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
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size 12 (The No. 200 sieve size is about the smallest particle visible to the naked eye)	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.
			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	
		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	
			Plastic fines (for identification procedures see CL below).	GC	Clayey gravels, poorly graded gravel–sand–clay mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.
	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	
			Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravely sands; little or no fines	EXAMPLE:– Silty Sand, gravely; about 20% hard, angular gravel particles ½ – 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).
		SANDS WITH FINES (Appreciable amount of fines)	Non–plastic fines (for indentification procedures see ML below).	SM	Silty sands, poorly graded sand–silt mixtures	
			Plastic fines (for identification procedures see CL below).	SC	Clayey sands, poorly graded sand–clay mixtures	
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to the naked eye)	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No 40 SIEVE SIZE					
		DRY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to skaking)	TOUGHNESS (Consistency near Plastic Limit)		
	SILTS AND CLAYS Liquid limit less than 50	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
	SILTS AND CLAYS Liquid limit greater than 50	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		Readily identified by color, odor, spongy feel and frequently by fibrous texture.			PT	Peat and other highly organic soils

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:– Clayey Silt, brown; slightly plastic. small percentage of fine sand. numerous vertical root holes, firm and dry in place, loess, (ML).

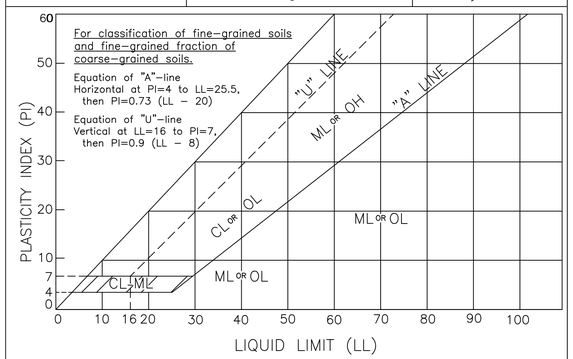
LABORATORY CLASSIFICATION CRITERIA

Use grain size curve identifying the fractions as given under field identification

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:

Less than 5% GW, GP, SW, SP
More than 12% GM, GC, SM, SC
5% to 12% Bordering cases requiring use of dual symbols.

$C_V = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})2}{D_{10}\ Dep}$ Between one and 3	
Not meeting all gradation requirements for GW	
Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
Atterberg limits above "A" line with PI greater than 7	
$Cv = \frac{D\ 60}{D\ 10}$ Greater than 6; $Cc = \frac{(D\ 30)2}{D\ 10\ Dep}$ Between one and 3	
Not meeting all gradation requirements for SW	
Afterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
Afterberg limits above "A" line with PI greater than 7	



FOR LABORATORY CLASSIFICATION OF FINE GRAINED 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.

FIELD IDENTIFICATION PROCEDURES FOR FINE GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, in for field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

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 ONLY ASPECTS.
1	2003– 12 –05 D – G.T.	REVISED PLASTICITY CHART. REDRAWN WITH AUTOCAD SOFTWARE.

DATE AND TIME PLOTTED 12-5-2003
PLOTTED BY Ray Dunbar

103–D–347

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
DIØ	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 ravels 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, Coarse sand	Sandstone (Very coarse, coarse, medium, fine, or very fine)	Coarse ash	Coarse tuff
0.5				
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 CHECKED
DRAWN TECH. APPROVAL
APPROVED PEER REVIEWER

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD Rel. 12 c4	40-D-7022.DWG	MAY 10, 2000 09:20
DENVER, COLORADO	MARCH 8, 2000	40-D-7022

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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.

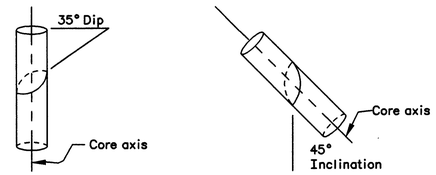
INCIPIENT JOINT (IJ) OR INCIPIENT FRACTURE (IF) – A joint or fracture which does not continue through the specimen or at least is not seen with the naked eye. However, when the specimen is wetted, and then allowed to dry, the joint or fracture trace is evident. When core is broken, it breaks along an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



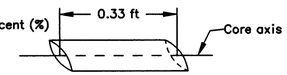
1. Vertical hole – true dip is measured and reported.
2. Angle hole – true dip usually not known; angle is measured from core axis and is called inclination.

ROCK QUALITY DESIGNATION (RQD)

EXAMPLE SHOWN FOR CORE, BUT APPLICABLE TO ANY LINEAR OBSERVATION

$$RQD = \frac{\text{Sum of length of solid core pieces} > 0.33 \text{ ft [4 in] (100 mm) long}}{\text{Length of the run in feet (mm)}} \times 100$$

Expressed as percent (%)



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

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

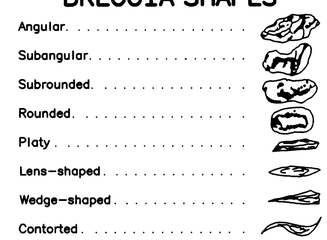
SHEAR/FAULT GOUGE CONSISTENCY

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



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

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

GEOLOGY FOR DESIGN & SPECIFICATIONS

STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES

GEOLOGY NOMENCLATURE COMMITTEE – CHECKED – Charles Salkin
DRAWN Marshall Munson TECH. APPROVAL Peter M. Rohrer
APPROVED Mark McKenna
PEER REVIEWER

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD Rel. 12, c4 DENVER, COLORADO	40-D-7023.DWG MARCH 8, 2000	MAY 10, 2000 08:20

40-D-7023

JUN 12 2000

GENERAL GEOLOGIC LEGEND

STRATIGRAPHY

Qal *Quaternary Alluvium*
Quaternary alluvium is derived from a variety of sources including slope wash, eolian and colluvial deposition as well as weathering and decomposition of in-place bedrock. Alluvium contains variable amounts of plastic to nonplastic fines and may contain sand, gravel, cobbles, and boulders on terraces and in river channels and flood plains.

Qtg *Quaternary Terrace Gravel*
Quaternary terrace gravel is comprised of 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.

Kpc *Cretaceous Pictured Cliffs Sandstone*
Pictured Cliffs Sandstone is composed of light brown to orange to gray, very fine- to medium- grained sandstone interbedded with minor gray siltstone and shale. The upper part consists of ledge-forming, moderately- to massively-bedded sandstone. The sandstone is calcareous, ferruginous, and exhibits cellular- to cavernous-weathering. The lower part consists of laminated to thinly bedded sandstone, shale and claystone. The sandstone is moderately soft (H5) and intensely weathered (W7) to hard (H3) and slightly weathered. The shale and claystone are generally very soft (H7) and intensely weathered (W7) to moderately soft (H5) and moderately weathered (W5).

Kl *Cretaceous Lewis Shale*
The Lewis Shale (Kl) is comprised of dark brown to gray shale with fine brownish gray sandstone interbeds and brownish red sandstone lenses. The shale is friable, fissile, laminated to thinly bedded with gypsum veins, iron oxide staining and occasional marine fossils. Hardness and weathering vary from very soft (H7) and intensely weathered (W7) to moderately hard (H4) and moderately weathered (H5). The sandstone is fine-grained laminated to moderately bedded, calcareous, and argillaceous. Hardness and weathering vary from soft (H6) and intensely weathered (W7) to moderately hard (H4) and moderately weathered (W5). Similar to the Pictured Cliffs Sandstone (Kpc), intermittent harder sandstone lenses are found within the Lewis Shale (Kl) formation and have a similar appearance to concretions because of their shape and mineral content. They are comprised of Siderite or iron oxide and calcium carbonate cemented, fine, thinly to moderately bedded sandstone. The lenses are spheroidal in shape and up to 10-feet in diameter. Lenses are often exposed at the surface due to differential weathering of softer surrounding rock and exhibit spalling of weathered outer layers. They are generally moderately hard (H4) to hard (H3) and moderately weathered (W5).

Kch *Cretaceous Cliff House Sandstone*
The Cliff House Sandstone (Kch) is comprised of brown to gray sandstone and light gray to dark brown shale. The sandstone is fine-grained, argillaceous, laminated to thickly bedded, hard (H3) and slightly weathered (W3) to moderately weathered (W5). The shale is laminated to thinly bedded, with calcite, iron oxide, and thin interbeds of hard (H3) sandstone. Hardness and weathering vary from very soft (H7) and intensely weathered (W7) to moderately soft (H5) and moderately weathered (W5). The Cliff House Sandstone (Kch) is exposed at the Hogback Monocline and will be encountered subsurface at the Chaco River crossing. Core samples and nearby outcrops exhibited beds dipping at about 56° to the east.

Kmf *Cretaceous Menefee Formation*
The Cretaceous Menefee Formation consists primarily of light brown, fine-grained sandstone with interbedded claystone, shale and siltstone but can vary in color and grain size. The sandstone is generally moderately weathered (W5), moderately soft (H5) to soft (H6) and slightly fractured at the surface. The same sandstone unit, when excavated below ground level, can occasionally be moderately hard (H4) and slightly weathered (W3). A hard, calcareous sandstone bed frequently caps the upper 1 to 3 feet in some areas and is occasionally interbedded or lensed within the softer sandstone units. Intermittent hard (H3) concretionary lenses are also present throughout the formation. This caprock/interbedded sandstone is often hard (H3) and can only be broken by a heavy hammer blow. The claystone is sandy, light brown to grey in color and is generally laminated to thinly bedded, intensely to moderately weathered (W6) and moderately soft (H5) to soft (H6). The claystone often grades to siltstone and occasionally becomes fissile, grading to shale. Thin coal seams are also sometimes encountered. The coal is subbituminous to bituminous, friable, soft (H6), and moderately to intensely weathered (W6) to moderately to slightly weathered (W4).

Kpl *Cretaceous Point Lookout Sandstone*
The Point Lookout Sandstone consists of light brown, gray, or brownish orange, fine-grained sandstone with interbedded claystone. The sandstone is moderately soft (H5) to hard (H3), slightly weathered (W3), to intensely weathered (W7), thinly to massively bedded, and has a variable reaction with HCl. It often contains calcite and gypsum veins, and iron and manganese oxide staining. The claystone is dark brown to grayish orange, soft (H6) to very soft (H7), and moderately to intensely weathered (W6). It usually has no reaction with HCl and contains gypsum veins and iron oxide staining.

Km *Cretaceous Mancos Shale*
The upper member of the Mancos Shale consists of interbedded fine-grained, mixed clastic laminations with interbeds of claystone, shale, siltstone and sandstone. Contacts between shale and claystone can be gradational. The shale is calcareous, sandy, fissile, light to dark gray, light to dark brown to black in color and banded or mottled in places. The shale ranges from moderately soft (H5) to hard (H3) and decomposed (W9) to slightly weathered (W3). Intermittent hard (H3) concessionary lenses are present throughout the formation. The claystone is light to dark brown, sandy and laminated to thinly bedded. The claystone ranges from very soft (H7) to moderately soft (H5) and very intensely weathered (W8) to moderately weathered (W5). The claystone is friable and easily separates on bedding planes, slakes rapidly in water, and exhibits iron and manganese oxide staining. The claystone is carbonaceous, contains calcium carbonate, mica and has thin to moderately thick gypsum infilling in some joints. Backhoe test pits generally reached refusal after excavating 2-to-4 feet into Mancos Shale (Km) bedrock. Shale was generally recovered as 2-to-10 inch subangular, flat fragments, depending on hardness and weathering.

GEOLOGIC EXPLANATION

DHR2-21-8 ○ — *Proposed Drill Hole location with identification number*

DHR2-21-8 ● — *Drill Hole location with identification number*

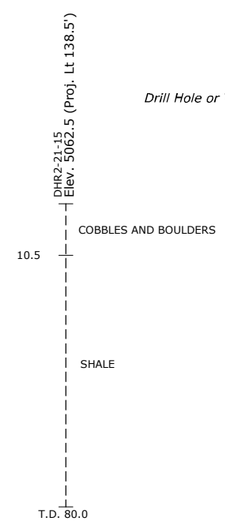
TPR2-21-5 □ — *Proposed Test Pit location with Identification number*

TPR2-21-5 ■ — *Test Pit location with Identification number*

Qal / Kmf — *Geologic Unit Contact*

Qal / Kmf — *Dashed where approximate*

? Qal / Kmf ? ? ? — *Queried where inferred*



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 Nos. 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:

SS- SANDSTONE
CLSTN - CLAYSTONE
SLTSTN - SILTSTONE

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL - BLOCK 2 - 3

PNM ALTERNATIVE

CHRIS BEYER
DESIGNED
D THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL - Deputy Construction Engineer

FARMINGTON, NM 2023-01-23

GENERAL GEOLOGIC LEGEND, EXPLANATIONS AND NOTES

1695-529-60340

SHEET 1

LAST SAVED DATE 2023-01-23
LAST SAVED BY DTHORNBURG

CAD SYSTEM AutoCAD Civil 3D (UMS TECH)
CAD FILENAME 1695-529-60340-RD-1.DWG

GENERAL GEOLOGIC LEGEND

STRATIGRAPHY

Qal *Quaternary Alluvium*

Quaternary alluvium consists of unconsolidated surficial deposits regardless of origin. It is derived from a variety of sources including slope wash, eolian and colluvial deposition as well as weathering and decomposition of in-place bedrock. Alluvium within the Morgan Lake Tank site is primarily composed of Silty Sand (SM) with possible Clayey Sand (SC) or Poorly Graded Sand (SP) overlying sandstone.

Kpc *Cretaceous Pictured Cliffs Sandstone*

Pictured Cliffs Sandstone is composed of light brown to orange to gray, very fine- to medium- grained sandstone interbedded with minor gray siltstone and shale. The upper part consists of ledge-forming, moderately- to massively-bedded sandstone. The sandstone is calcareous, ferruginous, and exhibits cellular- to cavernous-weathering. The lower part consists of laminated to thinly bedded sandstone, shale and claystone. The sandstone is moderately soft (H5) and intensely weathered (W7) to hard (H3) and slightly weathered (W3). The shale and claystone are generally very soft (H7) and intensely weathered (W7) to moderately soft (H5) and moderately weathered (W5).

GEOLOGIC EXPLANATION

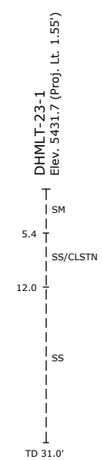
DHR2-21-8 — *Drill Hole location with identification number*

TPR2-21-5 — *Test Pit location with Identification number*

Qal / Kmf — *Geologic Unit Contact*

Qal / Kmf — *Dashed where approximate*

? Qal / Kmf ? — ? — ? — *Queried where inferred*



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 Nos. 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:

SS- SANDSTONE
CLSTN - CLAYSTONE
SLTSTN - SILTSTONE

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BUREAU OF RECLAMATION
NAVAJO-GALLUP WATER SUPPLY PROJECT
NEW MEXICO

SAN JUAN LATERAL - BLOCK 2 - 3

SAN JUAN LATERAL WATER TREATMENT PLANT
REGULATING TANK SITE

REV NO	DATE	DESCRIPTION
1	2025-02-13	529 CHANGES TITLE BLOCK FROM MORGAN LAKE TANK SITE TO SAN JUAN LATERAL WATER TREATMENT PLANT REGULATING TANK SITE

Beyer, Christopher
DESIGNED
D. Thornburg
DRAWN
Graham, Kris
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L
APPROVED
ADMIN APPROVAL - Geologist

FARMINGTON, NM 2024-09-27

GENERAL GEOLOGIC LEGEND, EXPLANATION, AND NOTES

1695-529-60426

SHEET 1

LAST SAVED DATE
2025-03-04
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD 2022 (LMS TECH)
CAD FILENAME
1695-529-60426-RD-1.DWG

DRILL HOLE Point Table

Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
DHPNM-21-1C	2081589.02	2537208.86	W108° 28' 03.25"	N36° 43' 07.83"	W108.46756925	N36.71884050
DHR2-22-1	2104541.06	2544828.18	W108° 26' 31.46"	N36° 46' 55.27"	W108.44207118	N36.78201839
DHR2-22-2	2100979.33	2542943.10	W108° 26' 54.35"	N36° 46' 19.93"	W108.44842986	N36.77220234
DHR2-22-3	2100550.85	2542966.29	W108° 26' 54.03"	N36° 46' 15.69"	W108.44834128	N36.77102585
DHR2-22-4	2099864.28	2542934.78	W108° 26' 54.36"	N36° 46' 08.90"	W108.44843382	N36.76913951
DHR2-22-5-WELL	2099703.04	2543037.71	W108° 26' 53.08"	N36° 46' 07.31"	W108.44807885	N36.76869844
DHR2-22-6	2099266.54	2543178.68	W108° 26' 51.32"	N36° 46' 03.01"	W108.44758803	N36.76750200
DHR2-22-7	2097845.33	2542967.85	W108° 26' 53.80"	N36° 45' 48.94"	W108.44827663	N36.76359468
DHR2-22-8	2097348.74	2542728.26	W108° 26' 56.70"	N36° 45' 44.02"	W108.44908364	N36.76222648
DHR2-22-9	2096759.29	2542803.54	W108° 26' 55.73"	N36° 45' 38.19"	W108.44881371	N36.76060876
DHR2-22-10	2096310.14	2543107.81	W108° 26' 51.95"	N36° 45' 33.77"	W108.44776517	N36.75938047
DHR2-22-12	2093768.27	2543007.10	W108° 26' 52.99"	N36° 45' 08.63"	W108.44805327	N36.75239696
DHR2-22-13	2090908.63	2543463.69	W108° 26' 47.16"	N36° 44' 40.38"	W108.44643228	N36.74455045
DHR2-22-15	2090491.70	2543056.35	W108° 26' 52.13"	N36° 44' 36.23"	W108.44781341	N36.74339811
DHR2-22-18	2086760.03	2539997.84	W108° 27' 29.41"	N36° 43' 59.14"	W108.45816879	N36.73309399
DHR2-22-19	2082528.18	2538924.19	W108° 27' 42.26"	N36° 43' 17.22"	W108.46173785	N36.72145112
WELLDHR2-22-16	2090009.86	2542892.49	W108° 26' 54.10"	N36° 44' 31.46"	W108.44836206	N36.74207175
WELLDHR2-22-17	2089796.70	2542846.16	W108° 26' 54.66"	N36° 44' 29.35"	W108.44851551	N36.74148545

TEST PIT Point Table

Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
TPR2-22-2	2102742.64	2544271.15	W108° 26' 38.16"	N36° 46' 37.45"	W108.44393404	N36.77706895
TPR2-22-4	2101229.88	2543120.37	W108° 26' 52.19"	N36° 46' 22.42"	W108.44783012	N36.77289364
TPR2-22-5	2100225.77	2542966.96	W108° 26' 53.99"	N36° 46' 12.48"	W108.44833189	N36.77013296
TPR2-22-6	2099133.56	2543269.97	W108° 26' 50.18"	N36° 46' 01.70"	W108.44727343	N36.76713837
TPR2-22-7	2098330.29	2543321.63	W108° 26' 49.49"	N36° 45' 53.76"	W108.44707950	N36.76493294
TPR2-22-9	2093483.64	2543782.16	W108° 26' 43.45"	N36° 45' 05.86"	W108.44540151	N36.75162881
TPR2-22-10	2092519.40	2543840.65	W108° 26' 42.65"	N36° 44' 56.33"	W108.44518084	N36.74898138
TPR2-22-12	2089269.82	2542018.61	W108° 27' 04.78"	N36° 44' 24.09"	W108.45132823	N36.74002364
TPR2-22-13	2089143.60	2541859.41	W108° 27' 06.73"	N36° 44' 22.83"	W108.45186874	N36.73967412
TPR2-22-14	2089032.00	2541623.29	W108° 27' 09.62"	N36° 44' 21.71"	W108.45267209	N36.73936341
TPR2-22-16	2086955.89	2540138.24	W108° 27' 27.70"	N36° 44' 01.08"	W108.45769401	N36.73363449
TPR2-22-17	2085802.29	2539708.33	W108° 27' 32.89"	N36° 43' 49.65"	W108.45913538	N36.73045819
TPR2-22-18	2084507.34	2539521.94	W108° 27' 35.07"	N36° 43' 36.83"	W108.45974251	N36.72689801
TPR2-22-19	2083523.84	2539294.14	W108° 27' 37.79"	N36° 43' 27.09"	W108.46049785	N36.72419255
TPR2-22-20	2081704.72	2538678.55	W108° 27' 45.21"	N36° 43' 09.07"	W108.46255751	N36.71918488
TPR2-22-21	2081535.84	2537475.64	W108° 27' 59.97"	N36° 43' 07.32"	W108.46665785	N36.71869925

0 1000' 2000'

GENERAL NOTES

1. *Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).*
2. *The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.*

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60352.

General Geologic Legend, Explanation and Notes.....1695-529-60340.
Surface Geology.....1695-529-60357 thru 1695-529-60362.

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BUREAU OF RECLAMATION
NAVAJO-GALLUP WATER SUPPLY PROJECT
NEW MEXICO

SAN JUAN LATERAL

REACH 2 PNM ALTERNATIVE

Beyer, Christopher
DESIGNED
D. Thornburg
DRAWN
Chris Beyer
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL - Deputy Construction Engineer

FARMINGTON, NM 2023-02-02

LOCATION OF EXPLORATION

1695-529-60355

SHEET 1

LAST SAVED DATE 2023-02-02
LAST SAVED BY DTHORNBURG

CAD SYSTEM AutoCAD Civil 3D (MS TECH)
CAD FILENAME 1695-529-60355-RD-1.DWG

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60352.
Location of Exploration Map.....1695-529-60355.
General Geologic Legend, Explanation and Notes.....1695-529-60340.
Surface Geology.....1695-529-60357 thru 1695-529-60362.

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BUREAU OF RECLAMATION
NAVAJO-GALLUP WATER SUPPLY PROJECT

SAN JUAN LATERAL

REACH 2 - PNM OPTION

REV NO	SYM	DESCRIPTION
1	529	ADDED REVISED ALIGNMENT EDITED TO TPR2-22-2 OWR2-22-1 DHR2-22-1

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R.
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM

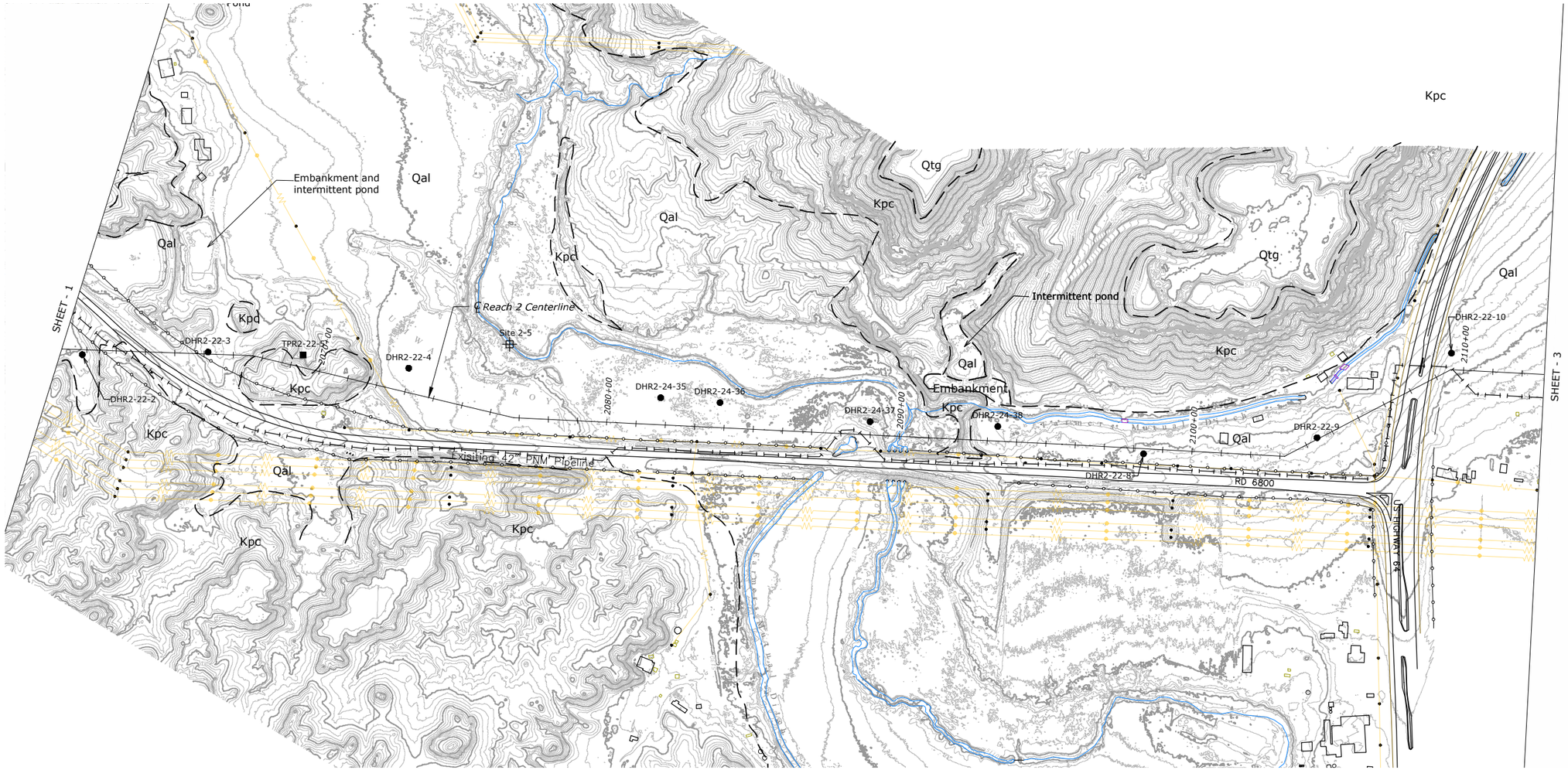
SURFACE GEOLOGY

1695-529-60357

SHEET 1

LAST SAVED DATE
2020-03-27
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Civil 3D 2021 (LMS TECH)
CAD FILENAME
1695-529-60357-RD-1.DWG



GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60352.
Location of Exploration Map.....1695-529-60355.
General Geologic Legend, Explanation and Notes.....1695-529-60340.

0 100 200 400 Feet
1:2400

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL

REACH 2 - PNM OPTION

REV NO	
1	5/29 ADDED REVISED ALIGNMENT. ADDED GEOLOGY CONTACTS & DRILL HOLES NEAR REALIGNMENT.

BEYER, CHRISTOPHER R.
DESIGNED
D. THORNBURG
DRAWN
GRAHAM, KRIS
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM

SURFACE GEOLOGY

1695-529-60358

SHEET 2

LAST SAVED DATE
2020-01-09 7:40:40
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Civil 3D 2025 (LMS TECH)
CAD FILENAME
1695-529-60358-RD-2.DWG

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60352.
Location of Exploration Map.....1695-529-60355.
General Geologic Legend, Explanation and Notes.....1695-529-60340.

0 100 200 400 Feet
1:2400

BUREAU OF RECLAMATION

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BUREAU OF RECLAMATION
NAVAJO-GALLUP WATER SUPPLY PROJECT

SAN JUAN LATERAL

REACH 2 - PNM OPTION

REV NO	DATE	
1	5/29	UPDATED ALIGNMENT.

Chris Beyer
DESIGNED
D. Thornburg
DRAWN
Chris Beyer
CHECKED
Beyer, Christopher R.
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM

SURFACE GEOLOGY

1695-529-60359

SHEET 3

LAST SAVED DATE
2022-05-31
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
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CAD FILENAME
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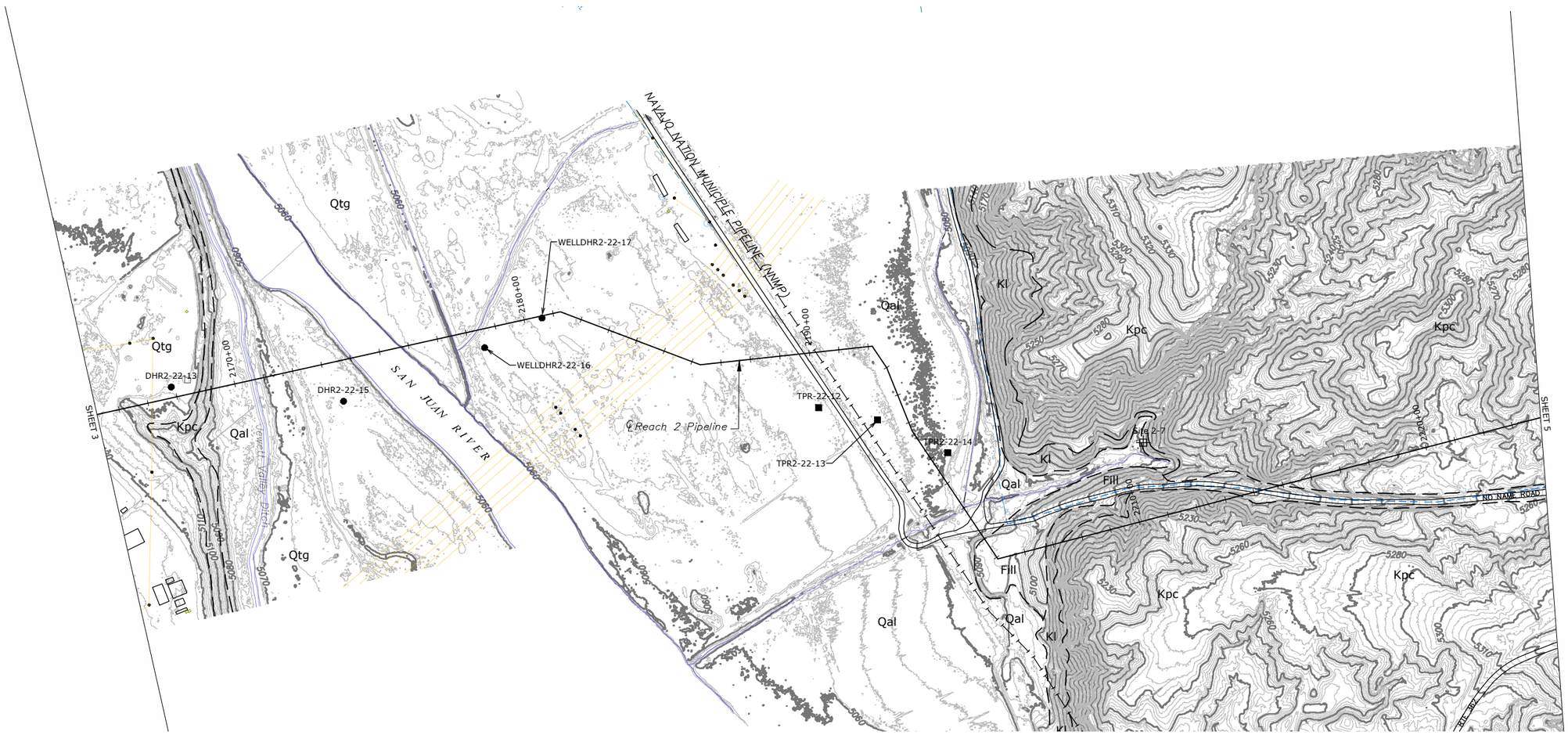

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60352.
Location of Exploration Map.....1695-529-60355.
General Geologic Legend, Explanation and Notes.....1695-529-60340.

0 100 200 400 Feet
1:2400

BUREAU OF RECLAMATION

ALWAYS THINK SAFETY

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

SAN JUAN LATERAL

REACH 2 - PNM OPTION

REV. NO		
1	529	ADDED REVISED ALIGNMENT AND HDD ALIGNMENT.

Beyer, Christopher R.
DESIGNED
D.THORNBURG
DRAWN
Beyer, Christopher R.
CHECKED
Beyer, Christopher R.
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM

SURFACE GEOLOGY

1695-529-60360

SHEET 4

LAST SAVED DATE
2022-05-06
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD 25 (MS TECH)
CAD FILENAME
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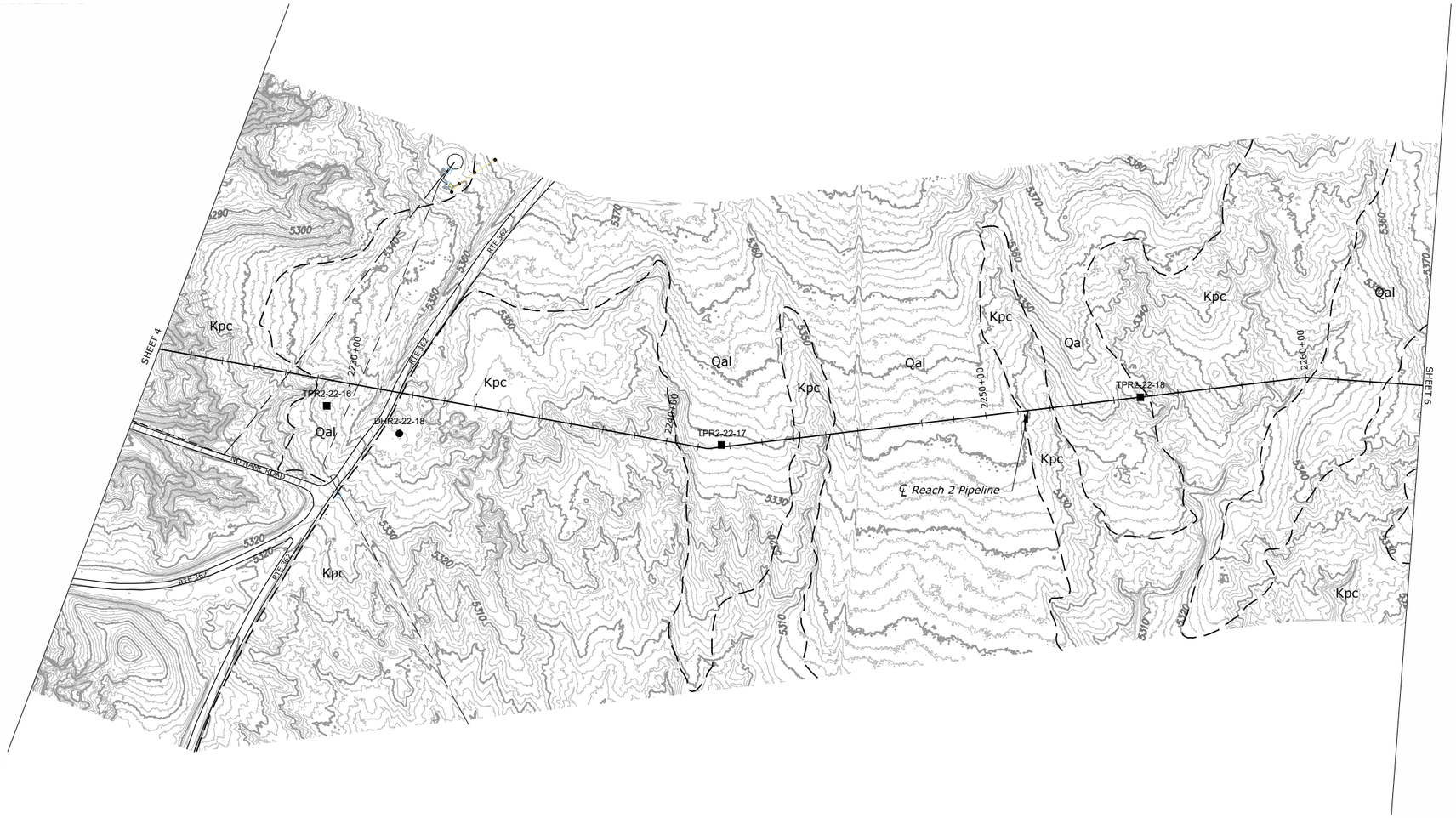

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60352.
Location of Exploration Map.....1695-529-60355.
General Geologic Legend, Explanation and Notes.....1695-529-60340.

0 100 200 400 Feet
1:2400

BUREAU OF RECLAMATION

ALWAYS THINK SAFETY

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

SAN JUAN LATERAL

REACH 2 - PNM OPTION

REV NO		
1	5/29	ADDED REVISED ALIGNMENT AND HDD ALIGNMENT.

BEYER, CHRISTOPHER R
DESIGNED
D. THORNBURG
DRAWN
GRAHAM, KRIS
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM

SURFACE GEOLOGY

1695-529-60361

SHEET 5

LAST SAVED DATE
7/29/2022
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
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CAD FILENAME
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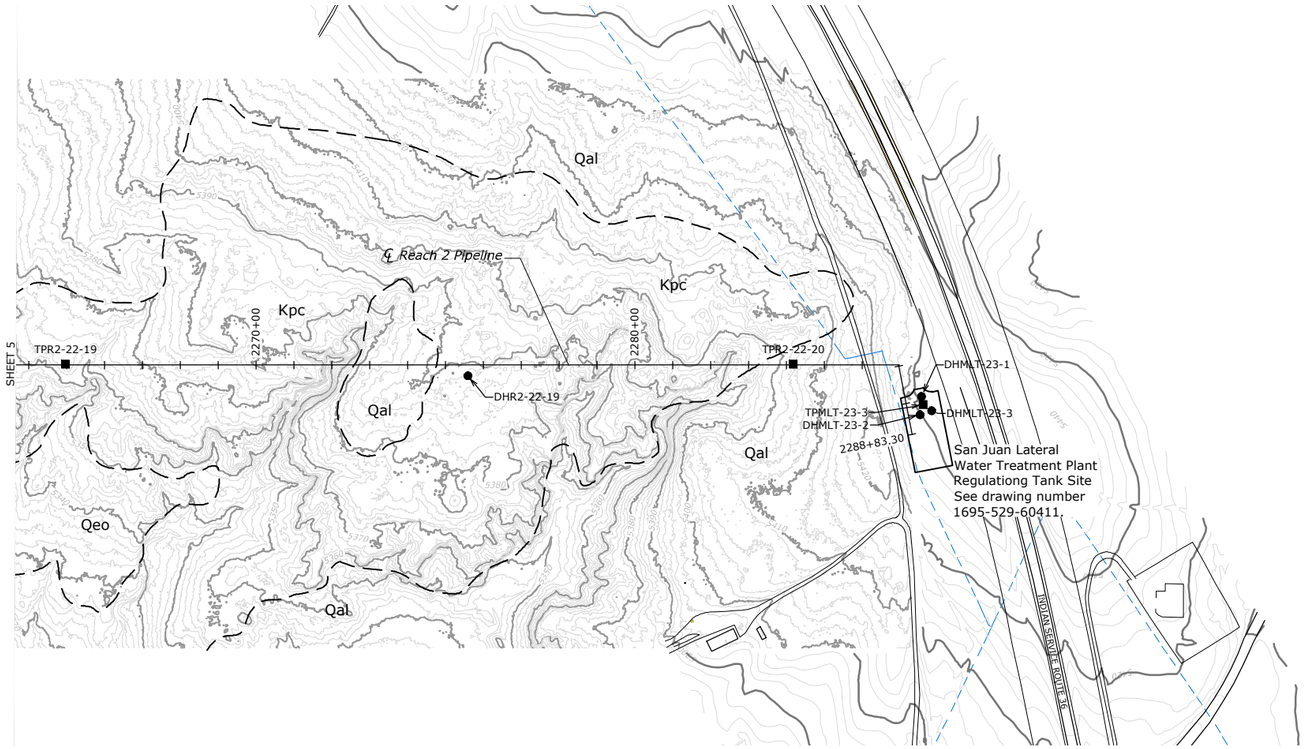

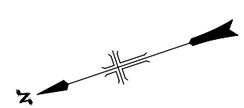

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60352.
Location of Exploration Map.....1695-529-60355.
General Geologic Legend, Explanation and Notes.....1695-529-60340.

BUREAU OF RECLAMATION

ALWAYS THINK SAFETY

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

SAN JUAN LATERAL

REACH 2 - PNM OPTION

REV NO		
1	529	UPDATED ALIGNMENT AND ADDED SAN JUAN LATERAL WATER TREATMENT PLANT REGULATING TANK SITE.

BEYER, CHRISTOPHER R
DESIGNED
D THORNBURG
DRAWN
GRAHAM, KRIS
CHECKED
Beyer, Christopher R.
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM

SURFACE GEOLOGY

1695-529-60362

SHEET 6

LAST SAVED DATE
2022-05-06
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD 24
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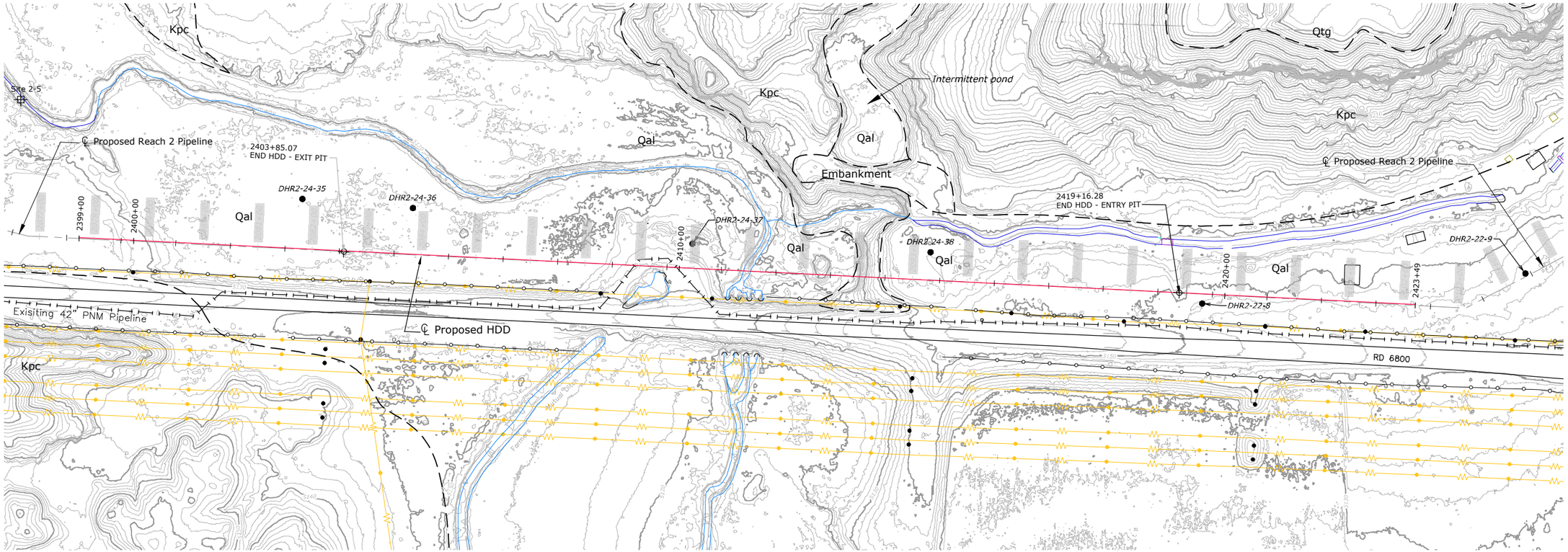

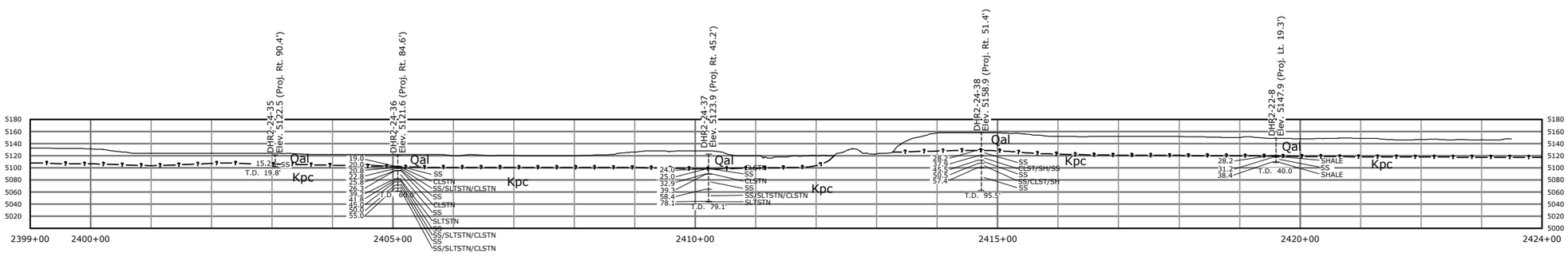

SHUMWAY HDD GEOLOGIC PROFILE

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60433.
General Geologic Legend, Explanation and Notes.....1695-529-60340.
Location of Exploration Map.....1695-529-60355.

