filled and compacted simultaneously. A spillway channel was constructed and armored with bedding. Riprap was placed just downstream of the cutoff wall, along the outside of the channel's bend. Photos 12 and 14 show the construction of the emergency spillway cutoff wall.

3.5 Tower Installation

The outlet towers were formed and poured according to the Construction Drawings and Specifications. The towers were constructed with two separate pours – one for the base and one

for the walls. Lids with hatches were placed on top of the towers. Photos 7 and 8 show the heavy-duty sluice gates for the outlet works. Photo 13 shows the construction of the primary outlet tower.

3.6 Complete Removal and Replacement of Dam Embankment

The embankment required complete removal and replacement. The Contractor excavated the existing embankment and segregated out material with large quantities of roots for disposal in the reservoir bottom. Approved material was moisture conditioned and placed in the new embankment.

Prior to placing the new embankment, the Engineer inspected and approved the foundation. Material used for the embankment came from either the clay borrow from the far end of the reservoir or from the reusable material from the existing embankment. The material was moisturized and placed in lifts between about 8 and 12 inches of loose material. The material was compacted to 95% compaction or greater using a sheepsfoot roller.

3.7 Riprap and Bedding

Existing riprap was removed and sorted through. The unwanted debris was separated and disposed of. The riprap was evaluated, and the portion that pasted visual inspection was reused later in the project. The contractor placed 24-inch layer of riprap on top a 6-inch layer of bedding. Existing riprap that could be salvaged and reused was mixed in with imported Class 12 (D_{50} = 12") riprap. Photo 15 shows the placement of bedding and riprap on the dam embankment.

3.8 Toe Drain

The toe drain was installed with the use of a box being pulled along the embankment. No. 8 Gavel was placed in the trench, then the box was placed on the gravel. C33 sand was placed in the box along with the toe drain. The box was then pulled across the embankment. The top gravel layer was placed on top of the sand, and the drain was covered with 2 feet of embankment. The sand, gavel, and embankment cover were all compacted according to the specifications.

4.0 MATERIALS TESTING

Quality assurance testing was conducted on the project as work progressed. Appendix C of this report provides a summary of all testing conducted. The summary includes gradations for the riprap bedding, proctor density curves for the backfill, moisture and density tests for the backfill, and concrete test data. As the tests indicate, the materials used during construction meet the project requirements except for some of the concrete strength tests. The 28-day strength of the concrete placed in the vault structure at Station 4+00 on November 20, 2017 required structural calculations to check that the structure still met design requirements. EA addressed the concrete strength with calculations in a technical letter dated January 8, 2018, which is included in Appendix D. It was concluded that the structures pass the structural design criteria with the low break strengths.

5.0 STANDARD OF CARE

The information contained in this report represents our findings at the time and location as indicated in this report. The methods utilized are in accordance with currently accepted engineering and testing procedures and other than this, no warranty, either expressed or implied, is intended.

APPENDIX A
WEATHER CONDITIONS

Lemoore (Abandoned) Willett A, CO

Lemoore (Abandoned) Willett A

2:21 PM MDT on April 13, 2018 (GMT -0600)

Today Forecast

Weather History for KLMO - August, 2017

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 Actual: **91°** | **57°** **0.00** in Average: - | - - in	**2** Actual: **90°** | **54°** **0.00** in Average: - | - - in	**3** Actual: **69°** | **57°** **0.10** in Average: - | - - in	**4** Actual: **90°** | **54°** **0.03** in Average: - | - - in	**5** Actual: **85°** | **57°** **0.27** in Average: - | - - in
6 Actual: **74°** | **54°** **0.00** in Average: - | - - in	**7** Actual: **64°** | **58°** **0.31** in Average: - | - - in	**8** Actual: **77°** | **57°** **0.00** in Average: - | - - in	**9** Actual: **78°** | **56°** **0.01** in Average: - | - - in	**10** Actual: **78°** | **55°** **0.09** in Average: - | - - in	**11** Actual: **80°** | **57°** **0.00** in Average: - | - - in	**12** Actual: **82°** | **55°** **0.00** in Average: - | - - in
13 Actual: **88°** | **57°** **0.00** in Average: - | - - in	**14** Actual: **92°** | **56°** **0.00** in Average: - | - - in	**15** Actual: **84°** | **56°** **0.02** in Average: - | - - in	**16** Actual: **78°** | **58°** **0.01** in Average: - | - - in	**17** Actual: **90°** | **51°** **0.00** in Average: - | - - in	**18** Actual: **89°** | **52°** **0.00** in Average: - | - - in	**19** Actual: **98°** | **53°** **0.00** in Average: - | - - in
20 Actual: **90°** | **57°** **0.00** in Average: - | - - in	**21** Actual: **90°** | **55°** **0.00** in Average: - | - - in	**22** Actual: **83°** | **55°** **0.00** in Average: - | - - in	**23** Actual: **91°** | **57°** **0.00** in Average: - | - - in	**24** Actual: **89°** | **54°** **0.00** in Average: - | - - in	**25** Actual: **91°** | **49°** **0.00** in Average: - | - - in	**26** Actual: **96°** | **54°** **0.00** in Average: - | - - in
27 Actual: **88°** | **59°** **0.00** in Average: - | - - in	**28** Actual: **91°** | **54°** **0.00** in Average: - | - - in	**29** Actual: **92°** | **53°** **0.00** in Average: - | - - in	**30** Actual: **90°** | **54°** **0.00** in Average: - | - - in	**31** Actual: **88°** | **54°** **0.00** in Average: - | - - in		

Calendar Legend

Sunny
Clear

Mostly Cloudy

Partly Cloudy

Cloudy

Rain

Snow

Hail Flurries

Thunderstorms

Hazy
Fog

Sleet

'?' denotes
'chance of'

Unknown

Lemoore (Abandoned) Willett A, CO

Lemoore (Abandoned) Willett A

2:21 PM MDT on April 13, 2018 (GMT -0600)

Today Forecast

Weather History for KLMO - September, 2017

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 Actual: **90° | 59°** **0.00** in Average: - | - - in	**2** Actual: **91° | 54°** **0.00** in Average: - | - - in
3 Actual: **99° | 52°** **0.00** in Average: - | - - in	**4** Actual: **90° | 55°** **0.00** in Average: - | - - in	**5** Actual: **72° | 51°** **0.00** in Average: - | - - in	**6** Actual: **81° | 46°** **0.00** in Average: - | - - in	**7** Actual: **85° | 47°** **0.00** in Average: - | - - in	**8** Actual: **86° | 50°** **0.00** in Average: - | - - in	**9** Actual: **93° | 53°** **0.00** in Average: - | - - in
10 Actual: **92° | 53°** **0.00** in Average: - | - - in	**11** Actual: **87° | 59°** **0.00** in Average: - | - - in	**12** Actual: **93° | 52°** **0.00** in Average: - | - - in	**13** Actual: **88° | 55°** **0.01** in Average: - | - - in	**14** Actual: **90° | 57°** **0.00** in Average: - | - - in	**15** Actual: **84° | 50°** **0.11** in Average: - | - - in	**16** Actual: **66° | 48°** **0.01** in Average: - | - - in
17 Actual: **76° | 45°** **0.00** in Average: - | - - in	**18** Actual: **84° | 44°** **0.00** in Average: - | - - in	**19** Actual: **88° | 48°** **0.00** in Average: - | - - in	**20** Actual: **77° | 40°** **0.00** in Average: - | - - in	**21** Actual: **90° | 40°** **0.00** in Average: - | - - in	**22** Actual: **74° | 44°** **0.00** in Average: - | - - in	**23** Actual: **56° | 47°** **0.60** in Average: - | - - in
24 Actual: **52° | 47°** **0.03** in Average: - | - - in	**25** Actual: **57° | 43°** **0.00** in Average: - | - - in	**26** Actual: **65° | 46°** **0.01** in Average: - | - - in	**27** Actual: **55° | 51°** **0.02** in Average: - | - - in	**28** Actual: **59° | 51°** **0.26** in Average: - | - - in	**29** Actual: **62° | 44°** **0.00** in Average: - | - - in	**30** Actual: **71° | 40°** **0.01** in Average: - | - - in

Calendar Legend

Sunny
Clear
Mostly Cloudy
Partly Cloudy
Cloudy
Rain
Snow
Hail Flurries
Thunderstorms
Hazy
Fog
Sleet
'?' denotes 'chance of'
Unknown

Lemoore (Abandoned) Willett A, CO

Lemoore (Abandoned) Willett A

2:20 PM MDT on April 13, 2018 (GMT -0600)

Today Forecast

Weather History for KLMO - October, 2017

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 Actual: **70° | 50°** **0.00** in Average: - | - - in	**2** Actual: **50° | 39°** **0.52** in Average: - | - - in	**3** Actual: **58° | 34°** **MM** in Average: - | - - in	**4** Actual: **69° | 40°** **0.00** in Average: - | - - in	**5** Actual: **68° | 43°** **0.00** in Average: - | - - in	**6** Actual: **72° | 48°** **0.00** in Average: - | - - in	**7** Actual: **77° | 40°** **0.00** in Average: - | - - in
8 Actual: **65° | 37°** **MM** in Average: - | - - in	**9** Actual: **43° | 31°** **MM** in Average: - | - - in	**10** Actual: **60° | 26°** **0.00** in Average: - | - - in	**11** Actual: **72° | 30°** **0.00** in Average: - | - - in	**12** Actual: **79° | 34°** **0.00** in Average: - | - - in	**13** Actual: **65° | 35°** **0.00** in Average: - | - - in	**14** Actual: **64° | 32°** **0.00** in Average: - | - - in
15 Actual: **62° | 28°** **0.00** in Average: - | - - in	**16** Actual: **79° | 32°** **0.00** in Average: - | - - in	**17** Actual: **81° | 31°** **0.00** in Average: - | - - in	**18** Actual: **79° | 41°** **0.00** in Average: - | - - in	**19** Actual: **74° | 32°** **0.00** in Average: - | - - in	**20** Actual: **80° | 39°** **0.00** in Average: - | - - in	**21** Actual: **63° | 33°** **0.00** in Average: - | - - in
22 Actual: **72° | 29°** **0.00** in Average: - | - - in	**23** Actual: **65° | 36°** **0.00** in Average: - | - - in	**24** Actual: **64° | 29°** **0.00** in Average: - | - - in	**25** Actual: **84° | 34°** **0.00** in Average: - | - - in	**26** Actual: **66° | 33°** **MM** in Average: - | - - in	**27** Actual: **46° | 22°** **0.00** in Average: - | - - in	**28** Actual: **63° | 37°** **0.00** in Average: - | - - in
29 Actual: **77° | 34°** **0.00** in Average: - | - - in	**30** Actual: **43° | 32°** **MM** in Average: - | - - in	**31** Actual: **61° | 28°** **MM** in Average: - | - - in				

Calendar Legend

Sunny
Clear

Mostly Cloudy

Partly Cloudy

Cloudy

Rain

Snow

Hail Flurries

Thunderstorms

Hazy
Fog

Sleet

'?' denotes
'chance of'

Unknown

Lemoore (Abandoned) Willett A, CO

Lemoore (Abandoned) Willett A

2:15 PM MDT on April 13, 2018 (GMT -0600)

Today Forecast

Weather History for KLMO - November, 2017

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 Actual: **75° | 57°** **0.00** in Average: - | - - in	**2** Actual: **60° | 32°** **0.00** in Average: - | - - in	**3** Actual: **57° | 33°** **0.00** in Average: - | - - in	**4** Actual: **72° | 31°** **0.00** in Average: - | - - in
5 Actual: **48° | 35°** **0.09** in Average: - | - - in	**6** Actual: **43° | 34°** **MM** in Average: - | - - in	**7** Actual: **35° | 28°** **MM** in Average: - | - - in	**8** Actual: **46° | 29°** **0.03** in Average: - | - - in	**9** Actual: **42° | 28°** **0.00** in Average: - | - - in	**10** Actual: **58° | 24°** **0.00** in Average: - | - - in	**11** Actual: **62° | 30°** **0.00** in Average: - | - - in
12 Actual: **55° | 26°** **0.00** in Average: - | - - in	**13** Actual: **73° | 32°** **0.00** in Average: - | - - in	**14** Actual: **73° | 35°** **0.00** in Average: - | - - in	**15** Actual: **53° | 28°** **0.00** in Average: - | - - in	**16** Actual: **73° | 27°** **0.00** in Average: - | - - in	**17** Actual: **65° | 39°** **0.07** in Average: - | - - in	**18** Actual: **52° | 25°** **0.00** in Average: - | - - in
19 Actual: **56° | 19°** **0.00** in Average: - | - - in	**20** Actual: **71° | 37°** **0.00** in Average: - | - - in	**21** Actual: **57° | 32°** **0.00** in Average: - | - - in	**22** Actual: **72° | 31°** **0.00** in Average: - | - - in	**23** Actual: **70° | 36°** **0.00** in Average: - | - - in	**24** Actual: **75° | 40°** **0.00** in Average: - | - - in	**25** Actual: **63° | 32°** **0.00** in Average: - | - - in
26 Actual: **68° | 32°** **0.00** in Average: - | - - in	**27** Actual: **78° | 41°** **0.00** in Average: - | - - in	**28** Actual: **49° | 27°** **0.00** in Average: - | - - in	**29** Actual: **67° | 23°** **0.00** in Average: - | - - in	**30** Actual: **54° | 22°** **0.00** in Average: - | - - in		

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Sunny
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Unknown

Lemoore (Abandoned) Willett A, CO

Lemoore (Abandoned) Willett A

2:21 PM MDT on April 13, 2018 (GMT -0600)

Today Forecast

Weather History for KLMO - December, 2017

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 Actual: **60° | 26°** **0.00** in Average: **-** | **-** - in	**2** Actual: **63° | 32°** **0.00** in Average: **-** | **-** - in
3 Actual: **62° | 30°** **0.00** in Average: **-** | **-** - in	**4** Actual: **45° | 19°** **0.00** in Average: **-** | **-** - in	**5** Actual: **48° | 12°** **0.00** in Average: **-** | **-** - in	**6** Actual: **43° | 19°** **0.00** in Average: **-** | **-** - in	**7** Actual: **38° | 10°** **0.00** in Average: **-** | **-** - in	**8** Actual: **63° | 24°** **0.00** in Average: **-** | **-** - in	**9** Actual: **64° | 21°** **0.00** in Average: **-** | **-** - in
10 Actual: **61° | 19°** **0.00** in Average: **-** | **-** - in	**11** Actual: **59° | 22°** **0.00** in Average: **-** | **-** - in	**12** Actual: **66° | 23°** **0.00** in Average: **-** | **-** - in	**13** Actual: **56° | 35°** **MM** in Average: **-** | **-** - in	**14** Actual: **45° | 19°** **MM** in Average: **-** | **-** - in	**15** Actual: **65° | 16°** **0.00** in Average: **-** | **-** - in	**16** Actual: **58° | 33°** **0.00** in Average: **-** | **-** - in
17 Actual: **42° | 21°** **MM** in Average: **-** | **-** - in	**18** Actual: **54° | 17°** **0.00** in Average: **-** | **-** - in	**19** Actual: **51° | 23°** **0.00** in Average: **-** | **-** - in	**20** Actual: **67° | 23°** **0.00** in Average: **-** | **-** - in	**21** Actual: **36° | 7°** **MM** in Average: **-** | **-** - in	**22** Actual: **40° | 3°** **MM** in Average: **-** | **-** - in	**23** Actual: **34° | 10°** **MM** in Average: **-** | **-** - in
24 Actual: **28° | -3°** **MM** in Average: **-** | **-** - in	**25** Actual: **27° | 11°** **MM** in Average: **-** | **-** - in	**26** Actual: **14° | 6°** **MM** in Average: **-** | **-** - in	**27** Actual: **55° | 0°** **MM** in Average: **-** | **-** - in	**28** Actual: **50° | 23°** **0.00** in Average: **-** | **-** - in	**29** Actual: **67° | 16°** **MM** in Average: **-** | **-** - in	**30** Actual: **24° | 13°** **MM** in Average: **-** | **-** - in
31 Actual: **27° | 15°** **MM** in Average: **-** | **-** - in						

Calendar Legend

Sunny
Clear
Mostly Cloudy
Partly Cloudy
Cloudy
Rain
Snow
Hail Flurries
Thunderstorms
Hazy
Fog
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'chance of'
Unknown

Lemoore (Abandoned) Willett A, CO

Lemoore (Abandoned) Willett A

2:22 PM MDT on April 13, 2018 (GMT -0600)

Today Forecast

Weather History for KLMO - January, 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1 Actual: **30° | 11°** **MM** in Average: - | - - in	**2** Actual: **46° | 8°** **0.00** in Average: - | - - in	**3** Actual: **52° | 14°** **0.00** in Average: - | - - in	**4** Actual: **54° | 23°** **0.00** in Average: - | - - in	**5** Actual: **53° | 21°** **0.00** in Average: - | - - in	**6** Actual: **54° | 24°** **0.00** in Average: - | - - in
7 Actual: **54° | 26°** **0.00** in Average: - | - - in	**8** Actual: **48° | 20°** **0.00** in Average: - | - - in	**9** Actual: **69° | 33°** **0.00** in Average: - | - - in	**10** Actual: **52° | 25°** **0.00** in Average: - | - - in	**11** Actual: **47° | 17°** **0.00** in Average: - | - - in	**12** Actual: **48° | 23°** **0.00** in Average: - | - - in	**13** Actual: **50° | 17°** **0.00** in Average: - | - - in
14 Actual: **52° | 20°** **0.00** in Average: - | - - in	**15** Actual: **31° | 4°** **MM** in Average: - | - - in	**16** Actual: **35° | -3°** **0.01** in Average: - | - - in	**17** Actual: **55° | 8°** **0.00** in Average: - | - - in	**18** Actual: **61° | 18°** **0.00** in Average: - | - - in	**19** Actual: **74° | 32°** **0.00** in Average: - | - - in	**20** Actual: **50° | 24°** **MM** in Average: - | - - in
21 Actual: **32° | 23°** **MM** in Average: - | - - in	**22** Actual: **49° | 7°** **0.11** in Average: - | - - in	**23** Actual: **42° | 15°** **0.00** in Average: - | - - in	**24** Actual: **52° | 12°** **0.00** in Average: - | - - in	**25** Actual: **46° | 21°** **0.00** in Average: - | - - in	**26** Actual: **42° | 24°** **0.00** in Average: - | - - in	**27** Actual: **42° | 21°** **0.00** in Average: - | - - in
28 Actual: **56° | 18°** **0.00** in Average: - | - - in	**29** Actual: **60° | 21°** **0.00** in Average: - | - - in	**30** Actual: **66° | 29°** **0.00** in Average: - | - - in	**31** Actual: **58° | 23°** **0.00** in Average: - | - - in			

Calendar Legend

Sunny
Clear
Mostly Cloudy
Partly Cloudy
Cloudy
Rain
Snow
Hail Flurries
Thunderstorms
Hazy
Fog
Sleet
'?' denotes
'chance of'
Unknown

