2R - 25

GENERAL CORRESPONDENCE

YEAR(S):

TELEPHONE
(505) 748-3311

EASYLINK
62905278

REFINING COMPANY

501 EAST MAIN STREET • P. O. BOX 159
ARTESIA, NEW MEXICO 88211-0159

FAX
(505) 746-6410 ACCTG
(505) 746-6155 EXEC
(505) 748-9077 ENGR
(505) 746-4438 P / L

July 8, 1997

Mr. Roger Anderson
Oil Conservation Division
2040 S. Pacheco
Santa Fe, NM 87505

Dear Mr. Anderson:

As you are aware, Navajo Refining Company is in the process of cleaning up a crude oil leak from our gathering system in Section 29, Township 18S, Range 28E (Figure 1 & Figure 2). This leak is on the edge of an area that may occasionally collect excess rain water from a very small part of the surrounding land.

It is our opinion that the area in question does not warrant the protection afforded the "waters of the State" as defined in the **Standards for Interstate and Intrastate Streams,** effective January 23, 1995, because the contour of the surrounding land is very close to being flat with a slope of less than 50' per mile in all directions of the site (Figure 1 & Figure 3); The shallowness of the area in question also contributes to a high evaporation rate at the site. Any water that may occasionally accumulate would be very transitory and appears to do little more than supply ample moisture to the native grass and mesquite growing in the area. We understand that mesquites will not grow in standing water, therefore, the stand of mesquites in the area in question indicates the absence of standing water on a sustained basis.

Please rest assured that Navajo Refining Company is aware of the need to protect our surface and groundwater and accepts that responsibility. However, we feel that this end may be accomplished without deeming this area as a "water of the State" and allowing clean up of this site under the **"Guidelines for Remediation of Leaks, Spills and Releases"** *New Mexico Oil Conservation Division* - August 13, 1993 using the 5,000 ppm THP level for the soil cleanup. The nearest depth to groundwater is in excess of 100' from the bottom of the excavation. This fact is verified by the driller's log attached as Exhibit A. Also any water that may accumulate in this area is more likely to evaporate rather than travel to groundwater due to the low permeability of the

soil (Exhibit B). The distance to the nearest water source on record with the New Mexico State Engineer's Office is excess of one (1) mile from the site. In Addition, the distance to the nearest perennial or intermittent stream or lake body of water is in excess of one (1) mile for the site according to the **USGS Artesia, Quadrangle New Mexico 1:100,000 Scale Series 1978** topographic map.

Assuming your concurrence with our assessment, we will proceed and file a work plan which will adequately protect any waters, surface or ground, that may be in the area. Thank you for your consideration in this matter. If I may be of further service, please contact me.