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL

SHUMWAY WASH - HDD

Beyer, Christopher
DESIGNED
D. Thornburg
DRAWN
Kris Graham
CHECKED
Beyer, Christopher
TECH. APPR.
Gladden, Ryan L.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM

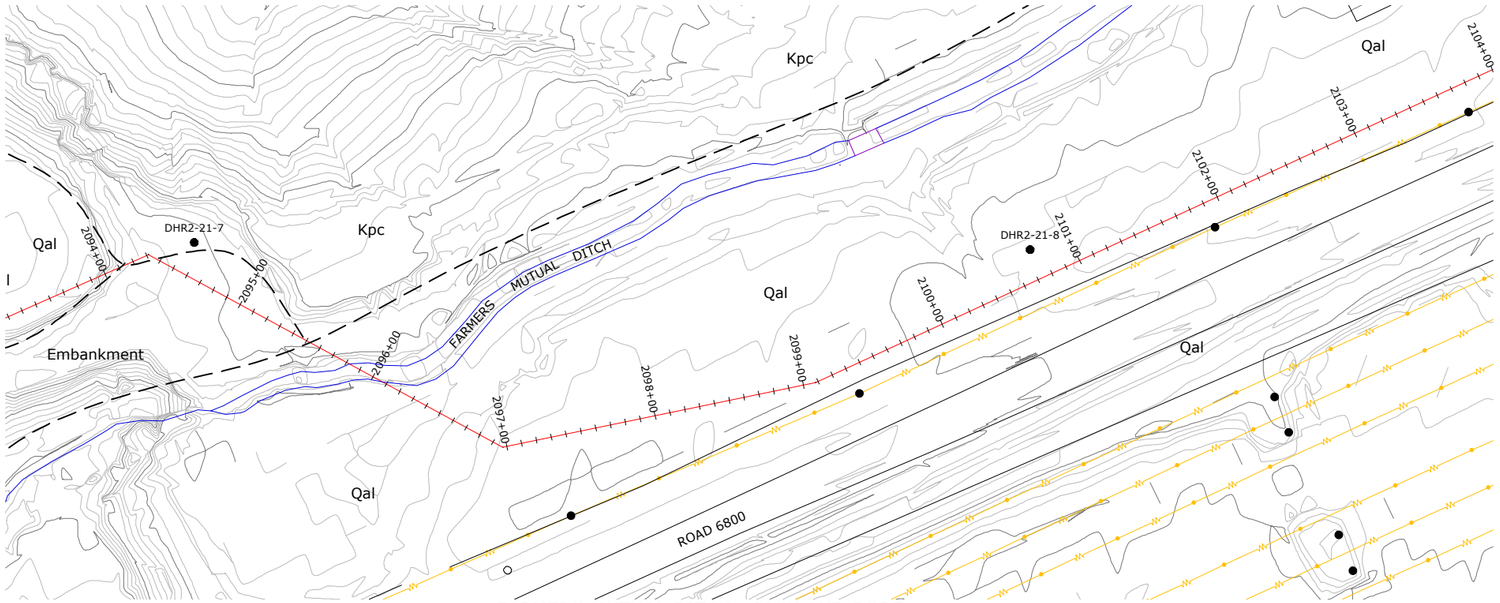
GEOLOGIC PROFILE

1695-529-60434

SHEET 1

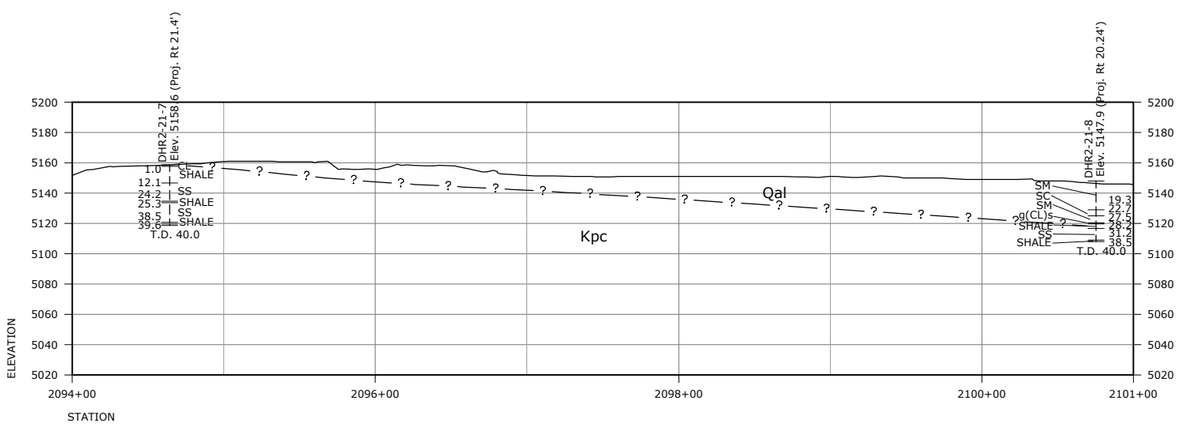
LAST SAVED DATE 2025-02-24 LAST SAVED BY DTHORNBURG

CAD SYSTEM AutoCAD 24.2S PLOT DATE 1695-529-60434-RD-1.DWG



FARMERS MUTUAL DITCH - JACK AND BORE
PLAN VIEW

0 50' 100'



FARMERS MUTUAL DITCH - JACK AND BORE
GEOLOGIC PROFILE

HORIZONTAL SCALE 1:50
VERTICAL SCALE 1:1

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60352.
Location of Exploration Map.....1695-529-60355.
General Geologic Legend, Explanation and Notes.....1695-529-60340.
Surface Geology.....1695-529-60357 thru 1695-529-60362.

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL

REACH 2

CHRIS BEYER
DESIGNED
D. THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL - Deputy Construction Engineer

FARMINGTON, NM 2023-01-31

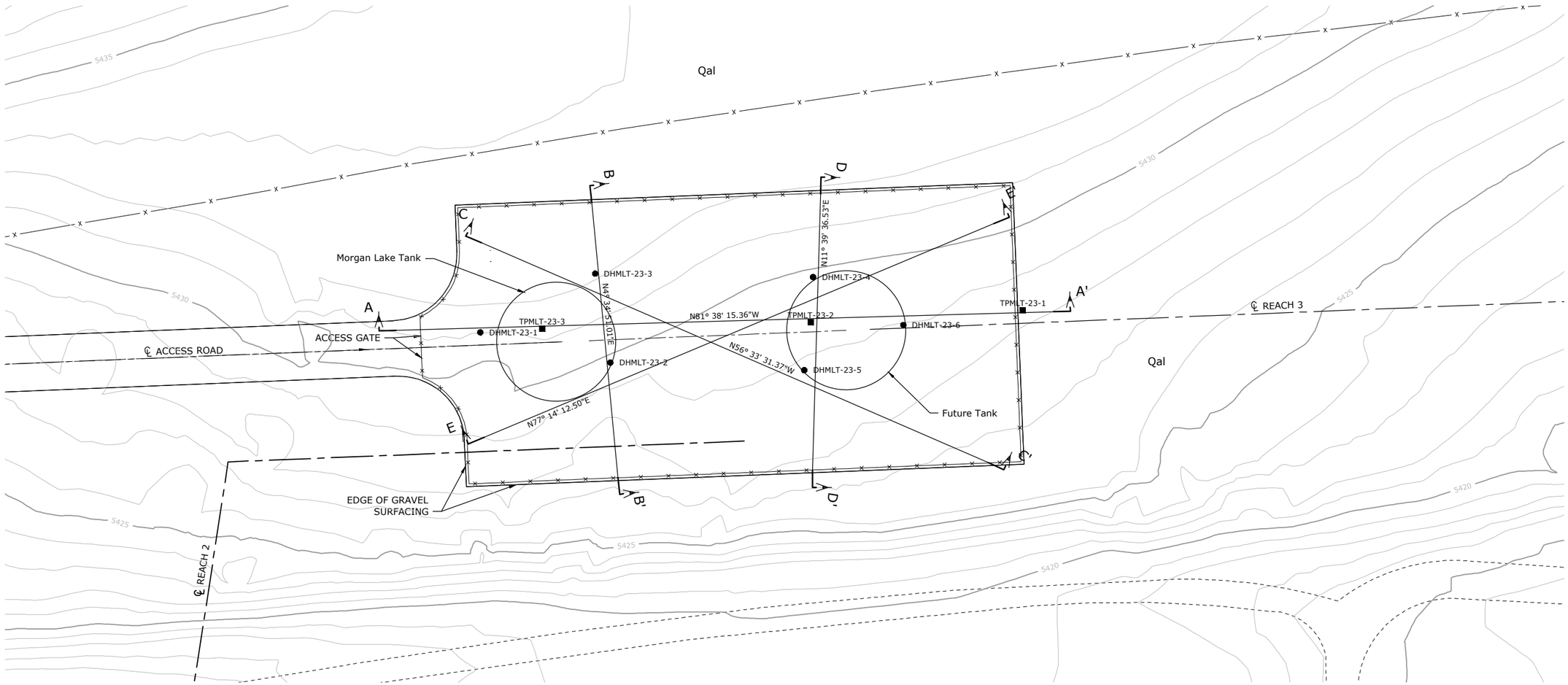
FARMERS MUTUAL DITCH
HDD GEOLOGIC PROFILE

1695-529-60389

SHEET 1

LAST SAVED DATE
2023-01-31
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Civil 3D (LMS TECH)
CAD FILENAME
1695-529-60389-RD-1.DWG



DRILL HOLE LOCATION TABLE							
	Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
	DHMLT-23-1	2081411.67	2538489.07	W108° 27' 47.51"	N36° 43' 06.16"	W108.46319741	N36.71837655
	DHMLT-23-2	2081430.59	2538444.68	W108° 27' 48.06"	N36° 43' 06.34"	W108.46334931	N36.71842772
	DHMLT-23-3	2081397.96	2538444.49	W108° 27' 48.06"	N36° 43' 06.02"	W108.46334922	N36.71833807
	DHMLT-23-4	2081412.88	2538367.07	W108° 27' 49.01"	N36° 43' 06.16"	W108.46361369	N36.71837768
	DHMLT-23-5	2081445.48	2538376.06	W108° 27' 48.90"	N36° 43' 06.48"	W108.46358375	N36.71846739
	DHMLT-23-6	2081435.64	2538337.95	W108° 27' 49.37"	N36° 43' 06.38"	W108.46371356	N36.71843965

TEST PIT LOCATION TABLE							
	Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
	TPMLT-23-1	2081437.95	2538294.44	W108° 27' 49.90"	N36° 43' 06.40"	W108.46386204	N36.71844523
	TPMLT-23-2	2081428.80	2538370.73	W108° 27' 48.97"	N36° 43' 06.32"	W108.46360156	N36.71842145
	TPMLT-23-3	2081414.29	2538466.88	W108° 27' 47.78"	N36° 43' 06.18"	W108.46327318	N36.71838334

0 10' 20' 40'

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 0.999713762328.

Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map see drawing 1695-529-60418

For Location Map see drawing 1695-529-60419

For Geologic Sections A-A' & B-B' see drawing 1695-529-60424

For Geologic Sections C-C, D-D and E-E' see drawing 1695-529-60425

For General Geologic Legend,Explanation,and Notes see drawing 1695-529-60426

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL - BLOCK 2 - 3

SAN JUAN LATERAL WATER TREATMENT PLANT REGULATING TANK SITE

529	CHANGED TITLE BLOCK FROM MORGAN LAKE TANK SITE TO SAN JUAN LATERAL WATER TREATMENT PLANT REGULATING TANK SITE	1

BEYER, CHRISTOPHER
GEOLOGY
D. THORNBURG
DRAWN
GRAHAM, KRIS
CHECKED
Beyer, Christopher R.
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL

FARMINGTON, NM

SURFACE GEOLOGY, LOCATION OF EXPLORATION & LOCATION OF GEOLOGIC SECTIONS

1695-529-60411

SHEET 1

LAST SAVED DATE
2025-05-05
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD 24.25 (LMS TECH)
CAD FILENAME
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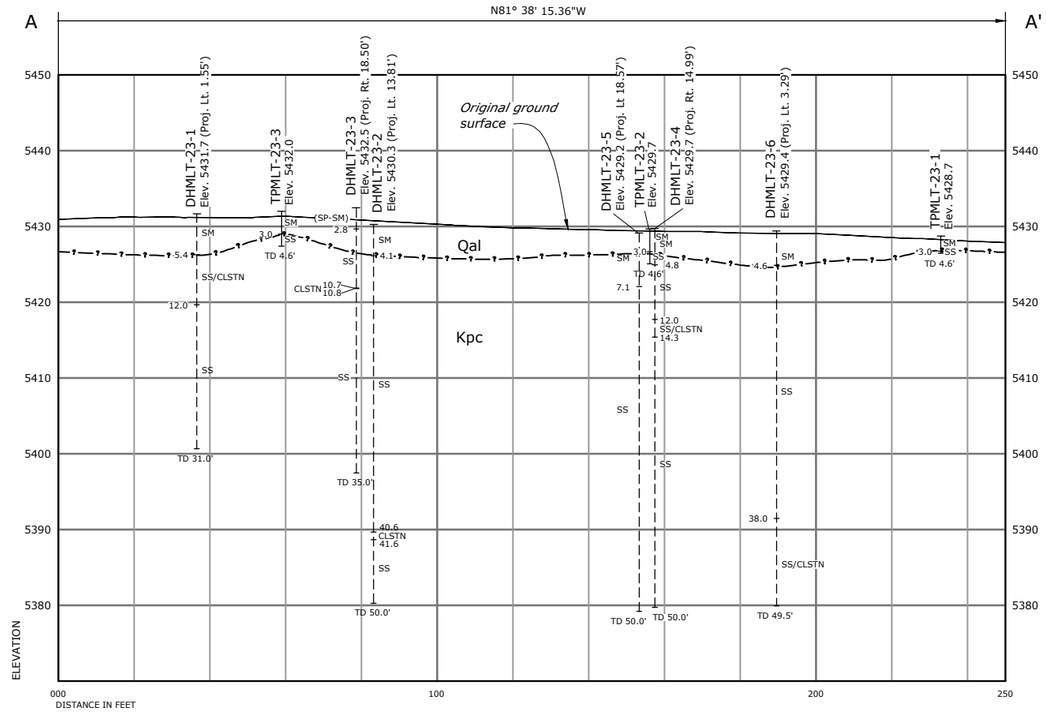
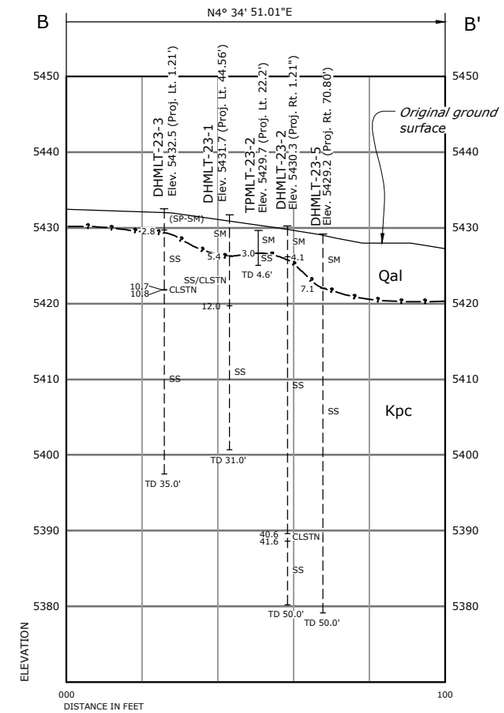


GEOLOGIC SECTION A-A'



GEOLOGIC SECTION B-B'

HORIZONTAL SCALE 1"=20'
VERTICAL SCALE 1"=10'

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 0.999713762328.

REFERENCE DRAWINGS

General Map see drawing 1695-529-60418

For Location Map see drawing 1695-529-60419

For Surface Geology, Location of Exploration and Location of Geologic Sections see drawing 1695-529-60411

For Geologic Sections C-C, D-D and E-E' see drawing 1695-529-60425

For General Geologic Legend,Explanation,and Notes see drawing 1695-529-60426

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL - BLOCK 2 - 3

SAN JUAN LATERAL WATER TREATMENT PLANT
REGULATING TANK SITE

REV NO		
1	529	CHANGES TITLE BLOCK FROM MORGAN LAKE TANK SITE TO SAN JUAN LATERAL WATER TREATMENT PLANT REGULATING TANK SITE

BEYER, CHRISTOPHER
GEOLOGY
D. THORNBURG
DRAWN
GRAHAM, KRIS
CHECKED
Beyer, Christopher R.
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL

FARMINGTON, NM

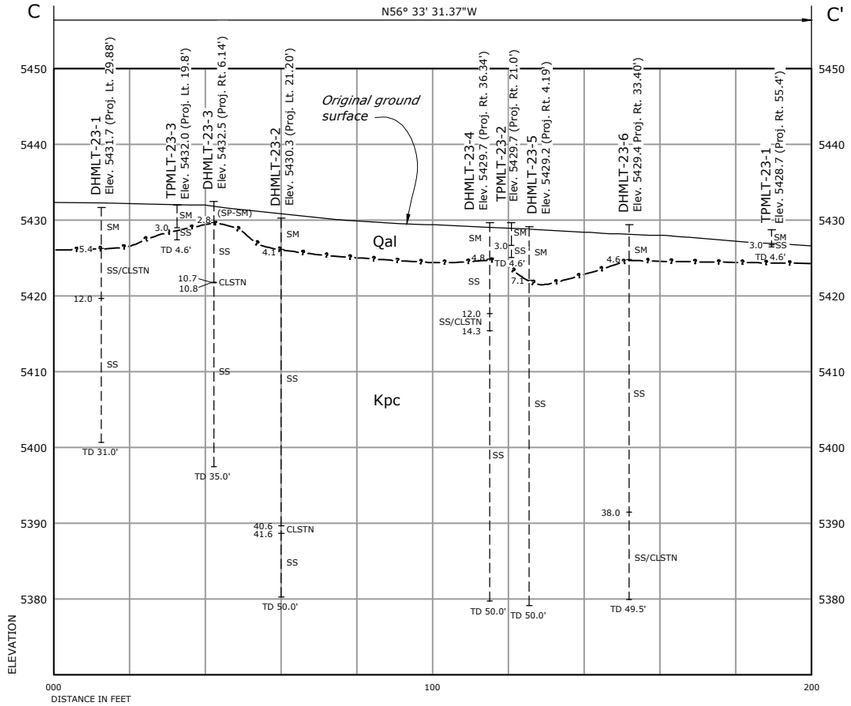
GEOLOGIC SECTIONS
A-A' AND B-B'

1695-529-60424

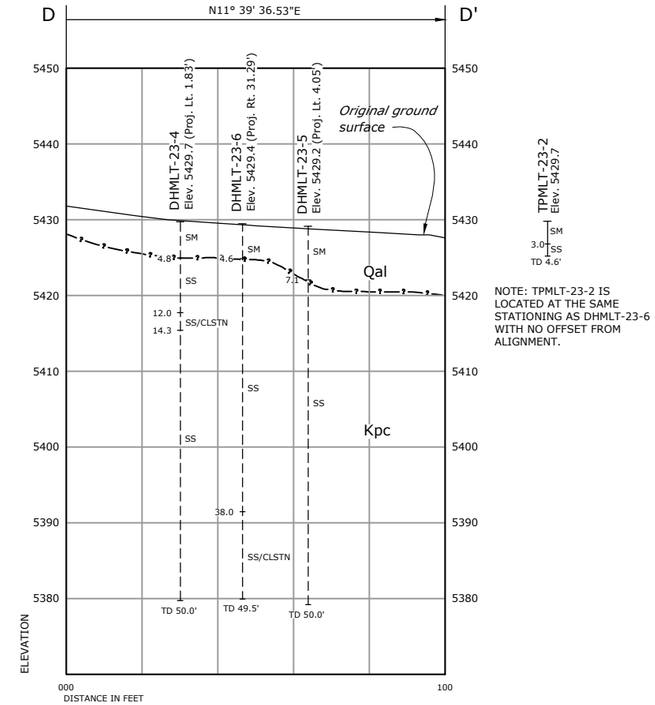
SHEET 1

LAST SAVED DATE
7/29/2019
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD 24.25 (LMS TECH)
CAD FILENAME
1695-529-60424-RD-1.DWG

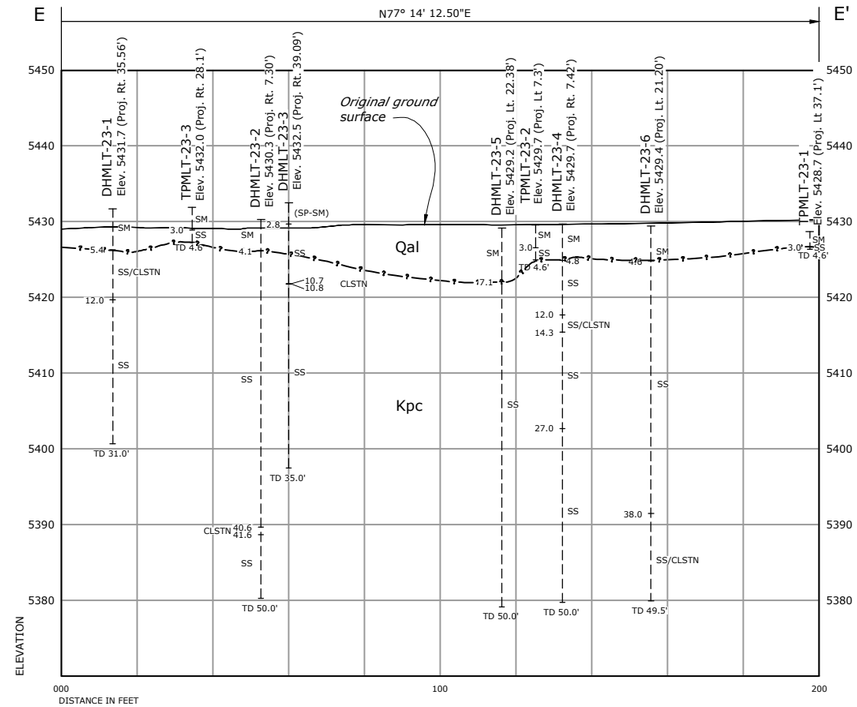


GEOLOGIC SECTION C-C'



NOTE: TPMLT-23-2 IS LOCATED AT THE SAME STATIONING AS DHMLT-23-6 WITH NO OFFSET FROM ALIGNMENT.

GEOLOGIC SECTION D-D'



GEOLOGIC SECTION E-E'

HORIZONTAL SCALE 1"=20'
VERTICAL SCALE 1"=10'

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 0.999713762328.

REFERENCE DRAWINGS

General Map see drawing 1695-529-60418

For Location Map see drawing 1695-529-60419

For Surface Geology, Location of Exploration and Location of Geologic Sections see drawing 1695-529-60411

For Geologic Sections A-A' and B-B' see drawing 1695-529-60424

For General Geologic Legend,Explanation,and Notes see drawing 1695-529-60426

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL - BLOCK 2 - 3

SAN JUAN LATERAL WATER TREATMENT PLANT
REGULATING TANK SITE

REV NO		
1	529	CHANGES TITLE BLOCK FROM MORGAN LAKE TANK SITE TO SAN JUAN LATERAL WATER TREATMENT PLANT REGULATING TANK SITE

BEYER, CHRISTOPHER
GEOLOGY
D. THORNBURG
DRAWN
GRAHAM, KRIS
CHECKED
Beyer, Christopher R.
TECH. APPR. Gladden, Ryan L.
APPROVED
ADMIN APPROVAL
FARMINGTON, NM

GEOLOGIC SECTIONS
C-C', D-D', AND E-E'

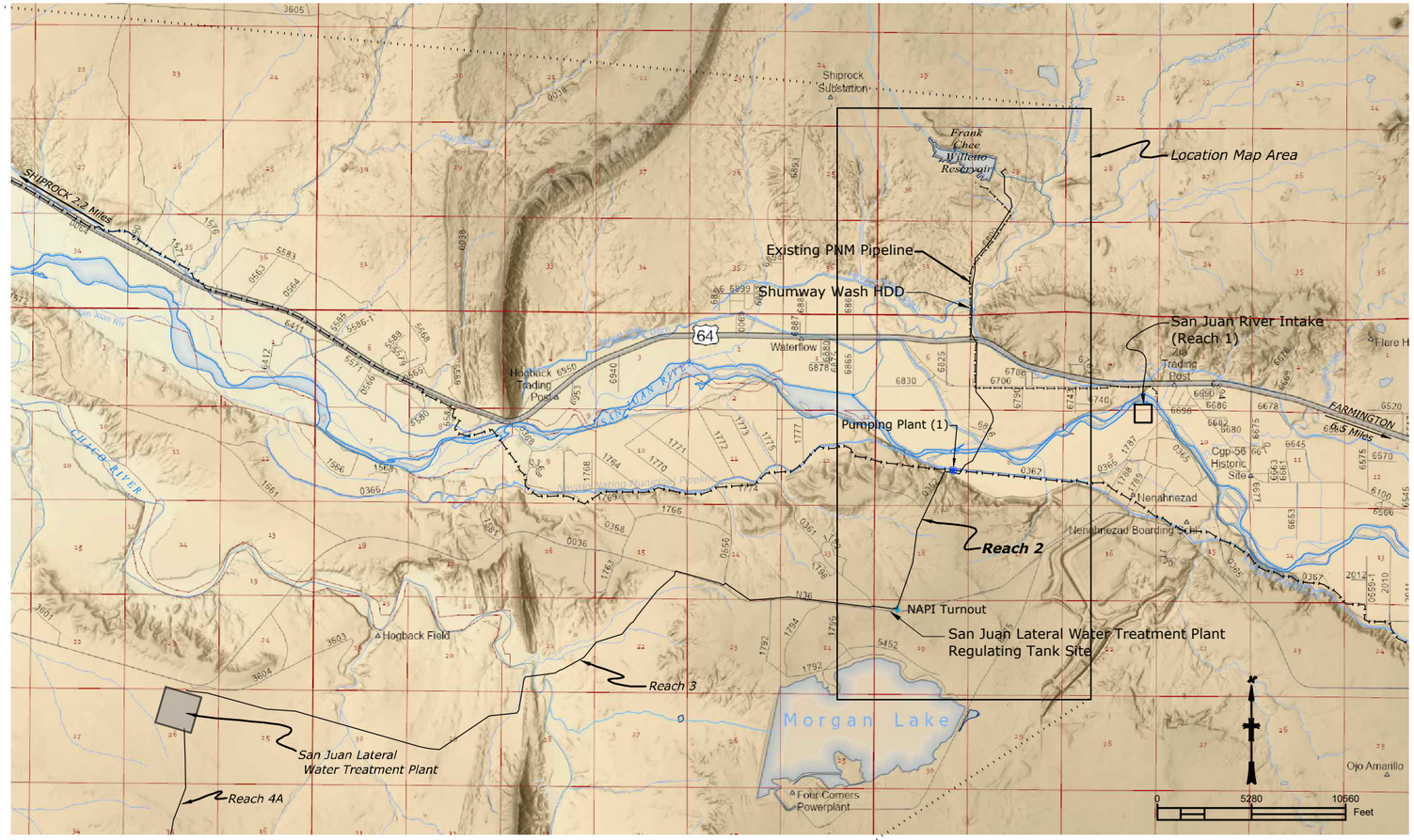
1695-529-60425

SHEET 1

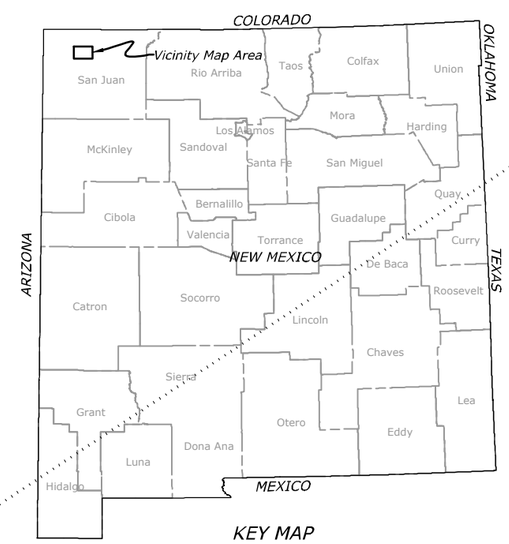
LAST SAVED DATE
2022-05-19
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD LAS (LMS TECH)
CAD FILENAME
1695-529-60425-RD-1.DWG

LOCATION MAP



VICINITY MAP



KEY MAP

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).
2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

REFERENCE DRAWINGS

General Map.....1695-529-60351
Surface Geology.....1695-529-60357-60362
Location of Exploration.....1695-529-60355
General Geologic Legend, Explanation, and Notes.....1695-529-60340

BUREAU OF RECLAMATION

ALWAYS THINK SAFETY

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

SAN JUAN LATERAL
REACH 2 PNM ALTERNATIVE

REV NO		
1	2025-03-24	529 UPDATED ALIGNMENT AND NEARBY FEATURES.
	Beyer, Christopher R	

D. Thornburg DESIGNED
D. Thornburg DRAWN
Chris Beyer CHECKED
Beyer, Christopher R TECH. APPR.
Gladden, Ryan L P.E. APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-02-01

LOCATION MAP

1695-529-60352

SHEET 1

LAST SAVED DATE 2025-03-24
LAST SAVED BY DTHORNBURG

CAD SYSTEM AutoCAD Civil 3D (LMS TECH)
CAD FILENAME 1695-529-60352-RD-1.DWG

DRILL HOLE Point Table (Explorations within 200 feet of latest alignment and included on Geologic Design Data Report, San Juan Lateral Reaches 2 and 3 San Juan Generating Station Alignment, February 2023)						
Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
DHR2-22-1	2104541.06	2544828.18	W108° 26' 31.46"	N36° 46' 55.27"	W108.44207118	N36.78201839
DHR2-22-2	2100979.33	2542943.10	W108° 26' 54.35"	N36° 46' 19.93"	W108.44842986	N36.77220234
DHR2-22-3	2100550.85	2542966.29	W108° 26' 54.03"	N36° 46' 15.69"	W108.44834128	N36.77102585
DHR2-22-4	2099864.28	2542934.78	W108° 26' 54.36"	N36° 46' 08.90"	W108.44843382	N36.76913951
DHR2-22-8	2097348.74	2542728.26	W108° 26' 56.70"	N36° 45' 44.02"	W108.44908364	N36.76222648
DHR2-22-9	2096759.29	2542803.54	W108° 26' 55.73"	N36° 45' 38.19"	W108.44881371	N36.76060876
DHR2-22-10	2096310.14	2543107.81	W108° 26' 51.95"	N36° 45' 33.77"	W108.44776517	N36.75938047
DHR2-22-12	2093768.27	2543007.10	W108° 26' 52.99"	N36° 45' 08.63"	W108.44805327	N36.75239696
DHR2-22-13	2090908.63	2543463.69	W108° 26' 47.16"	N36° 44' 40.38"	W108.44643228	N36.74455045
DHR2-22-15	2090491.70	2543056.35	W108° 26' 52.13"	N36° 44' 36.23"	W108.44781341	N36.74339811
DHR2-22-18	2086760.03	2539997.84	W108° 27' 29.41"	N36° 43' 59.14"	W108.45816879	N36.73309399
DHR2-22-19	2082528.18	2538924.19	W108° 27' 42.26"	N36° 43' 17.22"	W108.46173785	N36.72145112
OWR2-22-16	2090009.86	2542892.49	W108° 26' 54.10"	N36° 44' 31.46"	W108.44836206	N36.74207175
OWR2-22-17	2089796.70	2542846.16	W108° 26' 54.66"	N36° 44' 29.35"	W108.44851551	N36.74148545

DRILL HOLE Point Table (Post Geologic Design Data Report, San Juan Lateral Reaches 2 and 3 San Juan Generating Station Alignment February 2023.)						
Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
DHR2-23-33	2103773.26	2544923.53	W108° 26' 30.22"	N36° 46' 47.68"	W108.44172892	N36.77991116
DHR2-23-34	2103678.76	2544868.29	W108° 26' 30.90"	N36° 46' 46.74"	W108.44191547	N36.77965061
DHR2-24-35	2099001.53	2542863.23	W108° 26' 55.17"	N36° 46' 00.37"	W108.44865915	N36.76676855
DHR2-24-36	2098798.60	2542853.59	W108° 26' 55.28"	N36° 45' 58.36"	W108.44868762	N36.76621099
DHR2-24-37	2098285.01	2542805.92	W108° 26' 55.82"	N36° 45' 53.28"	W108.44883907	N36.76479948
DHR2-24-38	2097848.79	2542805.13	W108° 26' 55.80"	N36° 45' 48.96"	W108.44883219	N36.76360131
OWR2-23-21	2105524.24	2544676.27	W108° 26' 33.40"	N36° 47' 04.98"	W108.44261126	N36.78471621
OWR2-23-22	2105631.50	2544629.92	W108° 26' 33.98"	N36° 47' 06.04"	W108.44277189	N36.78501002
PWR2-23-1	2105565.38	2544652.17	W108° 26' 33.70"	N36° 47' 05.38"	W108.44269446	N36.78482878

TEST PIT Point Table (Explorations within 200 feet of latest alignment and included on Geologic Design Data Report, San Juan Lateral Reaches 2 and 3 San Juan Generating Station Alignment. February 2023)						
Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
TPR-22-12	2089269.82	2542018.61	W108° 27' 04.78"	N36° 44' 24.09"	W108.45132823	N36.74002364
TPR2-22-2	2102742.64	2544271.15	W108° 26' 38.16"	N36° 46' 37.45"	W108.44393404	N36.77706895
TPR2-22-4	2101229.88	2543120.37	W108° 26' 52.19"	N36° 46' 22.42"	W108.44783012	N36.77289364
TPR2-22-5	2100225.77	2542966.96	W108° 26' 53.99"	N36° 46' 12.48"	W108.44833189	N36.77013296
TPR2-22-10	2092519.40	2543840.65	W108° 26' 42.65"	N36° 44' 56.33"	W108.44518084	N36.74898138
TPR2-22-13	2089143.60	2541859.41	W108° 27' 06.73"	N36° 44' 22.83"	W108.45186874	N36.73967412
TPR2-22-14	2089032.00	2541623.29	W108° 27' 09.62"	N36° 44' 21.71"	W108.45267209	N36.73936341
TPR2-22-16	2086955.89	2540138.24	W108° 27' 27.70"	N36° 44' 01.08"	W108.45769401	N36.73363449
TPR2-22-17	2085802.29	2539708.33	W108° 27' 32.89"	N36° 43' 49.65"	W108.45913538	N36.73045819
TPR2-22-18	2084507.34	2539521.94	W108° 27' 35.07"	N36° 43' 36.83"	W108.45974251	N36.72689801
TPR2-22-19	2083523.84	2539294.14	W108° 27' 37.79"	N36° 43' 27.09"	W108.46049785	N36.72419255
TPR2-22-20	2081704.72	2538678.55	W108° 27' 45.21"	N36° 43' 09.07"	W108.46255751	N36.71918488

TEST PIT Point Table (Post Geologic Design Data Report, San Juan Lateral Reaches 2 and 3 San Juan Generating Station Alignment February 2023.)						
Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
TPR2-23-22	2104789.90	2544584.37	W108° 26' 34.47"	N36° 46' 57.71"	W108.44290911	N36.78269760
TPR2-23-23	2105305.60	2544705.17	W108° 26' 33.03"	N36° 47' 02.82"	W108.44250782	N36.78411617
TPR2-23-24	2105883.84	2544541.43	W108° 26' 35.09"	N36° 47' 08.53"	W108.44307955	N36.78570154

0 1000' 2000'

GENERAL NOTES

1. *Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).*
2. *The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.*

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60352.

General Geologic Legend, Explanation and Notes.....1695-529-60340.
Surface Geology.....1695-529-60357 thru 1695-529-60362.

BUREAU OF RECLAMATION

ALWAYS THINK SAFETY

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

SAN JUAN LATERAL
REACH 2 PNM ALTERNATIVE

REV. NO. 1
529 ADDED SURVEY LOCATIONS OF ADDITIONAL EXPLORATION. REVISED ALIGNMENT LOCATION. REMOVED ANY >200' OFFSET

Beyer, Christopher
DESIGNED
D. Thornburg
DRAWN
Chris Beyer
CHECKED
Beyer, Christopher R.
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM

LOCATION OF EXPLORATION

1695-529-60355

SHEET 1

LAST SAVED DATE
2023-03-01
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AUTOCAD 2025 (MS TECH)
CAD FILENAME
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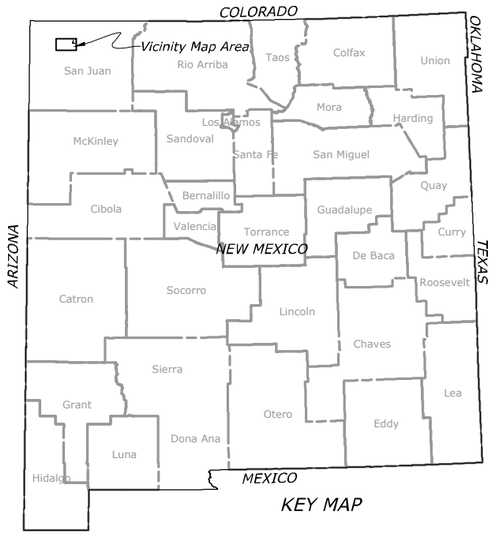
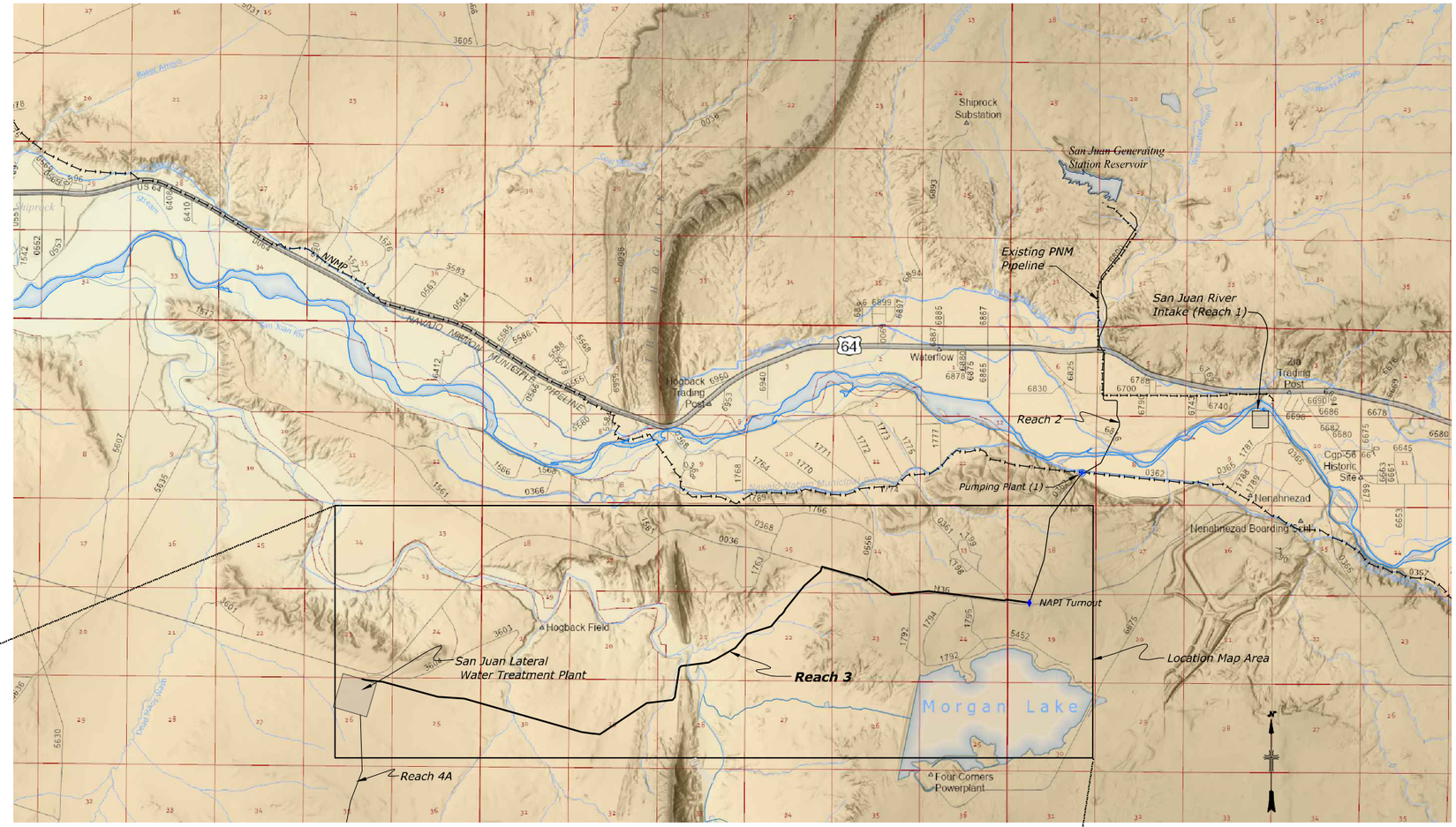
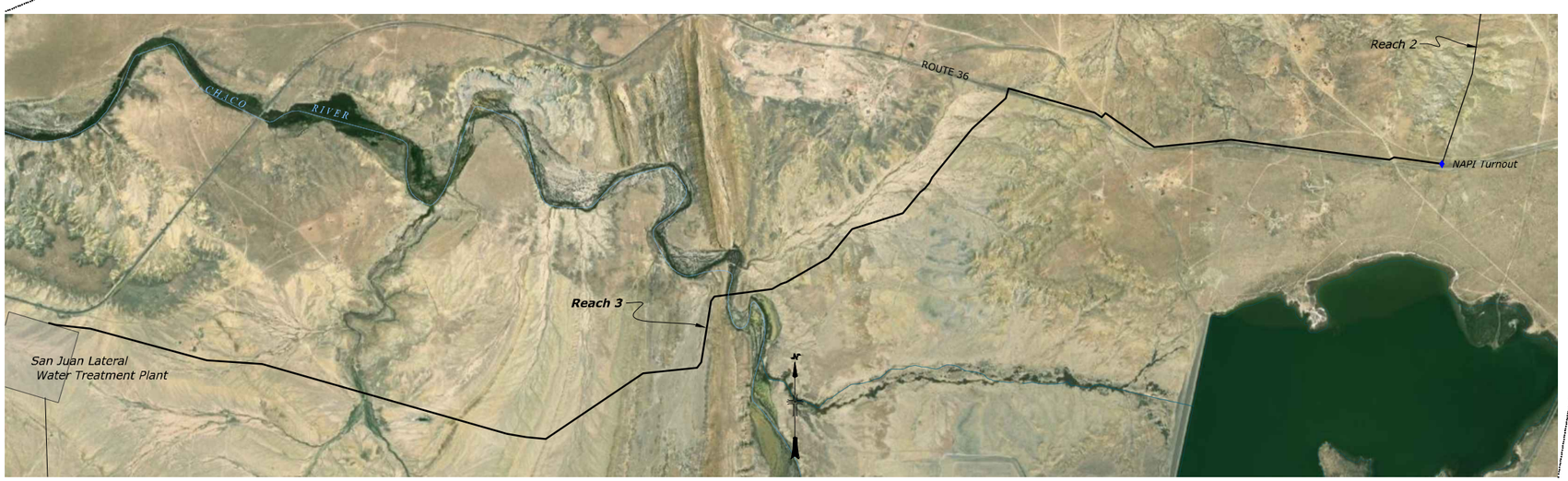


KEY MAP



VICINITY MAP

0 8000 16000 Feet



LOCATION MAP

0 4000 8000 Feet

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).
2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

REFERENCE DRAWINGS

General Map.....1695-529-60351
Location of Exploration.....1695-529-60354
Surface Geology.....1695-529-60363-60371
General Geologic Legend Explanation, and Notes.....1695-529-60340

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL
REACH 3 PNM ALTERNATIVE

DESIGNED X
D.Thornburg
DRAWN
CHECKED X
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL - Deputy Construction Engineer

FARMINGTON, NM 2023–02–01

LOCATION MAP

1695-529-60353
SHEET 1

LAST SAVED DATE 2023-02-01
LAST SAVED BY DTHORNBURG

CAD SYSTEM AutoCAD Civil 3D (LMS TECH)
CAD FILENAME 1695-529-60353-RD-1.DWG

TEST PIT Point Table						
Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
TPR3-21-1	2081523.86	2537080.36	W108° 28' 04.88"	N36° 43' 07.13"	W108.46802344	N36.71864765
TPR3-21-2	2081652.34	2536046.54	W108° 28' 17.59"	N36° 43' 08.33"	W108.47155354	N36.71898166
TPR3-21-3	2081791.98	2534934.48	W108° 28' 31.26"	N36° 43' 09.64"	W108.47535091	N36.71934481
TPR3-21-4	2081905.64	2534035.72	W108° 28' 42.31"	N36° 43' 10.71"	W108.47841992	N36.71964043
TPR3-21-5	2082024.36	2533022.17	W108° 28' 54.77"	N36° 43' 11.81"	W108.48188075	N36.71994771
TPR3-21-6	2082048.50	2532045.49	W108° 29' 06.77"	N36° 43' 11.98"	W108.48521361	N36.71999583
TPR3-21-7	2081963.30	2531156.93	W108° 29' 17.68"	N36° 43' 11.08"	W108.48824328	N36.71974517
TPR3-21-8	2082110.11	2530003.16	W108° 29' 31.86"	N36° 43' 12.46"	W108.49218319	N36.72012668
TPR3-21-9	2082839.32	2528958.62	W108° 29' 44.75"	N36° 43' 19.60"	W108.49576424	N36.72210979
TPR3-21-10	2083122.70	2527714.24	W108° 30' 00.06"	N36° 43' 22.31"	W108.50001671	N36.72286446
TPR3-21-11	2083364.21	2526801.80	W108° 30' 11.29"	N36° 43' 24.64"	W108.50313568	N36.72351032
TPR3-21-12	2082640.55	2525369.74	W108° 30' 28.82"	N36° 43' 17.38"	W108.50800451	N36.72149508
TPR3-21-13	2081881.79	2524662.89	W108° 30' 37.43"	N36° 43' 09.83"	W108.51039793	N36.71939731
TPR3-21-14	2081116.24	2524059.75	W108° 30' 44.77"	N36° 43' 02.22"	W108.51243723	N36.71728287
TPR3-21-15	2080422.55	2523504.88	W108° 30' 51.53"	N36° 42' 55.32"	W108.51431346	N36.71536674
TPR3-21-16	2079300.66	2521463.54	W108° 31' 16.50"	N36° 42' 44.08"	W108.52125031	N36.71224525
TPR3-21-17	2078384.43	2520518.49	W108° 31' 28.03"	N36° 42' 34.96"	W108.52445180	N36.70970998
TPR3-21-18	2077824.82	2519405.77	W108° 31' 41.64"	N36° 42' 29.34"	W108.52823386	N36.70815083
TPR3-21-19	2076731.12	2517499.32	W108° 32' 04.96"	N36° 42' 18.39"	W108.53471005	N36.70510866
TPR3-21-21	2075484.82	2516371.41	W108° 32' 18.69"	N36° 42' 05.99"	W108.53852627	N36.70166278
TPR3-21-22	2075238.13	2515459.33	W108° 32' 29.87"	N36° 42' 03.48"	W108.54163116	N36.70096675
TPR3-21-23	2074118.93	2513800.02	W108° 32' 50.15"	N36° 41' 52.29"	W108.54726260	N36.69785887
TPR3-21-24	2073541.41	2512924.04	W108° 33' 00.85"	N36° 41' 46.52"	W108.55023571	N36.69625467
TPR3-21-25	2073661.35	2511965.47	W108° 33' 12.63"	N36° 41' 47.63"	W108.55350823	N36.69656439
TPR3-21-26	2073934.49	2510897.84	W108° 33' 25.76"	N36° 41' 50.25"	W108.55715672	N36.69729251
TPR3-21-27	2074464.23	2509090.64	W108° 33' 48.00"	N36° 41' 55.36"	W108.56333447	N36.69870989

TEST PIT Point Table						
Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
TPR3-21-28	2075273.87	2506191.82	W108° 34' 23.68"	N36° 42' 03.14"	W108.57324324	N36.70087263
TPR3-21-29	2075549.42	2505235.46	W108° 34' 35.45"	N36° 42' 05.79"	W108.57651264	N36.70160916
TPR3-21-30	2075703.53	2504225.64	W108° 34' 47.86"	N36° 42' 07.24"	W108.57996123	N36.70201089
TPR3-21-31	2075774.68	2503252.18	W108° 34' 59.82"	N36° 42' 07.87"	W108.58328360	N36.70218545
TPR3-21-32	2076027.43	2502265.83	W108° 35' 11.96"	N36° 42' 10.29"	W108.58665481	N36.70285840
TPR3-21-33	2076289.98	2501312.01	W108° 35' 23.70"	N36° 42' 12.81"	W108.58991537	N36.70355892
TPR3-21-34	2076561.67	2500338.62	W108° 35' 35.67"	N36° 42' 15.42"	W108.59324303	N36.70428399

DRILL HOLE Point Table						
Description	Northing	Easting	Longitude	Latitude	Longitude (DEC DEG)	Latitude (DEC DEG)
DHR3-21-1	2083290.36	2526085.68	W108° 30' 20.08"	N36° 43' 23.86"	W108.50557733	N36.72329371
DHR3-21-1	2083559.30	2526177.40	W108° 30' 18.98"	N36° 43' 26.52"	W108.50527084	N36.72403416
DHR3-21-1	2081589.02	2537208.86	W108° 28' 03.31"	N36° 43' 07.78"	W108.46758647	N36.71882897
DHR3-21-2	2082733.33	2528835.67	W108° 29' 46.25"	N36° 43' 18.54"	W108.49618122	N36.72181634
DHR3-21-3A	2083563.08	2526179.39	W108° 30' 18.95"	N36° 43' 26.56"	W108.50526414	N36.72404458
DHR3-21-4A	2083290.29	2526088.13	W108° 30' 20.05"	N36° 43' 23.86"	W108.50556898	N36.72329355
DHR3-21-5	2079824.09	2522785.34	W108° 31' 00.31"	N36° 42' 49.35"	W108.51675370	N36.71370889
DHR3-21-6	2077814.68	2518632.14	W108° 31' 51.14"	N36° 42' 29.19"	W108.53087271	N36.70810756
DHR3-21-7	2077734.76	2518284.39	W108° 31' 55.41"	N36° 42' 28.37"	W108.53205700	N36.70788106
DHR3-21-8	2077658.53	2518007.91	W108° 31' 58.79"	N36° 42' 27.60"	W108.53299825	N36.70766615
DHR3-21-9	2074678.99	2514671.96	W108° 32' 39.49"	N36° 41' 57.89"	W108.54430270	N36.69941497
DHR3-21-10	2074195.23	2510028.10	W108° 33' 36.47"	N36° 41' 52.77"	W108.56012999	N36.69799059
DHR3-21-11	2074674.00	2508229.47	W108° 33' 58.60"	N36° 41' 57.36"	W108.56627728	N36.69926800
DHR3-21-12	2074791.83	2507869.60	W108° 34' 03.03"	N36° 41' 58.50"	W108.56750784	N36.69958407
DHR3-21-13	2074896.61	2507336.75	W108° 34' 09.58"	N36° 41' 59.50"	W108.56932809	N36.69986064

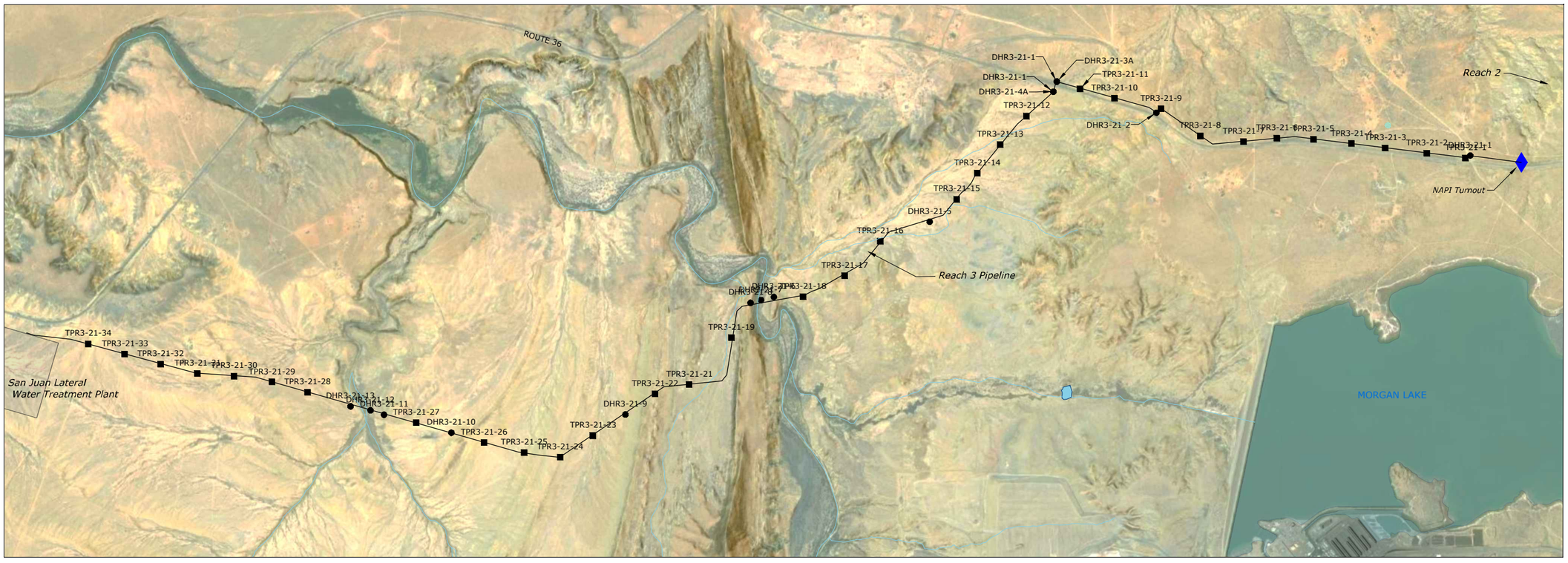
0 1500 3000 Feet

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).
2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60353.
Surface Geology.....1695-529-60363 thru 60371.