Lemoore (Abandoned) Willett A, CO

Lemoore (Abandoned) Willett A

2:22 PM MDT on April 13, 2018 (GMT -0600)

Today Forecast

Weather History for KLMO - February, 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1 Actual: **33° | 25°** **MM** in Average: - | - - in	**2** Actual: **44° | 24°** **0.00** in Average: - | - - in	**3** Actual: **62° | 29°** **0.00** in Average: - | - - in
4 Actual: **52° | 16°** **MM** in Average: - | - - in	**5** Actual: **59° | 22°** **MM** in Average: - | - - in	**6** Actual: **51° | 25°** **0.00** in Average: - | - - in	**7** Actual: **51° | 27°** **0.00** in Average: - | - - in	**8** Actual: **61° | 27°** **0.00** in Average: - | - - in	**9** Actual: **56° | 14°** **MM** in Average: - | - - in	**10** Actual: **20° | 3°** **MM** in Average: - | - - in
11 Actual: **36° | 2°** **MM** in Average: - | - - in	**12** Actual: **25° | 17°** **MM** in Average: - | - - in	**13** Actual: **60° | 13°** **0.00** in Average: - | - - in	**14** Actual: **65° | 42°** **0.00** in Average: - | - - in	**15** Actual: **54° | 23°** **MM** in Average: - | - - in	**16** Actual: **44° | 23°** **0.00** in Average: - | - - in	**17** Actual: **59° | 37°** **0.00** in Average: - | - - in
18 Actual: **68° | 25°** **MM** in Average: - | - - in	**19** Actual: **23° | 5°** **MM** in Average: - | - - in	**20** Actual: **18° | -9°** **MM** in Average: - | - - in	**21** Actual: **28° | -6°** **MM** in Average: - | - - in	**22** Actual: **34° | 6°** **0.00** in Average: - | - - in	**23** Actual: **36° | 8°** **MM** in Average: - | - - in	**24** Actual: **39° | 8°** **0.07** in Average: - | - - in
25 Actual: **45° | 25°** **0.00** in Average: - | - - in	**26** Actual: **53° | 21°** **0.00** in Average: - | - - in	**27** Actual: **55° | 23°** **0.00** in Average: - | - - in	**28** Actual: **53° | 25°** **0.00** in Average: - | - - in			

Calendar Legend

Sunny
Clear

Mostly Cloudy

Partly Cloudy

Cloudy

Rain

Snow

Hail Flurries

Thunderstorms

Hazy
Fog

Sleet

'?' denotes
'chance of'

Unknown

Lemoore (Abandoned) Willett A, CO

Lemoore (Abandoned) Willett A

2:22 PM MDT on April 13, 2018 (GMT -0600)

Today Forecast

Weather History for KLMO - March, 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1 Actual: **52° | 22°** **0.00** in Average: **-** | **-** - in	**2** Actual: **72° | 28°** **0.00** in Average: **-** | **-** - in	**3** Actual: **70° | 27°** **0.00** in Average: **-** | **-** - in
4 Actual: **69° | 26°** **0.00** in Average: **-** | **-** - in	**5** Actual: **44° | 29°** **0.00** in Average: **-** | **-** - in	**6** Actual: **51° | 20°** **0.00** in Average: **-** | **-** - in	**7** Actual: **55° | 16°** **0.00** in Average: **-** | **-** - in	**8** Actual: **67° | 22°** **0.00** in Average: **-** | **-** - in	**9** Actual: **68° | 43°** **0.00** in Average: **-** | **-** - in	**10** Actual: **57° | 25°** **0.00** in Average: **-** | **-** - in
11 Actual: **54° | 17°** **0.00** in Average: **-** | **-** - in	**12** Actual: **59° | 19°** **0.00** in Average: **-** | **-** - in	**13** Actual: **60° | 22°** **0.00** in Average: **-** | **-** - in	**14** Actual: **70° | 25°** **0.00** in Average: **-** | **-** - in	**15** Actual: **67° | 29°** **0.14** in Average: **-** | **-** - in	**16** Actual: **57° | 33°** **0.00** in Average: **-** | **-** - in	**17** Actual: **64° | 26°** **0.00** in Average: **-** | **-** - in
18 Actual: **59° | 28°** **MM** in Average: **-** | **-** - in	**19** Actual: **50° | 30°** **0.00** in Average: **-** | **-** - in	**20** Actual: **56° | 26°** **0.00** in Average: **-** | **-** - in	**21** Actual: **64° | 26°** **0.00** in Average: **-** | **-** - in	**22** Actual: **78° | 35°** **0.00** in Average: **-** | **-** - in	**23** Actual: **71° | 48°** **0.00** in Average: **-** | **-** - in	**24** Actual: **68° | 31°** **0.00** in Average: **-** | **-** - in
25 Actual: **64° | 30°** **0.02** in Average: **-** | **-** - in	**26** Actual: **53° | 34°** **MM** in Average: **-** | **-** - in	**27** Actual: **53° | 31°** **MM** in Average: **-** | **-** - in	**28** Actual: **48° | 30°** **MM** in Average: **-** | **-** - in	**29** Actual: **51° | 25°** **0.00** in Average: **-** | **-** - in	**30** Actual: **66° | 27°** **0.00** in Average: **-** | **-** - in	**31** Actual: **60° | 32°** **0.00** in Average: **-** | **-** - in

Calendar Legend

Sunny Clear · Mostly Cloudy · Partly Cloudy · Cloudy · Rain · Snow

Hail Flurries · Thunderstorms · Hazy Fog · Sleet · '?' denotes 'chance of' · Unknown

APPENDIX B
CONSTRUCTION PHOTOGRAPHS

Photo 01 (08-04-2017) Excavation of clay

Photo 02 (08-22-2017) Roots in embankment by primary spillway (1)

Photo 03 (08-22-2017) Roots in embankment by primary spillway (2)

Photo 04 (08-25-2017) Roots in north dam embankment

Photo 05 (09-20-2017) Outlet excavation

Photo 06 (10-18-2017) Irrigation outlet rebar

Photo 07 (10-24-2017) 15-inch heavy duty slide gate

Photo 08 (10-24-2017) 24-inch heavy duty slide gate

Photo 09 (10-24-2017) Irrigation PIP anchored to base of encasement

Photo 10 (10-24-2017) Primary outlet DIP ancored to base of encasement

Photo 11 (11-03-2017) Irrigation outlet ecasement rebar and formwork

Photo 12 (11-20-2017) Spillway grade beam reinforcement

Photo 13 (11-21-2017) Northeast wingwall foundation after form removal

Photo 14 (12-14-2017) Spillway grade control beam backfill

Photo 15 (01-02-2018) Bedding and riprap on upstream face

APPENDIX C
MATERIALS TESTING

ENGINEERING ANALYTICS

CONSOLIDATED DRAINED DIRECT SHEAR TEST

Swede Lake | Borrow 1

Sample Data:		NORMAL LOAD (psf)	PEAK SHEAR LOAD (psf)	SHEAR LOAD AT 5% STRAIN (psf)	SHEAR LOAD AT 10% STRAIN (psf)
Bulk Unit Weight (pcf):	118.4				
Dry Unit Weight (pcf):	101.5				
moisture content (%):	14.4				
sample mass (grams):	187.6				
sample diameter (inch):	2.48				
sample height (inch):	1.25	1000.0	924	865	924
sample area (sq inch):	4.83	2000.0	1371	1312	1371
shear rate (inch per min.):	0.002500	4000.0	1997	1818	1997

NORMAL LOAD (psf)	SHEAR LOAD (lbs)	SHEAR LOAD (psf)	HORIZ DIAL 0.001(inch)	HORIZ DISP (inch)		HORIZ DISP (inch)	SHEAR LOAD (psf)
1000	**0**	0	**660**	0.000		0.000	0
1000	**5**	149	**670**	0.010		0.010	149
1000	**11**	328	**680**	0.020		0.020	328
1000	**16**	477	**690**	0.030		0.030	477
1000	**18**	537	**700**	0.040		0.040	537
1000	**20**	596	**710**	0.050		0.050	596
1000	**23**	686	**720**	0.060		0.060	686
1000	**24**	715	**730**	0.070		0.070	715
1000	**24**	715	**740**	0.080		0.080	715
1000	**26**	775	**750**	0.090		0.090	775
1000	**27**	805	**760**	0.100		0.100	805
1000	**28**	835	**770**	0.110		0.110	835
1000	**28**	835	**780**	0.120		0.120	835
1000	**29**	865	**790**	0.130		0.130	865
1000	**30**	894	**800**	0.140		0.140	894
1000	**31**	924	**810**	0.150		0.150	924
1000	**31**	924	**820**	0.160		0.160	924
1000	**31**	924	**830**	0.170		0.170	924
1000	**31**	924	**840**	0.180		0.180	924
1000	**31**	924	**850**	0.190		0.190	924
1000	**31**	924	**860**	0.200		0.200	924
1000	**31**	924	**870**	0.210		0.210	924
1000	**31**	924	**880**	0.220		0.220	924
1000	**31**	924	**890**	0.230		0.230	924
1000	**31**	924	**900**	0.240		0.240	924
1000	**31**	924	**910**	0.250		0.250	924
1000	**31**	924	**920**	0.260		0.260	924
1000	**31**	924	**930**	0.270		0.270	924

ENGINEERING ANALYTICS

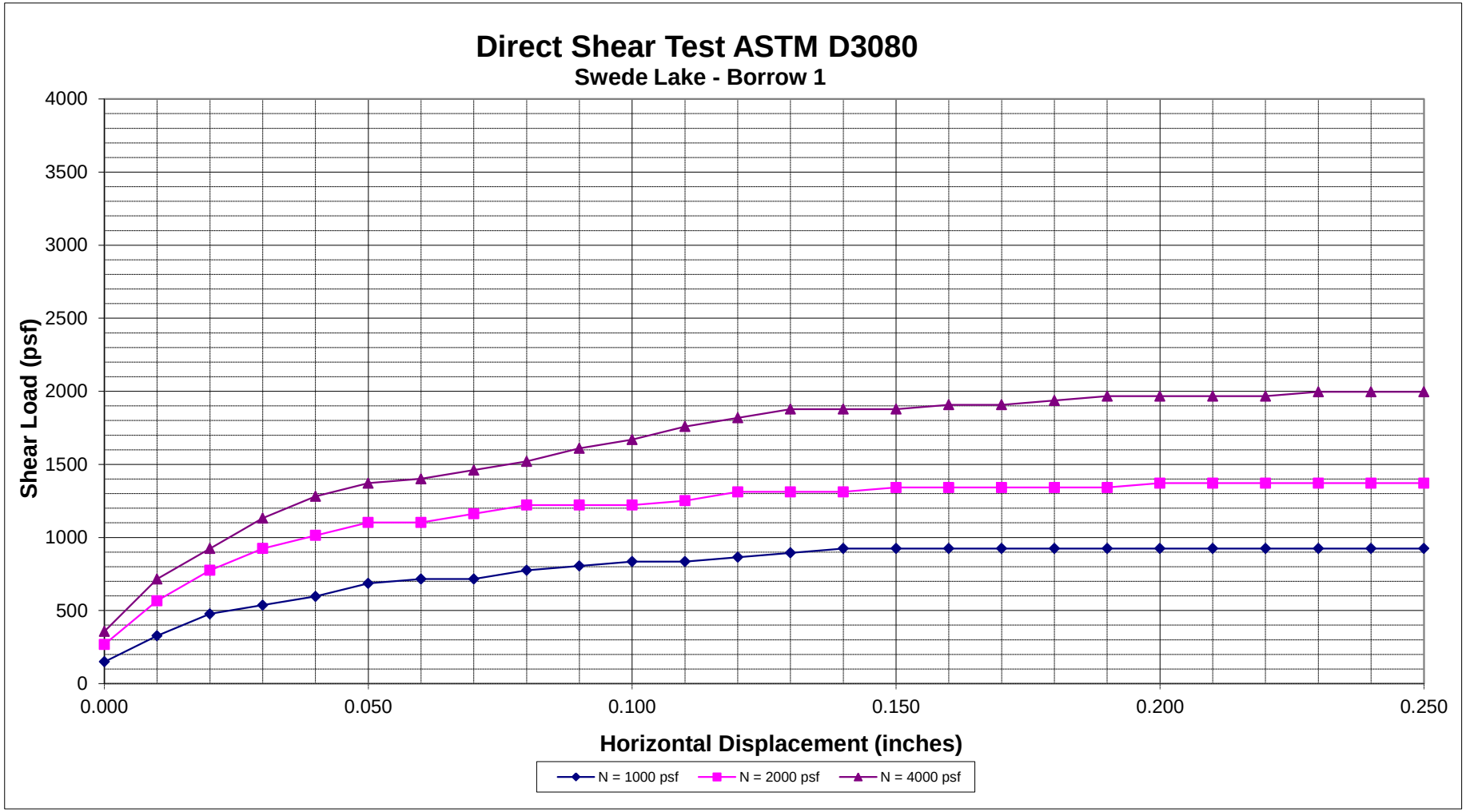
CONSOLIDATED DRAINED DIRECT SHEAR TEST

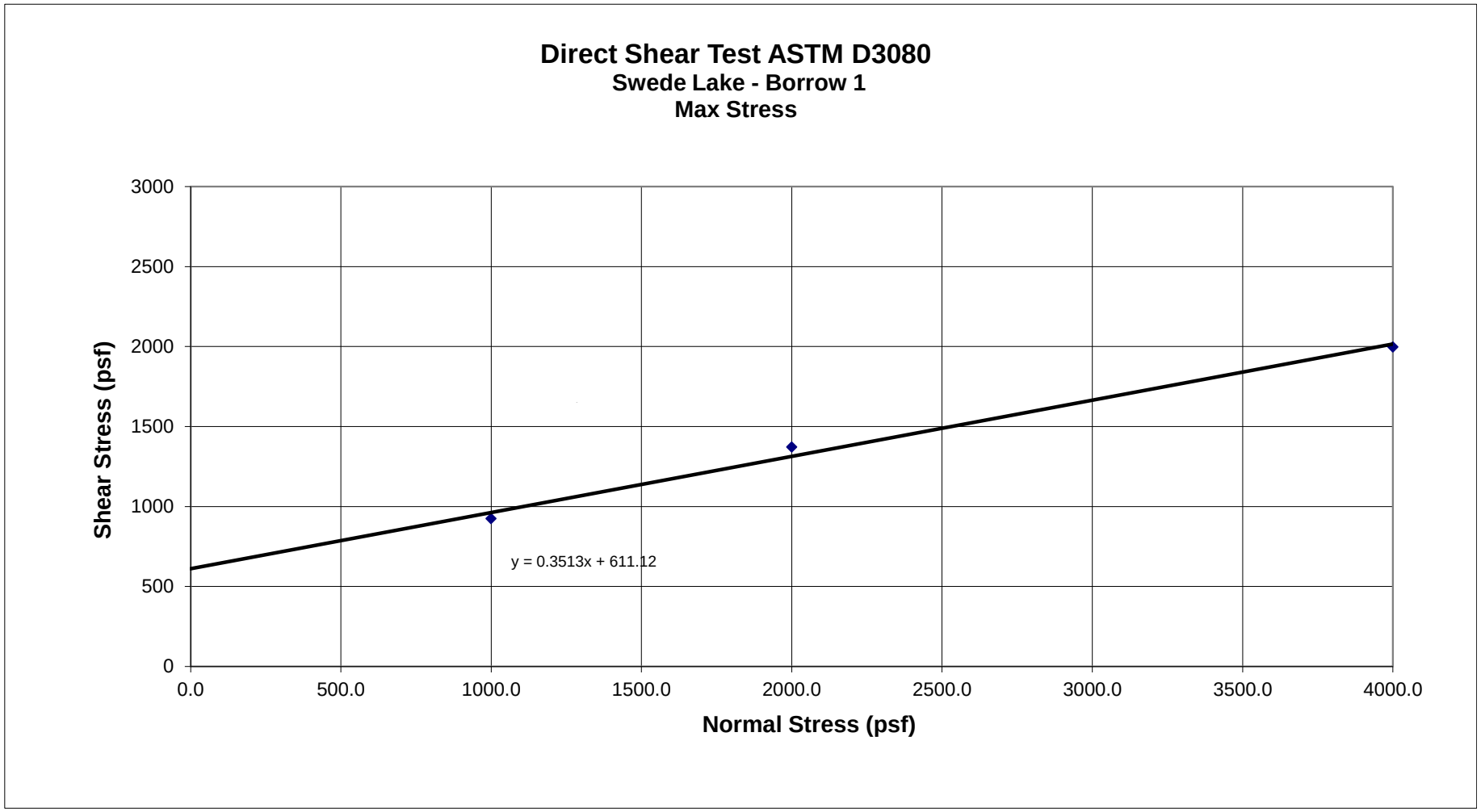
		Swede Lake		Borrow 1	0		
NORMAL LOAD (psf)	SHEAR LOAD (lbs)	SHEAR LOAD (psf)	HORIZ DIAL 0.001(inch)	HORIZ DISP (inch)		HORIZ DISP (inch)	SHEAR LOAD (psf)
2,000	**0**	0	**660**	0.000		0.000	0
2,000	**9**	268	**670**	0.010		0.010	268
2,000	**19**	566	**680**	0.020		0.020	566
2,000	**26**	775	**690**	0.030		0.030	775
2,000	**31**	924	**700**	0.040		0.040	924
2,000	**34**	1014	**710**	0.050		0.050	1014
2,000	**37**	1103	**720**	0.060		0.060	1103
2,000	**37**	1103	**730**	0.070		0.070	1103
2,000	**39**	1163	**740**	0.080		0.080	1163
2,000	**41**	1222	**750**	0.090		0.090	1222
2,000	**41**	1222	**760**	0.100		0.100	1222
2,000	**41**	1222	**770**	0.110		0.110	1222
2,000	**42**	1252	**780**	0.120		0.120	1252
2,000	**44**	1312	**790**	0.130		0.130	1312
2,000	**44**	1312	**800**	0.140		0.140	1312
2,000	**44**	1312	**810**	0.150		0.150	1312
2,000	**45**	1341	**820**	0.160		0.160	1341
2,000	**45**	1341	**830**	0.170		0.170	1341
2,000	**45**	1341	**840**	0.180		0.180	1341
2,000	**45**	1341	**850**	0.190		0.190	1341
2,000	**45**	1341	**860**	0.200		0.200	1341
2,000	**46**	1371	**870**	0.210		0.210	1371
2,000	**46**	1371	**880**	0.220		0.220	1371
2,000	**46**	1371	**890**	0.230		0.230	1371
2,000	**46**	1371	**900**	0.240		0.240	1371
2,000	**46**	1371	**910**	0.250		0.250	1371
2,000	**46**	1371	**920**	0.260		0.260	1371
2,000	**46**	1371	**930**	0.270		0.270	1371

