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UNIFIED SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION												
FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3 inches and basing fractions on estimated weights)					GROUP SYMBOLS	TYPICAL NAMES	INFORMATION REQUIRED FOR DESCRIBING SOILS	LABORATORY CLASSIFICATION CRITERIA				
COARSE GRAINED SOILS More than half of material is <u>larger</u> than No. 200 sieve size 12	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size (For visual classifications, the " size may be used as equivalent to the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.		GW	Well graded gravel's, gravel-sand mixtures; little or no fines	Give typical name; indicate approximate percentages of sand and gravel; max. size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information, and symbol in parentheses. For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.	Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: GW, GP, SW, SP GM, GC, SM, SC Bordering cases requiring use of dual symbols. Less than 5% More than 12% 5% to 12% requiring use of dual symbols.	$C_V = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \text{ Dep}}$ Between one and 3			
			Predominantly one size or a range of sizes with some intermediate sizes missing.		GP	Poorly graded gravel's, gravel-sand mixtures; little or no fines			Not meeting all gradation requirements for GW			
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		GM	Silty gravels, poorly graded gravel-sand-silt mixtures			Atterberg limits below "A" line or PI less than 4			Above "A" line with PI between 4 and 7 are <u>borderline</u> cases requiring use of dual symbols.
			Plastic fines (for identification procedures see CL below).		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures			Atterberg limits above "A" line with PI greater than 7			
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size (For visual classifications, the " size may be used as equivalent to the No. 4 sieve size)	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		SW	Well graded sands, gravely sands; little or no fines	EXAMPLE:— <u>Silty Sand</u> , gravely; about 20% hard, angular gravel particles $\frac{1}{2}$ – inch maximum size; rounded and subangular sand grains coarse to fine; about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).		$C_v = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \text{ Dep}}$ Between one and 3			
			Predominantly one size or a range of sizes with some intermediate sizes missing.		SP	Poorly graded sands, gravely sands; little or no fines			Not meeting all gradation requirements for SW			
SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for indentification procedures see ML below).		SM	Silty sands, poorly graded sand-silt mixtures	Afterberg limits below "A" line or PI less than 4				Above "A" line with PI between 4 and 7 are <u>borderline</u> cases requiring use of dual symbols.			
	Plastic fines (for identification procedures see CL below).		SC	Clayey sands, poorly graded sand-clay mixtures	Afterberg limits above "A" line with PI greater than 7							
IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No 40 SIEVE SIZE												
FINE GRAINED SOILS More than half of material is <u>smaller</u> than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to the naked eye)	SILTS AND CLAYS Liquid limit less than 50	DRY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to skaking)	TOUGHNESS (Consistency near Plastic Limit)					Give typical name; degree and character of plasticity, amount and maximum size of coarse grains; color in wet condition, odor in any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses. For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states. Moisture and drainage conditions. EXAMPLE:— <u>Clayey Silt</u> , brown; slightly plastic. small percentage of fine sand. numerous vertical root holes, firm and dry in place, loess, (ML).	Use grain size curve identifying the fractions as given under field identification		
		None to slight	Quick to slow	None	ML	Inorganic silty and very fine sands, rock flour, silty or clayey fine sands with slight plasticity						
	Medium to high	None to very slow	Medium	CL	Inorganic clays to low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays							
	Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity							
	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts							
	High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays							
	Medium to high	None to very slow	Slight to medium	OH	Inorganic clays of medium to high plasticity							
	HIGHLY ORGANIC SOILS					PT	Peat and other highly organic soils					

* Boundary classifications:— Soils processing characteristics of two groups are designated by combinations of group symbols for Example GW–GC, well graded gravel mixture with clay binder

* All sieve sizes on this chart are US standard.

DILATANCY (Reaction to shaking)

After removing particles larger than No 40 sieve sieve, prepare a pat striking vigorously against the other of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky. Place the pot in the open palm of one hand and shake horizontally, hand several times. A positive reaction consists of the appearance of water on the surface of the pot which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pot stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the times in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction inorganic silts, such as a typical rock flour, show a moderately quick reaction.

DRY STRENGTH (Crushing Characteristics)

After removing particles larger than No. 40 sieve size, mold a pot of soil to the consistency of putty, adding water if necessary. Allow the pot to dry completely by oven, sun, or air drying and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group A typical inorganic silt possesses only very slight dry strength Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Letter symbols in the logs, are group symbols of the Unified soil classification system based on field indent. Copies of Drawing No. 103–D–347, Unified Soil Classification, may be obtained on request office of Director of Design and Construction. Bureau of Reclamation, Denver, Colorado R0225.

TOUGHNESS (Consistency near plastic limit)

After removing particles larger than No. 40 sieve size, a specimen of soil about one-half inch cube in size is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation, the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin – type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

ADOPTED BY – CORPS OF ENGINEERS AND BUREAU OF RECLAMATION 1952

REV NO 2	2016-03-31 D C.F.S.	FIXED OFFICIAL RENDITION, FONT SPACING AND OTHER VISUAL ASPECTS.
REV NO 1	2003- 12 -05 D - G.T.	REVISED PLASTICITY CHART. REDRAWN WITH AUTOCAD SOFTWARE.

WEATHERING

FRESH (W1): Body of rock is not oxidized or discolored; fracture surfaces are not oxidized or discolored*; no separation of grain boundaries; no change of texture and no solutioning. Hammer rings when crystalline rocks are struck.

SLIGHTLY WEATHERED TO FRESH (W2):**

SLIGHTLY WEATHERED (W3): Discoloration or oxidation is limited to surface of, or short distance from fractures; some feldspar crystals are dull; fracture surfaces have minor to complete discoloration or oxidation; no visible separation of grain boundaries; texture preserved and minor leaching of soluble minerals may be present. Hammer rings when crystalline rocks are struck, body of rock is not weakened by weathering.

MODERATELY TO SLIGHTLY WEATHERED (W4):**

MODERATELY WEATHERED (W5): Discoloration or oxidation extends from fractures, usually throughout body of rock; ferromagnesian minerals are "rusty", feldspar crystals are "cloudy"; all fracture surfaces are discolored or oxidized; partial opening of grain boundaries visible; texture generally preserved, but soluble minerals may be mostly leached. Hammer does not ring when rock is struck, body of rock is slightly weakened.

INTENSELY TO MODERATELY WEATHERED (W6):**

INTENSELY WEATHERED (W7): Body of rock is discolored or oxidized throughout; all feldspars and ferromagnesian minerals are altered to clay to some extent. All fracture surfaces are discolored or oxidized, and friable; partial separation of grain boundaries, rock is friable; in situ disaggregation of granitics common in semi-arid regions; texture altered and leaching of soluble minerals may be complete. Rock has dull sound when struck with hammer; rock is weakened, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness.

VERY INTENSELY WEATHERED (W8):**

DECOMPOSED (W9): Body of rock is discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and ferro-magnesian minerals are completely altered to clay; complete separation of grain boundaries (disaggregated), partial or complete remnant rock structure may be preserved, but resembles a soil.

NOTE: Weathering categories are established primarily for crystalline rocks and those with ferromagnesian minerals, weathering in various sedimentary rocks will not always fit the categories established – weathering categories may be modified for particular site conditions or alteration such as hydrothermal alteration. Where modified criteria are established, they should be identified and described.

* Characteristics of fracture surfaces do not include directional weathering along shears or faults and their associated fracture zones; for example a shear that carries weathering to great depths in a fresh rock mass would not require the whole rock mass to be classified as weathered.

** Combination descriptors are used when equal distribution of both weathering characteristics are present over significant intervals or where characteristics noted are "in between" the diagnostic characteristics.

DURABILITY INDEX

DURABILITY DESCRIPTOR	DESCRIPTIVE CRITERIA
DI0	Rock specimen or exposure remains intact with no deleterious cracking after exposure longer than 1 year.
DI1	Rock specimen or exposure develops hairline cracking on surfaces within 1 month, but no disaggregation within 1 year of exposure.
DI2	Rock specimen or exposure develops hairline cracking on surfaces within 1 week, and/or disaggregation within 1 month of exposure.
DI3	Specimen or exposure may develop hairline cracks in 1 day and displays pronounced separation of bedding and/or disaggregation within 1 week of exposure.
DI4	Specimen or exposure displays pronounced cracking and disaggregation within 1 day (24 hours) of exposure. Generally ravel and degrades to small fragments.

COLOR

The Munsell color system (Geologic Society of America Rock Color Chart) should be used. This system defines wet color by its hue, value, and chroma. Color symbols used (i.e., 5 YR 5/6 may be included).

SEDIMENTARY AND PYROCLASTIC
ROCK PARTICLE SIZES

Size in mm	Sedimentary Rounded, subrounded, subangular		Pyroclastic	
	Particle or fragment	Lithified product	Fragment	Lithified product
256	Boulder	Boulder conglomerate	Block ^(a) or Bomb ^(b)	Volcanic ^(a) breccia or Volcanic ^(b) agglomerate
64	Cobble	Cobble conglomerate		
4	Pebble	Pebble conglomerate	Lapilli	Lapillistone and Lapilli tuff
2	Granule	Granule conglomerate		
1	Very coarse sand	Sandstone (Very coarse, coarse, medium, fine, or very fine)	Coarse ash	Coarse tuff
0.5	Coarse sand			
0.25	Medium sand			
0.125	Fine sand			
0.0625	Very fine sand			
0.00391	Silt	Siltstone/Shale	Fine ash	Fine tuff
	Clay	Claystone Shale		

(a) Broken from previous igneous rock, block shaped (angular to subangular).
(b) Solidified from plastic material while in flight, rounded clasts.

IGNEOUS AND METAMORPHIC
ROCK TEXTURE

TEXTURE DESCRIPTOR	AVERAGE GRAIN DIAMETER
VERY COARSE GRAINED OR PEGMATITIC	>10 mm [$>3/8$ in]
COARSE GRAINED	5–10 mm [$3/16$ – $3/8$ in]
MEDIUM GRAINED	1–5 mm [$1/32$ – $3/16$ in]
FINE GRAINED	0.1–1 mm [0.004 – $1/32$ in]
APHANITIC (Cannot be seen with the unaided eye)	<0.1 mm [<0.004 in]

ADDITIONAL TEXTURAL
ADJECTIVES

- PIT (pitted) – pinhole to 0.03 ft [3/8 in] (<1 to 10 mm) openings.
- VUG (vuggy) – Small openings (usually lined with crystals) ranging in diameter from 0.03 ft [3/8 in] to 0.33 ft [4 in] (10 to 100 mm).
- CAVITY – An opening larger than 0.33 ft [4 in] (100 mm), size descriptions are required, and adjectives such as small, large, etc., may be used.
- HONEYCOMBED – If numerous enough that only thin walls separate individual pits or vugs, this term further describes the preceding nomenclature to indicate cell-like form.
- VESICLE (vesicular) – Small openings in volcanic rocks of variable shape and size formed by entrapped gas bubbles during solidification.

BEDDING FOLIATION
OR FLOW TEXTURE

DESCRIPTORS	THICKNESS/SPACING
MASSIVE	Greater than 10 ft (>3 m)
VERY THICKLY (bedded, foliated or banded)	3 to 10 ft (1 to 3 m)
THICKLY	1 to 3 ft (300 mm to 1 m)
MODERATELY	0.3 to 1 ft (100 to 300 mm)
THINLY	0.1 to 0.3 ft (30 to 100 mm)
VERY THINLY	0.03 [3/8 in] to 0.1 ft (10 to 30 mm)
LAMINATED (Intensely foliated or banded)	Less than 0.03 ft [3/8 in] (<10 mm)

BEDROCK
HARDNESS/STRENGTH

- EXTREMELY HARD (H1): Core, fragment or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.
- VERY HARD (H2): Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.
- HARD (H3): Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.
- MODERATELY HARD (H4): Can be scratched with knife or sharp pick with light or moderate pressure. Core or fragment breaks with moderate hammer blow.
- MODERATELY SOFT (H5): Can be grooved 1/16 inch (2 mm) deep by knife or sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.
- SOFT (H6): Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
- VERY SOFT (H7): Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.
- Any bedrock unit softer than H7, Very Soft, is to be described using USBR 5005–86 (visual classification of soils) consistency characteristics.

REV NO
1

3-8-00
D - P. M. R.

CONVERTED ORIGINAL DRAWING 40-D-6493 TO ACAD, CHANGED DWG. NO., MINOR REVISIONS.

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

GEOLOGY FOR DESIGN & SPECIFICATIONS
STANDARD DESCRIPTORS AND DESCRIPTIVE
CRITERIA FOR ROCK

GEOLOGY NOMENCLATURE COMMITTEE
DRAWN Marshall N. Nason

CHECKED
TECH. APPROVAL
PEER REVIEWER

DATE AND TIME PLOTTED
MAY 10, 2000 09:30

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DENVER, COLORADO

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DISCONTINUITY TERMINOLOGY

DISCONTINUITY – A collective term used for all structural breaks in geologic materials which usually are unhealed and have zero or low tensile strength. Discontinuities also may be healed and exhibit high tensile strength. Discontinuities comprise fractures (including joints), planes of weakness, shears/faults, and shear/fault zones. Contacts between various units also may be considered discontinuities.

FRACTURE – A term used to describe any natural break in geologic material excluding shears and shear zones. Additional fracture terminology is provided below.

SHEAR – A structural break where differential movement has taken place along a surface or zone of failure by shear; characterized by striations, slickensides, gouge, breccia, mylonite, or any combination of these. Often direction, amount of displacement, and continuity may not be known because of limited exposures or observations.

FAULT – A shear with significant continuity which can be correlated between observations; occurs over a significant portion of a given site, foundation area, or region; or is a segment of a fault or fault zone defined in the literature. The designation of a shear as a fault or fault zone is a site-specific determination.

SHEAR/FAULT ZONE – A shear that is expressed in relative terms of width. The zone may consist of gouge, breccia, or many related faults or shears together with fractured and crushed rock between the shears and faults, or any combination of these. In the literature many fault zones simply are referred to as faults.

SHEAR-/FAULT-DISTURBED ZONE – An associated zone of fractures and/or folds adjacent to a shear or shear zone where the country rock has been subjected to only minor cataclastic action and may be mineralized. If adjacent to a fault or fault zone, the term is fault-disturbed zone. Occurrence, orientation, and areal extent of these phenomena depend upon depth of burial (pressure and temperature) during shearing, brittleness of materials, and the stress envelope.

FRACTURE TERMINOLOGY

EXAMPLES SHOWN FOR CORE, BUT APPLICABLE TO ANY OBSERVATION



JOINT (JT) – A relatively planar fracture along which there has been little or no shearing displacement.



FOLIATION JOINT (FJ) OR BEDDING JOINT (BJ) – a relatively planar fracture which is parallel to foliation or bedding along which there has been little or no shearing displacement.



BEDDING PLANE SEPARATION – A separation along bedding after extraction or exposure due to stress relief or slaking.



INCIPIENT JOINT (IJ) OR INCIPIENT FRACTURE (IF) – A joint or fracture which does not continue through the specimen or at least is not seen with the naked eye. However, when the specimen is wetted, and then allowed to dry, the joint or fracture trace is evident. When core is broken, it breaks along an existing plane.



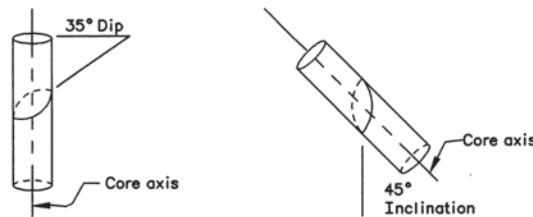
RANDOM FRACTURE (RF) – A natural break which does not belong to a joint set, and which exhibits a generally rough, very irregular, nonplanar surface.



MECHANICAL BREAK (MB) – A break due to drilling, blasting, or handling. Mechanical breaks parallel to bedding or foliation are called Bedding Breaks (BB) or Foliation Breaks (FB), respectively. Recognizing mechanical breaks may be difficult. The absence of oxidation, staining, or mineral fillings, and often a hackly or irregular surface are clues for recognition.

FRACTURE ZONE (FZ) – Numerous, very closely spaced intersecting fractures. Often fragmented core cannot be fitted together.

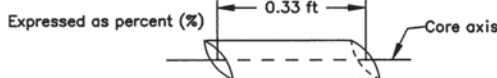
METHOD OF MEASURING DIP OF PLANAR DISCONTINUITIES, FOLIATION, AND BEDDING IN CORE



1. Vertical hole – true dip is measured and reported.
2. Angle hole – true dip usually not known; angle is measured from core axis and is called inclination.

ROCK QUALITY DESIGNATION (RQD)

EXAMPLE SHOWN FOR CORE, BUT APPLICABLE TO ANY LINEAR OBSERVATION
$$RQD = \frac{\text{Sum of length of solid core pieces} > 0.33 \text{ ft [4 in] (100 mm) long}}{\text{Length of the run in feet (mm)}} \times 100$$



FRACTURE FREQUENCY

FRACTURE FREQUENCY – The number of natural fractures occurring within a base length or core run. The number of fractures is divided by the length and is reported as fractures per foot or fractures per meter. Expressed as 3/m or 6/ft.

FRACTURE DENSITY

FRACTURE DENSITY – Based on the spacing of all natural fractures in an exposure or core recovery lengths in boreholes; excludes mechanical breaks, shears, and shear zones; however, shear-disturbed zones (fracturing outside the shear) are included. Descriptors for fracture density apply to all rock exposures such as tunnel walls, dozer trenches, outcrops, or foundation cut slopes and inverts, as well as boreholes. Descriptive criteria presented below are based on borehole cores where lengths are measured along the core axis. For other exposures the criterium is distance measured between fractures (size of blocks).

