GROUNDWATER QUALITY MONITORING PLAN
AMEN AGGREGATE RESOURCES
DRMS PERMIT FILE M-2019-025

Prepared by:
WEILAND INC.
PO BOX 18087
BOULDER, CO 80308

Prepared for:
COULSON EXCAVATING CO., INC
3609 N. COUNTY RD 13
LOVELAND, CO 80538

July 24, 2023

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1.0 INTRODUCTION

Pursuant to Rule 3.1.7 of the Mineral Rules and Regulations of The Colorado Mined Land Reclamation Board for The Extraction of Construction Materials, this Groundwater Monitoring Plan has been developed for the purpose of determining if sand and gravel mining and reclamation activities will degrade local groundwater quality to analyte concentrations above the State-wide groundwater quality standards established by the Water Quality Control Commission (WQCC). Since the area of the Amen Aggregate Resource (AAR) is identified by the state as "unclassified" the numeric standards as identified in 5 CCR 1002-41 shall be that quality which meets the most stringent criteria set forth in Tables 1 through 4 of "The Basic Standards for Groundwater." Which is given in **Appendix I**- **Basic Standards for Groundwater Tables 1-4, Code of Colorado Regulations Water Quality Control Commission, 5 CCR 1002-41**.

2.0 HYDROGEOLOGIC SETTING

The Amen Aggregate Resource is located in the Big Thompson River Alluvial Valley (see Figure 1 Alluvial Aquifer). The valley width is approximately 2,000 ft – 3,000 ft wide and follows the trend of the river. The aquifer is composed of quaternary alluvial sand and gravel. Saturated sediment thickness ranges from 6ft-20ft and the average transmissivity is between 10,000 – 30,000 gpd/ft. Regional water table elevation contours are given in **Figure 1 Hydrogeologic Map** are based on the GIS layer published by the USGS Interactive Map of the Colorado Front Range Infrastructure Resources. The regional direction of groundwater flow in the valley is perpendicular to the flow of the river in the distal regions and becoming sub parallel and parallel to the flow of the river near the river. More detailed groundwater elevation contours for the AAR are given in **Figure 2 Proposed Monitoring Well Locations**. The water table elevation contours in Figure 2 are based on measurements from 2018 as follows:

- 32 test hole borings completed by Landmark Engineering (April 2018)
- 3 onsite existing wells EW-1, EW-2, EW-3 (April 2018) surveyed and measured by Weiland, Inc. (WI)
- 3 monitor wells LRM-MW-1, LRM-MW-2, LRM-MW-3, to the south collected by Loveland Ready Mix for Permit M-2001-022 (April 2018),
- 2 Terracon Test Borings B-2, B3 at the WCR 54 bridge (Jan 2020)
- Weiland, Inc. surveyed river water surface elevations (April 2018)
- Regional groundwater elevation contours published in 1998, USGS. **Front Range Infrastructure Resources Project Fact Sheet** 126-98, https://doi.org/10.3133/fs12698).

Landmark Test hole data, LRM water level measurements and Terracon water level measurements are given in **Appendix I – Water Level Data**. All onsite data is based on survey level accuracy positioning. Offsite data positions were determined with GIS and scanned images with vertical wellhead locations taken from 1ft lidar surveys. A 3D surface model of water levels was then developed in Civil 3D resulting in the water level

contours shown in **Figure 2 Proposed Monitoring Well Locations.** The 2018 water level well locations are not shown in **Figure 2 Proposed Monitoring Well Locations,** however, can be available upon request.

The bedrock underneath the alluvial deposit is composed of weathered claystone and shale which is saturated to a thickness of 1-4ft. The soils above the alluvial aquifer in the vadose zone are composed primarily of sandy silt.

3.0 GROUNDWATER QUALITY MONITORING PLAN

3.1 GROUNDWATER STANDARDS

As described in the introduction above, the numeric standards shall be the most restrictive of Tables 1-4 given in **Appendix I- Basic Standards for Groundwater Tables 1-4, Code of Colorado Regulations Water Quality Control Commission, 5 CCR 1002-41**

It is requested that the following analytes be removed from the above tables for the baseline and site monitoring;

- Gross Alpha Particle Activity
- Beta and Photon Emitters
- Chlorophenol
- Color
- Odor
- Asbestos
- Foaming Agents
- Phenol

The reasoning for this request is as follows; Concentrations of Gross Alpha Particle and Beta Photon Emitters are the result of decaying radionuclides, which occur naturally or are the result of man-made nuclear power plants and defense industry and some industrial waste. Not any of those activities have occurred in the area of the AAR. Additionally, it is known concentrations of radionuclides can occur in sedimentary rocks, the primary the local aquifer occurs in a sand and gravel deposit. Weathered claystone will be used for the compacted clay liner; however, the permeability of that liner will be so low that it will not transmit water.

Chlorophenol, color, odor, asbestos, foaming agents, and Phenol are all parameters typically tested for in surface wastewater effluent. The groundwater in the area of the AAR is not directly subject to wastewater effluent and the site monitoring is for groundwater.

3.2 MONITOR WELL LOCATIONS AND CONSTRUCTION

The proposed monitor wells have been placed hydrologically upgradient and downgradient of the mining Cells (see **Figure 2 - Proposed Monitor Well Locations**). Due to the fact that the site is hydrologically divided by the Big Thompson River, monitor

wells have been placed upgradient and downgradient for the group of mining Cells as follows:

- For mining Cells 2,3, 4 and 6 – upgradient wells include MW-1, MW-2, MW-4 and downgradient wells include MW-3 and MW-5.
- For Mining Cell 1 the upgradient well is MW-6 and the downgradient well is MW-7.
- For mining Cell 5 – upgradient wells include MW-8 and MW-9 and the downgradient well is MW-10.

The monitor wells will be completed to fully penetrate the alluvial aquifer and will have screened intervals and depths as given in **Table 1.3.1 Monitor Well Construction Specifications.** The depths given in Table 1.3.1 are based on 3D surface model for top of bedrock developed from test hole data (see **Appendix I – Water Level Data**). The screened interval will be 2" #10 slotted PVC tubing and the annulus will be backfilled with #10 Colorado silica sand. The 2" solid PVC sections will be backfilled with native sandy silt and capped with a bentonite seal. The wells will be fitted with a square tube riser set in concrete with a hinged lid. Wells will be developed by rapidly pumping and stopping until water runs clear.

