Comanche Station, Pueblo County, Colorado

Monitoring Well Installation Report

Comanche Station

Xcel Energy

August 1, 2016

Table of Contents

List of Tables

List of Figures

List of Appendices

Table of Abbreviations and Acronyms

Abbreviation	Definition
AMSL	above mean sea level
bgs	below ground surface
BTOC	below top of casing
CCR	Coal Combustion Residuals
cm/sec	centimeter per second
HP Geotech	Hepworth-Pawlak Geotechnical, Inc.
µS/cm	microsiemens per centimeter
NTU	nephelometric turbidity unit
PSCo	Public Service Company of Colorado
TOC	top of casing
USCS	Unified Soil Classification System

1.0 Introduction

The purpose of this Monitoring Well Installation Report is to document details pertaining to the drilling, construction, and development of three groundwater monitoring wells installed at the Xcel Energy Comanche Generating Station (Comanche Station) in Pueblo, Colorado (**Figure 1**). The groundwater monitoring system is intended to support compliance with the U.S. Environmental Protection Agency's final Coal Combustion Residuals (CCR) Rule (40 CFR Parts 257 and 261). Comanche Station has two units[1], an impoundment and a landfill, subject to the CCR Rule. The drilling and well installation was performed in accordance with the State of Colorado Water Well Construction Rules (2 Code of Colorado Regulations 402-2).

HDR was contracted to locate, permit, and oversee the installation of the three groundwater monitoring wells at Comanche Station. HDR retained Hepworth-Pawlak Geotechnical, Inc. (HP Geotech) to provide on-site drilling services, while HDR provided field monitoring of the drilling, well installation, and development. All on-site personnel completed the site-specific safety training. Additionally, daily safety briefs were conducted by the on-site project team prior to commencing work. The training and safety briefs were documented in accordance with the *PSCo CCR Rule Compliance Health & Safety Plan.*

2.0 Background Information

Prior hydrogeologic and geotechnical investigations conducted at Comanche Station are identified and summarized in the Comanche Station Monitoring Well Installation Plan (HDR, 2015a). Comanche Station is underlain by unconsolidated colluvium consisting of stiff clays and silts, with interbedded sand and gravel west and northwest of the CCR landfill. Typical colluvium thickness is less than 20 feet but ranges between 5 and 75 feet (Woodward-Clyde, 1987; URS, 2005). The Pierre Shale is the uppermost bedrock at the Comanche Station and has a measured hydraulic conductivity of 3×10^{-10} to 3×10^{-7} cm/sec. The uppermost aquifer beneath the Site is the Dakota Sandstone at a depth of over 1,400 feet (GeoTrans, Inc., 2009). Approximately 1,400 feet of low-permeability shale deposits separate the surface impoundments from this aquifer. Tetra Tech (2015) estimated that the groundwater velocity through the Pierre Shale is 0.1 feet per year. Given that the Pierre Shale is estimated to be over 230 feet thick beneath the Site, it will take 2,300 years just to migrate through the Pierre Shale. It will take an additional 12,200 years to migrate through the underlying shale deposits before leachate from the ADF would reach the Dakota Sandstone Aquifer.

The shallow unconsolidated colluvium deposits beneath the site have been predominantly unsaturated, with some isolated areas of perched water[2] (GeoTrans, Inc., 2009). Areas of perched water are likely controlled by the bedrock topography where water becomes trapped by topographic lows in the shale bedrock surface (GeoTrans, Inc., 2009). The conceptual model for surface water infiltration is that it migrates vertically into low-permeability bedrock and/or is trapped in topographic lows in the bedrock surface prior to migrating vertically (GeoTrans, Inc., 2009). A potential south-

[1] Comanche Station includes three coal-fired generation units. All CCR generated at Comanche Station is stored in two active CCR units subject to compliance with the CCR Rule: a CCR impoundment and a CCR landfill (Figure 2). The CCR impoundment is located southeast of the coal storage area, and the CCR landfill is west of the raw water storage pond.
[2] Only two of the seven previously installed wells at the site, MW-3 and W-3, have contained measurable water, and most borings previously drilled at the site, including boreholes that penetrate the Pierre Shale, have been dry.

southeasterly flow gradient is assumed based on the ground surface topography, which slopes to the south-southeast towards the St. Charles River. The alluvial aquifers associated with the Arkansas River (north), the St. Charles River (south), and Salt Creek (west) do not extend beneath the site (Xcel Energy, 2005).

Given the lack of a laterally extensive shallow groundwater system in the colluvium deposits beneath the site and the depth of the uppermost aquifer (Dakota Sandstone), a wet/dry monitoring well system has been selected to detect changes in perched groundwater conditions and/or potential contaminants from the ash landfill and CCR impoundment.

The three new monitoring wells installed at Comanche Station (W-4, W-5, W-6) were sited based on monitoring requirements in the CCR Rule, facility design, and existing hydrogeologic data for the vicinity, as described in the Groundwater Monitoring System Certification (HDR, 2015b). Well locations are shown on **Figure 2**.