UNFRACTURED (FD0): No fractures.

VERY SLIGHTLY FRACTURED (FD1): Core recovered mostly in lengths greater than 3 feet (1 m).

SLIGHTLY TO VERY SLIGHTLY FRACTURED (FD2) *

SLIGHTLY FRACTURED (FD3): Core recovered mostly in lengths from 1 to 3 feet (300 to 1000 mm) with few scattered lengths less than 1 foot (300 mm) or greater than 3 feet (1000 mm).

MODERATELY TO SLIGHTLY FRACTURED (FD4) *

MODERATELY FRACTURED (FD5): Core recovered mostly in 0.3– to 1.0-foot (100– to 300-mm) lengths with most lengths about 0.6 foot (200 mm).

INTENSELY TO MODERATELY FRACTURED (FD6) *

INTENSELY FRACTURED (FD7): Lengths average from 0.1 to 0.3 foot (30 to 100 mm) with scattered fragmented intervals. Core recovered mostly in lengths less than 0.3 foot (100 mm).

VERY INTENSELY TO INTENSELY FRACTURED (FD8) *

VERY INTENSELY FRACTURED (FD9): Core recovered mostly as chips and fragments with a few scattered short core lengths.

* Combinations of fracture densities (e.g., Very Intensely to Intensely Fractured or Moderately to Slightly Fractured) are used where equal distribution of both fracture density characteristics are present over a significant interval or exposure, or where characteristics are "in between" the descriptor definitions.

FRACTURE SPACING

JOINT SET, OR FRACTURE SPACING DESCRIPTOR

TRUE SPACING

EXTREMELY WIDELY SPACED (SP1)	Greater than 10 ft (>3 m)
VERY WIDELY SPACED (SP2)	3 to 10 ft (1 to 3 m)
WIDELY SPACED (SP3)	1 to 3 ft (300 mm to 1 m)
MODERATELY SPACED (SP4)	0.3 to 1 m (100 to 300 mm)
CLOSELY SPACED (SP5)	0.1 to 0.3 ft (30 to 100 mm)
VERY CLOSELY SPACED (SP6)	less than 0.1 ft (<30 mm)

FRACTURE CONTINUITY

CONTINUITY DESCRIPTOR

DISCONTINUITY LENGTH

DISCONTINUOUS (C1)	Less than 3 ft (<1 m)
SLIGHTLY CONTINUOUS (C2)	3 to 10 ft (1 to 3 m)
MODERATELY CONTINUOUS (C3)	10 to 30 ft (3 to 10 m)
HIGHLY CONTINUOUS (C4)	30 to 100 ft (10 to 30 m)
VERY CONTINUOUS (C5)	Greater than 100 ft (>30 m)

FRACTURE ENDS (JOINT SURVEYS)

FRACTURE ENDS DESCRIPTOR

DESCRIPTIVE CRITERIA

E0	Zero ends leave the exposure (both ends can be seen).
E1	One end of the fracture terminates in the exposure (one end can be seen).
E2	Neither fracture end terminates in the exposure (neither end can be seen).

FRACTURE OPENNESS OR FILLING THICKNESS

FILLING THICKNESS DESCRIPTOR

THICKNESS/OPENNESS

OPENNESS DESCRIPTOR

CLEAN (T0)	No film or coating.	TIGHT (O0)
	No visible separation.	SLIGHTLY OPEN (O1)
VERY THIN (T1)	Less than 0.003 ft [1/32 in] (<1 mm).	MODERATELY OPEN (O2)
MODERATELY THIN (T2)	0.003 to 0.01 ft [1/32 to 1/8 in] (1 to 3 mm).	OPEN (O3)
THIN (T3)	0.01 to 0.03 ft [1/8 to 3/8 in] (3 to 10 mm).	MODERATELY WIDE (O4)
MODERATELY THICK (T4)	0.03 ft [3/8 in] to 0.1 ft (10 to 30 mm).	WIDE (O5)
THICK (T5)	Greater than 0.1 ft (>30 mm). Actual thickness or openings recorded.	

FRACTURE MOISTURE CONDITIONS

MOISTURE DESCRIPTOR

DESCRIPTIVE CRITERIA

M1	The fracture is dry. It is tight or filling (where present) is of sufficient density or composition to impede waterflow. Waterflow along the fracture does not appear possible.
M2	The fracture is dry with no evidence of previous waterflow. Waterflow appears possible.
M3	The fracture is dry, but shows evidence of waterflow such as staining, leaching and/or vegetation.
M4	The fracture or filling (where present) is damp, but no free water is present.
M5	The fracture shows seepage. It is wet with occasional drops of water.
M6	The fracture emits a continuous flow (estimate flow rate) under low pressure. Filling materials (where present) may show signs of leaching or piping.
M7	The fracture emits a continuous flow (estimate flow rate) under moderate to high pressure. Water is squirting and/or filling material (where present) may be substantially washed out.

FRACTURE ROUGHNESS

Refers to small-scale asperities of surfaces, not large-scale undulations or waviness.

STEPPED (R1): Near-normal steps and ridges occur on the fracture surface.
ROUGH (R2): Large, angular asperities can be seen.
MODERATELY ROUGH (R3): Asperities are clearly visible and fracture surface feels abrasive.
SLIGHTLY ROUGH (R4): Small asperities on the fracture surface are visible and can be felt.
SMOOTH (R5): No asperities, smooth to the touch.
POLISHED (R6): Extremely smooth and shiny.

FRACTURE SURFACE AND/OR FILLING ALTERATION AND HARDNESS

Descriptors for weathering or alteration of fracture surfaces and fracture fillings (excluding soil materials) are the same as those used for weathering and alteration of rock.

Descriptors for hardness/strength of fillings and/or fracture surfaces are the same as those presented for hardness of rock and consistency of soils.

DISCONTINUITY HEALING

TOTALLY HEALED (HL1) – All fragments bonded, discontinuity is completely healed or recemented to a degree at least as hard as surrounding rock.

MODERATELY HEALED (HL3) – Greater than 50 percent of fractured or sheared material, discontinuity surfaces or filling is healed or recemented; and/or strength of healing agent is less hard than surrounding rock.

PARTLY HEALED (HL5) – Less than 50 percent of fractured or sheared material, discontinuity surface or filling is healed or recemented.

NOT HEALED (HL6) – Discontinuity surface, fractured zone, sheared material or filling is not healed or recemented, rock fragments or filling (if present) held in place by their own angularity and/or cohesiveness.

SHEAR/FAULT DESCRIPTORS

SHEAR/FAULT GOUGE CONSISTENCY

DESCRIPTOR	DESCRIPTIVE CRITERIA (Similar to consistency of soils)
VERY HARD	Gouge cannot be broken with finger pressure; cannot be indented with fingernail.
HARD	Gouge can be broken with firm finger pressure; can be indented with fingernail; cannot be indented with thumb.
FIRM	Gouge can be easily crumbled; can be indented with thumb 1 to 5 mm.
SOFT	Gouge can be easily molded; can be penetrated with thumb 5 to 25 mm.
VERY SOFT	Gouge can be penetrated with thumb more than 25 mm.

SHEAR/FAULT MOISTURE DESCRIPTORS

The apparent moisture content of gouge is described as WET (visible free water); MOIST (damp, but no visible water); and DRY (absence of moisture, dusty, dry to the touch). Moisture descriptors M1 through M7 may be used to describe the shear or shear zone.

BRECCIA SHAPES

Angular	
Subangular	
Subrounded	
Rounded	
Platy	
Lens-shaped	
Wedge-shaped	
Contorted	

REV NO 1 3-8-00 1 D-P.M.R. CONVERTED ORIGINAL DRAWING 40-D-6499 TO ACAD, CHANGED DWG. NO., MINOR REVISIONS.

ALWAYS THINK SAFETY

UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

GEOLOGY FOR DESIGN & SPECIFICATIONS STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES

GEOLOGY NOMENCLATURE COMMITTEE CHECKED BY *Charles Sullivan* DRAWN BY *Michael P. Mason* TECH. APPROVAL BY *John W. Baker* APPROVED BY *Mark W. Brown* PEER REVIEWER

CADD SYSTEM AutoCAD Rev 12.04 CADD FILENAME 40-D-7023.DWG DATE AND TIME PLOTTED MAY 10, 2000 09:20 DENVER, COLORADO MARCH 8, 2000 40-D-7023

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CAD FILE NAME
1695-529-60234-RD-1.DWG
LAST MODIFIED BY
DTHORNBURG
LAST SAVED DATE
2018-07-27

D

C

B

A

GENERAL GEOLOGIC LEGEND

STRATIGRAPHY

Embk Embankment

Compacted earth material. Fine to coarse, miscellaneous engineered material used for road grade above the existing ground surface. Embankment may contain foundation or subgrade material ranging from well to poorly graded material and oversized particles

Qal Quaternary Alluvium

Unconsolidated soils that overlie bedrock at the investigation site. Soils are generally fine grained with variable amounts of plastic to non-plastic fines and occasionally contain sand and gravel. Alluvial soils range from Silty Sand (SM), Lean Clay (CL), Lean Clay with Sand (CL)s and Sandy Lean Clay s(CL). The alluvium is derived from a variety of sources including slope wash, eolian and alluvial deposition as well as weathering and decomposition of in-place bedrock. Quaternary Alluvium is used to describe surficial deposits regardless of origin.

Qtg Quaternary Terrace Gravel

Unconsolidated deposits of gravel, cobbles and boulders in a predominantly sandy matrix with lesser amounts of silt and clay. The terrace gravels originate from the San Juan River alluvium forming terraces and exhibit weak to moderate cementation. Terrace gravels may contain glacial outwash deposits. Terrace gravels range from Lean Clay (CL), Silty Sand with Gravel (SM)g to Poorly Graded Gravel with Sand and Cobble (GP)sc and were noted to contain lenses and pockets of clean sand and gravel. Sand, gravel and cobble are generally hard to very hard, rounded to subrounded with occasional flat and elongated particles. Boulders are encountered on the surface surrounding the site but were not encountered in explorations.

Km Cretaceous Mancos Shale

The Cretaceous Mancos Shale is predominantly shale with interbedded claystone and sandstone. The shale is a light to dark gray, marine deposit that is laminated to thinly bedded and fissile. The shale is generally moderately soft (H5) to hard (H3). The shale can be intensely weathered (W7) to slightly weathered (W3) and has a no to strong reaction with HCl. The claystone is light to dark brown, laminated to thinly bedded, very soft (H7) to moderately soft (H5) and decomposed (W9) to slightly weathered (W3). The claystone has a strong reaction with HCl. Generally, the shale and claystone contains calcium carbonate as nodules, stringers and in bedding planes. Iron and manganese oxide staining and carbon blebs are also present.

GEOLOGIC EXPLANATION

DHWTP3-17-1



Drill hole location with identification number

TPWTP3-18-1



Test Pit location and Identification number

Qal

Km

Geologic Unit Contact

Qal

Km

Dashed where approximate

Qal

Km

Queried where inferred

DHWTP3-17-1

Elev. 5175.1

1.8

CL

1.8

CLSTN

7.9

SHALE

13.9

CLSTN

16.2

SHALE

T.D. 45.0

Drill Hole or Test Pit on profile
(dashed where projected)

GENERAL GEOLOGIC NOTES

Geologic standards and definitions used for rock quality and rock discontinuities are based on Bureau of Reclamation Engineering Geology Field Manual and drawing numbers 40-D-6493 and 40-D-6499.

Soil classification and descriptions are based on the Unified Soil Classification System (USCS) and Bureau of Reclamation procedures and guidelines as described in Geotechnical Branch Training Manuals numbers 4, 5, 6, and Designations USBR 5000 (laboratory classification) and USBR - 5005 (visual classification). These procedures are similar to ASTM D2487-11 and ASTM D2488-09A respectively.

Interpretations shown on geologic profiles are based on Test Pit, Drill Hole, outcrop, and field mapping data. Interpretations suggest general trends between data points and do not depict localized irregularities.

For the entire description of material, drilling or excavation method and conditions, exact locations of the hole, etc., see complete log.

BEDROCK ABBREVIATIONS:

CLSTN - CLAYSTONE

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO-GALLUP WATER SUPPLY PROJECT
NEW MEXICO
SAN JUAN LATERAL
WATER TREATMENT PLANT

Paul Gardner

DESIGNED

D.Thornburg

DRAWN

Paul Gardner

CHECKED

Beyer, Christopher R

TECH. APPR.

Longwell, Barry D

APPROVED

ADMIN APPROVAL - Project Construction Engineer

FARMINGTON, NM

2018-07-26

GENERAL GEOLOGIC
LEGEND, EXPLANATION
AND NOTES

1695-529-60234

SHEET 1

D

C

B

A

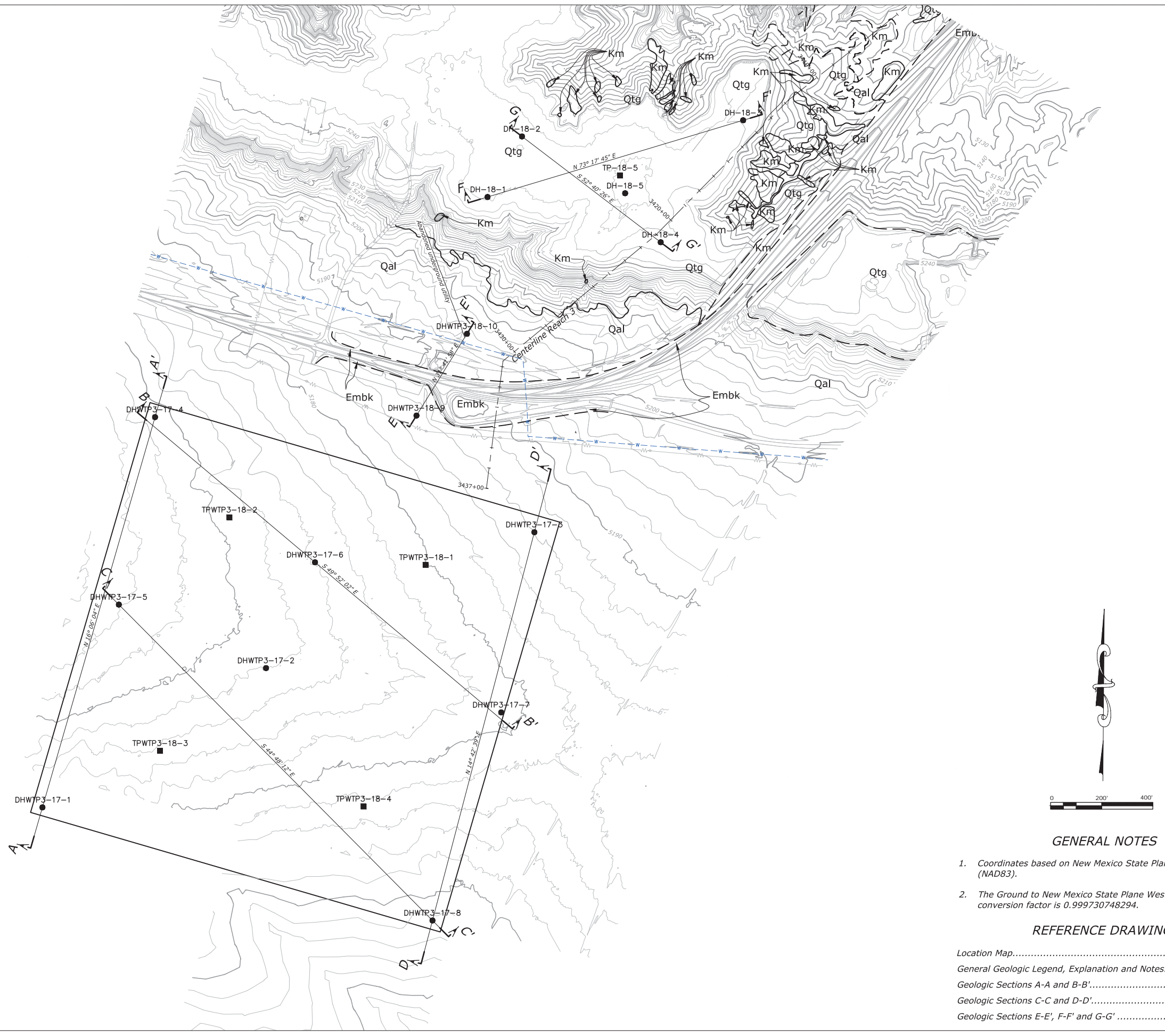
G4

DESIGNED	PAUL GARDNER
DRAWN	D. THORNBERG
CHECKED	PAUL GARDNER
TECH. APPR.	Beyer, Christopher R
APPROVED	Longwell, Barry D
APPROVAL	Project Construction Engineer
FARMINGTON, NM	2018-07-26

SURFACE GEOLOGY,
LOCATION OF
EXPLORATION AND
GEOLOGIC SECTIONS

DATE AND TIME PLOTTED
JULY 24, 2018 10:55
PLOTTER BY
DTHORNBERG

CADD SYSTEM
CADD FILENAME
1695-529-60208-RD-1.DWG
22.08



GENERAL NOTES

- Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).
- The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999730748294.

REFERENCE DRAWINGS

Location Map.....	1695-529-60182.
General Geologic Legend, Explanation and Notes.....	1695-529-60234.
Geologic Sections A-A' and B-B'.....	1695-529-60231.
Geologic Sections C-C' and D-D'.....	1695-529-60232.
Geologic Sections E-E', F-F' and G-G'	1695-529-60233.