Table 1.3.1 Monitor Well Construction Specifications

Well	Depth (below ground surface)	Screen Interval
MW-1	22.0'	22.0'-12.0'
MW-2	24.7'	24.7'-17.7'
MW-3	9.1'	9.1'-4.1'
MW-4	24.4'	24.4'-14.4'
MW-5	12.2'	12.2'-4.2'
MW-6	20.0'	20.0'-10.0'
MW-7	25.0'	25.0'-15.0'
MW-8	11.0'	11.0'-5.0'
MW-9	12.0'	12.0'-4.0'
MW-10	9.3'	9.3'-4.3'

3.3 SAMPLING PLAN

3.3.1 Background Water Quality

For the purpose of establishing background water quality, 5 quarters of background sampling (quarterly) and 5 quarters of monthly water level measurements will be performed on *all* monitor wells following installation. Following the initial 5 quarters, water quality will be monitored as directed by DRMS described below in **Section 3.3.2. Continued Monitoring and Compliance**. Water levels will be monitored monthly for the duration of the permit.

For monitoring the potential effects of mining and reclamation on groundwater in the vicinity of Cells 2, 3, 4 and 6, monitor wells 1-5 were installed on 7/17/23 -7/18/23.

Similarly, for monitoring the potential effects from Cell 5 and Cell 1, monitor wells 6, 7, 8, 9, and 10 will be installed a minimum of 1.25 years prior to any mining activity in those areas east north of the Big Thompson River. It is felt that the installation of these wells at that time is appropriate since the areas will not be mined for approximately 10+ years. Cell 5 occurs north of the river and Cell 1 occurs east of the river. The river serves as a hydrologic divide between these Cells and Cells 2, 3, 4 and 6. The groundwater upgradient of Cells 1 and 5 is also subject to different bedrock and land use. Additionally, timing background monitoring closer to the time of mining will provide a better picture of water chemistry and levels relative to the potential effects of mining at that future time.

Coulson Excavating Co., Inc. (CEC) will commit to not mining Cell 1 and Cell 5 until at least 5 quarters of background sampling and 5 quarters of monthly water levels have been completed.

Sampling will begin immediately following well construction and development. Sampling methodology will be to purge 3 times the water column volume followed by sampling with a dedicated bailer. Samples will be placed in analytical laboratory sampling vessels and sealed with a chain of custody. Field water quality parameters will include water level, pH, temp, and specific conductivity. All field meters shall be regularly calibrated.

At the time of sampling for inorganic analytes, appropriate filtering, preservation and or maintenance of temperature parameters will be followed as directed by the analytical laboratory. These procedures will be documented in the field logs.

Water quality samples will be delivered (not to exceed holding times or temperatures) to a reputable analytical laboratory certified for current EPA standards and methodologies.

A field logbook will be developed and will include date, time, purge method and volume, temp. pH, specific conductivity, samples collected, filtering information, preservation,

instrument calibration data and other pertinent data as needed for each sampling event.

A Background Water Quality and Water Level Monitoring Summary Report will be submitted to the DRMS with the annual report by the end of the 2024 calendar year. A Water Level Monitoring Summary Report will be submitted with the annual report for 2023.

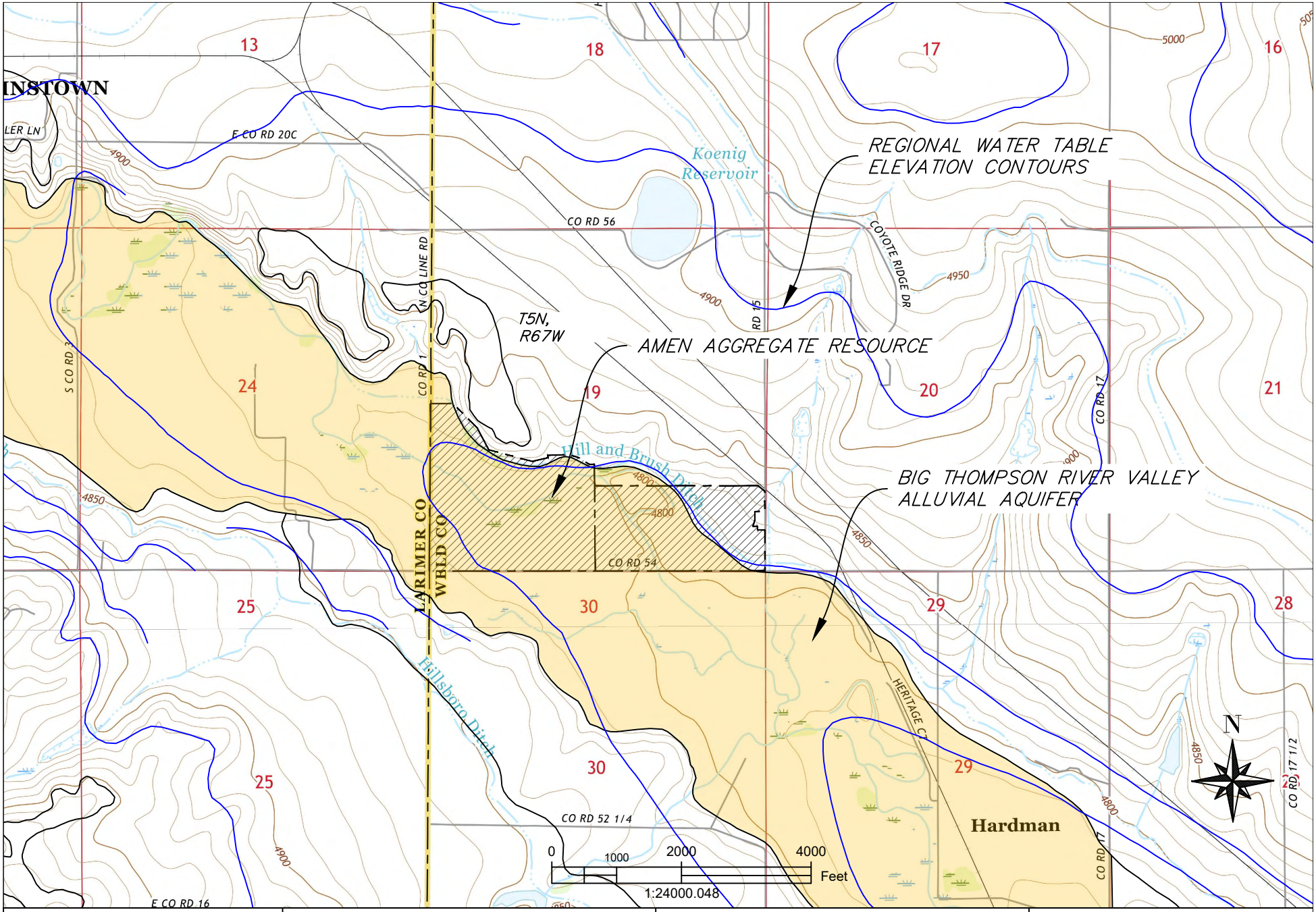
3.3.2 Continued Monitoring and Compliance

A Technical Revision (TR) will be submitted following the completion of the 5 quarters of monitoring and water level measurement for wells 1-5. Another TR will be submitted following the completion of 5 quarters of the same for wells 5-10. The TR's will contain a baseline data report, comparisons to the Table Value Standards, surveyed monitoring well locations and elevations, construction diagrams, and an updated groundwater contour map.