BUREAU OF RECLAMATION

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

SAN JUAN LATERAL

REACH 3 PNM ALTERNATIVE

Chris Beyer
DESIGNED
D.Thornburg
DRAWN
Chris Beyer
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL - Deputy Construction Engineer

FARMINGTON, NM 2023-02-02

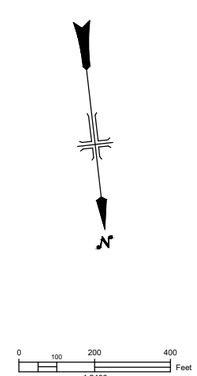
LOCATION OF EXPLORATION

1695-529-60354

SHEET 1

LAST SAVED DATE 2023-02-02
LAST SAVED BY DTHORNBURG

CAD SYSTEM AutoCAD 24.0S (LMS TECH)
CAD FILENAME 1695-529-60354-RD-1.DWG



GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.
Location Map.....1695-529-60353.
Location of Exploration.....1695-529-60354.
General Geologic Legend, Explanation and Notes.....1695-529-60340.
Surface Geology.....1695-529-60363 thru 1695-529-60371.

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL

REACH 3 - PNM OPTION

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-01-23

SURFACE GEOLOGY

1695-529-60363

SHEET 1

LAST SAVED DATE
2023-01-23
LAST SAVED BY
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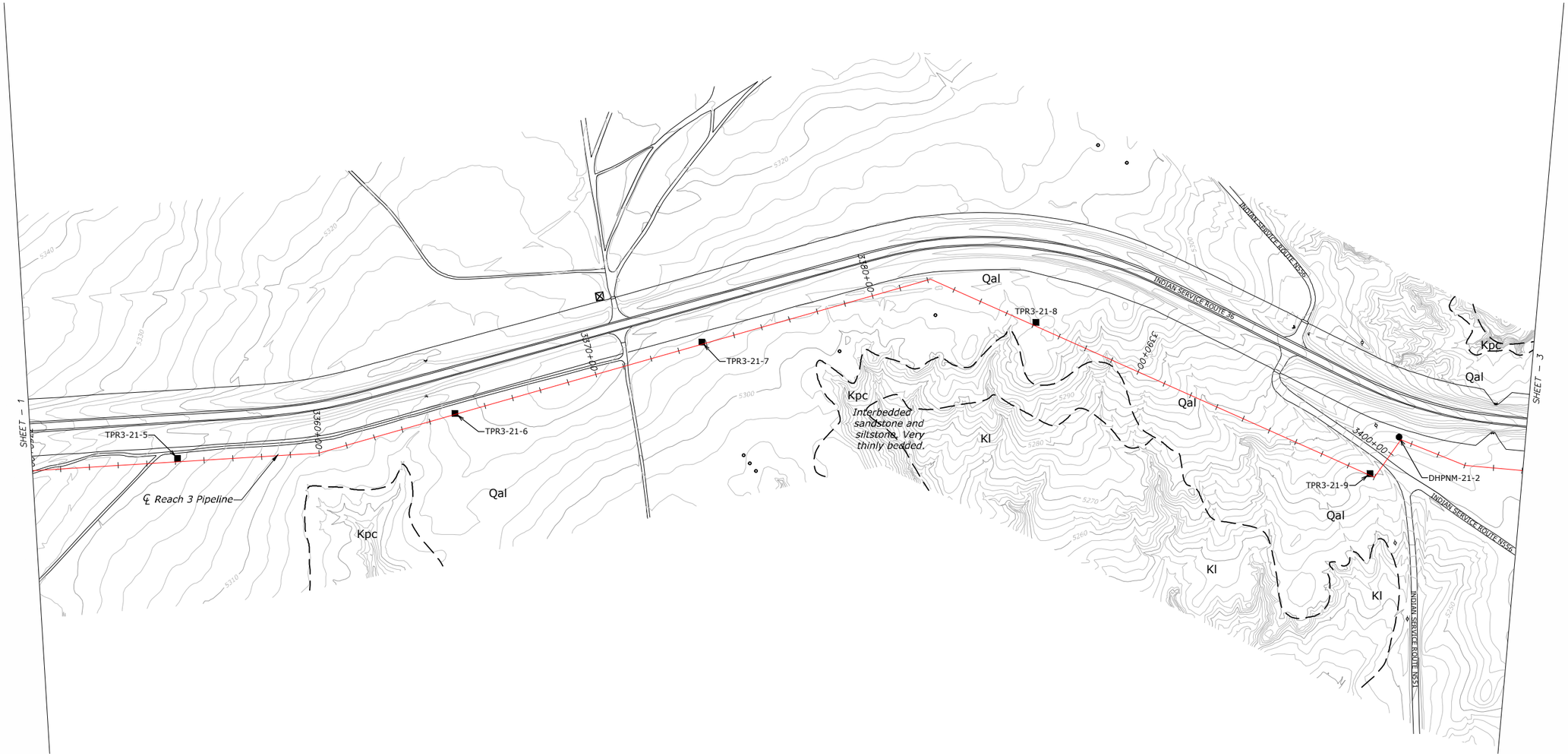

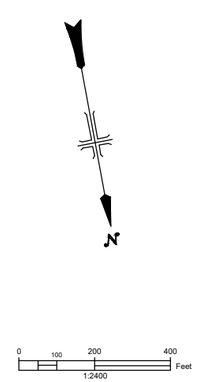

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60353.
Location of Exploration.....1695-529-60354.

General Geologic Legend, Explanation and Notes.....1695-529-60340.

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL

REACH 3 - PNM OPTION

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-01-23

SURFACE GEOLOGY

1695-529-60364

SHEET 2

LAST SAVED DATE
2023-01-23
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Plus (LMS TECH)
CAD FILENAME
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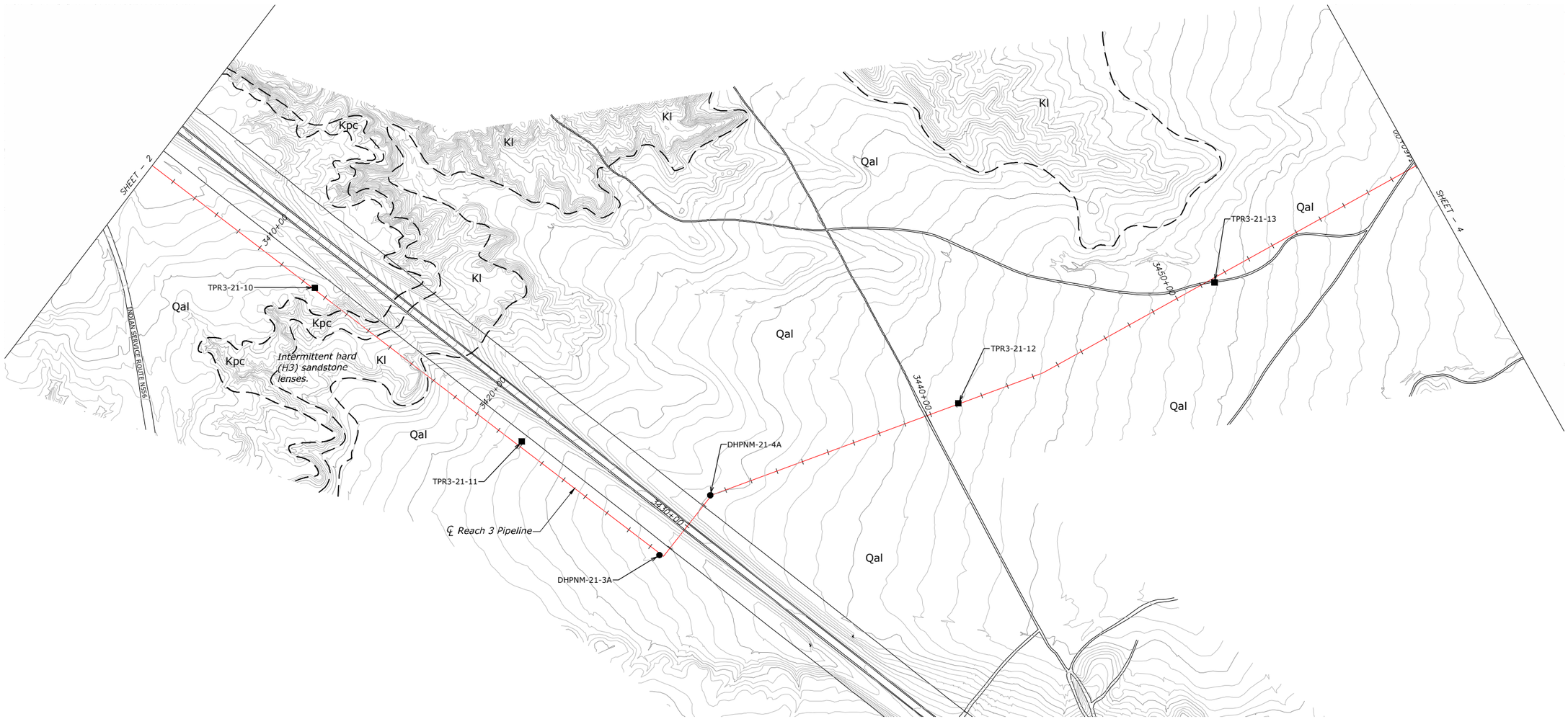

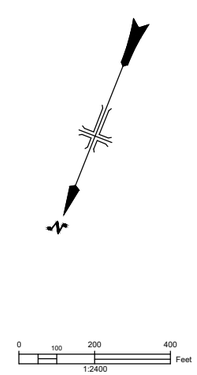

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60353.
Location of Exploration.....1695-529-60354.

General Geologic Legend, Explanation and Notes.....1695-529-60340.

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL

REACH 3 - PNM OPTION

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-01-23

SURFACE GEOLOGY

1695-529-60365

SHEET 3

LAST SAVED DATE
2023-01-23
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Civil 3D (LMS TECH)
CAD FILENAME
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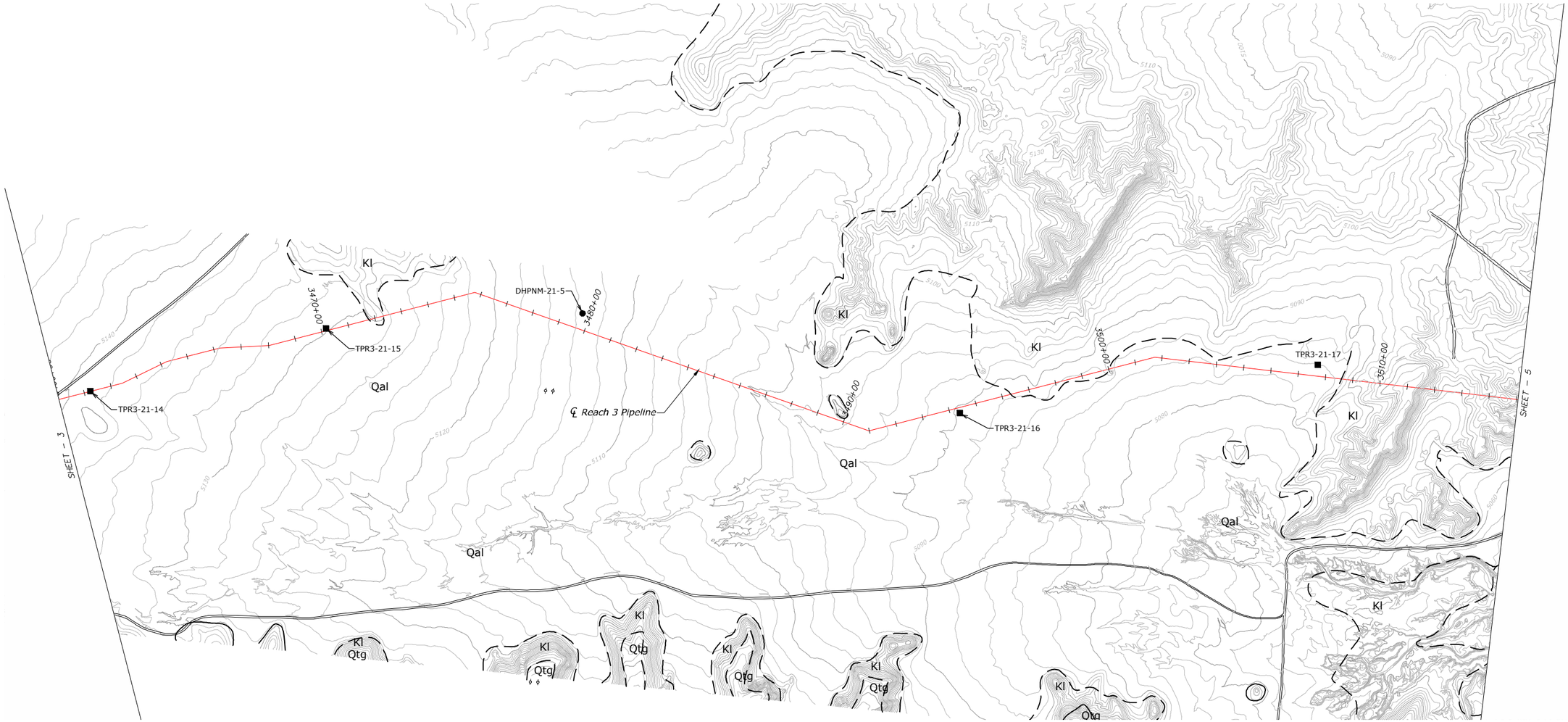

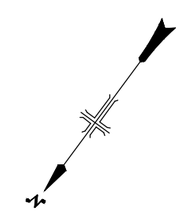

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60353.
Location of Exploration.....1695-529-60354.

General Geologic Legend, Explanation and Notes.....1695-529-60340.

BUREAU OF RECLAMATION

ALWAYS THINK SAFETY

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

SAN JUAN LATERAL

REACH 3 - PNM OPTION

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-01-23

SURFACE GEOLOGY

1695-529-60366

SHEET 4

LAST SAVED DATE
2022-01-13
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Civil 3D (LMS TECH)
CAD FILENAME
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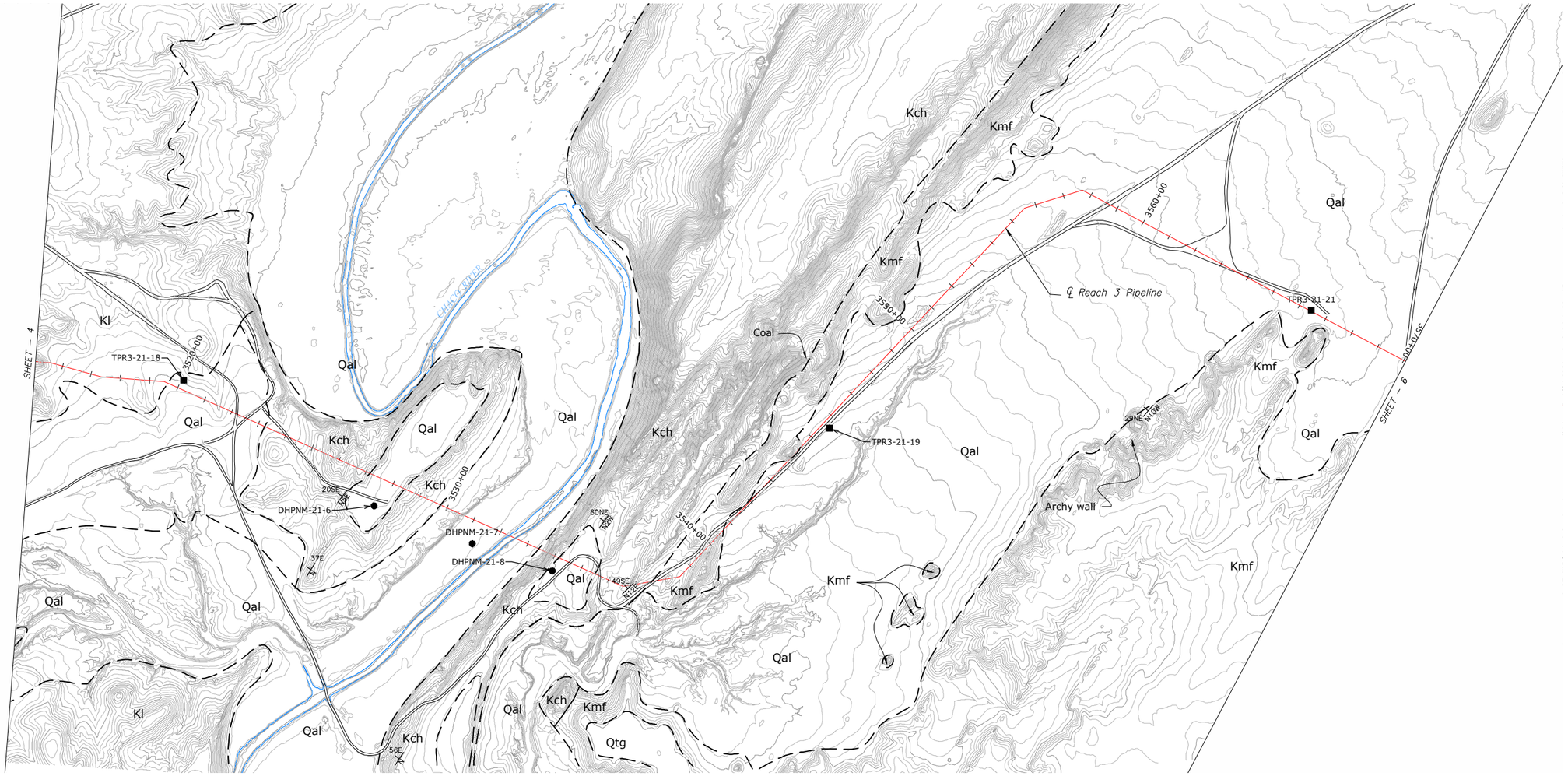

0 100 200 400 Feet
1:2400

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60353.
Location of Exploration.....1695-529-60354.

General Geologic Legend, Explanation and Notes.....1695-529-60340.

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL

REACH 3 - PNM OPTION

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-01-23

SURFACE GEOLOGY

1695-529-60367

SHEET 5

LAST SAVED DATE
2023-01-23
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Civil 3D 24.0S (LMS TECH)
CAD FILENAME
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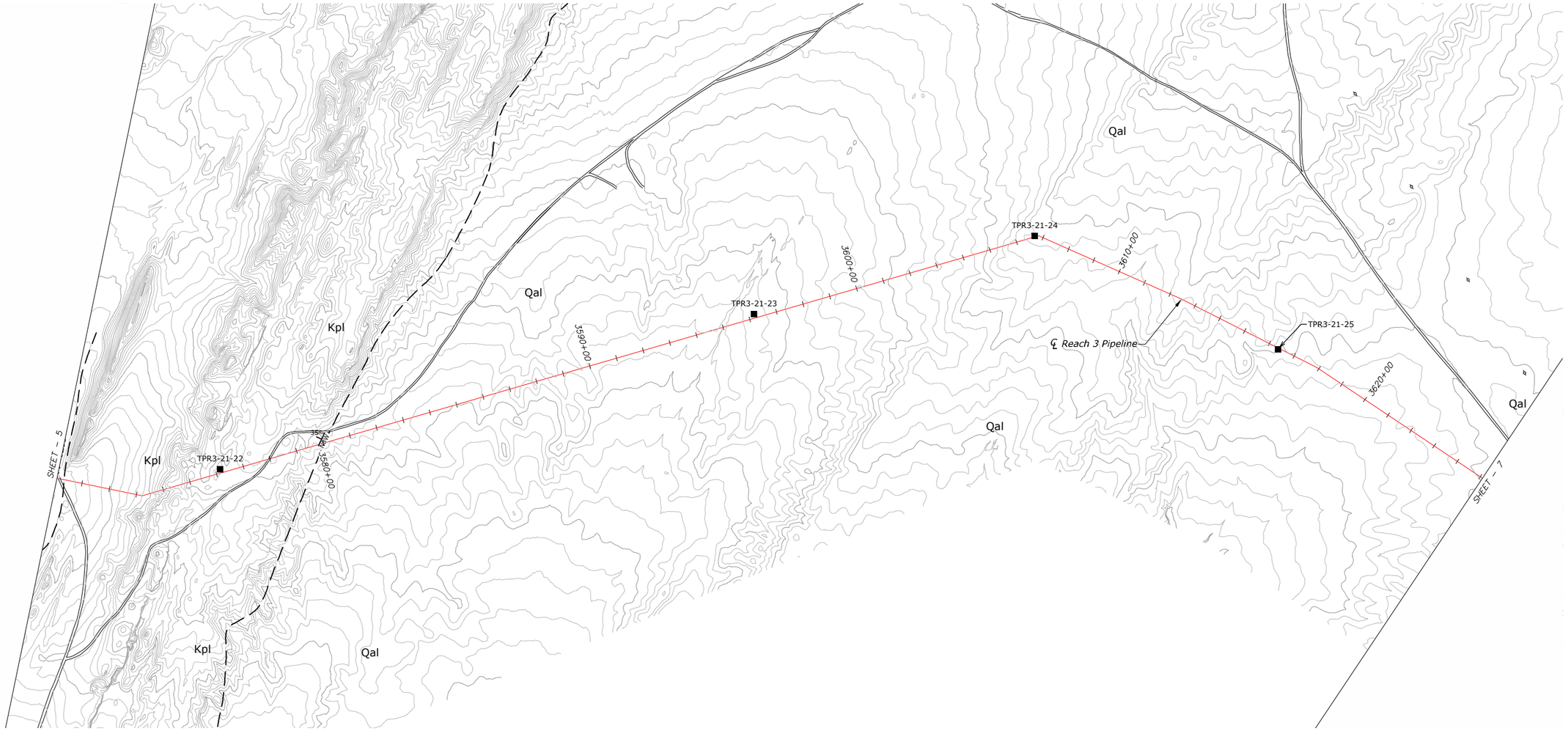

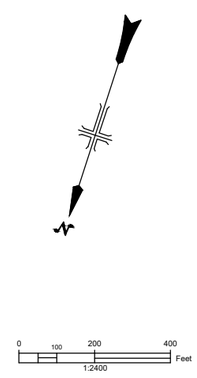

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60353.
Location of Exploration.....1695-529-60354.

General Geologic Legend, Explanation and Notes.....1695-529-60340.

BUREAU OF RECLAMATION

ALWAYS THINK SAFETY

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

SAN JUAN LATERAL

REACH 3 - PNM OPTION

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-01-23

SURFACE GEOLOGY

1695-529-60368

SHEET 6

LAST SAVED DATE
2023-01-23
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Civil 3D (UMS TECH)
CAD FILENAME
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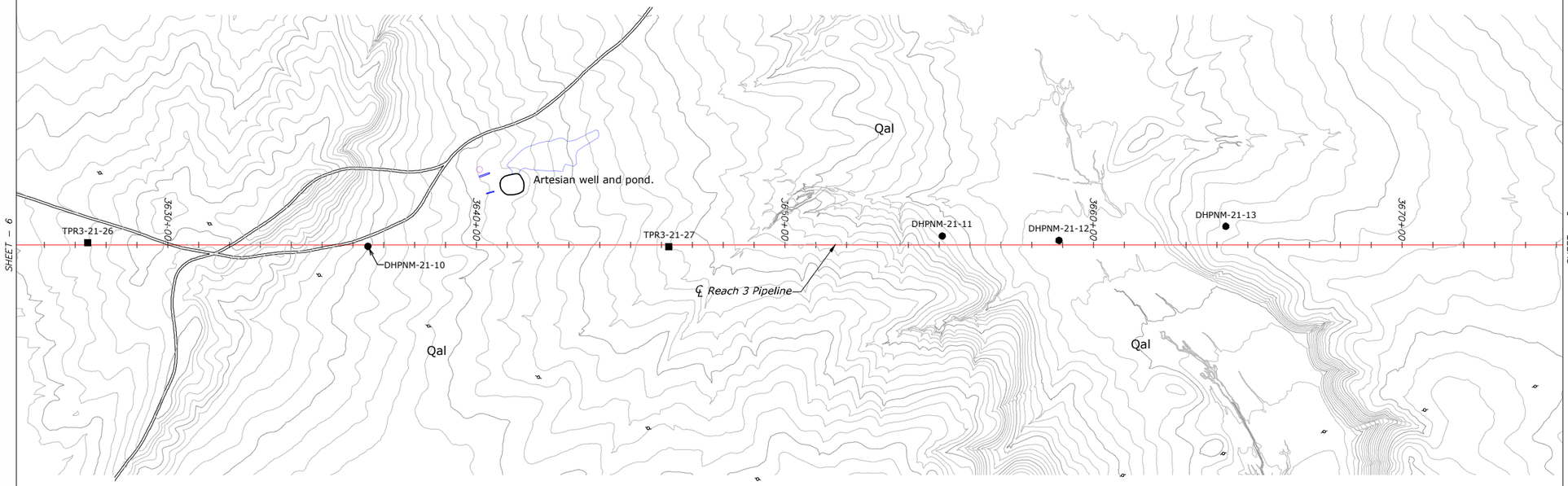

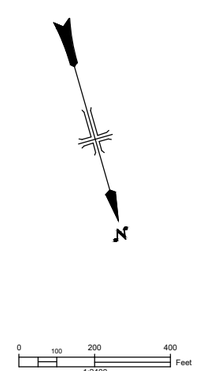

GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60353.
Location of Exploration.....1695-529-60354.

General Geologic Legend, Explanation and Notes.....1695-529-60340.

BUREAU OF RECLAMATION

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

SAN JUAN LATERAL

REACH 3 - PNM OPTION

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-01-23

SURFACE GEOLOGY

1695-529-60369

SHEET 7

LAST SAVED DATE
2023-01-23
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Civil 3D (LMS TECH)
CAD FILENAME
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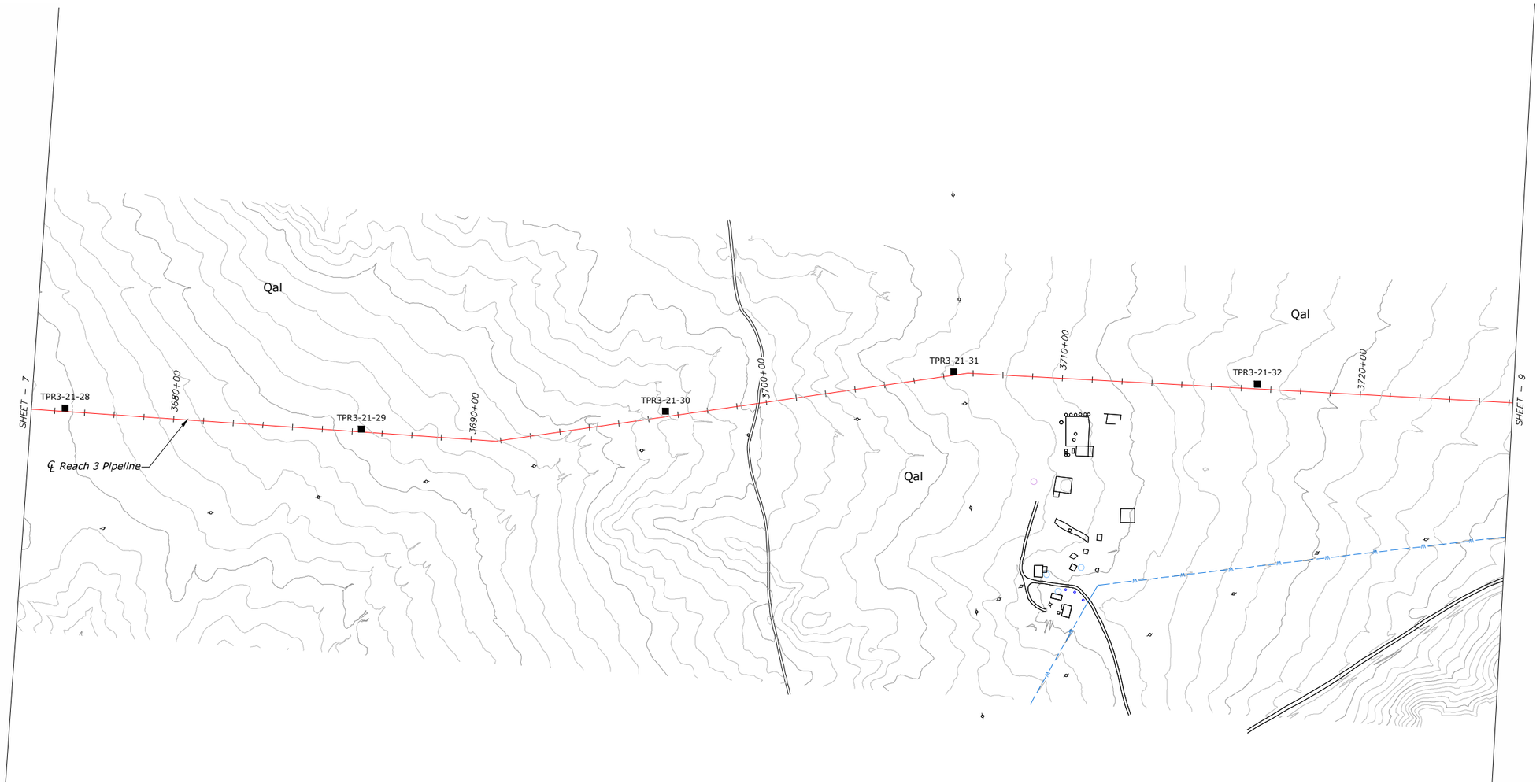
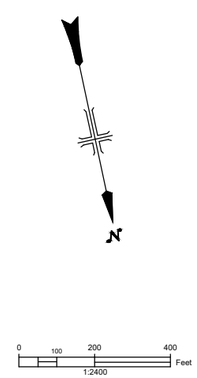




GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60353.
Location of Exploration.....1695-529-60354.

General Geologic Legend, Explanation and Notes.....1695-529-60340.

BUREAU OF RECLAMATION

ALWAYS THINK SAFETY

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

SAN JUAN LATERAL

REACH 3 - PNM OPTION

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-01-23

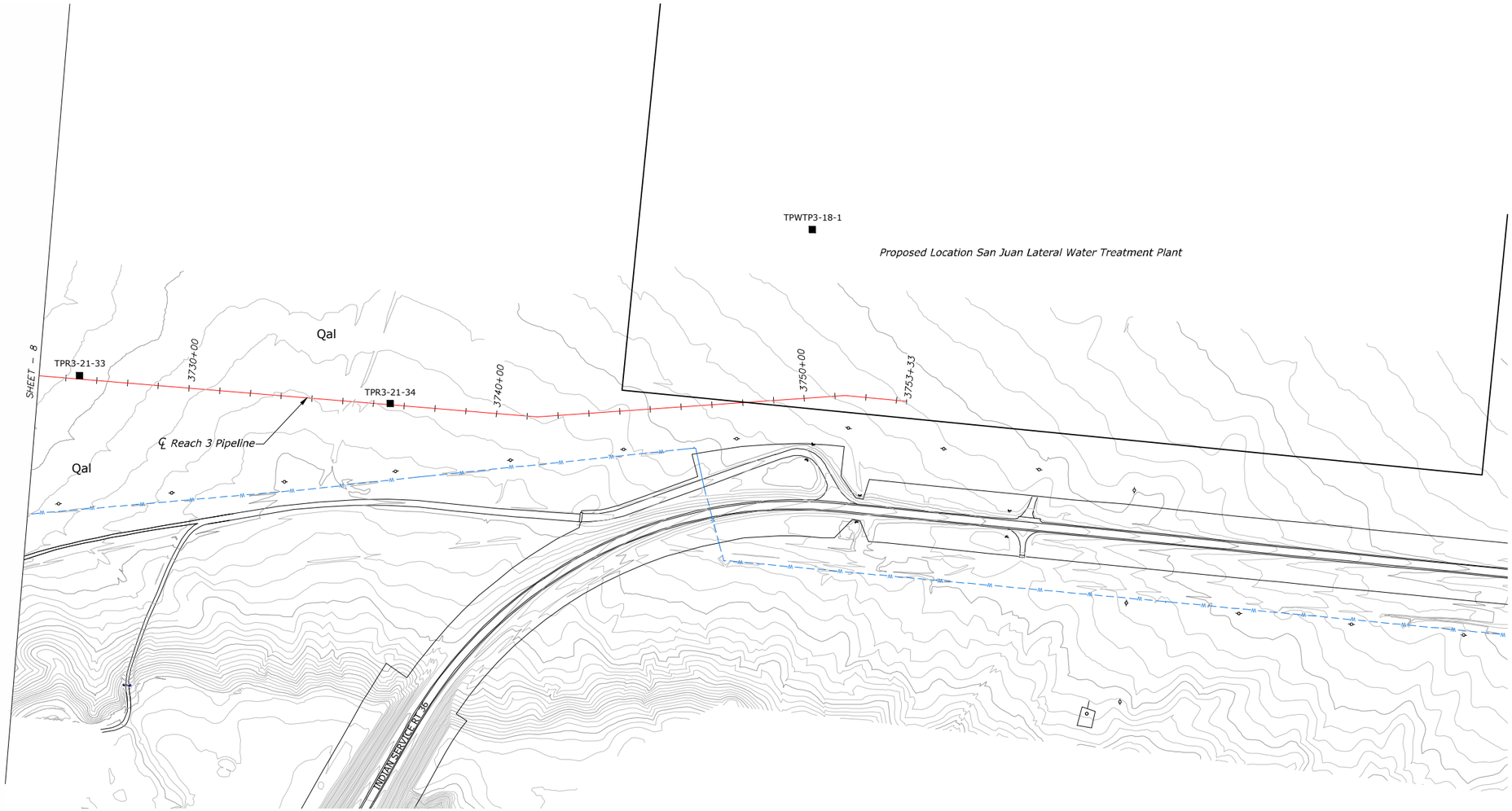
SURFACE GEOLOGY

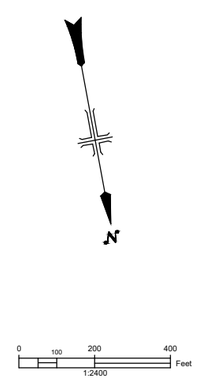
1695-529-60370

SHEET 8

LAST SAVED DATE
2023-01-23
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD 24.0S (LMS TECH)
CAD FILENAME
1695-529-60370-RD-8.DWG





GENERAL NOTES

1. Coordinates based on New Mexico State Plane West Zone, feet. (NAD83).

2. The Ground to New Mexico State Plane West Zone Grid conversion factor is 0.999713762328.

3. Contour interval is 2 feet.

REFERENCE DRAWINGS

General Map.....1695-529-60351.

Location Map.....1695-529-60353.
Location of Exploration.....1695-529-60354.

General Geologic Legend, Explanation and Notes.....1695-529-60340.

BUREAU OF RECLAMATION

ALWAYS THINK SAFETY

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

SAN JUAN LATERAL

REACH 3 - PNM OPTION

CHRIS BEYER
DESIGNED
D.THORNBURG
DRAWN
CHRIS BEYER
CHECKED
Beyer, Christopher R
TECH. APPR.
Gladden, Ryan L P.E.
APPROVED
ADMIN APPROVAL -

FARMINGTON, NM 2023-01-23

SURFACE GEOLOGY

1695-529-60371

SHEET 9

LAST SAVED DATE
2023-01-23
LAST SAVED BY
DTHORNBURG

CAD SYSTEM
AutoCAD Civil 3D (UMS TECH)
CAD FILENAME
1695-529-60371-RD-9.DWG

GEOLOGIC LOG OF DRILL HOLE NO. OWR2-23-22

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 4/17/2023 FINISHED: 4/17/2023
DEPTH TO WATER & ELEVATION: 4.9 ft ∇ (5199.5)
WATER DEPTH MEASURED ON: 4/17/2023

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2105631.5 E 2544629.9 NAD83
TOTAL DEPTH: 37.9 ft
DEPTH TO BEDROCK: 12.2 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5204.4 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES

ALL MEASUREMENTS ARE TAKEN FROM GROUND LEVEL AND REPORTED IN ENGINEERING FEET UNLESS OTHERWISE NOTED

DRILLED BY: UCB Provo Drill Crew
DRILLER: CJ Weber
HELPER(S): Morgan Janisse, Ryan Ward

PURPOSE:
Preconstruction soil and bedrock investigations below Willetto Reservoir Dam.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary Drill Rig.

DRILL METHOD:
0.0 to 4.5 ft: 4.25-inch HSA with pilot bit.
4.5 to 14.0 ft: 4.25-inch HSA with dry core system and SPT sampling.
14.0 to 37.9 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.

DRILLING MEDIUM:
0.0 to 14.0: Dry
14.0 to 37.9 ft: Freshwater

CASING/DRILLING NOTES:
0.0 to 4.5 ft: Pilot bit.
4.5 to 14.0 ft: Advanced HSA/SPT at 2.5-foot sample intervals.
14.0 to 17.9 ft: Advanced HQ3 3.9 ft.
17.9 to 37.9 ft: Advanced HQ3 at 5-foot sample intervals.

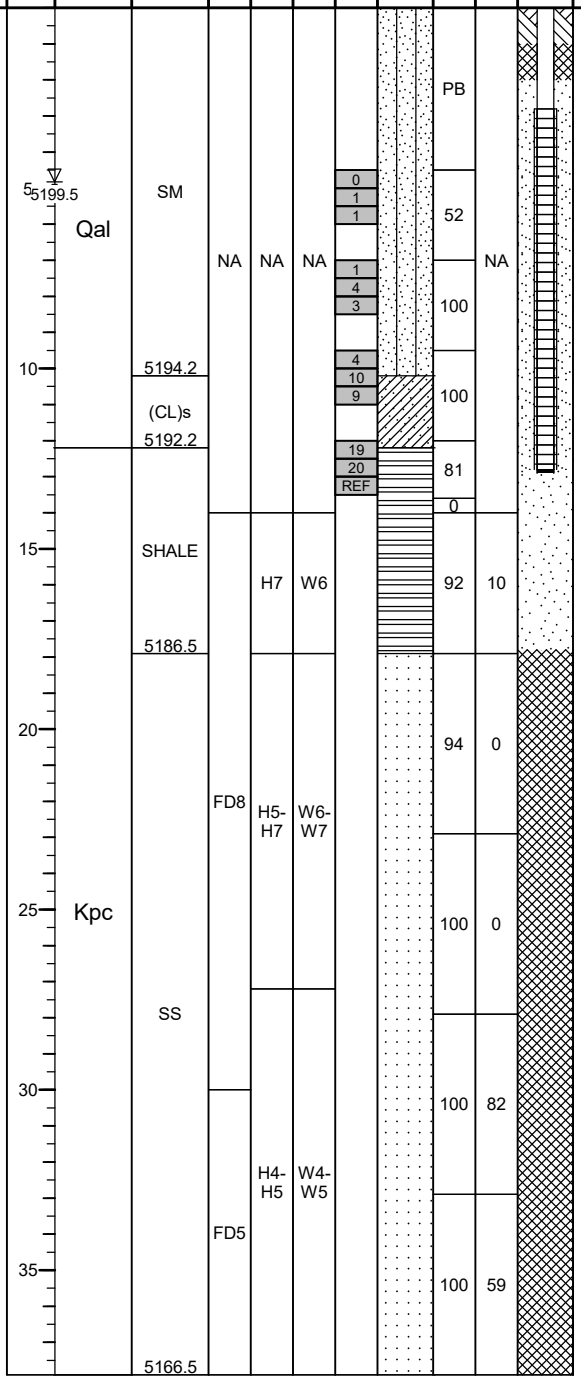
HOLE COMPLETION:
0.0 to 1.0 ft: Cement seal for 3.0-foot-tall lockable observation riser
1.0 to 2.0 ft: Bentonite seal
2.0 to 17.8 ft: 8/12 sand filter pack with 1.0 ft sump and sand backfill from 12.8 to 17.8 ft
2.8 to 12.8 ft: 0.020 steel wire wrapped slotted screen with 16/30 sand pre-pack and pipe cap
17.8 to 37.9 ft: Bentonite backfill
MATERIALS: 9 bags of 8/12 sand, 1 bag of 16/30 sand, and 4 buckets of coated bentonite pellets

SAMPLING:
34.6 to 35.5 ft: HQ3 A

4.5 to 6.0 ft: SPT 1
7.0 to 8.5 ft: SPT 2
9.5 to 11.0 ft: SPT 3
12.0 to 13.5 ft: SPT 4

***SPT lab data unavailable**

Core sample conditions are immediately preserved for shipping and testing by the Denver Geotechnical Laboratory and Field Support (GLFS) group.



BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 12.2 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 10.2 ft // SILTY SAND: About 65% medium to fine, hard, subangular to subrounded sand; about 20% nonplastic fines with rapid dilatancy, and no dry strength; gray, dry, strong reaction with HCl.

10.2 to 12.2 // LEAN CLAY WITH SAND: About 85% fines with medium plasticity, medium dry strength, no dilatancy, and medium toughness; about 15% medium to fine, hard, subangular to subrounded sand; trace FeOx; reddish-brown, dry, strong reaction to HCL.

12.2 to 37.9 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

12.2 to 17.9 ft // SHALE and CLAYSTONE: Dark brown to occasionally black color; very soft (H7) and intensely weathered (W7); very thinly to laminated and easily separates along bedding planes; very intensely to intensely fractured (FD8) with mechanical breaks and bedding plane separations throughout core interval; weak reaction with HCl.

17.9 to 27.2 ft // SANDSTONE and SHALE: Tan to dark brown to gray in color; sandstone is fine grained and argillaceous; moderately soft (H5) and moderately to intensely weathered (W6); intermittent shale is very soft (H7) and intensely weathered (W7); thinly bedded to laminated in places; easily separates along bedding planes; very intensely to intensely fractured (FD8) with common mechanical breaks, incipient fractures, and bedding plane separations throughout core interval; common FeOx and gypsum; strong reaction with HCl.

27.2 to 37.9 ft // SANDSTONE: Banded light to dark gray color, fine-grained and argillaceous with intermittent homogenous zones; moderately soft (H5) grading to hard (H3); moderately to intensely weathered (W6) grading to slightly weathered (W3) in places; thinly to thickly bedded; moderately fractured (FD5); 60° random fracture at 30.5 ft; 65° random fracture across bedding at 32.2 ft; strong reaction with HCl.