ALWAYS THINK SAFETY

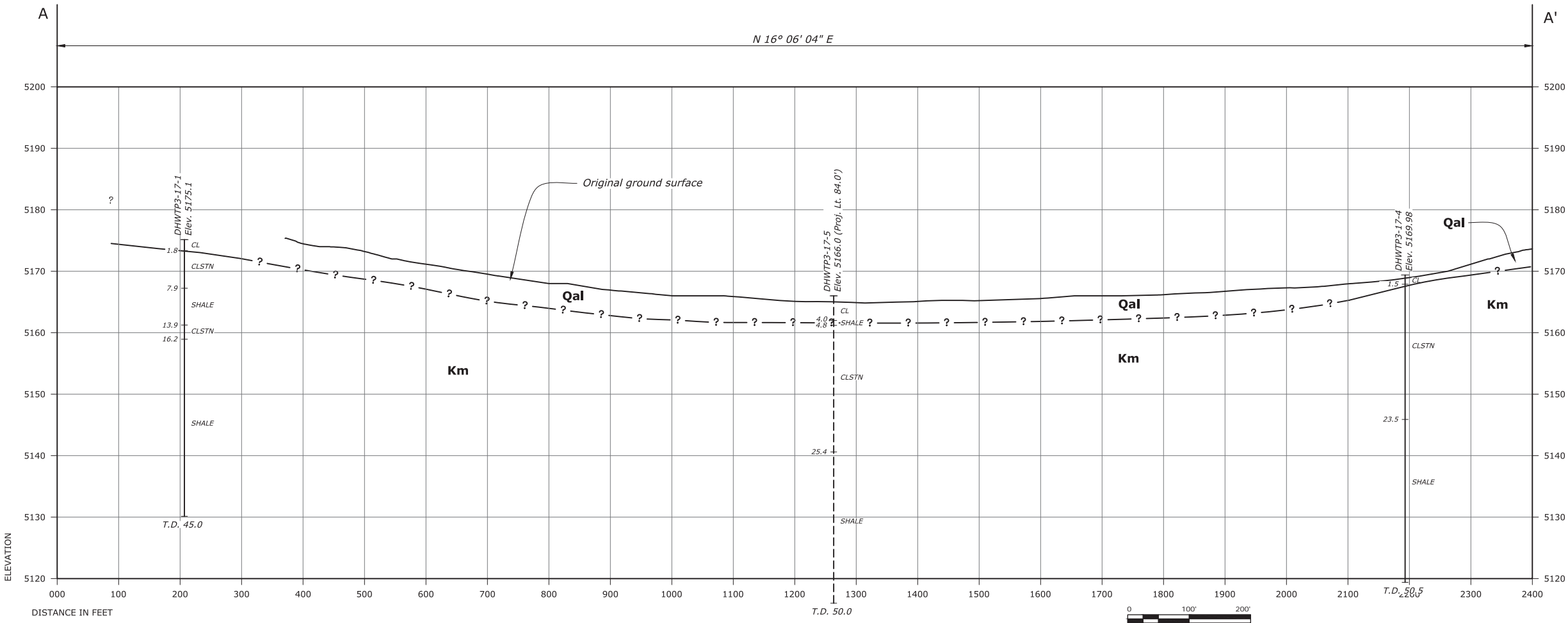
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO-GALLUP WATER SUPPLY PROJECT
NEW MEXICO

SAN JUAN LATERAL
WATER TREATMENT PLANT

PAUL GARDNER
DESIGNED
D. THORNBURG
DRAWN
PAUL GARDNER
CHECKED
Beyer, Christopher R
TECH. APPR.
Longwell, Barry D
APPROVED
CORRECTION APPROVAL - Project Construction Engineer
FARMINGTON, NM 2018-07-26

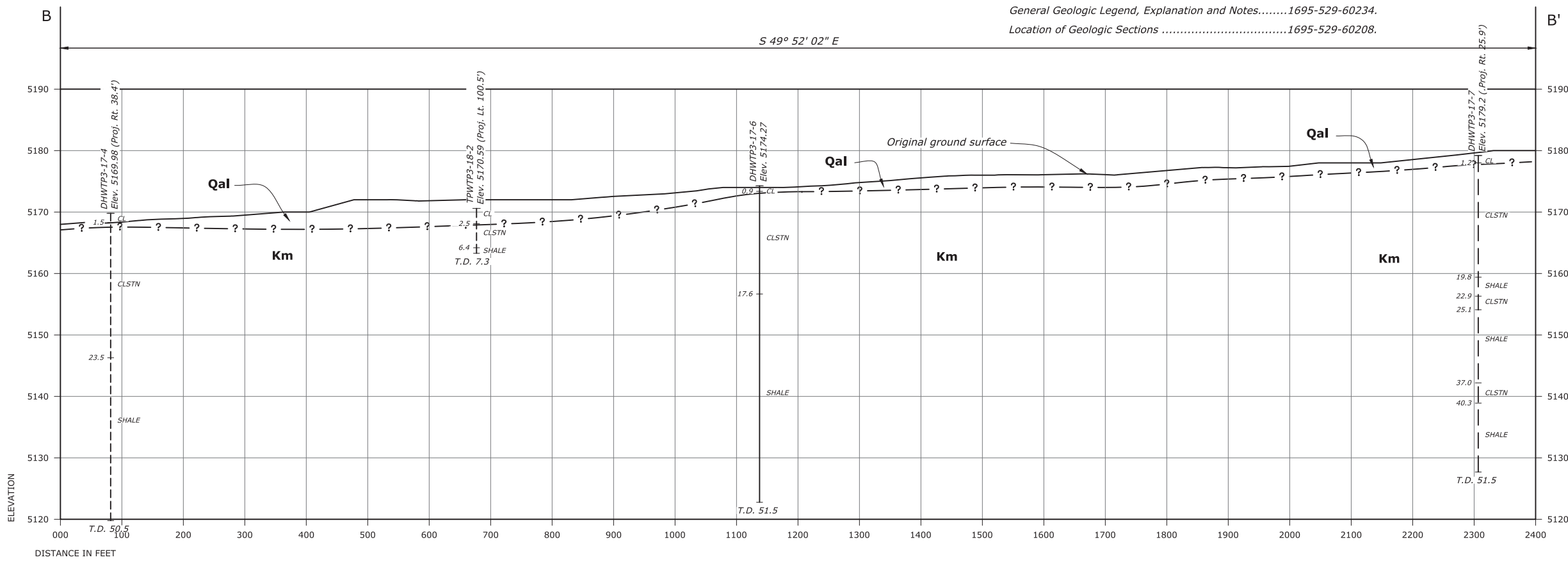
GEOLOGIC SECTIONS
A-A' AND B-B'

1695-529-60231
SHEET 1



GEOLOGIC SECTION A-A'

REFERENCE DRAWINGS
General Geologic Legend, Explanation and Notes.....1695-529-60234.
Location of Geologic Sections1695-529-60208.



GEOLOGIC SECTION B-B'

DATE AND TIME PLOTTED
PLOTTED BY
CAD SYSTEM
CAD FILENAME

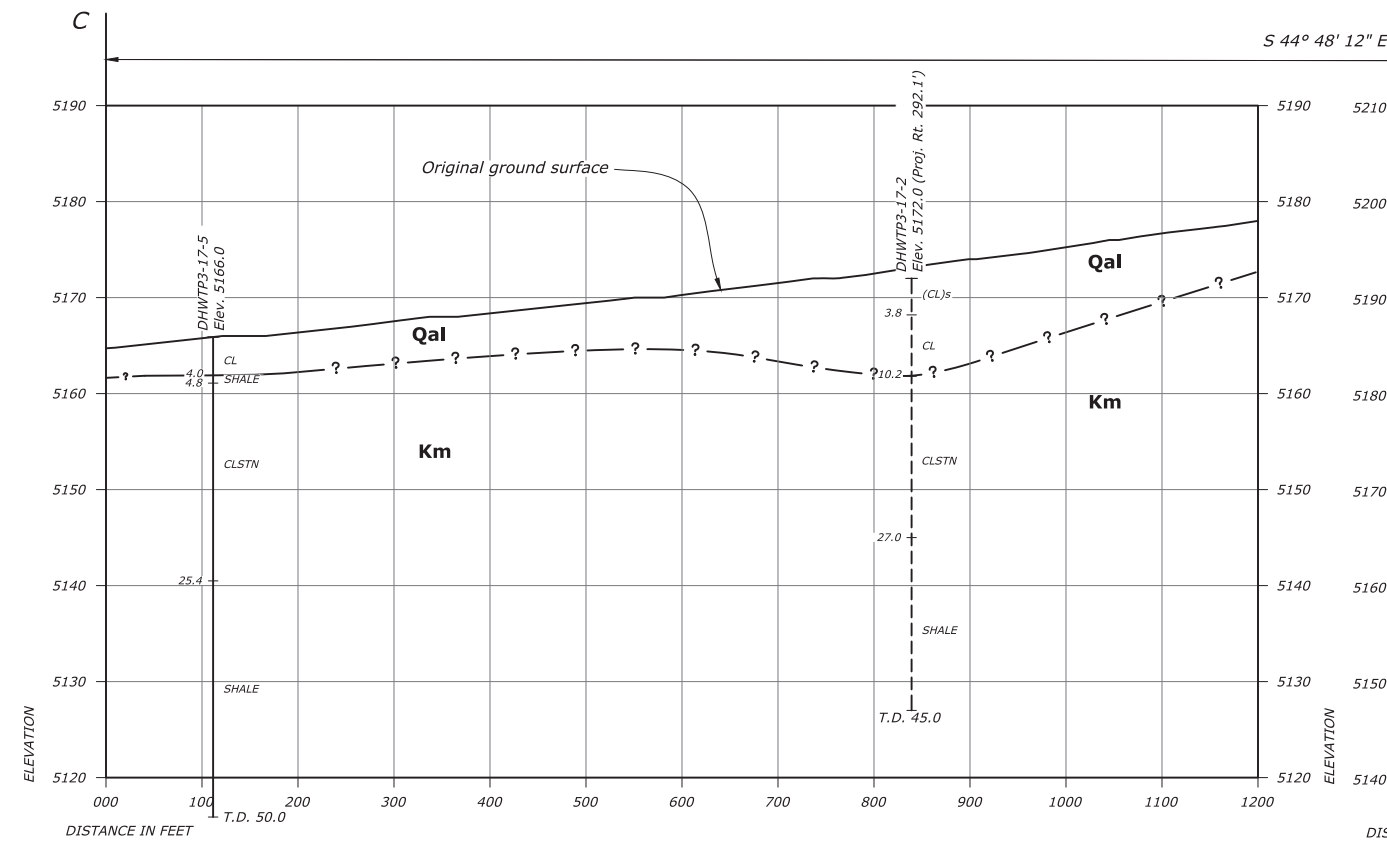
ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO-GALLUP WATER SUPPLY PROJECT
NEW MEXICO

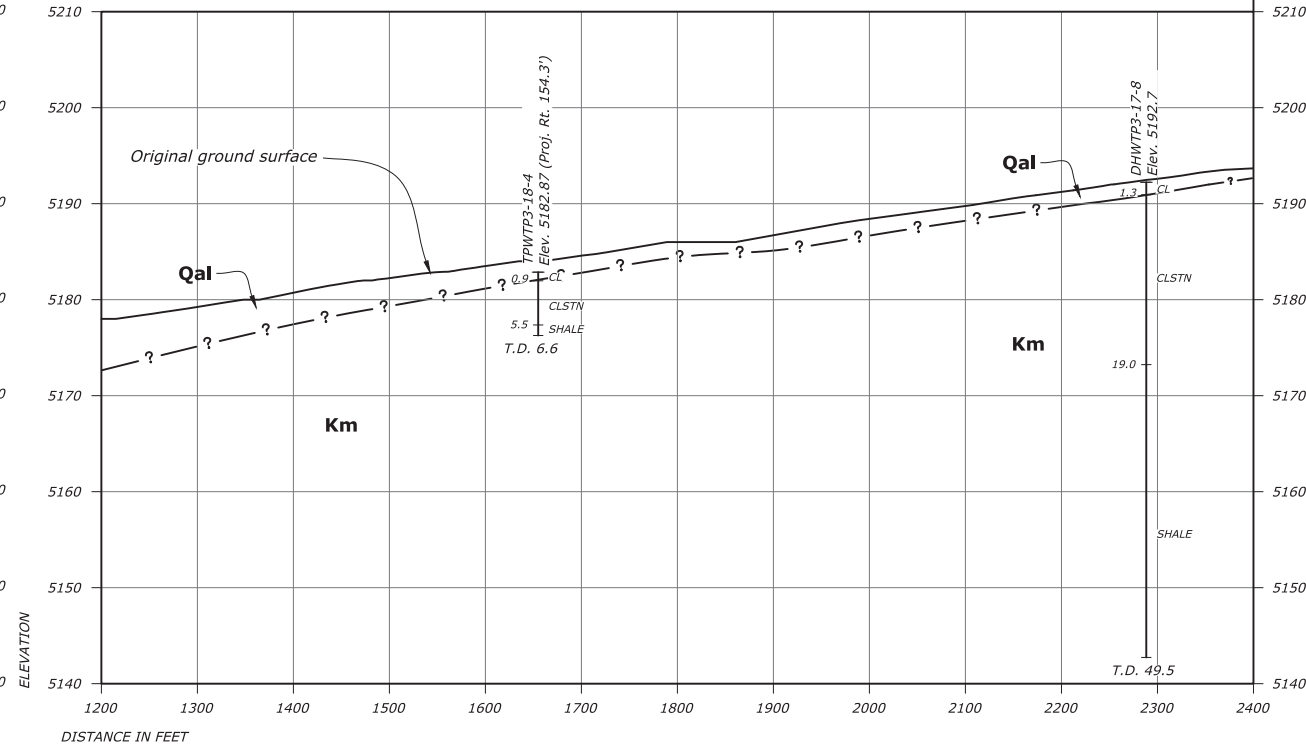
SAN JUAN LATERAL
WATER TREATMENT PLANT

DESIGNED	PAUL GARDNER
DRAWN	D. THORNBURG
CHECKED	PAUL GARDNER
TECH. APPR.	Beyer, Christopher R
APPROVED	Longwell, Barry D
CONTRACT APPROVAL - Project Construction Engineer	
FARMINGTON, NM 2018-07-26	

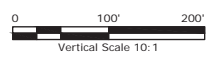
GEOLOGIC SECTIONS
C-C' AND D-D'



GEOLOGIC SECTION C-C'

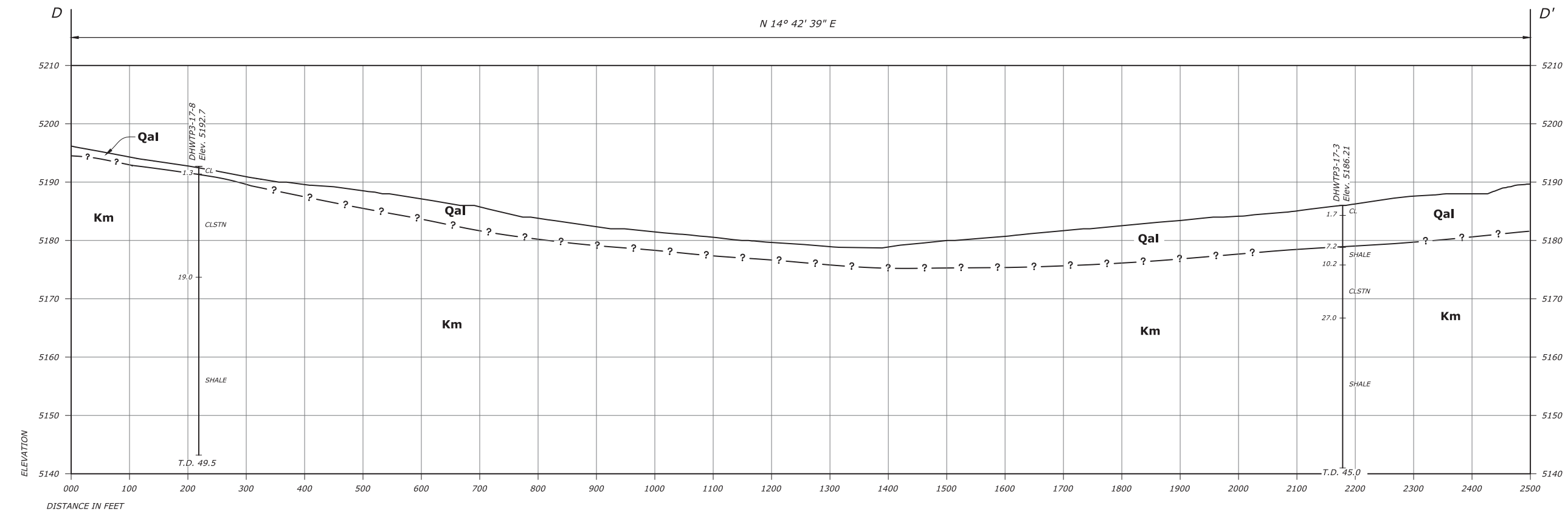


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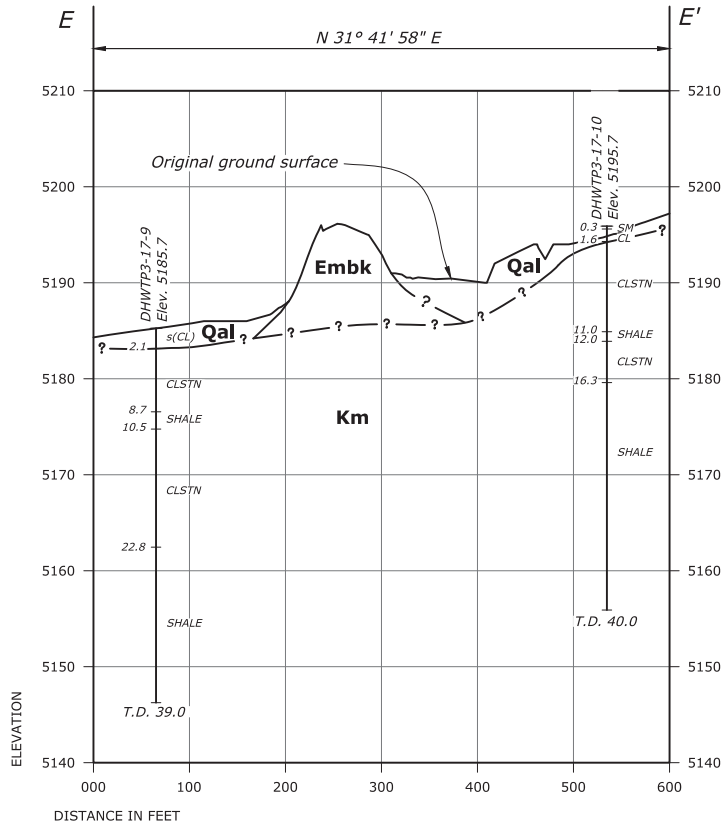
REFERENCE DRAWINGS

General Geologic Legend, Explanation and Notes.....1695-529-60234.
Location of Geologic Sections1695-529-60208.