Following submittal of the TR's, DRMS will evaluate the 5 quarters of data and constituents identified as exceeding table value standards in baseline data. Permit-specific benchmarks will be set by DRMS for those constituents identified as exceeding table value standards in baseline data, as wells as sampling and reporting requirements for continued monitoring. Reporting requirements and follow-up actions for observed exceedances of either groundwater level or quality benchmarks will be specified and approved in these revisions.

The continued water quality monitoring will utilize the same standards, methodology and documentation as identified in **Section 3.3.1 Background Water Quality** above.

At a minimum, Water Quality and Water Level Monitoring Summary Reports will be submitted to the DRMS annually with the annual report. It is noted that they may need to be submitted more frequently as described above.



REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

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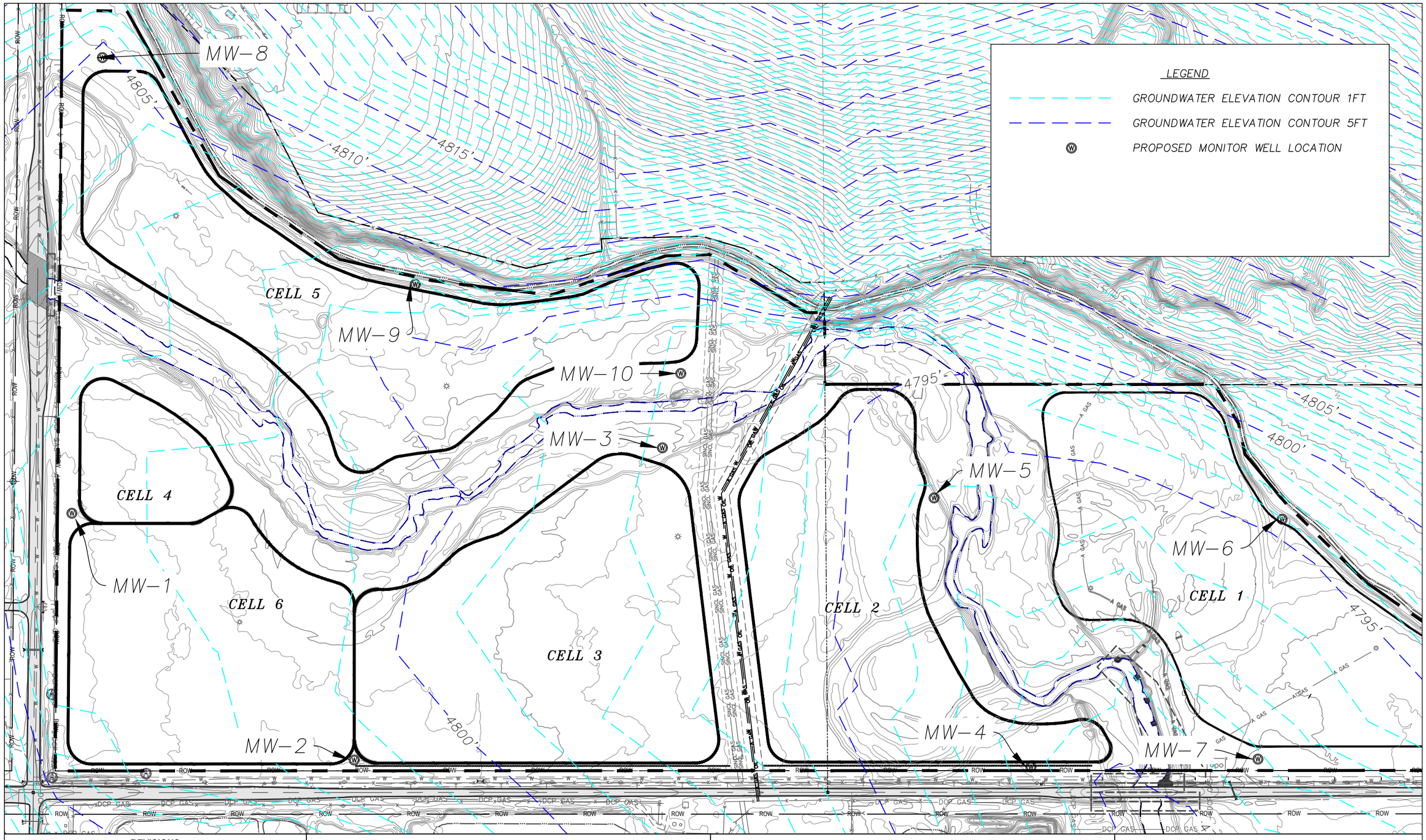
AMEN AGGREGATE RESOURCES
REG. 112 CONSTRUCTION PERMIT M-2019-025
WELD COUNTY,CO
PREPARED FOR: COULSON EXCAVATING CO., INC.

FIGURE 1
HYDROGEOLOGIC MAP

SCALE	DWG NO.	REV
1"=2,000'	FIGURE 1.DWG	REV

DRAWN BY:	CHECKED BY:	DATE:	SHEET
CTW	PFW	06/14/2023	1 OF 1



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AMEN AGGREGATE RESOURCE

WELD COUNTY

PREPARED FOR:
COULSON EXCAVATING CO., INC.