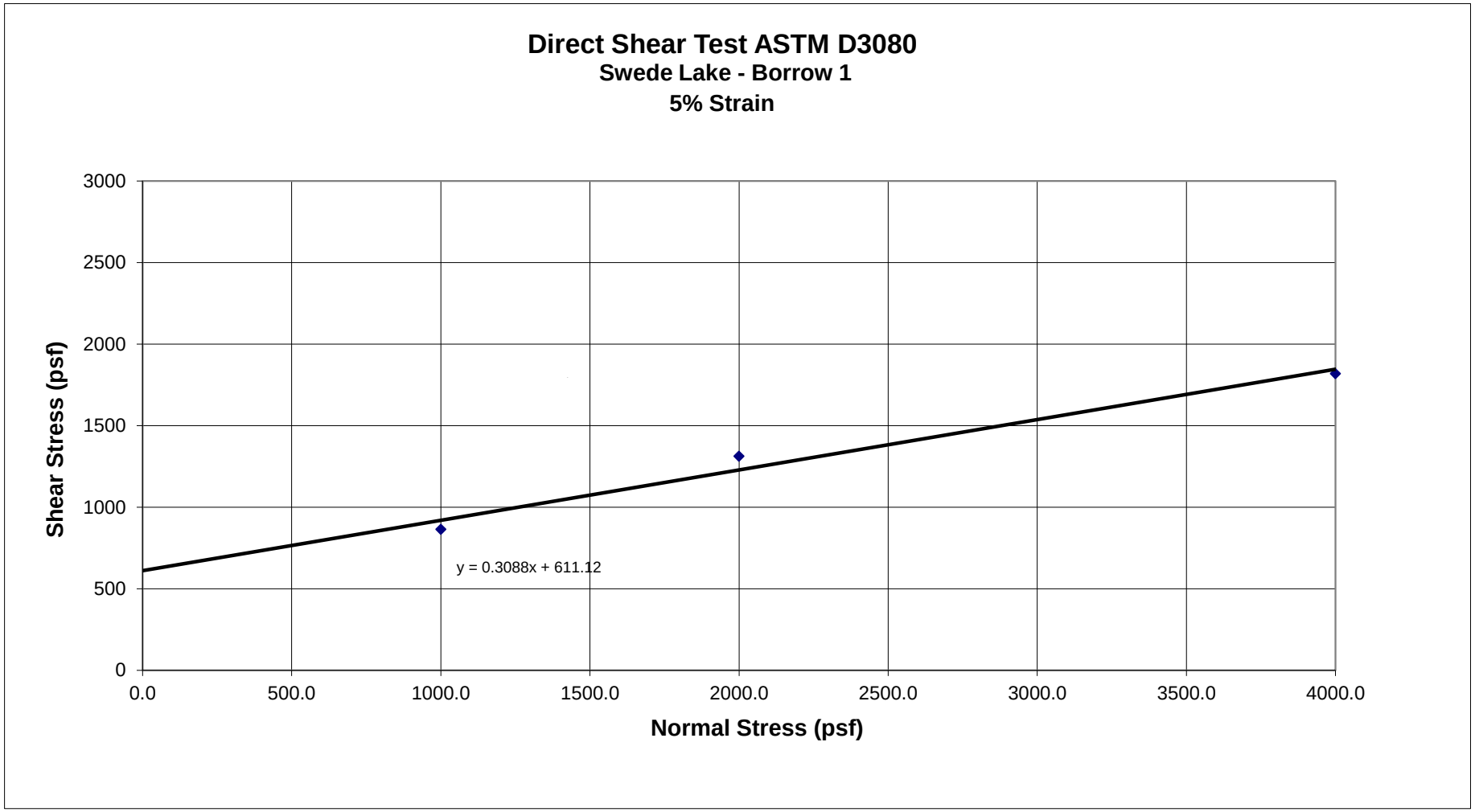
ENGINEERING ANALYTICS

CONSOLIDATED DRAINED DIRECT SHEAR TEST

		Swede Lake		Borrow 1	0		
NORMAL LOAD (psf)	SHEAR LOAD (lbs)	SHEAR LOAD (psf)	HORIZ DIAL 0.001(inch)	HORIZ DISP (inch)		HORIZ DISP (inch)	SHEAR LOAD (psf)
4,000	**0**	0	**660**	0.000		0.000	0
4,000	**12**	358	**670**	0.010		0.010	358
4,000	**24**	715	**680**	0.020		0.020	715
4,000	**31**	924	**690**	0.030		0.030	924
4,000	**38**	1133	**700**	0.040		0.040	1133
4,000	**43**	1282	**710**	0.050		0.050	1282
4,000	**46**	1371	**720**	0.060		0.060	1371
4,000	**47**	1401	**730**	0.070		0.070	1401
4,000	**49**	1461	**740**	0.080		0.080	1461
4,000	**51**	1520	**750**	0.090		0.090	1520
4,000	**54**	1610	**760**	0.100		0.100	1610
4,000	**56**	1669	**770**	0.110		0.110	1669
4,000	**59**	1759	**780**	0.120		0.120	1759
4,000	**61**	1818	**790**	0.130		0.130	1818
4,000	**63**	1878	**800**	0.140		0.140	1878
4,000	**63**	1878	**810**	0.150		0.150	1878
4,000	**63**	1878	**820**	0.160		0.160	1878
4,000	**64**	1908	**830**	0.170		0.170	1908
4,000	**64**	1908	**840**	0.180		0.180	1908
4,000	**65**	1938	**850**	0.190		0.190	1938
4,000	**66**	1967	**860**	0.200		0.200	1967
4,000	**66**	1967	**870**	0.210		0.210	1967
4,000	**66**	1967	**880**	0.220		0.220	1967
4,000	**66**	1967	**890**	0.230		0.230	1967
4,000	**67**	1997	**900**	0.240		0.240	1997
4,000	**67**	1997	**910**	0.250		0.250	1997
4,000	**67**	1997	**920**	0.260		0.260	1997
4,000	**67**	1997	**930**	0.270		0.270	1997

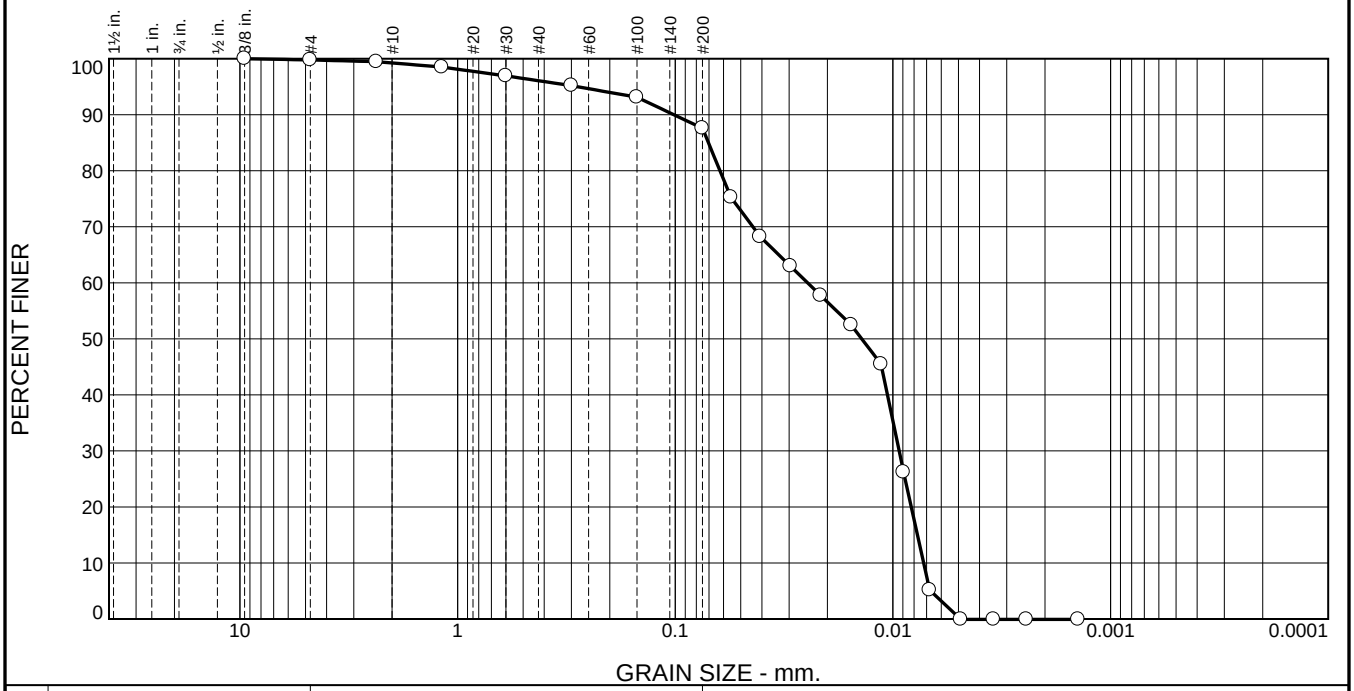

Direct Shear Test ASTM D3080
Swede Lake - Borrow 1
Shear Load (psf)
4000
3500
3000
2500
2000
1500
1000
500
0
0.000
0.050
0.100
0.150
0.200
0.250
Horizontal Displacement (inches)
N = 1000 psf
N = 2000 psf
N = 4000 psf


Direct Shear Test ASTM D3080
Swede Lake - Borrow 1
Max Stress
Shear Stress (psf)
Normal Stress (psf)
y = 0.3513x + 611.12
0
500
1000
1500
2000
2500
3000
0.0
500.0
1000.0
1500.0
2000.0
2500.0
3000.0
3500.0
4000.0


Direct Shear Test ASTM D3080
Swede Lake - Borrow 1
5% Strain
Shear Stress (psf)
Normal Stress (psf)
y = 0.3088x + 611.12
0
500
1000
1500
2000
2500
3000
0.0
500.0
1000.0
1500.0
2000.0
2500.0
3000.0
3500.0
4000.0


Direct Shear Test ASTM D3080
Swede Lake - Borrow 1
10% Strain
Shear Stress (psf)
3000
2500
2000
1500
1000
500
0
y = 0.3513x + 611.12
0.0
500.0
1000.0
1500.0
2000.0
2500.0
3000.0
3500.0
4000.0
Normal Stress (psf)

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.6	3.1	8.5	87.3	0.3

TEST RESULTS (AASHTO T 27)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8	100.0		
#4	99.8		
#8	99.5		
#16	98.5		
#30	96.9		
#50	95.2		
#100	93.1		
#200	87.6		
0.0555 mm.	75.2		
0.0407 mm.	68.2		
0.0296 mm.	63.0		
0.0215 mm.	57.7		
0.0156 mm.	52.5		
0.0113 mm.	45.5		
0.0089 mm.	26.2		
0.0068 mm.	5.2		
0.0049 mm.			
0.0034 mm.			
0.0024 mm.			
0.0014 mm.			

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.1015 D_{85}= 0.0704 D_{60}= 0.0247
D_{50}= 0.0139 D_{30}= 0.0094 D_{15}= 0.0077
D_{10}= 0.0072 C_u= 3.41 C_c= 0.49

Remarks

Date Received: 8/14/17 **Date Tested:** 8/17/17

Tested By: KG

Checked By: KG

Title:

Source of Sample: Borrow 1 **Date Sampled:** 8/14/17

Sample Number: 1

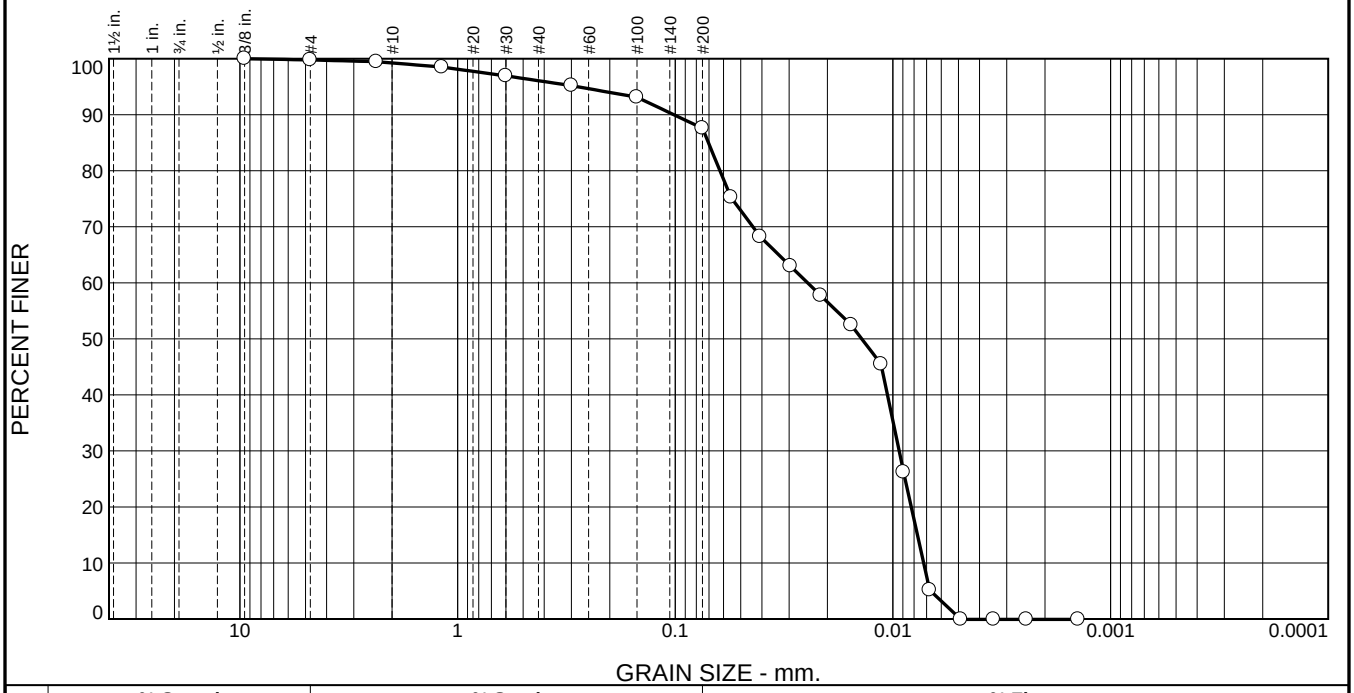
ENIGNEERING ANALYTICS, INC.

Client: Boulder County Parks & open Space

Project: Swede Lake

Project No: 110480 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.6	3.1	8.5	87.3	0.3

TEST RESULTS (AASHTO T 27)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8	100.0		
#4	99.8		
#8	99.5		
#16	98.5		
#30	96.9		
#50	95.2		
#100	93.1		
#200	87.6		
0.0555 mm.	75.2		
0.0407 mm.	68.2		
0.0296 mm.	63.0		
0.0215 mm.	57.7		
0.0156 mm.	52.5		
0.0113 mm.	45.5		
0.0089 mm.	26.2		
0.0068 mm.	5.2		
0.0049 mm.			
0.0034 mm.			
0.0024 mm.			
0.0014 mm.			

* (no specification provided)

Material Description

Clay

Atterberg Limits (ASTM D 4318)

PL= 15 **LL=** 42 **PI=** 27

Classification

USCS (D 2487)= CL **AASHTO (M 145)=** A-7-6(24)

Coefficients

D_{90}= 0.1015 D_{85}= 0.0704 D_{60}= 0.0247
D_{50}= 0.0139 D_{30}= 0.0094 D_{15}= 0.0077
D_{10}= 0.0072 C_u= 3.41 C_c= 0.49

Remarks

Date Received: 8/14/17 **Date Tested:** 8/17/17

Tested By: KG

Checked By: KG

Title:

Source of Sample: Borrow 1 **Date Sampled:** 8/14/17

Sample Number: 1

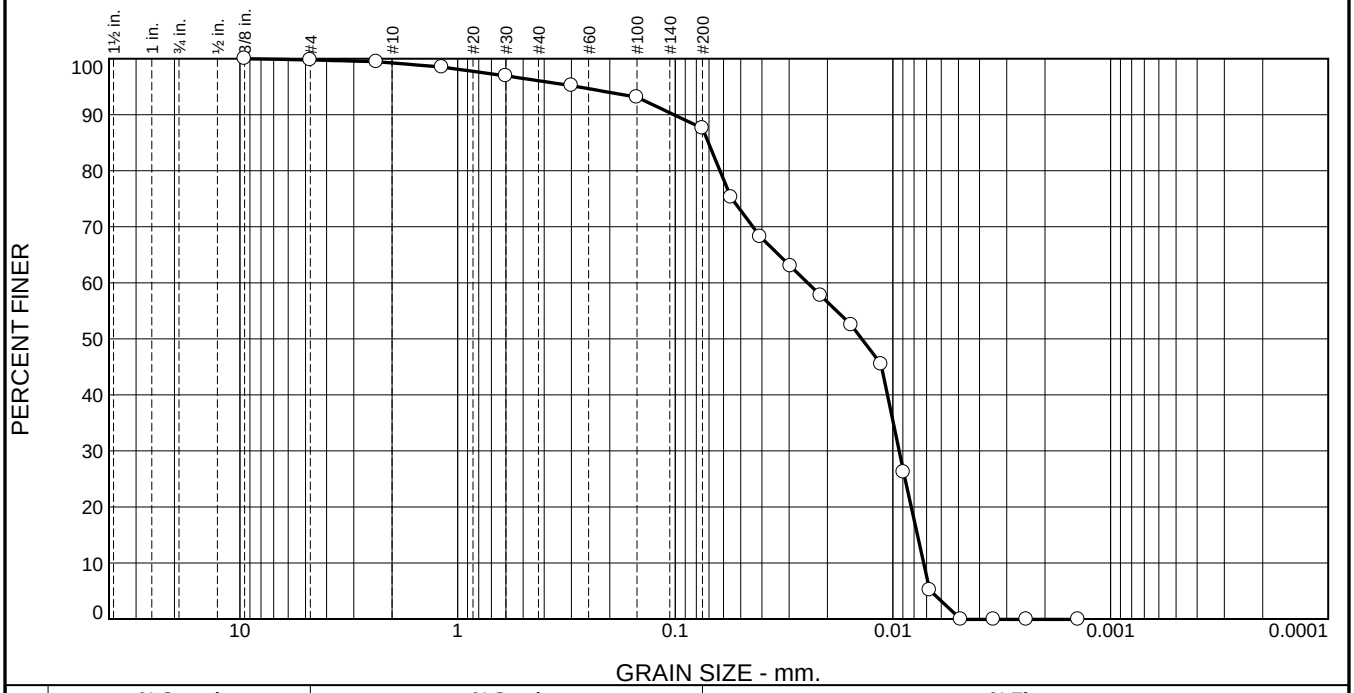
ENIGNEERING ANALYTICS, INC.