STRATIGRAPHY:
0.0 to 12.2 ft: QUATERNARY ALLUVIUM (Qal)
12.2 to 37.9 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ∇= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:

Silty Sand
Lean Clay with Sand
Shale
Sandstone
Cement Seal: 1 pipe group, 1 pipe
Bentonite seal with 1 pipe
Filter Pack: 1 pipe group, 1 pipe
Field Filter Pack: 1 pipe group, 1 pipe
Pipe Cap: 1 pipe group, 1 pipe
Filter Pack: Bottom of hole

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 ALIGNMENT DRILL LOGS.GPJ GINT STD US LAB.GDT 3/31/25

GEOLOGIC LOG OF DRILL HOLE NO. PWR2-23-1

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/30/2023 FINISHED: 3/30/2023
DEPTH TO WATER & ELEVATION: 6.0 ft ∇ (5194.4)
WATER DEPTH MEASURED ON: 3/30/2023

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2105565.6 E 2544652.3 NAD83
TOTAL DEPTH: 28.0 ft
DEPTH TO BEDROCK: 21.5 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5200.4 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: C. Beyer
REVIEWED BY: K. Graham

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER(S): Braden Samuels
HELPER(S): Dereck Nate

PURPOSE:
Installation of pump well for dewatering design investigation.

DRILL EQUIPMENT:
Eijkelkamp XL Max Sonic drilling rig.

DRILL METHOD:
0.0 to 28.0 ft: Sonic drilling with 12-inch casing.

DRILLING MEDIUM:
0.0 to 28.0 ft: none.

CASING RECORD/ DRILLING NOTES:
0.0 to 11.5 ft: 6" steel casing with 3 ft riser.

HOLE COMPLETION:
0.0 to 11.5 ft: 6" steel casing with bentonite seal and 3 ft riser.
10.5 to 24.5 ft: 16/30 sand filter pack.
11.5 to 21.5 ft: 0.020 steel wire wrapped slotted screen.
21.8 to 28.0 ft: Bentonite.

SAMPLING:
None

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	% RQD
	Qal	SC	NA	NA	NA	NO SPTs	100	NA
		5198.9 (SC)g						
		5198.4						
5							0	
5194.4 ∇								
10							0	
		SC						
15							0	
20							100	
		5178.9						
	Kpc	SHALE		7	8			
		5177.4						
25		SS		4	5		100	
		5172.9						
		SHALE		6	6			
		5172.4						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 21.5 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 1.5 ft: CLAYEY SAND (SC)
About 70% predominately fine sand, trace medium to coarse sand; about 30% fines with medium plasticity, medium dry strength and medium toughness; maximum size, coarse sand; brown and moist; strong reaction with HCl.

1.5 to 2.0 ft: CLAYEY SAND WITH GRAVEL (SC)g
About 45% predominately fine sand, trace medium to coarse sand; about 30% fines with medium plasticity, medium dry strength and medium toughness; about 25% fine to coarse gravel; maximum size, 50mm; brown and moist; strong reaction with HCl.

2.0 to 21.5 ft: CLAYEY SAND (SC)
About 70% predominately fine sand; trace medium to coarse sand; about 30% fines with medium plasticity, medium dry strength and medium toughness; maximum size, coarse sand; brown and moist; becomes wet at 6.0 ft; strong reaction with HCl.

21.5 to 28.0 ft: CRETACEOUS PICTURED CLIFFS SANDSTONE (Kpc)

21.5 to 23.0 ft: SHALE
Dark gray, laminated, sandy, very intensely weathered (W8), very soft (H7), slightly fissile, gypsum veins, dry, strong reaction with HCl.

23.0 TO 27.5 ft: SANDSTONE
Very fine grained, dark gray to brown, laminated to moderately bedded, argillaceous, moderately hard (H4) moderately weathered (W5), gypsum veins and iron oxide staining, strong reaction with HCl.

27.5 TO 28.0 ft: SHALE
Dark gray, laminated, sandy, very intensely weathered (W8), very soft (H7), slightly fissile, gypsum veins, dry, strong reaction with HCl.

STRATIGRAPHY:
0.0 to 21.5 ft: QUATERNARY ALLUVIUM (Qal)
21.5 to 28.0 ft: CRETACEOUS PICTURED CLIFFS SANDSTONE (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ∇= water level.

All angles measured from horizontal axis at zero degrees unless otherwise denoted

GRAPHIC LEGEND:
Clayey Sand
Clayey Sand with Gravel
Shale
Sandstone
Bentonite Seal: 1 pipe group, 1 pipe
Filter Pack: 1 pipe group, 1 pipe
Slotted Pipe: 1 pipe group, 1 pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 ALIGNMENT DRILL LOGS.GPJ GINT STD US LAB.GDT 3/31/25

GEOLOGIC LOG OF DRILL HOLE NO. OWR2-23-21

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 2/16/2023 FINISHED: 2/18/2023
DEPTH TO WATER & ELEVATION: 4.4 ft ∇ (5201.8)
WATER DEPTH MEASURED ON: 2/18/2023

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2105524.2 E 2544676.3 NAD83
TOTAL DEPTH: 39.4 ft
DEPTH TO BEDROCK: 16.8 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5206.2 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES

ALL MEASUREMENTS ARE TAKEN FROM GROUND LEVEL AND REPORTED IN ENGINEERING FEET UNLESS OTHERWISE NOTED

DRILLED BY: UCB Provo Drill Crew
DRILLER: CJ Weber
HELPER(S): Morgan Janisse, Ryan Ward

PURPOSE:
Preconstruction soil and bedrock investigations below Willetto Reservoir Dam.

DRILL EQUIPMENT:
CME model 85 Rubber Tire Drilling Rig.

DRILL METHOD:
0.0 to 5.0 ft: 4.25-inch HSA with pilot bit.
5.0 to 20.0 ft: 4.25-inch HSA with dry core system and SPT sampling.
20.0 to 39.4 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.

DRILLING MEDIUM:
0.0 to 20.0 ft: Dry
20.0 to 39.4 ft: Freshwater

CASING/DRILLING NOTES:
0.0 to 5.0 ft: Pilot bit.
5.0 to 20.0 ft: Advanced HSA/SPT at 2.5-foot sample intervals.
20.0 to 35.0 ft: Advanced HQ3 at 5-foot sample intervals.
35.0 to 39.4 ft: Advanced HQ3 4.4 ft.

HOLE COMPLETION:
0.0 to 1.0 ft: Cement seal for 3.0-foot-tall lockable observation riser
1.0 to 5.0 ft: Bentonite seal
5.0 to 19.8 ft: 8/12 sand filter pack with 1.0 ft sump and sand backfill from 16.8 to 19.8 ft
6.8 to 16.8 ft: 0.020 steel wire wrapped slotted screen with 10/20 sand pre-pack and pipe cap
19.8 to 39.4 ft: Bentonite backfill
MATERIALS: 2 bags of bentonite chips, 8 bags of 8/12 sand, 1 bag of 10/20 sand, and 5 buckets of coated bentonite pellets

SAMPLING:
29.0 to 29.5 ft: HQ3 A
31.8 to 32.7 ft: HQ3 B
32.7 to 33.6 ft: HQ3 C

5.0 to 6.5 ft: SPT 1
7.5 to 9.0 ft: SPT 2
10.0 to 11.5 ft: SPT 3
12.5 to 14.0 ft: SPT 4
15.0 to 16.5 ft: SPT 5
17.5 to 19.0 ft: SPT 6

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	% RQD
		5206.7					PB	
5 (∇ 5201.8)	Qal	SM	NA	NA	NA	1, 1, 1	92	
						1ft sink, 2, 0	100	NA
10						1, 1, 1	NR	
						0.3 ft sink, 1, 1	100	
15						7, 13, 9	88	
		5189.4						
	Kpc						68	
20		SHALE	FD7	H7	W5		84	17
25			FD5				100	62
		5177.6						
30		SS	FD4	H5-H3	W5-W3		100	
35								86
							NA	
		5166.8						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 16.8 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 0.5 ft // CLAYEY SAND: About 50% fines with medium plasticity, medium dry strength and medium toughness; About 50% medium to fine, hard, subangular to subrounded sand; dry to moist, brown to dark brown; strong reaction with HCl.

0.5 to 16.8 // SILTY SAND: About 75% medium to fine, hard, subangular to subrounded sand; about 15% nonplastic fines with rapid dilatancy, and no dry strength; trace gravel; maximum size, 60mm; dry, tan to brown; strong reaction with HCl.

LAB TEST DATA: Test interval 5.0 to 6.5 ft;
39.6% fines, 53.0% sand, 7.4% gravel;
LL= NA, PI= NP, SL= NA, SpG= 2.66,
Moisture= 20.2%; lab classification is SILTY SAND (SM)

LAB TEST DATA: Test interval 7.5 to 9.0 ft;
34.7% fines, 59.7% sand, 5.6% gravel;
LL= NA, PI= NP, SL= NA, SpG= 2.67,
Moisture= 22.5%; lab classification is SILTY SAND (SM)

LAB TEST DATA: Test interval 10.0 to 11.5 ft;
34.1% fines, 62.2% sand, 3.7% gravel;
LL= NA, PI= NP, SL= NA, SpG= 2.66,
Moisture= 23.7%; lab classification is SILTY SAND (SM)

LAB TEST DATA: Test interval 12.5 to 14.0 ft;
42.1% fines, 48.9% sand, 9.0% gravel;
LL= 22.8%, PI= 6.8%, SL= NA, SpG= 2.61,
Moisture= 19.8%; lab classification is CLAYEY SAND with SILT (SC-SM)

LAB TEST DATA: Test interval 15.0 to 16.5 ft;
44.0% fines, 51.6% sand, 4.4% gravel;
LL= NA, PI= NP, SL= NA, SpG= 2.76,
Moisture= 18.9%; lab classification is SILTY SAND (SM)

16.8 to 39.4 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

16.8 to 28.6 ft // SHALE: Dark gray to black color; very soft (H7) and moderately weathered (W5); laminate beds of sandstone and claystone; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; no reaction with HCl.

28.6 to 39.4 ft // SANDSTONE: Light gray color, fine grained and argillaceous; moderately soft (H5) and moderately weathered (W5) with intermittent hard (H3) and slightly weathered zones; thinly bedded with near horizontal bedding planes; mechanical breaks and bedding plane separation throughout core; gypsum present; strong reaction with HCl.

STRATIGRAPHY:
0.0 to 16.8 ft: QUATERNARY ALLUVIUM (Qal)
16.8 to 39.4 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ∇= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Clayey Sand
Silty Sand
Shale
Sandstone
Cement Seal: 1 pipe group, 1 pipe
Bentonite seal with 1 pipe
Filter Pack: 1 pipe group, 1 pipe
Field Filter Pack: 1 pipe group, 1 pipe
Pipe Cap: 1 pipe group, 1 pipe
Filter Pack: Bottom of hole

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 ALIGNMENT DRILL LOGS.GPJ GINT STD US LAB.GDT 3/31/25

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22- 1

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/17/22 FINISHED: 3/17/22
DEPTH AND ELEVATION OF WATER LEVEL: NE ⊻
DATE MEASURED: 3/17/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2104541.06 E 2544828.18 NAD83
TOTAL DEPTH: 19.5 ft
DEPTH TO BEDROCK: 13.9
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5227.6 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: K. Graham

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: CJ. Weber, D. Nate

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.5: 4.25-inch HSA with pilot bit.
4.5 to 16.5: 4.25-inch HSA with dry core system and SPT sampling.
16.5 to 19.5: 4.25-inch HSA with pilot bit.

DRILLING MEDIUM:
0.0 to 19.5: None

CASING RECORD/ DRILLING NOTES:
0.0 to 4.5: HSA with pilot bit
4.5 to 7.0: FADC
7.0 to 9.5: FADC
9.5 to 12.0: FADC
12.0 to 14.5: FADC
14.5 to 16.5: FADC
16.5 to 19.5: FADC with pilot bit
Casing removed.

HOLE COMPLETION:
0.0 to 19.5: Cuttings.

SAMPLING:
4.5 to 6.0: SPT
7.0 to 8.5: SPT
9.5 to 11.0: SPT
12.0 to 13.5: SPT
14.5 to 16.0: SPT

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
	Qal	NA	SM								
5	Qal	92	SM	7, 7, 9	27.7	72.3	0.0	NA	NP	2.4	SM
	Qal	28	SM	5, 6, 6	22.9	77.1	0.0	NA	NP	3.1	SM
10	Qal	44	SM	4, 7, 10	25.7	74.3	0.0	NA	NP	3.3	SM
			5215.9								
	Qal	60	s(CL)	11, 23, 23	31.6	54.2	14.2	NA	NP	5.2	SM
			5213.7								
15	Kpc	60	Sandstone	40, NA, NA	38.4	61.6	0.0	NA	NP	2.2	SM
	Kpc	NA	Sandstone								
			5208.1								

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 13.9 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 11.7 ft SILTY SAND (SM): About 85% fine sand; about 15% nonplastic fines with no dry strength and rapid dilatancy; trace of fine, hard, subrounded gravel; maximum size, 20 mm; brown and dry; no reaction with HCl.

LAB TEST DATA: Test interval 4.5 to 6.0 ft; 72.3% sand, 27.7% fines, LL= NA, PI= NP, SpG= 2.58, moisture= 2.4%. Lab classification is SILTY SAND (SM). Sample representative of 1.4 ft of the sample interval.

LAB TEST DATA: Test interval 7.0 to 8.5 ft; 77.1% sand, 22.9% fines, LL= NA, PI= NP, SpG= 2.62, moisture= 3.1%. Lab classification is SILTY SAND (SM). Sample representative of 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 9.5 to 11.0 ft; 74.3% sand, 25.7% fines, LL= NA, PI= NP, SpG= 2.60, moisture= 3.3%. Lab classification is SILTY SAND (SM). Sample representative of 1.4 ft of the sample interval.

11.7 to 13.9 ft SANDY LEAN CLAY s(CL): About 55% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 35% fine to coarse, hard, angular to rounded sand; about 10% fine, hard, angular to subrounded gravel; maximum size, 50 mm; brown and dry; FeOx and CaCOx present; strong reaction with HCl.

LAB TEST DATA: Test interval 12.0 to 13.5 ft; 54.2% sand, 31.6% fines, 14.2% gravel; LL= NA, PI= NP, SpG= 2.66, moisture= 5.2%. Lab classification is SILTY SAND (SM). sample representative of 1.4 ft of the sample interval.

13.9 to 19.5 ft CRETACEOUS PICTURED CLIFFS (Kpc)

13.9 to 16.5 ft SANDSTONE: Light brown color and fine grained; moderately soft (H5) and intensely weathered (W7); laminated to thinly bedded and dips from 11° to horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; weak reaction with HCl.

LAB TEST DATA: Test interval 14.5 to 16.0 ft; 61.6% sand, 38.4% fines, LL= NA, PI= NP, SpG= NA, moisture= 2.2%. Lab classification is SILTY SAND (SM). sample representative of 0.6 ft of the sample interval. SPT met refusal after 10 blows with no advancement.

16.5 to 19.5 ft NO RECOVERY: Interpreted to be hard (H3) and moderately weathered (W5) sandstone by drilling characteristics.

STRATIGRAPHY:
0.0 to 13.9 ft QUATERNARY ALLUVIUM (Qal)
13.9 to 19.5 ft CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ⊻= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Silty Sand
Sandy Lean Clay
Sandstone
Auger Cuttings: NO pipe group, NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22- 2

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/18/2022 FINISHED: 3/18/2022
DEPTH TO WATER & ELEVATION: NE ▽
WATER DEPTH MEASURED ON: 3/18/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2100979.3 E 2542943.1 NAD83
TOTAL DEPTH: 40.0 ft
DEPTH TO BEDROCK: 8.3 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5159.8 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: CJ. Weber, D. Nate

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.0: 4.25-inch HSA with pilot bit.
4.0 to 9.0: 4.25-inch HSA with dry core system with California and SPT sampling.
9.0 to 40.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel..

DRILLING MEDIUM:
0.0 to 9.0: None
9.0 to 40.0: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 4.0: HSA with pilot bit
4.0 to 6.5: FADC
6.5 to 9.0: FADC
9.0 to 12.0: HQ3
12.0 to 17.0: HQ3
17.0 to 22.0: HQ3
22.0 to 27.0: HQ3
27.0 to 32.0: HQ3
32.0 to 37.0: HQ3
37.0 to 40.0: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 40.0: Bentonite.

SAMPLING:
4.0 to 5.5: SPT
6.5 to 8.0: SPT
9.0 to 10.0: A CA
11.2 to 12.0: A HQ3
13.0 to 13.9: B HQ3
18.5 to 19.4: C HQ3
23.0 to 23.6: D HQ3
37.9 to 38.7: E HQ3

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	RQD
	Qal	CL					NA	
		5155.1				5, 6, 6	64	
5		s(CL)				14, 23, 33	76	
		5151.5						
	Kpc	Sandstone	NA	H5	W7	CA Sample		NA
10			FD1			A	93	46
			FD0			B	90	82
15								
			FD0			C	100	100
20								
			FD0		W5	D	100	100
25								
			FD0				100	86
30								
			FD0				98	78
35								
			FD0			E	100	100
40		5119.8						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 8.3 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 4.3 ft LEAN CLAY (CL): About 90% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 10% fine sand; maximum size, fine sand; brown and dry; weak reaction with HCl.

LAB TEST DATA: Test interval 4.0 to 5.5 ft; 57.4% fines, 40.6% sand, 2.0% gravel; LL= 27.2, PI= 7.7, SpG= 2.67, moisture= 4.8%. Lab classification is SANDY LEAN CLAY s(CL). Sample representative of 1.1 ft of the sample interval. Test extended into underlying interval.

4.3 to 8.3 ft SANDY LEAN CLAY s(CL): About 60% fines with medium plasticity, low toughness, low dry strength and no dilatancy; about 35% fine to coarse, hard, angular to rounded sand; about 5% fine, hard, angular to subrounded gravel; maximum size, 30 mm; brown and dry; weak reaction with HCl.

LAB TEST DATA: Test interval 6.5 to 8.0 ft; 41.6% sand, 58.4% fines, LL= 36.7, PI= 9.9, SpG= 2.76, moisture= 2.8%. Lab classification is SANDY SILT s(ML). Sample representative of 1.4 ft of the sample interval.

8.3 to 40.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

8.3 to 12.0 ft SANDSTONE: Light gray color, fine grained and argillaceous; moderately soft (H5) and intensely weathered (W7); moderately to thinly bedded and dips from 11° to horizontal; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; no reaction with HCl.

12.0 to 14.2 ft SANDSTONE: Light brown color, fine grained and argillaceous; moderately soft (H5) and intensely weathered (W7); moderately to thinly bedded and dips from 11° to horizontal; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; gypsum in some bedding planes; no reaction with HCl.

14.2 to 21.5 ft SANDSTONE: Light to dark gray and brown color, fine grained and argillaceous; moderately soft (H5) and moderately weathered (W5); moderately to thinly bedded and dips from 11° to horizontal; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; gypsum in some bedding planes; very soft (H7) claystone lamination present; no reaction with HCl.

21.5 to 35.4 ft SANDSTONE: Light gray color, fine grained and argillaceous; moderately soft (H5) and moderately weathered (W5); moderately to thinly bedded and dips from 11° to horizontal; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; no reaction with HCl.

35.4 to 40.0 ft SANDSTONE: Light to dark gray and brown color, fine grained and argillaceous; moderately soft (H5) and moderately weathered (W5); moderately to thinly bedded and dips from 11° to horizontal; mechanical breaks and bedding plane separation throughout core; gypsum in some bedding planes; very soft (H7) claystone lamination present; no reaction with HCl.

STRATIGRAPHY:
0.0 to 8.3 ft QUATERNARY ALLUVIUM (Qal)
8.3 to 40.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Lean Clay
Sandy Lean Clay
Sandstone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22- 3

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/19/2022 FINISHED: 3/19/2022
DEPTH TO WATER & ELEVATION: NE ∇
WATER DEPTH MEASURED ON: 3/19/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2100550.8 E 2542966.3 NAD83
TOTAL DEPTH: 40.0 ft
DEPTH TO BEDROCK: 5.4 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5156.7 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: CJ. Weber, D. Nate

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.0: 4.25-inch HSA with pilot bit.
4.0 to 5.4: 4.25-inch HSA with dry core system and SPT sampling.
5.4 to 40.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel..

DRILLING MEDIUM:
0.0 to 5.4: None
5.4 to 40.0: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 4.0: HSA with pilot bit
4.0 to 5.4: FADC
5.4 to 7.0: FADC
7.0 to 12.0: HQ3
12.0 to 17.0: HQ3
17.0 to 22.0: HQ3
22.0 to 27.0: HQ3
27.0 to 32.0: HQ3
32.0 to 37.0: HQ3
37.0 to 40.0: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 40.0: Bentonite

SAMPLING:
4.0 to 5.5: SPT
9.8 to 10.9: A HQ3
18.4 to 19.4: B HQ3
29.7 to 30.7: C HQ3
37.6 to 38.6: D HQ3

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	RQD
	Qal	CL					NA	
						27		
5						50	100	
		5151.3				refusal		
	Kpc		FD2				88	25
					H7			
			FD1				100	82
10		Sandstone		H5		A		
					H5			
			FD0				100	70
15		5141.3						
		Shale 5139.7		H7				
			FD0			B	100	98
20								
		Sandstone	FD0	H5			100	38
25								
			FD0		H3		100	72
30		5126.0				C		
		Shale	FD0	H7			100	96
35								
		5118.1	FD0			D		93
		Sandstone 5116.7		H5				
40								

GRAPHIC

HOLE COMPLETION

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 5.4 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 4.4 ft LEAN CLAY (CL): About 90% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 10% fine sand; maximum size, fine sand; brown and dry; strong reaction with HCl.

LAB TEST DATA: Test interval 4.0 to 5.5 ft; 50.1% sand, 49.9% fines, LL= 29.5, PI= 5.9, SpG= 2.69, moisture= 8.7%. Lab classification is SILTY, CLAYEY SAND (SC-SM). Sample representative of 0.9 ft of the sample interval. Test extended into underlying interval.

4.4 to 40.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

5.4 to 10.2 ft SANDSTONE: Light brown color, fine grained and argillaceous; moderately soft (H5) and intensely weathered (W7); laminated to thinly bedded and dips from 19° to horizontal; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; gypsum present; no reaction with HCl.

10.2 to 15.4 ft SANDSTONE: Light gray color, fine grained and argillaceous; moderately soft (H5) and intensely weathered (W7); thinly bedded and dips from 19° to horizontal; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; gypsum present; no reaction with HCl.

15.4 to 17.0 ft SHALE: Light to dark gray and black color; very soft (H7) and moderately weathered (W5); laminate beds of sandstone and claystone; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; no reaction with HCl.

17.0 to 30.7 ft SANDSTONE: Light gray color and fine to medium grained; moderately soft (H5) and slightly weathered (W3); laminated to thinly bedded; very soft (H7) claystone lamination at 22.0 ft below ground surface; strong reaction with HCl.

30.7 to 38.6 ft SHALE: Light to dark gray and black color; very soft (H7) and slightly weathered (W3); laminate beds of sandstone and claystone; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; no reaction with HCl.

38.6 to 40.0 ft SANDSTONE: Light gray color and fine to medium grained; moderately soft (H5) and slightly weathered (W3); laminated to thinly bedded; strong reaction with HCl.

STRATIGRAPHY:
0.0 to 5.4 ft QUATERNARY ALLUVIUM (Qal)
5.4 to 40.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Lean Clay
Sandstone
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22- 4

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/21/2022 FINISHED: 3/21/2022
DEPTH TO WATER & ELEVATION: 14.2 ft ▽ (5122.9)
WATER DEPTH MEASURED ON: 3/19/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2099864.3 E 2542934.8 NAD83
TOTAL DEPTH: 50.0 ft
DEPTH TO BEDROCK: 26.0 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5137.1 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: CJ. Weber, D. Nate

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.0: 4.25-inch HSA with pilot bit.
4.0 to 26.0: 4.25-inch HSA with dry core system and SPT sampling.
26.0 to 50.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel..

DRILLING MEDIUM:
0.0 to 26.0: None
26.0 to 50.0: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 4.0: HSA with pilot bit
4.0 to 6.5: FADC
6.5 to 9.0: FADC
9.0 to 11.5: FADC
11.5 to 14.0: FADC
14.0 to 19.0: FADC
19.0 to 24.0: FADC
24.0 to 26.0: FADC
26.0 to 32.0: HQ3
32.0 to 37.0: HQ3
37.0 to 42.0: HQ3
42.0 to 47.0: HQ3
47.0 to 50.0: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 50.0: Bentonite

SAMPLING:
4.0 to 5.5: SPT
6.5 to 8.0: SPT
9.0 to 10.5: SPT
11.5 to 13.0: SPT
14.0 to 15.5: SPT
19.0 to 20.5: SPT
24.0 to 25.5: SPT
33.4 to 34.4: A HQ3
35.7 to 36.2: B HQ3
43.3 to 44.1: C HQ3
48.6 to 49.6: D HQ3

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% RECOVERY
	Qal	s(CL)	4, 3, 4	76
			4, 4, 5	40
		5126.8	4, 7, 9	60
		CL	5, 8, 8	76
		5123.5		
5122.9		SM	3, 5, 7	
		5121.8		100
		CL		
		5117.2	1, 1, 6	
		SM		68
		5113.5		
		(SM)g	0, 1, 5	50

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 26.0 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 10.3 ft SANDY LEAN CLAY s(CL): About 55% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 40% fine to coarse, hard, angular to rounded sand; about 5% fine, hard, angular to subrounded gravel; maximum size, 50 mm; brown and dry; FeOx and CaCOx present; strong reaction with HCl.

LAB TEST DATA: Test interval 4.0 to 5.5 ft; 62.7% fines, 37.3% sand, LL= 27.7, PI= 7.3, SpG= 2.68, moisture= 5.7%; lab classification is SANDY LEAN CLAY s(CL).

LAB TEST DATA: Test interval 6.5 to 8.0 ft; 63.4% fines, 36.6% sand, LL= 29.3, PI= 11.3, SpG= 2.64, moisture= 6.7%; lab classification is SANDY LEAN CLAY s(CL).

LAB TEST DATA: Test interval 9.0 to 10.5 ft; 62.7% fines, 31.4% sand, LL= 39.6, PI= 23.4, SL= 10.6 SpG= 2.65, moisture= 12.4%; lab classification is LEAN CLAY (CL).

10.3 to 13.6 ft LEAN CLAY (CL): About 90% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 10% fine sand; maximum size, fine sand; dark brown and dry; strong reaction with HCl.

LAB TEST DATA: Test interval 11.5 to 13.0 ft; 94.1% fines, 5.9% sand, LL= 39.4, PI= 21.6, SL= 12.8 SpG= 2.65, moisture= 11.7%; lab classification is LEAN CLAY (CL).

13.6 to 15.3 ft SILTY SAND (SM): About 80% fine sand; about 20% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; light brown and dry; weak reaction with HCl.

LAB TEST DATA: Test interval 14.0 to 15.5 ft; 37.8% sand, 62.2% fines, LL= NA, PI= NP, SpG= 2.62, moisture= 4.7%; lab classification is SANDY SILT (SM).

15.3 to 19.9 ft LEAN CLAY (CL): About 90% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 10% fine sand; maximum size, fine sand; dark brown and wet at 18.7 ft below ground surface; strong reaction with HCl.

LAB TEST DATA: Test interval 19.0 to 21.5 ft; 81.1% fines, 18.9% sand, LL= 31.9, PI= 11.5, SpG= 2.66, moisture= 26.6%; lab classification is LEAN CLAY WITH SAND (CL)s.

19.9 to 23.6 ft SILTY SAND (SM): About 75% fine sand; about 25% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; light brown and wet; no reaction with HCl.

23.6 to 26.0 ft SILTY SAND WITH GRAVEL (SM)g: About 65% fine to coarse, hard subrounded to rounded sand; about 20% fine to coarse, hard subangular to subrounded gravel; about 15% nonplastic fines with no dry strength and rapid dilatancy; maximum size, 40 mm; brown and wet; no reaction

LAB TEST DATA: Test interval 24.0 to 25.5 ft; 72.4% sand, 16.4% gravel, 11.2% fines, LL= NA, PI= NP, SpG= 2.65, moisture= 18.0%; lab classification is SILTY SAND WITH GRAVEL (SM)g.

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Sandy Lean Clay
Lean Clay
Silty Sand
Silty Sand with Gravel
Sandstone
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22- 4

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/21/2022 FINISHED: 3/21/2022
DEPTH TO WATER & ELEVATION: 14.2 ft ∇ (5122.9)
WATER DEPTH MEASURED ON: 3/19/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2099864.3 E 2542934.8 NAD83
TOTAL DEPTH: 50.0 ft
DEPTH TO BEDROCK: 26.0 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5137.1 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES	DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	GRAPHIC	% RECOVERY	RQD	HOLE COMPLETION
		Qal	(SM)g 5111.1						50		
		Kpc	Sandstone	NA	NA	NA			68	NA	
				FD0						0	
	30				H5	W7	A		100	90	
			5102.3	FD0							
	35						B				
			Shale		H7				100	100	
				FD0							
	40		5096.5								
						W5					
							C		100	100	
	45		Sandstone	FD0	H5						
									100	100	
			5088.4	FD0							
			Shale 5087.1		H7		D				
	50										

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

with HCl.

26.0 to 50.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

26.0 to 31.5 ft POOR RECOVERY: Interpreted to be very soft (H7) sandstone. Recovered flowing sand and some sandstone core.

31.5 to 32.7 ft SANDSTONE: Brown color and fine grained; moderately soft (H5) and intensely weathered (W7); laminated to thinly bedded and dips from 11° to horizontal; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; FeOx staining present; weak reaction with HCl.

32.7 to 34.8 ft SANDSTONE: Light to dark gray color and fine grained; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips from 11° to horizontal; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; FeOx staining present; weak reaction with HCl.

34.8 to 40.4 ft SHALE: Light to dark gray color interbedded sandstone and claystone; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded; easily separates on bedding planes; mechanical breaks and bedding plane separation throughout core; weak reaction with HCl.

40.4 to 48.7 ft SANDSTONE: Light gray color and fine grained; hard (H3) and slightly weathered (W3); laminated to thinly bedded; strong reaction with HCl.

34.8 to 40.4 ft SHALE: Light to dark gray color interbedded sandstone and claystone; moderately soft (H5) and slightly weathered (W3); laminated to thinly bedded; strong reaction with HCl.

STRATIGRAPHY:
0.0 to 26.0 ft QUATERNARY ALLUVIUM (Qal)
26.0 to 50.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ∇ = water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Sandy Lean Clay
Lean Clay
Silty Sand
Silty Sand with Gravel
Sandstone
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-23-33

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 4/14/2023 FINISHED: 4/14/2023
DEPTH TO WATER & ELEVATION: WLNE ▽

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2103773.3 E 2544923.5 NAD83
TOTAL DEPTH: 22.2 ft
DEPTH TO BEDROCK: 4.3 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5208.4 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES

ALL MEASUREMENTS ARE TAKEN FROM GROUND LEVEL AND REPORTED IN ENGINEERING FEET UNLESS OTHERWISE NOTED

DRILLED BY: UCB Provo Drill Crew
DRILLER: CJ Weber
HELPER(S): Ryan Ward, Andrew Heath

PURPOSE:
Preconstruction soil and bedrock investigations along existing 42" pipe crossing (BLM).

DRILL EQUIPMENT:
CME model 850XR track mounted rotary drilling rig

DRILL METHOD:
0.0 to 4.0 ft: 4.25-inch HSA with pilot bit
4.0 to 5.5 ft: SPT sampling (No HSA)
4.0 to 22.2 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel

DRILLING MEDIUM:
0.0 to 4.0 ft: Dry
4.0 to 22.2 ft: Freshwater

CASING RECORD/DRILLING NOTES:
*All steel pipe/casing removed for prescribed hole completion;
4.0 to 7.2 ft: Advanced HQ3 3.2 ft.
7.2 to 22.2 ft: Advanced HQ3 at 5-foot sample intervals.

HOLE COMPLETION:
Casing removed; backfill with bentonite from 22.2 ft to surface.

SAMPLING:
20.0 to 20.8 ft: HQ3 A
4.0 to 5.5 ft: SPT 1

***SPT lab data unavailable**

Core sample conditions are immediately preserved for shipping and testing by the Denver Geotechnical Laboratory and Field Support (GLFS) group.

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	% RQD
	Qal	SM	NA	NA	NA		PB	NA
		5204.1				Sink 0.3' Ref. @ 4.3'		
5	Kpc	SS	FD4	H5	W5		100	53
		5201.2						
		SS / CLSTN	FD7-FD9	H5-H6	W6		94	44
10		5198.1						
		SS	FD3	H5	W5		100	66
15		5192.7						
		SS / CLSTN	FD7	H5-H6	W6-W7		100	70
20		5188.4						
		SS 5187.6	FD0	H3	W2			
		SS / CLSTN 5186.2	FD5	H5	W5			

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 4.3 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 4.3 ft // SILTY SAND: About 70% medium to fine, hard, subangular to subrounded sand; about 30% nonplastic fines; FeOx staining; brown, dry, strong reaction with HCl.

4.3 to 22.2 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

4.3 to 7.2 ft // SANDSTONE: Brown in color, fine grained and argillaceous; moderately soft (H5) and moderately weathered (W5); thinly to thickly bedded; moderately to slightly fractured (FD4) with horizontal mechanical breaks and bedding joints exhibiting partial gypsum fracture infill; $CaCO_3$ specks and FeOx banding present; strong reaction with HCl.

JOINT MEASUREMENTS:

DEPTH	INCL	TYPE	R T HL	INFILLING
4.8 ft	0°	BJ	5 3 5	Gypsum
5.3 ft	0°	BJ	4 2 5	Gypsum
5.9 ft	0°	BJ	4 2 3	Gypsum

7.2 to 10.3 ft // INTERBEDDED SANDSTONE & CLAYSTONE: Reddish-brown color, fine grained; moderately soft (H5) to soft (H6) in places and moderately to intensely weathered (W6); thinly bedded; intensely fractured (FD7) to very intensely fractured (FD9) in places with horizontal mechanical breaks and trace bedding joints with partial gypsum fracture fill; intermittent thin claystone interbeds and black organic material; common FeOx banding; strong reaction with HCl.

JOINT MEASUREMENTS:

DEPTH	INCL	TYPE	R T HL	INFILLING
7.2 ft	0°	BJ	3 3 5	Gypsum
7.4 ft	0°	BJ	5 3 5	Gypsum

10.3 to 15.7 ft // SANDSTONE: Brown color, fine grained, homogenous and argillaceous; moderately soft (H5) and moderately weathered (W5); thickly to very thickly bedded; slightly fractured (FD3) with horizontal mechanical breaks; FeOx throughout interval; strong reaction with HCl.

15.7 to 20.0 ft // INTERBEDDED SANDSTONE & CLAYSTONE: Brown color, fine grained, and argillaceous; moderately soft (H5) and moderately to intensely weathered (W6); laminated to thinly bedded with common variegated interbedding throughout; predominantly intensely fractured (FD7) with horizontal mechanical breaks; FeOx throughout interval; dark gray, soft (H6), and intensely weathered (W7) claystone at 16.5 ft; weak reaction with HCl.

20.0 to 20.8 ft // SANDSTONE: Light gray color, very fine grained, homogenous and argillaceous; hard (H3) and slightly weathered to fresh (W2); thickly bedded and unfractured (FD0); no significant secondary mineralization; strong reaction with HCl.

20.8 to 22.2 ft // INTERBEDDED SANDSTONE & SHALE: Brown color, fine grained, homogenous and argillaceous; moderately soft (H5) and moderately weathered (W5); thickly to thinly bedded and moderately fractured (FD5) with mottled shale and claystone laminations at 19.8 ft; claystone fracture at 19.6 ft; FeOx intermittently present; strong reaction with HCl.

STRATIGRAPHY
0.0 to 4.3 ft: QUATERNARY ALLUVIUM (Qal)
4.3 to 22.2 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ▽= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Silty Sand
Sandstone
Interbedded Claystone and Sandstone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 ALIGNMENT DRILL LOGS.GPJ GINT STD US LAB.GDT 3/31/25

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-23-34

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 4/15/2023 FINISHED: 4/15/2023
DEPTH TO WATER & ELEVATION: WLNE ▽

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2103678.8 E 2544868.3 NAD83
TOTAL DEPTH: 36.1 ft
DEPTH TO BEDROCK: 18.1 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5209.9 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES

ALL MEASUREMENTS ARE TAKEN FROM GROUND LEVEL AND REPORTED IN ENGINEERING FEET UNLESS OTHERWISE NOTED

DRILLED BY: UCB Provo Drill Crew
DRILLER: CJ Weber
HELPER(S): Ryan Ward, Andrew Heath

PURPOSE:
Preconstruction soil and bedrock investigations along existing 42" pipe crossing (BLM)

DRILL EQUIPMENT:
CME model 850XR track mounted rotary drilling rig

DRILL METHOD:
0.0 to 4.0 ft: 4.25-inch HSA with pilot bit
4.0 to 14.0 ft: 4.25-inch HSA with dry core system and SPT sampling
14.0 to 36.1 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel

DRILLING MEDIUM:
0.0 to 14.0 ft: Dry
14.0 to 36.1 ft: Freshwater

CASING/DRILLING NOTES:
0.0 to 4.0 ft: Pilot bit
4.0 to 14.0 ft: Advanced HSA/SPT at 2.5-foot sample intervals
14.0 to 16.1 ft: Advanced HQ3 2.1 ft
16.1 to 36.1 ft: Advanced HQ3 at 5-foot sample intervals

HOLE COMPLETION:
Casing removed; backfill with bentonite from 36.1 ft to surface.

SAMPLING:
29.5 to 30.4 ft: HQ3 A

4.0 to 5.5 ft: SPT 1
6.5 to 8.0 ft: SPT 2
9.0 to 10.5 ft: SPT 3
11.5 to 13.0 ft: SPT 4
14.0 to 15.5 ft: SPT 5

***SPT lab data unavailable**

Core sample conditions are immediately preserved for shipping and testing by the Denver Geotechnical Laboratory and Field Support (GLFS) group.

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	% RQD
	Qal	(SM)g	NA	NA	NA	6, 6, 7	PB	NA
5							20	
						6, 8, 8	56	
						5, 9, 10	60	
10								
						6, 10, 13	48	
						8, 13, 18	NR	0
15								
		5191.8						
	Kpc	SS	FD7	H5	W7		62	0
20		5189.3	FD4	H3	W3			
		SS / CLSTN	FD7	H5-H6	W6		92	5
25								
		5180.9					100	40
30		SS	FD4	H3	W3		100	90
35		5173.8						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 18.1 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 14.0 ft // SILTY SAND WITH GRAVEL: About 55% medium to fine, hard, subangular to subrounded sand; about 30% nonplastic fines with rapid dilatancy, and no dry strength; about 15% fine to medium, hard, subrounded gravel; maximum dimension 40 mm; FeOx staining; tan, dry, strong reaction with HCl; hit refusal at 15.4 ft with no returns.

14.0 to 16.1 ft: NO RECOVERY

16.1 to 18.1 ft: RECOVERED AS GRAVEL CAVINGS

18.1 to 36.1 Ft: CRETACEOUS PICTURED CLIFFS (Kpc)

18.1 to 19.7 ft // SANDSTONE: Brown color, fine grained and argillaceous; moderately soft (H5) and intensely weathered (W7); thinly bedded and dips from 6° to horizontal; mechanical breaks and bedding plane separation throughout core; common FeOx; CaCOx rings near top of bedrock; very intensely fractured zone (FD9) at 18.9 ft; no reaction with HCl.

JOINT MEASUREMENTS:

DEPTH	INCL	TYPE	R T HL	INFILLING
18.5 ft	4°	BJ	2 2 6	CaCO3
18.8 ft	4°	BJ	2 2 6	CaCO3

19.7 to 20.6 ft // SANDSTONE: Light gray color, very fine grained, homogenous and argillaceous; hard (H3) and slightly weathered (W3); thickly bedded with horizontal strata; moderately to slightly fractured (FD4); FeOx specs and banding; strong reaction with HCl.

JOINT MEASUREMENTS:

DEPTH	INCL	TYPE	R T HL	INFILLING
19.9 ft	0°	BJ	2 2 6	NE
20.1 ft	0°	BJ	2 0 6	NE

20.6 to 29.0 ft // INTERBEDDED SANDSTONE, CLAYSTONE, & SHALE: Predominantly brown to variegated gray colors, fine grained; moderately soft (H5) to soft (H6) in places and moderately to intensely weathered (W6); thinly interbedded with mottled shale and claystone interbeds and laminations; intensely fractured (FD7); bedding joints and mechanical breaks dip from about 4° to horizontal; common yellowish to reddish FeOx staining; strong reaction with HCl.

29.0 to 36.1 ft // SANDSTONE: Light to medium gray color; very fine grained, homogenous, and argillaceous; hard (H3) and slightly weathered (W3); thickly bedded and moderately to slightly fractured (FD4); mechanical breaks and bedding joints dip from 9° to horizontal; common MnOx and FeOx banding throughout; strong reaction with HCl.

STRATIGRAPHY
0.0 to 4.3 ft: QUATERNARY ALLUVIUM (Qal)
4.3 to 22.2 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ▽= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Silty Sand with Gravel
Sandstone
Interbedded Claystone and Sandstone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 ALIGNMENT DRILL LOGS.GPJ GINT STD US LAB.GDT 3/31/25

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-24-35

FEATURE: Reach 2
LOCATION: Pipeline Alignment HDD
BEGUN: 9/13/2024 FINISHED: 9/13/2024
DEPTH TO WATER & ELEVATION: 6.8 ft ∇ (5115.7)
WATER DEPTH MEASURED ON: 9/14/2024

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2099001.5 E 2542863.2 NAD83
TOTAL DEPTH: 19.8 ft
DEPTH TO BEDROCK: 15.2 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5122.5 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: C. Beyer
REVIEWED BY: K.Graham

NOTES

All measurements are from ground level and reported in feet unless otherwise noted

DRILLED BY:
Upper Colorado Drill Crew
DRILLER(S): M. Howell
HELPER(S): A. Heath

PURPOSE:
Preconstruction soil and bedrock pipeline alignment/ HDD investigation.

DRILL EQUIPMENT:
CME Model 85 truck mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.8 ft: 4.25-inch HSA with pilot bit.
4.8 to 19.8 ft: 4.25-inch HSA with dry core system and SPT sampling.

DRILLING MEDIUM:
0.0 to 19.8 ft: None

CASING RECORD/ DRILLING NOTES:
0.0 to 4.8: HSA with pilot bit
4.8 to 7.3 ft: FADC
7.3 to 9.8 ft: FADC
9.8 to 12.3 ft: FADC
12.3 to 14.8 ft: FADC
14.8 to 19.8 ft: FADC
Casing removed.

HOLE COMPLETION:
0.0 to 19.8 ft: Bentonite

SAMPLING:
4.8 to 6.3 ft: SPT 1
7.3 to 8.8 ft: SPT 2
9.8 to 11.3 ft: SPT 3
12.3 to 13.8 ft: SPT 4

Discontinued SPTs due to flowing sands.

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	LITHOLOGY	% RECOVERY	% RQD	HOLE COMPLETION
	Qal	SC	NA	NA	NA			NA	NA	
		5118.5								
5		SP-SM				1, 2, 1		20		
5115.7 ∇		5115.2								
		SC				sank, 7, 10		60		
		5114.1								
10		SP				4, 7, 6		76		
		5110.7								
		(SP)g				1, 4, sank		NR		
15		5107.3								
	Kpc	SS	NR	6	6			72	NR	
		5102.7		4	4					

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 15.2 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 4.0 ft: CLAYEY SAND (SC)
About 80% predominately fine sand, trace medium to coarse sand; about 20% fines with low plasticity, low dry strength and low toughness; maximum size, fine sand; brown and moist, roots; strong reaction with HCl.

4.0 to 7.3 ft: POORLY GRADED SAND WITH SILT (SP-SM)
About 90% predominately fine sand; about 10% nonplastic fines with rapid dilatancy and no dry strength; maximum size, fine sand; brown and moist; strong reaction with HCl.

7.3 to 8.4 ft: CLAYEY SAND (SC)
About 80% predominately fine sand, with trace medium to coarse sand; about 20% fines with low plasticity, low dry strength and low toughness; maximum size, fine sand; brown and moist; strong reaction with HCl.

8.4 to 11.8 POORLY GRADED SAND (SP)
About 95% fine sand; trace medium to coarse sand and fine gravel; about 5% nonplastic fines with rapid dilatancy and no dry strength; maximum size, 20mm; strong reaction with HCl.

11.8 to 15.2 ft: POORLY GRADED SAND WITH GRAVEL(SP)g
About 75% fine sand; trace medium to coarse sand; about 15% fine to coarse subangular gravel; about 5% nonplastic fines with rapid dilatancy and no dry strength; maximum size, 75mm; strong reaction with HCl.

15.2 to 19.8 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

15.2 to 19.8 ft: SANDSTONE
Fine grained, brown to gray in color, argillaceous; soft (H6) and intensely to moderately weathered (W6), to moderately hard (H4) and slightly to moderately weathered (W4); moderately bedded, calcite veins and claystone laminations along bedding planes; easily separates along bedding planes.

STRATIGRAPHY:
0.0 to 15.2 ft: QUATERNARY ALLUVIUM (Qal)
15.2 to 19.8 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ∇= water level.

All angles measured from horizontal axis at zero degrees unless otherwise denoted

GRAPHIC LEGEND:
Clayey Sand
Poorly-graded Sand
Sandstone
Bentonite seal with NO pipe
Poorly Graded Sand with Silt
Poorly Graded Sand with Gravel

BUREAU OF RECLAMATION

NGWSP ROCK SHUMWAY WASH HDD DRILL LOGS.GPJ GINT STD US LAB.GDT 3/31/25

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-24-36

FEATURE: Reach 2
LOCATION: Pipeline Alignment HDD
BEGUN: 9/14/2024 FINISHED: 9/16/2024
DEPTH TO WATER & ELEVATION: 8.3 ft ∇ (5113.3)
WATER DEPTH MEASURED ON: 9/14/2024

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2098794.4 E 2542848.5 NAD83
TOTAL DEPTH: 60.0 ft
DEPTH TO BEDROCK: 19.0 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5121.6 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: C. Beyer
REVIEWED BY: K.Graham

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: M. Howell
HELPER: A. Heath

PURPOSE:
Preconstruction soil and bedrock pipeline alignment/ HDD investigation.

DRILL EQUIPMENT:
CME Model 85 truck mounted rotary drill rig.