FIGURE 2 - PROPOSED MONITOR WELL LOCATIONS

SCALE	DWG NO.	REV.
1"=300'	GRONDWATER.DWG	REV

DRAWN BY:	CHECKED BY:	DATE:	SHEET
CTW	PFW	6/13/2023	1 OF 1

APPENDIX I

TABLE 1

TABLE 1 Domestic Water Supply – Human Health Standards	
Parameter	**Standard[1]**
Biological	
Total Coliforms (30 day average)	2.2 [a]org/100 ml
Total Coliforms (max in 30 days)	23org/100 ml
Inorganic	
Antimony (Sb)[d, M]	0.006mg/l
Asbestos [M]	7,000,000fibers/Liter
Arsenic (As)[d, M]	0.01mg/l
Barium (Ba)[d, M]	2.0mg/l
Beryllium (Be)[d, M]	0.004mg/l
Cadmium (Cd)[d, M]	0.005mg/l
Chromium (Cr)[c, d, M]	0.1mg/l
Cyanide [Free] (CN)[M]	0.2mg/l
Fluoride (F)[d, M]	4.0mg/l
Lead (Pb)[d]	0.05mg/l
Mercury (inorganic) (Hg)[d,M]	0.002mg/l
Molybdenum (Mo) [d]	0.21mg/l
Nickel (Ni)[d]	0.1mg/l
Nitrate (NO3)[d, M]	10.0mg/l as N
Nitrite (NO2)[d, M]	1.0mg/l as N
Total Nitrate+Nitrite (NO_2+NO_3)[d, f]	10.0mg/l as N
Selenium (Se)[d, M]	0.05mg/l
Silver (Ag)[d]	0.05mg/l
Thallium (Tl)[d, M]	0.002mg/l
Uranium (U) [d, 2]	0.0168 to 0.03[M]mg/l
Radiological[b, d]	
Gross Alpha Particle Activity[i, M]	15 pCi/l
Beta and Photon Emitters[e]	4 mrem/year

TABLE 2 Domestic Water Supply – Drinking Water Standards

Parameter	Standard
Chlorophenol	0.0002 mg/l
Chloride (Cl)[d]	250 mg/l
Color	15 color units
Copper (Cu)[d]	1 mg/l
Corrosivity	Noncorrosive
Foaming Agents	0.5 mg/l
Iron (Fe)[d]	0.3 mg/l
Manganese (Mn)[d]	0.05 mg/l
Odor	3 threshold odor numbers
pH	6.5 - 8.5
Phenol	0.3 mg/l
Sulfate (SO 4)[d]	250 mg/l
Zinc (Zn)[d]	5 mg/l

TABLE 3 Agricultural Standards

Parameter	Standard
Aluminum (Al)[d, f]	5 mg/l
Arsenic (As)[d]	0.1 mg/l
Beryllium (Be)[d]	0.1 mg/l
Boron (B)[d, g]	0.75 mg/l
Cadmium (Cd)[d]	0.01 mg/l
Chromium (Cr)[d]	0.1 mg/l
Cobalt (Co)[d]	0.05 mg/l
Copper (Cu)[d]	0.2 mg/l
Fluoride (F)[d]	2 mg/l
Iron (Fe)[d]	5 mg/l
Lead (Pb)[d, f]	0.1 mg/l
Lithium (Li)[d, h]	2.5 mg/l
Manganese (Mn)[d, j]	0.2 mg/l
Mercury (Hg)[d, f]	0.01 mg/l
Nickel (Ni)[d]	0.2 mg/l
Nitrite (NO2)[d, f]	10 mg/l as N
Nitrite & Nitrate (NO2 +NO3)[d, f]	100 mg/l as N
Selenium (Se)[d]	0.02 mg/l
Vanadium (V)[d]	0.1 mg/l
Zinc (Zn)[d]	2 mg/l
pH	6.5 - 8.5

TABLE 4 TDS Water Quality Standards

Background TDS Value (mg/l)	Maximum Allowable TDS Concentrations
0 - 500	400 mg/l or 1.25 times the background level, whichever is least restrictive
501 - 10,000	1.25 times the background value
10,001 or greater	No limit

1 Chronic or 30-day standard based on information contained in EPA's Integrated Risk Information System (IRIS) using a 10-6 incremental risk factor.

2 Whenever a range of standards is listed and referenced to this footnote, the first number in the range is a strictly health-based value, based on the Commission's established methodology for human health-based standards. The second number in the range is a maximum contaminant level, established under the federal Safe Drinking Water Act that has been determined to be an acceptable level of this chemical in public water supplies, taking treatability and laboratory detection limits into account. The Commission intends that control requirements for this chemical be implemented to attain a level of ambient water quality that is at least equal to the first number in the range except as follows:

- Where groundwater quality exceeds the first number in the range due to a release of contaminants that occurred prior to September 15, 2012, (regardless of the date of discovery or subsequent migration of such contaminants) clean-up levels for the entire contaminant plume shall be no more restrictive than the second number in the range or the groundwater quality resulting from such release, whichever is more protective.

- Wherever the Commission has adopted alternative, site-specific standards for the chemical, the site-specific standards shall apply instead of these statewide standards.

The Commission does not intend the adoption of this range of standards to result in changes to clean-up requirements previously established by an implementing agency, unless such change is mandated by the implementing agency pursuant to its independent statutory authority.

a When the Membrane Filter Technique is used for analysis, the average of all samples taken within thirty days must be less than 1 organism per 100 milliliters of sample. When the Multiple Tube Fermentation Method is used for analysis, the limit is less than 2.2 org/100 ml.

b If the identity and concentration of each radionuclide in a mixture are known, the limiting value would be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit specified. The sum of such ratios for all radionuclides in the mixture shall not exceed "1" (i.e. unity). A radionuclide may be considered as not present in a mixture if the ratio of the concentration to the limit does not exceed 1/10 and the sum of such ratios for all radionuclides considered as not present in the mixture does not exceed 1/4.

c The chromium standard is based on the total concentration of both trivalent and hexavalent forms of dissolved chromium.

d Measured as dissolved concentration. The sample water shall be filtered through a 0.45 micron membrane filter prior to preservation. The total concentration (not filtered) may be required on a case-by-case basis if deemed necessary to adequately characterize the pollution caused by the activity for the protection of groundwater uses.

e If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 mrem per year. Except for Tritium and Strontium 90 the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168-hour data listed in "Maximum Permissible Body Burden and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69, as amended, August 1963, US Department of Commerce.

f These more stringent levels are necessary to protect livestock watering. Levels for parameters without this footnote are set to protect irrigated crops at the same level. Where a party can demonstrate that a livestock watering use of groundwater is not reasonably expected, the applicable standard for lead is 5.0 mg/l.

g This level is set to protect the following plants in ascending order of sensitivity: Pecan, Black Walnut, Persian (English) Walnut, Jerusalem Artichoke, Navy Bean, American Elm, Plum, Pear, Apple, Grape (Sultanina and Malaga), Kadota Fig, Persimmon, Cherry, Peach, Apricot, Thornless Blackberry, Orange, Avocado, Grapefruit, Lemon. Where a party can demonstrate that a crop watering use of groundwater is not reasonably expected, the applicable standard for boron is 5.0 mg/l.

h This level protects all crops, except citrus which do not grow in Colorado and therefore a more stringent level of protection is not required.

i The Gross Alpha Activity standard excludes alpha activity due to Radon and Uranium.

j This standard is only appropriate where irrigation water is applied to soils with pH values lower than 6.0.