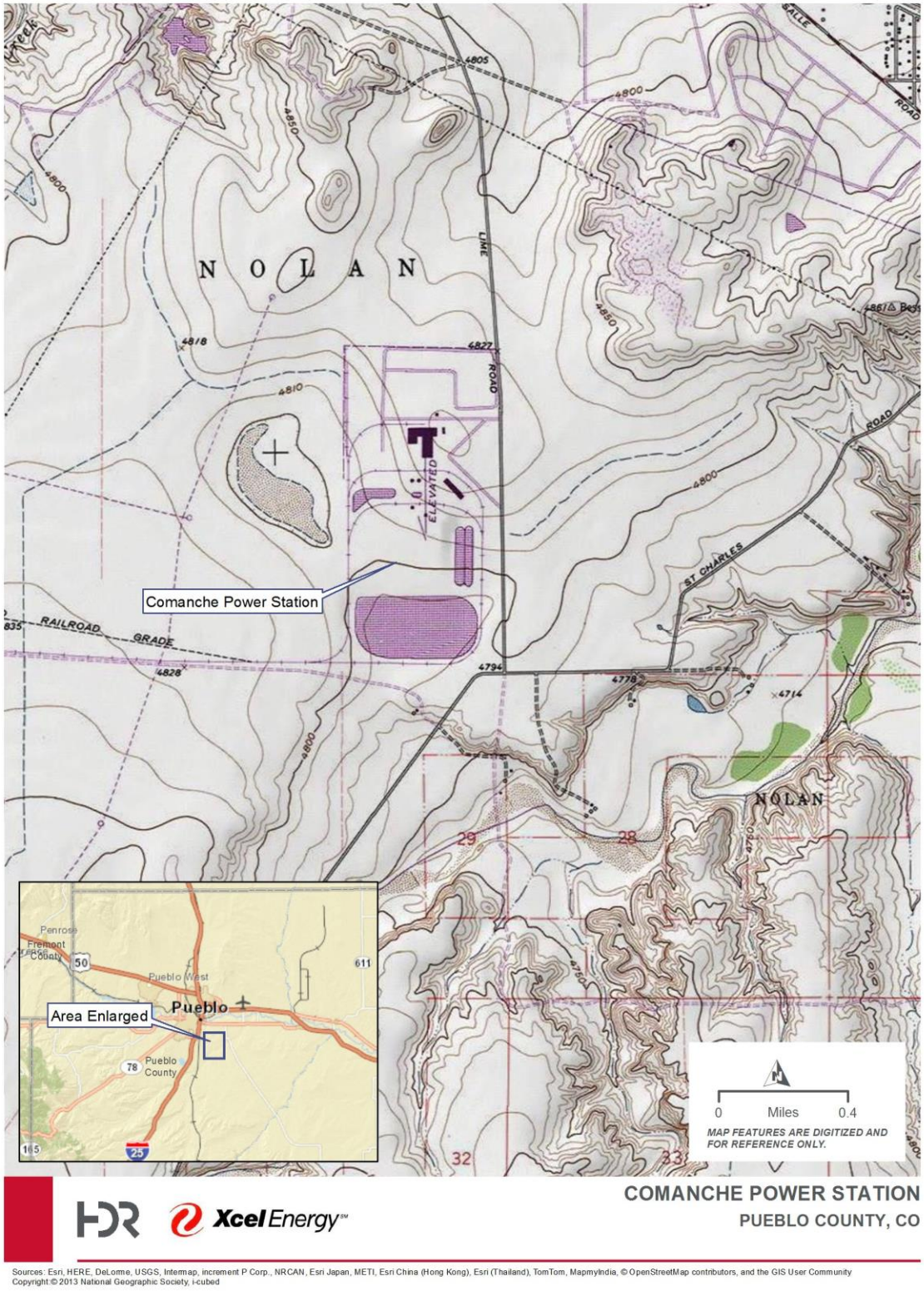


Figure 1. Vicinity Map for Comanche Station

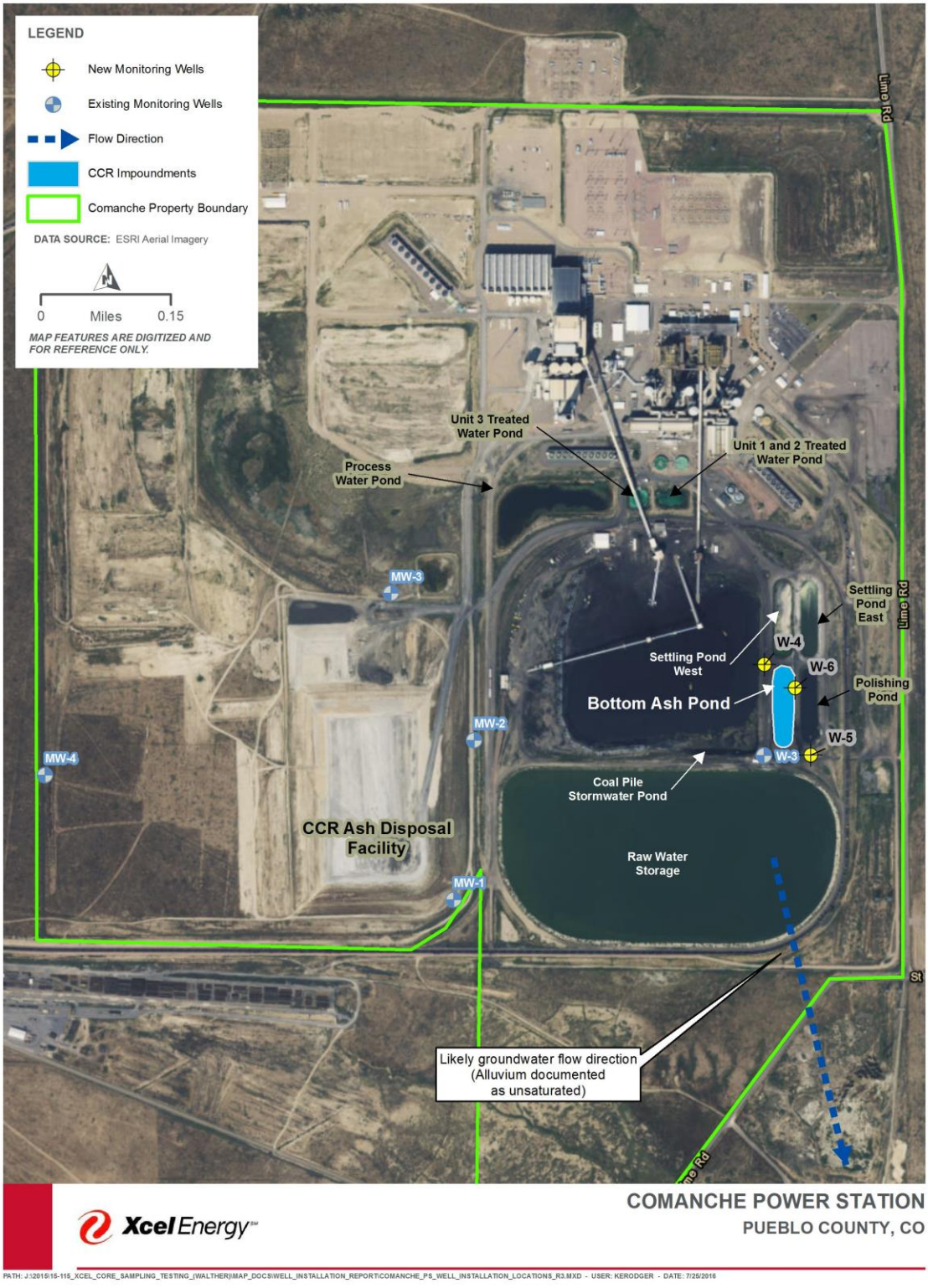


Figure 2. Well Location Map, Comanche Station

3.0 Field and Laboratory Methods

3.1 Borehole Drilling

The boreholes for each well were drilled by HP Geotech using a hollow stem auger drilling method from November 9 through 11, 2015. Utility locations were identified prior to beginning drilling operations. However, to verify the absence of any buried utilities, the driller advanced soil borings from the ground surface by using a pot-holing technique to a minimum depth of 8 feet prior to drilling. The borehole was then advanced using the hollow stem auger drilling method with a CME-55 drill rig. The nominal borehole diameter was 8 inches to accommodate construction of 2-inch diameter wells.

Screen depth was targeted for the top of a perched water-bearing zone, if encountered, or 5 feet above the top of weathered shale/claystone bedrock in order to intersect the colluvium-bedrock contact. Boreholes were drilled to a minimum of 15 feet beneath the top of the weathered shale/claystone at the site. This resulted in total borehole depths that ranged from 25 feet to 30 feet, as further described in **Section 4.3**.

An HDR geologist was present during drilling operations to collect samples and log the subsurface material, in addition to overseeing site safety and proper well construction. Soil samples from boreholes were collected in plastic bags and logged every 5 feet by the field geologist during drilling to document lithologic soil characteristics. The geologist visually classified soil type, consistency/relative density, color, and water content in accordance with the Unified Soil Classification System (USCS) as well as grain size, mineralogy, sorting, rounding, hardness, and matrix/clast support, among other textural properties. Samples were placed in sample bags labeled with the borehole identification and depth interval. One undisturbed soil sample from each well was collected within the well screen depth interval and submitted to a lab for hydraulic properties analysis, as described in **Section 3.2**. Boring logs for each borehole are provided in **Appendix A**.

Soil cuttings, fluids, and potholing slurry generated during drilling were transported to and disposed of at the existing onsite ash landfill. Drilling equipment was decontaminated with potable water before moving to the next borehole.