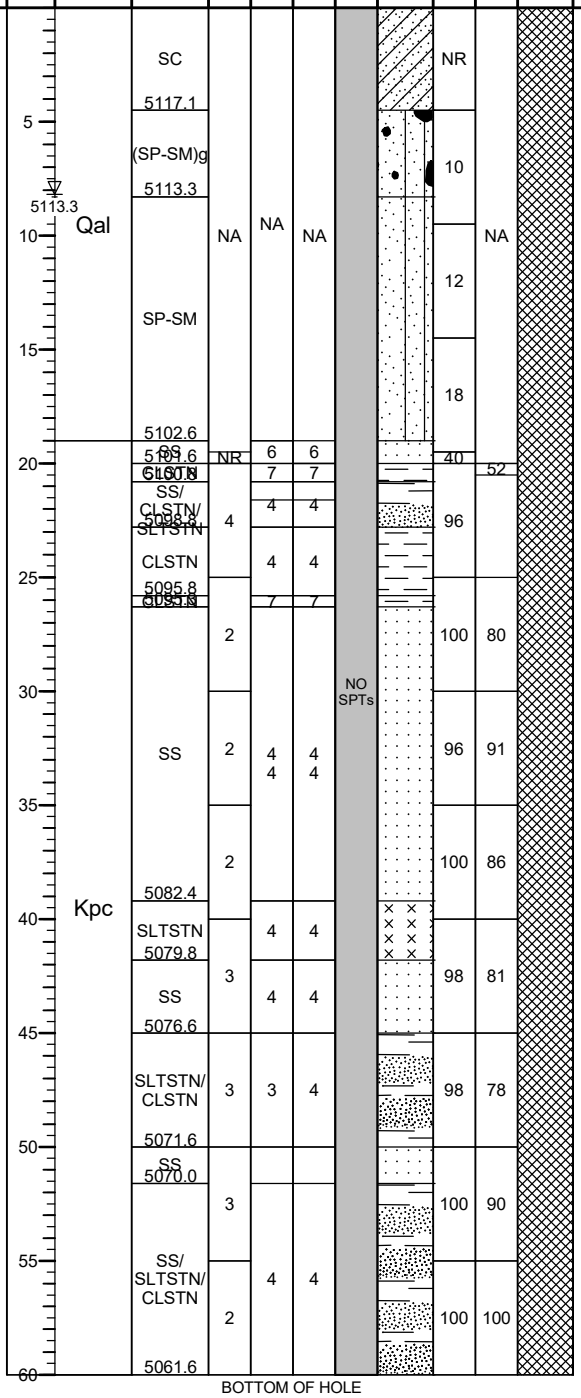
DRILL METHOD:
0.0 to 4.5 ft: 4.25-inch HSA with pilot bit.
4.8 to 19.5 ft: 4.25-inch HSA with dry core system and SPT sampling.
19.5 to 60.0 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.

DRILLING MEDIUM:
0.0 to 19.5 ft: None
19.5 to 60.0 ft: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 4.5 ft: HSA with pilot bit
4.5 to 9.5 ft: FADC
9.5 to 14.5 ft: FADC
14.5 to 19.5 ft: FADC
19.5 to 20.0 ft: HQ3
20.0 to 25.0 ft: HQ3
25.0 to 30.0 ft: HQ3
30.0 to 35.0 ft: HQ3
35.0 to 40.0 ft: HQ3
40.0 to 45.0 ft: HQ3
45.0 to 50.0 ft: HQ3
50.0 to 55.0 ft: HQ3
55.0 to 60.0 ft: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 60.0 ft: Bentonite

SAMPLING:
A 27.8 to 29.1 ft: HQ3 wrapped core
B 25.0 to 25.8 ft: HQ3 wrapped core
C 35.0 to 35.9 ft: HQ3 wrapped core
D 45.3 to 46.3 ft: HQ3 wrapped core



CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 19.0 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 4.5 ft: CLAYEY SAND (SC)
About 70% predominately fine sand; trace medium to coarse sand; about 30% fines with medium plasticity, medium dry strength and medium toughness; maximum size, fine sand; brown and dry, moist below 2.0 ft; strong reaction with HCl.

4.5 to 8.3 ft: POORLY GRADED SAND WITH GRAVEL(SP)g
About 75% fine sand; trace medium to coarse sand; about 15% fine to coarse subangular gravel; about 5% nonplastic fines with rapid dilatancy and no dry strength; maximum size, 50mm; wood fragments; strong reaction with HCl.

8.3 to 19.0 ft: POORLY GRADED SAND (SP)
About 90% fine sand; trace medium to coarse sand and fine gravel; about 10% nonplastic fines with rapid dilatancy and no dry strength; moist, wet below 9.3 ft; maximum size, 20mm; strong reaction with HCl.

19.0 to 60.0 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

19.0 to 20.0 ft: SANDSTONE
Fine grained, brown to gray in color, and argillaceous; soft (H6) and intensely to moderately weathered (W6) to moderately hard (H4) and moderately to slightly weathered (W4), moderately bedded and easily separates along bedding planes; calcite veins and claystone laminations along bedding planes.

20.0 to 20.8 ft: CLAYSTONE
Dark gray in color; very soft (H7) and very intensely weathered (W7); thinly bedded and easily separates along bedding planes; slakes rapidly; strong reaction with HCl.

20.8 to 22.8 ft: INTERBEDDED SANDSTONE/ SILTSTONE/ CLAYSTONE
Sandstone and siltstone are brown to gray in color, fine to very fine grained, and argillaceous; moderately hard (H4) and moderately to slightly weathered (W4); thinly bedded; strong reaction with HCl. Claystone is dark gray in color, very soft (H7) and very intensely weathered (W7); thinly bedded and easily separates along bedding planes; slakes rapidly; strong reaction with HCl.

22.8 to 25.8 ft: SANDSTONE
Brown to gray in color, fine grained, and argillaceous; moderately hard (H4) and moderately to slightly weathered (W4), moderately bedded and easily separates along bedding planes; calcite veins and claystone laminations along bedding planes.

25.8 to 26.3 ft: CLAYSTONE
Dark gray in color; very soft (H7) and very intensely weathered (W7); thinly bedded and easily separates along bedding planes; slakes rapidly; strong reaction with HCl.

26.3 to 39.2 ft: SANDSTONE
Brown to gray in color, fine grained, and argillaceous; moderately hard (H4) and moderately to slightly weathered (W4); moderately bedded and easily separates along bedding planes.

39.2 to 41.8 ft: SILTSTONE
Brown to gray in color, very fine grained, and argillaceous; moderately hard (H4) and moderately to slightly weathered (W4); moderately bedded and easily separates along bedding

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ∇= water level.

All angles measured from horizontal axis at zero degrees unless otherwise denoted

GRAPHIC LEGEND:
Clayey Sand
Poorly Graded Sand with Silt and Gravel
Poorly Graded Sand with Silt
Sandstone
Claystone
Interbedded Claystone and Sandstone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK SHUMWAY WASH HDD DRILL LOGS.GPJ GINT STD US LAB.GDT 3/31/25

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-24-36

FEATURE: Reach 2
LOCATION: Pipeline Alignment HDD
BEGUN: 9/14/2024 FINISHED: 9/16/2024
DEPTH TO WATER & ELEVATION: 8.3 ft ∓ (5113.3)
WATER DEPTH MEASURED ON: 9/14/2024

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2098794.4 E 2542848.5 NAD83
TOTAL DEPTH: 60.0 ft
DEPTH TO BEDROCK: 19.0 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5121.6 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: C. Beyer
REVIEWED BY: K.Graham

NOTES	DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	ENGINEERING PROPERTIES: Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	LITHOLOGY	% RECOVERY	% RQD	HOLE COMPLETION	CLASSIFICATION AND PHYSICAL CONDITION

planes.

41.8 to 45.0 ft: SANDSTONE
Brown to gray in color, fine grained, and argillaceous; moderately hard (H4) and moderately to slightly weathered (W4); moderately bedded and easily separates along bedding planes; calcite veins and claystone laminations along bedding planes.

45.0 to 50.0 ft: INTERBEDDED SANDSTONE/ SILTSTONE/ CLAYSTONE
Sandstone and siltstone are brown to gray in color, fine to very fine grained, and argillaceous; moderately hard (H4) and moderately to slightly weathered (W4); thinly bedded; strong reaction with HCl. Claystone is dark gray in color, very soft (H7) and very intensely weathered (W7); thinly bedded and easily separates along bedding planes; slakes rapidly; strong reaction with HCl.

50.0 to 55.0 ft: SANDSTONE
Brown to gray in color, fine grained, and argillaceous; moderately hard (H4) and moderately to slightly weathered (W4); moderately bedded and easily separates along bedding planes; calcite veins and claystone laminations along bedding planes.

50.0 to 60.0 ft: INTERBEDDED SANDSTONE/ SILTSTONE/ CLAYSTONE
Brown to gray in color, fine grained, and argillaceous; moderately hard (H4) and moderately to slightly weathered (W4); moderately bedded and easily separates along bedding planes; calcite veins and claystone laminations along bedding planes.

STRATIGRAPHY:
0.0 to 19.0 ft: QUATERNARY ALLUVIUM (Qal)
19.0 to 60.0 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ∓= water level.

All angles measured from horizontal axis at zero degrees unless otherwise denoted

GRAPHIC LEGEND:
- Clayey Sand
- Poorly Graded Sand with Silt and Gravel
- Poorly Graded Sand with Silt
- Sandstone
- Claystone
- Interbedded Claystone and Sandstone
- Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK SHUMWAY WASH HDD DRILL LOGS.GPJ GINT STD US LAB.GDT 3/31/25

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22- 8

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/23/22 FINISHED: 3/23/22
DEPTH AND ELEVATION OF WATER LEVEL: NA ∇
DATE MEASURED: 3/23/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2097348.74 E 2542728.26 NAD83
TOTAL DEPTH: 40.0 ft
DEPTH TO BEDROCK: 28.2
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5147.9 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: CJ. Weber, D. Nate

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.0: 4.25-inch HSA with pilot bit.
4.0 to 29.0: 4.25-inch HSA with dry core system and SPT sampling.
29.0 to 40.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel..

DRILLING MEDIUM:
0.0 to 29.0: None
29.0 to 40.0: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 4.0: HSA with pilot bit
4.0 to 6.5: FADC
6.5 to 9.0: FADC
9.0 to 11.5: FADC
11.5 to 14.0: FADC
14.0 to 19.0: FADC
19.0 to 24.0: FADC
24.0 to 29.0: FADC
29.0 to 32.0: HQ3
32.0 to 37.0: HQ3
37.0 to 40.0: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 40.0: Bentonite

SAMPLING:
4.0 to 5.5: SPT
6.5 to 8.0: SPT
9.0 to 10.5: SPT
11.5 to 13.0: SPT
14.0 to 15.5: SPT
19.0 to 20.5: SPT
24.0 to 25.5: SPT
29.0 to 30.5: SPT
30.5 to 31.2: A HQ3
34.6 to 35.3: B HQ3

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
	Qal	NA	SM								
5		32		8, 7, 5	48.9	51.1	0.0	NA	NP	2.3	SM
		36		4, 6, 4	29.1	60.9	0.0	NA	NP	2.0	SM
10		100		4, 4, 4	27.5	72.5	0.0	NA	NP	3.5	SM
		100		4, 4, 4	33.5	66.5	0.0	NA	NP	4.1	SM
15		68		4, 5, 4	18.3	77.5	4.2	NA	NP	3.6	SM
		98	5128.6 SC	3, 2, 4	56.7	43.3	0.0	NA	NP	12.6	s(ML)
20											

GRAPHIC

HOLE COMPLETION

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 28.2 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 4.0 ft SILTY SAND (SM): About 80% fine to medium sand; about 20% nonplastic fines with no dry strength and rapid dilatancy; trace of fine to coarse, hard, subrounded gravel; trace of hard, rounded cobbles; maximum size, 5-inch; brown and dry; weak reaction with HCl.

4.0 to 19.3 ft SILTY SAND (SM): About 85% fine sand; about 15% nonplastic fines with no dry strength and rapid dilatancy; trace of fine to coarse, hard, rounded gravel; maximum size, 25 mm; brown and dry; weak reaction with HCl.

LAB TEST DATA: Test interval 4.0 to 5.5 ft; 51.1% sand, 48.9% fines, LL= NA, PI= NP, SpG= 2.67, moisture= 2.3%; lab classification is SILTY SAND (SM); sample representative of 1.4 ft of the sample interval.

LAB TEST DATA: Test interval 6.5 to 8.0 ft; 60.9% sand, 29.1% fines, LL= NA, PI= NP, SpG= 2.70, moisture= 2.0%; lab classification is SILTY SAND (SM); sample representative of 1.4 ft of the sample interval.

LAB TEST DATA: Test interval 9.0 to 10.5 ft; 72.5% sand, 27.5% fines, LL= NA, PI= NP, SpG= 2.70, moisture= 3.5%; lab classification is SILTY SAND (SM); sample representative of 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 11.5 to 13.0 ft; 66.5% sand, 33.5% fines, LL= NA, PI= NP, SpG= 2.70, moisture= 4.1%; lab classification is SILTY SAND (SM); sample representative of 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 14.0 to 15.5 ft; 77.5% sand, 18.3% fines, 4.2% gravel; LL= NA, PI= NP, SpG= 2.72, moisture= 3.6%; lab classification is SILTY SAND (SM); sample representative of 1.4 ft of the sample interval.

LAB TEST DATA: Test interval 19.0 to 21.5 ft; 56.7% fines, 43.3% sand, LL= NA, PI= NP, SpG= 2.67, moisture= 12.6%; lab classification is SANDY SILT s(ML); sample representative of 1.4 ft of the sample interval; test extended into underlying interval.

19.3 to 22.7 ft CLAYEY SAND (SC): About 80% fine sand; about 20% fines with low plasticity, low toughness, low dry strength and slow dilatancy; maximum size, fine sand; brown and dry; weak reaction with HCl.

22.7 to 27.6 ft SILTY SAND (SM): About 85% fine sand; about 15% nonplastic fines with no dry strength and rapid dilatancy; trace of fine to coarse, hard, rounded gravel; maximum size, 50 mm; brown and dry; no reaction with HCl.

LAB TEST DATA: Test interval 24.0 to 25.5 ft; 90.4% sand, 9.6% fines, LL= NA, PI= NP, SpG= 2.68, moisture= 3.7%; lab classification is POORLY GRADED SAND WITH SILT (SP-SM); sample representative of 1.5 ft of the sample interval.

27.6 to 28.2 ft GRAVELY LEAN CLAY WITH SAND g(CL)s: About 55% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 35% fine, hard, rounded gravel; about 10% fine sand; maximum size, 50 mm; dark brown and dry; strong reaction with HCl.

LAB TEST DATA: Test interval 29.0 to 30.5 ft; 64.9% fines, 35.1% sand, LL= 33.1, PI= 18.1,

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Silty Sand
Clayey Sand
Gravelly Clay with Sand
Shale
Sandstone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22- 8

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/23/22 FINISHED: 3/23/22
DEPTH AND ELEVATION OF WATER LEVEL: NA ⊻
DATE MEASURED: 3/23/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2097348.74 E 2542728.26 NAD83
TOTAL DEPTH: 40.0 ft
DEPTH TO BEDROCK: 28.2
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5147.9 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION	GRAPHIC	HOLE COMPLETION
					4									
			98	SC										
				5125.2										
		Qal			7									
					11	9.6	90.4	0.0	NA	NP	3.7	SP-SM		
	25			SM	12									
			64											
				5120.3										
				g(CL)s 5119.7										
					8									
				Shale	20	64.9	35.1	0.0	33.1	18.1	13.3	s(CL)		
	30				28									
			90		A									
				5116.7										
		Kpc												
			98	Sandstone	B									
	35													
			97	5109.5										
				Shale										
	40			5107.9										

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

SpG= 2.72, moisture= 13.3%; lab classification is SILTY SAND (SM); sample representative of 1.4 ft of the sample interval.

28.2 to 40.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

28.2 to 31.2 ft SHALE: Brown color interbedded sandstone and claystone; very soft (H7) and intensely weathered (W7); laminated to thinly bedded and dips from 9° to horizontal; unfractured (FD0) and friable; mechanical breaks and bedding plane separation throughout core; FeOx and gypsum present; no reaction with HCl.

31.2 to 38.4 ft SANDSTONE: Brown color and fine grained; moderately soft (H5) and intensely weathered (W7); laminated to thickly bedded and dips from 9° to horizontal; unfractured (FD0) and friable; mechanical breaks and bedding plane separation throughout core; very soft (H7) claystone lamination; FeOx and MnOx staining present; no reaction with HCl.

38.4 to 40.0 ft SHALE: Brown color interbedded sandstone and claystone; very soft (H7) and intensely weathered (W7); laminated to thinly bedded and dips from 9° to horizontal; unfractured (FD0) and friable; mechanical breaks and bedding plane separation throughout core; FeOx and gypsum present; no reaction with HCl.

STRATIGRAPHY:
0.0 to 28.2 ft QUATERNARY ALLUVIUM (Qal)
28.2 to 40.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ⊻= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
- Silty Sand
- Clayey Sand
- Gravelly Clay with Sand
- Shale
- Sandstone
- Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22- 9

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 4/15/22 FINISHED: 4/16/22
DEPTH AND ELEVATION OF WATER LEVEL: 23.1 ft ∇ (5122.4)
DATE MEASURED: 4/16/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2096759.29 E 2542803.54 NAD83
TOTAL DEPTH: 34.5 ft
DEPTH TO BEDROCK: NE
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5145.5 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: CJ. Weber
HELPER: M. Howell

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.0: 4.25-inch HSA with pilot bit.
4.0 to 18.7: 4.25-inch HSA with FADC and SPT sampling.
18.7 to 24.0: 4.25-inch HSA with pilot bit.
24.0 to 34.5: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel..

DRILLING MEDIUM:
0.0 to 24.0: None
24.0 to 34.5: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 4.0: HSA with pilot bit
4.0 to 6.5: FADC
6.5 to 9.0: FADC
9.0 to 11.5: FADC
11.5 to 14.0: FADC
14.0 to 18.7: FADC
18.7 to 24.0: HSA with pilot bit
24.0 to 25.6: HQ3
25.6 to 27.0: HQ3
27.0 to 32.0: HQ3
32.0 to 34.5: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 34.5: Bentonite

SAMPLING:
4.0 to 5.5: SPT
6.5 to 8.0: SPT
9.0 to 10.5: SPT
11.5 to 13.0: SPT
14.0 to 15.5: SPT

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
	Qal	NA									
5		76		5, 8, 8	47.4	51.2	1.4	NA	NP	3.1	SM
		76		5, 3, 3	49.1	50.9	0.0	NA	NP	3.2	SM
10		44	s(CL)	5, 5, 5	60.7	39.3	0.0	NA	NP	4.4	s(ML)
		88		3, 4, 4	47.7	51.3	0.0	NA	NP	6.1	SM
15		74		2, 3, 3	44.4	55.6	0.0	NA	NP	8.3	SM
			5127.5 GC 5126.8								
20		NA									
5122.4											
25		100									
	Qtg	100	Cobbles and boulders								
30		NA									
		NA	5111.0								

BOTTOM OF HOLE

GRAPHIC

HOLE COMPLETION

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 18.0 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 9.4 ft SANDY LEAN CLAY s(CL): About 60% fines with low plasticity, low toughness, low dry strength and slow dilatancy; about 40% predominantly fine sand; trace of fine, hard, subangular to subrounded gravel; maximum size, 10 mm; brown and dry; strong reaction with HCl.

9.4 to 18.0 ft SANDY LEAN CLAY s(CL): About 55% fines with low plasticity, low toughness, low dry strength and slow dilatancy; about 45% predominantly fine sand; trace of fine, hard, subangular to subrounded gravel; maximum size, 10 mm; brown and moist at 13.6 ft below ground surface; strong reaction with HCl.

18.0 to 34.5 ft QUATERNARY TERRACE GRAVEL (Qtg)

18.0 to 18.7 ft CLAYEY GRAVEL (GC): About 50% fine to coarse, hard, subrounded to rounded gravel; about 40% fine to coarse, hard angular to rounded sand; about 10% fines with low plasticity, low toughness, low dry strength and slow dilatancy; maximum size, 50 mm; brown and dry; strong reaction with HCl.

18.7 to 24.0 ft NO RECOVERY: Hollow stem auger with pilot bit; interpreted to be cobbles and boulders by drilling characteristics.

24.0 to 34.5 ft POOR RECOVERY: Recovered cobbles and gravels washed by the drilling process; some recovery determined to be greater than 5-inches; flowing sand encountered at 28.0 ft below ground surface.

STRATIGRAPHY:
0.0 to 18.0 ft QUATERNARY ALLUVIUM (Qal)
18.0 to 34.5 ft QUATERNARY TERRACE GRAVEL (Qtg)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Sandy Lean Clay
Clayey Gravel
Boulders and cobbles
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22-10

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/30/22 FINISHED: 3/30/22
DEPTH AND ELEVATION OF WATER LEVEL: 15.2 ft ∇ (5127.3)
DATE MEASURED: 3/30/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2096310.14 E 2543107.81 NAD83
TOTAL DEPTH: 30.4 ft
DEPTH TO BEDROCK: NE
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5142.5 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: CJ. Weber, D. Nate

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.5: 4.25-inch HSA with pilot bit.
4.5 to 21.2: 4.25-inch HSA with FADC and SPT sampling.
21.2 to 30.4: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel..

DRILLING MEDIUM:
0.0 to 21.2: None
21.2 to 30.4: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 4.5: HSA with pilot bit
4.5 to 7.0: FADC
7.0 to 9.5: FADC
9.5 to 12.0: FADC
12.0 to 14.5: FADC
14.5 to 19.0: FADC
19.0 to 21.2: FADC Refusal
21.2 to 22.0: HQ3
22.0 to 27.0: HQ3
27.0 to 29.5: HQ3
29.5 to 30.4: HQ3 Welded bit
Casing removed.

HOLE COMPLETION:
0.0 to 30.4: Bentonite

SAMPLING:
4.5 to 6.0: SPT
7.0 to 8.5: SPT
9.5 to 11.0: SPT
12.0 to 13.5: SPT
14.5 to 16.0: SPT
19.5 to 21.0: SPT

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
	Qal	NA	s(CL)								
			5139.0								
5		92	SM	2, 2, 2	37.6	62.4	0.0	NA	NP	7.8	SM
		100	5134.5	2, 2, 2	49.9	50.1	0.0	NA	NP	10.2	SM
10		100	s(CL)	4, 4, 2	63.5	36.5	0.0	NA	NP	NA	s(ML)
		100		2, 3, 2	54.7	45.3	0.0	NA	NP	12.9	s(ML)
15 ∇		52		2, 1	53.7	46.3	0.0	NA	NP	18.3	s(ML)

GRAPHIC

HOLE COMPLETION

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 16.9 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 3.5 ft SANDY LEAN CLAY s(CL): About 60% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 40% predominantly fine sand; trace of fine, hard, subrounded gravel; maximum size, 10 mm; grayish brown and dry; strong reaction with HCl.

3.5 to 8.0 ft SILTY SAND (SM): About 65% predominantly fine sand; about 35% nonplastic fines with no dry strength and rapid dilatancy; trace of fine, hard, subrounded gravel; maximum size, 10 mm; light brown and dry; strong reaction with HCl.

LAB TEST DATA: Test interval 4.5 to 6.0 ft; 62.4% sand, 37.6% fines, LL= NA, PI= NP, SpG= 2.68, moisture= 7.8%. Lab classification is SILTY SAND (SM). Sample representative of 1.3 ft of the sample interval.

LAB TEST DATA: Test interval 7.0 to 8.5 ft; 50.1% sand, 49.9% fines, LL= NA, PI= NP, SpG= 2.67, moisture= 10.2%. Lab classification is SILTY SAND (SM). Sample representative of 1.4 ft of the sample interval. Test extended into underlying interval.

8.0 to 16.9 ft SANDY LEAN CLAY s(CL): About 55% fines with low plasticity, low toughness, low dry strength and slow dilatancy; about 45% fine sand; maximum size, fine sand; brown and wet at 15.2 ft below ground surface; weak reaction with HCl.

LAB TEST DATA: Test interval 9.5 to 11.0 ft; 63.5% fines, 36.5% sand, LL= NA, PI= NP, SpG= 2.63, moisture= NA%. Lab classification is SANDY SILT s(ML). Sample representative of 1.3 ft of the sample interval.

LAB TEST DATA: Test interval 12.0 to 13.5 ft; 54.7% fines, 45.3% sand, LL= NA, PI= NP, SpG= 2.60, moisture= 12.9%. Lab classification is SANDY SILT s(ML). Sample representative of 1.4 ft of the sample interval.

LAB TEST DATA: Test interval 14.5 to 16.0 ft; 53.7% fines, 46.3% sand, LL= NA, PI= NP, SpG= 2.62, moisture= 18.3%. Lab classification is SANDY SILT s(ML). Sample representative of the full 1.5 ft of the sample interval.

16.9 to 30.4 ft QUATERNARY TERRACE GRAVEL (Qtg)

16.9 to 21.2 ft CLAYEY GRAVEL (GC): About 50% fine to coarse, hard, subrounded to rounded gravel; about 40% fine to coarse, hard angular to rounded sand; about 10% fines with low plasticity, low toughness, low dry strength and slow dilatancy; maximum size, 50 mm; brown and wet; strong reaction with HCl.

LAB TEST DATA: Test interval 19.5 to 21.0 ft; 51.5% gravel; 39.5% sand, 9.0% fines, LL= NA, PI= NP, SpG= 2.60, moisture= 1.5%. Lab classification is POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)s. Sample representative of 1.1 ft of the sample interval.

21.2 to 29.5 ft POOR RECOVERY: Recovered cobbles and gravels washed by the drilling process; some recovery determined to be greater than 5-inches.

29.5 to 30.4 ft NO RECOVERY: Interval would not accept water through the drill string; removed drill string and found the HQ3 bit had welded closed; the hole was plugged and abandoned due to time constraint imposed by the land owner.

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Sandy Lean Clay
Silty Sand
Clayey Gravel
Boulders and cobbles
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22-10

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/30/22 FINISHED: 3/30/22
DEPTH AND ELEVATION OF WATER LEVEL: 15.2 ft ∇ (5127.3)
DATE MEASURED: 3/30/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2096310.14 E 2543107.81 NAD83
TOTAL DEPTH: 30.4 ft
DEPTH TO BEDROCK: NE
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5142.5 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	LABORATORY DATA: % FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION	GRAPHIC	HOLE COMPLETION	CLASSIFICATION AND PHYSICAL CONDITION
	5127.3	Qal	52	s(CL)	2										**STRATIGRAPHY:** **0.0 to 16.9 ft QUATERNARY ALLUVIUM (Qal)** **16.9 to 30.4 ft QUATERNARY TERRACE GRAVEL (Qtg)**
				5125.6											
		Qtg		GC											
	20		100		16										
					57	9.0	39.5	51.5	NA	NP	1.5	(GP-GM)			
					28										
				5121.3											
			88												
			38												
	25			Poor recovery											
			56												
	30		NA												
				5112.1											

BOTTOM OF HOLE

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:

- Sandy Lean Clay
- Silty Sand
- Clayey Gravel
- Boulders and cobbles
- Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22-12

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 3/31/2022 FINISHED: 3/31/2022
DEPTH TO WATER & ELEVATION: 17.3 ft ∇ (5111.2)
WATER DEPTH MEASURED ON: 3/31/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2093768.3 E 2543007.1 NAD83
TOTAL DEPTH: 40.0 ft
DEPTH TO BEDROCK: 21.4 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5128.5 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: CJ. Weber, D. Nate

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

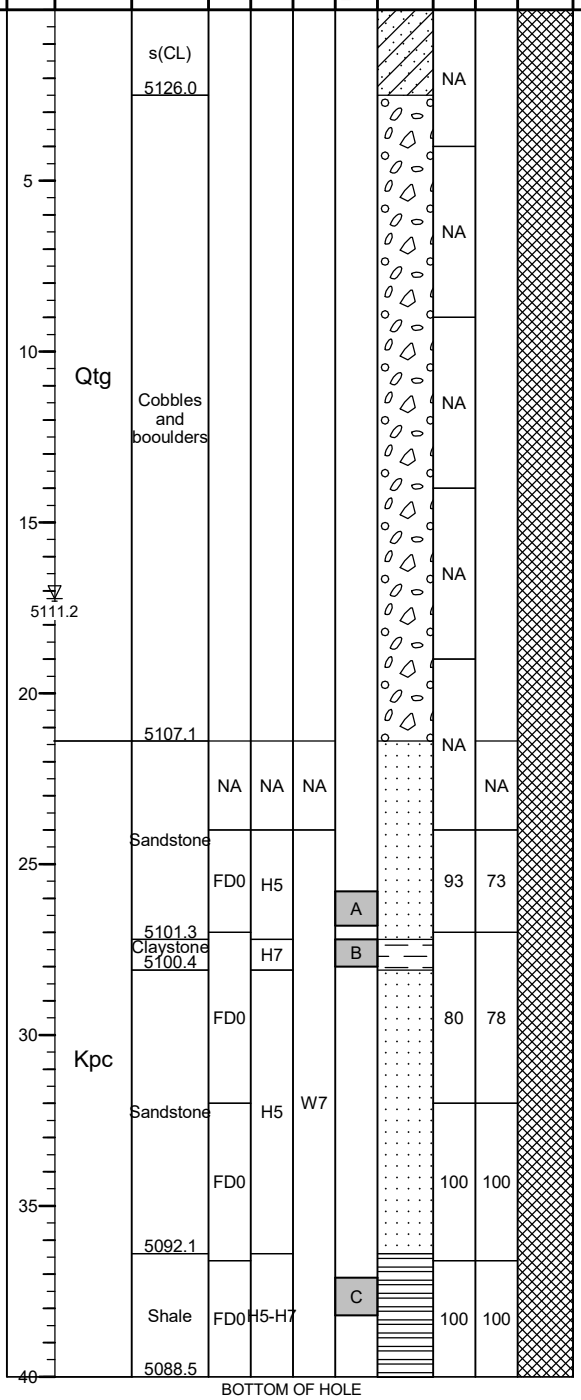
DRILL METHOD:
0.0 to 24.0: 4.25-inch HSA with pilot bit.
24.0 to 40.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel..

DRILLING MEDIUM:
0.0 to 24.0: None
24.0 to 40.0: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 4.0: HSA with pilot bit
4.0 to 9.0: HSA with pilot bit
9.0 to 14.0: HSA with pilot bit
14.0 to 19.0: HSA with pilot bit
19.0 to 24.0: HSA with pilot bit
24.0 to 27.0: HQ3
27.0 to 32.0: HQ3
32.0 to 37.0: HQ3
37.0 to 40.0: HQ3

HOLE COMPLETION:
0.0 to 40.0: Bentonite

SAMPLING:
25.8 to 26.8: A HQ3
27.2 to 28.0: B HQ3
37.1 to 38.2: C HQ3



CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 13.6 ft QUATERNARY TERRACE GRAVEL (Qtg)

0.0 to 2.5 ft SANDY LEAN CLAY s(CL): About 55% fines with low plasticity, low toughness, low dry strength and slow dilatancy; about 40% fine to coarse, hard, subangular to rounded sand; about 5% fine, hard, rounded gravel; maximum size, 10 mm; brown and dry; strong reaction with HCl.

2.5 to 21.4 ft NO RECOVERY: Hollow stem auger with pilot bit. Interpreted to be cobbles and boulders with lesser amounts of gravel, sand and silt by cuttings and drilling characteristics.

21.4 to 40.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

21.4 to 24.0 ft NO RECOVERY: Hollow stem auger with pilot bit. Interpreted to be sandstone by drilling characteristics.

24.0 to 25.0 ft SANDSTONE: Brown color and fine grained; moderately soft (H5) and intensely weathered (W7); laminated to thinly bedded and dips from 12° to horizontal; unfractured (FD0) with mechanical breaks throughout core; no to weak reaction with HCl.

25.0 to 27.2 ft SANDSTONE: Light gray color and fine grained; moderately soft (H5) and intensely weathered (W7); moderately bedded and dips from 12° to horizontal; unfractured (FD0); weak reaction with HCl.

27.2 to 28.1 ft CLAYSTONE: Dark brown color and friable; very soft (H7) and intensely weathered (W7); laminated and dips from 12° to horizontal; unfractured (FD0); weak reaction with HCl.

28.1 to 36.4 ft SANDSTONE: Light gray color and fine grained; moderately soft (H5) and intensely weathered (W7); moderately bedded and dips from 12° to horizontal; unfractured (FD0); weak reaction with HCl.

36.4 to 40.0 ft SHALE: Light to dark gray and black color interbedded sandstone and siltstone; sandstone is fine grained, moderately soft (H5) and moderately weathered (W5); siltstone is very soft (H7) and moderately weathered (W5); laminated to thinly bedded and dips from 12° to horizontal; unfractured (FD0) with mechanical breaks throughout core; weak to strong reaction with HCl.

STRATIGRAPHY:
0.0 to 21.4 ft QUATERNARY ALLUVIUM (Qal)
21.4 to 40.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ∇ = water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Sandy Lean Clay
Boulders and cobbles
Sandstone
Claystone
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22-17

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 4/13/2022 FINISHED: 4/14/2022
DEPTH TO WATER & ELEVATION: 8.2 ft ▽ (5057.0)
WATER DEPTH MEASURED ON: 4/14/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2089796.7 E 2542846.2 NAD83
TOTAL DEPTH: 50.0 ft
DEPTH TO BEDROCK: 12.9 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5065.2 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: CJ. Weber
HELPER: M. Howell

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 14.0: 4.25-inch HSA with pilot bit.
14.0 to 50.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel..

DRILLING MEDIUM:
0.0 to 14.0: None
14.0 to 50.0: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 4.0: HSA with pilot bit
4.0 to 9.0: HSA with pilot bit
9.0 to 14.0: HSA with pilot bit
14.0 to 17.0: HQ3
17.0 to 22.0: HQ3
22.0 to 27.0: HQ3
27.0 to 32.0: HQ3
32.0 to 37.0: HQ3
37.0 to 42.0: HQ3
42.0 to 47.0: HQ3
47.0 to 50.0: HQ3
Casing removed.
Observation well installed.
-2.7 to 8.0: 2-inch Sch. 80 PVC Blank.
8.0 to 13.0: 2-inch Sch. 80 PVC Slotted 0.010-inch Upack Screen.
13.0 to 15.0: 2-inch Sch. 80 PVC Blank with end cap.

HOLE COMPLETION:
-3.0 to 2.0: Locking stand pipe
0.0 to 6.0: Bentonite
6.0 to 15.0: #8 graded sand
15.0 to 50.0: Bentonite

SAMPLING:
15.9 to 17.0: A HQ3
24.5 to 25.3: B HQ3
33.3 to 34.3: C HQ3
42.0 to 43.0: D HQ3
48.0 to 49.0: E HQ3

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	RQD
0–5.2	Qtg	Cobbles and boulders					NA	
5–10	Qtg	Cobbles and boulders					NA	
10–5052.3	Qtg	Cobbles and boulders					NA	
5052.3–5015.2	Kl	Shale	NA	H5	W7			NA
15–20	Kl	Shale	FD0	H5	W7	A	93	77
20–25	Kl	Shale	FD0	H5	W7		98	98
25–30	Kl	Shale	FD0	H5	W7	B	100	78
30–35	Kl	Shale	FD0	H5	W7		94	80
35–40	Kl	Shale	FD0	H5	W7	C	100	100
40–45	Kl	Shale	FD0	H5	W7		98	98
45–50	Kl	Shale	FD0	H5	W7	D	100	100
50	Kl	Shale	FD0	H5	W7	E	100	100

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 12.9 ft QUATERNARY TERRACE GRAVEL (Qtg)

0.0 to 12.9 ft NO RECOVERY: Hollow stem auger with pilot bit. Interpreted to be cobbles and boulders with lesser amounts of gravel, sand and silt. Bottom of interval determined by drilling characteristics.

12.9 to 50.0 ft CRETACEOUS LEWIS SHALE (Kl)

12.9 to 14.0 ft NO RECOVERY: Hollow stem auger with pilot bit. Interpreted to be shale by drilling characteristics.

14.0 to 50.0 ft SHALE: Light to dark gray and black color interbedded sandstone and claystone; sandstone is fine grained, moderately soft (H5) and intensely weathered (W7); claystone is very soft (H7) and intensely weathered (W7); laminated to thinly bedded and dips from 17° to horizontal; unfractured (FD0) with mechanical breaks and bedding separation throughout core; carbonaceous; no to weak reaction with HCl.

STRATIGRAPHY:
0.0 to 12.9 ft QUATERNARY TERRACE GRAVEL (Qtg)
12.9 to 50.0 ft CRETACEOUS LEWIS SHALE (Kl)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ▽= water level

All angles measured from horizontal 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."

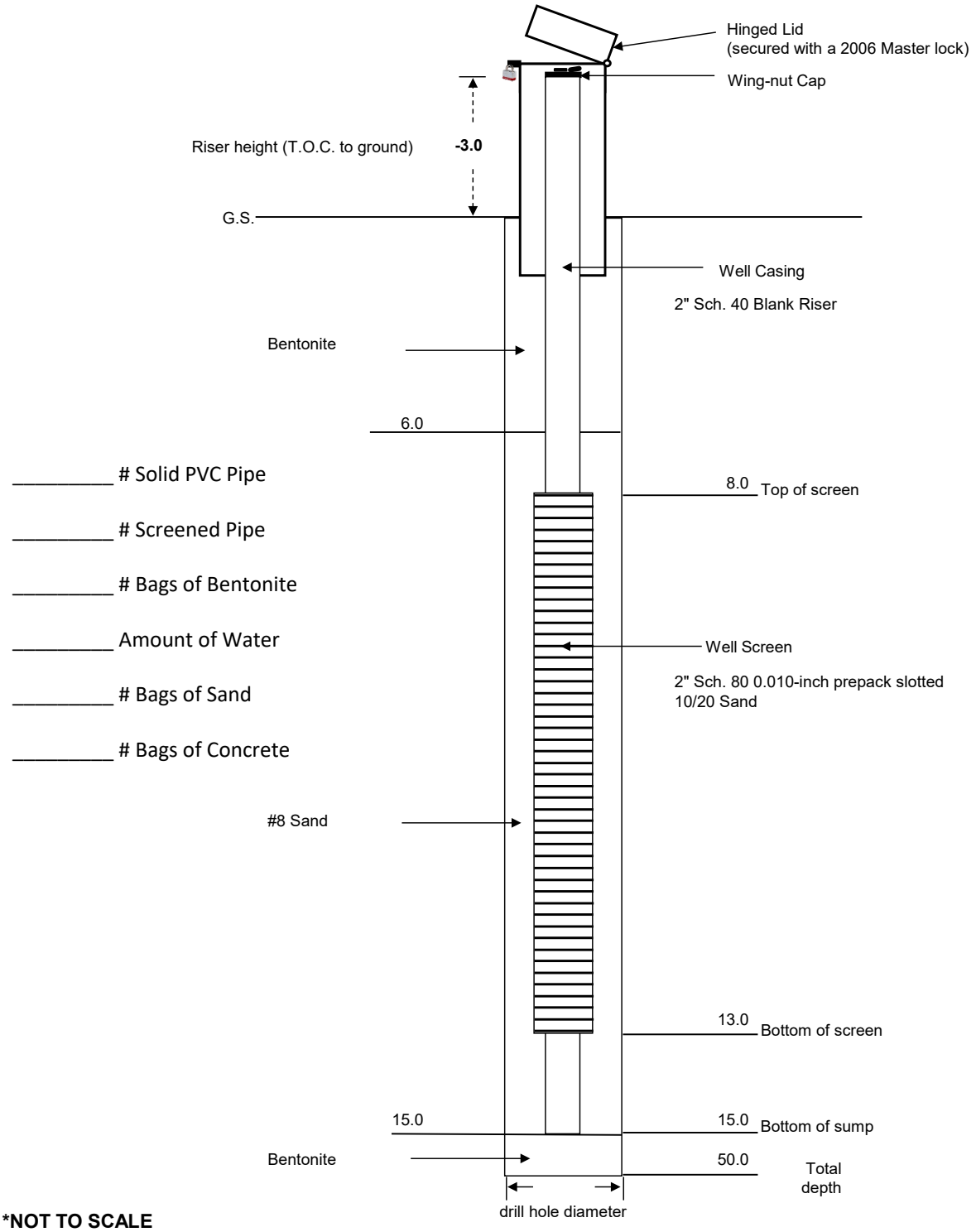
GRAPHIC LEGEND:
Boulders and cobbles
Shale
Bentonite seal with 1 pipe
Filter Pack: 1 pipe group, 1 pipe
Field Filter Pack: 1 pipe group, 1 pipe
Pipe Cap: 1 pipe group, 1 pipe
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

OBSERVATION WELL COMPLETION DIAGRAM

DRILL HOLE: DHR2-22-17	GEOLOGIST: P. Gardner
DATE COMPLETED: 4/14/22	DRILLER: CJ. Weber
PROJECT: Navajo Gallup Water Supply Project	HELPERS:
T.O.C. COORDINATES and ELEVATION:	
G.S. ELEVATION: 5065.2	



***NOT TO SCALE**

NOTES:

T.O.C. = Top of well casing
SPT = Standard Penetration Test
i.d. = inside diameter
o.d. = outside diameter
EL. = Elevation
G.S. = Ground surface

GEOLOGIC LOG OF DRILL HOLE NO. DHR2-22-19

FEATURE: Reach 2
LOCATION: Pipeline Alignment
BEGUN: 4/15/2022 FINISHED: 4/15/2022
DEPTH TO WATER & ELEVATION: NE ∇
WATER DEPTH MEASURED ON: 4/15/2022

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2082528.2 E 2538924.2 NAD83
TOTAL DEPTH: 20.0 ft
DEPTH TO BEDROCK: 0.0 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5387.5 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY:

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: CJ. Weber
HELPER: M. Howell

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 20.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel..

DRILLING MEDIUM:
0.0 to 20.0: Water

CASING RECORD/ DRILLING NOTES:
0.0 to 2.5: HQ3
2.5 to 7.5: HQ3
7.5 to 12.5: HQ3
12.5 to 17.5: HQ3
17.5 to 20.0: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 20.0: Bentonite

SAMPLING:
4.5 to 5.1: A HQ3
11.8 to 12.5: B HQ3
14.1 to 14.9: C HQ3

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	RQD
	Kpc	Sandstone	FD0	H5	W7		96	56
5			FD0			A	98	54
10			FD0			B	100	90
		5374.6						
		Shale		H7				
		5373.0				C		
15	Kl		FD0				100	72
		Sandstone		H5				
			FD0				100	84
20		5367.5						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 12.9 ft CRETACEOUS PICTURED CLIFFS (Kpc)

0.0 to 12.9 ft SANDSTONE: Brown color, fine grained and argillaceous; moderately soft (H5) and intensely weathered (W7); laminated to moderately bedded and dips from 14° to horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks throughout core; siltstone laminations present; no reaction with HCl.

12.9 to 20.0 ft CRETACEOUS LEWIS SHALE (Kl)

12.9 to 14.5 ft SHALE: Light brown to dark gray color and friable; very soft (H7) and intensely weathered (W7); laminated to thinly bedded and dips from 14° to horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks throughout core; FeOx present; no reaction with HCl.

14.5 to 20.0 ft SANDSTONE: Brown color, fine grained and argillaceous; moderately soft (H5) and intensely weathered (W7); laminated to moderately bedded and dips from 14° to horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks throughout core; no reaction with HCl.

STRATIGRAPHY:
0.0 to 12.9 ft CRETACEOUS PICTURED CLIFFS (Kpc)
12.6 to 21.0 ft CRETACEOUS LEWIS SHALE (Kl)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Sandstone
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK REACH 2 PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 7/6/22

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-24

FEATURE: Reach 2
LOCATION: Reach 2 Pipeline Alignment
COORDINATES: N 2,105,883.8 E 2,544,541.4
APPROXIMATE DIMENSIONS: NA
DEPTH TO WATER: WLNE DATE: 12/1/22

PROJECT: Navajo Gallup Water Supply Project
GROUND ELEVATION: 5208.6
METHOD OF EXPLORATION: JCB 3CX eco Backhoe; 1.3 ft bucket dimension
LOGGED BY: K. Graham

DATE EXCAVATED: 12/1/2023

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	(SC)g	**0.0 to 2.1 ft // CLAYEY SAND with GRAVEL:** About 60% fine sand; about 25% fines with low plasticity, low dry strength and slow dilatancy; About 15% fine to coarse, hard, subrounded gravel; maximum dimension, 70 mm; weak reaction with HCl. IN-PLACE CONDITION: Light tan color and dry GEOLOGIC INTERPRETATION: Engineered backfill; Quaternary alluvium (Qal)		5%	
2	2.1 ft (5206.5) 2.2 ft (5206.4) SS	**2.1 to 2.2 ft // SANDSTONE:** Light brown to gray and fine grained; moderately soft (H6) and intensely weathered (W7); laminated to thinly bedded; trace gypsum veins and organic laminations present; HCl reaction is NA. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs sandstone (Kpc)			

COMMENTS: Fill / Quaternary alluvium (Qal); surface unvegetated due to road base. Discontinued excavation upon encountering subsurface PVC conduit; hand shoveled to bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-23

FEATURE: Reach 2
LOCATION: Reach 2 Pipeline Alignment
COORDINATES: N 2,105,305.6 E 2,544,705.2
APPROXIMATE DIMENSIONS: 8'X1.3'X6.5'
DEPTH TO WATER: WLNE DATE: 12/1/2023

PROJECT: Navajo Gallup Water Supply Project
GROUND ELEVATION: 5226.8
METHOD OF EXPLORATION: JCB 3CX eco Backhoe; 1.3 ft bucket dimension
LOGGED BY: K. Graham

DATE EXCAVATED: 12/1/2023

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
	(SC)gcb	**0.0 to 5.8 ft // CLAYEY SAND with GRAVEL, COBBLES and BOULDERS:** MINUS 3-INCH FRACTION (BY MASS) About 70% fine to coarse, hard, subangular to subrounded sand; about 20% fines with low plasticity, medium dry strength and rapid dilatancy; about 10% fine to coarse, hard, subrounded gravel; maximum dimension, 70 mm; strong reaction with HCl. TOTAL SAMPLE (BY VOLUME) About 5% 3- to 5-inch hard, subrounded cobbles; about 5% plus 12-inch hard, subrounded to rounded boulders; remainder minus 3-inch; maximum dimension, 1.3 ft. IN-PLACE CONDITION: Gray color, dry to moist GEOLOGIC INTERPRETATION: Engineered backfill; Quaternary alluvium (Qal)	5%		5%
	5.8 ft (5221.0)				
	(SP-SM)gc 6.5 ft (5220.3)	**5.8 to 6.5 ft // POORLY GRADED SAND with SILT, GRAVEL, and COBBLES:** MINUS 3-INCH FRACTION (BY MASS) About 75% predominantly fine, hard, subangular to subrounded sand; about 15% fine to coarse, hard, subrounded to rounded gravel; about 10% nonplastic fines; maximum dimension, 70 mm; strong reaction with HCl. TOTAL SAMPLE (BY VOLUME) About 5% 3- to 5-inch hard, subrounded cobble lens at 4.0 ft bgs; remainder minus 3-inch; maximum dimension, 100 mm. IN-PLACE CONDITION: Gray in color, moist GEOLOGIC INTERPRETATION: Quaternary alluvium (Qal) **Corrosivity sample @ 6.5 ft**	5%		

COMMENTS: Fill / Quaternary alluvium (Qal); surface vegetated with grass and rabbit brush; discontinued excavation due to encountering strongly cemented materials.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-2

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5208.0
COORDINATES: N 2,102,743 E 2,544,271
METHOD OF EXPLORATION: JCB 3CX eco Backhoe.
APPROXIMATE DIMENSIONS: 2544271.149
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 4/19/2022
DATE EXCAVATED: 4/19/2022

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, 2, 3	(SP)g 3.6 ft (5204.4)	0.0 to 3.6 ft POORLY GRADED SAND WITH GRAVEL: About 85% fine sand; about 10% fine to medium subrounded gravel; about 5% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, medium gravel; Strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
4, 5, 6, 7	(SP)gc Corrosivity sample collected at 6.0 feet. 7.5 ft (5200.5)	3.6 to 7.5 ft POORLY GRADED SAND WITH GRAVEL AND COBBLES: About 50% fine to coarse sand, predominately fine sand; about 35% fine to coarse subrounded gravel; about 10% subrounded cobbles; about 5% fines with no plasticity, no dry strength and rapid dilatancy; Trace subangular sandstone boulders; maximum size, 760mm; Strong reaction with HCl. IN-PLACE CONDITION: Brown in color, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).	10%	trace	trace
8, 9, 10, 11, 12	SP 12.0 ft (5196.0)	7.5 to 12.0 ft POORLY GRADED SAND: About 95% fine sand; \about 5% fines with no plasticity, no dry strength and rapid dilatancy; trace gravel; maximum size, 50mm; Strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			

COMMENTS: Surface sparsely vegetated with grass and brush. Discontinued excavation due to limit of equipment.