M Drinking water MCL.

APPENDIX II

Engineers Planners Surveyors Geotechnical

Landmark Engineering

Loveland 970-667-6286 Toll Free 866-379-6252
Fax 970-667-6298
www.landmarkltd.com

3521 West Eisenhower Blvd. Loveland, Colorado 80537

April 19, 2018
Project No. CEXCAV-18D9A-14-709

Ken Coulson
Coulson Excavation
3609 North County Road 13
Loveland, CO 80538

Dear Ken,

At your request, Landmark Engineering Ltd performed subsurface exploration drilling on the Amen property located at the northeast corner of Weld County Roads 13 and 54. This property is bisected by the Big Thompson River. The purpose of this investigation was to evaluate the thickness of the overburden soil and alluvial sands, gravels and cobbles via 32 test boring locations on the site.

As the boring operation advanced, an index of soils relative density and consistency was obtained, in Test Boring No.'s 1, 8 & 11 at various depths, by use of the standard penetration test (SPT), ASTM Standard Test D-1586. The penetration test results, listed on the grain size distribution graphs, are the number of blows required to drive a 2-inch diameter split-spoon sampler 1 foot into undisturbed soil/gravel using a 140-pound hammer dropped 30 inches.

In summary, the overburden soil classified as sandy lean clay/silty clayey sand/sandy silt soils that ranged in thicknesses from 0 to 9 feet while the underlying sand, gravel and cobble deposit thicknesses ranged from 2 to 20.5 feet thick. Even though a few SPT and auger samples were obtained and classified, the true quality of sand and gravel deposit was not evaluated at this time. If necessary, it is recommended that test pits be dug to collect sizeable bulk samples containing large gravel and cobble material that was omitted from our test boring samples.

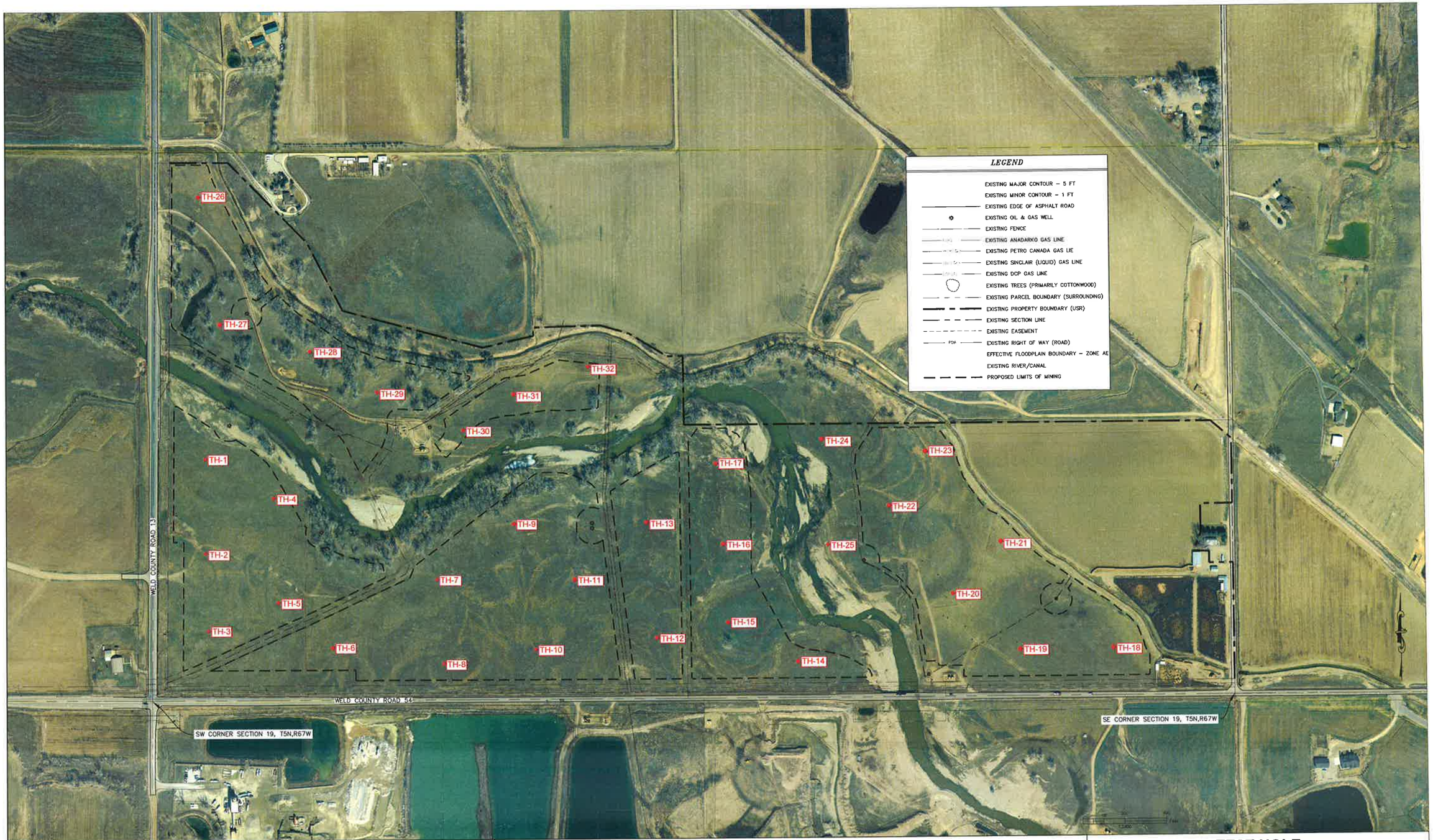
Please find enclosed the Test Hole Site Plan, Boring Summary Sheet and soil classification/SPT test results. If you have any questions please call our office.

Best Regards,

Landmark Engineering Ltd.

Larry Miller, PG

Enclosures



REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

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AMEN PIT
USE BY SPECIAL REVIEW
WELD COUNTY, CO

PREPARED FOR
COULSON EXCAVATING CO., INC.