3.2 Soil Samples - Geotechnical Analysis

Soils were logged from the cutting returns during drilling and classified based on the USCS. During drilling, one undisturbed soil sample was obtained from each borehole at a depth coinciding with the well screen depth. An 18-inch long California Modified Style Split-Spoon Sampler was used to collect the undisturbed core of sediment. The undisturbed soil samples (one from each well) were submitted to HP Geotech for analysis of the following parameters:

- Grain-size: Sieve and Hydrometer (ASTM D421/422)
- Total Porosity (SW9100)
- Bulk Density (ASTM D2937)
- Moisture Content (ASTM D2216)
- Specific Gravity (ASTM D854)

Analysis was completed in accordance with the method for grain-size analysis using sieve and hydrometer described in ASTM D421/422 (ASTM D421-85, 1998 and ASTM D422-63, 2007). Chain of custody documentation and laboratory results are provided in **Appendix B**.

3.3 Well Construction

Once the target drilling depth was reached at each location, the 2-inch diameter, Schedule 40 PVC casing and well screen (0.010-inch slots) were assembled and lowered into the borehole. Approximately 10 feet of screen was installed in each new well. The top of the well screen was placed at the top of a perched water-bearing zone, where encountered. Where perched water was not encountered, the well screen was immediately above the top of weathered shale/claystone bedrock to intersect the colluvium-bedrock contact. To capture infiltrating perched water[3], a 10-foot long sump consisting of blank casing was placed beneath the screen, as requested by CDPHE in a meeting with Xcel Energy on April 24, 2014 (Tetra Tech, 2014).

After PVC casing and screen placement in the borehole, sand filter pack and the bentonite seal was placed via gravity feed from the surface into the annular space. The sump was sealed in with bentonite to 2-feet below the bottom of the screen. The filter pack consisted of 10-20 (sieve size) washed silica sand emplaced from approximately 2 feet below the bottom of the screen to approximately 0.5 to 2 feet above the well screen. The annular seal of medium bentonite chips was placed above the top of the filter pack and hydrated in lifts throughout placement, while the remaining drill casing was removed from the borehole using the hydraulic jacks.

An annular surface seal consisting of neat cement was installed from the top of the bentonite to the surface. All wells were finished with a 2-foot-by-2-foot concrete pad using Quickrete fast setting concrete, extending to a depth of approximately 0.5 to 2 feet below grade (to the top of the bentonite grout). Each well included between 3 and 4 feet of PVC stick-up. Two bollards were placed on either side of monitor wells W-4 and W-5, parallel to the road; three bollards were installed around monitor well W-6. Each well was secured with a protective steel casing and lock. Well construction is further described in **Section 4.3.**

3.4 Well Development

Wells are typically developed over several days to improve hydraulic connectivity in the area immediately surrounding the well and remove any fluids introduced during drilling. Well development involves removing as much of the introduced drilling fluids, cuttings, and particulates from within and adjacent to the well as possible. Development did not begin until at least 12 hours after the wells had been grouted to ensure grout had sufficiently set.

Wells were to be developed by surge blocking and pumping. This method involves moving a surge block up and down the well screen and casing, which alternately forces water in and out of the screen, loosens sediment, and draws fine-grained materials into the well, then removing the purge water and fine sediment from the well using a pump. Well W-5 was found to be dry; therefore, well development was not attempted. Well development at W-4 and W-6 is further discussed in **Section 4.4**.

[3] Previously constructed wells W-1, W-2, and W-3 incorporated a 2-foot sump to capture infiltrating perched water. Due to the lack of a laterally extensive shallow groundwater system in the colluvium deposits beneath the site and the depth of the uppermost aquifer (Dakota Sandstone), a wet/dry monitoring well system is an effective way to detect changes in perched groundwater conditions and/or potential contaminants from the ash landfill and CCR impoundment.

3.5 Well Survey

Surveying of the monitoring wells was performed by professional surveyor Edward-James Surveying, Inc. after well completion. The surveyor recorded elevations of the top of PVC casing (point at notch on the north side of the casing top) and ground surface using a level loop. The northing and easting coordinates of the wells were initially surveyed using a local coordinate system and converted to NAD 1983 UTM Zone 13 South.

3.6 Groundwater Level Measurement and Aquifer (Slug) Testing

Slug tests are typically performed on new monitoring wells to obtain estimates of hydraulic conductivity for shallow unconfined aquifers. Slug testing consists of injecting and removing a volume of water and recording the change in groundwater level over time, then calculating aquifer parameters based on the groundwater level response. Slug testing was not performed at the three new Comanche Station wells because the well screens were not installed at the bottom of the well. Each well has a sump and the static water level is towards the bottom of the screen at approximately the screen/sump boundary. Therefore, dropping a slug into the water in the sump would not result in a response by the shallow groundwater geologic formation outside the well.

3.7 Decontamination of Field Equipment

Field instrumentation (such as interface probes or water quality meters) was decontaminated between sample locations by rinsing with an Alconox/distilled water solution followed by a potable water rinse and a final rinse with deionized water.

4.0 Field and Laboratory Results

4.1 Borehole Drilling

Boring logs for each borehole are provided in **Appendix A**. Soil cuttings from the borehole samples consisted primarily of silt and clay, with some sand. Iron staining was noted in samples collected from all three borings. Shale was encountered at approximately 14 feet bgs in all three borings; silt with shale deposits was logged at W-6 while clay with shale was recorded at wells W-4 and W-5 at this depth. This was presumed to be the top of the Pierre Shale formation. Silt was encountered below the shale layers at all three borings. Soil cuttings ranged from dry to moist. A perched, water bearing zone was encountered at wells W-4 and W-6; W-5 was dry. Approximately 24 hours after drilling, depth to perched water was measured at 14.11 feet bgs at W-4 and 11.10 feet bgs at W-6.

4.2 Soil Samples – Geotechnical Analysis

The undisturbed soil samples collected from the well screen depth interval of each borehole analyzed for grain size and porosity by HP Geotech are summarized in **Table 1**. The soils laboratory results are presented in **Appendix B**.

Table 1. Summary of Geotechnical Testing Results at Comanche Station, 2015						
Well I.D.	Sample Depth (feet bgs)	Gradation			Porosity (%)	Moisture Content (%)
		Gravel (%)	Sand (%)	Silt and Clay (%)		
W-4	9	0	14	86	36.2	17.2
W-5	9	0	7	93	39.2	18.9
W-6	9	0	8	92	35.4	17.4

Note:
BGS = below ground surface

Laboratory results show the wells are screened in silt and clay with some sand, with porosities between 35 and 40 percent, which is consistent with the silt and clay material noted in the drilling logs. A general range of hydraulic conductivity for such sediments is 10^{-9} to 10^{-4} centimeter per second (cm/s) (Fetter, 1994).

4.3 Well Construction

A diagram for each well that documents well construction is provided in **Appendix C**. Approximately 10 feet of screen was installed in each well. The screen was placed above the Pierre Shale formation from approximately 3.4 to 13.4 feet bgs at W-4, 3.5 to 13.5 feet bgs at W-5, and 5-15 feet bgs at W-6. The 10-foot blank casing sumps were placed below each well screen. Total well depths (including the sumps) ranged from 23.4 to 25.5 feet bgs. Well construction details for all four wells are summarized in **Table 2**. State-issued well construction permits are included in **Appendix D**.

Table 2. Well Construction Details for Groundwater Monitoring Wells W-4, W-5, W-6 at Comanche Station, 2015

Well ID	Northing (State Plane, NAD 1983 UTM Zone 13 S meters)	Easting (State Plane, NAD 1983 UTM Zone 13 S meters)	Elevation TOC (feet AMSL)	Well Total Depth (feet bgs)	Depth of Screen Interval (feet bgs)	Well Stickup (feet)	Casing Type	Depth to Water (feet BTOC)	Static Water Level (feet AMSL)
W-4	537310.48	4228491.35	4812.47	23.4	3.4-13.4	3.625	2-inch PVC	22.8	4789.67
W-5	537396.38	4228323.54	4807.46	23.5	3.5-13.5	3.829	2-inch PVC	12.33	4795.13
W-6	537367.35	4228447.92	4811.89	24.54	5-15	3.900	2-inch PVC	15.38	4796.51

Notes:
TOC = top of casing
BTOC = below top of casing
BGS = below ground surface

4.4 Well Development

On November 11, 2015, the depth to water was measured in each well in preparation to begin well development. Well W-5 was found to be dry; therefore, well development was not attempted in this monitor well.