Sincerely,

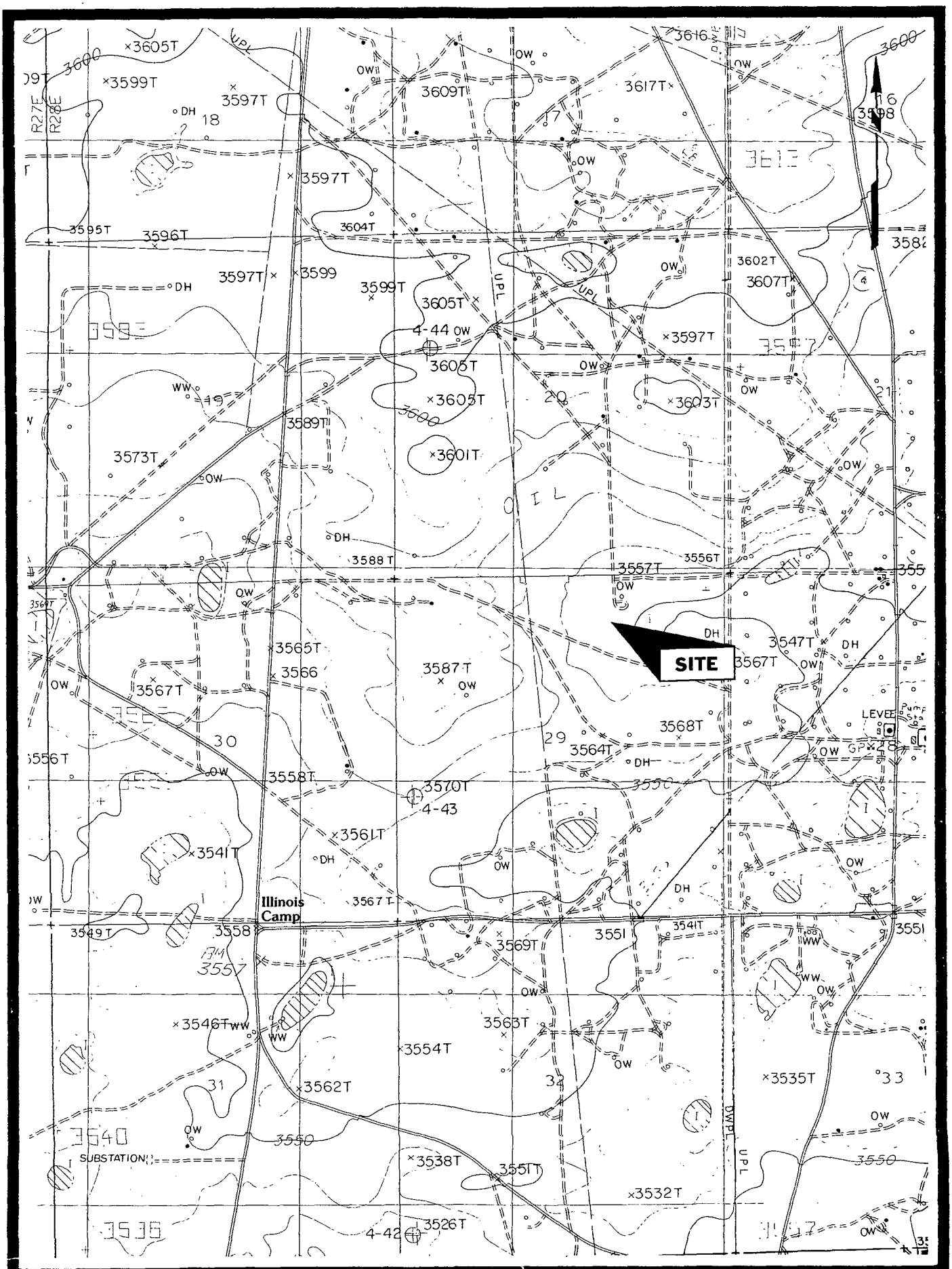
Darrell Moore
Environmental Manager for
Water and Waste