Client: Boulder County Parks & Open Space

Project: Swede Lake

Project No: 110480 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.6	3.1	8.5	87.3	0.3

TEST RESULTS (AASHTO T 27)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8	100.0		
#4	99.8		
#8	99.5		
#16	98.5		
#30	96.9		
#50	95.2		
#100	93.1		
#200	87.6		
0.0555 mm.	75.2		
0.0407 mm.	68.2		
0.0296 mm.	63.0		
0.0215 mm.	57.7		
0.0156 mm.	52.5		
0.0113 mm.	45.5		
0.0089 mm.	26.2		
0.0068 mm.	5.2		
0.0049 mm.			
0.0034 mm.			
0.0024 mm.			
0.0014 mm.			

* (no specification provided)

Material Description

Clay

Atterberg Limits (ASTM D 4318)

PL= 15 **LL=** 42 **PI=** 27

Classification

USCS (D 2487)= CL **AASHTO (M 145)=** A-7-6(24)

Coefficients

D_{90}= 0.1015 D_{85}= 0.0704 D_{60}= 0.0247
D_{50}= 0.0139 D_{30}= 0.0094 D_{15}= 0.0077
D_{10}= 0.0072 C_u= 3.41 C_c= 0.49

Remarks

Date Received: 8/14/17 **Date Tested:** 8/17/17

Tested By: KG

Checked By: KG

Title:

Source of Sample: Borrow 1 **Date Sampled:** 8/14/17

Sample Number: 1

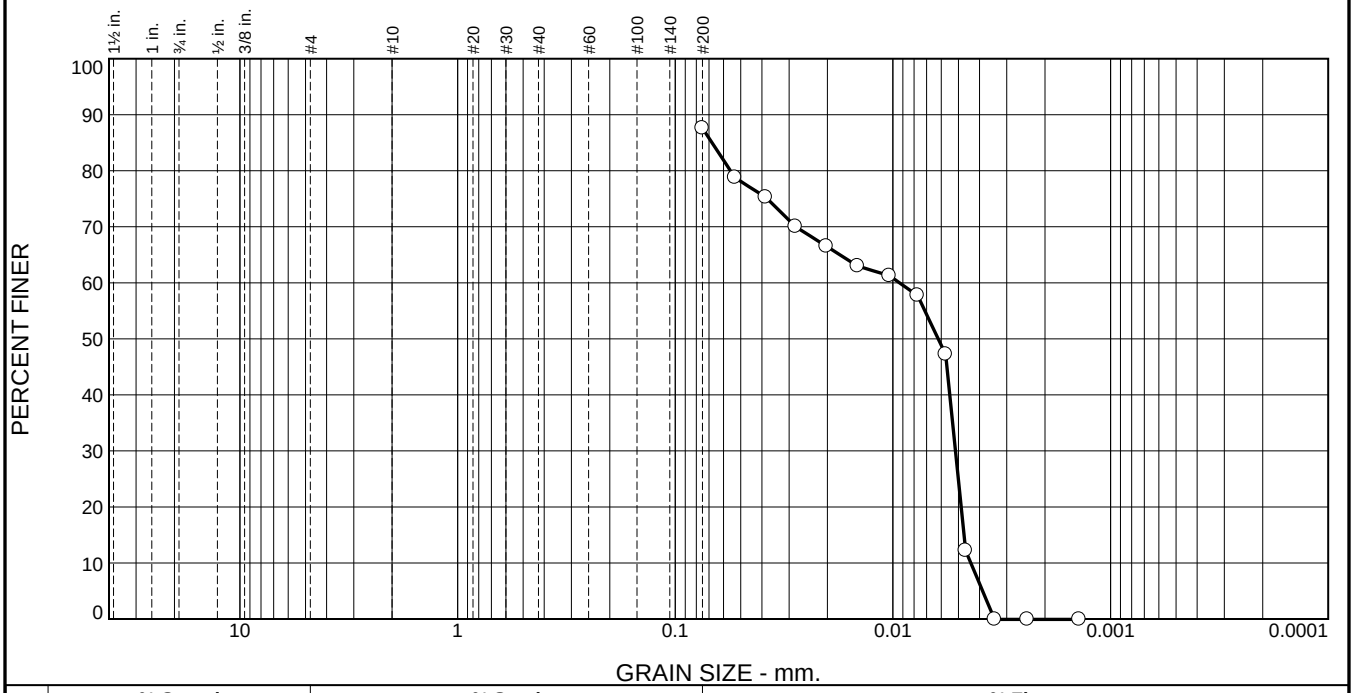
ENIGNEERING ANALYTICS, INC.

Client: Boulder County Parks & Open Space

Project: Swede Lake

Project No: 110480 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						62.8	24.8

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	87.6		
0.0532 mm.	78.8		
0.0384 mm.	75.3		
0.0280 mm.	70.0		
0.0202 mm.	66.5		
0.0145 mm.	63.0		
0.0104 mm.	61.3		
0.0077 mm.	57.7		
0.0057 mm.	47.2		
0.0046 mm.	12.2		
0.0034 mm.			
0.0024 mm.			
0.0014 mm.			

* (no specification provided)

Material Description

Clay

Atterberg Limits (ASTM D 4318)

PL= 15 **LL=** 40 **PI=** 25

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= D_{85}= 0.0678 D_{60}= 0.0093
D_{50}= 0.0062 D_{30}= 0.0052 D_{15}= 0.0047
D_{10}= 0.0044 C_u= 2.13 C_c= 0.65

Remarks

Date Received: **Date Tested:**

Tested By: _____

Checked By: _____

Title: _____

Source of Sample: Borrow 3 **Date Sampled:**
Sample Number: 1

ENIGNEERING ANALYTICS, INC.

Client: Boulder County Parks & Open Space
Project: Swede Lake

Project No: 110480 **Figure**

COMPACTION TEST REPORT

Curve No.: 1

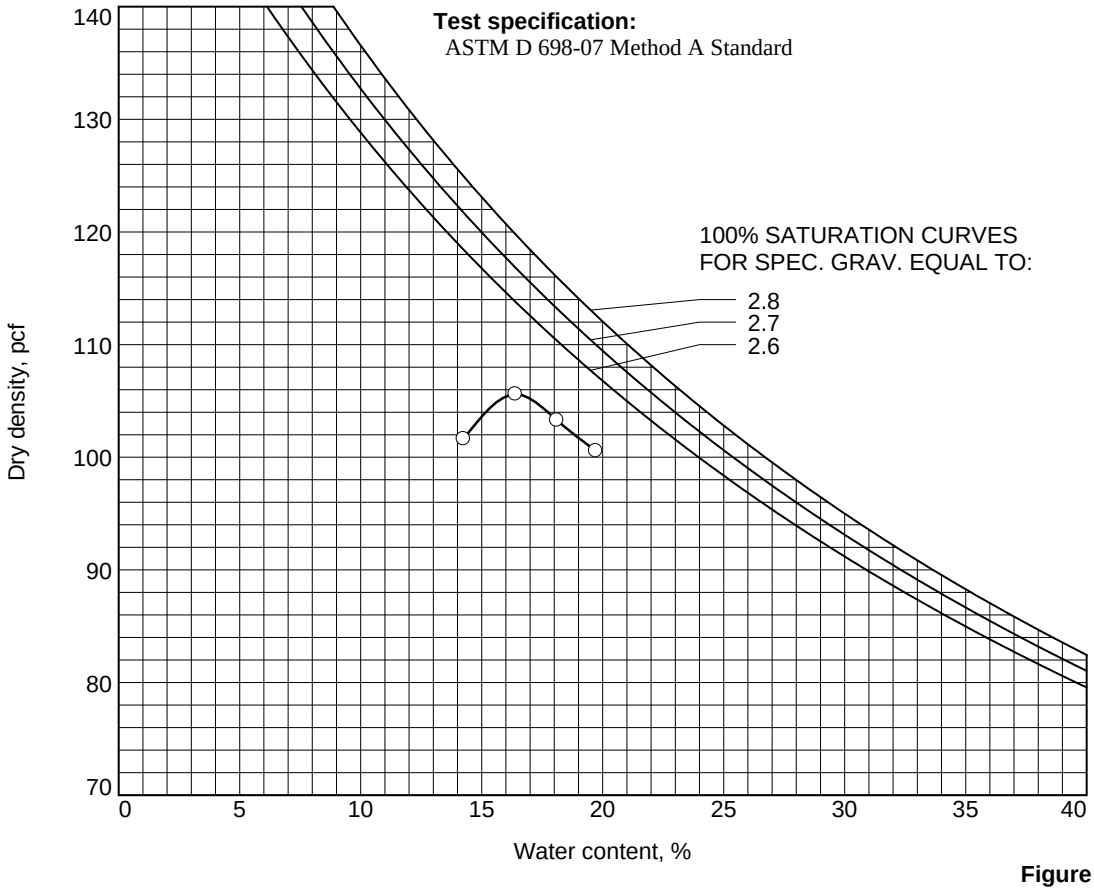
Project No.: 110480 **Date:** 9/18/2017
Project: Swede Lake
Client: Boulder County Parks & Open Space
Source of Sample: Borrow 1
Sample Number: 1
Remarks:

MATERIAL DESCRIPTION

Description: Clay

Classifications - **USCS:** CL **AASHTO:** A-7-6(24)
Nat. Moist. = **Sp.G. =**
Liquid Limit = 42 **Plasticity Index =** 27
%<No.10 = 99.2 % **%<No.40 =** 96.1 %
%<No.60 = 94.6 % **%<No.200 =** 87.6 %

TEST RESULTS
Maximum dry density = 105.6 pcf
Optimum moisture = 16.4 %



Figure

ENIGNEERING ANALYTICS, INC.

Tested By: KG

COMPACTION TEST REPORT

Curve No.: 2

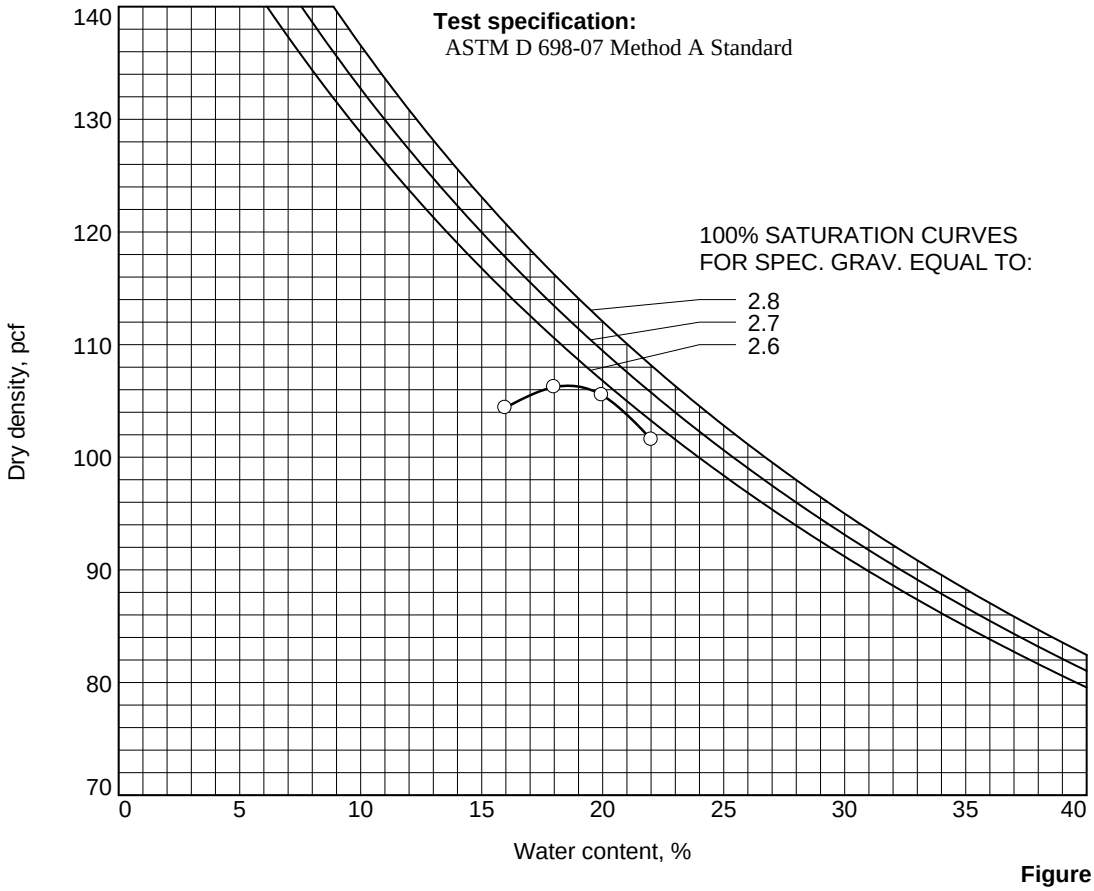
Project No.: 110480 **Date:** 9/19/2017
Project: Swede Lake
Client: Boulder County Parks & Open Space
Source of Sample: Borrow 3
Sample Number: 1
Remarks:

MATERIAL DESCRIPTION

Description: Clay

Classifications - **USCS:** **AASHTO:**
Nat. Moist. = **Sp.G. =**
Liquid Limit = 40 **Plasticity Index =** 25
%<No.10 = **%<No.40 =**
%<No.60 = **%<No.200 =** 87.6 %

TEST RESULTS
Maximum dry density = 106.4 pcf
Optimum moisture = 18.6 %



Figure

ENIGNEERING ANALYTICS, INC.

Tested By: KG

COMPACTION TEST REPORT

Curve No.: 3

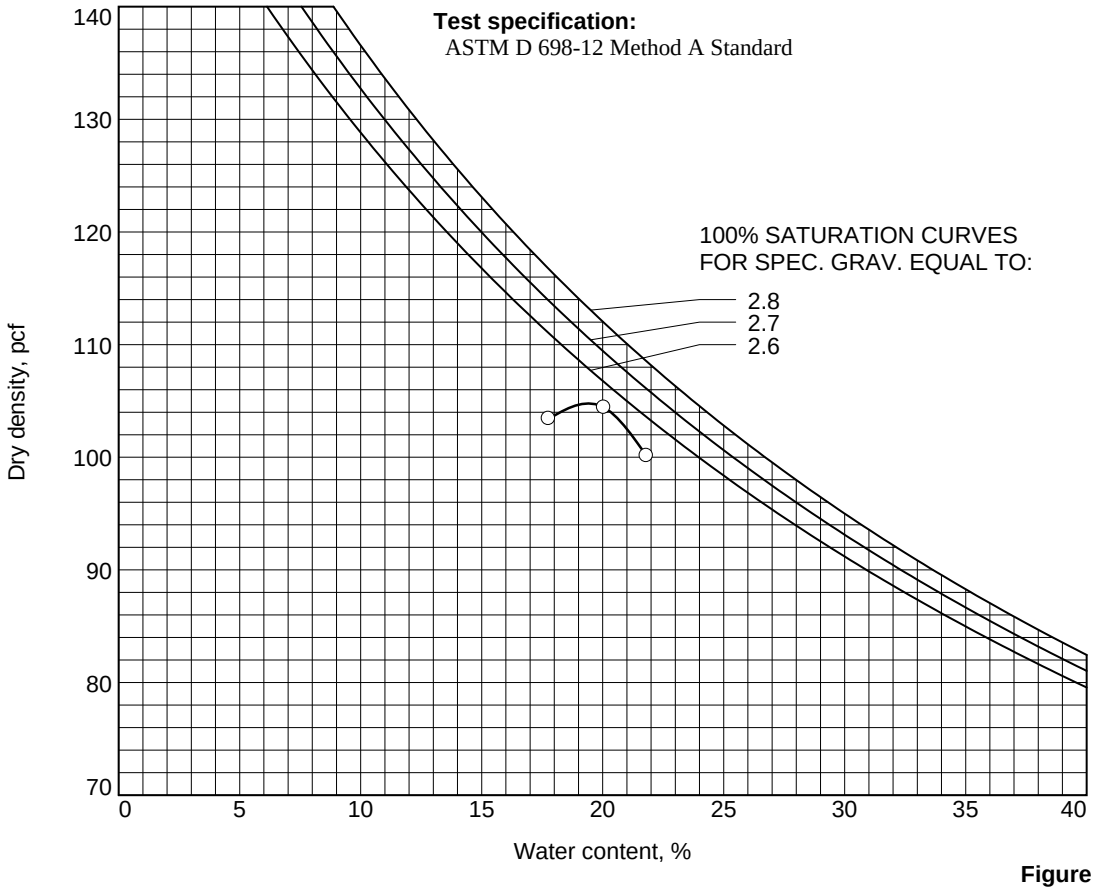
Project No.: 110480 **Date:** 10/20/2017
Project: Swede Lake
Client: Boulder County Parks & Open Space
Source of Sample: Borrow 4
Sample Number: 1
Remarks:

MATERIAL DESCRIPTION

Description: Clay

Classifications - **USCS:** **AASHTO:**
Nat. Moist. = **Sp.G. =**
Liquid Limit = **Plasticity Index =**
%<No.10 = **%<No.40 =**
%<No.60 = **%<No.200 =**

TEST RESULTS
Maximum dry density = 104.8 pcf
Optimum moisture = 19.4 %



Figure

ENIGNEERING ANALYTICS, INC.