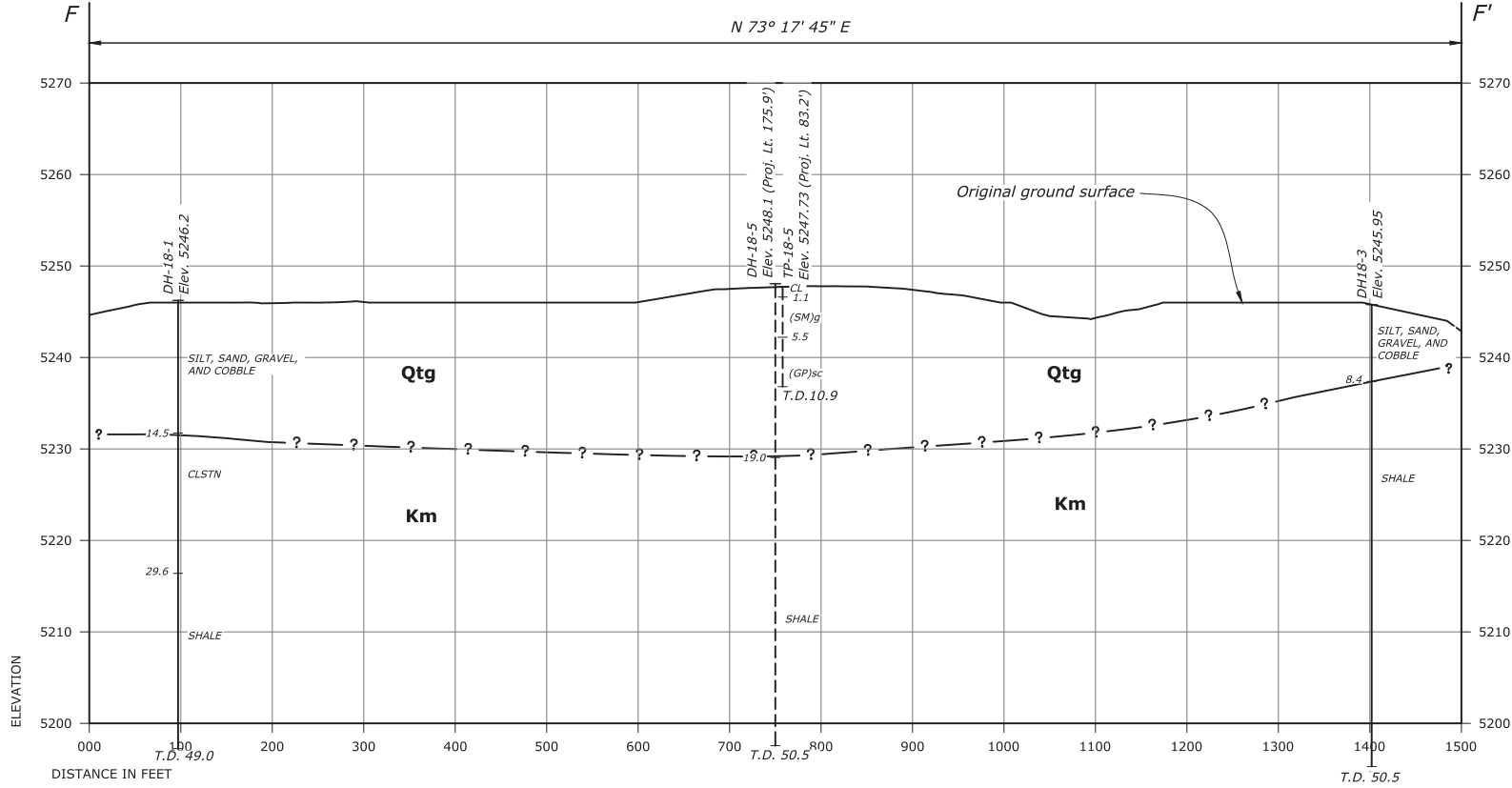


GEOLOGIC SECTION D-D'

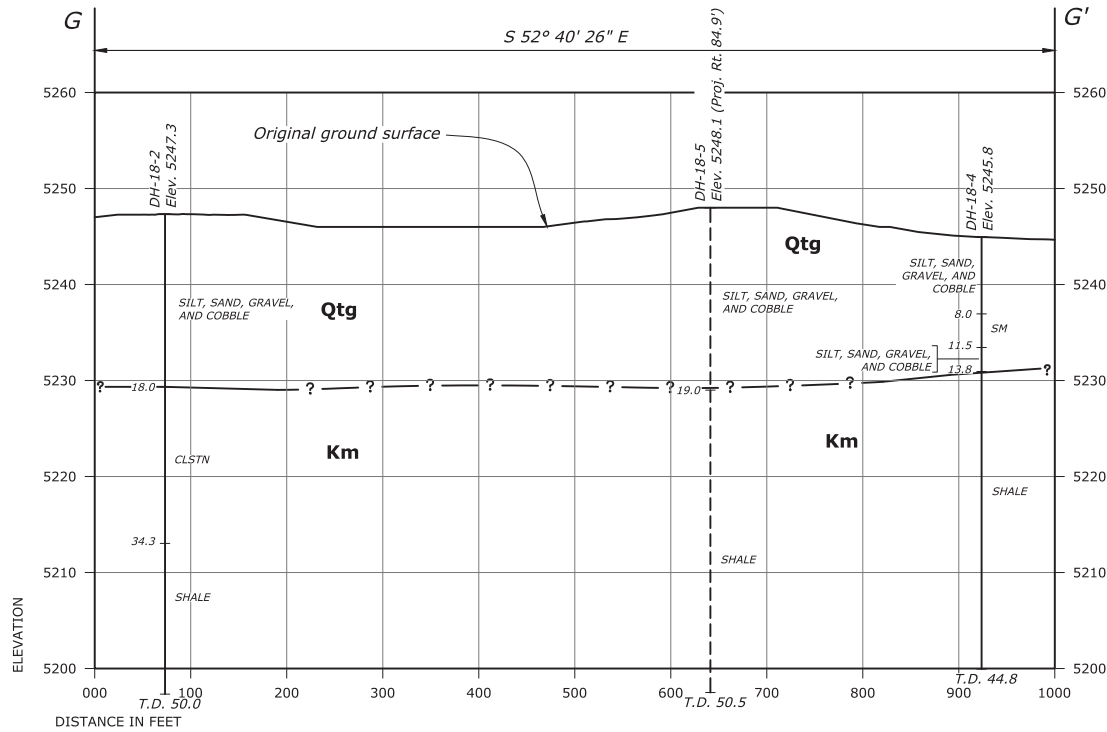
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CAD SYSTEM
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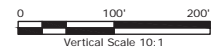
GEOLOGIC SECTION E-E'



GEOLOGIC SECTION F-F'



GEOLOGIC SECTION G-G'



REFERENCE DRAWINGS

General Geologic Legend, Explanation and Notes.....1695-529-60234.
Location of Geologic Sections1695-529-60208.

GEOLOGIC LOG OF DRILL HOLE NO. DHWTP3-17-1

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
 LOCATION: Site Investigation
 BEGUN: 6/14/17 FINISHED: 6/15/17
 DEPTH AND ELEVATION OF WATER LEVEL: NE
 DATE MEASURED: 6/15/2017

PROJECT: Navajo Gallup Water Supply Project
 COORDINATES: N 2,075,067.9 E 2,497,016.8 N.M. State Plane
 TOTAL DEPTH: 45.0 ft
 DEPTH TO BEDROCK: 1.8 ft

STATE: New Mexico
 GROUND ELEVATION: 5175.1 ft NAD 83
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: P. Gardner
 REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				

<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: M. Butler</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 850 track mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 3.0 ft: 4.25 inch HSA with pilot bit. 3.0 to 26.5 ft: 4.25 inch HSA with dry core system and SPT. 26.5 to 45.0 ft: 4.25 inch HSA with dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 45.0 ft: None.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLING: 3.0 to 4.5 ft: SPT 5.0 to 6.5 ft: SPT 7.5 to 9.0 ft: SPT 10.0 to 11.5 ft: SPT 12.5 to 14.0 ft: SPT 15.0 to 16.5 ft: SPT 20.0 to 21.5 ft: SPT 25.0 to 26.5 ft: SPT (NR)</p>	5	Qal	NR											CL 5173.3	<p>0.0 to 1.8 ft QUATERNARY ALLUVIUM (Qal)</p> <p>0.0 to 1.8 ft LEAN CLAY (CL): About 90% fines with low plasticity, low toughness, medium dry strength and no dilatancy; about 10% fine to coarse, hard, angular sand; maximum size, coarse sand; brown and dry; strong reaction with HCl.</p> <p>1.8 to 45.0 ft CRETACEOUS MANCOS SHALE (Km)</p> <p>1.8 to 7.9 ft CLAYSTONE: Light to dark brown color. Laminated to thinly bedded. Very soft (H7) and decomposed (W9) to 4.5 ft. Intensely weathered (W7) below 4.5 ft. CaCO₃ in laminations. Strong reaction with HCl.</p> <p>7.9 to 13.9 ft SHALE: Light to dark gray color, laminated to very thinly bedded and fissile. Very soft (H7) and intensely weathered (W7). Gypsum present below 10.4 ft. FeOx and MnOx staining below 13.3 ft. Easily breaks on bedding planes. Strong reaction with HCl.</p> <p>13.9 to 16.2 ft CLAYSTONE: Light to dark brown color. Laminated to thinly bedded. Very soft (H7) and intensely weathered (W7). CaCO₃ in laminations. MnOx and FeOx staining present. Strong reaction with HCl.</p> <p>16.2 to 45.0 ft SHALE: Light to dark gray color, laminated to very thinly bedded and fissile. Moderately soft (H5) and moderately weathered (W5). FeOx, MnOx staining and gypsum present. Easily breaks on bedding planes. Hard pan, moderately hard (H4) and moderately weathered (W5), encountered between 26.2 to 27.4 ft. Weak reaction with HCl.</p> <p>STRATIGRAPHY:</p> <p>0.0 to 1.8 ft QUATERNARY ALLUVIUM (Qal) 1.8 to 45.0 ft CRETACEOUS MANCOS SHALE (Km)</p>		
			25	0		9	87.8	12.2	0.0	32.0	16.2	4.9	CL	14/40/50		CLSTN	
			60	0			76.0	24.0	0.0	29.5	13.2	3.3	(CL)s	50/NA/NA			
			48	0	7		90.8	9.2	0.0	34.3	19.6	5.7	CL	21/45/50		5167.2	SHALE
			68	0		7	92.3	7.7	0.0	33.8	18.5	5.2	CL	17/50/NA			
			28	0			89.0	11.0	0.0	35.7	21.1	7.0	CL	31/42/50		5161.2	
			60	0			86.0	14.0	0.0	33.6	17.3	4.1	CL	50/NA/NA		5158.9	
					5												SHALE
							94.4	5.6	0.0	33.8	17.4	2.6	CL	50/NA/NA			
			100	0													
					4		NA	NA	NA	NA	NA	NA	NA	50/NA/NA			
			18	0													
					5												
			32	0													
		32	0	5													
		26	0														
	45													5130.1			

BOTTOM OF HOLE

BOTTOM OF HOLE

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide
 CaCO₃= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled Geology for Designs and Specification as follows "Drawing No. 40-D-6493 Standard Descriptions and Descriptive Criteria for rock. Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities.



GEOLOGIC LOG OF DRILL HOLE NO. DHWTP3-17-2

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
 LOCATION: Site Investigation
 BEGUN: 6/16/17 FINISHED: 6/17/17
 DEPTH AND ELEVATION OF WATER LEVEL: NE
 DATE MEASURED: 6/17/2017

PROJECT: Navajo Gallup Water Supply Project
 COORDINATES: N 2,075,749.0 E 2,498,110.4 N.M. State Plane
 TOTAL DEPTH: 45.0 ft
 DEPTH TO BEDROCK: 10.2 ft

STATE: New Mexico
 GROUND ELEVATION: 5172.0 ft NAD 83
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: P. Gardner
 REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: M. Butler</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 850 track mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 2.5 ft: 4.25 inch HSA with pilot bit. 2.5 to 4.0 ft: 4.25 inch HSA and SPT. 4.0 to 5.0 ft: 4.25 inch HSA with pilot bit. 5.0 to 36.5 ft: 4.25 inch HSA with dry core system and SPT. 36.5 to 45.0 ft: 4.25 inch HSA with dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 45.0 ft: None.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLING: 2.5 to 4.0 ft: SPT 5.0 to 6.5 ft: SPT 7.5 to 9.0 ft: SPT 10.0 to 11.5 ft: SPT 12.5 to 14.0 ft: SPT 15.0 to 16.5 ft: SPT 20.0 to 21.5 ft: SPT 25.0 to 26.5 ft: SPT 30.0 to 31.5 ft: SPT (NR) 35.0 to 36.5 ft: SPT (NR)</p>			NR													0.0 to 10.2 ft QUATERNARY ALLUVIUM (Qal)
															(CL)s	0.0 to 3.8 ft LEAN CLAY WITH SAND (CL)s: About 85% fines with low plasticity, low toughness, high dry strength and slow dilatancy; about 15% fine to medium sand; maximum size, medium sand; brown and dry; CaCO ₃ stringers and nodules; strong reaction with HCl.
	5	Qal	NR	NR			95.2	4.8	0.0	35.0	21.0	5.9	CL	16/25/24	5168.2	3.8 to 10.2 ft LEAN CLAY (CL): About 95% fines with medium plasticity, medium toughness, high dry strength and no dilatancy; about 5% fine to medium, subangular sand; trace of coarse, hard, subangular gravel; maximum size, 30mm; brown and dry; strong reaction with HCl.
			72	0			93.1	6.9	0.0	35.2	19.6	7.6	CL	8/18/17		
			36	0			98.6	1.4	0.0	37.2	20.8	7.5	CL	18/33/41		
	10														5161.8	10.2 to 45.0 ft CRETACEOUS MANCOS SHALE (Km)
			40	0			91.0	9.0	0.0	33.2	15.6	6.3	CL	31/50/NA		10.2 to 27.0 ft CLAYSTONE: Light to dark brown color. Laminated to very thinly bedded. Very soft (H7) and very intensely weathered (W8). Carbon blebs and CaCO ₃ in laminations. Gypsum present and sandy. Strong reaction with HCl.
			52	0			99.0	1.0	0.0	38.7	21.6	7.0	CL	18/50/NA		27.0 to 28.2 ft SHALE: Dark gray color and no bedding foliation. Moderately hard (H4) and moderately weathered (W5). Weak reaction with HCl.
	15						96.0	4.0	0.0	34.1	16.6	6.9	CL	9/32/34		28.2 to 45.0 ft SHALE: Light to dark gray color, laminated, sandy and fissile. Moderately soft (H5) and moderately to slightly weathered (W4). Easily breaks on bedding planes. Bedding planes near horizontal. Strong reaction with HCl.
			20	0	7	8										STRATIGRAPHY:
	20						94.1	5.9	0.0	35.6	18.3	7.0	CL	20/30/32		0.0 to 10.2 ft QUATERNARY ALLUVIUM (Qal)
			26	0												10.2 to 45.0 ft CRETACEOUS MANCOS SHALE (Km)
	25						94.9	5.1	0.0	35.2	17.9	6.5	CL	7/33/50	5145.0	
		Km	30	0	4	5										
	30						NA	NA	NA	NA	NA	NA	NA	50/NA/NA		
			56	0												
	35						NA	NA	NA	NA	NA	NA	NA	50/NA/NA		
			95	0	5	4										
	40		100	0												
			100	0												
	45		100	0											5127.0	

BOTTOM OF HOLE

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide
 CaCO₃= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Geology Field Manual and Drawing Titled Geology for Designs and Specification as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for rock. Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities.