TEST HOLE
SITE MAP

SCALE	DWG NO.		REV.
1"=200'	SITE PLAN.DWG		REV
DRAWN BY	CHECKED BY	DATE	SHEET
CTW	PFW	04/04/2018	1 OF 1

4/17/2018

BORING SUMMARY SHEET

BORING NO.	THICKNESS OF OVERBURDEN	DEPTH TO SHALE BEDROCK	SAND/GRAVEL THICKNESS	WATER LEVEL
B1	6'	20'	14'	5'
B2	5.5'	21'	15.5'	5'
B3	6'	22.5'	16.5'	4'
B4	5.5'	21'	15.5'	5.5'
B5	2'	22.5'	20.5'	4.5'
B6	5.5'	23'	17.5'	5'
B7	8'	22.5'	14.5'	6'
B8	6.5'	25'	18.5'	6'
B9	5'	20'	15'	6.5'
B10	7.5'	24'	16.5	6'
B11	4.5'	12.5	8'	5'
B12	5'	25'	20'	5'
B13	1.5'	12.5'	11'	5.5'
B14	4.5'	23'	18.5'	6'
B15	5.5'	15'	9.5'	6'
B16	3'	12'	9'	7'
B17	1'	9'	8'	7'
B18	6.5'	25'	18.5'	7'
B19	6.5'	23'	16.5'	6.5'
B20	8'	19.5'	11.5'	7'
B21	9'	18'	9'	8.5'
B22	5.5'	15'	9.5'	6.5'
B23	4'	16.5'	12.5'	5'
B24	6.5'	9'	2.5'	5.5'
B25	0'	13.5'	13.5'	3'
B26	8'	10'	2'	5'
B27	5'	15'	10'	6'
B28	3.5'	15'	11.5'	6'
B29	5'	14'	9'	7'
B30	3.5'	15'	11.5'	6'
B31	5.5'	9'	3.5'	8'
B32	2'	10.5'	8.5'	5'

Bokelman-Walters Depth to Water Measurements

Well Name	Date Measured	1/12/2018		4/5/2018		7/24/2018		10/4/2018		1/11/2019	
	Stick-up (ft)	Depth_TOC (ft)	DTW (ft)	Depth_TOC (ft)	DTW (ft)	Depth_TOC (ft)	DTW (ft)	Depth_TOC (ft)	DTW (ft)	Depth_TOC (ft)	DTW (ft)
MW-01	2.92	7.97	5.05	8.05	5.13	8.55	5.63	8.81	5.89	8.60	5.68
MW-01A	3.05	18.82	15.77	19.12	16.07	20.34	17.29	20.73	17.68	18.77	15.72
MW-02	3.04	7.22	4.18	7.70	4.66	7.88	4.84	8.09	5.05	7.62	4.58
MW-02A	3.31	19.15	15.84	19.10	15.79	18.90	15.59	19.23	15.92	17.81	14.50
MW-03	2.95	11.31	8.36	11.25	8.30	11.88	8.93	12.18	9.23	11.26	8.31
MW-04	2.83	10.82	7.99	10.91	8.08	9.36	6.53	9.55	6.72	10.08	7.25
MW-04A	3.31	20.27	16.96	20.81	17.50	18.66	15.35	18.10	14.79	18.22	14.91
MW-05	2.75	9.62	6.87	9.62	6.87	8.92	6.17	9.23	6.48	9.18	6.43
MW-06	3.00	15.03	12.03	14.88	11.88	14.50	11.50	15.00	12.00	15.17	12.17
MW-06A	3.17	24.81	21.64	24.37	21.20	24.95	21.78	24.81	21.64	24.63	21.46
MW-07	2.92	12.40	9.48	12.52	9.60	10.01	7.09	12.26	9.34	11.98	9.06
MW-07A	3.05	18.19	15.14	18.55	15.50	18.52	15.47	18.26	15.21	18.54	15.49
MW-08	3.27	11.23	7.96	11.36	8.09	11.45	8.18	12.32	9.05	12.41	9.14
MW-09	3.20	11.18	7.98	11.26	8.06	11.57	8.37	12.05	8.85	11.75	8.55

NOTE:

TOC = TOP OF CASING

DTW = DEPTH TO WATER

GROUNDWATER OBSERVATION DATA Green Property - Well Number 1			
Date	Depth Measured (PVC rim to water) (ft.)	Depth Below Original Ground (ft)	Notes
9/10/2010	9.1	6	
12/7/2010	10.27	7.17	
3/15/2011	10.39	7.29	
6/8/2011	9.75	6.65	
9/9/2011	10.2	7.1	
1/9/2012	10.27	7.17	
3/12/2012	10.38	7.28	
6/19/2012	9.6	6.5	
9/2/2012	9.34	6.24	
1/9/2013	10.32	7.22	
7/9/2013	9.9	6.8	
9/9/2013	9.75	6.65	
12/18/2013	10.15	7.05	
3/27/2014	10.3	7.2	
7/5/2014	9.7	6.6	
11/7/2014	10.45	7.35	
1/11/2015	10.2	7.1	
3/30/2015	10.12	7.02	
6/25/2015	9.47	6.37	
9/30/2015	9.8	6.7	
1/11/2016	10.05	6.95	
3/22/2016	10.17	7.07	
6/9/2016	10.5	7.4	
10/6/2016	9.9	6.8	
1/11/2017	10.12	7.02	
5/15/2017	9.7	6.6	
10/5/2017	9.38	6.28	
1/12/2018	10.22	7.12	
4/5/2018	10.35	7.25	Cell 4 Filled in February
7/24/2018	10.17	7.07	
10/4/2018	10.54	7.44	
1/8/2019	10.81	7.71	
4/23/2019	10.67	7.57	
7/10/2019	10.25	7.15	
10/15/2019	10.68	7.58	

6.913333333

Prepared by: Stephanie Fancher English
970.667.2680
stephanief@Lrmconcrete.com

GROUNDWATER OBSERVATION DATA Green Property - Well Number 2			
Date	Depth Measured (PVC rim to water) (ft.)	Depth Below Original Ground (ft)	Notes
9/10/2010	5.64	2.74	
12/7/2010	5.45	2.55	
3/15/2011	5.64	2.74	
6/8/2011	5.85	2.95	
9/9/2011	5.65	2.75	
1/9/2012	5.7	2.8	
3/12/2012	5.64	2.74	
6/19/2012	5.75	2.85	
9/2/2012	6.03	3.13	
1/9/2013	7.5	4.6	farm pond drained
7/9/2013	5.9	3	
9/9/2013	5.63	2.73	
12/18/2013	5.3	2.4	
3/27/2014	6.03	3.13	
7/5/2014	5.63	2.73	
11/7/2014	5.53	2.63	
1/11/2015	5.5	2.6	
3/30/2015	5.33	2.43	
6/25/2015	5.4	2.5	deer flys horrendous
9/30/2015	5.61	2.71	
1/11/2016	5.13	2.23	
3/22/2016	6.1	3.2	
6/9/2016	6.56	3.66	
10/6/2016	5.4	2.5	
1/11/2017	5.1	2.2	
5/15/2017	5.4	2.5	
10/5/2017	4.41	1.51	
1/12/2018	5.33	2.43	
4/5/2018	5.87	2.97	Cell 4 Filled in February
7/24/2018	5.61	2.71	
10/4/2018	6.4	3.5	
1/8/2019	6.13	3.23	
4/23/2019	6.32	3.42	
7/10/2019	6.26	3.36	
10/15/2019	6.01	3.11	