Tested By: KG **Checked By:** KG

COMPACTION TEST REPORT

Curve No.: 4

Project No.: 110480 **Date:** 10/30/17
Project: Swede Lake
Client: Boulder County Parks & Open Space
Source of Sample: Borrow 5
Sample Number: 1
Remarks:

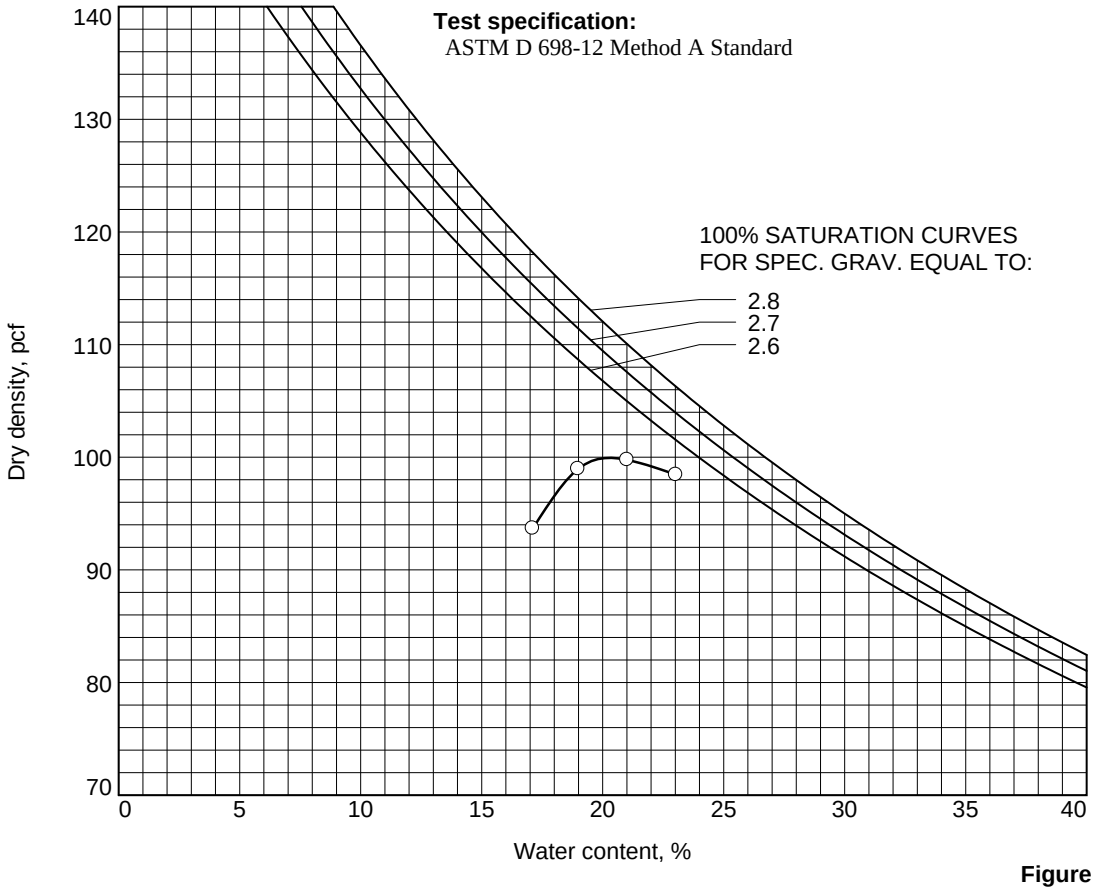
MATERIAL DESCRIPTION

Description: Silty Clay

Classifications - **USCS:** **AASHTO:**
Nat. Moist. = **Sp.G. =**
Liquid Limit = **Plasticity Index =**
%<No.10 = **%<No.40 =**
%<No.60 = **%<No.200 =**

TEST RESULTS

Maximum dry density = 99.9 pcf
Optimum moisture = 20.3 %



Figure

ENIGNEERING ANALYTICS, INC.

Tested By: KG

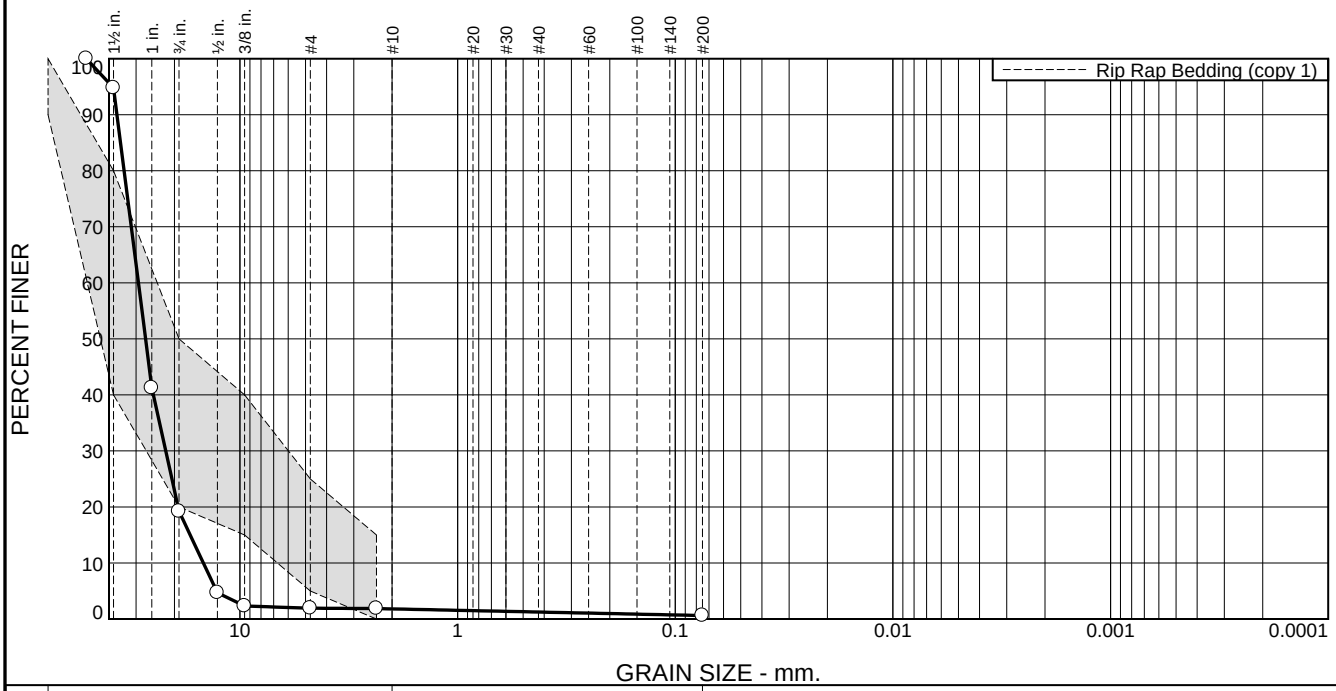
SUMMARY OF LABORATORY TEST RESULTS

JOB NAME: Swede Lake JOB NUMBER: 110480 DATE: 9/27/2017

Depth (ft.)	Sample Type	Moisture (%)	Falling Head Permeability	Atterbergs LL / PL / PI	Grain Size Analysis	Percent Passing No. 200 (%)	Hydrometer	D698 Standard Proctor
Borrow 1								
	BKT		3.60E-07	42 / 15 / 27	(1)	87.2	(1)	105.6 @ 16.4%
Borrow 2								
	BKT			33 / 18 / 15		79.1		
Borrow 3								
	BKT			40 / 15 / 25		87.6	(1)	106.4 @ 18.6%

*LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index N.P. = Non Plastic (1) = See Attached

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	98.2	0.6	0.6	0.6	

TEST RESULTS (AASHTO T 27)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2'	100.0		
1-1/2"	94.8	40.0 - 80.0	X
1"	41.2		
3/4"	19.2	20.0 - 50.0	X
1/2"	4.7		
3/8"	2.3	15.0 - 40.0	X
#4	1.9	5.0 - 25.0	X
#8	1.9	0.0 - 15.0	
#200	0.6		

* Rip Rap Bedding (copy 1)

Material Description

Bedding Material

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= GP **AASHTO (M 145)=**

Coefficients

D_{90}= 36.7456 D_{85}= 35.3803 D_{60}= 29.2783
D_{50}= 27.1431 D_{30}= 21.9317 D_{15}= 16.9321
D_{10}= 14.7256 C_u= 1.99 C_c= 1.12

Remarks

Date Received: 12/15/17 **Date Tested:** 12/20/2017

Tested By: KG

Checked By: KG

Title:

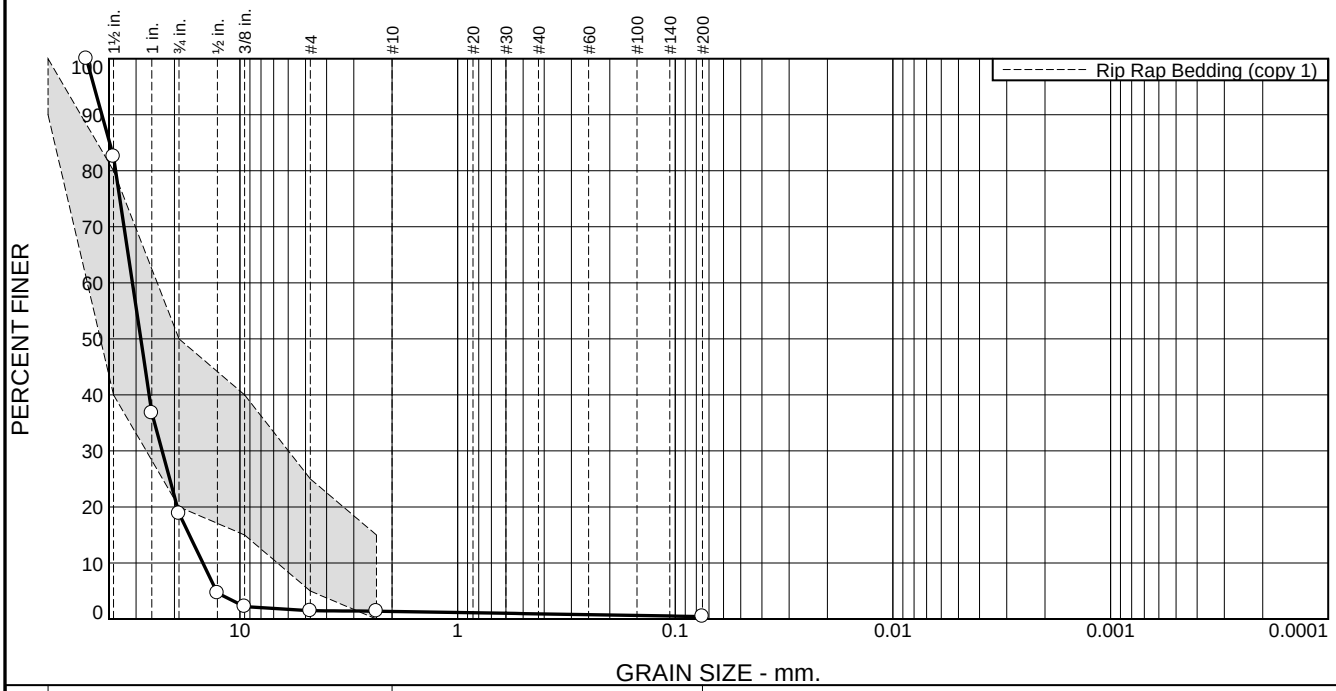
Source of Sample: Bedding Material **Date Sampled:** 12/15/17
Sample Number: 1

ENIGNEERING ANALYTICS, INC.

Client: Boulder County Parks & Open Space
Project: Swede Lake

Project No: 110480 **Figure**

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	98.6	0.5	0.5	0.4	

TEST RESULTS (AASHTO T 27)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2"	100.0		
1-1/2"	82.5	40.0 - 80.0	X
1"	36.8		
3/4"	18.8	20.0 - 50.0	X
1/2"	4.7		
3/8"	2.2	15.0 - 40.0	X
#4	1.5	5.0 - 25.0	X
#8	1.4	0.0 - 15.0	
#200	0.4		

* Rip Rap Bedding (copy 1)

Material Description

Rip Rap Bedding Material

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= GP **AASHTO (M 145)=**

Coefficients

D_{90}= 43.0840 D_{85}= 39.6773 D_{60}= 31.2013
D_{50}= 28.5550 D_{30}= 22.7826 D_{15}= 17.0742
D_{10}= 14.7990 C_u= 2.11 C_c= 1.12

Remarks

Date Received: 12/21/17 **Date Tested:** 12/27/2017

Tested By: KG

Checked By: KG

Title:

Source of Sample: Bedding Material **Date Sampled:** 12/21/17

Sample Number: 2

ENIGNEERING ANALYTICS, INC.

Client: Boulder County Parks & Open Space

Project: Swede Lake

Project No: 110480 **Figure**

Relative Density Testing

Project: Swede Lake Date: 10/27/2017

Material: Sand Description: Sand

Tested By: KG TEST PROCEDURE: ASTM 4253 & D4254

NOTE: Smith Geotechnical standard bucket: vol. = 0.50 ft3, Diam = 11" = 0.9167'
and death 9.125 = 0.760'

Density				Left		Right	
Empty Bucket	21.20	lb	Initial dial reading: L	0	in	0	in
Bucket+ Loose Soil	68.30	lb	Compacted dial reading: L	1.985	in R	1.985	in
WT of soil:	47.10	lb	Change in Height: F	1.99	in B	1.99	in
Volume at start:	0.50	ft3	Average:	1.99	in	0.17	ft

Change in Volume: 0.11 ft3 [(change in ht)*Area of cylinder(0.66]

Compacted Volume: 0.39 ft3 [(Volume at start-(change in vol.)]

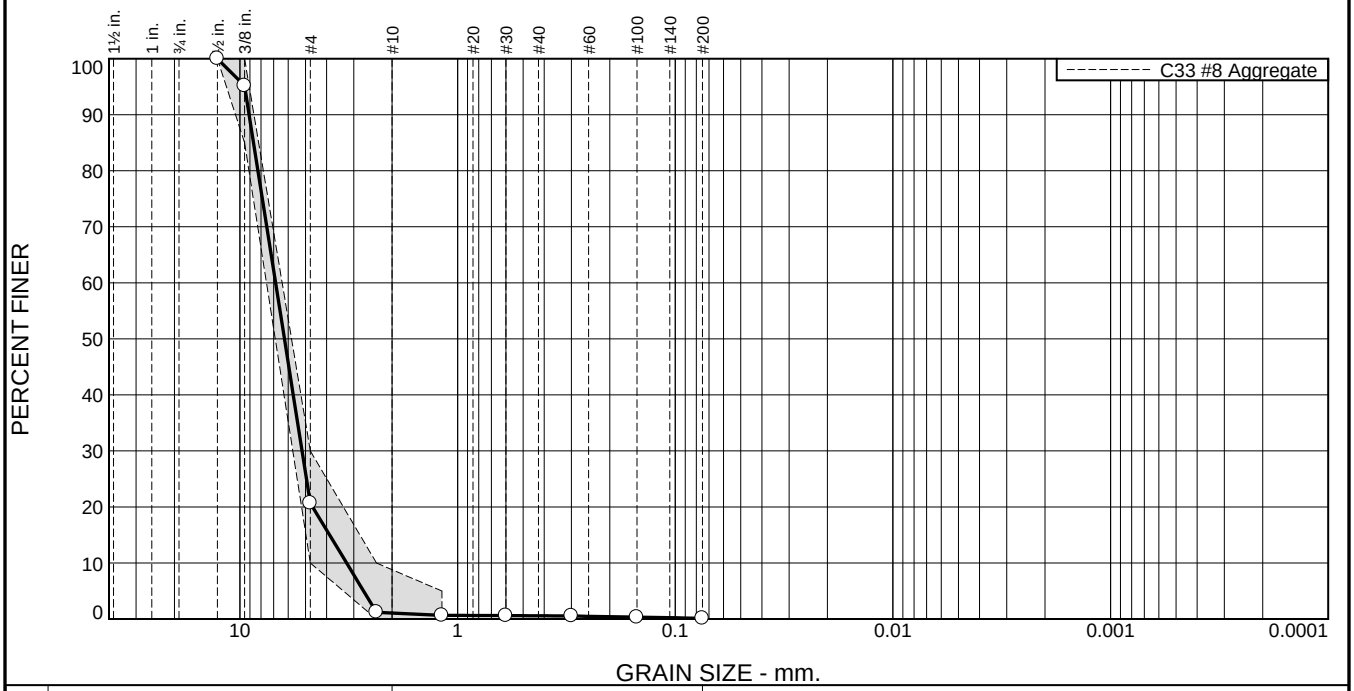
Minimum unit wt γ: 93.9 pcf [(wt of soil)/Volume at start]

Maximum unit wt γ: 119.9 pcf [(wt of soil)/(compacted volume)]

70% unit wt γ: 112.1 pcf [γmin + 0.7*(γmax-ymax)]

Relative Density	Dry Unit Weight		Relative Density	Dry Unit Weight	
55% unit wt	108.2	pcf	71% unit wt	112.4	pcf
56% unit wt	108.5	pcf	72% unit wt	112.6	pcf
57% unit wt	108.7	pcf	73% unit wt	112.9	pcf
58% unit wt	109.0	pcf	74% unit wt	113.2	pcf
59% unit wt	109.3	pcf	75% unit wt	113.4	pcf
60% unit wt	109.5	pcf	76% unit wt	113.7	pcf
61% unit wt	109.8	pcf	77% unit wt	113.9	pcf
62% unit wt	110.0	pcf	78% unit wt	114.2	pcf
63% unit wt	110.3	pcf	79% unit wt	114.5	pcf
64% unit wt	110.6	pcf	80% unit wt	114.7	pcf
65% unit wt	110.8	pcf	81% unit wt	115.0	pcf
66% unit wt	111.1	pcf	82% unit wt	115.3	pcf
67% unit wt	111.3	pcf	83% unit wt	115.5	pcf
68% unit wt	111.6	pcf	84% unit wt	115.8	pcf
69% unit wt	111.9	pcf	85% unit wt	116.0	pcf
70% unit wt	112.1	pcf			

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	98.9	0.5	0.5	0.1	

TEST RESULTS (AASHTO T 27)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1/2	100.0	100.0	
3/8	95.2	85.0 - 100.0	
#4	20.7	10.0 - 30.0	
#8	1.2	0.0 - 10.0	
#16	0.7	0.0 - 5.0	
#30	0.6		
#50	0.5		
#100	0.3		
#200	0.1		

* C33 #8 Aggregate

Material Description

#8 Aggregate

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= GP **AASHTO (M 145)=**

Coefficients

D_{90}= 9.0768 D_{85}= 8.6626 D_{60}= 6.8585
D_{50}= 6.2468 D_{30}= 5.1823 D_{15}= 3.8737
D_{10}= 3.2366 C_u= 2.12 C_c= 1.21

Remarks

Date Received: 1/5/18 **Date Tested:** 1/10/2018

Tested By: KG

Checked By: KG

Title:

Source of Sample: #8 Aggregate **Date Sampled:** 1/5/18

Sample Number: 1

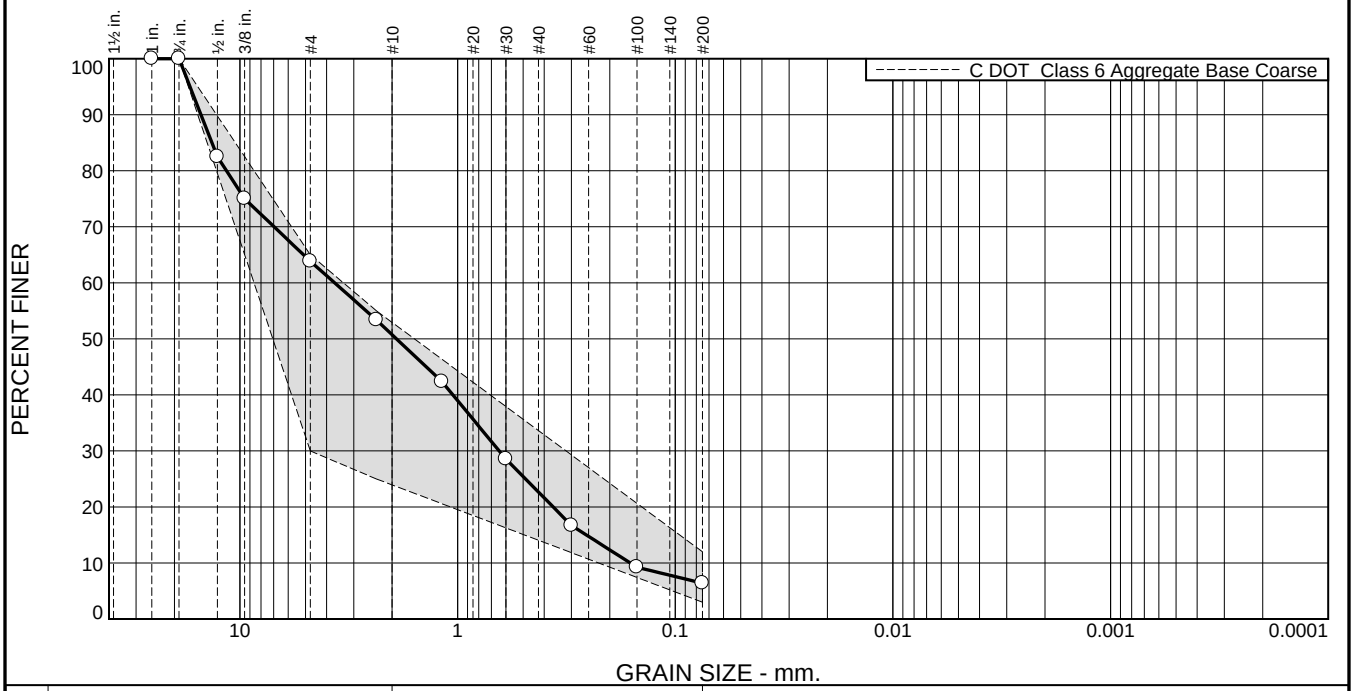
ENIGNEERING ANALYTICS, INC.