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-4

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5159.2
COORDINATES: N 2,101,230 E 2,543,120
METHOD OF EXPLORATION: JCB 3CX eco Backhoe.
APPROXIMATE DIMENSIONS: 10'X10'X11.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 4/18/2022
DATE EXCAVATED: 4/18/2022

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
	0.4 ft (5158.8) SC	0.0 to 0.4 ft CLAYEY SAND: About 80% fine sand; about 20% fines with low plasticity, low dry strength, and low toughness; maximum size, fine sand; weak reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
1 2 3 4	SP-SM	0.4 to 5.0 ft POORLY GRADED SAND WITH SILT: About 90% fine sand; about 10% fines with no plasticity, no dry strength and rapid dilatancy; trace gravel and cobbles; maximum size, 130mm; Strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots in top 6.0 feet.	trace		
5	5.0 ft (5154.2)	GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
6 7 8 9 10	SC In-Place Density Test and 50 pound bag sample taken at 6.0 feet in depth.	0.4 to 5.0 ft CLAYEY SAND: About 80% fine sand; about 20% fines with low plasticity, low dry strength, and low toughness; trace gravel; maximum size, 30mm; weak reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry. IN-PLACE UNIT WEIGHT AND MOISTURE FROM 6.0 ft. Total: 80.7 lb/ft³, 7.3% (73.8% compaction) LAB TEST DATA: 32.6% sand, 65% fines, 2.4 % gravel, LL=29.8, PI = 10.9, SPG= 2.44. Maximum dry density: 10.94 lb/ft³, optimum water content = 16.3 %. Laboratory classification is SANDY LEAN CLAY. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
11	11.0 ft (5148.2)				
12	SS 12.0 ft (5147.2)	11.0 to 12.0 ft SANDSTONE: Fine grained, moderately bedded, gray in color, moderately hard (H4) and moderately to intensely weathered (W6), strong reaction with HCl, recovered as 3-to-6 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs Sandstone (Kpc).			

COMMENTS: Surface vegetated with brush. Discontinued due to limit of equipment.

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-5

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5155.3
COORDINATES: N 2,100,226 E 2,542,967
METHOD OF EXPLORATION: JCB 3CX eco Backhoe.
APPROXIMATE DIMENSIONS: 10'X3'X5.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 4/18/2022
DATE EXCAVATED: 4/18/2022

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	(SM)g	0.0 to 2.0 ft SILTY SAND WITH GRAVEL: About 70% fine sand; about 20% fines with no plasticity, no dry strength and rapid dilatancy; About 10% fine to coarse subrounded gravel; maximum size, 70 mm; Strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2	2.0 ft (5153.3)				
3	CLSTNE	2.0 to 5.5 ft CLAYSTONE: Sandy, Silty, soft (H6) to moderately soft (H5), intensely weathered (W7) to moderately weathered (W5), gray, thinly bedded, gypsum veins and iron oxide staining. Very stiff difficult excavation. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs Sandstone (Kpc).			
4	Two Quart corrosivity sample collected at 5.0 feet in depth.				
5	5.5 ft (5149.8)				

COMMENTS: Surface vegetated with brush. Discontinued at 5.5 feet due to very difficult excavation in stiff claystone.

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-10

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5133.4
COORDINATES: N 2,092,519 E 2,543,841
METHOD OF EXPLORATION: JCB 3CX eco Backhoe.
APPROXIMATE DIMENSIONS: 10'X3'X7"
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 4/19/2022
DATE EXCAVATED: 4/19/2022

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 2	SC 2.5 ft (5130.9)	0.0 to 2.5 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; weak reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
3 4 5 6 7	COBBLES AND BOULDERS Corrosivity sample collected at 6.0 feet. 7.0 ft (5126.4)	2.5 to 7.0 ft COBBLES AND BOULDERS WITH GRAVEL AND SAND: MINUS 3-INCH FRACTION (BY MASS) About 50% fine to coarse sand; about 45% rounded to sub rounded hard gravel; about 5% nonplastic fines with no dry strength and rapid dilatancy; maximum size, 75mm; gray in color; strong reaction with HCl. TOTAL SAMPLE (BY VOLUME): About 35% 3- to 5-inch hard, subrounded cobbles; About 30% 5- to 12-inch hard, subrounded cobbles; trace subrounded, hard boulders; remainder minus 3-inch; maximum dimension, 300 mm. IN-PLACE CONDITION: Gray in color, dry. GEOLOGIC INTERPRETATION: Quaternary Terrace Gravel (Qtg).	35	30	trace

COMMENTS: Surface recently cleared of vegetation to plant hay field. Stockpiled top soil seperately to be replaced atop cobbles and boulders when finished. Discontinued test pit due to unstable sloughing test pit walls.

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-12

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5063.1
COORDINATES: N 2,089,270 E 2,542,019
METHOD OF EXPLORATION: Case 580 N Backhoe.
APPROXIMATE DIMENSIONS: 10'X3'X8.0'
LOGGED BY: C. Beyer
DEPTH TO WATER: 7.7 ft. (5055.4) DATE: 2/14/2022
DATE EXCAVATED: 2/14/2022

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, 2	SC	0.0 to 2.6 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; weak reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2.6 ft (5060.5)					
3, 4	SP	2.6 to 5.0 feet POORLY GRADED SAND: About 95% fine sand; about 5% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, moist, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
5.0 ft (5058.1)					
5, 6	(SP)gc	2.6 to 7.0 ft POORLY GRADED SAND WITH GRAVEL AND COBBLES: About 80% fine sand, trace medium to coarse sand; about 15% fine to coarse, hard gravel; about 5% nonplastic fines with rapid dilatancy and no dry strength. TOTAL SAMPLE (BY VOLUME): 10% 3- to 5-inch hard, subrounded cobbles; 5% 5- to 12-inch hard, subrounded cobbles; remainder minus 3-inch; maximum dimension, 250 mm. IN-PLACE CONDITION: Brown, moist. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).	10%	5%	
7.0 ft (5056.1)					
7, 8	(SP)gcb	7.0 to 8.0 ft POORLY GRADED SAND WITH GRAVEL COBBLES AND BOULDERS: About 70% fine sand, trace medium to coarse sand; about 25% fine to coarse, hard gravel; about 5% nonplastic fines. TOTAL SAMPLE (BY VOLUME): 15% 3- to 5-inch hard, subrounded cobbles; 10% 5- to 12-inch hard, subrounded cobbles; trace subrounded, hard boulders; remainder minus 3-inch; maximum dimension, 310 mm. IN-PLACE CONDITION: Brown in color, moist, becomes wet at 7.7 feet. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).	15	10	trace
8.0 ft (5055.1)					

COMMENTS: Surface vegetated with grass, brush and Russian Olive. Discontinued excavation due to sloughing test pit walls and groundwater.

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-17

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5338.1
COORDINATES: N 2,085,802 E 2,539,708
METHOD OF EXPLORATION: Case 580 N Backhoe.
APPROXIMATE DIMENSIONS: 10'X3'X7.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 2/14/2022
DATE EXCAVATED: 2/14/2022

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, 2, 3	SM 3.0 ft (5335.1)	0.0 to 3.0 ft SILTY SAND: About 80% fine sand; about 20% fines with no plasticity, low dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brownish red in color, homogeneous, calcite cement, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
4, 5, 6, 7	SHALE Corrosivity sample collected at 7.0 feet. 7.5 ft (5330.6)	3.0 to 7.5 ft SHALE: Fissile, laminated, dark gray in color, soft (H6) and very intensely weathered (W8) from 3.0 to 7.0 feet. becomes moderately hard (H4) and moderately weathered (W5) from 7.0 to 7.5 feet.. Recovered as 1-to- 4 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs Sandstone (Kpc).			

COMMENTS: Surface vegetated with grass, and brush. Discontinued excavation due to refusal in shale bedrock.

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-18

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5342.1
COORDINATES: N 2,084,507 E 2,539,522
METHOD OF EXPLORATION: Case 580 N Backhoe.
APPROXIMATE DIMENSIONS: 10'X3'X2'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 2/15/2022
DATE EXCAVATED: 2/15/2022

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
	SM	0.0 to 0.7 ft SILTY SAND: About 80% fine sand; about 20% fines with no plasticity, low dry strength and rapid dilatancy; trace fine to coarse gravel on the surface; maximum size, coarse gravel; strong reaction with HCl. IN-PLACE CONDITION: Brownish red in color, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
	0.7 ft (5341.4)				
	SS	0.7 to 2.0 ft SANDSTONE: Fine grained, laminated to thinly bedded, brownish gray in color, moderately hard (H4) moderately weathered (W5), strong reaction with HCl, recovered as 3- to- 12 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs Sandstone (Kpc).			
1	Corrosivity sample collected at 2.0 ft.				
	2.0 ft (5340.1)				
2					

COMMENTS: Surface vegetated with grass, and brush. Discontinued excavation due to refusal in sandstone bedrock.

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-19

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5365.2
COORDINATES: N 2,083,524 E 2,539,294
METHOD OF EXPLORATION: Case 580 N Backhoe.
APPROXIMATE DIMENSIONS: 10'X3'X0.7'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 2/15/2022
DATE EXCAVATED: 2/15/2022

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
	SM	0.0 to 0.3 ft SILTY SAND: About 80% fine sand; about 20% fines with no plasticity, low dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brownish red in color, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
	0.3 ft (5364.9)				
	SS	0.3 to 0.7 ft SANDSTONE: Fine grained, laminated to thinly bedded, brownish gray in color, moderately hard (H4) moderately weathered (W5), strong reaction with HCl, siderite nodules, recovered as 3- to- 12 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs Sandstone (Kpc).			
	0.7 ft (5364.5)				

COMMENTS: Surface vegetated with grass, and brush. Discontinued excavation due to refusal in sandstone bedrock.

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-20

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5402.1
COORDINATES: N 2,081,705 E 2,538,679
METHOD OF EXPLORATION: Case 580 N Backhoe.
APPROXIMATE DIMENSIONS: 10'X3'X3'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 2/15/2022
DATE EXCAVATED: 2/15/2022

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 2	SM	0.0 to 2.6 ft SILTY SAND: About 80% fine sand; about 20% fines with no plasticity, low dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brownish red in color, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
	2.6 ft (5399.5)				
3	SS 3.0 ft (5399.1)	2.6 to 3.0 ft SANDSTONE: Fine grained, thinly to moderately bedded, gray in color, moderately hard (H4) moderately weathered (W5), strong reaction with HCl, recovered as 3-to-12" inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs Sandstone (Kpc).			

COMMENTS: Surface vegetated with grass, and brush. Discontinued excavation due to refusal in sandstone bedrock.

GEOLOGIC LOG OF DRILL HOLE NO. DHMLT-23-1

FEATURE: Reach 2 Regulating Tanks
LOCATION: Reach 2 Alignment
BEGUN: 7/23/2023 FINISHED: 7/24/2023
DEPTH TO WATER & ELEVATION: WLNE ▽

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2081411.7 E 2538489.1 NAD 83
TOTAL DEPTH: 31.0 ft
DEPTH TO BEDROCK: 5.4 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5431.7 ft
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in engineering feet unless otherwise noted

DRILLED BY:
Upper Colorado Drill Crew
DRILLER(S): Renato Matheson, Mike Howell
HELPER(S): Andrew Heath, Ryan Ward

PURPOSE:
Preconstruction soil and bedrock tank foundation investigation

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drilling rig

DRILL METHOD:
0.0 to 4.9 ft: 4.25-inch HSA with pilot bit
4.9 to 31.0 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel

DRILLING MEDIUM:
0.0 to 4.9 ft: None
4.9 to 31.0 ft: Freshwater

CASING RECORD/DRILLING NOTES:
0.0 to 4.9 ft: Pilot bit
4.9 to 7.0 ft: Advanced HQ3 2.1 ft.
7.0 to 27.0 ft: Advanced HQ3 in 5-foot sample intervals.
27.0 to 31.0 ft: Advanced HQ3 4.0 ft to total depth.
*Driller reported significant complications beginning at 27.0 ft. Upon reaching 31.0 ft. drill string became stuck and unable to retrieve. The decision was made to abandon downhole tools and casing at approximately 21.0 ft.

HOLE COMPLETION:
Backfill hole with bentonite from 31.0 ft (total depth) to surface.

SAMPLING:
13.5 to 14.1 ft: HQ3 A
14.1 to 14.6 ft: HQ3 B

Core sample conditions are immediately preserved for shipping and testing by the Denver Geotechnical Laboratory and Field Support (GLFS) group.

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	% RQD
	Qal	SM	NA	NA	NA	NO SPTs	0	NA
5		5426.3						
	Kpc	SS	FD4	H7	W7		48	0
							100	16
10		5420.7						
		CLSTN 5419.7						
							100	62
15								
		SS	FD6	H4 - H5	W5		100	56
20								
							100	27
25		5404.7						
		NO REC.	NR	NR	NR		NR	NR
30		5400.7						

BOTTOM OF HOLE

HOLE COMPLETION

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 5.4 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 5.4 SILTY SAND (SM): (Pilot spoils) About 85% fine sand; about 15% nonplastic fines; maximum size, fine sand; brown and dry; strong reaction with HCl.

5.4 to 31.0 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

5.4 to 11.0 ft // SANDSTONE: Brown to dark brown color and fine grained; very soft (H7) and intensely weathered (W7); thinly to very thinly bedded; moderately to slightly fractured (FD4) with mechanical breaks and bedding plane separations; FeOx staining; weak reaction with HCl.

11.0 to 12.0 ft // CLAYSTONE: Dark gray to black in color, very soft (H7) and very intensely weathered (W7); thinly bedded to laminated; intensely fractured (FD7) and easily separates along bedding planes; slakes rapidly with exposure; weak reaction with HCl.

12.0 to 27.0 ft // SANDSTONE: Light brown to dark brown color with intermittent dark clay banding; moderately soft (H5) to moderately hard (H4) and moderately weathered (W5); very thinly to moderately bedded; intensely to moderately fractured (FD6) with mechanical breaks, incipient fractures and bedding plane separations; FeOx common along fracture zones; weak reaction with HCl.

27.0 to 31.0 ft: NO RECOVERY

STRATIGRAPHY:
0.0 to 5.4 ft: QUATERNARY ALLUVIUM (Qal)
5.4 to 31.0 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ▽= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Silty Sand
Sandstone
Claystone
No recovery
Bentonite seal with 1 pipe
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK 04 DHMLT INV SDP -UPD- FEB 19 2025.GPJ GINT STD US LAB.GDT 3/3/25

GEOLOGIC LOG OF DRILL HOLE NO. DHMLT-23-2

FEATURE: Reach 2 Regulating Tanks
LOCATION: Reach 2 Alignment
BEGUN: 8/20/2023 FINISHED: 8/22/2023
DEPTH TO WATER & ELEVATION: WLNE ▽

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2081430.6 E 2538444.7 NAD 83
TOTAL DEPTH: 50.0 ft
DEPTH TO BEDROCK: 4.1 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5430.3 ft
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in engineering feet unless otherwise noted

DRILLED BY:
Upper Colorado Drill Crew
DRILLER(S): Renato Matheson, Mike Howell
HELPER(S): Ryan Ward

PURPOSE:
Preconstruction soil and bedrock tank foundation investigation

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drilling rig

DRILL METHOD:
0.0 to 4.5 ft: 4.25-inch HSA with pilot bit
4.5 to 50.0 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel

DRILLING MEDIUM:
0.0 to 4.5 ft: None
4.5 to 50.0 ft: Freshwater; added 2% polymer at 24.9 ft

CASING RECORD/DRILLING NOTES:
0.0 to 4.5 ft: Pilot bit
4.5 to 50.0 ft: Advanced HQ3 in 5-foot sample intervals.
*Driller reported hitting sandstone at 4.1 ft with pilot bit.
*Switch to impregnated diamond core drill bit series 6A0 (#6) due to tight hole.
*Driller sounded hole at 50.0 ft upon reaching total depth.

HOLE COMPLETION:
Casing removed; backfill hole with bentonite from 50.0 ft (total depth) to surface.

SAMPLING:
7.3 to 8.2 ft: HQ3 A
38.9 to 40.2 ft: HQ3 B
42.5 to 43.6 ft: HQ3 C

Core sample conditions are immediately preserved for shipping and testing by the Denver Geotechnical Laboratory and Field Support (GLFS) group.

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	% RQD
	Qal	SM	NA	NA	NA		0	NA
		5426.2						
5	Kpc	SS	FD4	H4 - H5	W5		92	41
10			FD8	H6	W7		100	12
15			FD4	H4 - H6	W5 - W7		100	46
20							100	52
		5405.8						
25		NE 5405.4	NR	NR	NR	NO SPTs	NR	NR
			FD5	H5 - H6			100	35
30		SS	FD4	H5	W5		100	76
35							100	92
40		5389.7						
		CLSTN 5387.7	NA	H7	W7		100	100
			FD0	H3	W3			
45		SS	FD3	H4	W5		100	94
50		5380.3						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 4.1 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 4.1 ft // SILTY SAND (SM): (Pilot bit spoils) About 80% fine sand; about 20% nonplastic fines; maximum size, fine sand; brown, dry; strong reaction with HCl.

4.1 to 50.0 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

4.1 to 10.5 ft // SANDSTONE: Brown to dark brown in color; fine to medium grained, moderately soft (H5) with intermittent moderately hard (H4) sections, and moderately weathered (W5); thinly to thickly bedded; moderately to slightly fractured (FD4) with flat-lying mechanical breaks and bedding plane separations; intermittent FeOx staining; no reaction with HCl.

10.5 to 13.7 ft // SANDSTONE: Brown to dark brown in color; fine to medium grained, soft (H6), and intensely weathered (W7); laminated to thinly bedded; very intensely to intensely fractured (FD8) with abundant flat-lying bedding plane separations; intermittent FeOx staining; no reaction with HCl.

13.7 to 24.5 ft // SANDSTONE: Brown to dark brown in color; fine to medium grained, soft (H6) to predominantly moderately hard (H4), and moderately weathered (W5) to intensely weathered (W7) in places; very thinly to thickly bedded; moderately to slightly fractured (FD4) and intermittently intensely fractured (FD8); common flat-lying mechanical breaks and bedding plane separations; FeOx staining; weak reaction with HCl.

24.5 to 24.9 ft // NO RECOVERY

24.9 to 30.0 ft // SANDSTONE: Brown in color with intermittent dark gray clayey residue; fine grained, moderately soft (H5) to soft (H6) and moderately weathered (W5); very thinly to thickly bedded with compacted moist heaving sand from 24.5 to 25.4 ft; moderately fractured (FD5) to very intensely fractured (FD9) with mechanical breaks and bedding plane separations; 80° joint from 29.5 to 30.0 ft; FeOx present; weak reaction with HCl.

30.0 to 40.6 ft // SANDSTONE: Brown in color, fine grained, and argillaceous; moderately soft (H5) and moderately weathered (W5); very thinly to thinly bedded, becoming thickly bedded at 32.5 ft; moderately to slightly fractured (FD4) with mechanical breaks and bedding plane separations; trace FeOx; weak reaction with HCl

40.6 to 42.5 ft // CLAYSTONE Dark brown to black color; very soft (H7) and intensely weathered (W7); bedding is laminated to indiscernible though dark clay banding suggests flat-lying stratigraphy; very intensely; common organic material and odor; moist, slakes rapidly with exposure; predominantly weak reaction with HCl.

42.5 to 43.6 ft // SANDSTONE: Light gray and fine grained; hard (H3) and slightly weathered (W3); thinly bedded; unfractured (FD0); trace FeOx; strong reaction with HCl.

43.6 to 50.0 ft // SANDSTONE: Brown to dark brown in color; fine grained, moderately hard (H4), and moderately weathered (W5); moderately to thickly bedded; slightly fractured (FD3) with some mechanical breaks; trace FeOx staining; weak reaction with HCl.

STRATIGRAPHY:
0.0 to 4.1 ft: QUATERNARY ALLUVIUM (Qal)
4.1 to 50.0 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ▽= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Silty Sand
Sandstone
No recovery
Claystone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK 04 DHMLT INV SDP -UPD- FEB 19 2025.GPJ GINT STD US LAB.GDT 3/3/25

GEOLOGIC LOG OF DRILL HOLE NO. DHMLT-23-3

FEATURE: Reach 2 Regulating Tanks
LOCATION: Reach 2 Alignment
BEGUN: 9/3/2023 FINISHED: 9/3/2023
DEPTH TO WATER & ELEVATION: WLNE ▽

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2081398. E 2538444.5 NAD 83
TOTAL DEPTH: 35.0 ft
DEPTH TO BEDROCK: 2.8 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5432.5 ft
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: C. Beyer
REVIEWED BY: K. Graham

NOTES

All measurements are from ground level and reported in feet unless otherwise noted

DRILLED BY:
Upper Colorado Basin Regional Drill Crew
DRILLER: R. Matheson
HELPER: M. Howell, R. Ward

PURPOSE:
Preconstruction soil and bedrock tank foundation investigation.

DRILL EQUIPMENT:
CME Model 850X track mounted rotary drill rig.

DRILL METHOD:
0.0 to 2.5 ft: 4.25-inch HSA with pilot biT
2.5 to 4.0 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel
4.0 to 35.0 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel

DRILLING MEDIUM:
0.0 to 2.5 ft: None
2.5 to 10.0 ft: Water with 2% polymer additive (polymer used since drill pipe got stuck multiple times in first two holes).
10.0 to 35.0 ft: Water (discontinued use of polymer since core repeatedly fell out of sampler).

CASING RECORD/ DRILLING NOTES:
0.0 to 2.5 ft: HSA with pilot bit
2.5 to 4.0 ft: HQ3
4.0 to 5.0 ft: HQ3
5.0 to 10.0 ft: HQ3
10.0 to 15.0 ft: HQ3
15.0 to 20.0 ft: HQ3
20.0 to 25.0 ft: HQ3
25.0 to 29.2 ft: HQ3
29.2 to 30.0 ft: HQ3
30.0 to 35.0 ft: HQ3
Drill pipe became stuck and sheared off at 27.5 ft. Unable to recover pipe from 27.5 to 35.0 ft.

HOLE COMPLETION:
Backfill hole with bentonite from 35.0 ft (total depth) to surface.

SAMPLING:
7.9 to 8.1 ft: HQ3 A
8.9 to 9.5 ft: HQ3 B
17.1 to 18.2 ft: HQ3 C
21.1 to 21.5 ft: HQ3 D
33.9 to 35.0 ft: HQ3 E

Core sample conditions are immediately preserved for shipping and testing by the Denver Geotechnical Laboratory and Field Support (GLFS) group.

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	LITHOLOGY	% RECOVERY	% RQD	HOLE COMPLETION
	Qal	SP-SM	NA	NA	NA			0	NA	
		5429.7								
	Kpc							0	NR	
								0	NR	
5				6	6					
		SS	FD0					98	28	
				5	5					
				4	5					
10		5421.8								
		5421.7		7	8					
								74	10	
15				3	3					
						NO SPTs		92	52	
20										
		SS	FD0					70	82	
25				4	5					
								82	48	
30										
				5	5			100	82	
35		5397.5								

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 2.8 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 2.8 ft: POORLY GRADED SAND WITH SILT (SP-SM): About 90% fine sand; about 10% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; brown and dry; no reaction with HCl.

2.8 to 35.0 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

2.8 to 10.7 ft SANDSTONE: Light brown color and fine grained; soft (H6) to moderately hard (H4) and moderately to intensely weathered (W6); thinly to moderately bedded, and easily separates along bedding planes; unfractured (FD0); weak reaction with HCl.

10.7 to 10.8 ft CLAYSTONE: Light brown color and fine grained; very soft (H7) and very intensely weathered (W8); thinly bedded; weak reaction with HCl.

10.8 to 35.0 ft SANDSTONE: Light brown color and fine grained; moderately soft (H5) to hard (H3) and moderately weathered (W5) to fresh (W3); thinly to moderately bedded, and easily separates on bedding planes; unfractured (FD0); intermittent hematite nodules; weak reaction with HCl.

STRATIGRAPHY:
0.0 to 2.8 ft QUATERNARY ALLUVIUM (Qal)
2.8 to 35.0 ft CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ▽= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Poorly Graded Sand with Silt
Sandstone
Claystone
Bentonite seal with NO pipe
Bentonite seal with 1 pipe

BUREAU OF RECLAMATION

NGWSP ROCK 04 DHMLT INV SDP -UPD- FEB 19 2025.GPJ GINT STD US LAB.GDT 3/3/25

GEOLOGIC LOG OF DRILL HOLE NO. DHMLT-23-4

FEATURE: Reach 2 Regulating Tanks
LOCATION: Reach 2 Alignment
BEGUN: 9/5/2023 FINISHED: 9/15/2023
DEPTH TO WATER & ELEVATION: WLNE ▽

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2081412.9 E 2538367.1 NAD 83
TOTAL DEPTH: 50.0 ft
DEPTH TO BEDROCK: 4.8 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5429.7 ft
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted

DRILLED BY:
Upper Colorado Drill Crew
DRILLER(S): Renato Matheson, Mike Howell
HELPER(S): Andrew Heath, Ryan Ward

PURPOSE:
Preconstruction soil and bedrock tank foundation investigation

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drilling rig

DRILL METHOD:
0.0 to 5.0 ft: 4.25-inch HSA with pilot bit
5.0 to 50.0 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel

DRILLING MEDIUM:
0.0 to 5.0 ft: None
5.0 to 50.0 ft: Freshwater with 2% polymer

CASING RECORD/ DRILLING NOTES:
0.0 to 5.0 ft: Pilot bit
5.0 to 7.0 ft: Advance HQ3 2.0 ft.
7.0 to 47.0 ft: Advance HQ3 in 5-foot sample intervals.
47.0 to 50.0 ft: Advance HQ3 3.0 ft.
*Driller reported hitting hard rock at 4.8 ft with pilot bit.
*Driller sounded hole at 50.0 ft upon reaching total depth.

HOLE COMPLETION:
Casing removed; backfill hole with bentonite from 50.0 ft (total depth) to surface.

SAMPLING:
31.3 to 31.7 ft: HQ3 AA
39.3 to 40.0 ft: HQ3 A
43.0 to 43.6 ft: HQ3 B

Core sample conditions are immediately preserved for shipping and testing by the Denver Geotechnical Laboratory and Field Support (GLFS) group.

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	LITHOLOGY	% RECOVERY	% RQD	HOLE COMPLETION
	Qal	SM	NA	NA	NA	NO SPTs		0	NA	
		5424.9								
5	Kpc							70	0	
			FD6	H6	W7			100	48	
10										
			--	H7	W8 - W9			92	26	
15										
								100	16	
20		SS								
								100	38	
25			FD5	H6 - H7	W7					
								100	60	
30										
								100	76	
35										
		5391.1								
		CLSTN 5389.3	FD7	H7				100	52	
40										
			FD4	H5	W5			98	88	
45		SS/CLSTN								
			~~FD0~~	~~H7~~	~~W7~~			100	87	
			FD4	H7	W5					
50		5379.7								

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 4.8 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 4.8 ft // SILTY SAND (SM): (Pilot spoils) About 80% fine sand; about 20% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; brown and dry; weak reaction with HCl.

4.8 to 50.0 ft // CRETACEOUS PICTURED CLIFFS (Kpc)

4.8 to 12.0 ft // SANDSTONE: Brown to dark brown color and fine grained; soft (H6) and intensely weathered (W7); thinly to very thinly bedded; intensely to moderately fractured (FD6) with mechanical breaks and bedding plane separation throughout core interval; common FeOx staining and CaCO3 streaks and specks; strong reaction with HCl.

12.0 to 15.3 ft // SANDSTONE: (Interpreted to be disaggregated heaving sand) brown color, fine grained and argillaceous; very soft (H7) and very intensely weathered (W8) to decomposed (W9); no bedding structure observed; FeOx present throughout core interval; weak reaction with HCl.

15.3 to 38.6 ft // SANDSTONE: Tan to brown color, fine grained and argillaceous; soft (H6) to very soft (H7) and intensely weathered (W7); thinly bedded; very intensely to intensely fractured (FD5) with mechanical breaks and bedding plane separation throughout core intervals; common FeOx staining; weak reaction with HCl.

38.6 to 40.4 ft // CLAYSTONE: Dark brown to dark gray color; very soft (H7) and intensely weathered (W7); thinly bedded to laminated in places and easily separates along bedding planes; intensely fractured (FD7) with common bedding plane separations; organic odor; FeOx staining throughout interval and slakes rapidly with exposure; no reaction with HCl.

40.4 to 50.0 ft // INTERBEDDED SANDSTONE/CLAYSTONE: Sandstone is tan to light brown, fine grained and argillaceous; moderately soft (H5) and slightly weathered (W5); thinly to thickly bedded; slightly to moderately fractured (FD4) with mechanical breaks and bedding plane separations throughout core interval; common FeOx staining; no reaction with HCl; thin dark gray to black clay interbeds from 48.0 to 48.2 ft are very soft (H6), intensely weathered (W7), unfractured (FD0), and no reaction with HCl.

STRATIGRAPHY:
0.0 to 4.8 ft: QUATERNARY ALLUVIUM (Qal)
4.8 to 50.0 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ▽= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Silty Sand
Sandstone
Claystone
Interbedded Claystone and Sandstone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK 04 DHMLT INV SDP -UPD- FEB 19 2025.GPJ GINT STD US LAB.GDT 3/3/25

GEOLOGIC LOG OF DRILL HOLE NO. DHMLT-23-5

FEATURE: Reach 2 Regulating Tanks
LOCATION: Reach 2 Alignment
BEGUN: 9/16/2023 FINISHED: 9/16/2023
DEPTH TO WATER & ELEVATION: WLNE ▽

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2081445.5 E 2538376.1 NAD 83
TOTAL DEPTH: 50.3 ft
DEPTH TO BEDROCK: 7.1 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5429.2 ft
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted

DRILLED BY:
Upper Colorado Drill Crew
DRILLER(S): Renato Matheson, Mike Howell
HELPER(S): Morgan Janisse, Ryan Ward

PURPOSE:
Preconstruction soil and bedrock tank foundation investigation

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drilling rig

DRILL METHOD:
0.0 to 5.0 ft: 4.25-inch HSA with pilot bit
5.0 to 50.3 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel

DRILLING MEDIUM:
0.0 to 5.0 ft: None
5.0 to 50.3 ft: Freshwater with 2% polymer

DRILLING NOTES:
0.0 to 5.0 ft: Pilot bit
5.0 to 45.0 ft: Advanced HQ3 in 5-foot sample intervals.
45.0 to 50.3 ft: Advanced HQ3 5.3 ft (picked up additional 0.3 ft mechanically in drilling shoe).

HOLE COMPLETION:
Casing removed; backfill hole with bentonite from 50.3 ft (total depth) to surface.

SAMPLING:
7.9 to 8.9 ft: HQ3 A
14.0 to 14.7 ft: HQ3 B

Core sample conditions are immediately preserved for shipping and testing by the Denver Geotechnical Laboratory and Field Support (GLFS) group.

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	LITHOLOGY	% RECOVERY	% RQD	HOLE COMPLETION
	Qal	SM	NA	NA	NA	NO SPTs		0	NA	
5		5422.1								
	Kpc		FD4	H3	W4			60	53	
10								100	80	
15			FD5	H5 - H6	W6			100	82	
20		SS						100	88	
			FD0	H3	W3					
25								100	100	
30			FD5	H5	W5			100	80	
35		5390.0						100	72	
40		CLSTN 5388.7	FD8	H7	W7					
								100	80	
45		SS	FD4	H5 - H6	W6			106	79	
50		5378.9	FD5	H3	W4					

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 7.1 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 7.1 // SILTY SAND (SM): (Pilot spoils) About 80% fine sand; about 20% nonplastic fines; maximum size, fine sand; brown and dry; strong reaction with HCl.

7.1 to 50.3 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

7.1 to 9.7 ft // SANDSTONE: Based on short recovery and drilling parameters sandstone top is interpreted to be at 7.1 ft despite photo irregularity; light gray in color and fine grained; medium grained in places; hard (H3) and moderately to slightly weathered (W4); thinly to moderately bedded; moderately to slightly fractured (FD4) with some mechanical breaks and bedding plane separations; intermittent FeOx staining along bedding fractures from exposure; strong reaction with HCl.

9.7 to 23.3 ft // SANDSTONE Brown in color, fine grained and argillaceous; moderately soft (H5) to soft (H6) and intensely to moderately weathered (W6); very thinly to thickly bedded and easily separates along bedding planes; moderately fractured (FD5) with mechanical breaks and bedding plane separations; common FeOx staining; weak reaction with HCl.

23.3 to 23.8 ft // SANDSTONE Light gray color, fine grained and homogenous; hard (H3) and slightly weathered (W3); thinly bedded; unfractured (FD0); CaCOx cemented; strong reaction with HCl.

23.8 to 39.2 ft // SANDSTONE Brown in color, fine grained and argillaceous; moderately soft (H5) and moderately weathered (W5); thinly to thickly bedded; moderately fractured (FD5) with mechanical breaks and bedding plane separations; common FeOx staining; weak reaction with HCl; trace and intermittent dark gray claystone interbeds present.

39.2 to 40.5 ft // CLAYSTONE Dark brown to dark gray color; very soft (H7) and intensely weathered (W7); thinly bedded to laminated; very intensely to intensely fractured (FD8); some mechanical breaks, easily separates along bedding planes; moist with trace organic odor; abundant FeOx staining along bedding planes and rapid slaking with exposure; no reaction with HCl.

40.5 to 49.6 ft // SANDSTONE Brown grading to light tan in color, fine grained and argillaceous; moderately soft (H5) to soft (H6) and intensely to moderately weathered (W6); thinly to thickly bedded; moderately to slightly fractured (FD4) with mechanical breaks and bedding plane separations; FeOx staining; weak reaction with HCl; trace and intermittent dark gray claystone interbeds present.

49.6 to 50.3 ft // SANDSTONE Light gray color, fine grained and homogenous; hard (H3) and moderately to slightly weathered (W4); thinly bedded with approximately 20° dips; moderately fractured (FD5) with bedding plane separations; strong reaction with HCl.

STRATIGRAPHY:
0.0 to 7.1 ft: QUATERNARY ALLUVIUM (Qal)
7.1 to 50.3 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ▽= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Silty Sand
Sandstone
Claystone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK 04 DHMLT INV SDP -UPD- FEB 19 2025.GPJ GINT STD US LAB.GDT 3/3/25

GEOLOGIC LOG OF DRILL HOLE NO. DHMLT-23-6

FEATURE: Reach 2 Regulating Tanks
LOCATION: Reach 2 Alignment
BEGUN: 9/16/2023 FINISHED: 9/16/2024
DEPTH TO WATER & ELEVATION: WLNE ▽

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2081435.6 E 2538337.9 NAD 83
TOTAL DEPTH: 49.5 ft
DEPTH TO BEDROCK: 4.6 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5429.4 ft
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in engineering feet unless otherwise noted

DRILLED BY:
Upper Colorado Basin Regional Drill Crew
DRILLER: R. Matheson
HELPERS: M. Howell, R. Ward

PURPOSE:
Preconstruction soil and bedrock tank foundation investigation

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drilling rig

DRILL METHOD:
0.0 to 4.5 ft: 4.25-inch HSA with pilot bit
4.5 to 49.5 ft: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel

DRILLING MEDIUM:
0.0 to 4.5 ft: None
4.5 to 50.0 ft: Freshwater WITH 2% polymer

CASING RECORD/ DRILLING NOTES:
0.0 to 4.5 ft: HSA with pilot bit
4.5 to 49.5 ft: Advanced HQ3 in 5-foot sample intervals.
*Driller sounded borehole at 49.5 ft total depth

HOLE COMPLETION:
Casing removed; backfill hole with bentonite from 49.5 ft (total depth) to surface.

SAMPLING:
20.6 to 21.6 ft: HQ3 A
35.4 to 36.1 ft: HQ3 B
38.6 to 39.5 ft: HQ3 C
48.9 to 49.5 ft: HQ3 D

Core sample conditions are immediately preserved for shipping and testing by the Denver Geotechnical Laboratory and Field Support (GLFS) group.

DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	% RQD
	Qal	SM	NA	NA	NA	NO SPTs	NR	NA
		5424.8						
5	Kpc	SS	FD6	H5	W6 - W8		94	19
10			NA	H7	W9		50	16
			NR	NR	NR			
15			FD6	H4	W4		100	48
20			FD4				100	90
25			FD0	H3	W2		100	60
			FD4	H5	W5			
30			FD7	H6	W7		100	0
			FD9	H7	W8 - W9			

LITHOLOGY

HOLE COMPLETION

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 4.6 ft: QUATERNARY ALLUVIUM (Qal)

0.0 to 4.6 SILTY SAND (SM): (Pilot spoils) About 85% fine sand; about 15% nonplastic fines; maximum size, fine sand; brown with occasional rusty appearance and dry; strong reaction with HCl.

4.6 to 49.5 ft: CRETACEOUS PICTURED CLIFFS (Kpc)

4.6 to 10.3 ft // SANDSTONE: Brown color, fine grained and argillaceous; moderately soft (H5) and intensely to moderately weathered (W6) to very intensely weathered (W8) in places; very thinly to moderately bedded; intensely to moderately fractured (FD6) to very intensely fractured (FD9) in places; common mechanical breaks, bedding plane separations and fracture zones; FeOx staining; no reaction to HCl.

10.3 to 11.2 ft // SANDSTONE: Interpreted as heaving sand; brown color, fine grained and argillaceous; very soft (H7) and decomposed (W9); disaggregated with no bedding structure; FeOx present throughout interval; no reaction with HCl.

11.2 to 14.5 ft: NO RECOVERY

14.5 to 17.5 ft // SANDSTONE: Brown color and fine grained; moderately hard (H4) and moderately to slightly weathered (W4); laminated to thinly bedded; intensely to moderately fractured (FD6) with mechanical breaks bedding plane separations throughout core interval; FeOx staining; weak reaction with HCl.

17.5 to 26.1 ft // SANDSTONE: Brown color and fine grained; moderately hard (H4) and moderately to slightly weathered (W4); thinly to thickly bedded; moderately to slightly fractured (FD4) with mechanical breaks and bedding plane separations throughout interval; FeOx staining; grades to strong reaction with HCl.

26.1 to 28.3 ft // SANDSTONE: Light gray color, fine grained and argillaceous; hard (H3) and slightly weathered (W2); thickly bedded; unfractured (FD0); trace FeOx staining; strong reaction with HCl.

28.3 to 29.7 ft // SANDSTONE: Brown color, fine grained and argillaceous; moderately soft (H5) and moderately weathered (W5); very thinly to thinly bedded and easily separates along bedding planes; moderately to slightly fractured (FD4) with mechanical breaks and bedding plane separations; FeOx staining; weak reaction with HCl.

29.7 to 32.0 ft // SANDSTONE: Brown color, fine grained and argillaceous; soft (H6) and friable; intensely weathered (W7); laminated to thinly interbedded and easily separates along bedding planes; intensely fractured (FD7) with bedding plane separations throughout interval; FeOx present throughout interval; no reaction with HCl.

32.0 to 34.5 ft // SANDSTONE: Reddish brown to brown color, fine grained and argillaceous; very soft (H7) and friable; very intensely weathered (W8) to decomposed (W9); thinly interbedded with disaggregated zones; very intensely fractured (FD9) throughout interval; heavy FeOx present throughout; no reaction with HCl.

34.5 to 38.0 ft // SANDSTONE: Tan to brown color and fine grained; moderately hard (H4) to moderately soft (H5) and moderately to slightly weathered (W4); thinly to thickly bedded;

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ▽= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Silty Sand
Sandstone
Claystone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK 04 DHMLT INV SDP -UPD- FEB 19 2025.GPJ GINT STD US LAB.GDT 3/3/25

GEOLOGIC LOG OF DRILL HOLE NO. DHMLT-23-6

FEATURE: Reach 2 Regulating Tanks
LOCATION: Reach 2 Alignment
BEGUN: 9/16/2023 FINISHED: 9/16/2024
DEPTH TO WATER & ELEVATION: WLNE ▽

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2081435.6 E 2538337.9 NAD 83
TOTAL DEPTH: 49.5 ft
DEPTH TO BEDROCK: 4.6 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5429.4 ft
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: K. Graham
REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC UNIT	CLASSIFICATION & CONTACT DEPTHS	ENGINEERING PROPERTIES: Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	LITHOLOGY	% RECOVERY	% RQD	HOLE COMPLETION	CLASSIFICATION AND PHYSICAL CONDITION
				FD9	H7	W8 - W9	NO SPTs		100	0		intensely to moderately fractured (FD6) grading to moderately to slightly fractured (FD4) with mechanical breaks and bedding plan separations; common FeOx staining; trace carbonaceous lenses; weak reaction with HCl.
	35	Kpc	SS	FD6	H4	W4			94	57		**38.0 to 40.2 // CLAYSTONE:** Reddish brown to dark gray color; very soft (H7) and intensely weathered (W7); thinly bedded to laminated and easily separates along bedding planes; moderately fractured (FD5) with bedding plane separations; slakes rapidly with exposure; FeOx staining along fractures; no reaction with HCl.
			5391.4 CLSTN	FD5	H7	W7						
	40		5389.2						100	0		**40.2 to 49.5 ft // SANDSTONE:** Brown to rusty color, fine grained and argillaceous; moderately soft (H5) and intensely to moderately weathered (W5); very thinly to thinly bedded and easily separates along bedding planes; intensely fractured (FD7) with mechanical breaks and bedding plane separations; FeOx staining throughout core interval; weak reaction with HCl.
	45		SS	FD7	H5	W5			100	0		**STRATIGRAPHY:** **0.0 to 4.6 ft: QUATERNARY ALLUVIUM (Qal)** **4.6 to 49.5 ft: CRETACEOUS PICTURED CLIFFS (Kpc)**
			5379.9									

BOTTOM OF HOLE

COMMENTS: Nomenclature for 'Engineering Properties' and 'Classification and Physical Condition' columns is used in convention with the Bureau of Reclamation Engineering Geology Field Manual, Vol. I [Unified Soil Classification System (USCS) - USBR 5000, 5005 standards (Chpt. 3); and composite drawings 40-D-6493, 40-D-6499 - 'Standard Descriptors & Descriptive Criteria for Rock & Discontinuities' (Chpts. 4, 5 respectively)].

Abbreviations: HSA= hollow stem auger; NA= not available; ft= feet; NE= not encountered; NP= nonplastic; NR= no recovery; HCl= hydrochloric acid; FeOx= iron oxide; CaCOx= calcium carbonate MnOx= manganese Oxide; SPT= standard penetration test; CA= California sample; FADC= flight auger dry core; HQ3= coring system; SS= sandstone; SLTST= siltstone; SH= shale; CLSTN= claystone; ▽= water level.

All angles measured from horizontal axis at zero degrees unless otherwise noted

GRAPHIC LEGEND:
Silty Sand
Sandstone
Claystone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK 04 DHMLT INV SDP -UPD- FEB 19 2025.GPJ GINT STD US LAB.GDT 3/3/25

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPMLT-23-01

FEATURE: Reach 2
LOCATION: Regulating Tank Site
COORDINATES: N 2,081,438 E 2,538,294.4
APPROXIMATE DIMENSIONS: 10'X3'X24"
DEPTH TO WATER: WLNE DATE: 6/13/2023

PROJECT: Navajo Gallup Water Supply Project
GROUND ELEVATION: 5428.7
METHOD OF EXPLORATION: JCB 3CX Eco Backhoe with 24" bucket
LOGGED BY: K. Graham

DATE EXCAVATED: 6/13/2023

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	SM Corrosivity sample collected at about 2.0 feet. No in-place density due to shallow bedrock. 2.0 ft (5426.7)	0.0 to 2.0 ft // SILTY SAND: About 80% fine sand; about 20% nonplastic fines with low dry strength and rapid dilatancy; maximum size, fine sand; trace FeOx present; strong reaction with HCl. IN-PLACE CONDITION: Tan, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2 3 4 5	SS 5.3 ft (5423.4)	2.0 to 5.3 ft // SANDSTONE: Tan to brown color and fine grained; moderately hard (H4) and moderately weathered (W5); laminated to thinly bedded; trace iron concretions, carbonaceous material, and FeOx staining; strong reaction with HCl. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs (Kpc).			