2.755277778

Prepared by: Stephanie Fancher English
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stephanief@Lrmconcrete.com

GROUNDWATER OBSERVATION DATA Green Property - Well Number 3			
Date	Depth Measured (PVC rim to water) (ft.)	Depth Below Original Ground (ft)	Notes
9/10/2010	9.21	6.31	
12/7/2010	7.9	5	
3/15/2011	9.21	6.31	
6/8/2011	7.9	5	
9/9/2011	7.23	4.33	
1/9/2012	7.4	4.5	
3/12/2012	7.85	4.95	
6/19/2012	8.88	5.98	
9/2/2012	8.82	5.92	
1/9/2013	8.8	5.9	
7/9/2013	7.53	4.63	
9/9/2013	8.7	5.8	
12/18/2013	7.7	4.8	
3/27/2014	8.62	5.72	
7/5/2014	7.7	4.8	
11/7/2014	8.2	5.3	
1/11/2015	8.9	6	
3/30/2015	8.8	5.9	
6/25/2015	9.9	7	
9/30/2015	9	6.1	
1/11/2016	8.62	5.72	
3/22/2016	8.4	5.5	
6/9/2016	8.05	5.15	
10/6/2016	8.9	6	
1/11/2017	8.7	5.8	
5/15/2017	8.9	6	
10/5/2017	7.33	4.43	
1/12/2018	9.12	6.22	
4/5/2018	9.21	6.31	Cell 4 Filled in February
7/24/2018	9.15	6.25	
10/4/2018	7.95	5.05	
1/8/2019	9.11	6.21	
4/23/2019	8.48	5.58	
7/10/2019	9.01	6.11	
10/15/2019	8.21	5.31	

5.646111111

Prepared by: Stephanie Fancher English
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Geotechnical Engineering Report

Weld County Bridge 54-13A
Johnstown, Colorado
January 24
Revised August 24, 2020
Terracon Project No. 21195074A (revised)

Prepared for:
J-U-B Engineers, Inc.
Fort Collins, Colorado

Prepared by:
Terracon Consultants, Inc.
Greeley, Colorado

January 24, 2020
Revised August 24, 2020

J-U-B Engineers, Inc.
4745 Boardwalk Drive
Fort Collins, Colorado 80525

Attn: Mr. Jeff Temple, P.E.
P: (970) 377-3602
E: jtemple@jub.com

Re: Geotechnical Engineering Report
Weld County Bridge 54-13A
6724 County Road 54
Johnstown, Colorado
Terracon Project No. 21195074A (revised)

Dear Mr. Temple:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the project referenced above. This study was performed in general accordance with Terracon Proposal No. P21195074A (Revised) dated September 6, 2019 and revised November 1, 2019. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and pavements for the proposed project. This report has been revised to include additional pavement thickness recommendations.

We appreciate the opportunity to be of service to you on this project. Materials testing and construction observation services are provided by Terracon as well. We would be pleased to discuss these services with you. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Maia G. Hayes, E.I.
Staff Geotechnical Engineer

COLORADO REGISTERED ERIC D. BERNHARDT 9/24/2020 38829 PROFESSIONAL ENGINEER

Eric D. Bernhardt, P.E.
Geotechnical Department Manager

REPORT TOPICS

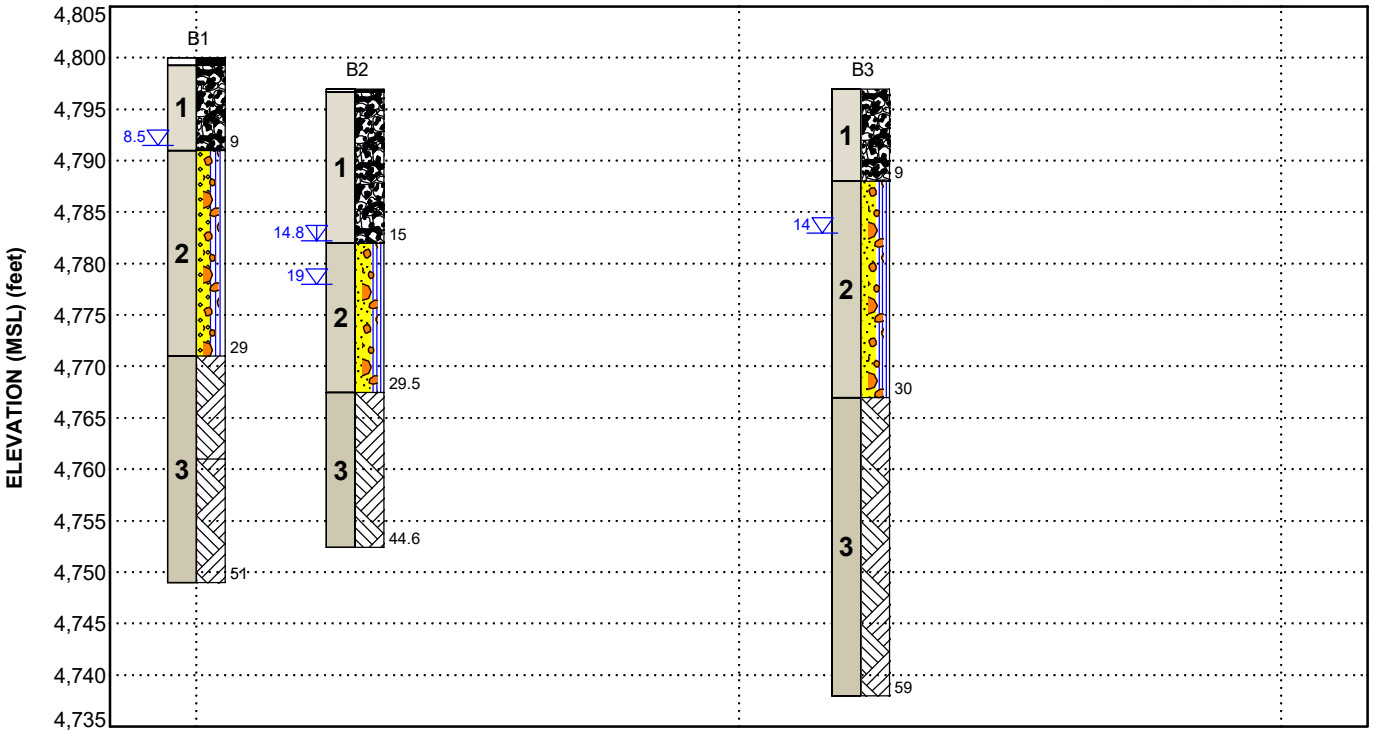
Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

GEOMODEL

Weld County Bridge 54-13A - Johnstown ■ Johnstown, CO
Terracon Project No. 21195074A



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**FILL**	Fill consisting of clayey sand to poorly graded sand. Loose to medium dense.
2	**Poorly to well graded sand**	Poorly to well graded sand with varying amounts of silt and gravel, brown to gray, medium dense to very dense.
3	**Bedrock**	Sandstone to siltstone bedrock, gray to dark gray, hard to very hard.