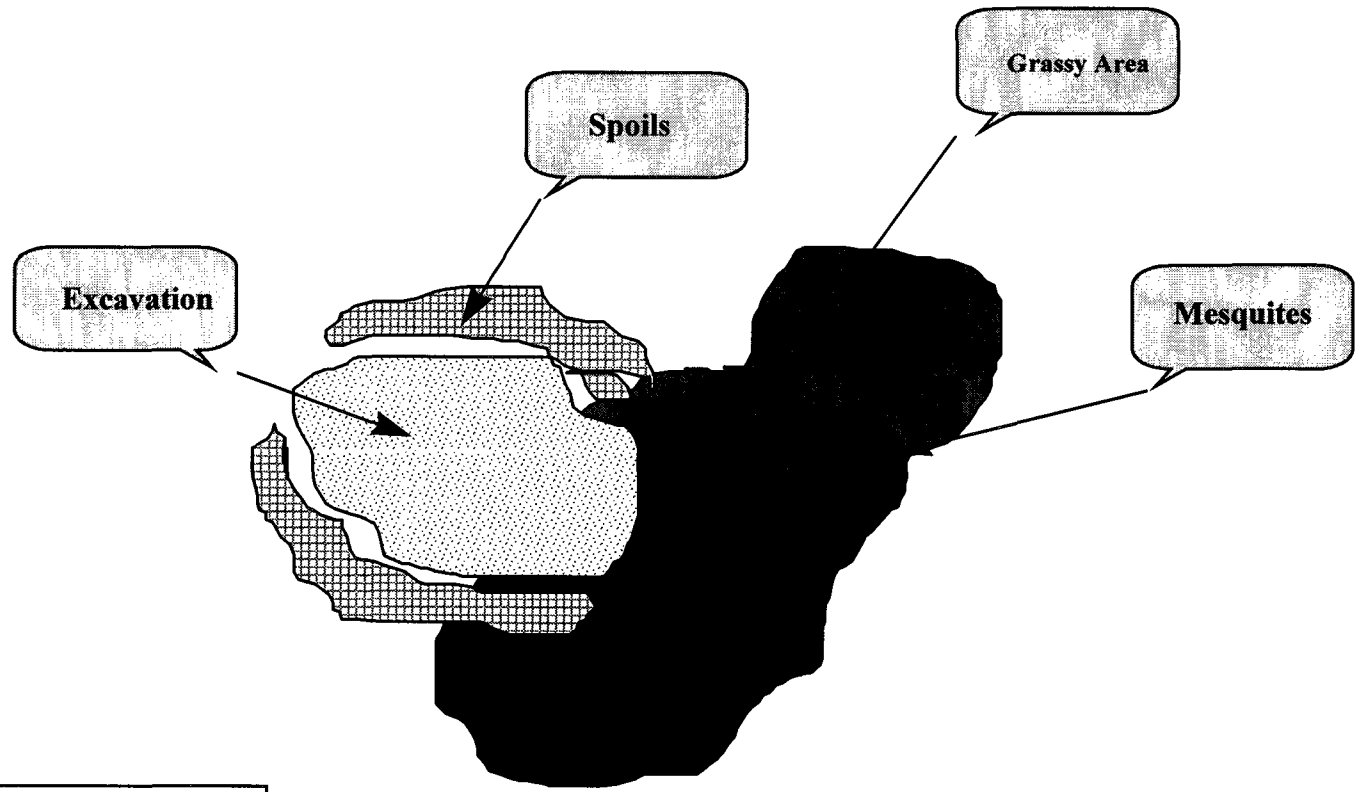
Enclosures

ncl

Navajo Refining Company

Figure 1 - Location of Artesia Station

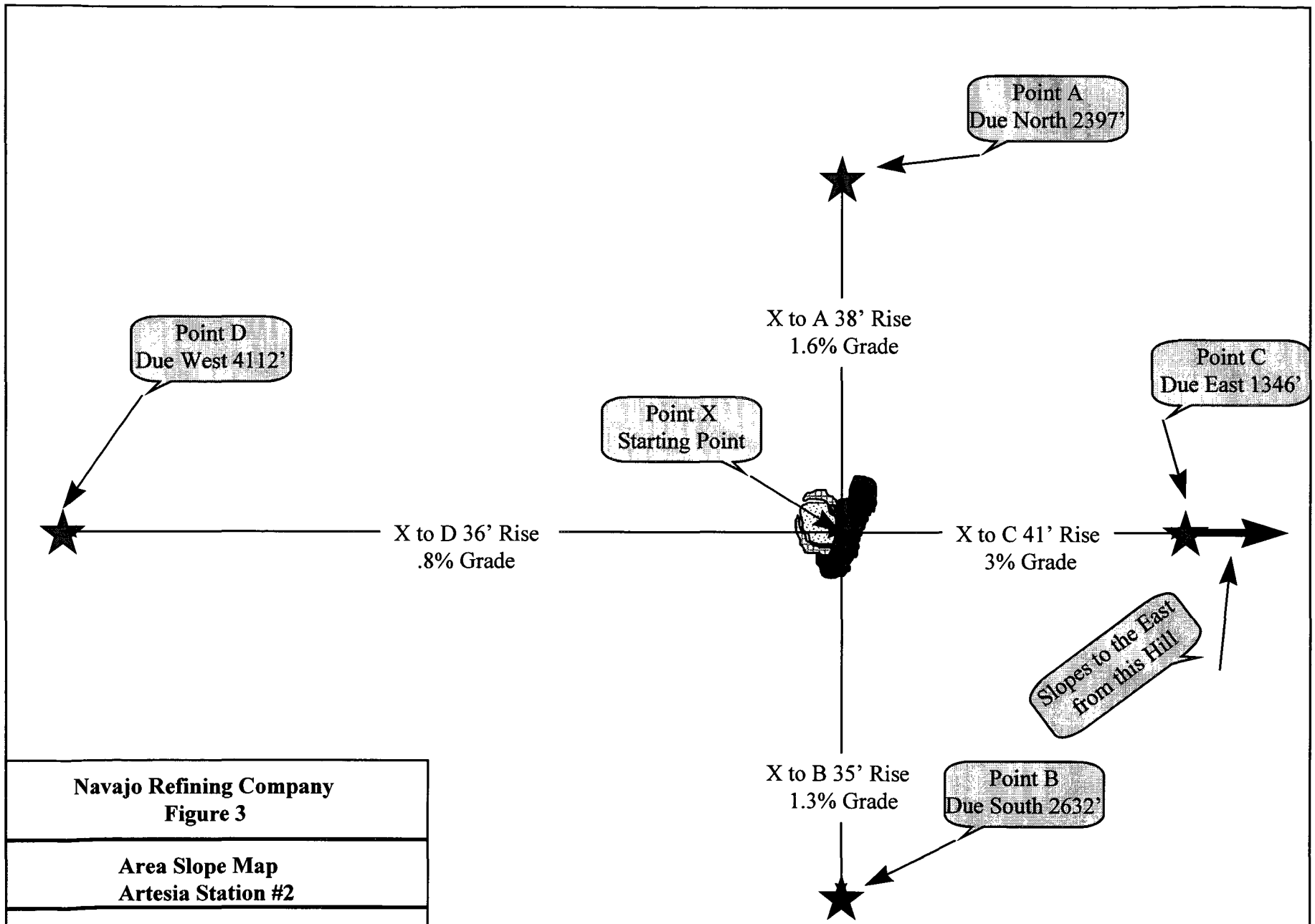




Navajo Refining Company
Figure 2

Site Map
Artesia Station #2

Safety & Environmental Solutions, Inc.



Navajo Refining Company
Figure 3

Area Slope Map
Artesia Station #2

Safety & Environmental Solutions, Inc.

Exhibit A
Boring Log

BORING LOG

ATKINS ENGINEERING ASSOCIATES, INC

2904 West Second Street, Roswell, New Mexico 88202-3156

PROJECT NAME: Navajo Refining - Safety Environmental Solutions, Inc.
Job #97202

PAGE 1 OF 4

DATE: 5-29-97

DRILL START: 9:55 A.M.
DRILL STOP: 1:00 P.M.

SITE LOCATION: 15 Miles East of Artesia

BORING LOCATION: Artesia Station Discharge
5 Miles South of Hwy

TH NUMBER: 2	AUGER TYPE: Hollow Stem	CASING ELEVATION: N/A
	DRILLED BY: ATKINS ENGINEERING ASSOCIATES, INC.	LOGGED BY: Mort Bates

Depth (Feet)	SAMPLE	Symbol	STRATUM DESCRIPTION	Well Construction Details	PID Reading	Lab Analysis	Lab Analysis	
			Silty Sandy Clay, Brown, has been escavated off. Started drilling at 2 ft.					
			Caliche w/Clay, Light Tan, Firm, Dry					
5			Clayey Sand w/Caliche Gravel, Tan Firm, Damp					
10								
15								
20								
25								
30								

BORING LOG

ATKINS ENGINEERING ASSOCIATES, INC

2904 West Second Street, Roswell, New Mexico 88202-3156

PROJECT NAME: Navajo Refining - Safety Environmental Solutions, Inc.
Job #97202

PAGE 2 OF 4

DATE: 5-29-97

DRILL START: 9:55 A.M.