Client: Boulder County Parks & Open Space

Project: Swede Lake

Project No: 110480 **Figure**

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	49.3	28.0	16.3	6.4	

TEST RESULTS (AASHTO T 27)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1	100.0		
3/4	100.0	100.0	
1/2	82.5		
3/8	75.0		
#4	63.8	30.0 - 65.0	
#8	53.4	25.0 - 55.0	
#16	42.4		
#30	28.6		
#50	16.7		
#100	9.2		
#200	6.4	3.0 - 12.0	

* C DOT Class 6 Aggregate Base Coarse

Material Description

Class 6

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 15.1056 D_{85}= 13.4512 D_{60}= 3.6740
D_{50}= 1.9090 D_{30}= 0.6439 D_{15}= 0.2562
D_{10}= 0.1609 C_u= 22.84 C_c= 0.70

Remarks

Date Received: 2/09/18 **Date Tested:** 2/14/2018

Tested By: KG

Checked By: KG

Title:

Source of Sample: Class 6 **Date Sampled:** 2/09/18

Sample Number: 1

ENIGNEERING ANALYTICS, INC.

Client: Boulder County Parks & Open Space

Project: Swede Lake

Project No: 110480 **Figure**

REPORT OF CONCRETE COMPRESSIVE STRENGTH TESTS

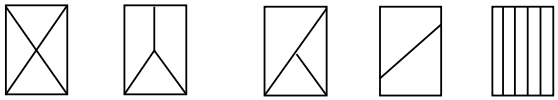
Engineering Analytics, Inc.

PROJECT: Swede Lake
JOB NO.: 110480
PLACEMENT DATE: 10/18/2017
CLIENT: Boulder County (BCPOS)
CONTRACTOR: CAP Excavation

SUPPLIER: Bestway
MIX CODE: 45VND01E4G
SPECIFIED STRENGTH: 4,500 psi
TESTED BY: DCH

	CYLINDER NUMBER	SLUMP (INCH)	AIR (%)	AIR TEMP (°F)	CONCRETE TEMP (°F)	WATER ADDED (GAL)	DATE TESTED	TEST AGE (DAYS)	MAX APPLIED LOAD (LBS)	COMPRESSIVE STRENGTH (PSI)	TYPE OF FAILURE	PLACEMENT LOCATION
BATCH # 20051938 TRUCK # 1303 TIME 3:43 PM	1-1 A 1-1 B 1-1 C 1-1 D	3.50	6.0	87	77	10	10/26/17 11/16/17 11/16/17	7 28 28	49,820 56,490 56,760	3,965 4,495 4,517	5 3 3	Primary outlet, bottom 6", base of outlet structure
BATCH # 20051950 TRUCK # 1504 TIME 4:16 PM		3.50	5.5	90	79	3 gal after						Primary outlet, bottom 6", base of outlet structure
BATCH # 20051960 TRUCK # 0715 TIME 4:39 PM	1-2 A 1-2 B 1-2 C 1-2 D	5.00	5.5	75	78	3 gal before	10/26/17 11/16/17 11/16/17	7 28 28	41,710 46,080 47,220	3,319 3,667 3,757	3 3 3	Bottom 6" of irrigation outlet
BATCH # TRUCK # TIME												

TYPE OF FAILURE



1 CONE | 2 SPLIT CONE | 3 SHEAR CONE | 4 SHEAR | 5 SPLIT

4-inch Diameter Cylinders Unless Noted Otherwise

All samples prepared and tested in accordance with the following ASTM standards: Sampling C172; Curing C31; Slump C143; Air C231; Temperature C1064; Compression C39

Remarks:

REPORT OF CONCRETE COMPRESSIVE STRENGTH TESTS

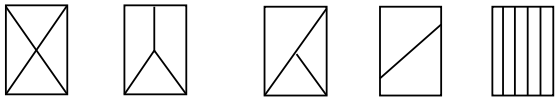
Engineering Analytics, Inc.

PROJECT: Swede Lake
JOB NO.: 110480
PLACEMENT DATE: 10/18/2017
CLIENT: Boulder County (BCPOS)
CONTRACTOR: CAP Excavation

SUPPLIER: Bestway
MIX CODE: 45VND01E4G
SPECIFIED STRENGTH: 4,500 psi
TESTED BY: DCH

		CYLINDER NUMBER	SLUMP (INCH)	AIR (%)	AIR TEMP (^{o}F)	CONCRETE TEMP (^{o}F)	WATER ADDED (GAL)	DATE TESTED	TEST AGE (DAYS)	MAX APPLIED LOAD (LBS)	COMPRESSIVE STRENGTH (PSI)	TYPE OF FAILURE	PLACEMENT LOCATION
BATCH #	20057120												Primary outlet pipe encasement
TRUCK #	613			4.0	55	76	11 before						
TIME	2:45 PM		4.00	5.3		76	12						
	3:05 PM												
BATCH #	20057141	2-1 A						11/10/17	7	45,680	3,634	3	
TRUCK #	1313	2-1 B	4.25	6.0	55	70	10 before	12/4/18	28	57,990	4,615	3	
TIME	3:25 PM	2-1 C						12/4/18	28	60,530	4,817	3	
		2-1 D											
BATCH #	20057154												
TRUCK #	714		3.25	5.0	58	71							
TIME	3:40 PM												
BATCH #	20057169	2-2 A						11/10/17	7	44,710	3,558	3	Farmer's irrigation outlet
TRUCK #	1717	2-2 B	3.50	3.5	55	67		12/4/18	28	58,460	4,652	3	
TIME	4:30 PM	2-2 C		5.6			5	12/4/18	28	55,750	4,436	3	
		2-2 D											

TYPE OF FAILURE



1 CONE | 2 SPLIT CONE | 3 SHEAR CONE | 4 SHEAR | 5 SPLIT

4-inch Diameter Cylinders Unless Noted Otherwise

All samples prepared and tested in accordance with the following ASTM standards: Sampling C172; Curing C31; Slump C143; Air C231; Temperature C1064; Compression C39

Remarks:

REPORT OF CONCRETE COMPRESSIVE STRENGTH TESTS

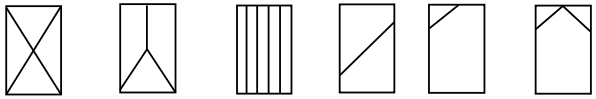
Engineering Analytics, Inc.

PROJECT: Swede Lake
JOB NO.: 110480
PLACEMENT DATE: 11/20/2017
CLIENT: Boulder County
CONTRACTOR: CAP

SUPPLIER: Martin Marietta
MIX CODE: CD4995
SPECIFIED STRENGTH: 4,500 psi
TESTED BY: EAH

	CYLINDER NUMBER	SLUMP (INCH)	AIR (%)	AIR TEMP (°F)	CONCRETE TEMP (°F)	WATER ADDED (GAL)	DATE TESTED	TEST AGE (DAYS)	MAX APPLIED LOAD (LBS)	COMPRESSIVE STRENGTH (PSI)	TYPE OF FAILURE	PLACEMENT LOCATION
BATCH # 46332331 TRUCK # 8906 TIME 2:15 PM	3-1 A 3-1 B 3-1 C 3-1 D	5.00 4.00	5.5	67	71	0	11/27/17 12/18/17 12/18/17	7 28 28	45,680 62,180 56,620	3,635 4,948 4,505	3 3 3	Grade control beam spillway
BATCH # 35054319 TRUCK # 1619 TIME 2:45 PM	3-2 A 3-2 B 3-2 C 3-2 D	4.00	6.0	67	78	0	11/27/17 12/18/17 12/18/17	7 28 28	47,590 61,570 66,780	3,787 4,900 5,314	3 3 3	NE & SE wingwall foundations at approx. STA 9+00
BATCH # TRUCK # TIME												
BATCH # TRUCK # TIME												

TYPE OF FAILURE



1 CONE
2 SPLIT CONE
3 SPLIT
4 SHEAR
5 EDGE SHEAR
6 CONE SHEAR

4-inch Diameter Cylinders Unless Noted Otherwise

All samples prepared and tested in accordance with the following ASTM standards: Sampling C172; Curing C31; Slump C143; Air C231; Temperature C1064; Compression C39

Remarks:

Initial check test had 5" slump. Retested in miiddle 1/3 of land out of pump house and got a 4" slump result.

REPORT OF CONCRETE COMPRESSIVE STRENGTH TESTS

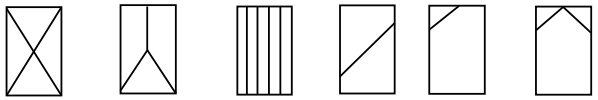
Engineering Analytics, Inc.

PROJECT: Swede Lake
JOB NO.: 110480
PLACEMENT DATE: 11/20/2017
CLIENT: Boulder County
CONTRACTOR: CAP

SUPPLIER: Martin Marietta
MIX CODE: CD4995
SPECIFIED STRENGTH: 4,500 psi
TESTED BY: EAH

	CYLINDER NUMBER	SLUMP (INCH)	AIR (%)	AIR TEMP (°F)	CONCRETE TEMP (°F)	WATER ADDED (GAL)	DATE TESTED	TEST AGE (DAYS)	MAX APPLIED LOAD (LBS)	COMPRESSIVE STRENGTH (PSI)	TYPE OF FAILURE	PLACEMENT LOCATION
BATCH # 46332499 TRUCK # 1517 TIME 10:10 AM	4-1 A 4-1 B 4-1 C 4-1 D 4-1 E		8.7	59	70		12/4/17 12/26/17 12/26/17 1/22/18 12/7/17	7 28 28 63 10	28,606 40,450 41,090 42,710 33,890	2,275 3,219 3,270 3,399 2,697	3 3 3 3 3	Spillway wall/drop structure at STA 4+00. *
BATCH # 4.63E+08 TRUCK # 0309 TIME 10:30 AM	4-2 A 4-2 B 4-2 C 4-2 D 4-2 E 4-2 F	4.50	7.4	59	68	10	12/4/17 12/26/17 12/26/17 1/22/18 12/7/17	7 28 28 63 10	38,600 48,480 48,330 54,490 40,780	3,072 3,858 3,846 4,336 3,245	3 5 5 3 3	Vault structure at STA 4+00
BATCH # 46332505 TRUCK # 1701 TIME 11:00 AM		5.00	7.4	59	70							**
BATCH # 46332517 TRUCK # 1741 TIME 12:50 PM						6						

TYPE OF FAILURE



1 CONE
2 SPLIT CONE
3 SPLIT
4 SHEAR
5 EDGE SHEAR
6 CONE SHEAR

4-inch Diameter Cylinders Unless Noted Otherwise

All samples prepared and tested in accordance with the following ASTM standards: Sampling C172; Curing C31; Slump C143; Air C231; Temperature C1064; Compression C39

Remarks:

*Rejected due to high air content
**Visual check only

REPORT OF CONCRETE COMPRESSIVE STRENGTH TESTS

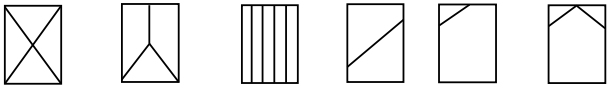
Engineering Analytics, Inc.

PROJECT: Swede Lake
JOB NO.: 110480
PLACEMENT DATE: 11/20/2017
CLIENT: Boulder County
CONTRACTOR: CAP

SUPPLIER: Martin Marietta
MIX CODE: CD4995
SPECIFIED STRENGTH: 4,500 psi
TESTED BY: EAH

	CYLINDER NUMBER	SLUMP (INCH)	AIR (%)	AIR TEMP (°F)	CONCRETE TEMP (°F)	WATER ADDED (GAL)	DATE TESTED	TEST AGE (DAYS)	MAX APPLIED LOAD (LBS)	COMPRESSIVE STRENGTH (PSI)	TYPE OF FAILURE	PLACEMENT LOCATION
BATCH # 35054767 TRUCK # 0703 TIME 1:40 PM	5-1 A 5-1 B 5-1 C 5-1 D 5-1 E 5-1 F	3.75	5.5	47	73		12/12/17 1/3/18 1/3/18	7 28 28	56,300 70,090 72,460	4,480 5,572 5,764	3 3 3	Wing walls and outlet structure at STA 9+00
BATCH # 35054768 TRUCK # 8620 TIME 2:05 PM		3.00	5.2	46	70							
BATCH # 35054773 TRUCK # 8601 TIME 2:25 PM		4.00	5.9	44	70	8						
BATCH # 35054777 TRUCK # 8687 TIME 3:00 PM		3.50	5	44	71	8						Measuring weirs and headwall at STA 9+00; pipe encasement at STA 4+00; *

TYPE OF FAILURE



1 CONE
2 SPLIT CONE
3 SPLIT
4 SHEAR
5 EDGE SHEAR
6 CONE SHEAR

4-inch Diameter Cylinders Unless Noted Otherwise

All samples prepared and tested in accordance with the following ASTM standards: Sampling C172; Curing C31; Slump C143; Air C231; Temperature C1064; Compression C39

Remarks:

*8 gallons were added after initial test.

REPORT OF CONCRETE COMPRESSIVE STRENGTH TESTS

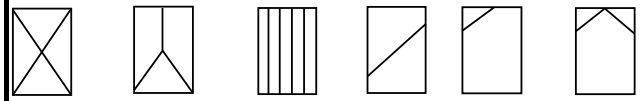
Engineering Analytics, Inc.

PROJECT: Swede Lake
JOB NO.: 110480
PLACEMENT DATE: 11/20/2017
CLIENT: Boulder County
CONTRACTOR: CAP

SUPPLIER: Martin Marietta
MIX CODE: CD4995
SPECIFIED STRENGTH: 4,500 psi
TESTED BY: EAH

	CYLINDER NUMBER	SLUMP (INCH)	AIR (%)	AIR TEMP (°F)	CONCRETE TEMP (°F)	WATER ADDED (GAL)	DATE TESTED	TEST AGE (DAYS)	MAX APPLIED LOAD (LBS)	COMPRESSIVE STRENGTH (PSI)	TYPE OF FAILURE	PLACEMENT LOCATION
BATCH # 35054779 TRUCK # 8671 TIME 3:20 PM	5-2 A 5-2 B 5-2 C 5-2 D 5-2 E	3.25	5.6	44	72		12/12/17 1/3/18 1/3/18	7 28 28	59,300 75,440 74,520	4,719 6,003 5,928	3 3 3	Measuring weirs and headwall at STA 9+00; pipe encasement at STA 4+00
BATCH # TRUCK # TIME												
BATCH # TRUCK # TIME												
BATCH # TRUCK # TIME												

TYPE OF FAILURE



1 CONE; 2 SPLIT CONE; 3 SPLIT; 4 SHEAR; 5 EDGE SHEAR; 6 CONE SHEAR

4-inch Diameter Cylinders Unless Noted Otherwise

All samples prepared and tested in accordance with the following ASTM standards: Sampling C172; Curing C31; Slump C143; Air C231; Temperature C1064; Compression C39

Remarks:
Observed use of concrete vibrator during/after placement.

REPORT OF CONCRETE COMPRESSIVE STRENGTH TESTS

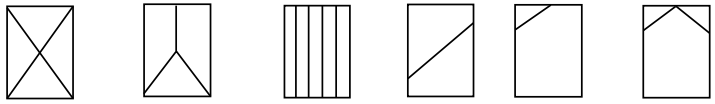
Engineering Analytics, Inc.