LEGEND

- Asphalt
- Fill
- Well-graded Sand with Silt and Gravel
- Bedrock
- Poorly-graded Sand with Silt and Gravel

- First Water Observation
- Second Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

BORING LOG NO. B1

PROJECT: Weld County Bridge 54-13A - Johnstown

CLIENT: J-U-B ENGINEERS, Inc.
Fort Collins, CO

SITE: 6724 County Road 54
Johnstown, CO

LOCATION See Exploration Plan

Latitude: 40.3779° Longitude: -104.933°

Surface Elev.: 4800 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SAMPLE NOTES	SWELL / LOAD (%/psf)	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		0.7	4799.5											
		ASPHALT, about 8 inches												
1		**FILL - CLAYEY SAND to POORLY GRADED SAND**, with clay, fine to medium grained, tan and olive, loose to medium dense trace gravel, dark brown		5	▽		10-14				1			
		9.0	4791				2-3-4 N=7				24			
2		**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, brown to orange brown, dense to very dense, flowing sands		10			8-5	no recovery			8			
		with clay, gray and light brown		15			30-46-50 N=96				10		NP	10
				20			27 - 50/5"				11			
		gray and orange brown, trace FeOx		25			21-29-37 N=66				8			
		29.0	4771											
3		**SILTSTONE (SM)**, light gray to dark gray, very hard, trace FeOx		30			50/6"				9		NP	38
				35			30 - 50/5"				15	117		
		39.0	4761											
		SANDSTONE (SC), dark gray, very hard, trace FeOx		40							16		35-16-19	18
				45			RQD = 92%			1653				
				50			RQD = 82%			1579				
		51.0	4749											
		Boring Terminated at 51 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6-inch continuous-flight, hollow-stem auger

Abandonment Method:
Boring backfilled with cement grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations obtained from publicly available topographic map

Notes:

WATER LEVEL OBSERVATIONS

▽ *8.5 feet while drilling*

Terracon
1289 1st Ave
Greeley, CO

Boring Started: 12-23-2019 | Boring Completed: 12-23-2019

Drill Rig: CME 75 | Driller: Mike B.

Project No.: 21195074A

BORING LOG NO. B2

PROJECT: Weld County Bridge 54-13A - Johnstown

CLIENT: J-U-B ENGINEERS, Inc.
Fort Collins, CO

SITE: 6724 County Road 54
Johnstown, CO

LOCATION See Exploration Plan

Latitude: 40.378° Longitude: -104.9327°

Surface Elev.: 4797 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DESCRIPTION
1		0.3	4796.5	**ASPHALT**, about 4 inches
				FILL - CLAYEY SAND to POORLY GRADED SAND (SC), trace gravel, fine to medium grained, brown and gray, stiff
		15.0	4782	
2				**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, trace clay, brown, medium dense to dense
				light gray, flowing sands
		29.5	4767.5	
3				**SANDSTONE**, dark gray, hard to very hard, trace FeOx
		44.6	4752.5	
				Auger Refusal at 44.6 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SAMPLE NOTES	SWELL / LOAD (%/psf)	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
			3-9		0/150		19	110		
5			6-6-7 N=13				15		86-15-71	49
10			10-12				8	106		
15	▽		10-10-8 N=18				7			
	▽									
20			10-13				19	116		
25			25-33-40 N=73				11		NP	7
30			17-36			1	15	121		
35			38 - 50/1"				17			
			RQD = 74%			5780				
40			RQD = 93%			432				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6-inch continuous-flight, hollow-stem auger

Abandonment Method:
Boring backfilled with cement grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations obtained from publicly available topographic map

Notes:

WATER LEVEL OBSERVATIONS

▽ *19 feet while drilling*

▽ *14.8 feet after drilling*

Terracon
1289 1st Ave
Greeley, CO

Boring Started: 12-09-2019 | Boring Completed: 12-09-2019

Drill Rig: CME 75 | Driller: Jeff C.

Project No.: 21195074A

BORING LOG NO. B3

PROJECT: Weld County Bridge 54-13A - Johnstown

CLIENT: J-U-B ENGINEERS, Inc.
Fort Collins, CO

SITE: 6724 County Road 54
Johnstown, CO

LOCATION See Exploration Plan

Latitude: 40.3779° Longitude: -104.9317°

Surface Elev.: 4797 (Ft.)

MODEL LAYER	DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SAMPLE NOTES	SWELL / LOAD (%/psf)	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1	0.0	4797	**FILL - CLAYEY SAND to POORLY GRADED SAND**, trace clay, dark brown, loose to medium dense											
							14-15	no recovery			4			
				5			4-8	no recovery			9			
2	9.0	4788	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, trace silt, brown to orange brown, medium dense											
				10			8-15-16 N=31				6		NP	6
					▽									
				15			4-6-9 N=15				17			
				20			9-12-14 N=26				9			
				25			8-37				17	106		
3	30.0	4767	**SANDSTONE (SC)**, dark gray, Trace FeOx	30			13-28-22 N=50				13			
				35			42-50/2"				15	119	32-15-17	38
				40			50/5"				15			
				45			36-50/4"				16			
				50			RQD = 61%			1874				
				55			RQD = 93%			2578				
	59.0	4738												
			Boring Terminated at 59 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6-inch continuous-flight, hollow-stem auger

Abandonment Method:
Boring backfilled with cement grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations obtained from publicly available topographic map

Notes:

WATER LEVEL OBSERVATIONS

▽ *14 feet while drilling*

Terracon
1289 1st Ave
Greeley, CO

Boring Started: 11-25-2019 | Boring Completed: 11-25-2019

Drill Rig: CME 55 | Driller: Jeff C.

Project No.: 21195074A