Well development was not attempted at well W-4 due to the lack of water in the screened interval. Well development was attempted at well W-6 but was ultimately unsuccessful due to extremely slow recharge in the well, combined with a water level of only 3 feet within the wetted screened interval (above the sump).

4.5 Well Survey

Survey coordinates and elevations are provided in **Table 2**.

4.6 Groundwater Level Measurement and Aquifer (Slug) Testing

Slug testing was not performed at the three new Comanche Station wells because the well screens were not installed at the bottom of the well. Each well has a sump and the static water level is towards the bottom of the screen at approximately the screen/sump boundary. Therefore, dropping a slug into the water in the sump would not result in a response by the shallow groundwater geologic formation outside the well. Static water level measurements are provided in **Table 2.**

5.0 References

Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.

Dagan, G., 1978. A note on packer, slug, and recovery tests in unconfined aquifers, Water Resources Research, vol. 14, no. 5. pp. 929-934.

Freeze, R.A. and J.A. Cherry, 1979. Groundwater, Prentice-Hall, Inc., Englewood Cliffs, NJ.

GeoTrans, Inc. (2009). Surface Water Impoundment Infiltration Characterization Analysis, Public Service Company of Colorado, Comanche Station, Pueblo, Colorado, December 1, 2009.

HDR, 2015a. Monitoring Well Installation Plan for Compliance with the Coal Combustion Residuals (CCR) Rule, Comanche Station. Xcel Energy.

HDR, 2015b. Groundwater Monitoring System Certification for Compliance with the Coal Combustion Residuals (CCR) Rule, Comanche Station. Xcel Energy.

Tetra Tech, 2012. Inventory and Preliminary Classification Report, Waste Impoundments, Comanche Station, Pueblo, Colorado, November 1, 2012.

Tetra Tech, 2014. Sitewide Monitoring Plan, Ash Disposal Facility, Comanche Station, Pueblo, Colorado, August 29, 2014.

Tetra Tech, 2015. Engineering Design and Operations Plan, Ash Disposal Facility, Comanche Station, Pueblo, Colorado, January 13, 2015.

URS, 2005. Geotechnical Investigation, Unit 3, Comanche Station, Pueblo, Colorado, March 2, 2005.

Woodward-Clyde Consultants, 1987. Feasibility Investigation, Two Ash Disposal Areas for Comanche Power Station, Pueblo, Colorado. March 1987.

Xcel Energy, 2005. Comanche Station Coal Ash Disposal Facility Design and Operations Plan. August 24, 2005.

Appendix A

Borehole Logs

Boring Log

Project Name	Project No.	Drilling Company
Xcel CCR	266180	HP Geotech

Boring No.	Location	Drilling Rig Type and Drilling Method
W-4	Comanche Power	CME-55 Hollow Stem Auger (8-inch borehole)

Sample No.	Blow Count	Depth (feet)	Description (USCS)	Remarks
1' below groung surface (bgs)	N/A		7.5YR 3/2; Sandy Silt (ML), some gravel; nonplastic; noncohesive; dry	Potholed to 8' on 11/9/2015
5' bgs	N/A	5	10YR 5/3; Lean Clay (CL); stiff, med-high plasticity; cohesive; moist	
W-4: 9' bgs	6-8 (Cal)	10	10YR 4/3; Lean Clay (CL); stiff, low plasticity; cohesive; some lamination; moist	Fe staining. Cal sample at 9'bgs submitted for geotech analysis
10' bgs	5-7-8 (SS)			
			10YR 4/3; Lean Clay (CL); very stiff, low plasticity; cohesive; laminated; moist	Fe staining
14' bgs	6-7-12 (SS)	15	Alluvium/bedrock contact at 14'bgs	
			Dark gray Gley 1 4/N; Lean Clay (CL) Black Shale, weathered; laminated	Fe staining
19' bgs	11-15-21(SS)	20	As above	Fe staining; hard, very micaceous
24' bgs	10-18-28(SS)	25	Very dark gray Gley 1 3/N; Silt (ML); hard, non-plastic; non-cohesive; laminted; dry to moist	Fe staining; micaceous

Total Depth (feet)	Water Level (feet)		Logged By:	Drilled/Sampled By:
	After Drilling:	Hours After:	Date Started:	Date Completed:
25.5	14.11	24	11/10/2015	11/10/2015

Nick Hanrahan

Brent McDaniel

Boring Log

Project Name	Project No.	Drilling Company
Xcel CCR	266180	HP Geotech

Boring No.	Location	Drilling Rig Type and Drilling Method
W-5	Comanche Power	CME-55 Hollow Stem Auger (8-inch borehole)

Sample No.	Blow Count	Depth (feet)	Description (USCS)	Remarks
				Potholed to 8' on 11/9/2015
2' bgs	N/A		10YR 4/3; Fat Clay (CH) with Sand and some Gravel; high plasticity; cohesive; moist to wet (likely due to potholing)	
		5		
5' bgs	N/A		As above	
W-5: 9' bgs	5-7 (Cal)	10	Brown 10YR 4/3; Lean Clay (CL), some gravel; stiff; medium plasticity; cohesive; dry to moist	Cal sample at 9' bgs submitted for geotech analysis
10' bgs	5-7-8 (SS)			
14' bgs	14-21 (Cal)	15	As above. Hit a layer of shale bedrock with quartz vein, became laminated to thinly bedded; hard	Fe staining; quartz vein visible
15' bgs	10-13-21(SS)			
19' bgs	10-12-22(SS)	20	As above; laminated	Fe staining; gravel-size mic grains
24' bgs	9-11-13 (SS)	25	Brown 7.5YR 4/4; fine-medium Sandy Silt (ML); some coarse; very stiff; non-plastic; non-cohesive; moist	

Total Depth (feet)	Water Level (feet)		Logged By:	Drilled/Sampled By:
	After Drilling:	Hours After:	Nick Hanrahan	Brent McDaniel
25	Dry	24	Date Started: 11/9/2015	Date Completed: 11/9/2015

Boring Log

Project Name	Project No.	Drilling Company
Xcel CCR	266180	HP Geotech

Boring No.	Location	Drilling Rig Type and Drilling Method
W-6	Comanche Power	CME-55 Hollow Stem Auger (8-inch borehole diameter)

Sample No.	Blow Count	Depth (feet)	Description (USCS)	Remarks
1' below ground surface (bgs)	N/A		10YR 3/2; Silty Sand (SM) with Gravel; nonplastic; non-cohesive (Fill); moist	Potholed to 8' on 11/9/2015
5' bgs	N/A	5	10YR 3/2; Silt w/ Sand (ML); nonplastic, noncohesive; wet	
W-6: 9' bgs 10.5' bgs	8-11 (Cal) 5-8-10 (SS)	10	Olive brown 2.5Y 4/3; Lean Clay (CL); very stiff; medium to high plasticity; cohesive; moist to wet	Fe staining. Cal sample at 9' bgs submitted for geotech analysis
14' bgs	4-7-8 (SS)	15	Top 14": As above; stiff Bottom 6": Gray Gley 1 5/N; Silt (ML) with Shale; stiff; nonplastic; cohesive; moist	Fe staining. Alluvium; top of refusal
19' bgs	6-7-8 (SS)	20	Olive brown 2.5Y 4/3; Lean Clay (CL); stiff; medium plasticity, cohesive; moist	Fe staining; micaceous
24' bgs	15-20 (Cal)	25	Dark grayish brown 10YR 4/2; Silt (ML); nonplastic; slightly cohesive, laminated (shale); moist	Very micaceous
29' bgs	50/5" (SS)	30	As above; noncohesive	Very micaceous