DRILL STOP: 1:00 P.M.

SITE LOCATION: 15 Miles East of Artesia

BORING LOCATION: Artesia Station Discharge
5 Miles South of Hwy

TH NUMBER: 2	AUGER TYPE: Hollow Stem	CASING ELEVATION: N/A
	DRILLED BY: ATKINS ENGINEERING ASSOCIATES, INC.	LOGGED BY: Mort Bates

Depth (Feet)	SAMPLE	Symbol	STRATUM	DESCRIPTION	Well Construction Details	PID Reading	Lab Analysis	Lab Analysis
				Clayey Sand w/Caliche Gravel, Firm, Damp to Dry				
35								
40								
45								
50								
55								
60								

BORING LOG

ATKINS ENGINEERING ASSOCIATES, INC

2904 West Second Street, Roswell, New Mexico 88202-3156

PROJECT NAME: Navajo Refining - Safety Environmental Solutions, Inc.
Job #97202

PAGE 3 OF 4

DATE: 5-29-97

DRILL START: 9:55 A.M.

DRILL STOP: 1:00 P.M.

SITE LOCATION: 15 Miles East of Artesia

BORING LOCATION: Artesia Station Discharge
5 Miles South of Hwy

TH NUMBER: 2

AUGER TYPE: Hollow Stem

CASING ELEVATION: N/A

DRILLED BY: ATKINS ENGINEERING ASSOCIATES, INC.

LOGGED BY: Mort Bates

Depth (Feet)	SAMPLE	Symbol	STRATUM DESCRIPTION	Well Construction Details	PID Reading	Lab Analysis	Lab Analysis
65			Clayey Sand w/Caliche Gravel, Tan, Firm, Dry to Damp				
70							
75							
80							
85			Sandy Clay w/Sandstone, Red, Firm, Dry				
90							

BORING LOG

ATKINS ENGINEERING ASSOCIATES, INC

2904 West Second Street, Roswell, New Mexico 88202-3156

PROJECT NAME: Navajo Refining - Safety Environmental Solutions, Inc.
Job #97202

DATE: 5-29-97

DRILL START: 9:55 A.M.

DRILL STOP: 1:00 P.M.

SITE LOCATION: 15 Miles East of Artesia

BORING LOCATION: Artesia Station Discharge
5 Miles South of Hwy

TH NUMBER: 2

AUGER TYPE: Hollow Stem

CASING ELEVATION: 3609.44

DRILLED BY: ATKINS ENGINEERING ASSOCIATES, INC.

LOGGED BY: Mort Bates

Depth (Feet)	SAMPLE	Symbol	STRATUM DESCRIPTION	Well Construction Details	PID Reading	Lab Analysis	Lab Analysis
95			Sandy Clay w/Sandstone, Red, Firm, Dry				
100			Sandy Clay w/Sandstone, Red, Firm, Damp				
			Sandy Clay w/Gravel, Red, Hard, Damp				
105			Sandy Clay w/Sandstone, Red, Firm, Damp				
110							
115			Placed a 6 ft. bentonite plug at bottom of test hole, backfilled with cuttings to 4 ft. below land surface. Placed a 4 ft. grout plug to land surface.				
120			TD = 120 ft.				

Exhibit B
Soil Permeability Data

Kermit soils are used for native pasture and wildlife habitat. They are productive if there is enough moisture. Revegetation is difficult once the plant cover is lost, because rainfall is undependable. Surface water is lacking. These soils are difficult to cross by ordinary means.

Typical profile of Kermit fine sand, near the center of sec. 1, T. 21 S., R. 29 E.

A1—0 to 7 inches, yellowish-red (5YR 5/6) fine sand, reddish brown (5YR 4/4) when moist; single grain; loose when dry and moist, nonsticky when wet; noncalcareous; neutral; clear, smooth boundary.