COMMENTS: Surface sparsely vegetated with grass, and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPMLT-23-02

FEATURE: Reach 2
LOCATION: Regulating Tank Site
COORDINATES: N 2,081,414.3 E 2,538,466.9
APPROXIMATE DIMENSIONS: 8'X3'X24"
DEPTH TO WATER: WLNE DATE: 6/13/2023

PROJECT: Navajo Gallup Water Supply Project
GROUND ELEVATION: 5432
METHOD OF EXPLORATION: JCB 3CX Eco Backhoe with 24" bucket
LOGGED BY: K. Graham

DATE EXCAVATED: 6/13/2023

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
	SM	0.0 to 3.0 ft // SILTY SAND: About 80% fine sand; about 20% nonplastic fines with low dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brownish red in color, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
1 2	Corrosivity sample collected at about 3.0 feet. No in-place density due to shallow bedrock.				
3	3.0 ft (5429.0)				
	SS	3.0 to 3.6 ft // SANDSTONE: Light tan color and fine grained; thinly bedded; moderately hard (H4) and moderately weathered (W5); FeOx staining; strong reaction with HCl. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs (Kpc).			
	3.6 ft (5428.4)				

COMMENTS: Surface sparsely vegetated with grass, and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPMLT-23-03

FEATURE: Reach 2
LOCATION: Regulating Tank Site
COORDINATES: N 2,081,428.8 E 2,538,370.7
APPROXIMATE DIMENSIONS: 10'X3'X24"
DEPTH TO WATER: WLNE DATE: 6/13/2023

PROJECT: Navajo Gallup Water Supply Project
GROUND ELEVATION: 5429.7
METHOD OF EXPLORATION: JCB 3CX Eco Backhoe with 24" bucket
LOGGED BY: K. Graham

DATE EXCAVATED: 6/13/2023

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 2 3	SM Corrosivity sample collected at about 3.0 feet. No in-place density due to shallow bedrock. 3.0 ft (5426.7)	0.0 to 3.0 ft // SILTY SAND: About 85% fine sand; about 15% nonplastic fines with low dry strength and rapid dilatancy; maximum size, fine sand; trace FeOx present; strong reaction with HCl. IN-PLACE CONDITION: Tan with occasional reddish color, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
4	SS 4.6 ft (5425.1)	3.0 to 4.6 ft // SANDSTONE: Light tan color and fine grained, laminated to thinly bedded; moderately hard (H4); moderately weathered (W5); trace carbonaceous material and FeOx staining; strong reaction with HCl. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs (Kpc).			

COMMENTS: Surface sparsely vegetated with grass, and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21- 1

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 2/3/2021 FINISHED: 2/3/2021
DEPTH TO WATER & ELEVATION: NE ∇
WATER DEPTH MEASURED ON: 2/3/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2081589. E 2537208.9 NAD83
TOTAL DEPTH: 19.5 ft
DEPTH TO BEDROCK: 3.3 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5400.0 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: C. Strebel, T. Morton

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.5: 4.25-inch HSA with pilot bit.
4.5 to 19.5: 4.25-inch HSA with dry core system and SPT sampling.

DRILLING MEDIUM:
0.0 to 19.5: None

CASING RECORD/ DRILLING NOTES:
0.0-4.5: HSA with pilot bit
4.5-9.5: FADC
9.5-14.5: FADC
14.5-19.5: FADC
Casing removed.

HOLE COMPLETION:
0.0 to 19.5: Bentonite

SAMPLING:
4.5 to 6.0: SPT

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	RQD
	Qal	SM					NA	
		5396.7						
	Kl	Sandstone	FD0	H7	W7	10, 26, 50	NA	NA
5			FD0				74	0
10			FD0	H5-H7			100	0
15			FD0				72	0
		5380.5						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 3.3 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 3.3 ft SILTY SAND (SM): About 85% fine sand; about 15% nonplastic fines with no dry strength and rapid dilatancy; maximum size, fine sand; brown and dry; bottom of interval determined by drilling charcateristics; strong reaction with HCl.

3.3 to 19.5 ft CRETACEOUS LEWIS SHALE (Kl)

3.3 to 9.0 ft SANDSTONE: Light gray to dark brown color and fine grained; very soft (H7) and intensely weathered (W7); laminated to thinly bedded and dips from 16° to horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; MnOx, FeOx staining, root casts and CaCOx present; strong reaction with HCl.

LAB TEST DATA: Test interval 4.5 to 6.0 ft; 69.1% sand, 30.9% fines, LL= NA, PI= NP, SpG= 2.62, moisture= 2.8%. Lab classification is SILTY SAND (SM). sample representative of 1.4 ft of the sample interval.

9.0 to 19.5 ft SANDSTONE: Light gray to dark brown color and fine grained; very soft (H7) and intensely weathered (W7); laminated to thinly bedded and dips from 16° to horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; thin beds of moderately soft (H5) sandstone; FeOx staining and CaCOx present; strong reaction with HCl.

STRATIGRAPHY:
0.0 to 3.3 ft QUATERNARY ALLUVIUM (Qal)
3.3 to 19.5 ft CRETACEOUS LEWIS SHALE (Kl)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered N/P= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit O.D.= outside diameter ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Silty Sand
Sandstone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21- 2

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 2/4/21 FINISHED: 2/4/21
DEPTH AND ELEVATION OF WATER LEVEL: NE ∇
DATE MEASURED: 2/4/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2082733.33 E 2528835.67 NAD83
TOTAL DEPTH: 19.5 ft
DEPTH TO BEDROCK: 18.6
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5261.4 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: C. Strebel, T. Morton

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.5: 4.25-inch HSA with pilot bit.
4.5 to 19.5: 4.25-inch HSA with dry core system and SPT sampling.

DRILLING MEDIUM:
0.0 to 19.5: None

CASING RECORD/ DRILLING NOTES:
0.0-4.5: HSA with pilot bit
4.5-7.0: FADC
7.0-9.5: FADC
9.5-12.0: FADC
12.0-14.5: FADC
14.5-19.5: FADC
Casing removed.

HOLE COMPLETION:
0.0 to 19.5: Bentonite

SAMPLING:
4.5 to 6.0: SPT
7.0 to 8.5: SPT
9.5 to 11.0: SPT
12.0 to 13.5: SPT
14.5 to 16.0: SPT

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
			SC								
			5259.9								
		NA									
5			s(CL)	5							
				15	57.0	43.0	0.0	21.6	5.2	4.5	s(CL-ML)
		36		15							
				7							
				15	71.3	28.7	0.0	30.8	11.3	9.1	(CL)s
		100	5253.1	17							
	Qal										
10				7							
				18	91.8	8.2	0.0	43.2	24.6	13.0	CL
		100		25							
				13							
				23	96.2	3.8	0.0	42.6	26.1	11.9	CL
		100		33							
			(CL)s								
15				15							
				32	92.4	7.6	0.0	33.8	18.1	8.2	CL
				50							
		90									
			5242.8								
	KI		Sandstone								
			5241.9								

BOTTOM OF HOLE

GRAPHIC

HOLE COMPLETION

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 18.6 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 1.5 ft CLAYEY SAND (SC): About 75% fine sand; about 25% fines with medium plasticity, medium toughness, medium dry strength and slow dilatancy; maximum size, fine sand; brown and dry; CaCOx present; strong reaction with HCl.

1.5 to 8.3 ft SANDY LEAN CLAY s(CL): About 55% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 45% fine sand; maximum size, fine sand; brown and dry; CaCOx present; strong reaction with HCl.

LAB TEST DATA: Test interval 4.5 to 6.0 ft; 57.0% fines, 43.0% sand, LL= 21.6, PI= 5.2, SpG= 2.68, moisture= 4.5%. Lab classification is SANDY, SILTY CLAY s(CL-ML). Sample representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 7.0 to 8.5 ft; 71.3% fines, 28.7% sand, LL= 30.8, PI= 11.3, SpG= 2.70, moisture= 9.1%. Lab classification is LEAN CLAY WITH SAND (CL)s. Sample representative of the full 1.5 ft of the sample interval. Test extended into underlying interval.

8.3 to 18.6 ft LEAN CLAY WITH SAND (CL)s: About 85% fines with medium plasticity, medium toughness, high dry strength and no dilatancy; about 15% fine sand; maximum size, fine sand; brown and dry; FeOx, MnOx staining and CaCOx present; strong reaction with HCl.

LAB TEST DATA: Test interval 9.5 to 11.0 ft; 91.8% fines, 8.2% sand, LL= 43.2, PI= 24.6, SpG= 2.78, moisture= 13.0%. Lab classification is LEAN CLAY (CL). Sample representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 12.0 to 13.5 ft; 96.2% fines, 3.8% sand, LL= 42.6, PI= 26.1, SpG= 2.72, moisture= 11.9%. Lab classification is LEAN CLAY (CL). Sample representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 14.5 to 16.0 ft; 92.4% fines, 7.6% sand, LL= 33.8, PI= 18.1, SpG= 2.72, moisture= 8.2%. Lab classification is LEAN CLAY (CL). Sample representative of the full 1.5 ft of the sample interval.

18.6 to 19.5 ft CRETACEOUS LEWIS SHALE (Kl)

18.6 to 19.5 ft SANDSTONE: Brownish gray color, fine grained and argillaceous; moderately soft (H5) and intensely weathered (W7); laminated to thinly bedded and dips near horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; strong reaction with HCl.

STRATIGRAPHY:
0.0 to 18.6 ft QUATERNARY ALLUVIUM (Qal)
18.6 to 19.5 ft CRETACEOUS LEWIS SHALE (Kl)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Clayey Sand
Sandy Lean Clay
Lean Clay with Sand
Sandstone
Bentonite and Cement: NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21- 3

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 2/4/21 FINISHED: 2/5/21
DEPTH AND ELEVATION OF WATER LEVEL: NE ∇
DATE MEASURED: 2/5/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2083559.30 E 2526177.40 NAD83
TOTAL DEPTH: 39.0 ft
DEPTH TO BEDROCK: 16.1
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5179.4 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: C. Strebel, T. Morton

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.0: 4.25-inch HSA with pilot bit.
4.0 to 39.0: 4.25-inch HSA with dry core system and SPT sampling.

DRILLING MEDIUM:
0.0 to 39.0: None

CASING RECORD/ DRILLING NOTES:
0.0-4.0: HSA with pilot bit
4.0-6.5: FADC
6.5-9.0: FADC
9.0-11.5: FADC
11.5-14.0: FADC
14.0-19.0: FADC
19.0-24.0: FADC
24.0-29.0: FADC
29.0-34.0: FADC
34.0-39.0: FADC
Casing removed.

HOLE COMPLETION:
0.0 to 39.0: Bentonite

SAMPLING:
4.0 to 5.5: SPT
6.5 to 8.0: SPT
9.0 to 10.5: SPT
11.5 to 13.0: SPT
14.0 to 15.5: SPT

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
	Qal	NA	SC								
5177.1											
5		92	CL	6, 16, 18	92.7	7.3	0.0	46.4	28.1	10.7	CL
		48	CL	12, 25, 31	97.6	2.4	0.0	49.7	28.5	10.2	CL
10		36	CL	13, 22, 28	98.7	1.9	0.0	48.8	27.4	8.9	CL
5167.6											
		36	CH	18, 24, 27	97.7	2.3	0.0	50.7	32.8	9.7	CH
15		100	CH	18, 41, 50	98.4	1.6	0.0	55.7	46.8	8.6	CH
5163.3											
20		66	Shale								
25	Kl	40	Shale								
30		58	Shale								
35		86	Shale								
5140.4											

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 16.1 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 2.3 ft CLAYEY SAND (SC): About 65% fine sand; about 35% fines with medium plasticity, medium toughness, high dry strength and slow dilatancy; maximum size, fine sand; brown and dry; weak reaction with HCl.

2.3 to 11.8 ft LEAN CLAY (CL): About 90% fines with low plasticity, low toughness, low dry strength and no dilatancy; about 10% fine sand; maximum size, fine sand; brown and dry; CaCOx present; no reaction with HCl.

LAB TEST DATA: Test interval 4.0 to 5.5 ft; 92.7% fines, 7.3% sand, LL= 46.4, PI= 28.1, SL= 12.5, SpG= 2.76, moisture= 10.7%. Lab classification is LEAN CLAY (CL). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 6.5 to 8.0 ft; 97.6% fines, 2.4% sand, LL= 49.7, PI= 28.5, SL= 9.0, SpG= 2.76, moisture= 10.2%. Lab classification is LEAN CLAY (CL). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 9.0 to 10.5 ft; 98.1% fines, 1.9% sand, LL= 48.8, PI= 27.4, SL= 10.1, SpG= 2.77, moisture= 10.2%. Lab classification is LEAN CLAY (CL). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

11.8 to 16.1 ft FAT CLAY (CH): About 95% fines with medium plasticity, high toughness, high dry strength and no dilatancy; about 5% fine sand; maximum size, fine sand; brown and dry; CaCOx present; no reaction with HCl.

LAB TEST DATA: Test interval 11.5 to 13.0 ft; 97.7% fines, 2.3% sand, LL= 50.7, PI= 32.8, SL= 13.4, SpG= 2.74, moisture= 9.7%. Lab classification is FAT CLAY (CH). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 14.0 to 15.5 ft; 98.4% fines, 1.6% sand, LL= 55.7, PI= 46.8, SL= 10.5, SpG= 2.73, moisture= 8.6%. Lab classification is FAT CLAY (CH). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

16.1 to 39.0 ft CRETACEOUS LEWIS SHALE (Kl)

16.1 to 22.2 ft SHALE: Dark brown color and friable; very soft (H7) and intensely weathered (W7); laminated to thinly bedded and dips near horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; slakes slowly in water; FeOx staining, CaCOx and carbon blebs present; no reaction with HCl.

22.2 to 39.0 ft SHALE: Dark brown color and friable; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips near horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; slakes slowly in water; FeOx staining, CaCOx and carbon blebs present; no reaction with HCl.

STRATIGRAPHY:
0.0 to 16.1 ft QUATERNARY ALLUVIUM (Qal)
16.1 to 39.0 ft CRETACEOUS LEWIS SHALE (Kl)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Clayey Sand
Sandy Lean Clay
Fat Clay
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21- 3A

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 7/21/21 FINISHED: 7/21/21
DEPTH AND ELEVATION OF WATER LEVEL: NE ▽
DATE MEASURED: 7/21/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2083563.08 E 2526179.39 NAD83
TOTAL DEPTH: 15.4 ft
DEPTH TO BEDROCK: NE
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5183.5 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: C. Strebel, T. Morton

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation. Companion hole to DHPNM-21-3 to collect California samples.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 9.5: 4.25-inch HSA with pilot bit.
9.5 to 15.4: 4.25-inch HSA with pilot bit and California sampling.

DRILLING MEDIUM:
0.0 to 15.4: None

CASING RECORD/ DRILLING NOTES:
0.0-4.5: HSA with pilot bit
4.5-7.0: HSA with pilot bit
7.0-9.5: HSA with pilot bit
9.5-12.0: HSA with pilot bit
12.0-14.5: HSA with pilot bit
Casing removed.

HOLE COMPLETION:
0.0 to 15.4: Bentonite

SAMPLING:
9.5 to 11.0: CA A, B
12.0 to 13.5: CA A, B
14.5 to 15.4: CA A

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
	Qal	NA	SC								
			5181.2								
5		NA	CL		92.7	7.3	0.0	46.4	28.1	10.7	CL
					97.6	2.4	0.0	49.7	28.5	10.2	CL
10		Sample tube A and B		26	98.7	1.9	0.0	48.8	27.4	8.9	CL
				50							
				50							
		NA	5171.7								
		Sample tube A and B		3	97.7	2.3	0.0	50.7	32.8	9.7	CH
				37							
				46							
		NA	CH								
15		Sample tube A		35	98.4	1.6	0.0	55.7	46.8	8.6	CH
			5168.1	50							

BOTTOM OF HOLE

GRAPHIC

HOLE COMPLETION

CLASSIFICATION AND PHYSICAL CONDITION

DHPNM-21-3
(companion hole stratigraphy and lab test data)

0.0 to 15.4 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 2.3 ft CLAYEY SAND (SC): About 65% fine sand; about 35% fines with medium plasticity, medium toughness, high dry strength and slow dilatancy; maximum size, fine sand; brown and dry; weak reaction with HCl.

2.3 to 11.8 ft LEAN CLAY (CL): About 90% fines with low plasticity, low toughness, low dry strength and no dilatancy; about 10% fine sand; maximum size, fine sand; brown and dry; CaCOx present; no reaction with HCl.

LAB TEST DATA: Test interval 4.0 to 5.5 ft; 92.7% fines, 7.3% sand, LL= 46.4, PI= 28.1, SL= 12.5, SpG= 2.76, moisture= 10.7%. Lab classification is LEAN CLAY (CL). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 6.5 to 8.0 ft; 97.6% fines, 2.4% sand, LL= 49.7, PI= 28.5, SL= 9.0, SpG= 2.76, moisture= 10.2%. Lab classification is LEAN CLAY (CL). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 9.0 to 10.5 ft; 98.1% fines, 1.9% sand, LL= 48.8, PI= 27.4, SL= 10.1, SpG= 2.77, moisture= 10.2%. Lab classification is LEAN CLAY (CL). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

CALIFORNIA SAMPLE: Test interval 9.5 to 11.0 ft; collected sample tube A and B. Test advanced the full 1.5 ft interval.

11.8 to 15.4 ft FAT CLAY (CH): About 95% fines with medium plasticity, high toughness, high dry strength and no dilatancy; about 5% fine sand; maximum size, fine sand; brown and dry; CaCOx present; no reaction with HCl.

LAB TEST DATA: Test interval 11.5 to 13.0 ft; 97.7% fines, 2.3% sand, LL= 50.7, PI= 32.8, SL= 13.4, SpG= 2.74, moisture= 9.7%. Lab classification is FAT CLAY (CH). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

CALIFORNIA SAMPLE: Test interval 12.0 to 13.5 ft; collected sample tube A and B. Test advanced the full 1.5 ft interval.

LAB TEST DATA: Test interval 14.0 to 15.5 ft; 98.4% fines, 1.6% sand, LL= 55.7, PI= 46.8, SL= 10.5, SpG= 2.73, moisture= 8.6%. Lab classification is FAT CLAY (CH). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

CALIFORNIA SAMPLE: Test interval 14.5 to 16.0 ft; collected sample tube A. Test met refusal after 50 blows and advanced 0.9 ft of the sample interval.

STRATIGRAPHY:
0.0 to 15.4 ft QUATERNARY ALLUVIUM (Qal)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Clayey Sand
Sandy Lean Clay
Fat Clay
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21- 4

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 2/6/21 FINISHED: 2/6/21
DEPTH AND ELEVATION OF WATER LEVEL: NE ∇
DATE MEASURED: 2/6/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2083290.36 E 2526085.68 NAD83
TOTAL DEPTH: 39.5 ft
DEPTH TO BEDROCK: 16.2
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5176.4 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: C. Strebel, T. Morton

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.5: 4.25-inch HSA with pilot bit.
4.5 to 39.5: 4.25-inch HSA with dry core system and SPT sampling.

DRILLING MEDIUM:
0.0 to 39.5: None

CASING RECORD/ DRILLING NOTES:
0.0-4.5: HSA with pilot bit
4.5-7.0: FADC
7.0-9.5: FADC
9.5-12.0: FADC
12.0-14.5: FADC
14.5-19.5: FADC
19.5-24.5: FADC
24.5-29.5: FADC
29.5-34.5: FADC
34.5-39.5: FADC
Casing removed.

HOLE COMPLETION:
0.0 to 39.5: Bentonite

SAMPLING:
4.5 to 6.0: SPT
7.0 to 8.5: SPT
9.5 to 11.0: SPT
12.0 to 13.5: SPT
14.5 to 16.0: SPT

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
			SC (5175.7)								
		NA									
5		100	CH	10, 32, 47	99	1.0	0.0	51.1	34.0	13.2	CH
	Qal	100		15, 19, 29	98	2.0	0.0	55.6	37.8	13.5	CH
10		84		12, 24, 32	94.9	5.1	0.0	50.2	31.0	11.5	CH
			(5164.2)								
		80		16, 25, 32	98.3	1.7	0.0	54.9	35.5	10.8	CH
			(CL)s								
15		98		21, 34, 50	96.6	3.4	0.0	51.8	35.9	10.0	CH
			(5160.2)								
20		100									
25	Kl	74	Shale								
30		98									
35		100									
			(5136.9)								

BOTTOM OF HOLE

GRAPHIC

HOLE COMPLETION

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 16.2 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 0.7 ft CLAYEY SAND (SC): About 60% fine sand; about 40% fines with low plasticity, low toughness, low dry strength and slow dilatancy; maximum size, fine sand; brown and dry; weak reaction with HCl.

0.7 to 12.2 ft FAT CLAY (CH): About 95% fines with high plasticity, medium toughness, medium dry strength and no dilatancy; about 5% fine sand; maximum size, fine sand; brown and dry; FeOx staining, carbon blebs and CaCOx present; no reaction with HCl.

LAB TEST DATA: Test interval 4.5 to 6.0 ft; 99.0% fines, 1.0% sand, LL= 51.1, PI= 34.0, SL= 15.3, SpG= 2.82, moisture= 13.2%. Lab classification is FAT CLAY (CH). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 7.0 to 8.5 ft; 98.0% fines, 2.0% sand, LL= 55.6, PI= 37.8, SL= 14.4, SpG= 2.82, moisture= 13.5%. Lab classification is FAT CLAY (CH). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 9.5 to 11.0 ft; 94.9% fines, 5.1% sand, LL= 50.2, PI= 31.0, SL= 15.1, SpG= 2.85, moisture= 11.5%. Lab classification is FAT CLAY (CH). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 12.0 to 13.5 ft; 98.3% fines, 1.7% sand, LL= 54.9, PI= 35.5, SL= 15.4, SpG= 2.71, moisture= 10.8%. Lab classification is FAT CLAY (CH). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval. Test extended into underlying interval.

12.2 to 16.2 ft LEAN CLAY WITH SAND (CL)s: About 85% fines with medium plasticity, high toughness, high dry strength and no dilatancy; about 15% fine sand; maximum size, fine sand; brown and dry; FeOx staining, carbon blebs and CaCOx present; no reaction with HCl.

LAB TEST DATA: Test interval 14.5 to 16.0 ft; 96.6% fines, 3.4% sand, LL= 51.8, PI= 35.9, SL= 15.7, SpG= 2.79, moisture= 10.0%. Lab classification is FAT CLAY (CH). One, quart sized bag sample taken representative of 1.4 ft of the sample interval.

16.2 to 39.5 ft CRETACEOUS LEWIS SHALE (Kl)

16.2 to 35.4 ft SHALE: Dark brown color and friable; very soft (H7) and intensely weathered (W7); laminated to thinly bedded and dips near horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; FeOx staining, CaCOx and carbon blebs present; no reaction with HCl.

35.4 to 39.5 ft SHALE: Dark brown color and friable; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips near horizontal; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; slakes slowly in water; FeOx staining, CaCOx and carbon blebs present; no reaction with HCl.

STRATIGRAPHY:
0.0 to 16.2 ft QUATERNARY ALLUVIUM (Qal)
16.2 to 39.5 ft CRETACEOUS LEWIS SHALE (Kl)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Clayey Sand
Fat Clay
Lean Clay with Sand
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21- 4A

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 7/21/21 FINISHED: 7/22/21
DEPTH AND ELEVATION OF WATER LEVEL: NE ∇
DATE MEASURED: 7/22/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2083290.29 E 2526088.13 NAD83
TOTAL DEPTH: 14.7 ft
DEPTH TO BEDROCK: NE
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5180.4 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: C. Strebel, T. Morton

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation. Companion hole to DHPNM-21-4 to collect California samples.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.5: 4.25-inch HSA with pilot bit.
4.5 to 39.5: 4.25-inch HSA with dry core system and SPT sampling.

DRILLING MEDIUM:
0.0 to 39.5: None

CASING RECORD/ DRILLING NOTES:
0.0-2.5: HSA with pilot bit
2.5-4.0: HSA with pilot bit
4.0-6.5: HSA with pilot bit
6.5-9.0: HSA with pilot bit
9.0-11.5: HSA with pilot bit
11.5-14.0: HSA with pilot bit
Casing removed.

HOLE COMPLETION:
0.0 to 14.7: Bentonite

SAMPLING:
2.5 to 4.0: CA A
4.0 to 5.5: CA A, B
6.5 to 8.0: CA A, B
9.0 to 10.5: CA A, B
11.5 to 13.0: CA A
14.0 to 15.5: CA A

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
			SC								
			5179.7								
		NA									
		Sample tube A		8							
				12							
	Qal			18							
			CH	23							
		Sample tube A and B		50							
5				50	99.0	1.0	0.0	51.1	34.0	13.2	CH
		NA									
		Sample tube A and B		29							
				46							

GRAPHIC

HOLE COMPLETION

CLASSIFICATION AND PHYSICAL CONDITION

DHPNM-21-4
(companion hole stratigraphy and lab test data)

0.0 to 14.7 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 0.7 ft CLAYEY SAND (SC): About 60% fine sand; about 40% fines with low plasticity, low toughness, low dry strength and slow dilatancy; maximum size, fine sand; brown and dry; weak reaction with HCl.

0.7 to 12.2 ft FAT CLAY (CH): About 95% fines with high plasticity, medium toughness, medium dry strength and no dilatancy; about 5% fine sand; maximum size, fine sand; brown and dry; FeOx staining, carbon blebs and CaCOx present; no reaction with HCl.

CALIFORNIA SAMPLE: Test interval 2.5 to 4.0 ft; collected sample tube A. Test advanced the full 1.5 ft interval.

CALIFORNIA SAMPLE: Test interval 4.0 to 5.5 ft; collected sample tube A and B, test met refusal after 50 blows and advanced 1.3 ft of the sample interval.

LAB TEST DATA: Test interval 4.5 to 6.0 ft; 99.0% fines, 1.0% sand, LL= 51.1, PI= 34.0, SL= 15.3, SpG= 2.82, moisture= 13.2%. Lab classification is FAT CLAY. One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

CALIFORNIA SAMPLE: Test interval 6.5 to 8.0 ft; collected sample tube A and B, test met refusal after 50 blows and advanced 1.4 ft of the sample interval.

LAB TEST DATA: Test interval 7.0 to 8.5 ft; 98.0% fines, 2.0% sand, LL= 55.6, PI= 37.8, SL= 14.4, SpG= 2.82, moisture= 13.5%. Lab classification is FAT CLAY. One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

CALIFORNIA SAMPLE: Test interval 9.0 to 10.5 ft; collected sample tube A and B. Test met refusal after 50 blows and advanced 0.9 ft of the sample interval.

LAB TEST DATA: Test interval 9.5 to 11.0 ft; 94.9% fines, 5.1% sand, LL= 50.2, PI= 31.0, SL= 15.1, SpG= 2.85, moisture= 11.5%. Lab classification is FAT CLAY. One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

CALIFORNIA SAMPLE: Test interval 11.5 to 13.0 ft; collected sample tube A. Test advanced the full 1.5 ft interval.

LAB TEST DATA: Test interval 12.0 to 13.5 ft; 98.3% fines, 1.7% sand, LL= 54.9, PI= 35.5, SL= 15.4, SpG= 2.71, moisture= 10.8%. Lab classification is FAT CLAY. One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval. Test extended into underlying interval.

12.2 to 14.7 ft LEAN CLAY WITH SAND (CL)s: About 85% fines with medium plasticity, high toughness, high dry strength and no dilatancy; about 15% fine sand; maximum size, fine sand; brown and dry; FeOx staining, carbon blebs and CaCOx present; no reaction with HCl.

LAB TEST DATA: Test interval 14.5 to 16.0 ft; 96.6% fines, 3.4% sand, LL= 51.8, PI= 35.9, SL= 15.7, SpG= 2.79, moisture= 10.0%. Lab

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ∇= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Clayey Sand
Fat Clay
Lean Clay with Sand
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21- 4A

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 7/21/21 FINISHED: 7/22/21
DEPTH AND ELEVATION OF WATER LEVEL: NE ▽
DATE MEASURED: 7/22/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2083290.29 E 2526088.13 NAD83
TOTAL DEPTH: 14.7 ft
DEPTH TO BEDROCK: NE
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5180.4 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES	DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	LABORATORY DATA: % FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION	GRAPHIC	HOLE COMPLETION	CLASSIFICATION AND PHYSICAL CONDITION
			Sample tube A and B		50	98.0	2.0	0.0	55.6	37.8	13.5	CH			classification is FAT CLAY. One, quart sized bag sample taken representative of 1.4 ft of the sample interval.
			NA												CALIFORNIA SAMPLE: Test interval 14.0 to 15.5 ft; collected sample tube A, test met refusal after 50 blows and advanced 0.7 ft of the sample interval. **STRATIGRAPHY: 0.0 to 14.7 ft QUATERNARY ALLUVIUM (Qal)**
			Sample tube A and B		43										
					50										
	10			CH		94.9	5.1	0.0	50.2	31.0	11.5	CH			
			NA												
		Qal													
					26										
			Sample tube A	5168.2	39										
					50	98.3	1.7	0.0	54.9	35.5	10.8	CH			
			NA	(CL)s											
			Sample tube A		38										
				5165.7	50	96.6	3.4	0.0	51.8	35.9	10.0	CH			

BOTTOM OF HOLE

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
- Clayey Sand
- Fat Clay
- Lean Clay with Sand
- Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21- 5

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 2/7/21 FINISHED: 2/8/21
DEPTH AND ELEVATION OF WATER LEVEL: NE ▽
DATE MEASURED: 2/8/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2079824.09 E 2522785.34 NAD83
TOTAL DEPTH: 20.2 ft
DEPTH TO BEDROCK: NE
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5109.3 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: B. Samuels
HELPER: C. Strebel, T. Morton

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.5: 4.25-inch HSA with pilot bit.
4.5 to 20.2: 4.25-inch HSA with dry core system and SPT sampling.

DRILLING MEDIUM:
0.0 to 20.2: None

CASING RECORD/ DRILLING NOTES:
0.0-4.5: HSA with pilot bit
4.5-7.0: FADC
2.0-9.5: FADC
9.5-12.0: FADC
12.0-14.5: FADC
14.5-19.5: FADC
Casing removed.

HOLE COMPLETION:
0.0 to 20.2: Bentonite

SAMPLING:
4.5 to 6.0: SPT
7.0 to 8.5: SPT
9.5 to 11.0: SPT
12.0 to 13.5: SPT
14.5 to 16.0: SPT
19.5 to 20.2: SPT

DEPTH	GEOLOGIC SYMBOL	% CORE RECOVERY	VISUAL CLASSIFICATION	Blows per 0.5 Foot (Sample Interval)	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT	LABORATORY CLASSIFICATION
	Qal	NA	CL								
5		40		3, 5, 5	83.2	16.8	0.0	27.1	11.3	5.9	(CL)s
		100		7, 9, 11	91.3	8.7	0.0	29.0	15.2	8.2	CL
10		100		16, 50	88.3	11.7	0.0	26.3	10.5	7.3	CL
		100	5096.0	28, 50	90.2	9.8	0.0	29.1	16.2	7.8	CL
15		74	(CL)s	34, 50	72.0	28.0	0.0	25.6	12.6	14.5	(CL)s
20		60	5089.1	17, 50	81.6	18.4	0.0	26.2	12.6	5.3	(CL)s

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 20.2 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 13.3 ft LEAN CLAY (CL): About 90% fines with low plasticity, low toughness, low dry strength and no dilatancy; about 10% fine sand; maximum size, fine sand; light brown and dry; FeOx staining, CaCOx present; weak reaction with HCl.

LAB TEST DATA: Test interval 4.5 to 6.0 ft; 83.2% fines, 16.8% sand, LL= 27.1, PI= 11.3, SpG= 2.61, moisture= 5.9%. Lab classification is LEAN CLAY WITH SAND (CL)s. One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 7.0 to 8.5 ft; 91.3% fines, 8.7% sand, LL= 29.0, PI= 15.2, SpG= 2.63, moisture= 8.2%. Lab classification is LEAN CLAY (CL). One, quart sized bag sample taken representative of the full 1.5 ft of the sample interval.

LAB TEST DATA: Test interval 9.5 to 11.0 ft; 88.3% fines, 11.7% sand, LL= 26.3, PI= 10.5, SpG= 2.76, moisture= 7.3%. Lab classification is LEAN CLAY (CL). One, quart sized bag sample taken representative of 0.8 ft of the sample interval.

LAB TEST DATA: Test interval 12.0 to 13.5 ft; 90.2% fines, 9.8% sand, LL= 29.1, PI= 16.2, SpG= 2.71, moisture= 7.8%. Lab classification is LEAN CLAY (CL). One, quart sized bag sample taken representative of 0.8 ft of the sample interval.

13.3 to 20.2 ft LEAN CLAY WITH SAND (CL)s: About 75% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 25% fine sand; maximum size, fine sand; brown and dry; FeOx staining and CaCOx present; no reaction with HCl.

LAB TEST DATA: Test interval 14.5 to 16.0 ft; 72.0% fines, 28.0% sand, LL= 25.6, PI= 12.6, SpG= 2.69, moisture= 14.5%. Lab classification is LEAN CLAY WITH SAND (CL)s. One, quart sized bag sample taken representative of 0.6 ft of the sample interval.

LAB TEST DATA: Test interval 19.5 to 21.0 ft; 81.6% fines, 18.4% sand, LL= 26.2, PI= 12.6, SpG= 2.68, moisture= 5.3%. Lab classification is LEAN CLAY WITH SAND (CL)s. One, quart sized bag sample taken representative of 0.7 ft of the sample interval.

STRATIGRAPHY:
0.0 to 20.2 ft QUATERNARY ALLUVIUM (Qal)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Lean Clay
Lean Clay with Sand
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP SOIL PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21- 9

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 7/27/2021 FINISHED: 7/28/2021
DEPTH TO WATER & ELEVATION: NE ▽
WATER DEPTH MEASURED ON: 7/28/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2074679. E 2514672 NAD83
TOTAL DEPTH: 19.5 ft
DEPTH TO BEDROCK: 6.8 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5131.3 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: CJ. Weber
HELPER: C. McFadden, K. Allred

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 7.0: 4.25-inch HSA with pilot bit, SPT and California sampling.
7.0 to 19.5: 4.25-inch HSA with dry core system.

DRILLING MEDIUM:
0.0 to 19.5: None

CASING RECORD/DRILLING NOTES:
0.0-2.5: HSA w/ pilot bit
2.5-4.5: HSA w/ pilot bit
4.5-7.0: FADC
7.0-9.5: FADC
9.5-14.5: FADC
14.5-19.5: FADC
Casing removed.

HOLE COMPLETION:
0.0 to 19.5: Bentonite

SAMPLING:
2.5 to 4.0: CA A, B
4.5 to 6.0: SPT
7.0 to 8.5: CA A, B

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	RQD
	Qal	(CL)s				10, 13, 13	NA	
5						7, 8, 8	NA	
		5124.5					92	
	Km		FD0			19, 40, 50		0
			FD0				48	0
10		Interbedded shale and claystone	FD0	H5-H7	W7		78	0
15		5115.1	FD0				82	0
		Shale		H5	W5			
		5111.8						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 6.8 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 6.8 ft LEAN CLAY WITH SAND (CL)s: About 85% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 15% fine sand; maximum size, fine sand; brown and dry; strong reaction with HCl.

CALIFORNIA SAMPLE: Test interval 2.5 to 4.0 ft; collected sample tube A and B. Test advanced the full 1.5 ft of the interval.

LAB TEST DATA: Test interval 4.5 to 6.0 ft; 74.7% fines, 25.3% sand, LL= 29.4, PI= 13.8, SpG= 2.79, moisture= 6.1%. Lab classification is LEAN CLAY WITH SAND. Sample representative of the full 1.5 ft of the test interval.

6.8 to 19.5 ft CRETACEOUS MANCOS SHALE (Km)

6.8 to 16.2 ft INTERBEDDED SHALE AND CLAYSTONE: Light to dark brown and friable; moderately soft (H5) and intensely weathered (W7); laminated to thinly bedded and dips from 5° to 28°; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; gypsum present; no reaction with HCl.

CALIFORNIA SAMPLE: Test interval 7.0 to 8.5 ft; collected sample tube A and B. Test met refusal after 50 blows and advanced 1.4 ft of the test interval.

16.2 to 19.5 ft SHALE: Light to dark gray, fissile and friable; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips from 5° to 28°; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; FeOx and MnOx staining and gypsum present; no reaction with HCl.

STRATIGRAPHY:
0.0 to 6.8 ft QUATERNARY ALLUVIUM (Qal)
6.8 to 19.5 ft CRETACEOUS MANCOS SHALE (Km)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Lean Clay with Sand
Interbedded claystone and shale
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21-10

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 7/26/2021 FINISHED: 7/26/2021
DEPTH TO WATER & ELEVATION: NE ▽
WATER DEPTH MEASURED ON: 7/26/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2074195.2 E 2510028.1 NAD83
TOTAL DEPTH: 19.5 ft
DEPTH TO BEDROCK: 5.2 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5150.1 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: CJ. Weber
HELPER: C. McFadden, K. Allred

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.5: 4.25-inch HSA with pilot bit and SPT sampling.
Moved hole 2 ft west.
0.0 to 4.0: 4.25-inch HSA with pilot bit and California sampling.
4.0 to 19.5: 4.25-inch HSA with dry core system.

DRILLING MEDIUM:
0.0 to 19.5: None

CASING RECORD/DRILLING NOTES:
0.0-4.5: HSA w/ pilot bit
Moved hole 2 ft west
0.0-4.0: HSA w/ pilot bit
4.0-9.5: FADC
9.5-14.5: FADC
14.5-19.5: FADC
Casing removed.

HOLE COMPLETION:
0.0 to 19.5: Bentonite

SAMPLING:
2.5 to 4.0: NR
4.0 to 5.5: CA A, B
4.5 to 6.0: SPT

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	RQD
	Qal	CL				9, 13, 16, 20, 27-13, 30-14, 16	NA, NA	
5		5144.9						
	Km	Shale	FD0				14	0
10			FD0	H7	W7		24	0
15			FD0	H5	W5		30	0
		5130.6						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 5.2 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 5.2 ft LEAN CLAY (CL): About 90% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 10% fine sand; maximum size, fine sand; brown and dry; CaCOx stringers present; strong reaction with HCl.

CALIFORNIA SAMPLE: Test interval 2.5 to 4.0 ft; no recovery. Test advanced the full 1.5 ft test interval.

CALIFORNIA SAMPLE: Test interval 4.0 to 5.5 ft; moved drill hole west 2 ft to collect the SPT interval, collected sample tube A and B (blow counts 20/27/30). Test advanced the full 1.5 ft test interval.

LAB TEST DATA: Test interval 4.5 to 6.0 ft; 96.3% fines, 3.7% sand, LL= 47.7, PI= 26.8, SL= 15.9, SpG= 2.74, moisture= 9.8%, Lab classification is LEAN CLAY (CL); Sample representative of the full 1.5 ft of the test interval. Test extended into underlying interval (blow counts 13/14/16).

5.2 to 19.5 ft CRETACEOUS MANCOS SHALE (Km)

5.2 to 15.8 ft POOR RECOVERY: Interpreted to be SHALE from drilling characteristics and recovery; light to dark brown and friable; very soft (H7) and intensely weathered (W7); laminated bedding and dips from 0° to 5°; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; CaCOx present; strong reaction with HCl.

15.8 to 19.5 ft POOR RECOVERY: Interpreted to be SHALE from drilling characteristics and recovery; light to dark gray, fissile and friable; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips from 0° to 5°; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; gypsum present; strong reaction with HCl.

STRATIGRAPHY:
0.0 to 5.2 ft QUATERNARY ALLUVIUM (Qal)
5.2 to 19.5 ft CRETACEOUS MANCOS SHALE (Km)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Lean Clay
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21-11

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 7/25/2021 FINISHED: 7/25/2021
DEPTH TO WATER & ELEVATION: NA ▽
WATER DEPTH MEASURED ON: 7/25/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2074674. E 2508229.5 NAD83
TOTAL DEPTH: 40.0 ft
DEPTH TO BEDROCK: 7.4 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5103.3 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: CJ. Weber
HELPER: C. McFadden, K. Allred

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 4.5: 4.25-inch HSA with pilot bit
4.5 to 7.0: 4.25-inch HSA with SPT sampling.
7.0 to 9.5: 4.25-inch HSA with dry core system.
9.5 to 40.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.

DRILLING MEDIUM:
0.0 to 9.5: None
9.5 to 40.0: Water

CASING RECORD/DRILLING NOTES:
0.0-4.5: HSA w/ pilot bit
4.5-9.5: FADC
9.5-12.5: HQ3
12.5-17.5: HQ3
17.5-22.5: HQ3
22.5-27.5: HQ3
27.5-32.5: HQ3
32.5-37.5: HQ3
37.5-40.0: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 40.0: Bentonite

SAMPLING:
4.5 to 6.0: SPT
7.0 to 8.5: SPT
21.0 to 21.5: HQ3 A
26.6 to 27.1: HQ3 B
29.3 to 30.3: HQ3 C
35.7 to 36.5: HQ3 D
38.7 to 39.3: HQ3 E

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	GRAPHIC	% RECOVERY	RQD	HOLE COMPLETION
	Qal	CL						NR		
5						10, 16, 19		24		
		5095.9				11, 3, 43				
	Km	Shale	FD0	H5-H7	W7			20	0	
10			FD0					50	0	
15			FD0					90	72	
20			FD2	H5	W5	A		88	62	
25			FD3			B		100	74	
30			FD0			C		100	76	
35			FD0			D		100	100	
40		5063.3	FD0			E		100	100	

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 7.4 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 7.4 ft LEAN CLAY WITH SAND (CL)s: About 80% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 20% fine sand; maximum size, fine sand; brown and dry; CaCOx stringers present; strong reaction with HCl.

LAB TEST DATA: Test interval from 4.5 to 6.0 ft; 62.1% fines, 30.6% sand, 7.3% gravel, LL= 31.3, PI= 15.2, SpG= 2.79, moisture= 6.6%, lab classification is SANDY LEAN CLAY s(CL); sample representative of the full 1.5 ft of the test interval.

LAB TEST DATA: Test interval from 7.0 to 8.5 ft; 81.5% fines, 18.5% sand, LL= 38.7, PI= 21.3, SL= 14.9, SpG= 2.81, moisture= 8.6%, Lab classification is LEAN CLAY WITH SAND (CL)s; sample representative of the full 1.5 ft of the test interval. Test interval extended into underlying interval.

7.4 to 40.0 ft CRETACEOUS MANCOS SHALE (Km)

7.4 to 12.5 ft POOR RECOVERY: Interpreted to be SHALE from drilling characteristics and recovery; light to dark brown and friable; very soft (H7) and intensely weathered (W7); laminated bedding and dips from 0° to 5°; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; CaCOx present; strong reaction with HCl.

12.5 to 18.1 ft SHALE: Light to dark brown, fissile and friable; very soft (H7) and intensely weathered (W7); laminated to thinly bedded and dips from 0° to 3°; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; moderately hard (H5) sandstone laminations; CaCOx and gypsum present; strong reaction with HCl.

18.1 to 40.0 ft SHALE: Light to dark gray and fissile; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips from 0° to 4°; easily separates on bedding planes; fracture density ranges from unfractured (FD0) to slightly fractured (FD3) with mechanical breaks and bedding plane separation throughout core; CaCOx and gypsum present; strong reaction with HCl.

JOINT MEASUREMENTS:

DEPTH	INCL	R	T	HL	INFILLING
20.1	3°	4	1	3	Gypsum
20.5	5°	4	2	5	Gypsum
21.1	0°	4	1	4	Gypsum
24.2	16°	3	1	4	Gypsum
24.5	29°	3	1	4	Gypsum
24.7	59°	3	1	2	Gypsum
25.2	3°	3	1	2	Gypsum
26.1	40°	3	1	2	Gypsum
26.5	9°	3	1	2	Gypsum

STRATIGRAPHY:
0.0 to 7.4 ft QUATERNARY ALLUVIUM (Qal)
7.4 to 40.0 ft CRETACEOUS MANCOS SHALE (Km)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Lean Clay
Shale
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21-12

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 7/24/2021 FINISHED: 7/24/2021
DEPTH TO WATER & ELEVATION: NA ▽
WATER DEPTH MEASURED ON: 7/24/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2074791.8 E 2507869.6 NAD83
TOTAL DEPTH: 40.0 ft
DEPTH TO BEDROCK: 19.0 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5093.5 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: CJ. Weber
HELPER: C. McFadden, K. Allred

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

DRILL METHOD:
0.0 to 9.5: 4.25-inch HSA with pilot bit
9.5 to 19.0: 4.25-inch HSA with dry core system and SPT sampling.
19.0 to 40.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.

DRILLING MEDIUM:
0.0 to 19.0: None
19.0 to 40.0: Water

CASING RECORD/DRILLING NOTES:
0.0-4.5: HSA w/ pilot bit
4.5-9.5: HSA w/ pilot bit
9.5-12.0: HQ3
12.0-16.5: HQ3
16.5-19.0: HQ3
19.0-22.5: HQ3
22.5-27.5: HQ3
27.5-32.5: HQ3
32.5-37.5: HQ3
37.5-40.0: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 40.0: Bentonite

SAMPLING:
9.5 to 11.0: SPT
12.0 to 13.5: SPT
16.5 to 18.0: SPT
21.9 to 22.5: HQ3 A
27.5 to 27.8: HQ3 B
31.3 to 32.2: HQ3 C
35.5 to 36.5: HQ3 D
38.6 to 39.6: HQ3 E

DEPTH	GEOLOGIC UNIT	CLASSIFICATION	Fracture Density	Hardness	Weathering	Blows per 0.5 Foot (Sample Interval)	% RECOVERY	RQD
	Qal	(CL)s					NA	
5							NA	
		5084.0				12, 23, 37	30	
10		CL				16, 24, 37	29	
15						14, 21, 32	28	
		5074.5						
20	Km		FD0			A	91	17
		Shale		H5				
25			FD3				100	82
		5066.0 Claystone 5065.7		H7		B		
30			FD0		W5	C	100	100
		Shale		H5				
35			FD0			D	100	100
			FD0			E	100	100
40		5053.5						

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 19.0 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 9.5 ft NO RECOVERY: Estimated to be LEAN CLAY WITH SAND (CL)s from cuttings; about 80% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 20% fine sand; maximum size, fine sand; brown and dry; CaCOx stringers present; strong reaction with HCl.

9.5 to 19.0 ft LEAN CLAY (CL): About 90% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; about 10% predominantly fine sand; maximum size, medium sand; brown and dry; CaCOx stringers present; strong reaction with HCl.

LAB TEST DATA: Test interval 9.5 to 11.0 ft; 97.8% fines, 2.2% sand, LL= 49.2, PI= 27.8, SL= 15.3, SpG= 2.70, moisture= 32.5%, Lab classification is LEAN CLAY (CL); sample representative of the full 1.5 ft of the test interval.

LAB TEST DATA: Test interval 12.0 to 13.5 ft; 89.9% fines, 11.1% sand, LL= 45.6, PI= 27.0, SL= 14.2, SpG= 2.76, moisture= 15.0%, Lab classification is LEAN CLAY (CL); sample representative of the full 1.5 ft of the test interval.

LAB TEST DATA: Test interval 16.5 to 18.0 ft; 81.6% fines, 18.4% sand, LL= 38.4, PI= 19.8, SL= 14.2, SpG= 2.70, moisture= 13.1%, Lab classification is LEAN CLAY WITH SAND (CL)s; sample representative of the full 1.5 ft of the test interval.