GEOLOGIC LOG OF DRILL HOLE NO. DHWTP3-17-3

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
 LOCATION: Site Investigation
 BEGUN: 6/17/17 FINISHED: 6/18/17
 DEPTH AND ELEVATION OF WATER LEVEL: NE
 DATE MEASURED: 6/18/2017

PROJECT: Navajo Gallup Water Supply Project
 COORDINATES: N 2,076,413.3 E 2,499,422.8 N.M. State Plane
 TOTAL DEPTH: 45.0 ft
 DEPTH TO BEDROCK: 1.7 ft

STATE: New Mexico
 GROUND ELEVATION: 5186.2 ft NAD 83
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: P. Gardner
 REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				
<p>All measurements are from ground level and are the same as those used by drillers.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: M. Butler</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 850 track mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 5.0 ft: 4.25 inch HSA with pilot bit. 5.0 to 26.5 ft: 4.25 inch HSA with dry core system with SPT. 26.5 to 45.0 ft: 4.25 inch HSA with dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 45.0 ft: None.</p> <p>HOLE COMPLETION: Backfilled with bentonite and cuttings.</p> <p>SAMPLING: 5.0 to 6.5 ft: SPT 7.5 to 9.0 ft: SPT (NR) 10.0 to 11.5 ft: SPT 12.5 to 14.0 ft: SPT 15.0 to 16.5 ft: SPT 20.0 to 21.5 ft: SPT 25.0 to 26.5 ft: SPT</p>		Qal													CL	0.0 to 1.7 ft QUATERNARY ALLUVIUM (Qal)
			NR		7	8									5184.5	
	5															
			24	0			95.5	4.5	0.0	40.7	21.6	7.8	CL	23/37/50		CLSTN
															5179.0	
			NR	NR	5	5	NA	NA	NA	NA	NA	NA	NA	50/NA/NA		SHALE
	10														5176.0	
			32	0			87.4	11.4	1.2	34.0	16.9	6.3	CL	17/33/26		
			44	0			84.4	15.6	0.0	33.3	16.7	5.9	(CL)s	26/39/33		CLSTN
	15				7	7										
			20	0			76.9	21.7	1.4	31.2	13.8	5.2	(CL)s	21/41/44		
															5166.9	
	20						88.1	11.9	0.0	33.6	16.4	6.0	CL	20/50/NA		
		Km	32	0												
	25						55.1	18.2	26.7	30.4	15.4	5.0	g(CL)s	50/NA/NA		
			42	0		5										
	30															
			100	0	5											SHALE
	35															
			100	0												
			100	0												
	40															
			100	0		4										
			100	0												
	45														5141.2	
BOTTOM OF HOLE																

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide
 CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock."
 Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



GEOLOGIC LOG OF DRILL HOLE NO. DHWTP3-17-4

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
 LOCATION: Site Investigation
 BEGUN: 12/4/17 FINISHED: 12/5/17
 DEPTH AND ELEVATION OF WATER LEVEL: NE
 DATE MEASURED: 12/5/2017

PROJECT: Navajo Gallup Water Supply Project
 COORDINATES: N 2,076,975.9 E 2,497,567.6 N.M. State Plane
 TOTAL DEPTH: 50.5 ft
 DEPTH TO BEDROCK: 1.5 ft

STATE: New Mexico
 GROUND ELEVATION: 5169.4 ft NAVD 88
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: P. Gardner
 REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: C. Reynolds, D. Hunter</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 850 track mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 3.5: 4.25 inch HSA with pilot bit. 3.5 to 26.0: 4.25 inch HSA and dry core system with SPT and California Sampling. 26.0 to 28.5: 4.25 inch HSA with pilot bit. 28.5 to 38.5: 4.25 inch HSA with dry core system and California Sampling. 38.5 to 50.5: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 38.5: None. 38.5 to 50.5: Water.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 3.5 to 5.0: SPT 6.0 to 7.0: California (A,B,C) 8.5 to 10.0: SPT 11.0 to 12.0: California (A,B) 13.5 to 15.0: SPT 18.5 to 19.5: California (A,B,C) 23.5 to 25.0: SPT (NR) 28.5 to 29.5: California (NR) 38.8 to 39.6: HQ3 Core (A) 40.0 to 40.5: HQ3 Core (B) 40.5 to 41.5: HQ3 Core (C) 42.6 to 43.3: HQ3 Core (D) 44.8 to 45.2: HQ3 Core (E) 46.5 to 47.5: HQ3 Core (F) 47.7 to 48.7: HQ3 Core (G)</p>		Qal													CL	<p>0.0 to 1.5 ft QUATERNARY ALLUVIUM (Qal)</p> <p>0.0 to 1.5 ft LEAN CLAY (CL): About 90% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 10% fine to medium sand; maximum size, medium sand; brown and dry; strong reaction with HCl.</p> <p>1.5 to 50.5 ft CRETACEOUS MANCOS SHALE (Km)</p> <p>1.5 to 23.5 ft CLAYSTONE: Light to dark brown color and sandy. Laminated to very thinly bedded and friable. Very soft (H7) to moderately soft (H5) and intensely weathered (W7). Carbon blebs and FeOx staining present. CaCOx nodules, stringers and in laminations. Grades to shale. Strong reaction with HCl.</p> <p>23.5 to 25.4 ft SHALE: Light to dark gray color and dry. Laminated to very thinly bedded and fissile. Moderately hard (H4) and slightly weathered (W3). FeOx staining present. CaCOx nodules, stringers and in laminations. Bedding planes near horizontal. Weak reaction with HCl.</p> <p>25.4 to 50.5 ft SHALE: Light to dark gray color. Laminated to thinly bedded and fissile. Moderately soft (H5) and slightly weathered (W3). FeOx staining present. CaCOx nodules, stringers and in laminations. Bedding planes near horizontal. Claystone interbeds. Weak reaction with HCl.</p> <p>JOINT MEASUREMENTS: DEPTH INCL R T HL INFILLING 37.6 88° 6 3 6 CaCOx, FeOx 50.0 90° 6 3 6 CaCOx, FeOx</p> <p>STRATIGRAPHY:</p> <p>0.0 to 1.5 ft QUATERNARY ALLUVIUM (Qal) 1.5 to 50.5 ft CRETACEOUS MANCOS SHALE (Km)</p>
		NR													5167.9	
	5	44					94.5	5.5	0.0	36.1	19.1	6.5	CL	24/38/32		
															28/44	
		76														
	10	48					70.3	29.7	0.0	31.6	15.8	5.2	(CL)s	21/39/50		
															27/27	
		76			5-7	7										
	15						75.3	24.7	0.0	30.6	14.2	5.1	(CL)s	10/27/39		
		74														
	20														31/34	
		78														
	25	100			4		NA	NA	NA	NA	NA	NA	NA	30/NA/NA	5145.9	
		NR														
	30														19/NA	
		100														
	35															
		100														
	40					3										
		93		87												
	45															
		80		52												
	50															
		100		95												5118.9
BOTTOM OF HOLE																

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide
 CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock." Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



GEOLOGIC LOG OF DRILL HOLE NO. DHWTP3-17-5

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
 LOCATION: Site Investigation
 BEGUN: 12/13/17 FINISHED: 12/14/17
 DEPTH AND ELEVATION OF WATER LEVEL: NE
 DATE MEASURED: 12/14/2017

PROJECT: Navajo Gallup Water Supply Project
 COORDINATES: N 2,076,059.4 E 2,497,390.5 N.M. State Plane
 TOTAL DEPTH: 50.0 ft
 DEPTH TO BEDROCK: 4.0 ft

STATE: New Mexico
 GROUND ELEVATION: 5166.0 ft NAVD 88
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: P. Gardner
 REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION	
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT					
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: C. Reynolds, D. Hunter</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 850 track mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 4.5: 4.25 inch HSA with pilot bit. 4.5 to 27.8: 4.25 inch HSA and dry core system with SPT and California Sampling. 27.8 to 28.0: 4.25 inch HSA with pilot bit. 28.0 to 50.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 28.0: None. 28.0 to 50.0: Water.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute.</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 4.5 to 6.0: SPT 7.0 to 8.0: California (A,B) 9.5 to 11.0: SPT 12.0 to 13.0: California (A,B) 14.5 to 16.0: SPT 19.5 to 20.5: California (A,B) 24.5 to 26.0: SPT 28.8 to 29.5: HQ3 Core (A) 31.0 to 31.7: HQ3 Core (B) 42.8 to 43.9: HQ3 Core (C) 44.0 to 44.8: HQ3 Core (D) 49.1 to 49.9: HQ3 Core (E)</p>		Qal	NR											CL		0.0 to 4.0 ft QUATERNARY ALLUVIUM (Qal)	
	5			5		96.0	4.0	0.0	33.5	20.0	8.1	CL	16/27/26	5162.0	SHALE	4.0 to 50.0 ft CRETACEOUS MANCOS SHALE (Km)	
			100														4.0 to 4.8 ft SHALE: Light to dark gray color, sandy, fissile and dry. Bedding is laminated and bedding planes near horizontal. Moderately soft (H5) and moderately to slightly weathered (W4). Strong reaction with HCl.
			100														4.8 to 25.4 ft CLAYSTONE: Light to dark brown color, sandy and dry. Laminated to thinly bedded and bedding planes near horizontal. Very soft (H7) to moderately soft (H5) and moderately to slightly weathered (W4). Carbon blebs present. CaCOx nodules, stringers and in laminations. Friable and easily breaks on bedding planes. Slakes rapidly in water. Strong reaction with HCl.
	10		36				98.0	2.0	0.0	36.9	20.5	9.0	CL	13/20/23			25.4 to 27.8 ft SHALE: Light to dark gray color, sandy and dry. Laminated to very thinly bedded and fissile. Moderately soft (H5) and slightly weathered (W3). FeOx staining present. CaCOx nodules, stringers and in laminations. Bedding planes near horizontal. Weak reaction with HCl.
			40														27.8 to 34.2 ft SHALE: Light to dark gray color, sandy and dry. Laminated to very thinly bedded and fissile. Hard (H3) and slightly weathered (W3). FeOx staining present. CaCOx nodules, stringers and in laminations. Bedding planes near horizontal. Weak reaction with HCl.
	15		52		5-7	4	97.8	2.2	0.0	36.6	18.8	8.3	CL	21/36/42			JOINT MEASUREMENTS: DEPTH INCL R T HL INFILLING 28.5 0° 4 1 1 CaCOx
																	34.2 to 50.0 ft SHALE: Light to dark gray color, sandy and dry. Laminated to thinly bedded and fissile. Moderately soft (H5) and slightly weathered (W3). FeOx staining present. CaCOx nodules, stringers and in laminations. Bedding planes near horizontal. Weak reaction with HCl.
	20		60														JOINT MEASUREMENTS: DEPTH INCL R T HL INFILLING 42.8 87° 4 2 3 CaCOx
																	STRATIGRAPHY: 0.0 to 1.7 ft QUATERNARY ALLUVIUM (Qal) 1.7 to 50.0 ft CRETACEOUS MANCOS SHALE (Km)
	25		91		5		96.8	3.2	0.0	37.4	20.4	7.4	CL	20/50/NA	5140.6		
		Km	NR														
	30		93	80	3												
	35		100	18													
	40		100	0	3												
	45		100	76	5												
	50		100	53													
BOTTOM OF HOLE																	

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide
 CaCO₃= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock." Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



GEOLOGIC LOG OF DRILL HOLE NO. DHWTP3-17-6

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
 LOCATION: Site Investigation
 BEGUN: 12/15/17 FINISHED: 12/15/17
 DEPTH AND ELEVATION OF WATER LEVEL: NE
 DATE MEASURED: 12/15/2017

PROJECT: Navajo Gallup Water Supply Project
 COORDINATES: N 2,076,266.1 E 2,498,350.0 N.M. State Plane
 TOTAL DEPTH: 51.5 ft
 DEPTH TO BEDROCK: 0.9 ft

STATE: New Mexico
 GROUND ELEVATION: 5174.3 ft NAVD 88
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: P. Gardner
 REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: C. Reynolds, D. Hunter</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 850 track mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 4.0: 4.25 inch HSA with pilot bit. 4.0 to 18.6: 4.25 inch HSA and dry core system with SPT and California Sampling. 18.6 to 19.0: 4.25 inch HSA with pilot bit. 19.0 to 51.5: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 19.0: None. 19.0 to 51.5: Water.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute.</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 4.0 to 5.5: SPT 6.5 to 7.5: California (A,B) 9.0 to 10.5: SPT 11.5 to 12.5: California (A,B) 14.0 to 15.5: SPT 24.7 to 25.2: HQ3 Core (A) 27.0 to 27.7: HQ3 Core (B) 28.3 to 29.2: HQ3 Core (C) 31.7 to 32.7: HQ3 Core (D) 34.9 to 35.5: HQ3 Core (E) 38.3 to 39.0: HQ3 Core (F)</p>		Qal													CL	0.0 to 0.9 ft QUATERNARY ALLUVIUM (Qal)
			NR												5178.4	0.0 to 0.9 ft LEAN CLAY (CL): About 95% fines with low plasticity, low toughness, medium dry strength and no dilatancy; about 5% fine sand; maximum size, fine sand; brown and dry; strong reaction with HCl.
	5		28				96.1	3.9	0.0	40.3	25.3	7.4	CL	13/25/34		0.9 to 51.5 ft CRETACEOUS MANCOS SHALE (Km)
			8											45/50		0.9 to 17.6 ft CLAYSTONE: Light to dark brown color and dry. Laminated to thinly bedded, bedding planes near horizontal. Very soft (H7) to moderately soft (H5) and intensely weathered (W7). Carbon blebs present. CaCO ₃ nodules, stringers and in laminations. Friable, easily breaks on bedding planes. Grades to shale. Strong reaction with HCl.
	10		28		5-7	7	98.4	1.6	0.0	38.7	19.5	8.0	CL	8/33/39	CLSTN	17.6 to 19.5 ft SHALE: Light to dark gray color and dry. Laminated to very thinly bedded and fissile. Moderately hard (H4) and slightly weathered (W3). FeOx staining present. Bedding planes near horizontal. Weak reaction with HCl.
			20											17/34		
	15		48				93.4	6.6	0.0	37.2	18.9	6.9	CL	27/33/28		19.5 to 51.5 ft SHALE: Light to dark gray color. Laminated to very thinly bedded and fissile. Moderately soft (H5) and slightly weathered (W3). FeOx staining present. CaCO ₃ in laminations. Bedding planes near horizontal. Easily separates on bedding planes. Claystone interbeds. No to strong reaction with HCl.
			NR		4										5156.7	
	20		88	33												JOINT MEASUREMENTS: DEPTH INCL R T HL INFILLING 34.2 89° 4 2 3 CaCO ₃
			100	62												STRATIGRAPHY: 0.0 to 0.9 ft QUATERNARY ALLUVIUM (Qal) 0.9 to 51.5 ft CRETACEOUS MANCOS SHALE (Km)
	25	Km														
			100	78												
	30															
			100	82		3									SHALE	
	35				5											
			100	84												
	40															
			100	80												
	45															
			100	84												
	50														5122.8	
BOTTOM OF HOLE																

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide
 CaCO₃= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock." Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



GEOLOGIC LOG OF DRILL HOLE NO. DHWTP3-17-7

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
 LOCATION: Site Investigation
 BEGUN: 12/16/17 FINISHED: 12/17/17
 DEPTH AND ELEVATION OF WATER LEVEL: NE
 DATE MEASURED: 12/17/2017

PROJECT: Navajo Gallup Water Supply Project
 COORDINATES: N 2,075,532.3 E 2,499,260.6 N.M. State Plane
 TOTAL DEPTH: 51.5 ft
 DEPTH TO BEDROCK: 1.2 ft