PROJECT: Swede Lake Dam
JOB NO.: 110480
PLACEMENT DATE: 12/12/2017
CLIENT: BCPOS
CONTRACTOR: CAP Excavation

SUPPLIER: Best Way Concrete
MIX CODE: 45VN01E4G
SPECIFIED STRENGTH: 4,500 psi
TESTED BY: Tyler Davis

	CYLINDER NUMBER	SLUMP (INCH)	AIR (%)	AIR TEMP (°F)	CONCRETE TEMP (°F)	WATER ADDED (GAL)	DATE TESTED	TEST AGE (DAYS)	MAX APPLIED LOAD (LBS)	COMPRESSIVE STRENGTH (PSI)	TYPE OF FAILURE	PLACEMENT LOCATION	REMARKS
BATCH # 20067737	6-1 A						12/19/17	7	52,850	4,206	3	Outlet Structure. Outlet pipe tie-in encasements to structure	Poured ~3yards
TRUCK # 1107	6-1 B						1/9/18	28	60,520	4,816	3		
TIME 12:45 PM	6-1 C	3.25	6.3	58	80	0	1/9/18	28	65,100	5,181	3		
	6-1 D												
	6-1 E												
BATCH #													
TRUCK #													
TIME													
BATCH #													
TRUCK #													
TIME													
BATCH #													
TRUCK #													
TIME													
BATCH #													
TRUCK #													
TIME													

TYPE OF FAILURE



1 CONE
2 SPLIT CONE
3 SPLIT
4 SHEAR
5 EDGE SHEAR
6 CONE SHEAR

4-inch Diameter Cylinders Unless Noted Otherwise

All samples prepared and tested in accordance with the following ASTM standards: Sampling C172; Curing C31; Slump C143; Air C231; Temperature C1064; Compression C39

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4
2	106.4	18.6

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Clint Brown
TESTED BY: Walter Kramb

NOTES: 1) First lift of fill
2) Compacted subgrade

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
1	9/22/2017	Outlet breach, station 0+50	5118.5	18.4	128.0	108.1	100+	95	2
2	9/22/2017	Outlet breach, station 0+20	5118	16.4	129.5	111.2	100+	95	2
3	9/22/2017	Outlet breach, station 0+20	5119.0	19.2	123.4	103.5	97	95	2
4	9/22/2017	Outlet breach, station 0+80	5119.0	19.4	121.9	102.1	96	95	2
5	9/22/2017	Outlet breach, station 0+40	5119.5	19.3	122.8	102.6	97	95	2
6	9/22/2017	Outlet breach, station 0+50	5120.0	17.9	125.3	106.2	100	95	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4
2	106.4	18.6

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County Parks & Open Space
CONTRACTOR: CAP Excavating & Construction
ENGINEER: Clint Brown
TESTED BY: Dylan Hoehn

NOTES: See dwg 11 for station#

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
7	9/27/2017	Outlet breach, sta 0+40 right side of fill	5121.5	18.1	127.7	108.2	100+	95	1
8	9/27/2017	Outlet breach sta 0+50 right side of fill	5121.0	17.6	128.9	109.7	100+	95	1
9	9/27/2017	Outlet breach sta 0+40 right side of fill	5120.5	15.3	126.2	109.5	100+	95	1

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4
2	106.4	18.6

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County Parks & Open Space
CONTRACTOR: CAP Excavating & Construction
ENGINEER: Clint Brown
TESTED BY: Dylan Hoehn

NOTES: See dwg 11 for station#

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
10	10/26/2017	STA 1+25 (Ref. sheet 6)	5132.0	17.9	124.4	105.6	99	95	2
11	10/26/2017	STA 2+25	5132.0	19.2	120.9	101.4	95	95	2
12	10/26/2017	STA 1+00	5132.5	18.3	127.1	107.4	100+	95	2
13	10/26/2017	STA 1+50	5133.0	18.4	104.4	123.6	98	95	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4
2	106.4	18.6

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County Parks & Open Space
CONTRACTOR: CAP Excavating & Construction
ENGINEER: Clint Brown
TESTED BY: Dylan Hoehn

NOTES: See dwg 11 for station#

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
14	10/27/2017	STA 2+50 (Ref.sheet 6)	5133.0	17.5	129.1	109.9	100+	95	2
15	10/27/2017	STA 1+70 (Ref. sheet 6)	5134.0	17.9	128.1	108.6	100+	95	2
16	10/27/2017	STA 2+05 (Ref. sheet 6)	5134.5	19.9	122.4	102.1	96	95	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4
2	106.4	18.6

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County Parks & Open Space
CONTRACTOR: CAP Excavating & Construction
ENGINEER: Clint Brown
TESTED BY: Dylan Hoehn

NOTES: See dwg 11 for station#

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
17	11/1/2017	STA 5+25 (Ref.sheet 6)	5125.5	19.6	127.8	107.1	100+	95	2
18	11/1/2017	STA 6+50 (Ref. sheet 6)	5126	18.0	127.9	108.0	100+	95	2
19	11/1/2017	STA 7+50 (Ref. sheet 6)	5126	18.3	127.2	107.5	100+	95	2
20	11/1/2017	STA 7+20 (Ref. sheet 6)	5125.5	17.0	126.5	108.1	100+	95	2
21	11/1/2017	STA 6+50 (Ref. sheet 6)	5126.5	18.3	125.6	106.1	100	95	2
22	11/1/2017	STA 4+80 (Ref. sheet 6)	5126.0	19.4	124.9	104.7	98	95	2
23	11/1/2017	STA 7+30 (Ref. sheet 6)	5126.5	18.9	124.0	104.3	98	95	2
24	11/1/2017	STA 5+25 (Ref. sheet 6)	5127.0	18.0	125.1	106.0	100	95	2
25	11/1/2017	STA 6+30 (Ref. sheet 6)	5127	20.0	126.0	105.0	99	95	2
26	11/1/2017	STA 7+60 (Ref. sheet 6)	5127.5	17.5	127.3	108.7	100+	95	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4
2	106.4	18.6

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County Parks & Open Space
CONTRACTOR: CAP Excavating & Construction
ENGINEER: Clint Brown
TESTED BY: Dylan Hoehn

NOTES: See dwg 11 for station#

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
27	11/1/2017	STA 4+70 (Ref.sheet 6)	5128.0	17.8	125.5	106.5	100+	95	2
28	11/1/2017	STA 6+55 (Ref. sheet 6)	5128	18.9	125.9	105.9	100	95	2
29	11/1/2017	STA 7+75 (Ref. sheet 6)	5128.58	18.3	127.9	108.1	100+	95	2
30	11/1/2017	STA 5+10 (Ref. sheet 6)	5129	18.5	127.1	107.3	100+	95	2
31	11/1/2017	STA 6+40 (Ref. sheet 6)	5129	20.6	125.4	104.0	98	95	2
32	11/1/2017	STA 7+40 (Ref. sheet 6)	5129.5	17.4	125.7	107.1	100+	95	2
33	11/1/2017	STA 5+20 (Ref. sheet 6)	5130	17.7	125.7	106.8	100+	95	2
34	11/1/2017	STA 5+00 (Ref. sheet 6)	5130.5	18.4	124.6	105.3	99	95	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4
2	106.4	18.6

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County Parks & Open Space
CONTRACTOR: CAP Excavating & Construction
ENGINEER: Clint Brown
TESTED BY: Dylan Hoehn

NOTES: See dwg 11 for station#

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
35	11/2/2017	STA 5+60 (Ref.sheet 6)	5131.5	18.1	126.7	107.3	100+	95	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4
2	106.4	18.6

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County Parks & Open Space
CONTRACTOR: CAP Excavating & Construction
ENGINEER: Clint Brown
TESTED BY: Dylan Hoehn

NOTES: See dwg 11 for station#

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
36	11/2/2017	Embankment STA 7+50	5130.5	18.5	125.7	106.1	99	95	2
37	11/3/2017	Embankment STA 6+50	5131.5	23.4	124.0	101.5	95	95	2
37R	11/3/2017	Embankment STA 6+50 move 10'	5131.5	20.5	125.9	104.4	98	95	2
38	11/3/2017	Embankment STA 5+00	5131.4	20.4	125.9	104.5	98	95	2
39	11/3/2017	SKIP							
40	11/3/2017	Embankment STA 4+50	3132.0	18.1	126.2	106.8	100	95	2
41	11/3/2017	Embankment STA 7+00	3133.5	22.9	120.9	98.4	92	95	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4
2	106.4	18.6

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County Parks & Open Space
CONTRACTOR: CAP Excavating & Construction
ENGINEER: Clint Brown
TESTED BY: Dylan Hoehn

NOTES: See dwg 11 for station#

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
42	11/5/2017	STA 7+00 Retest of test No. 41 (Ref. sheet 6)	5132	17.9	124.4	105.5	99	95	2
43	11/5/2017	STA 6+50	5133	17.9	126.0	106.9	100+	95	2
44	11/5/2017	STA 5+70	5133	17.8	125.8	106.8	100+	95	2
45	11/5/2017	STA 4+90, Need to Retest	5133.5	23.8	122.6	99.0	92	95	2
46	11/5/2017	STA 6+10, Need to Retest	5133.5	25.9	119.0	94.5	89	95	2
47	11/5/2017	STA 9+75	5124.5	17.2	125.2	106.8	100+	95	2
48	11/5/2017	STA 10+30	5124.5	18.1	120.1	101.7	95	95	2
49	11/5/2017	STA 11+50	5124.5	18.9	121.2	101.9	95	95	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4%
2	106.4	18.6%
4	99.9	20.3%

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES: Test No. 50 and 51 will be retested at a later date
*Indicates failure to meet moisture specifications
**Indicates approval by Engineer

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
*50	11/9/2017	STA 9+60 (Ref. sheet 6)	5125.5	14.60%	123.8	108.0	100+%	95%	2
*51	11/9/2017	STA 10+85 (Ref. sheet 6)	5125.5	14.90%	123.1	107.1	100+%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4%
2	106.4	18.6%
4	99.9	20.3%

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES:
*Indicates failure to meet specifications
**Indicates approval by Engineer

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
52	11/10/2017	Retest of No. 50, STA 9+60 (Ref. sheet 6)	5125.5	17.00%	126.7	108.3	100+%	95%	2
53	11/10/2017	Retest of No. 51, STA 10+85 (Ref. sheet 6)	5125.5	17.40%	126.1	107.4	100+%	95%	2
54	11/10/2017	STA 12+90	5125.5	18.30%	126.8	107.2	100+%	95%	2
55	11/10/2017	STA 14+00	5128.5	16.70%	125.7	107.7	100+%	95%	2
56	11/10/2017	STA 15+25	5130.5	19.20%	116.2	97.5	98%	95%	4
57	11/10/2017	STA 12+00	5125.5	17.70%	126.4	107.4	100+%	95%	2
58	11/10/2017	STA 9+75	5126.3	21.30%	121.4	100.1	100+%	95%	4
59	11/10/2017	STA 13+53	5127.0	20.60%	121.2	100.5	100+%	95%	4
60	11/10/2017	STA 14+50	5128.3	18.20%	126.9	107.4	100+%	95%	2
61	11/10/2017	STA 15+25	5131.3	20.30%	120.8	100.4	100+%	95%	4

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4%
2	106.4	18.6%
4	99.9	20.3%

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES:
*Indicates failure to meet moisture specifications
**Indicates approval by Engineer

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
62	11/10/2017	STA 11+00 (Ref. sheet 6)	5126.5	22.30%	121.2	99.1	99%	95%	4
63	11/10/2017	STA 12+30	5126.5	17.50%	126.9	108.0	100+%	95%	2
**64	11/10/2017	STA 13+70	5128.0	22.60%	123.8	101.0	100+%	95%	4
65	11/10/2017	STA 14+90	5130.3	20.60%	127.2	105.5	99%	95%	4

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4%
2	106.4	18.6%
4	99.9	20.3%

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES:
*Indicates failure to meet moisture specifications
**Indicates approval by Engineer

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
66	11/11/2017	STA 10+30 (Ref. sheet 6)	5127.0	16.60%	118.2	101.4	95%	95%	2
67	11/11/2017	STA 11+60 (Ref. sheet 6)	5127.3	16.70%	126.0	108.0	100+%	95%	2
68	11/11/2017	STA 13+20 (Ref. sheet 6)	5128.8	16.80%	125.8	107.7	100+%	95%	2
69	11/11/2017	STA 14+40 (Ref. sheet 6)	5131.0	21.10%	121.2	100.1	100+%	95%	4
70	11/11/2017	STA 15+30 (Ref. sheet 6)	5132.0	20.00%	121.1	100.9	100+%	95%	4
71	11/11/2017	STA 9+65 (Ref. sheet 6)	5127.5	17.00%	126.2	107.9	100+%	95%	2
72	11/11/2017	STA 11+10 (Ref. sheet 6)	5128.0	16.80%	124.6	106.7	100+%	95%	2
**73	11/11/2017	STA 12+30 (Ref. sheet 6)	5128.0	22.90%	124.1	101.0	100+%	95%	4
74	11/11/2017	STA 13+55 (Ref. sheet 6)	5129.5	21.40%	121.5	100.1	100+%	95%	4
75	11/11/2017	STA 14+50 (Ref. sheet 6)	5132	21.70%	122.1	100.3	100+%	95%	4

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

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Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
76	11/11/2017	STA 10+50 (Ref. sheet 6)	5128.7	17.80%	125.9	106.9	100+%	95%	2
77	11/11/2017	STA 12+20 (Ref. sheet 6)	5128.7	22.20%	123.4	101.0	100+%	95%	4
78	11/11/2017	STA 13+40 (Ref. sheet 6)	5130.3	22.20%	123.8	101.3	100+%	95%	4
79	11/11/2017	STA 14+50 (Ref. sheet 6)	5133.0	21.80%	123.1	101.1	100+%	95%	4
80	11/11/2017	STA 15+30 (Ref. sheet 6)	5133.7	20.10%	122.5	102.0	100+%	95%	4
81	11/11/2017	STA 10+00 (Ref. sheet 6)	5129.5	21.40%	122.7	101.1	100+%	95%	4
**82	11/11/2017	STA 11+30 (Ref. sheet 6)	5129.5	22.50%	123.2	100.6	100+%	95%	4
83	11/11/2017	STA 10+85 (Ref. sheet 6)	5130.5	21.30%	121.4	100.1	100+%	95%	4
84	11/11/2017	STA 12+05 (Ref. sheet 6)	5130.0	20.60%	120.2	99.7	100%	95%	4
85	11/11/2017	STA 13+05 (Ref. sheet 6)	5131.0	18.70%	124.9	105.2	99%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES:
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Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
86	11/13/2017	STA 10+15 (Ref. sheet 6)	5131.0	20.00%	127.4	106.2	100%	95%	2
87	11/13/2017	STA 11+10 (Ref. sheet 6)	5131.0	18.60%	126.9	107.0	100+%	95%	2
88	11/13/2017	STA 12+05 (Ref. sheet 6)	5131.0	18.40%	126.5	106.8	100+%	95%	2
89	11/13/2017	STA 13+25 (Ref. sheet 6)	5131.5	16.70%	125.1	107.2	100+%	95%	2
90	11/13/2017	STA 14+20 (Ref. sheet 6)	5133.5	16.60%	125.1	107.3	100+%	95%	2
91	11/13/2017	STA 15+15 (Ref. sheet 6)	5134.3	17.10%	125.4	107.1	100+%	95%	2
92	11/13/2017	STA 10+05 (Ref. sheet 6)	5131.5	18.00%	122.8	104.1	98%	95%	2
93	11/13/2017	STA 11+40 (Ref. sheet 6)	5131.5	20.70%	121.2	100.4	100+%	95%	4
94	11/13/2017	STA 12+60 (Ref. sheet 6)	5132.0	19.00%	126.7	106.5	100+%	95%	2
95	11/13/2017	STA 13+95 (Ref. sheet 6)	5132.5	19.60%	127.5	106.6	100+%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES:
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**Indicates approval by Engineer

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
96	11/13/2017	STA 9+90 (Ref. sheet 6)	5132.0	18.90%	122.6	103.1	97%	95%	2
97	11/14/2017	STA 11+15 (Ref. sheet 6)	5132.7	21.80%	121.9	100.1	100+%	95%	4
98	11/14/2017	STA 12+05 (Ref. sheet 6)	5133.0	19.00%	126.7	106.5	100+%	95%	2
99	11/14/2017	STA 13+30 (Ref. sheet 6)	5134.0	22.10%	123.3	101.0	100+%	95%	4
100	11/14/2017	STA 14+00 (Ref. sheet 6)	5135.0	21.00%	121.8	100.7	100+%	95%	4
101	11/14/2017	STA 15+20 (Ref. sheet 6)	5132.7	17.70%	125.9	107.0	100+%	95%	2
102	11/14/2017	STA 10+15 (Ref. sheet 6)	5133.0	16.90%	125.6	107.4	100+%	95%	2
103	11/14/2017	STA 11+40 (Ref. sheet 6)	5133.3	17.30%	125.5	107.0	100+%	95%	2
104	11/14/2017	STA 12+50 (Ref. sheet 6)	5133.5	17.10%	125.9	107.5	100+%	95%	2
105	11/14/2017	STA 13+80 (Ref. sheet 6)	5135.0	18.40%	127.2	107.4	97%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

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Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
106	11/14/2017	STA 15+00 (Ref. sheet 6)	5135.0	21.30%	117.7	97.0	97%	95%	4
107	11/15/2017	STA 10+50 (Ref. sheet 6)	5133.3	16.70%	125.3	107.4	100+%	95%	2
108	11/15/2017	STA 12+25 (Ref. sheet 6)	5134.0	17.40%	126.3	107.6	100+%	95%	2
109	11/15/2017	STA 14+50 (Ref. sheet 6)	5135.0	18.00%	125.9	106.7	100+%	95%	2
110	11/15/2017	STA 10+00 (Ref. sheet 6)	5133.8	19.40%	128.1	107.3	100+%	95%	2
111	11/15/2017	STA 12+20 (Ref. sheet 6)	5134.5	18.40%	123.8	104.6	98%	95%	2
112	11/15/2017	STA 10+25 (Ref. sheet 6)	5134.5	18.20%	127.5	107.9	100+%	95%	2
113	11/15/2017	STA 11+25 (Ref. sheet 6)	5134.5	17.70%	127.1	108.0	100+%	95%	2
114	11/15/2017	STA 13+00 (Ref. sheet 6)	5134.0	18.80%	127.0	106.9	100+%	95%	2
115	11/15/2017	STA 14+15 (Ref. sheet 6)	5135.3	17.40%	126.6	107.8	100+%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES:
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**Indicates approval by Engineer

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
*116	11/15/2017	STA 10+30 (Ref. sheet 6)	5135.0	16.20%	125.6	108.1	100+%	95%	2
117	11/15/2017	STA 12+00 (Ref. sheet 6)	5135.0	19.00%	125.7	105.6	99%	95%	2
118	11/15/2017	STA 13+00 (Ref. sheet 6)	5135.0	17.00%	125.9	107.6	100+%	95%	2
119	11/15/2017	STA 14+00 (Ref. sheet 6)	5135.7	22.10%	122.2	100.1	100+%	95%	4
120	11/15/2017	STA 10+30 (Ref. sheet 6) (Retest of Test No. 116)	5135.0	18.20%	126.4	106.9	100+%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
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Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
121	11/16/2017	STA 10+50 (Ref. sheet 6)	5136.0	20.50%	127.9	106.1	100%	95%	2
122	11/16/2017	STA 11+40 (Ref. sheet 6)	5136.0	18.80%	125.9	106.0	100%	95%	2
123	11/16/2017	STA 12+50 (Ref. sheet 6)	5136.0	20.50%	124.6	103.4	97%	95%	2
124	11/16/2017	STA 13+50 (Ref. sheet 6)	5136.0	17.40%	126.0	107.3	100+%	95%	2
125	11/16/2017	STA 14+50 (Ref. sheet 6)	5136.0	17.60%	125.8	107.0	100+%	95%	2
126	11/16/2017	STA 15+25 (Ref. sheet 6)	5136.0	16.80%	126.1	108.0	100+%	95%	2
**127	11/16/2017	STA 7+50 (Ref. sheet 6)	5133.5	23.20%	121.0	98.2	98%	95%	4
**128	11/16/2017	STA 6+10 (Ref. sheet 6) (Retest of Test No. 46)	5133.5	20.70%	126.0	104.4	98%	95%	2
129	11/16/2017	STA 4+90 (Ref. sheet 6) (Retest of Test No. 46)	5133.5	19.40%	124.8	104.5	98%	95%	2
130	11/16/2017	STA 5+10 (Ref. sheet 6)	5134.5	19.50%	124.3	104.0	98%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES:
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Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
131	11/16/2017	STA 6+25 (Ref. sheet 6)	5134.5	22.10%	121.1	99.2	99%	95%	4
132	11/16/2017	STA 7+40 (Ref. sheet 6)	5134.5	16.80%	125.4	107.4	100+%	95%	2
133	11/16/2017	STA 5+75 (Ref. sheet 6)	5135.3	20.00%	122.6	102.2	100+%	95%	4
134	11/16/2017	STA 4+85 (Ref. sheet 6)	5135.3	18.90%	115.6	97.2	97%	95%	4

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

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PROJECT: Swede Lake
JOB NO: 110480

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Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
135	11/17/2017	STA 5+00 (Ref. sheet 6)	5136.0	17.80%	125.1	106.2	100%	95%	2
136	11/17/2017	STA 6+15 (Ref. sheet 6)	5136.0	17.70%	126.3	107.3	100+%	95%	2
137	11/17/2017	STA 7+00 (Ref. sheet 6)	5136.0	18.00%	127.3	107.9	100+%	95%	2
138	11/17/2017	STA 7+60 (Ref. sheet 6)	5135.5	19.50%	126.0	105.4	99%	95%	2
139	11/17/2017	STA 2+50 (Ref. sheet 6)	5135.3	21.00%	121.1	100.1	100+%	95%	4
140	11/17/2017	STA 1+50 (Ref. sheet 6)	5135.5	19.00%	125.4	105.4	99%	95%	2
141	11/17/2017	STA 1+40 (Ref. sheet 6)	5136.0	18.10%	127.1	107.6	100+%	95%	2
142	11/17/2017	STA 2+75 (Ref. sheet 6)	5136.0	18.00%	127.2	107.8	100+%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

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Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
143	11/20/2017	STA 4+35 (Ref. sheet 6)	5126.0	20.50%	127.0	105.4	99%	95%	2
144	11/20/2017	STA 4+40 (Ref. sheet 6)	5128.0	19.40%	127.6	106.9	100+%	95%	2
145	11/20/2017	STA 4+30 (Ref. sheet 6)	5130.0	19.80%	124.8	104.2	98%	95%	2
146	11/20/2017	STA 4+40 (Ref. sheet 6)	5132.0	20.00%	127.9	106.6	100+%	95%	2
147	11/20/2017	STA 9+20 (Ref. sheet 6)	5126.5	19.20%	126.2	105.9	100%	95%	2
148	11/20/2017	STA 9+35 (Ref. sheet 6)	5127.5	19.60%	128.2	107.2	100+%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: Emmett Hite

NOTES: Test 154 - Location received extra passes with sheep's foot compactor after testing. Test 152 failed to meet expectations. Its retest is shown in Test 158.