Total Depth (feet)	Water Level (feet)		Logged By:	Drilled/Sampled By:
	After Drilling:	Hours After:	Nick Hanrahan	Brent McDaniel
30	11.10	24	Date Started: 11/10/2015	Date Completed: 11/10/2015

Appendix B

Geotechnical Soil Testing Results and Chain of Custody Records

Hepworth-Pawlak Geotechnical, Inc.
10302 South Progress Way
Parker, Colorado 80134
Phone: 303-841-7119
Fax: 303-841-7556
www.hpgeotech.com

December 14, 2015

Anna Lundin
HDR
1670 Broadway, Suite 3400
Denver, CO 80202

215333B
Anna.Lundin@HDRinc.com

Subject: Laboratory Tests Results – Xcel Coal Combustion Residuals Rule Compliance Project, Comanche Power Station.

Dear Ms. Lundin:

This letter presents the results of laboratory tests performed on samples submitted for the subject project. The test results are presented on the attached Figures 1-3 and Table 1.

If there are any questions, please feel free to contact us.

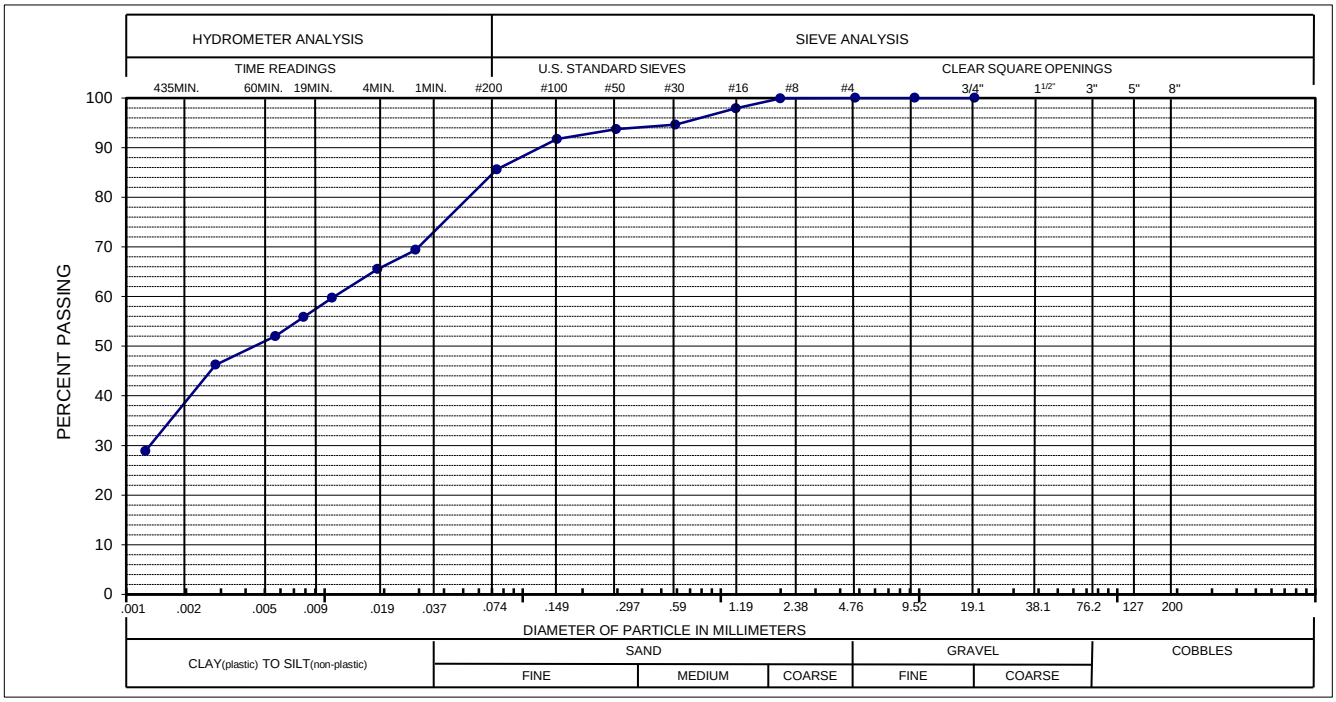
Sincerely,

HEPWORTH-PAWLAK GEOTECHNICAL, Inc.

Cuong Vu, Ph.D., P.E.

Reviewed by: Arben Kalaveshi, P.E.

215333B (Comanche) xmittal.doc



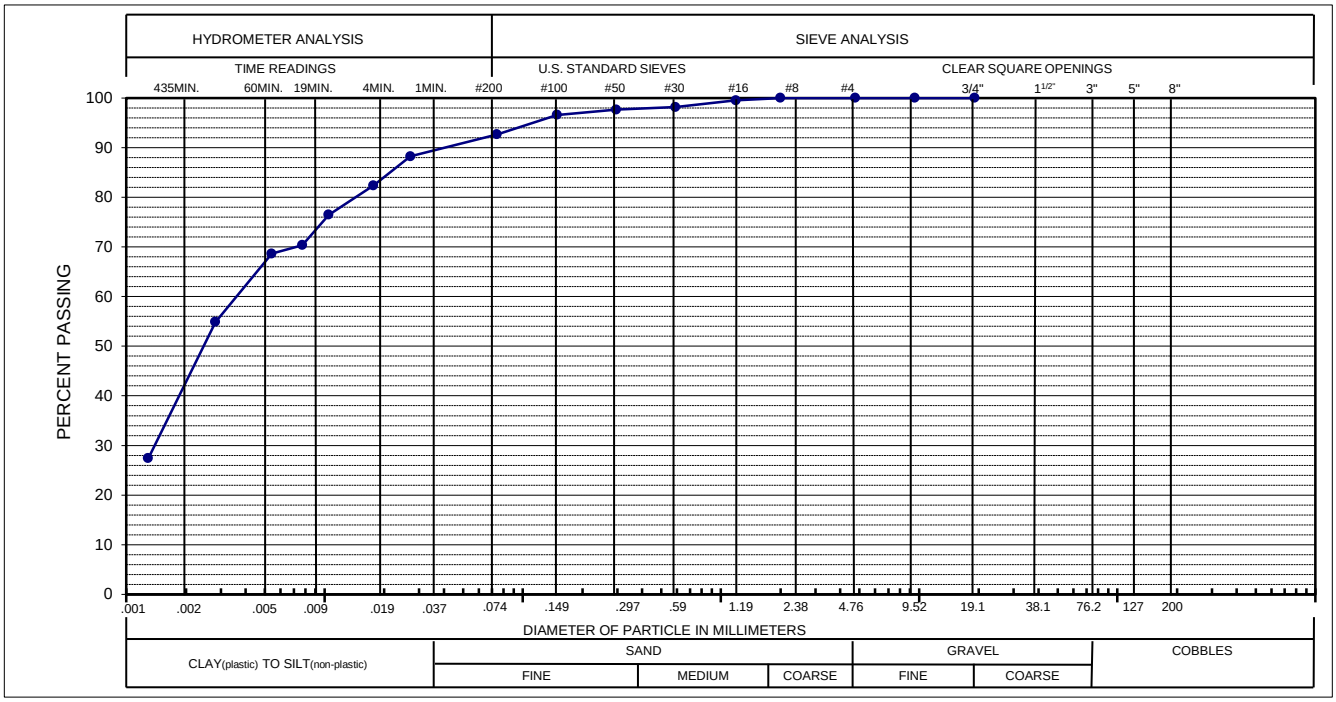
GRAVEL: 0% SAND: 14% SILT / CLAY: 86%

BORING : MW4 Specific Gravity: 2.87

DEPTH : 9 feet Porosity : 36.2%

Sieve Size / Particle Diameter	Percent Passing
(1")	100
(3/4")	100
(1/2")	100
(3/8")	100
(#4)	100
(#10)	100
(#16)	98
(#30)	95
(#50)	94
(#100)	92
(#200)	86
0.0288	69
0.0185	66
0.0109	60
0.0078	56
0.0057	52
0.0028	46
0.0012	29