STATE: New Mexico
 GROUND ELEVATION: 5179.2 ft NAVD 88
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: P. Gardner
 REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: C. Reynolds, D. Hunter</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 850 track mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 4.0: 4.25 inch HSA with pilot bit. 4.0 to 20.0: 4.25 inch HSA and dry core system with SPT and California Sampling. 20.0 to 51.5: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 20.0: None. 20.0 to 51.5: Water.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute.</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 4.0 to 5.5: SPT 6.5 to 7.5: California (A,B) 9.0 to 10.5: SPT 11.5 to 12.5: California (A,B) 14.0 to 15.5: SPT 19.0 to 20.0: California (A,B) 20.1 to 20.7: HQ3 Core (A) 37.0 to 40.3: Bag 47.5 to 48.5: HQ3 Core (B)</p>		Qal													CL 5178.0	<p>0.0 to 1.2 ft QUATERNARY ALLUVIUM (Qal)</p> <p>0.0 to 1.2 ft LEAN CLAY (CL): About 90% fines with low plasticity, low toughness, medium dry strength and no dilatancy; about 10% fine sand; maximum size, fine sand; brown and dry; strong reaction with HCl.</p> <p>1.2 to 51.5 ft CRETACEOUS MANCOS SHALE (Km)</p> <p>1.2 to 19.8 ft CLAYSTONE: Light to dark brown color and dry. Laminated to thinly bedded. Bedding planes near horizontal. Very soft (H7) to moderately soft (H5) and intensely weathered (W7). Carbon blebs present. CaCO₃ in laminations. Friable and easily breaks on bedding planes. Slakes rapidly in water. Strong reaction with HCl.</p> <p>JOINT MEASUREMENTS: DEPTH INCL R T HL INFILLING 10.9 90° 5 3 1 CaCO₃, gypsum 11.0 90° 5 3 1 CaCO₃, gypsum 11.5 0° 4 1 1 CaCO₃, FeOx, gypsum</p> <p>19.8 to 21.6 ft SHALE: Light to dark gray color. Laminated to thinly bedded and fissile. Moderately hard (H4) and moderately to slightly weathered (W4). CaCO₃ in laminations. Bedding planes near horizontal. Weak reaction with HCl.</p> <p>21.6 to 22.9 ft SHALE: Light to dark gray color. Laminated to thinly bedded and fissile. Moderately soft (H5) and slightly weathered (W3). FeOx staining present. CaCO₃ nodules, stringers and in laminations. Bedding planes near horizontal. Weak reaction with HCl.</p> <p>22.9 to 25.1 ft CLAYSTONE: Light to dark brown color. Laminated to thinly bedded. Bedding planes near horizontal. Very soft (H7) to moderately soft (H5) and slightly weathered (W3). Carbon blebs present. CaCO₃ in laminations. Friable and easily breaks on bedding planes. Grades to shale. Strong reaction with HCl.</p> <p>25.1 to 37.0 ft SHALE: Light to dark gray color. Laminated to thinly bedded and fissile. Moderately soft (H5) and slightly weathered (W3). Carbon blebs present. CaCO₃ in laminations. Bedding planes near horizontal. Claystone interbeds. Sandstone interbeds between 35.0 to 37.1 ft. No to weak reaction with HCl.</p> <p>37.0 to 40.3 ft CLAYSTONE: Light to dark brown color and sandy. Laminated to thinly bedded. Bedding planes near horizontal. Very soft (H7) to moderately soft (H5) and slightly weathered (W3). Carbon blebs present. CaCO₃ in laminations. Friable and easily breaks on bedding planes. Grades to shale. Shale and sandstone interbeds. Strong reaction with HCl.</p> <p>40.3 to 51.5 ft SHALE: Light to dark gray color and sandy. Laminated to thinly bedded and fissile. Very soft (H7) to moderately soft (H5) and slightly weathered (W3). Carbon blebs present. CaCO₃ in laminations. Bedding planes near horizontal. Claystone interbed intervals from 45.4 to 46.6 and 48.8 to 50.8 feet. No to weak reaction with HCl.</p> <p>STRATIGRAPHY:</p> <p>0.0 to 1.2 ft QUATERNARY ALLUVIUM (Qal) 1.2 to 51.5 ft CRETACEOUS MANCOS SHALE (Km)</p>
	5		NR													
			20				97.4	2.6	0.0	39.0	21.2	7.0	CL	17/24/22		
			100											25/40		
	10		32		5-7	7	96.1	3.9	0.0	38.9	23.8	7.2	CL	28/43/48	CLSTN	
			68											49/50		
	15		60				89.5	10.5	0.0	34.9	17.3	6.5	CL	20/34/38		
			70													
	20		69	38	4	4								19/50	5159.4	
					5											
			100	14	5-7											
	25	Km	100	0												
			100	60												
	30				5											
			100	10												
	35					3										
			100	18			67.0	33.0	0.0	27.3	12.0	4.2	s(CL)			
	40															
			100	45	5-7											
	45															
			100	35												
	50														5127.7	

BOTTOM OF HOLE

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide
 CaCO₃= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock." Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



SHEET 1 OF 1

STATE: New Mexico

GROUND ELEVATION: 5192.7 ft NAVD 88

ANGLE FROM HORIZONTAL: -90°

HOLE LOGGED BY: P. Gardner

REVIEWED BY: C. Beyer

BOTTOM OF HOLE

GEOLOGIC LOG OF DRILL HOLE NO. DHWTP3-18-9

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
 LOCATION: Road Crossing
 BEGUN: 5/2/18 FINISHED: 5/3/18
 DEPTH AND ELEVATION OF WATER LEVEL: NE
 DATE MEASURED: 5/3/2018

PROJECT: Navajo Gallup Water Supply Project
 COORDINATES: N 2,076,983.5 E 2,498,846.1 N.M. State Plane
 TOTAL DEPTH: 39.0 ft
 DEPTH TO BEDROCK: 2.1 ft

STATE: New Mexico
 GROUND ELEVATION: 5185.7 ft NAVD 88
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: P. Gardner
 REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: B. Kenyon, B. Samuels</p> <p>PURPOSE: Preconstruction soil and bedrock investigations for trenchless construction methods.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 4.0: 4.25 inch HSA with pilot bit. 4.0 to 8.7: 4.25 inch HSA and dry core system with SPT and California Sampling. 8.7 to 11.5: 4.25 inch HSA with pilot bit. 11.5 to 30.0: 4.25 inch HSA and dry core system with SPT and California Sampling. 30.0 to 39.0: 4.25 inch HSA with dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 39.0: None.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute.</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 0.0 to 10.0: Bulk 0.0 to 1.0: California (A,B) 4.0 to 5.5: SPT 6.5 to 7.5: California (A,B) 11.5 to 13.0: SPT 14.0 to 15.0: California (A,B) 16.5 to 18.0: SPT 19.0 to 20.0: California (NR) 24.0 to 25.5: SPT (NR) 29.0 to 30.0: California (NR)</p>		Qal												4/4	s(CL)	0.0 to 2.1 ft QUATERNARY ALLUVIUM (Qal)
			NR												5183.6	
	5		93		5-7	7	93.8	6.2	0.0	37.7	20.7	13.5	CL	19/45/50		2.1 to 39.0 ft CRETACEOUS MANCOS SHALE (Km)
			100											48/50		
	10		NR		5										5177.0	SHALE
															5175.2	
			100				84.4	12.8	2.8	34.4	18.1	6.3	CL	7/25/25		8.7 to 10.5 ft SHALE: Light to dark gray color. Laminated to thinly bedded and fissile. Moderately soft (H5) and slightly weathered (W3). Bedding planes near horizontal. No to weak reaction with HCl.
	15		88		5-7									50/38		
							72.9	27.1	0.0	30.2	15.1	5.6	(CL)s	39/50/NA		10.5 to 22.8 ft CLAYSTONE: Light to dark brown color. Laminated to thinly bedded and bedding planes near horizontal. Very soft (H7) to moderately soft (H5) and intensely weathered (W7). Carbon blebs present. CaCO ₃ nodules, stringers and in laminations. FeOx present. Friable and easily breaks on bedding planes. Shale interbeds. Strong reaction with HCl.
			100													
	20	Km		NA										35/NA		JOINT MEASUREMENTS: DEPTH INCL R T HL INFILLING 17.0 60° 4 2 6 CaCO ₃ 18.0 72° 4 3 6 CaCO ₃ 18.1 83° 4 3 6 CaCO ₃ 20.2 58° 4 0 6 CaCO ₃ 20.3 78° 4 0 6 CaCO ₃ 20.5 90° 4 2 6 CaCO ₃ 20.9 90° 4 2 6 CaCO ₃ 21.2 56° 4 3 6 CaCO ₃ 21.8 78° 4 3 6 CaCO ₃ 22.2 90° 4 2 6 CaCO ₃
			94												5162.9	
	25					3	NA	NA	NA	NA	NA	NA	NA	40/NA/NA		22.8 to 39.0 ft SHALE: Light to dark gray color. Laminated to thinly bedded and fissile. Moderately soft (H5) and slightly weathered (W3). Bedding planes near horizontal. FeOx staining. No to weak reaction with HCl.
			28													
	30													35/NA		STRATIGRAPHY: 0.0 to 2.1 ft QUATERNARY ALLUVIUM (Qal) 2.1 to 39.0 ft CRETACEOUS MANCOS SHALE (Km)
			100		5											
	35															SHALE
			66													
															5146.7	

BOTTOM OF HOLE

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide
 CaCO₃= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock." Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



GEOLOGIC LOG OF DRILL HOLE NO. DHWTP3-18-10

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
 LOCATION: Road Crossing
 BEGUN: 5/4/18 FINISHED: 5/9/18
 DEPTH AND ELEVATION OF WATER LEVEL: NE
 DATE MEASURED: 5/9/2018

PROJECT: Navajo Gallup Water Supply Project
 COORDINATES: N 2,077,383.1 E 2,499,092.9 N.M. State Plane
 TOTAL DEPTH: 40.0 ft
 DEPTH TO BEDROCK: 1.6 ft

STATE: New Mexico
 GROUND ELEVATION: 5195.9 ft NAVD 88
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: P. Gardner
 REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	% RQD	HARDNESS	WEATHERING	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	VISUAL CLASSIFICATION	CLASSIFICATION AND PHYSICAL CONDITION
							% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT				
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: B. Kenyon, B. Samuels</p> <p>PURPOSE: Preconstruction soil and bedrock investigations for trenchless construction methods.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 4.0: 4.25 inch HSA with pilot bit. 4.0 to 11.2: 4.25 inch HSA and dry core system with SPT and California Sampling. 11.2 to 14.0: 4.25 inch HSA with pilot bit. 14.0 to 21.9: 4.25 inch HSA and dry core system with SPT and California Sampling. 21.9 to 33.5: 4.25 inch HSA with dry core system. 33.5 to 36.5: 4.25 inch HSA with pilot bit. 36.5 to 40.0: 4.25 inch HSA with dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 40.0: None.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute.</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 0.0 to 10.0: Bulk Sample 0.0 to 1.0: California (A,B) 4.0 to 5.5: SPT 6.5 to 7.5: California (A,B) 9.0 to 10.5: SPT 14.0 to 15.0: California (A,B) 16.5 to 18.0: SPT 19.0 to 20.0: California (A) 21.5 to 23.0: SPT (shale)</p>		Qal												3/3	SM	0.0 to 1.6 ft QUATERNARY ALLUVIUM (Qal)
			NR												CL 5194.3	
	5		100		5-7	7	94.3	5.7	0.0	38.9	21.8	7.1	CL	24/48/50		0.3 to 1.6 ft LEAN CLAY (CL): About 90% fines with medium plasticity, medium toughness, high dry strength and no dilatancy; about 10% fine sand; trace of fine to coarse, hard, subangular to subrounded gravel; maximum size, 60mm; dark brown, dry, CaCO ₃ stringers and nodules present; strong reaction with HCl.
			40											33/50	CLSTN	
	10		64				98.5	1.5	0.0	44.1	27.8	7.5	CL	21/32/42		1.6 to 40.0 ft CRETACEOUS MANCOS SHALE (Km)
			NR		5										5184.9	
															SHALE 5183.9	11.0 to 12.0 ft SHALE: Light to dark brown color. Laminated to thinly bedded and bedding planes near horizontal. Very soft (H7) to moderately soft (H5) and intensely weathered (W7). CaCO ₃ laminations. FeOx staining. Friable and easily breaks on bedding planes. Grades to shale. Strong reaction with HCl.
	15		80		5-7									19/21	CLSTN	
			72				77.3	21.9	0.8	31.8	14.7	4.8	(CL)s	37/44/50	5179.6	12.0 to 16.3 ft CLAYSTONE: Light to dark brown color. Laminated to thinly bedded and bedding planes near horizontal. Very soft (H7) to moderately soft (H5) and intensely weathered (W7). Carbon blebs present. CaCO ₃ nodules, stringers and in laminations. FeOx present. Friable and easily breaks on bedding planes. Shale interbeds. Strong reaction with HCl.
	20	Km	60	NA										50/NA		
			48				NA	NA	NA	NA	NA	NA	NA	18/NA/NA		16.3 to 40.0 ft SHALE: Light to dark gray color. Laminated to thinly bedded and fissile. Moderately soft (H5) and slightly weathered (W3). Bedding planes near horizontal. FeOx staining. Claystone interbeds. No to weak reaction with HCl.
	25					3										
			90													STRATIGRAPHY: 0.0 to 1.6 ft QUATERNARY ALLUVIUM (Qal) 1.6 to 40.0 ft CRETACEOUS MANCOS SHALE (Km)
	30		100		5											
			NR													
	35		NR													
			100													
	40														5155.9	

BOTTOM OF HOLE

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide
 CaCO₃= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock." Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



GEOLOGIC LOG OF DRILL HOLE NO. DH-18-1

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
LOCATION: Terrace Investigation
BEGUN: 5/19/2018 FINISHED: 5/19/2018
DEPTH TO WATER & ELEVATION: NE
WATER DEPTH MEASURED ON: 5/19/2018

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2,078,052.1 E 2,499,193.7 N.M. State Plane
TOTAL DEPTH: 49.0 ft
DEPTH TO BEDROCK: 14.5 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5246.2 ft NAVD 88
ANGLE FROM HORIZONTAL: -90 °
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC UNIT	CLASSIFICATION	ENGINEERING PROPERTIES				GRAPHIC	% RECOVERY	RQD	HOLE COMPLETION	CLASSIFICATION AND PHYSICAL CONDITION																																																																																																																																									
				Fracture Density	Hardness	Weathering	Blows/0.5 Ft																																																																																																																																														
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: M. Matheson, B. Samuels</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 16.5: 4.25 inch HSA with pilot bit. 16.5 to 35.0: 4.25 inch HSA with dry core system and California Sampling. 35.0 to 49.0: 4.25 inch HSA with dry core system.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 49.0: None.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute.</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 16.5 to 17.5: California (A,B) 19.0 to 20.0: California (A,B) 21.5 to 22.5: California (A,B) 24.0 to 25.0: California (A,B) 26.5 to 27.5: California (A,B) 29.0 to 30.0: California (A,B) 34.0 to 35.0: California (NR)</p>	5	Qtg	Silt, Sand, Gravel and Cobble						0	NA	<p>0.0 to 14.5 ft Quaternary Terrace Gravel (Qtg)</p> <p>0.0 to 16.5 ft NO RECOVERY: Silt, sand, gravel, and cobbles; observation from cuttings using pilot bit; gravel and cobbles are hard and subrounded; brown to tan and dry; bottom of geologic unit determined by drilling action; strong reaction with HCl.</p> <p>14.5 to 49.0 ft Cretaceous Mancos Shale (Km)</p> <p>14.5 to 29.6 ft CLAYSTONE: Light to dark brown and laminated to thinly bedded. Soft (H6) and intensely weathered (W7). FeOx and CaCOx in laminations and friable. Easily separates on bedding planes. Grades to shale. Weak to no reaction with HCl.</p> <p>29.6 to 49.0 ft SHALE: Light to dark gray, sandy, fissile and laminated to thinly bedded. Moderately soft (H5) and moderately weathered (W5). CaCOx and gypsum in bedding planes and joints. FeOx staining present. Bedding planes near horizontal. Strong reaction with HCl.</p>																																																																																																																																										
	10								0	NA																																																																																																																																											
	15			5231.7					0	NA																																																																																																																																											
	20		CLSTN	6	7	49/50		84	0		<p>JOINT MEASUREMENTS:</p> <table><thead><tr><th>DEPTH</th><th>INCL</th><th>R</th><th>T</th><th>HL</th><th>INFILLING</th></tr></thead><tbody><tr><td>30.8</td><td>18°</td><td>4</td><td>3</td><td>6</td><td>Gypsum, CaCOx.</td></tr><tr><td>31.5</td><td>85°</td><td>4</td><td>2</td><td>5</td><td>Gypsum, CaCOx.</td></tr><tr><td>31.7</td><td>74°</td><td>4</td><td>2</td><td>5</td><td>Gypsum, CaCOx.</td></tr><tr><td>32.9</td><td>84°</td><td>4</td><td>2</td><td>5</td><td>Gypsum, CaCOx.</td></tr><tr><td>34.8</td><td>90°</td><td>4</td><td>3</td><td>6</td><td>Gypsum, CaCOx.</td></tr><tr><td>35.1</td><td>88°</td><td>4</td><td>2</td><td>5</td><td>Gypsum, CaCOx.</td></tr><tr><td>35.4</td><td>89°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>36.2</td><td>87°</td><td>4</td><td>3</td><td>5</td><td>CaCOx.</td></tr><tr><td>36.8</td><td>87°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>37.3</td><td>74°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>37.8</td><td>16°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>38.0</td><td>78°</td><td>3</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>40.2</td><td>45°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>40.6</td><td>86°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>41.2</td><td>55°</td><td>4</td><td>2</td><td>5</td><td>Gypsum, CaCOx.</td></tr><tr><td>42.5</td><td>52°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>43.5</td><td>90°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>45.4</td><td>3°</td><td>4</td><td>3</td><td>6</td><td>Gypsum, CaCOx.</td></tr><tr><td>46.1</td><td>56°</td><td>4</td><td>2</td><td>5</td><td>Gypsum, CaCOx.</td></tr><tr><td>46.8</td><td>90°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>47.1</td><td>84°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr><tr><td>48.4</td><td>41°</td><td>4</td><td>2</td><td>5</td><td>CaCOx.</td></tr></tbody></table> <p>STRATIGRAPHY:</p> <p>0.0 to 14.5 ft QUATERNARY TERRACE GRAVEL (Qtg) 14.5 to 49.0 ft CRETACEOUS MANCOS SHALE (Km)</p>	DEPTH	INCL	R	T	HL	INFILLING	30.8	18°	4	3	6	Gypsum, CaCOx.	31.5	85°	4	2	5	Gypsum, CaCOx.	31.7	74°	4	2	5	Gypsum, CaCOx.	32.9	84°	4	2	5	Gypsum, CaCOx.	34.8	90°	4	3	6	Gypsum, CaCOx.	35.1	88°	4	2	5	Gypsum, CaCOx.	35.4	89°	4	2	5	CaCOx.	36.2	87°	4	3	5	CaCOx.	36.8	87°	4	2	5	CaCOx.	37.3	74°	4	2	5	CaCOx.	37.8	16°	4	2	5	CaCOx.	38.0	78°	3	2	5	CaCOx.	40.2	45°	4	2	5	CaCOx.	40.6	86°	4	2	5	CaCOx.	41.2	55°	4	2	5	Gypsum, CaCOx.	42.5	52°	4	2	5	CaCOx.	43.5	90°	4	2	5	CaCOx.	45.4	3°	4	3	6	Gypsum, CaCOx.	46.1	56°	4	2	5	Gypsum, CaCOx.	46.8	90°	4	2	5	CaCOx.	47.1	84°	4	2	5	CaCOx.	48.4	41°	4	2	5	CaCOx.
	DEPTH	INCL				R	T	HL	INFILLING																																																																																																																																												
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BOTTOM OF HOLE