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
149	12/11/2017	Irrigation structure backfill, STA 0+50 (Ref. sheet 17), west side of pipe	5123.0	14.0%	121.0	106.1	100%	95%	2
150	12/11/2017	Irrigation structure backfill, STA 1+00 (Ref. sheet 17), west side of pipe	5123.0	19.5%	121.9	102.0	96%	95%	2
151	12/11/2017	Irrigation structure backfill, STA 1+05 (Ref. sheet 17), east side of pipe	5123.0	18.1%	123.8	104.8	99%	95%	2
152	12/11/2017	Irrigation structure backfill, STA 0+50 (Ref. sheet 17), east side of pipe	5123.0	15.4%	122.9	106.5	100+%	95%	2
153	12/11/2017	Irrigation structure backfill, STA 0+80 (Ref. sheet 17), west side of pipe	5123.5	18.7%	124.9	105.2	99%	95%	2
154	12/11/2017	Irrigation structure backfill, STA 0+80 (Ref. sheet 17), east side of pipe	5123.5	18.3%	119.6	101.1	95%	95%	2
155	12/11/2017	Irrigation structure backfill, STA1+10 (Ref. sheet 17), west side of pipe	5124.5	16.7%	125.1	107.2	100+%	95%	2
156	12/11/2017	Irrigation structure backfill, STA 1+12 (Ref. sheet 17), east side of pipe	5124.5	18.0%	123.1	104.3	98%	95%	2
157	12/11/2017	Irrigation structure backfill, STA 0+50 (Ref. sheet 17), west side of pipe (Retest of Test 149)	5123.0	16.9%	125.1	107.0	100+%	95%	2
158	12/11/2017	Irrigation structure backfill, STA 0+50 (Ref. sheet 17), east side of pipe (Retest of Test 152)	5123.0	17.0%	125.1	106.9	100+%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
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2	106.4	18.6%
4	99.9	20.3%

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: Emmett Hite & Tyler Davis

NOTES: 8" Depth

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
159	12/12/2017	Irrigation structure backfill, outlet towers STA 0+40 (Ref. sheet 17), west side of pipe	~5142.0	17.9%	125.2	106.2	100%	95%	2
160	12/12/2017	Irrigation structure backfill, outlet towers STA 0+40 (Ref. sheet 17), east side of pipe	5124.0	20.4%	123.0	102.2	96%	95%	2
161	12/12/2017	Irrigation structure backfill, outlet towers (Ref. sheet 17), east side of pipe	5125.0	18.7%	130.8	110.2	100+%	95%	2
162	12/13/2017	Irrigation structure backfill, outlet towers STA 0+60 (Ref. sheet 17), west side of pipe	5126.3	18.4%	130.2	110.0	100+%	95%	2
163	12/13/2017	Irrigation structure backfill, outlet towers STA 0+50 (Ref. sheet 17), east side of pipe	5127.0	16.6%	125.8	107.9	100+%	95%	2
164	12/13/2017	Irrigation structure backfill, outlet towers STA 0+40 (Ref. sheet 17), west side of pipe	5127.0	16.7%	125.3	107.4	100+%	95%	2
165	12/13/2017	Irrigation structure backfill, outlet towers STA 0+60 (Ref. sheet 17), east side of pipe	5127.7	17.2%	126.2	107.7	100+%	95%	2
166	12/13/2017	Irrigation structure backfill, outlet towers STA 0+50 (Ref. sheet 17), west side of pipe	5132.0	20.1%	129.1	107.5	100+%	95%	2
167	12/13/2017	Irrigation structure backfill, outlet towers STA 0+60 (Ref. sheet 17), east side of pipe	5132.7	17.9%	128.5	109.0	100+%	95%	2
168	12/13/2017	Irrigation structure backfill, outlet towers STA 0+55 (Ref. sheet 17), west side of pipe	5133.3	18.3%	128.0	108.2	100+%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4%
2	106.4	18.6%
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PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: Emmett Hite

NOTES: Test 169 approved by engineer. Test 175 failed to meet specification. Its retest is shown at Test 176

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
169	12/14/2017	Spillway grade control beam backfill (Ref. sheet 14) STA -0+04 (South side of beam)	5131.5	23.3%	123.1	99.8	100%	95%	4
170	12/14/2017	Spillway grade control beam backfill (Ref. sheet 14) STA 0+04 (North side of beam)	5132.0	20.9%	122.4	101.2	100+%	95%	4
171	12/14/2017	Spillway grade control beam backfill (Ref. sheet 14) STA -0+05 (South side of beam)	5133.0	21.2%	121.4	100.2	100+%	95%	4
172	12/15/2017	Irrigation structure backfill (Ref. sheet 17) STA 0+55 (East side of pipe)	5134.5	20.3%	124.1	103.2	100+%	95%	4
173	12/15/2017	Irrigation structure backfill (Ref. sheet 17) STA 0+60 (West side of pipe)	5135.5	20.0%	123.5	102.9	100+%	95%	4
174	12/15/2017	Irrigation structure backfill (Ref. sheet 17) STA 0+65 (East side of pipe)	5136.0	21.6%	125.4	103.1	100+%	95%	4
175	12/18/2017	Outlet structure backfill (Ref. sheet 11) STA 0+30 (North side of pipe)	5122.0	16.7%	116.6	99.9	94%	95%	2
176	12/18/2017	Outlet structure backfill (Ref. sheet 11) STA 0+30 (North side of pipe) **Retest of Test 175**	5122.0	18.3%	121.3	102.5	96%	95%	2
177	12/18/2017	Outlet structure backfill (Ref. sheet 11) STA 0+50 (North side of pipe)	5123.5	16.8%	123.6	105.8	99%	95%	2
178	12/18/2017	Outlet structure backfill (Ref. sheet 11) STA 0+55 (South side of pipe)	5122.7	16.6%	126.7	108.7	100+%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
1	105.6	16.4%
2	106.4	18.6%
4	99.9	20.3%

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: Tyler Davis

NOTES: Approximate embankment STA 9+00 outlet pipe stationing noted for tests

Datum:

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
189	12/20/2017	Outlet structure backfill, STA 0+50 (Ref. sheet 11) North of outlet structure	5134.5	18.4%	127.3	107.5	100+%	95%	2
190	12/20/2017	Outlet structure backfill, STA 0+45 (Ref. sheet 11) South of outlet structure	5134.5	19.7%	127.1	106.2	100%	95%	2
191	12/20/2017	Outlet structure backfill, STA 0+30 (Ref. sheet 11) At outlet structure	5134.5	18.4%	125.7	106.2	100%	95%	2
192	12/20/2017	Outlet structure backfill, STA 0+40 (Ref. sheet 11) South of outlet structure	5135.3	18.9%	127.1	106.9	100+%	95%	2
193	12/20/2017	Outlet structure backfill, STA 0+30 (Ref. sheet 11) At outlet structure	5135.3	19.5%	115.3	96.5	91%	95%	2
194	12/20/2017	Outlet structure backfill, STA 0+50 (Ref. sheet 11) North of outlet structure	5136.0	18.4%	128.6	108.6	102%	95%	2
195	12/20/2017	Outlet structure backfill, STA 0+30 (Ref. sheet 11) At outlet structure **Retest of 193**	5135.3	20.5%	122.1	101.3	95%	95%	2
196	12/20/2017	Outlet structure backfill, STA 0+50 (Ref. sheet 11) South of outlet structure	5136.0	20.4%	127.7	106.1	100%	95%	2

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
RD-1	110.8-113.4	

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: LCB

NOTES: Approximate embankment STA 9+00 outlet pipe stationing noted for tests

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
197	1/16/2018	MH-5 Toe drain	5120.5	10.7%	123.1	111.2	67%	65-75%	RD-1
198	1/17/2018	MH-5 Toe drain + 25'	5120.5	13.5%	125.8	110.8	65%	65-75%	RD-1

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
RD-1	110.8-113.4	

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES: Approximate embankment STA 9+00 outlet pipe stationing noted for tests

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
199	1/25/2018	MH-2 Toe drain + 16' W	5124.3	9.9%	124.5	113.3	74%	65-75%	RD-1

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
RD-1	110.8-113.4	

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES: Approximate embankment STA 9+00 outlet pipe stationing noted for tests

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
200	2/8/2018	Toe drain, 120' S of MH-7 between MH-7 and MH-8	5126.0	10.0%	124.1	112.8	75%	65-75%	RD-1

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
2	106.4	18.6%
4	99.9	20.3%

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES: Approximate embankment STA 9+00 outlet pipe stationing noted for tests

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
201	2/17/2018	Toe drain, STA 10+10 (Ref sheet 6)	5129.0	17.1%	125.2	106.9	100+%	95%	3
202	2/17/2018	Toe drain, STA 9+35 (Ref sheet 6)	5129.0	18.9%	127.2	107.0	100+%	95%	3
203	2/17/2018	Toe drain, STA 11+70 (Ref sheet 6)	5129.0	17.8%	124.3	105.5	99%	95%	3
204	2/17/2018	Toe drain, STA 13+20 (Ref sheet 6)	5130.0	16.8%	126.1	108.0	100+%	95%	3
205	2/17/2018	Toe drain, STA 14+60 (Ref sheet 6)	5131.0	17.0%	125.0	106.8	100+%	95%	3
206	2/17/2018	Toe drain, STA 10+15 (Ref sheet 6)	5130.0	18.6%	126.8	106.9	100+%	95%	3
207	2/17/2018	Toe drain, STA 9+50 (Ref sheet 6)	5130.0	17.9%	126.4	107.2	100+%	95%	3

Engineering Analytics, Inc.

FIELD DENSITY TEST REPORT

ASTM D 2922-Density
ASTM D3017-Moisture

MOISTURE-DENSITY RELATIONSHIPS
ASTM D 4253 & 4254

Curve No.	Maximum Dry Density (pcf)	Optimum Moisture (%)
2	106.4	18.6%
4	99.9	20.3%

PROJECT: Swede Lake
JOB NO: 110480

CLIENT: Boulder County
CONTRACTOR: CAP
ENGINEER: Engineering Analytics, Inc.
TESTED BY: EAH

NOTES: Approximate embankment STA 9+00 outlet pipe stationing noted for tests

Datum: _____

Test No.	Date	Location	Elevation	% Moist	Density (pcf) Moist	Density (pcf) Dry	% Compaction	Required Compaction	Curve No.
208	2/26/2018	Toe drain backfill, STA 7+50	5128.3	18.2%	123.5	104.5	98%	95%	2
209	2/26/2018	Toe drain backfill, STA 6+25	5128.5	17.4%	125.6	107.0	100+%	95%	2
210	2/26/2018	Toe drain backfill, STA 5+00	5128.7	20.5%	122.8	101.9	96%	95%	2
211	2/26/2018	Toe drain backfill, STA 4+00	5129.7	17.6%	126.1	107.2	100+%	95%	2
212	2/26/2018	Toe drain backfill, STA 3+00	5131.0	16.9%	122.0	104.4	98%	95%	2
213	2/26/2018	Toe drain backfill, STA 1+75	5131.0	16.7%	118.7	101.7	96%	95%	2

Engineering Analytics, Inc.

APPENDIX D
STRUCTURAL DESIGN LETTER

Engineering Analytics, Inc. ▪ 1600 Specht Point Rd. ▪ Suite 209 ▪ Fort Collins, CO 80525 ▪ 970.488.3111 ▪ www.EngAnalytics.com

January 8, 2018
Project No. 110480

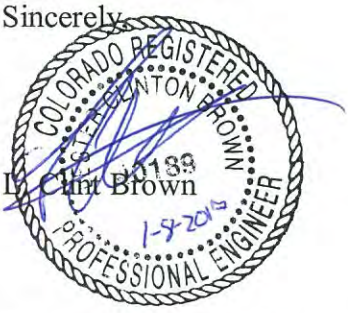
Mr. Tim Zych
Project Manager
Boulder County Parks and Open Space
5201 Saint Vrain Rd.
Longmont, CO, 80503

Subject: Swede Dam, Dam ID: 050304
Construction File No.: C-2064
Water Division 1, Water District 5
Evaluation of Structural Integrity of the Irrigation Tower

Dear Mr. Zych

During the construction of the irrigation tower, concrete tests and cylinders were taken per usual. The cylinders were low on the 28-day strength test. The two samples tested at 3,858 and 3,846 psi rather than the required 4,500 psi according to the Construction Specifications. The structural calculations on the irrigation tower were redone, and it was determined that the tower is structurally sound with a concrete strength of 3,846 psi. See the attached documents for structural calculations.

Sincerely,



P. Clint Brown

Engineering Analytics, Inc.

DESIGN OF CONCRETE BEAMS

ACI 350-06 Page

PROJECT: Swede Lake MEMBER I.D.: Irrigation Outlet

INPUT VALUES

f'c =	3846 psi	b =	12 in	Ult L.F. =	1.6001	Calculated	
fy =	60000 psi	D =	12 in	Env. Exp.	None	Quadratic Coefficients	
Es =	29000 ksi	d_{cvr} =	2.65 in	One Way Member		a	45884.1883
Mo =	3.07 k-ft	L.F.	1.60	$S_d = \phi fy/\gamma fs$ =	1.00	b	-542250
Mu =	4.91 k-ft	de cvr =	0 in <-----	(0 for slabs)		c	65520

CALCULATED VALUES

(see ACI 350-06 Section 10.5 for As_{min})

Ec = 3573 ksi
n = 8.1
d = 9.0375 in
B_1 = 0.85
$\rho_{min(MOR)}$ = 0.0031 As_{min} = 0.36 in² (max of 2 eqns)
$\rho_{min(ACI)}$ = 0.0033
ρ_{max} = 0.0174 As_{max} = 1.884 in²
ρ_{bal} = 0.0274
ρ_{req} = 0.0011 As_{req} = 0.122 in²
= 0.04 ρ_{bal}
(1.33*As_{req}) = 0.16 in²

As_{min} = 0.16 in² (min of As_{min} or 1.33*As_{req})

As = 0.16 in²

----------> Minimum steel controls - Use Asmin or provide 1.33(Asreq) per ACI 10.5

QTY	SIZE	Area	As pro
1	#4	0.20	0.20
1	#5	0.31	0.31
1	#6	0.44	0.44
1	#7	0.60	0.60
1	#8	0.79	0.79
1	#9	1.00	1.00
1	#10	1.27	1.27

REBAR SPACING

ACI 318-05 Crack Control Provisions (10.6.4)

INPUT---> Selected Bar Size #5
Qty of bars used = 1

Calced Values

Area of bar = 0.31 in²
Clear Cover = 2.65 in
As_{pro} = 0.31 in² **OK**
ρ = 0.3%
Mo = 3.071 k-ft
a = 0.47 in
j = 0.97
fs = Mo/[As*(d-a/2)] = 13.5 ksi
s = 12.0 in **OK**
s_{max} = 18.0 in

#5@12 in 12 inch deep beam is: OK

ACI 350-06 REBAR SPACING

s_{max} = 12.0 in **OK**

CRACK CONTROL

ACI 350-06 Crack Control Provisions
Reinforcement Stresses ACI 350 Section 10.6.4.1-3
β = 1.35 ACI 350 Section 10.6.4.4

Exposure	Allowable Bar Stress, fs		
Normal	20.0	ksi	OK
Severe	17.0	ksi	OK

Actual Bar Stress = 13.5 ksi

Stress Ratio		Concrete Stress	
Normal	0.68	fc =	736.0 psi
Severe	0.79	fc,all =	1731 psi

Given: Retained Wall Height, $H := 13.75$ ft

Construction Load Height, $H_{const} := 2$ ft

Unit Weight of Soil, $\gamma := 130$ lbs/ft3

Strength Reduction Factor, $\phi := 0.75$

Compressive Strength of Concrete, $f'_c := 3846$ psi

Construction Load, $L_{const} := 130$ lb/ft2

Earth Loading Factor of Safety, $FS_{Earth} := 1.6$

Width of Vault Gate $l := 6$ ft

Calculate the maximum Shear Load

Retained Wall Height at a, accounting for pipe and concrete encasement on east wall

$H_a := H + H_{const} = 15.75 \quad ft$

$V_0 := 0.5 \cdot \gamma \cdot H \cdot \frac{l}{2} = 2.68 \cdot 10^3 \quad \frac{lbs}{ft}$

$V_u := FS_{Earth} \cdot V_0 = 4.29 \cdot 10^3 \quad \frac{lbs}{ft}$

$d := 12 - 2.625 = 9.375 \quad inches$

$\phi V_{na} := 2 \cdot \phi \cdot 12 \cdot d \cdot \sqrt{f'_c} = 1.05 \cdot 10^4 \quad \frac{lbs}{ft}$

Thus, wall thickness of (D) $D := 2.625 + d = 12$ in. will not require stirrups.