215333B	HEPWORTH-PAWLAK GEOTECHNICAL, INC.	HDR COMANCHE HYDROMETER AND SIEVE ANALYSIS	FIG. 1



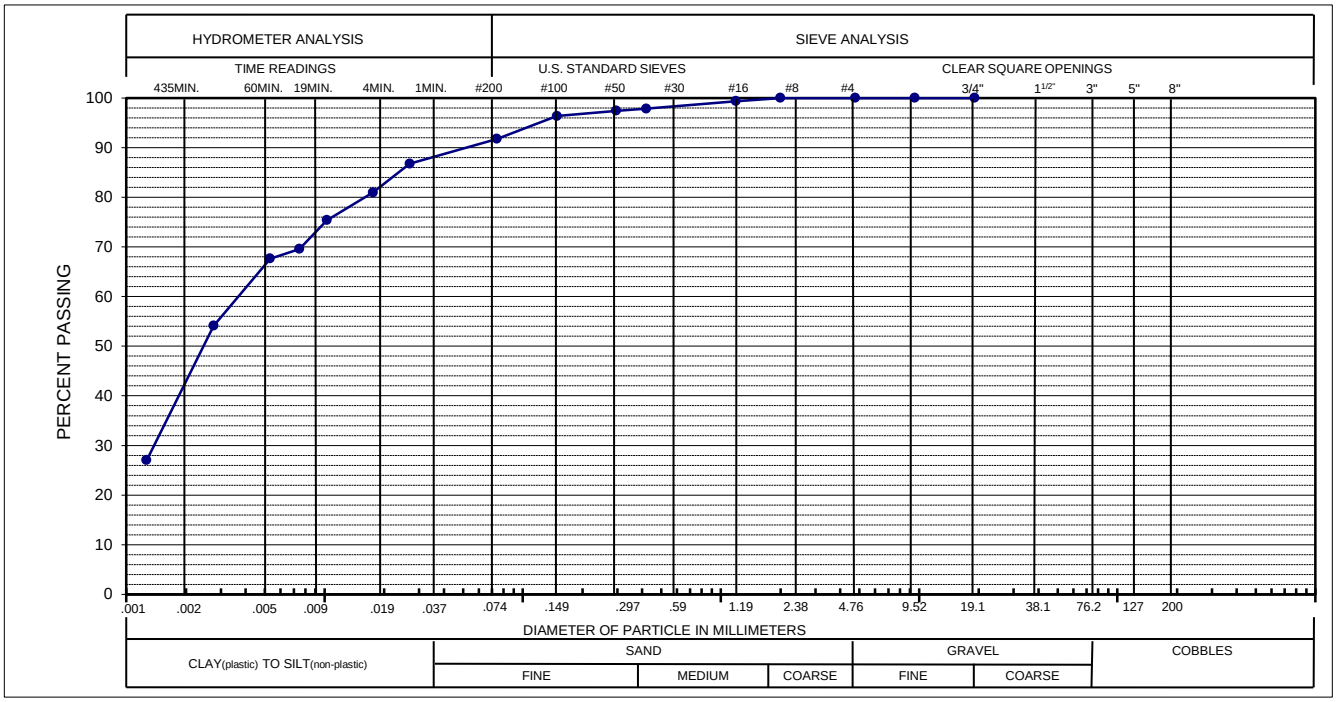
GRAVEL: 0% SAND: 7% SILT / CLAY: 93%

BORING : MW5 Specific Gravity: 2.78

DEPTH : 9 feet Porosity : 39.2%

Sieve Size / Particle Diameter	Percent Passing
(1")	100
(3/4")	100
(1/2")	100
(3/8")	100
(#4)	100
(#10)	100
(#16)	100
(#30)	98
(#50)	98
(#100)	97
(#200)	93
0.027	88
0.018	82
0.010	76
0.008	70
0.005	69
0.003	55
0.001	27

215333B	HEPWORTH-PAWLAK GEOTECHNICAL, INC.	HDR COMANCHE HYDROMETER AND SIEVE ANALYSIS	FIG. 2



GRAVEL: 0% SAND: 8% SILT / CLAY: 92%

BORING : MW6 Specific Gravity: 2.85

DEPTH : 9 feet Porosity : 35.4%

Sieve Size / Particle Diameter	Percent Passing
(1")	100
(3/4")	100
(1/2")	100
(3/8")	100
(#4)	100
(#10)	100
(#16)	99
(#30)	98
(#50)	97
(#100)	96
(#200)	92
0.027	87
0.018	81
0.010	75
0.007	70
0.005	68
0.003	54
0.001	27

215333B	HEPWORTH-PAWLAK GEOTECHNICAL, INC.	HDR COMANCHE HYDROMETER AND SIEVE ANALYSIS	FIG. 3

HEPWORTH-PAWLAK GEOTECHNICAL, INC.