BOTTOM OF HOLE

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock. Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



GEOLOGIC LOG OF DRILL HOLE NO. DH-18-2

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
LOCATION: Terrace Investigation
BEGUN: 5/20/2018 FINISHED: 5/21/2018
DEPTH TO WATER & ELEVATION: NE
WATER DEPTH MEASURED ON: 5/21/2018

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2,078,348.2 E 2,499,362.1 N.M. State Plane
TOTAL DEPTH: 50.0 ft
DEPTH TO BEDROCK: 18.0 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5247.3 ft NAVD 88
ANGLE FROM HORIZONTAL: -90 °
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC UNIT	CLASSIFICATION	ENGINEERING PROPERTIES				GRAPHIC	% RECOVERY	RQD	HOLE COMPLETION	CLASSIFICATION AND PHYSICAL CONDITION		
				Fracture Density	Hardness	Weathering	Blows/0.5 Ft							
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: M. Matheson, B. Samuels</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 19.0: 4.25 inch HSA with pilot bit. 19.0 to 25.0: 4.25 inch HSA with dry core system and California Sampling. Moved drill hole 4 ft south 0.0 to 24.0: 4.25 inch HSA with pilot bit. 24.0 to 27.5: 4.25 inch HSA with dry core system and California Sampling. 27.5 to 50.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.</p> <p>DRILLING MEDIUM: 0.0 to 26.5: None. 26.5 to 50.0: Water.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute.</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 19.0 to 20.0: California (A,B) 21.5 to 22.5: California (A) 24.0 to 25.0: California (A,B) 26.5 to 27.5: California (NR) 35.6 to 36.3: HQ3 core (A) 36.5 to 37.0: HQ3 core (B) 37.3 to 37.9: HQ3 core (C) 49.0 to 49.7: HQ3 core (D)</p>	5	Qtg	Silt, Sand, Gravel and Cobble									0.0 to 18.0 ft Quaternary Terrace Gravel (Qtg)		
													0.0 to 19.0 ft NO RECOVERY: Silt, sand, gravel, and cobbles; observation from cuttings using pilot bit; gravel and cobbles are hard and subrounded; brown to tan and dry; bottom of geologic unit determined by drill action; strong reaction with HCl.	
													18.0 to 50.0 ft Cretaceous Mancos Shale (Km)	
													18.0 to 34.3 ft CLAYSTONE: Light to dark brown and laminated to thinly bedded. Bedding planes near horizontal. Very soft (H7) to moderately soft (H5) and intensely weathered (W7). FeOx and CaCOx in laminations and friable. Easily separates on bedding planes. Grades to shale. Weak to no reaction with HCl.	
		10											JOINT MEASUREMENTS:	
		15	5229.3										DEPTH INCL R T HL INFILLING	
													24.5 75° 3 3 5 Gypsum, CaCOx.	
													25.1 86° 4 2 5 Gypsum, CaCOx.	
													25.4 19° 4 2 6 CaCOx.	
													28.2 86° 3 2 5 Gypsum, CaCOx.	
													30.4 44° 4 3 6 Gypsum, CaCOx.	
													31.1 87° 4 3 5 Gypsum, CaCOx.	
													31.4 88° 4 3 5 Gypsum, CaCOx.	
													31.9 78° 4 3 5 Gypsum, CaCOx.	
													32.1 69° 4 2 5 Gypsum, CaCOx.	
													33.0 90° 4 2 5 CaCOx.	
		20	CLSTN		7			50/NA		100			34.3 to 50.0 ft SHALE: Light to dark gray, sandy, fissile and laminated to thinly bedded. Light to dark brown claystone interbeds. Moderately soft (H5) and moderately weathered (W5). Hard (H3) below 48.6 feet. CaCOx and gypsum in bedding planes and joints. FeOx staining present. Bedding planes near horizontal. Strong reaction with HCl.	
		9				50/NA		100			JOINT MEASUREMENTS:			
											DEPTH INCL R T HL INFILLING			
											36.6 90° 4 2 5 Gypsum, CaCOx.			
	25			9	5-7	7	50/29		100			39.2 59° 1 2 5 Gypsum, CaCOx.		
							50/NA					40.5 63° 4 3 5 Gypsum, CaCOx.		
				7					100	67		41.3 90° 4 2 5 Gypsum, CaCOx.		
	30	Km										41.6 68° 4 2 3 Gypsum, CaCOx.		
													42.0 88° 3 2 5 Gypsum, CaCOx.	
													42.2 67° 4 2 5 Gypsum, CaCOx.	
													42.7 73° 4 3 5 Gypsum, CaCOx.	
	35			5					100	64		43.7 70° 4 3 5 Gypsum.		
												45.6 59° 4 2 5 Gypsum, CaCOx.		
												47.1 84° 4 2 5 Gypsum, CaCOx.		
	40	SHALE		6	5	5						47.3 28° 4 2 5 Gypsum, CaCOx.		
													48.0 86° 4 3 5 Gypsum, CaCOx.	
	45			7					90	82				
	50	5197.3		5		3			100	70				
BOTTOM OF HOLE														

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock. Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



GEOLOGIC LOG OF DRILL HOLE NO. DH-18-3

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
LOCATION: Terrace Investigation
BEGUN: 5/22/2018 FINISHED: 5/23/2018
DEPTH TO WATER & ELEVATION: NE
WATER DEPTH MEASURED ON: 5/22/2018

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2,078,427.2 E 2,500,443.8 N.M. State Plane
TOTAL DEPTH: 50.5 ft
DEPTH TO BEDROCK: 8.4 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5245.9 ft NAVD 88
ANGLE FROM HORIZONTAL: -90 °
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC UNIT	CLASSIFICATION	ENGINEERING PROPERTIES				GRAPHIC	% RECOVERY	RQD	HOLE COMPLETION	CLASSIFICATION AND PHYSICAL CONDITION
				Fracture Density	Hardness	Weathering	Blows/0.5 Ft					
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: B. Samuels</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 9.0: 4.25 inch HSA with pilot bit. 9.0 to 17.5: 4.25 inch HSA with dry core system and California Sampling. 17.5 to 50.5: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 17.5: None. 17.5 to 50.5: Water.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute.</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 9.0 to 10.0: California (A,B) 11.5 to 12.5: California (A,B) 14.0 to 15.0: California (A,B) 16.5 to 17.5: California (NR)</p>	5	Qtg	Silt, Sand, Gravel and Cobble									0.0 to 8.4 ft Quaternary Terrace Gravel (Qtg)
		5237.5										0.0 to 9.0 ft NO RECOVERY: Silt, sand, gravel, and cobbles; observation from cuttings using pilot bit; gravel and cobbles are hard to very hard and round to subrounded; some flat and elongated particles; bottom of geologic unit determined by drilling action; brown to tan and dry; strong reaction with HCl.
	10			9			39/50		28			8.4 to 50.5 ft Cretaceous Mancos Shale (Km)
				9			42/50		32			8.4 to 50.5 ft CLAYSTONE: Light to dark brown and laminated to thinly bedded. Very soft (H7) to moderately soft (H5) and intensely weathered (W7). FeOx and CaCOx in laminations and friable. Easily separates on bedding planes. Shale interbeds. Weak to no reaction with HCl.
	15			9			38/50		36			JOINT MEASUREMENTS:
				9			50/NA		100			DEPTH INCL R T HL INFILLING
				9					100			20.0 70° 2 2 5 CaCOx.
												25.2 20° 4 2 5 CaCOx.
												26.2 82° 4 2 5 CaCOx.
												29.2 42° 4 2 5 CaCOx.
												31.0 46° 4 3 5 CaCOx.
												31.6 48° 4 2 5 CaCOx.
												32.3 29° 4 3 5 CaCOx.
												34.6 90° 4 3 5 CaCOx.
												34.8 90° 4 3 5 CaCOx.
												36.3 50° 4 3 5 CaCOx.
												36.8 62° 4 2 5 CaCOx.
												38.0 90° 4 2 5 CaCOx.
												38.7 41° 4 2 5 CaCOx.
												40.6 81° 4 2 5 CaCOx.
												40.7 33° 4 3 5 CaCOx.
												41.5 90° 4 3 5 Gypsum, CaCOx.
												41.8 89° 4 3 5 Gypsum, CaCOx.
												42.0 90° 4 3 5 Gypsum, CaCOx.
												42.2 63° 4 2 5 Gypsum, CaCOx.
												42.7 90° 4 3 5 Gypsum, CaCOx.
												42.9 74° 4 3 5 Gypsum, CaCOx.
												43.2 88° 4 3 5 Gypsum, CaCOx.
												44.2 87° 4 3 5 CaCOx.
	20			6					100	73		STRATIGRAPHY:
												0.0 to 8.4 ft QUATERNARY TERRACE GRAVEL (Qtg)
												8.4 to 50.5 ft CRETACEOUS MANCOS SHALE (Km)
	25			7					100	80		
	30	Km	CLSTN	6	5-7	7			100	30		
	35			7					100	60		
	40			7					100	90		
	45			7					100	58		
	50	5195.4		7					96	52		

BOTTOM OF HOLE

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock. Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



GEOLOGIC LOG OF DRILL HOLE NO. DH-18-4

SHEET 1 OF 1

FEATURE: San Juan Lateral Water Treatment Plant
LOCATION: Terrace Investigation
BEGUN: 5/31/2018 FINISHED: 5/31/2018
DEPTH TO WATER & ELEVATION: NE
WATER DEPTH MEASURED ON: 5/31/2018

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2,077,830.9 E 2,500,040.5 N.M. State Plane
TOTAL DEPTH: 44.8 ft
DEPTH TO BEDROCK: 13.8 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5245.8 ft NAVD 88
ANGLE FROM HORIZONTAL: -90 °
HOLE LOGGED BY: C. Beyer
REVIEWED BY: P. Gardner

NOTES	DEPTH	GEOLOGIC UNIT	CLASSIFICATION	ENGINEERING PROPERTIES				GRAPHIC	% RECOVERY	RQD	HOLE COMPLETION	CLASSIFICATION AND PHYSICAL CONDITION
				Fracture Density	Hardness	Weathering	Blows/0.5 Ft					
<p>All measurements are from ground level and reported in feet unless otherwise noted.</p> <p>DRILLED BY: Upper Colorado Drill Crew DRILLER: B. Lane HELPER: C. McFadden, B. Samuels</p> <p>PURPOSE: Preconstruction soil and bedrock foundation investigations.</p> <p>DRILL EQUIPMENT: CME Model 85 truck mounted rotary drill rig.</p> <p>DRILL METHOD: 0.0 to 9.0: 4.25 inch HSA with pilot bit. 9.0 to 14.0: 4.25 inch HSA with dry core system and California Sampling. 14.0 to 16.5: 4.25 inch HSA with pilot bit. 16.5 to 44.8: 4.25 inch HSA with dry core system and California Sampling.</p> <p>CASING RECORD: None used.</p> <p>DRILLING MEDIUM: 0.0 to 44.8: None.</p> <p>DRILLING NOTES: Auto Hammer set at constant RPM rate of 20-40 blows per minute.</p> <p>HOLE COMPLETION: Backfilled with bentonite.</p> <p>SAMPLING: 16.5 to 17.5: California (A) 19.0 to 20.0: California (A) 21.5 to 22.5: California (A) 24.0 to 25.0: California (A, B) 29.0 to 30.0: California (A) 34.0 to 35.0: California (NR) 39.0 to 40.0: California (NR)</p>	5	Qtg	Silt, Sand, Gravel and Cobble						0			<p>0.0 to 13.8 ft Quaternary Terrace Gravel (Qtg)</p> <p>0.0 to 8.0 ft NO RECOVERY: Silt, sand, gravel, and cobbles; No sample using pilot bit. Gravel and cobbles are hard and subrounded. Dry, strong reaction with HCl. (Depths based on drilling action while pilot bit was in use)</p> <p>8.0 to 11.5 ft: SILTY SAND (SM): About 85% fine sand; about 15% nonplastic fines with rapid dilatancy, and no dry strength; trace medium to coarse sand; Maximum size, coarse sand; dry, light brown in color; strong reaction with HCl.</p> <p>11.5 to 13.8 ft NO RECOVERY: Silt, sand, gravel, and cobbles; No sample using pilot bit. Gravel and cobbles are hard and subrounded. Dry, Strong reaction with HCl.</p> <p>13.8 to 44.8 ft Cretaceous Mancos Shale (Km)</p> <p>13.8 to 14.0 ft NO RECOVERY: Hard pan; calcite cemented sand and gravel atop shale bedrock.</p> <p>14.0. to 44.8 ft SHALE: Brownish gray, sandy, fissile, laminated to thinly bedded, moderately soft (H5), moderately to intensely weathered (W6), slakes rapidly. Calcite, gypsum and iron oxide along some bedding planes and fractures. Core often separates along bedding planes. Strong reaction with HCl. Becomes moderately hard (H4) below 31.0 ft. Core ground by auger.</p> <p>STRATIGRAPHY:</p> <p>0.0 to 13.8 ft QUATERNARY TERRACE GRAVEL (Qtg) 13.8 to 44.8 ft CRETACEOUS MANCOS SHALE (Km)</p>
									0			
	10		SM						0			
			Silt, Sand, Gravel and Cobble						24			
	15	Km	SHALE	NA	5		50/NA		0	NA		
									32			
	20						50/NA		92			
							50/NA		100			
	25						50/NA		96			
									100			
	30						50/NA		100			
									100			
	35				6		50/NA		100			
									100			
	40						50/NA		100			
									100			
	5201.0											

BOTTOM OF HOLE

COMMENTS:

HSA= hollow stem auger NA= not available ft= feet NE= not encountered NP= non plastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SPT= standard penetration test HQ3= coring system SS= sandstone CLSTN= claystone

All angles measured from core axis at zero degrees unless otherwise noted.

The data for the center column and "classification and physical condition" column are based on Bureau of Reclamation Engineering Geology Field Manual and drawings titled Geology for Designs and Specifications as follows "Drawing No. 40-D-6493 Standard Descriptors and Descriptive Criteria for Rock. Drawing No. 40-D-6499 Standard Descriptors and Descriptive Criteria for Discontinuities."



SHEET 1 OF 1

STATE: New Mexico
GROUND ELEVATION: 5248.1 ft NAVD 88
ANGLE FROM HORIZONTAL: -90 °
HOLE LOGGED BY: C. Beyer
REVIEWED BY: P. Gardner

BOTTOM OF HOLE

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TPWTP3-18-1			SHEET 1 OF 1		
FEATURE: San Juan Lateral Water Treatment Plant				PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Site Investigation				GROUND ELEVATION: 5179.70			
COORDINATES: N 2,076,253 E 2,498,891				METHOD OF EXPLORATION: Case 580N Rubber Tire Backhoe			
APPROXIMATE DIMENSIONS: 2x12x6				LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 2/21/2018				DATE EXCAVATED: 2/21/2018			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)				
			3 - 5 in	5 - 12 in	PLUS 12 in		
1	CL 1.5 ft (5178.2)	0.0 to 1.5 ft LEAN CLAY : About 90% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 10% predominantly fine sand; maximum size, coarse sand; strong reaction with HCl. IN-PLACE CONDITION: Dark to light brown and dry, homogeneous and hard. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)					
2	CLSTN 2.8 ft (5176.9)	1.5 to 2.8 ft CLAYSTONE: Light to dark brown and laminated to thinly bedded. Very soft (H7), intensely weathered (W7) and friable. Grades to shale. Carbon blebs and roots present. CaCOx nodules, stringers and in laminations. Strong reaction with HCl. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km)					
3	SHALE 6.0 ft (5173.7)	2.8 to 6.0 ft SHALE: Light to dark gray and laminated to thinly bedded. Moderately soft (H5), intensely weathered (W7) and fissile. Carbon blebs and claystone laminations. FeOx staining present. Weak reaction with HCl. Recovered as flat, angular, 1 to 10 inch particles. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km)					
4							
5							
6							
COMMENTS: Surface vegetation consists of grasses and weeds. Discontinued excavation at 6.0 feet due to refusal on bedrock.							