19.0 to 40.0 ft CRETACEOUS MANCOS SHALE (Km)

19.0 to 27.5 ft SHALE: Light to dark gray, friable and fissile; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips from 0° to 3°; easily separates on bedding planes; fracture density ranges from unfractured (FD0) to slightly fractured (FD3) with mechanical breaks and bedding plane separation throughout core; gypsum present; strong reaction with HCl.

JOINT MEASUREMENTS:

DEPTH	INCL	R	T	HL	INFILLING
23.6	49°	4	1	6	Gypsum
25.6	66°	2	1	6	Clay
26.8	67°	4	1	1	Gypsum

27.5 to 27.8 ft CLAYSTONE: Light gray color; very soft (H7) and moderately weathered (W5); no bedding observed; no reaction with HCl.

27.8 to 40.0 ft SHALE: Light to dark gray, friable and fissile; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips from 0° to 3°; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; gypsum present; strong reaction with HCl.

STRATIGRAPHY:
0.0 to 19.0 ft QUATERNARY ALLUVIUM (Qal)
19.0 to 40.0 ft CRETACEOUS MANCOS SHALE (Km)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Lean Clay with Sand
Lean Clay
Shale
Claystone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

GEOLOGIC LOG OF DRILL HOLE NO. DHPNM-21-13

FEATURE: Reach 3 PNM Alternative
LOCATION: Pipeline Alignment
BEGUN: 7/22/2021 FINISHED: 7/23/2021
DEPTH TO WATER & ELEVATION: NA ▽
WATER DEPTH MEASURED ON: 7/23/2021

PROJECT: Navajo Gallup Water Supply Project
COORDINATES: N 2074896.6 E 2507336.7 NAD83
TOTAL DEPTH: 40.0 ft
DEPTH TO BEDROCK: 4.5 ft
TOP OF CASING ELEVATION: NA

STATE: New Mexico
GROUND ELEVATION: 5106.7 ft NAVD88
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: P. Gardner
REVIEWED BY: C. Beyer

NOTES

All measurements are from ground level and reported in feet unless otherwise noted.

DRILLED BY:
Upper Colorado Drill Crew
DRILLER: CJ. Weber
HELPER: C. McFadden, K. Allred

PURPOSE:
Preconstruction soil and bedrock pipeline alignment investigation.

DRILL EQUIPMENT:
CME Model 850XR track mounted rotary drill rig.

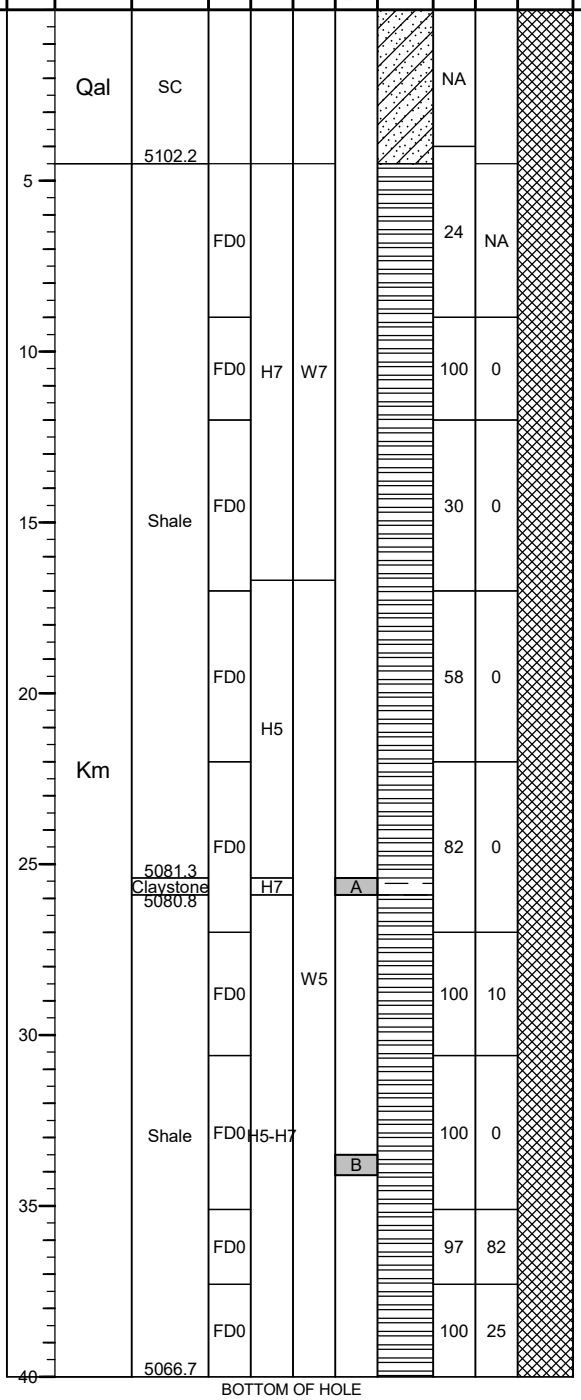
DRILL METHOD:
0.0 to 4.0: 4.25-inch HSA with pilot bit.
4.0 to 9.0: 4.25-inch HSA with dry core system.
9.0 to 40.0: HQ3 diamond core drilling system with 5-foot-long split tube sample barrel.

DRILLING MEDIUM:
0.0 to 19.0: None
19.0 to 40.0: Water

CASING RECORD/DRILLING NOTES:
0.0-4.0: HSA w/ pilot bit
4.0-9.0: FADC
9.0-12.0: HQ3 no return water
12.0-17.0: HQ3
17.0-22.0: HQ3
22.0-27.0: HQ3
27.0-30.6: HQ3
30.6-35.1: HQ3
35.1-37.3: HQ3
37.3-40.0: HQ3
Casing removed.

HOLE COMPLETION:
0.0 to 40.0: Bentonite

SAMPLING:
25.4 to 25.9: HQ3 A
33.5 to 34.1: HQ3 B



CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 4.5 ft QUATERNARY ALLUVIUM (Qal)

0.0 to 4.5 ft CLAYEY SAND (SC): About 80% fine sand; about 20% fines with medium plasticity, medium toughness, medium dry strength and no dilatancy; maximum size, fine sand; brown and dry; strong reaction with HCl.

4.5 to 40.0 ft CRETACEOUS MANCOS SHALE (Km)

4.5 to 16.7 ft POOR RECOVERY: Interpreted to be SHALE from drilling characteristics and recovery; light to dark brown and friable; very soft (H7) and intensely weathered (W7); laminated bedding and dips from 0° to 3°; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; moderately soft (H5) sandstone laminations; CaCOx and gypsum present; strong reaction with HCl.

16.7 to 25.4 ft SHALE: Light to dark gray, friable and fissile; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips from 0° to 3°; easily separates on bedding planes; unfractured (FD0 with mechanical breaks and bedding plane separation throughout core; strong reaction with HCl.

25.4 to 25.9 ft CLAYSTONE: Dark grayish brown color; very soft (H7) and moderately weathered (W5); no bedding planes observed; strong reaction with HCl.

25.9 to 40.0 ft SHALE: Light to dark gray, friable and fissile; moderately soft (H5) and moderately weathered (W5); laminated to thinly bedded and dips from 0° to 3°; easily separates on bedding planes; unfractured (FD0) with mechanical breaks and bedding plane separation throughout core; very soft (H7) interbedded claystone; strong reaction with HCl.

CLAYSTONE INTERBEDS:
31.8 to 31.9: very soft (H7)
33.2 to 33.5: very soft (H7)
34.5 to 34.7: very soft (H7)
34.9 to 35.3: very soft (H7)
35.8 to 35.9: very soft (H7)
36.1 to 36.4: very soft (H7)

STRATIGRAPHY:
0.0 to 4.5 ft QUATERNARY ALLUVIUM (Qal)
4.5 to 40.0 ft CRETACEOUS MANCOS SHALE (Km)

COMMENTS: HSA= hollow stem auger FADC= flight auger dry core HQ3= coring system SPT= standard penetration test CA= California sample NA= not available ft= feet NE= not encountered NP= nonplastic NR= no recovery HCl= hydrochloric acid FeOx= iron oxide CaCOx= calcium carbonate MnOx= manganese oxide SpG= specific gravity SL= shrinkage limit ▽= water level

All angles measured from horizontal 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."

GRAPHIC LEGEND:
Clayey Sand
Shale
Claystone
Bentonite seal with NO pipe

BUREAU OF RECLAMATION

NGWSP ROCK PNM DRILL HOLES.GPJ GINT STD US LAB.GDT 10/13/21

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR2-22-21

FEATURE: Reach 2 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Reach 2 Pipeline Alignment.
GROUND ELEVATION: 5407.0
COORDINATES: N 2,081,536 E 2,537,476
METHOD OF EXPLORATION: Case 580 N Backhoe.
APPROXIMATE DIMENSIONS: 10'X3'X7.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 2/15/2022
DATE EXCAVATED: 2/15/2022

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, 2	SM 2.5 ft (5404.5)	0.0 to 2.5 ft SILTY SAND: About 80% fine sand; about 20% fines with no plasticity, low dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brownish red in color, calcite cement, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
3, 4, 5, 6	SS Corrosivity sample collected at 6.0 ft. 6.0 ft (5401.0)	2.5 to 6.0 ft SANDSTONE: Fine grained, thinly to moderately bedded, gray in color, soft (H6) and intensely weathered (W7) from 5.8 to 7.0 ft. Becomes moderately hard (H4) moderately weathered (W5) below 7.0 ft. Strong reaction with HCl, recovered as 3-to-12- inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Pictured Cliffs Sandstone (Kpc).			
7					

COMMENTS: Surface vegetated with grass, and brush. Discontinued excavation due to refusal in sandstone bedrock.

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-1

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5401
COORDINATES: N 2,081,523.9 E 2,537,080.4
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/13/2021

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	SM	0.0 to 2.0 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2	2.0 ft (5399.0)				
3	SS	2.0 to 5.0 ft SANDSTONE: Fine grained, thinly bedded, argillaceous, and gray in color, soft (H6) and intensely weathered (W7), becomes moderately weathered (W5) and moderately hard (H4) with depth. It has a strong reaction with HCl and is recovered as 2-to-6 inch flat subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl). Two quart corrosivity sample collected at at 5.0 ft.			
4					
5	5.0 ft (5396.0)				

COMMENTS: Surface vegetated with grass and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-2

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5366.3
COORDINATES: N 2,081,652.3 E 2,536,046.5
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X3'X9.2'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/13/2021

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, 2, 3	SM	0.0 to 3.3 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, calcite nodules. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
3.3 ft (5363.0)					
4, 5, 6	SC (visual) SC (lab Class) In-Place Density Test at 5.0 ft.	3.3 to 6.0 ft CLAYEY SAND: About 85% fine sand; about 15% fines with low plasticity, low dry strength, and low toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, calcareous, homogeneous, dry. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. IN-PLACE DRY UNIT WEIGHT AND MOISTURE FROM 5.0 ft. Total: 113.4 lb/ft³, 6.3 % moisture (80.5 % compaction). LAB TEST DATA: 41.6 % fines, 58.4% sand, LL=31.3 PI=8.6. Maximum dry Unit Weight: 91.3 lb/ft³, optimum water content = 14.0% Laboratory classification is CLAYEY SAND. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
6.0 ft (5360.3)					
7, 8, 9	SS	6.0 to 9.2 ft SANDSTONE: Fine grained, thinly bedded, argilacious, and gray in color. The sandstone is soft (H6) and intensely weathered (W7), and becomes moderately weathered (W5) and moderately hard (H4) with depth. It has a strong reaction with HCl and is recovered as 2-to-6 inch flat subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl). Two quart corrosivity sample collected at 6.0 ft.			
9.2 ft (5357.1)					

COMMENTS: Surface vegetated with grass and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-3

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5353.1
COORDINATES: N 2,081,792 E 2,534,934.5
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X6.7'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/13/2021

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, 2, 3, 4	SM	0.0 to 4.5 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
4.5 ft (5348.6)					
5, 6	SS	4.5 to 6.7 ft SANDSTONE: Fine grained, thinly bedded, argillaceous and gray in color. The sandstone is soft (H6) and intensely weathered (W7), becomes moderately weathered (W5) and moderately hard (H4) with depth. It has a strong reaction with HCl and is recovered as 2-to-6 inch flat subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			
6.7 ft (5346.4)					

COMMENTS: Surface vegetated with grass and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-4

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5335.3
COORDINATES: N 2,081,905.6 E 2,534,035.7
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X3'X7'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/13/2021

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 2 3 4 5	SM	0.0 to 5.5 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, moist from 0.5 to 1.0 ft, otherwise dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
5.5 ft (5329.8)					
6 7	SS	5.5 to 7.0 ft SANDSTONE: Fine grained, thinly bedded, argillaceous, and gray in color. The sandstone is soft (H6) and intensely weathered (W7), becomes moderately weathered (W5) and moderately hard (H4) with depth. It has a strong reaction with HCl and is recovered as 2-to-6 inch flat subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			
7.0 ft (5328.3)					

COMMENTS: Surface vegetated with grass and sage brush. Waste concrete dumped on the surface in the area, Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-5

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5320.1
COORDINATES: N 2,082,024.4 E 2,533,022.2
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X6'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/13/2021

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 2 3 4	SM 4.0 ft (5316.1)	0.0 to 4.0 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; trace subangular flat sandstone cobbles, maximum size, 200mm; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
5 6	SS 6.0 ft (5314.1)	4.0 to 6.0 ft SANDSTONE: Fine grained, thinly bedded, argillaceous and gray in color. The sandstone is soft (H6) and intensely weathered (W7), becomes moderately weathered (W5) and moderately hard (H4) with depth. It has a strong reaction with HCl and is recovered as 1-to-3 inch flat subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			

COMMENTS: Surface vegetated with grass and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-6

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5309
COORDINATES: N 2,082,048.5 E 2,532,045.5
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/13/2021

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	SM 2.0 ft (5307.0)	0.0 to 2.4 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; trace subangular flat sandstone cobbles, maximum size, 200mm; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2 3 4	CL 1 gal bag sample collected at 2.4 ft. 4.5 ft (5304.5)	2.0 to 4.5 ft LEAN CLAY: About 90% fines with medium plasticity, medium toughness, and medium dry strength; about 10% fine sand; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry, calcite nodules. Bag Sample Collected at 2.0 ft. LAB TEST DATA: 96.9 % fines, 3.1 % sand, LL=53.5 PI=34.1SL=10.8. fill water content= 10.3 % Laboratory classification is FAT CLAY. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
5	SS 5.0 ft (5304.0)	4.5 to 5.0 ft SANDSTONE: Fine grained, thinly to moderately bedded, argilacious, and gray in color. The sandstone is soft (H6) and intensely weathered (W7), becomes moderately weathered (W5) and moderately hard (H4) with depth. It has a strong reaction with HCl and is recovered as 6-to-12 inch flat subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl). Two quart corrosivity sample collected at 5.0 ft.			

COMMENTS: Surface vegetated with grass and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-7

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5306.6
COORDINATES: N 2,081,963.3 E 2,531,157
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/13/2021

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	SM	0.0 to 2.0 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2	2.0 ft (5304.6)				
3	SS	2.0 to 4.5 ft SANDSTONE: Fine grained, thinly bedded, argilacious, and gray in color, soft (H6) and intensely weathered (W7). It has a strong reaction with HCl, iron oxide staining along bedding planes and is recovered as 3-to-6 inch flat subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			
4	4.5 ft (5302.1)				
5	SHALE 5.0 ft (5301.6)	4.5 to 5.0 ft SHALE: Gray in color, fissile, thinly bedded, sandy, iron oxide staining, moderately hard (H4) and moderately weathered (H5). GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			

COMMENTS: Surface vegetated with grass and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-8

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5304.9
COORDINATES: N 2,082,110.1 E 2,530,003.2
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X2'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/14/2021
DATE EXCAVATED: 9/14/2021

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
	(SM)g	0.0 to 0.5 ft SILTY SAND GRAVEL: About 65% fine sand; about 20% fine to coarse subangular sandstone gravel; about 15% fines with no plasticity, no dry strength and rapid dilatancy; trace cobbles, maximum size, 150mm; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).		tr	
	0.5 ft (5304.4)				
	SM	0.5 to 1.8 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
1					
	1.8 ft (5303.1)				
	SS	1.8 to 2.0 ft SANDSTONE: Fine grained, moderately bedded, argilacious, and gray in color, hard (H3) and slightly to moderately weathered (W4), strong reaction with HCl, recovered as 3-to-6" inch flat subangular fragments.			
	2.0 ft (5302.9)				
2		GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			

COMMENTS: Surface vegetated with grass and brush. Discontinued excavation due to refusal in sandstone bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-9

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5260.3
COORDINATES: N 2,082,839.3 E 2,528,958.6
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X10'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/14/2021
DATE EXCAVATED: 9/14/2021

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, 2, 3	SM	0.0 to 3.2 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
3.2 ft (5257.1)					
4.0 ft (5256.3)	CL	3.2 to 4.0 ft LEAN CLAY: About 90% fines with medium plasticity, medium toughness, and medium dry strength; about 10% fine sand; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry, calcite nodules. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
4, 5, 6, 7, 8, 9	SHALE	4.0 to 10.0 ft SHALE: Fissile, laminated, gray in color, calcite cement, gypsum veins, soft (H6) and intensely weathered (W7), becomes moderately soft (H5) and moderately weathered (W5) around 10 feet in depth. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl). Two quart corrosivity sample collected at 6.0 ft.			
10.0 ft (5250.3)					
10					

COMMENTS: Surface vegetated with grass and brush. Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-10

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5247.6
COORDINATES: N 2,083,122.7 E 2,527,714.2
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X3.7'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/14/2021
DATE EXCAVATED: 9/14/2021

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
	(SM)g	0.0 to 0.5 ft SILTY SAND WITH GRAVEL: About 70% fine sand; about 15% fine to coarse subangular sandstone gravel; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, 75mm; strong reaction with HCl.			
0.5 ft (5247.1)	SS	IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal). 0.5 to 2.2 ft SANDSTONE: Fine grained, thinly to moderately bedded, argilacious, and gray in color highly fractured, moderately hard (H4), moderately weathered (W5) strong reaction with HCl, recovered as 6-to-10 inch flat subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			
1 2 2.2 ft (5245.4)	SHALE	2.2 to 3.7 ft SHALE: Fissile, laminated, gray in color, sandy interbeds, moderately soft (H5) and moderately weathered (W5), becomes hard (H3) and slightly to moderately weathered (W4) at 3.7 feet in depth. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			
3 3.7 ft (5243.9)					

COMMENTS: Surface vegetated with grass and brush. Discontinued excavation due to limit of equipment.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-11

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5194
COORDINATES: N 2,083,364.2 E 2,526,801.8
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X3'X9'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/14/2021
DATE EXCAVATED: 9/14/2021

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, 2, 3	SC	0.0 to 3.8 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
3.8 ft (5190.2)					
4, 5, 6, 7, 8	SHALE	3.8 to 9.0 ft SHALE: Fissile, laminated, gray in color, gypsum veins and iron oxide. It is very soft (H7) and decomposed (W9) from 3.8 to 5.0 ft. It is soft (H6) and intensely weathered from below 5.0 ft. It is moderately soft (H5) and moderately weathered (W5) below 8.0 ft. Recovered as 1-to-3 inch subangular flat fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl). Two quart corrosivity sample at 6.0 ft.			
9.0 ft (5185.0)					
9					

COMMENTS: Surface mostly barren, discontinued excavation due to limit of equipment.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-12

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5166.2
COORDINATES: N 2,082,640.6 E 2,525,369.7
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X10'X11'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/14/2021
DATE EXCAVATED: 9/14/2021

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 2 3 4 5 6 7 8 9	SC (visual) s(CL) (lab class) In-place density test and 50 lb bag sample at 5.5 ft. Two quart corrosivity sample collected at 6.0 ft. 9.0 ft (5157.2)	0.0 to 9.0 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. IN-PLACE DRY UNIT WEIGHT AND MOISTURE FROM 5.5 ft. Total: 118.7 lb/ft³, 8.9 % moisture (80.5 % compaction). LAB TEST DATA: 50.8 % fines, 49.1% sand, LL=22.2 PI=8.9. Maximum dry Unit Weight: 99.2 lb/ft³, optimum water content = 14.0 % Laboratory classification is SANDY LEAN CLAY. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
10 11	SHALE 11.0 ft (5155.2)	9.0 to 11.0 ft SHALE: Fissile, thinly bedded, gypsum veins, dark gray in color, moderately soft (H5) and moderately weathered (W5). GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			

COMMENTS: Surface mostly barren, Discontinued excavation due to limit of equipment.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-13

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5151.6
COORDINATES: N 2,081,881.8 E 2,524,662.9
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X10'X11'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/14/2021
DATE EXCAVATED: 9/14/2021

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 2 3 4 5 6 7 8 9	SC(visual) CL (lab class) In-place density test and 50 lb bag sample at 5.5 ft. 9.5 ft (5142.1)	0.0 to 9.5 ft CLAYEY SAND: About 60% fine sand; about 40% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. IN-PLACE DRY UNIT WEIGHT AND MOISTURE FROM 6.0 ft. Total: 112.1 lb/ft³, 11.4 % moisture (91.0% compaction). LAB TEST DATA: 91.0 % fines, 9.0% sand, LL=42.5 PI=24.9. Maximum dry Unit Weight: 102.0 lb/ft³, optimum water content= 16.0% Laboratory classification is LEAN CLAY. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
10 11	SHALE 11.0 ft (5140.6)	9.5 to 11.0 ft SHALE: Fissile, laminated, gray in color, gypsum veins and iron oxide. It is very soft (H7) and very intensely weathered (W8) recovered as 1-to-3 inch subangular flat fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			

COMMENTS: Surface mostly barren, Discontinued excavation due to limit of equipment.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-14

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5138.8
COORDINATES: N 2,081,116.2 E 2,524,059.8
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X3'X10.0'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/15/2021
DATE EXCAVATED: 9/15/2021

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	SC	0.0 to 2.0 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2.0 ft (5136.8)	SHALE	2.0 to 10.0 ft SHALE: Fissile, laminated, gray in color, gypsum veins, muscovite, iron oxide and two inch clam shaped marine fossils. It is very soft (H7) and decomposed (W9) from 2.0 to 3.0 ft. Becomes soft (H6) and moderately to intensely weathered (W6) from 3.0 to 6.0 ft. Becomes moderately soft (H5) to moderately hard (H4) and moderately weathered (W5) from 6.0 to 10.0 ft. Recovered as 1-to-3 inch subangular flat fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl). Two quart corrosivity sample collected at 7.0 ft.			
10.0 ft (5128.8)					

COMMENTS: Surface mostly barren. Discontinued excavation due to limit of equipment.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-15

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5130
COORDINATES: N 2,080,422.6 E 2,523,504.9
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X3'X10'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/15/2021
DATE EXCAVATED: 9/15/2021

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, 2, 3	SC	0.0 to 3.8 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
3.8 ft (5126.2)					
4, 5, 6, 7, 8, 9	SHALE	3.8 to 10.0 ft SHALE: Fissile, laminated, gray in color, gypsum veins and iron oxide. It is very soft (H7) and very intensely weathered (W8) from 3.8 to 5.0 ft. It is soft (H6) and moderately to intensely weathered (W6) from 5.0 to 8.0 ft. It is moderately soft and moderately weathered (W5) from 8.0 to 10.0 ft. Recovered as 2-to-5 inch subangular flat fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			
10.0 ft (5120.0)					
10					

COMMENTS: Surface mostly barren, Discontinued excavation due to limit of equipment.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-16

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5089.4
COORDINATES: N 2,079,300.7 E 2,521,463.5
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X3'X8'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/15/2021
DATE EXCAVATED: 9/15/2021

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 2 3	SC 3.0 ft (5086.4)	0.0 to 3.0 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
4 5 6 7 8	SHALE 8.0 ft (5081.4)	3.0 to 8.0 ft SHALE: Fissile, thinly bedded, gray in color, sandy interbeds, moderately soft (H5) to moderately hard (H4) and moderately weathered (W5). Recovered as 5-to-10 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl). Two quart corrosivity sample collected at 6.0 ft.			

COMMENTS: Surface mostly barren. Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-17

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5083.7
COORDINATES: N 2,078,384.4 E 2,520,518.5
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X3'X8.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/15/2021
DATE EXCAVATED: 9/15/2021

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, 2, 3, 4	SC	0.0 to 4.9 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
4.9 ft (5078.8)					
5, 6, 7, 8	SHALE	4.9 to 8.5 ft SHALE: Fissile, thinly bedded, gray in color, gypsum veins, iron oxide staining, moderately soft (H5) and moderately weathered (W5). Recovered as 5-to-10 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Lewis Shale (Kl).			
8.5 ft (5075.2)					

COMMENTS: Surface mostly barren, Discontinued excavation due to limit of equipment, backhoe on uneven ground reducing reach of bucket.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-19

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5071.2
COORDINATES: N 2,076,731.1 E 2,517,499.3
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X10'X10.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/15/2021
DATE EXCAVATED: 9/15/2021

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, 2, 3	SP-SM	0.0 to 3.6 ft POORLY GRADED SAND WITH SILT: About 90% fine sand, about 10% nonplastic fines with rapid dilatancy, and no dry strength; trace coarse sand; maximum size, coarse sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
3.6 ft (5067.6)					
4, 5, 6, 7, 8, 9	SC (visual) SM (lab class)	3.6 to 10.0 ft CLAYEY SAND: About 85% fine sand; about 15% fines with low plasticity, low dry strength, and low toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, calcareous, homogeneous, dry. IN-PLACE DRY UNIT WEIGHT AND MOISTURE FROM 6.0 ft. Total: 115.3 lb/ft³, 6.1% moisture (75.5% compaction). LAB TEST DATA: 39.6 % fines, 58.7% sand, 1.7% gravel, LL=NA PI=NP Maximum dry Unit Weight: 87.0 lb/ft³, optimum water content= 13.7% Laboratory classification is SILTY SAND. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal). In-place density test and 50 lb bag sample at 6.0 ft. Two quart corrosivity sample collected at 6.0 ft.			
10.0 ft (5061.2)					
10	10.5 ft (5060.7) CL	10.0 to 10.5 ft LEAN CLAY: About 90% fines with medium plasticity, medium toughness, and medium dry strength; about 10% fine sand; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry, calcite nodules. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			

COMMENTS: Surface mostly barren, Discontinued excavation due to limit of equipment.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-21

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5096.9
COORDINATES: N 2,075,484.8 E 2,516,371.4
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X10'X10'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/15/2021
DATE EXCAVATED: 9/15/2021

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, 2, 3, 4, 5, 6, 7, 8, 9	SC (visual) s(CL) (lab class)	0.0 to 9.5 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, calcite cement below 4.5 feet, dry. IN-PLACE DRY UNIT WEIGHT AND MOISTURE FROM 6.0 ft. Total: 112.9 lb/ft³,5.9 % moisture (80.6% compaction). LAB TEST DATA: 59.8 % fines, 40.2 % sand, LL= 26.3 PI=13.1. Maximum dry Unit Weight: 91.0 lb/ft³, optimum water content= 14.7% Laboratory classification is SANDY LEAN CLAY. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
	In-place density test and 50 lb bag sample at 5.5 ft.				
9.5 ft (5087.4)					
10	SS 10.0 ft (5086.9)	9.5 to 10.0 ft SANDSTONE: fine grained, light brown in color, moderately bedded, soft (H6), intensely weathered (W7), strong reaction with HCl, recovered as 3 to 6 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Menefee Formation (Kmf).			

COMMENTS: Surface mostly barren, Discontinued excavation due to limit of equipment.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-22

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5142.6
COORDINATES: N 2,075,238.1 E 2,515,459.3
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X2'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/15/2021
DATE EXCAVATED: 9/15/2021

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
	SM	0.0 to 2.0 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
1					
2	2.0 ft (5140.6)				
	SS	2.0 to 2.5 ft SANDSTONE: fine grained, light brown in color, moderately bedded, moderately hard (H4) to hard (H3), moderately weathered (W5), strong reaction with HCl, recovered as 3 to 6 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Point Lookout Sandstone (Kpl). Two quart corrosivity sample collected at 2.5 ft.			
	2.5 ft (5140.1)				

COMMENTS: Surface mostly barren, Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-23

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5136.8
COORDINATES: N 2,074,118.9 E 2,513,800
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X10'X7.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/16/2021
DATE EXCAVATED: 9/16/2021

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, 2, 3, 4, 5, 6	SC (visual) (CL)s (lab class) In-place density test and 50 lb bag sample at 5.0 ft. 6.5 ft (5130.3)	0.0 to 6.5 ft CLAYEY SAND: About 60% fine sand; about 40% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, roots in top 2.0 ft, dry. IN-PLACE DRY UNIT WEIGHT AND MOISTURE FROM 5.0 ft. Total: 116.2 lb/ft³, 6.0% moisture (81.2 % compaction). LAB TEST DATA: 81.4 % fines,17.9 % sand, LL=26.0 PI= 9.7 Maximum dry Unit Weight: 94.3 lb/ft³, optimum water content= 14.2 % Laboratory classification is LEAN CLAY WITH SAND. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
7	SHALE 7.5 ft (5129.3)	6.5 to 7.5 ft SHALE: Fissile, laminated, gray in color, sandy interbeds, moderately soft (H5) and moderately weathered (W5), becomes moderately hard (H4) and slightly to moderately weathered (W4) at 7.0 feet in depth, strong reaction with HCl. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km).			

COMMENTS: Surface mostly barren, Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-24

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5168
COORDINATES: N 2,073,541.4 E 2,512,924
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X3.8'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/16/2021
DATE EXCAVATED: 9/16/2021

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	SM	0.0 to 2.0 ft SILTY SAND: About 85% fine sand; about 15% fines with no plasticity, no dry strength and rapid dilatancy; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Brown in color, homogeneous, dry, roots. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2	2.0 ft (5166.0) SHALE	2.0 to 3.8 ft SHALE: Fissile, laminated, gray in color, sandy interbeds, moderately soft (H5) and moderately weathered (W5), becomes moderately hard (H4) and slightly to moderately weathered (W4) at 7.5 feet in depth, strong reaction with HCl. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km).			
3	3.8 ft (5164.2)				

COMMENTS: Surface mostly barren, Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-25

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5159.5
COORDINATES: N 2,073,661.4 E 2,511,965.5
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X3'X5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/16/2021
DATE EXCAVATED: 9/16/2021

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
	SC	0.0 to 0.8 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, roots, dry.			
0.8 ft (5158.7)	SHALE	GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal). 0.8 to 5.0 ft SHALE: Fissile, laminated to thinly bedded, gray in color, sandy interbeds, soft (H6) to moderately soft (H5) and intensely weathered (W7), becomes moderately hard (H4) and moderately weathered (W5) at 4.5 feet in depth, strong reaction with HCl. Recovered as 4-to-8 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km). Two quart corrosivity sample collected at 5.0 ft.			
5.0 ft (5154.5)					

COMMENTS: Surface mostly barren, Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-26

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5165.5
COORDINATES: N 2,073,934.5 E 2,510,897.8
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X6.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/16/2021
DATE EXCAVATED: 9/16/2021

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	SC	0.0 to 1.2 ft CLAYEY SAND: About 80% fine sand; about 20% fines with low plasticity, low dry strength, and low toughness; max size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
1.2 ft (5164.3)	CL	1.2 to 3.5 ft LEAN CLAY: About 90% fines with medium plasticity, medium dry strength, and medium toughness; about 10% fine sand; maximum size fine sand; strong reaction with HCl. IN-PLACE CONDITION: Decomposed Mancos Shale (W9) very soft (H7), fissile, fissured, dark gray in color, carbonaceous, gypsum and calcite veins, iron oxide staining. GEOLOGIC INTERPRETATION: Mancos Shale (Km).			
2 3					
3.5 ft (5162.0)	SHALE	3.5 to 6.5 ft SHALE: Fissile, laminated, gray in color, soft (H6) and moderately to intensely weathered (W6), becomes moderately hard (H4) and moderately weathered (W5) at 6.0 feet in depth, strong reaction with HCl. Recovered as 1-to-6" subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km).			
4 5 6					
6.5 ft (5159.0)					

COMMENTS: Surface mostly barren, Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-27

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5122.7
COORDINATES: N 2,074,464.2 E 2,509,090.6
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X4'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/16/2021
DATE EXCAVATED: 9/16/2021

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
	SC	0.0 to 4.0 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, high dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, strong cementation, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
1					
2					
3					
4	4.0 ft (5118.7)				

COMMENTS: Surface sparsely vegetated with grass and brush. Soil becomes very difficult to excavate below 2.0 feet, due to strong calcite cementation. Cementation possibly related to evaporite minerals from nearby artesian well and pond. Discontinued at 4.0 feet due to difficult excavation.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-28

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5119.7
COORDINATES: N 2,075,273.9 E 2,506,191.8
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X6'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/16/2021
DATE EXCAVATED: 9/16/2021

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	SC	0.0 to 1.8 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
1.8 ft (5117.9)					
2	(CL)s	1.8 to 5.5 ft LEAN CLAY WITH SAND: About 70% fines with medium plasticity, medium toughness, and high dry strength; about 30% fine sand; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Dark brown in color, homogeneous, dry, calcite nodules. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
3					
4					
5					
5.5 ft (5114.2)					
6.0 ft (5113.7)	SHALE	5.5 to 6.0 ft SHALE: Fissile, laminated, gray in color, sandy interbeds, moderately soft (H5) and intensely weathered (W7), strong reaction with HCl. Recovered as 1-to-3 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km). Two quart corrosivity sample collected at 6.0 ft.			
6					

COMMENTS: Surface sparsely vegetated with grass and brush. Discontinued due to difficult excavation in stiff shale.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-29

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5131.6
COORDINATES: N 2,075,549.4 E 2,505,235.5
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X5.3'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/16/2021
DATE EXCAVATED: 9/16/2021

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
	SC	0.0 to 1.0 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
1.0 ft (5130.6)					
1	s(CL)	1.0 to 3.0 ft SANDY LEAN CLAY: About 70% fines with medium plasticity, medium toughness, and high dry strength; about 30% fine sand; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Dark brown in color, homogeneous, dry, calcite nodules. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2					
3.0 ft (5128.6)					
3	SHALE	3.0 to 5.3 ft SHALE: Fissile, laminated to thinly bedded, gray in color, sandy interbeds, soft (H6) and intensely weathered (W7), becomes moderately hard (H4) and moderately weathered (W5) around 5.0 feet in depth, strong reaction with HCl. Recovered as 4-to-8 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km).			
4					
5					
5.3 ft (5126.3)					

COMMENTS: Surface mostly barren, Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-30

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5144.8
COORDINATES: N 2,075,703.5 E 2,504,225.6
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X3'X8.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/16/2021

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, 2, 3, 4, 5	SC	0.0 to 5.3 ft CLAYEY SAND: About 75% fine sand; about 25% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
5.3 ft (5139.5)					
6, 7, 8	SHALE	5.3 to 8.5 ft SHALE: Fissile, laminated to thinly bedded, gray in color, sandy interbeds, soft (H6) and intensely weathered (W7), becomes moderately soft (H5) to moderately hard (H4) and moderately weathered (W5) around 7.0 feet in depth, strong reaction with HCl. Recovered as 3-to-6 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km). Two quart corrosivity sample collected at 7.0 ft.			
8.5 ft (5136.3)					

COMMENTS: Surface mostly barren, Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-31

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5164.3
COORDINATES: N 2,075,774.7 E 2,503,252.2
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X6.0'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/16/2021

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 2 3	SC 3.5 ft (5160.8)	0.0 to 3.5 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal)			
4	SALE 4.5 ft (5159.8)	3.5 to 6.0 ft SHALE: Fissile, laminated, gray in color, sandy interbeds, soft (H6) and intensely weathered (W7), becomes moderately hard (H4) and moderately weathered (W5) around 4.5 feet in depth, strong reaction with HCl. Recovered as 6-to-10 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km).			
5 6					

COMMENTS: Surface mostly barren, Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-32

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5176.9
COORDINATES: N 2,076,027.4 E 2,502,265.8
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X3.5'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/16/2021

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	SC 1.1 ft (5175.8)	0.0 to 1.1 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2 3	SHALE 3.2 ft (5173.7)	1.1 to 3.2 ft SHALE: Fissile, laminated, gray in color, sandy interbeds, moderately soft (H5) and moderately to intensely weathered (W6), strong reaction with HCl. Recovered as 3-to-6 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km).			

COMMENTS: Surface mostly barren, Discontinued excavation due to consistent geology.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-33

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5188.4
COORDINATES: N 2,076,290 E 2,501,312
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X5.2'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/16/2021

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	SC 1.2 ft (5187.2)	0.0 to 1.2 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
2 3 4 5	SHALE 5.2 ft (5183.2)	1.2 to 5.2 ft SHALE: Fissile, laminated, gray in color, sandy interbeds, iron oxide staining, very soft (H7) to moderately soft (H5) and moderately to intensely weathered (W6), strong reaction with HCl. Recovered as 3-to-6 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km).			

COMMENTS: Surface mostly barren, Discontinued excavation due to consistent geology.

BUREAU OF RECLAMATION

7-1336-A (1-86)
Bureau of Reclamation

LOG OF TEST PIT NO. TPR3-21-34

FEATURE: Reach 3 PNM Option
PROJECT: Navajo Gallup Water Supply Project
LOCATION: Pipeline Alignment
GROUND ELEVATION: 5196
COORDINATES: N 2,076,561.7 E 2,500,338.6
METHOD OF EXPLORATION: Case 580 N Backhoe
APPROXIMATE DIMENSIONS: 10'X2'X4.8'
LOGGED BY: C. Beyer
DEPTH TO WATER: WLNE DATE: 9/13/2021
DATE EXCAVATED: 9/16/2021

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	SC	0.0 to 1.8 ft CLAYEY SAND: About 80% fine sand; about 20% fines with medium plasticity, medium dry strength, and medium toughness; maximum size, fine sand; strong reaction with HCl. IN-PLACE CONDITION: Gray in color, homogeneous, dry. GEOLOGIC INTERPRETATION: Quaternary Alluvium (Qal).			
1.8 ft (5194.2)					
2	SHALE	1.8 to 4.8 ft SHALE: Fissile, laminated, gray in color, sandy interbeds, very soft (H7) and very intensely weathered (W8) from 1.8 to 3.5 ft. Moderately hard (H5) and moderately weathered (W5), below 3.5 ft, strong reaction with HCl. Recovered as 6-to-10 inch subangular fragments. GEOLOGIC INTERPRETATION: Cretaceous Mancos Shale (Km).			
3					
4					
4.8 ft (5191.2)					

COMMENTS: Surface mostly barren, Discontinued excavation due to refusal in shale bedrock.

BUREAU OF RECLAMATION

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

PROJECT: Navajo Gallup Water Supply Project **FEATURE: Reach 2**

DHR2-22-9 PNM

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	4.0 – 5.5	SM	16.0	31.4	51.2	1.4	0.0	0.0	N/A	NP	--	--	3.1	2.59	2.69	--	--	--	--
SPT-2	6.5 – 8.0	SM	12.0	37.1	50.9	0.0	0.0	0.0	N/A	NP	--	--	3.2	--	2.66	--	--	--	--
SPT-3	9.0 – 10.5	S(ML)	11.5	49.2	39.3	0.0	0.0	0.0	N/A	NP	--	--	4.4	--	2.68	--	--	--	--
SPT-4	11.5 – 13.0	SM	9.7	39.0	51.3	0.0	0.0	0.0	N/A	NP	--	--	6.1	--	2.63	--	--	--	--
SPT-5	14.0 – 15.5	SM	14.5	29.9	55.6	0.0	0.0	0.0	N/A	NP	--	--	8.3	--	2.69	--	--	--	--

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:** **REACH 2**

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS				
			FINES																	
TEST PIT NUMBER	DEPTH – feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005 mm	0.005 to0.074 mm	SAND #200 (.074mm) to #4 (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 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 - %
TPR2-22-4	6.0	s(CL)	32.4	32.6	32.6	2.4	-	-	29.8	10.9	-	80.7	7.3	2.44	2.67	109.4	16.3	400	73.8	-

** 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: PNM**

DHPNM-21-1

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	4.5 – 6.0	SM	16.6	14.3	69.1	0	0	0	NP	NP	--	--	2.8	--	2.62	--	--	--	--

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: PNM**

DHPNM-21-2

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	4.5 – 6.0	S(CL-ML)	24.3	32.7	43.0	0	0	0	21.6	5.2	--	--	4.5	--	2.68	--	--	--	--
SPT-2	7.0 – 8.5	(CL)s	34.9	36.4	28.7	0	0	0	30.8	11.3	--	--	9.1	--	2.70	--	--	--	--
SPT-3	9.5 – 11.0	CL	50.2	41.6	8.2	0	0	0	43.2	24.6	13.5	--	13.0	--	2.78	--	--	--	--
SPT-4	12.0 – 13.5	CL	49.5	46.7	3.8	0	0	0	42.6	26.1	12.3	--	11.9	--	2.72	--	--	--	--
SPT-5	14.5 – 16.0	CL	39.1	53.3	7.6	0	0	0	33.8	18.1	--	--	8.2	--	2.72	--	--	--	--

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: PNM**

DHPNM-21-3

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	4.0 – 5.5	CL	61.9	30.8	7.3	0	0	0	46.4	18.3	12.5	--	10.7	--	2.76	--	--	--	--
SPT-2	6.5 – 8.0	CL	66.2	31.4	2.4	0	0	0	49.7	28.5	9.0	--	10.2		2.76	--	--	--	--
SPT-3	9.0 – 10.5	CL	66.9	31.2	1.9	0	0	0	48.8	21.4	10.1	--	8.9	--	2.77	--	--	--	--
SPT-4	11.5 – 13.0	CH	67.8	29.9	2.3	0	0	0	50.7	32.8	13.4	--	9.7	--	2.74	--	--	--	--
SPT-5	14.0 – 15.5	CH	69.7	28.7	1.6	0	0	0	55.7	8.9	10.5	--	8.6	--	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 3 (PNM)**

DHPNM-21-4

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	4.5-6.0	CH	70.4	28.6	1.0	0	0	0	51.1	34.0	15.3	-	13.2	-	2.82	-	-	-	-
SPT-2	7.0-8.5	CH	73.4	24.6	2.0	0	0	0	55.6	37.8	14.4	-	13.5	-	2.82	-	-	-	-
SPT-3	9.5-11.0	CH	66.9	28.0	5.1	0	0	0	50.2	31.0	15.1	-	11.5	-	2.85	-	-	-	-
SPT-4	12.0-13.5	CH	70.6	27.7	1.7	0	0	0	54.9	35.5	15.4	-	10.8	-	2.71	-	-	-	-
SPT-5	14.5-16.0	CH	67.5	29.1	3.4	0	0	0	51.8	35.9	15.7	-	10.0	-	2.79	-	-	-	-

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 3 (PNM)**

DHPNM-21-5

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	4.5-6.0	(CL)s	32.6	50.6	16.8	0	0	0	27.1	11.3	-	-	5.9	-	2.61	-	-	-	-
SPT-2	7.0-8.5	CL	44.5	46.8	8.7	0	0	0	29.0	15.2	-	-	8.2	-	2.63	-	-	-	-
SPT-3	9.5-11.0	CL	40.7	47.6	11.7	0	0	0	26.3	10.5	-	-	7.3	-	2.76	-	-	-	-
SPT-4	12.0-13.5	CL	38.0	52.2	9.8	0	0	0	29.1	16.2	-	-	7.8	-	2.71	-	-	-	-
SPT-5	14.5-16.0	(CL)s	35.1	36.9	28.0	0	0	0	25.6	12.6	-	-	14.5	-	2.69	-	-	-	-
SPT-6	19.5-21.0	(CL)s	35.4	46.2	18.4	0	0	0	26.2	12.6	-	-	5.3	-	2.68	-	-	-	-

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 3 (PNM)**

DHPNM-21-9

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	4.5-6.0	(CL)s	32.5	42.2	25.3	0	0	0	29.4	13.8	-	-	6.1	-	2.79	-	-	-	-

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 3 (PNM)**

DHPNM-21-10

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	4.5-6.0	CL	64.2	32.1	3.7	0	0	0	47.7	26.8	15.9	-	9.8	-	2.74	-	-	-	-

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 3 (PNM)**

DHPNM-21-11

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	4.5-6.0	$_S$(CL)	36.8	25.3	30.6	7.3	0	0	31.3	15.2	-	-	6.6	2.60	2.79	-	-	-	-
SPT-2	7.0-8.5	(CL)$_S$	50.2	31.3	18.5	0	0	0	38.7	21.3	14.9	-	8.6	-	2.81	-	-	-	-

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 3 (PNM)**

DHPNM-21-12

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
			FINES																
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005mm	0.005 to 0.074mm	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 - %
SPT-1	9.5 - 11.0	CL	66.2	31.6	2.2	0	0	0	49.2	27.8	15.3	-	32.5	-	2.70	-	-	-	-
SPT-2	12.0 - 13.5	CL	63.5	25.4	11.1	0	0	0	45.6	27.0	14.2	-	15.0	-	2.76	-	-	-	-
SPT-3	16.5 - 18.0	(CL)s	54.4	27.2	18.4	0	0	0	38.4	19.8	14.2	-	13.1	-	2.70	-	-	-	-

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:** **REACH 3**

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS				
			FINES																	
TEST PIT NUMBER	DEPTH – feet	CLASSIFICATION SYMBOL	SMALLER THAN 0.005 mm	0.005 to0.074 mm	SAND #200 (.074mm) to #4 (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 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 - %
*TPR3-21-2	5.0	SC	22.5	19.1	58.4	0	0	0	31.3	8.6	-	91.3	6.3	-	2.62	113.4	14.0	700	80.5	-
*TPR3-21-12	5.5	s(CL)	28.4	22.4	49.1	0.1	0	0	22.2	8.9	-	99.2	6.8	2.46	2.73	118.7	14.0	370	83.6	-
*TPR3-21-13	6.0	CL	57.8	33.2	9.0	0	0	0	42.5	24.9	9.6	102.0	11.4	-	2.72	112.1	16.0	500	91.0	-
*TPR3-21-19	6.0	SM	21.0	18.6	58.7	1.7	0	0	NA	NP	-	87.0	6.1	2.45	2.62	115.3	13.7	600	75.5	-
*TPR3-21-21	6.0	s(CL)	34.1	25.7	40.2	0	0	0	26.3	13.1	-	91.0	5.9	-	2.59	112.9	14.7	450	80.6	-
*TPR3-21-23	5.0	(CL)s	30.5	50.9	17.9	0.7	0	0	26.0	9.7	-	94.3	6.0	2.48	2.76	116.2	14.2	813	81.2	-
TPR3-21-6 (Bag Sample)	2.4	CH	72.0	24.9	3.1	0	0	0	53.5	34.1	10.8	-	10.3	-	2.71	-	-	-	-	-

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