JOB NO. 215333B

PROJECT: COMANCHE

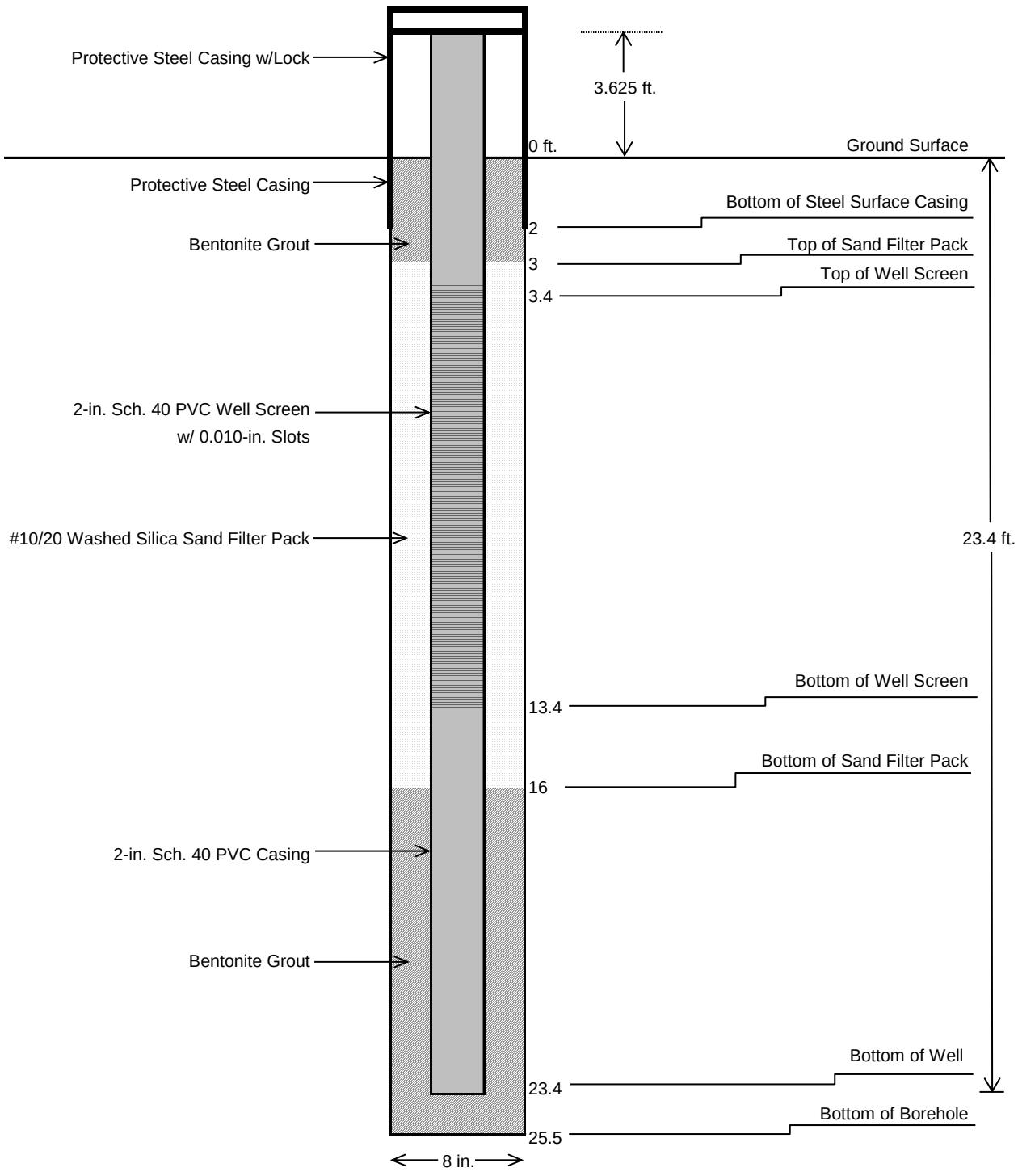
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY UNIT WEIGHT (PCF)	GRADATION			SPECIFIC GRAVITY	POROSITY (%)
BORING	DEPTH (feet)			GRAVEL (%)	SAND (%)	SILT & CLAY (%)		
MW4	9	17.2	114	0	14	86	2.87	36.2
MW5	9	18.9	109	0	7	93	2.78	39.2
MW6	9	17.4	115	0	8	92	2.85	35.4