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TPWTP3-18-2		SHEET 1 OF 1	
FEATURE: San Juan Lateral Water Treatment Plant		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Site Investigation		GROUND ELEVATION: 5170.59			
COORDINATES: N 2,076,486 E 2,497,931		METHOD OF EXPLORATION: Case 580N Rubber Tire Backhoe			
APPROXIMATE DIMENSIONS: 2x12x7		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 2/21/2018		DATE EXCAVATED: 2/21/2018			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	CL (visual) s(CL) (lab class)	0.0 to 2.5 ft LEAN CLAY : About 90% fines with low plasticity, low toughness, medium dry strength and no dilatancy; about 10% fine sand; trace of fine, hard subangular gravel; maximum size, 20 mm; strong reaction with HCl.			
	In-place density taken at 0.5 feet.	IN-PLACE CONDITION: Brown and dry, homogeneous and hard.			
2		IN-PLACE UNIT WEIGHT AND MOISTURE FROM 0.5 ft. Total: 94.3 lbf/ft³, 3.8% (78.2% compaction) LAB TEST DATA: 65.6% fines, 33.3% sand, 1.1% gravel LL= 20.2 PI= 8.3 SPG= 2.70 Maximum dry density: 120.6 lbf/ft³, optimum water content= 12.2 % Laboratory classification is SANDY LEAN CLAY.			
	2.5 ft (5168.1)				
3	CLSTN	GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal) 2.5 to 6.4 ft CLAYSTONE: Light to dark brown and laminated to thinly bedded. Very soft (H7), intensely weathered (W7) and friable. Grades to shale. Carbon blebs, FeOx staining and roots present. CaCOx nodules, stringers and in laminations. Strong reaction with HCl.			
4		GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km)			
5					
6					
	6.4 ft (5164.2)				
7	SHALE	6.4 to 7.3 ft SHALE: Light to dark gray and laminated to thinly bedded. Moderately soft (H5), moderately weathered (W5) and fissile. Carbon blebs and claystone laminations. FeOx staining present. CaCOx nodules, stringers and in laminations. Weak reaction with HCl. Recovered as flat, angular, 1 to 8 inch particles.			
	7.3 ft (5163.3)				
		GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km)			
COMMENTS: Surface vegetation consists of grasses and weeds. Discontinued excavation at 7.3 feet due to refusal on bedrock.					

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TPWTP3-18-3		SHEET 1 OF 1	
FEATURE: San Juan Lateral Water Treatment Plant		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Site Investigation		GROUND ELEVATION: 5174.51			
COORDINATES: N 2,075,345 E 2,497,592		METHOD OF EXPLORATION: Case 580N Rubber Tire Backhoe			
APPROXIMATE DIMENSIONS: 2x12x7		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 2/22/2018		DATE EXCAVATED: 2/22/2018			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	CL 1.0 ft (5173.5)	0.0 to 2.5 ft LEAN CLAY : About 95% fines with low plasticity, low toughness, medium dry strength and no dilatancy; about 5% fine sand; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown and dry, homogeneous and hard.			
2	CLSTN 3.0 ft (5171.5)	GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal) 2.5 to 6.4 ft CLAYSTONE: Light to dark brown and laminated to thinly bedded. Very soft (H7), intensely weathered (W7) and friable. Grades to shale. Carbon blebs, FeOx staining and roots present. CaCOx nodules, stringers and in laminations. Strong reaction with HCl. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km)			
3	SHALE Corrosion sample taken at 6.0 ft.	6.4 to 6.8 ft SHALE: Light to dark gray and laminated to thinly bedded. Moderately soft (H5), moderately weathered (W5) and fissile. Carbon blebs and claystone laminations. FeOx staining present. CaCOx nodules, stringers and in laminations. Weak reaction with HCl. Recovered as flat, angular, 1 to 6 inch particles. Corrosion sample taken at 6.0 ft. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km)			
4					
5					
6					
6.8 ft (5167.7)					
COMMENTS: Surface vegetation consists of grasses and weeds. Discontinued excavation at 6.8 feet due to refusal on bedrock.					

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TPWTP3-18-4		SHEET 1 OF 1	
FEATURE: San Juan Lateral Water Treatment Plant		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Site Investigation		GROUND ELEVATION: 5182.87			
COORDINATES: N 2,075,073 E 2,498,588		METHOD OF EXPLORATION: Case 580N Rubber Tire Backhoe			
APPROXIMATE DIMENSIONS: 2x12x7		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 2/21/2018		DATE EXCAVATED: 2/21/2018			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	CL	0.0 to 0.9 ft LEAN CLAY : About 95% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 5% fine sand; maximum size, fine sand; strong reaction with HCl.			
	0.9 ft (5182.0)	IN-PLACE CONDITION: Light to dark brown and dry, homogeneous and hard.			
2	CLSTN CL (lab class)	GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal) 0.9 to 5.5 ft CLAYSTONE: Light to dark brown and laminated to thinly bedded. Very soft (H7), intensely weathered (W7) and friable. Grades to shale. Carbon blebs and roots present. CaCO ₃ nodules, stringers and in laminations. Strong reaction with HCl.			
		IN-PLACE UNIT WEIGHT AND MOISTURE FROM 1.5 ft. Total: 102.3 lbf/ft ³ , 9.2% (88.8% compaction) LAB TEST DATA: 97.6% fines, 2.4% sand LL= 36.9 PI= 19.9 SPG= 2.80 Maximum dry density: 115.2 lbf/ft ³ , optimum water content= 15.4 % Laboratory classification is LEAN CLAY.			
3	In-place density taken at 1.5 feet.	GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km)			
4					
5					
	5.5 ft (5177.4)				
6	SHALE	5.5 to 6.6 ft SHALE: Light to dark gray and laminated to thinly bedded. Moderately soft (H5), moderately weathered (W5) and fissile. Carbon blebs and claystone laminations. FeO _x staining present. CaCO ₃ nodules, stringers and in laminations. Weak reaction with HCl. Recovered as flat, angular, 1 to 8 inch particles.			
	Corrosion sample taken at 6.0 ft.				
	6.6 ft (5176.3)	Corrosion sample taken at 6.0 ft.			
		GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km)			
COMMENTS: Surface vegetation consists of grasses and weeds. Discontinued excavation at 6.6 feet due to refusal on bedrock.					

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT NO. TP-18-5		SHEET 1 OF 1	
FEATURE: San Juan Lateral Water Treatment Plant		PROJECT: Navajo Gallup Water Supply Project			
LOCATION: Terrace Investigation		GROUND ELEVATION: 5247.73			
COORDINATES: N 2,078,162 E 2,499,849		METHOD OF EXPLORATION: Case 580N Rubber Tire Backhoe			
APPROXIMATE DIMENSIONS: 2x12x11		LOGGED BY: P. Gardner			
DEPTH TO WATER: NE DATE: 2/22/2018		DATE EXCAVATED: 2/22/2018			
DEPTH	CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE USBR 5000, 5005)	% PLUS 3 in (BY VOLUME)		
			3 - 5 in	5 - 12 in	PLUS 12 in
1	CL 1.1 ft (5246.6)	0.0 to 1.1 ft LEAN CLAY : About 95% fines with low plasticity, low toughness, medium dry strength and no dilatancy; about 5% fine sand; trace of fine to coarse, hard, round to subrounded gravel; maximum size, 75mm; strong reaction with HCl.			
2	(SM)g (lab class)	IN-PLACE CONDITION: Brown and dry, homogeneous and hard.	tr		
3	In-place density taken at 4.0 ft.	GEOLOGIC INTERPRETATION: Quaternary Terrace Gravel (Qtg) 1.1. to 5.5 ft SILTY SAND WITH GRAVEL: About 45% fine to coarse, hard, subangular to rounded sand; about 35% fines with no plasticity, no toughness, low dry strength and rapid dilatancy; about 20% fine to coarse, hard, rounded to subrounded gravel; trace of very hard, round to subrounded cobbles; maximum size, 150mm; no to weak reaction with HCl.			
4		IN-PLACE CONDITION: Light to dark brown and dry, lenses and pockets of gravel and sand about 3 inches thick and the width of the trench, moderate cementation.			
5	5.5 ft (5242.2)	IN-PLACE UNIT WEIGHT AND MOISTURE FROM 4.0 ft. Total: 91.7 lbf/ft³, 6.7% (78.7% compaction) LAB TEST DATA: 46.6% sand, 34.8% fines, 18.6% gravel LL= NA PI= NP SPG= 2.81			
6	(GP)sc	Maximum dry density: 116.5 lbf/ft³, optimum water content= 15.5 % Laboratory classification is SILTY SAND WITH GRAVEL.	5	tr	
7		GEOLOGIC INTERPRETATION: Quaternary Terrace Gravel (Qtg) 5.5 to 10.9 ft POORLY GRADED GRAVEL WITH SAND AND COBBLE: About 65% hard, rounded to subrounded gravel (about 1/8 of gravel gravel particles are flat and elongated); about 30% fine to coarse, hard, subangular to subrounded sand; about 5% nonplastic fines with rapid dilatancy and no dry strength; no reaction with HCl.			
8	Corrosion sample taken at 6.0 ft.	TOTAL SAMPLE (BY VOLUME): About 5% 3- to 5-inch hard, rounded to subangular cobbles; trace of 5- to 12-inch hard, subrounded cobbles; remainder minus 3 inch; maximum size, 200 mm.			
9		IN-PLACE CONDITION: Gray to tan color and dry, weak cementation, sloughing walls.			
10		Corrosion sample taken at 6.0 ft.			
	10.9 ft (5236.8)	GEOLOGIC INTERPRETATION: Quaternary Terrace Gravel (Qtg)			
COMMENTS: Surface vegetation consists of grasses and weeds. Discontinued excavation at 10.9 feet due to sloughing walls but not refusal.					

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS (Maximum Density by Proctor)

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Reach 1 Water Treatment Plant

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DHWTP3-17-1

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	<u>FINES</u>		SAND #200 (0.074mm) to 3" (4.76mm)	GRAVEL #4 (4.76mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY- pcf	FILL MOISTURE CONTENT- %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.074mm															
SPT-1	3.0 - 4.5	CL	43.3	44.5	12.2	0	0	0	32.0	16.2	-	--	4.9	-	2.61	--	--	--	--
SPT-2	5.0 - 6.5	(CL)s	31.6	44.4	24.0	0	0	0	29.5	13.2	-	--	3.3	-	2.67	--	--	--	--
SPT-3	7.5 - 9.0	CL	41.0	49.8	9.2	0	0	0	34.3	19.6	-	--	5.7	-	2.67	--	--	--	--
SPT-4	10.0 - 11.5	CL	42.9	49.4	7.7	0	0	0	33.8	18.5	-	--	5.2	-	2.66	--	--	--	--
SPT-5	12.5 - 14.0	CL	44.1	44.9	11.0	0	0	0	35.7	21.1	-	--	7.0	-	2.64	--	--	--	--
SPT-6	15.0 - 16.5	CL	38.6	47.4	14.0	0	0	0	33.6	17.3	-	--	4.1	-	2.59	--	--	--	--
SPT-7	20.0 - 21.5	CL	39.5	54.9	5.6	0	0	0	33.8	17.4	-	--	2.6	-	-	--	--	--	--

NOTE: Numbers in parentheses are metric equivalents of numbers directly above.

*Denotes In-place density and 5-point curve.

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS (Maximum Density by Proctor)

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Reach 1 Water Treatment Plant

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DHWTP3-17-2

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	<u>FINES</u>		SAND #200 (0.074mm) to 3" (4.76mm)	GRAVEL #4 (4.76mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY- pcf	FILL MOISTURE CONTENT- %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.074mm															
SPT-1	2.5 – 4.0	CL	49.0	46.2	4.8	0	0	0	35.0	21.0	--	--	5.9	--	2.72	--	--	--	--
SPT-2	5.0 – 6.5	CL	48.6	44.5	6.9	0	0	0	35.2	19.6	--	--	7.6	--	2.77	--	--	--	--
SPT-3	7.5 – 9.0	CL	56.2	42.4	1.4	0	0	0	37.2	20.8	--	--	7.5	--	2.71	--	--	--	--
SPT-4	10.0 – 11.5	CL	46.6	44.4	9.0	0	0	0	33.2	15.6	--	--	6.3	--	2.72	--	--	--	--
SPT-5	12.5 – 14.0	CL	56.0	43.0	1.0	0	0	0	38.7	21.6	--	--	7.0	--	2.74	--	--	--	--
SPT-6	15.0 – 16.5	CL	51.0	45.0	4.0	0	0	0	34.1	16.6	--	--	6.9	--	2.73	--	--	--	--
SPT-7	20.0 – 21.5	CL	53.1	41.0	5.9	0	0	0	35.6	18.3	--	--	7.0	--	2.71				
SPT-8	25.0 – 26.5	CL	51.6	43.3	5.1	0	0	0	35.2	17.9	--	--	6.5	--	2.73				

NOTE: Numbers in parentheses are metric equivalents of numbers directly above.

*Denotes In-place density and 5-point curve.

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS (Maximum Density by Proctor)

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Reach 1 Water Treatment Plant

DHWTP3-17-3

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (0.074mm) to 3" (4.76mm)	GRAVEL #4 (4.76mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY- pcf	FILL MOISTURE CONTENT- %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.074mm															
SPT-1	5.0 – 6.5	CL	56.6	38.9	4.5	0	0	0	40.7	21.6	14.0	--	7.8	--	2.71	--	--	--	--
SPT-2	10.0 - 11.5	CL	45.1	42.3	11.4	1.2	0	0	34.0	16.9	14.1	--	6.3	2.91	2.68	--	--	--	--
SPT-3	12.5 – 14.0	(CL) _s	40.8	43.6	15.6	0	0	0	33.3	16.7	14.0	--	5.9	--	2.67	--	--	--	--
SPT-4	15.0 – 16.5	(CL) _s	37.1	39.8	21.7	1.4	0	0	31.2	13.8	--	--	5.2	2.46	2.67	--	--	--	--
SPT-5	20.0 – 21.5	CL	44.5	43.6	11.9	0	0	0	33.6	16.4	14.4	--	6.0	--	2.65	--	--	--	--
SPT-6	25.0 -26.5	_g (CL) _s	22.7	32.4	18.2	26.7	0	0	30.4	15.4	14.0	--	5.0	2.32	2.62	--	--	--	--

NOTE: Numbers in parentheses are metric equivalents of numbers directly above.
*Denotes In-place density and 5-point curve.

Drill Hole Number: DHRWTP3-17-4[illegible]

Drill Hole Number: DHRWTP3-17-5[illegible]

Drill Hole Number: DHRWTP3-17-6[illegible]

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS (Maximum Density by Proctor)

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Reach 1 Water Treatment Plant

DHWTP3-17-7

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (0.074mm) to 3" (4.76mm)	GRAVEL #4 (4.76mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY- pcf	FILL MOISTURE CONTENT- %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.074mm															
SPT-1	4.0 – 5.5	CL	55.5	41.9	2.6	0	0	0	39.0	21.2	--	--	7.0	--	2.76	--	--	--	--
SPT-2	9.0 – 10.5	CL	54.2	41.9	3.9	0	0	0	38.9	23.8	14.9	--	7.2	--	2.74	--	--	--	--
SPT-3	14.0 – 15.5	CL	47.2	42.3	10.5	0	0	0	34.9	17.3	--	--	6.5	--	2.78	--	--	--	--

NOTE: Numbers in parentheses are metric equivalents of numbers directly above.
*Denotes In-place density and 5-point curve.

Drill Hole Number: DHRWTP3-17-7[illegible]

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS (Maximum Density by Proctor)

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Reach 1 Water Treatment Plant

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DHWTP3-17-8

[illegible]

NOTE: Numbers in parentheses are metric equivalents of numbers directly above.

*Denotes In-place density and 5-point curve.

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

FEATURE: SJWTP

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[illegible]

* Denotes In-place density and 5-point curve

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS (Maximum Density by Proctor)

PROJECT: Navajo Gallup Water Supply Project

FEATURE: Reach 1 Water Treatment Plant

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DHWT3-18-9

[illegible]

NOTE: Numbers in parentheses are metric equivalents of numbers directly above.

**Denotes In-place density and 5-point curve.*

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS (Maximum Density by Proctor)

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (0.074mm) to 3" (4.76mm)	GRAVEL #4 (4.76mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY- pcf	FILL MOISTURE CONTENT- %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM MOISTURE CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %
			SMALLER THAN 0.005mm	0.005 to 0.074mm															
SPT-1	4.0 – 5.5	CL	53.6	40.7	5.7	0	0	0	38.9	21.8	--	--	7.1	--	2.81	--	--	--	--
SPT-2	9.0 – 10.5	CL	58.6	39.9	1.5	0	0	0	44.1	27.8	15.0	--	7.5	--	2.69	--	--	--	--
SPT-3	16.5 – 18.0	(CL) _s	35.6	41.7	21.9	0.8	0	0	31.8	14.7	--	--	4.8	--	2.73	--	--	--	--

NOTE: Numbers in parentheses are metric equivalents of numbers directly above.
*Denotes In-place density and 5-point curve.

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

FEATURE: SJWTP

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IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS				
TEST PIT NUMBER	DEPTH – feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (0.75mm) to #4 (4.75mm)	GRAVEL #4 (4.75mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY - pcf	FILL WATER CONTENT - %	SPECIFIC GRAVITY PLUS No. 4	SPECIFIC GRAVITY MINUS No. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM WATER CONTENT - %	PENETRATION RESISTANCE - psi	D-VALUE - %	RELATIVE COMPACTION - %
			SMALLER THAN 0.075 mm	0.075 to 0.425 mm																
TPWTP3-18-2	Surface	s(CL)	24.7	40.9	33.3	1.1	-	-	20.2	8.3	-	94.3	3.8	2.61	2.70	120.6	12.2	800	78.2	-
TPWTP3-18-4	Surface	CL	55.0	42.6	2.4	-	-	-	36.9	19.9	-	102.3	9.2	-	2.80	115.2	15.4	550	88.8	-
TP-18-5	4.0	(SM)g	5.0	29.8	46.6	18.6	-	-	NA	NP	-	91.7	6.7	2.56	2.81	116.5	15.5	1000	78.7	116.1

* Denotes In-place density and 5-point curve