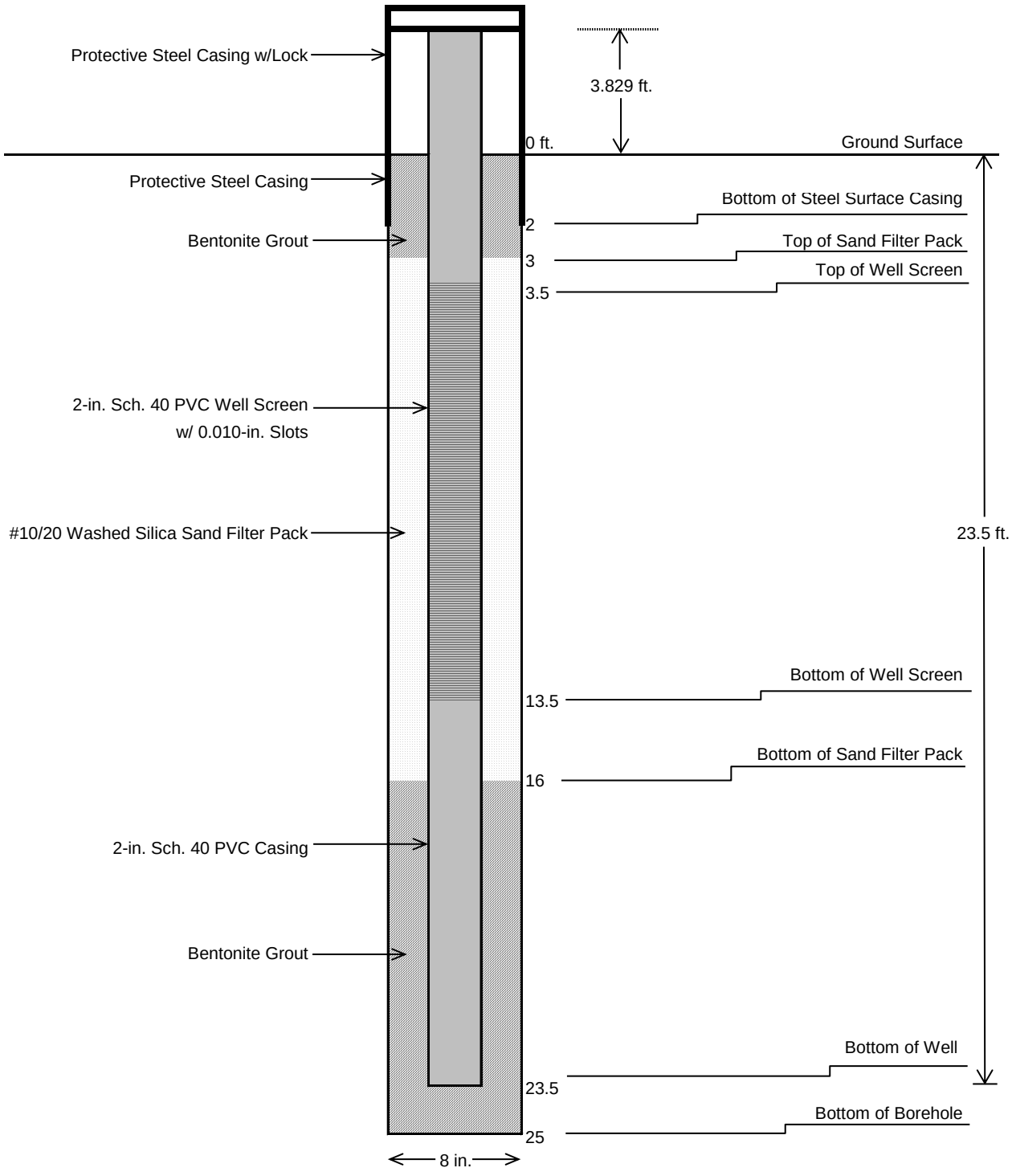
Appendix C

Well Construction Diagrams



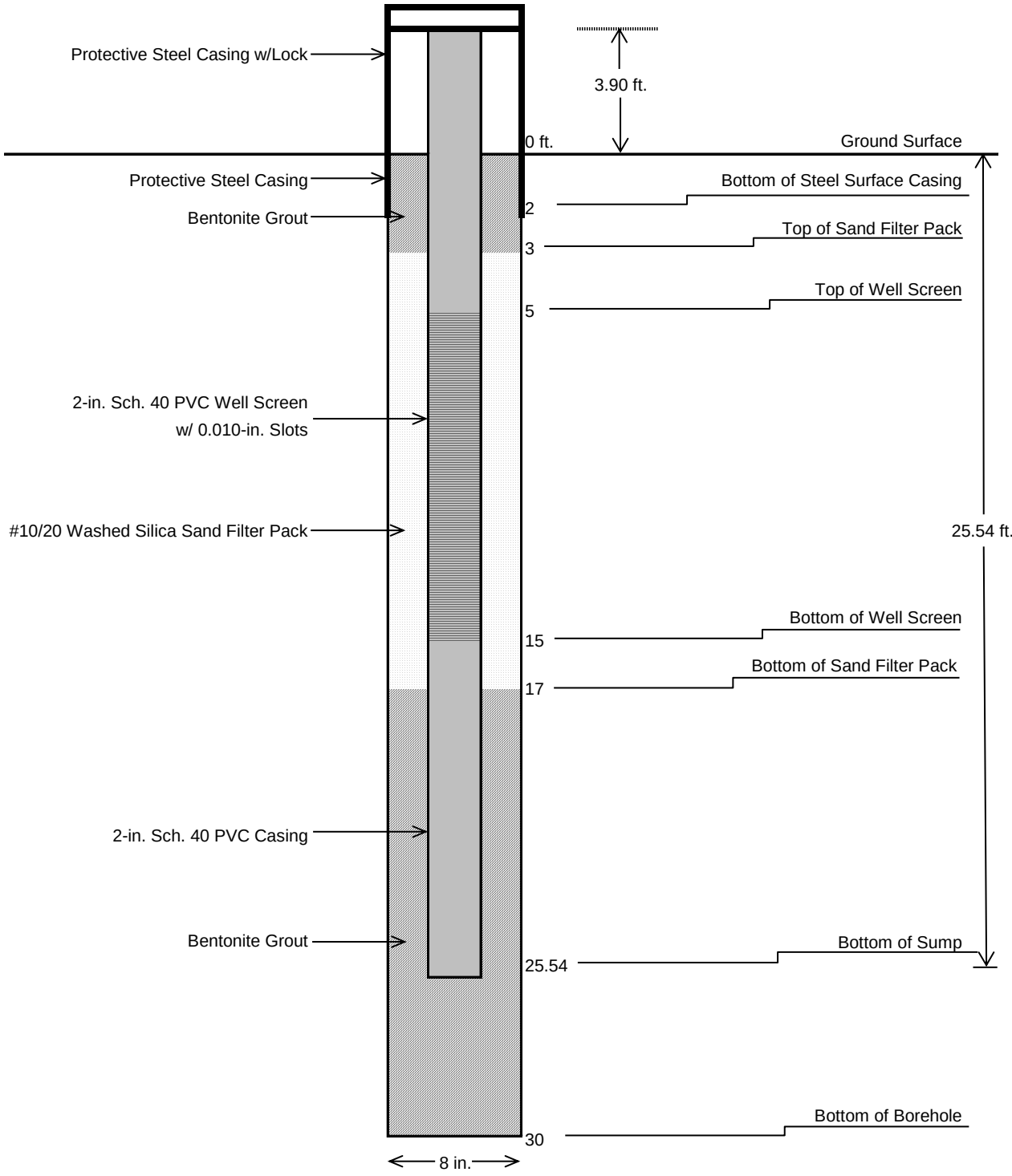
Constructed: **11/10/2015**
Drilled By: **HP Geotech**
PVC Casing EL: **4812.47 ft amsl**
Water EL: **4789.67 ft amsl (December 2015)**

Monitoring Well Construction Diagram
W-4
Comanche Station
Xcel Energy



Constructed: **11/9/2015**
Drilled By: **HP Geotech**
PVC Casing EL: **4807.46 ft amsl**
Water EL: **4795.13 ft amsl (December 2015)**

Monitoring Well Construction Diagram
W-5
Comanche Station
Xcel Energy



Constructed: **11/11/2015**
Drilled By: **HP Geotech**
PVC Casing EL: **4811.89 ft amsl**
Water EL: **4796.51 ft amsl (December 2015)**

Monitoring Well Construction Diagram
W-6
Comanche Station
Xcel Energy

Appendix D

State Well Permits

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 299843 - - -
DIV. 2 WD 15 DES. BASIN MD

APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
2005 LIME RD
PUEBLO, CO 81006-

(303) 571-7340

PERMIT TO USE AN EXISTING WELL

APPROVED WELL LOCATION
PUEBLO COUNTY
NE 1/4 SE 1/4 Section 20
Township 21 S Range 64 W Sixth P.M.

DISTANCES FROM SECTION LINES
1961 Ft. from South Section Line
978 Ft. from East Section Line

UTM COORDINATES (Meters,Zone:13,NAD83)
Easting: 537307 Northing: 4228492

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
4) Approved for the use of an existing well known as W-4.
5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

NOTICE: This permit has been approved subject to the following changes: The distances from section lines, quarter/quarter, quarter, Section, Township, Range and P.M. were determined from UTM coordinate values provided with the permit application. You are hereby notified that you have the right to appeal the issuance of this permit, by filing a written request with this office within sixty (60) days of the date of issuance, pursuant to the State Administrative Procedures Act. (See Section 24-4-104 through 106, C.R.S.)

APPROVED
GAD

Dick Wolfe by Geoff L Davis
State Engineer By

Receipt No. 3672803A DATE ISSUED 01-08-2016 EXPIRATION DATE N/A

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 299844 - - -
DIV. 2 WD 15 DES. BASIN MD

APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
2005 LIME RD
PUEBLO, CO 81006-

(303) 571-7340

APPROVED WELL LOCATION
PUEBLO COUNTY
NE 1/4 SE 1/4 Section 20
Township 21 S Range 64 W Sixth P.M.

DISTANCES FROM SECTION LINES
1795 Ft. from South Section Line
765 Ft. from East Section Line

UTM COORDINATES (Meters,Zone:13,NAD83)
Easting: 537372 Northing: 4228441

PERMIT TO USE AN EXISTING WELL

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
4) Approved for the use of an existing well known as W-5.
5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

NOTICE: This permit has been approved subject to the following changes: The distances from section lines, quarter/quarter, quarter, Section, Township, Range and P.M. were determined from UTM coordinate values provided with the permit application. You are hereby notified that you have the right to appeal the issuance of this permit, by filing a written request with this office within sixty (60) days of the date of issuance, pursuant to the State Administrative Procedures Act. (See Section 24-4-104 through 106, C.R.S.)

APPROVED
GAD

Dick Wolfe by
State Engineer

Geoff L. Davis
By

Receipt No. 3672803B DATE ISSUED 01-08-2016 EXPIRATION DATE N/A

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 299845 - - -
DIV. 2 WD 15 DES. BASIN MD

APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
2005 LIME RD
PUEBLO, CO 81006-

(303) 571-7340

APPROVED WELL LOCATION
PUEBLO COUNTY
NE 1/4 SE 1/4 Section 20
Township 21 S Range 64 W Sixth P.M.

DISTANCES FROM SECTION LINES
1425 Ft. from South Section Line
683 Ft. from East Section Line

UTM COORDINATES (Meters,Zone:13,NAD83)
Easting: 537397 Northing: 4228328

PERMIT TO USE AN EXISTING WELL

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
4) Approved for the use of an existing well known as W-6.
5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

NOTICE: This permit has been approved subject to the following changes: The distances from section lines, quarter/quarter, quarter, Section, Township, Range and P.M. were determined from UTM coordinate values provided with the permit application. You are hereby notified that you have the right to appeal the issuance of this permit, by filing a written request with this office within sixty (60) days of the date of issuance, pursuant to the State Administrative Procedures Act. (See Section 24-4-104 through 106, C.R.S.)

APPROVED
GAD

Dick Wolfe by
State Engineer

Geoff L Davis
By

Receipt No. 3672803C DATE ISSUED 01-08-2016 EXPIRATION DATE N/A