C—7 to 60 inches, yellowish-red (5YR 5/6) fine sand, reddish brown (5YR 4/4) when moist; single grain; loose when dry and moist, nonsticky when wet; noncalcareous; neutral.

The A1 horizon ranges from 1 to 8 inches in thickness. Its color ranges from 10YR to 5YR in hue, from 5 to 6 in value, and from 3 to 6 in chroma. The C horizon ranges from 3 to more than 5 feet in thickness. Its color is slightly lighter than that of the surface layer.

Kermit soils are associated with Berino soils.

Kermit-Berino fine sands, 0 to 3 percent slopes (KM).—The Kermit and Berino soils of this complex have the profile described as typical of their respective series. Kermit fine sand makes up about 40 to 60 percent of the acreage, and Berino fine sand, 30 to 40 percent. Included in mapping were areas of Active dune land and Dune land. These areas make up less than 20 percent of the acreage.

All of the acreage is used for native pasture and wildlife habitat. The soils are productive if there is enough moisture. They are highly susceptible to wind erosion, and good management is needed to maintain a cover of vegetation. (Dryland capability unit VIIe–3; Kermit soil is in Sand Hills range site; Berino soil is in Deep Sand range site)

Kimbrough Series

The Kimbrough series consists of moderately dark colored, well-drained, noncalcareous to weakly calcareous soils that are shallow or very shallow over fractured, platy, indurated caliche. These soils occur on the High Plains, in the northeastern part of the survey Area. They are nearly level to gently sloping.

Soils of the Kimbrough series typically have a surface layer of dark grayish-brown to dark-brown loam about 7 inches thick. The next layer, about 2 inches thick, consists of brown loam enriched with calcium carbonate. Fractured, platy, indurated caliche begins at a depth below about 9 inches.

These soils are uneroded or only slightly eroded. Permeability is moderate, and the water-holding capacity is very low. Runoff is slow. The organic-matter content is moderate. Rainfall amounts to 10 to 16 inches annually, and the mean annual temperature is 60° to 64° F. The frost-free season is 195 to 210 days. Elevations range from 4,200 to 4,500 feet.

Kimbrough soils are fertile. They are used for native pasture and wildlife habitat. The vegetation is mainly black grama, blue grama, side-oats grama, tobosa, broom snakeweed, and mesquite. Oilfields have been extensively developed in these areas.

Typical profile of Kimbrough loam, 60 feet south and 40 feet west of the quarter corner between sections 13 and 24, in sec. 24, T. 16 S., R. 31 E.

A11—0 to 3 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, thin, platy structure to moderate, fine, subangular blocky; hard when dry, friable when moist, slightly plastic when wet; noncalcareous; mildly alkaline; abrupt, smooth boundary.

A12—3 to 7 inches, dark-brown (7.5YR 4/3) loam, dark brown (7.5YR 3/2) when moist; weak, medium to fine, subangular blocky structure; very hard when dry, friable when moist, sticky and slightly plastic when wet; slightly calcareous; mildly alkaline; abrupt, smooth boundary.

C1ca—7 to 9 inches, brown (7.5YR 5/3) loam, dark brown (7.5YR 3/3) when moist; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; mildly alkaline; abrupt, smooth boundary.

C2cam—9 inches, white, fractured, platy, indurated caliche.

The combined thickness of the A11 and A12 horizons ranges from 2 to 10 inches. The color ranges from 10YR to 7.5YR in hue, from 4 to 5 in value, and from 2 to 3 in chroma. The C2ca horizon does not occur in all profiles. If it is present, it is as much as 5 inches thick. Its color is lighter in value and higher in chroma than that of the A11 horizon. The depth to fractured, layered, indurated caliche ranges from 2 to 15 inches. Large fragments of indurated caliche occur in some profiles.

Kimbrough soils are associated with Stegall and Potter soils.

Kimbrough loam, 0 to 3 percent slopes (KO).—This soil has the profile described as typical of the Kimbrough series. It occurs on uplands in the northeastern part of the Area. Included in mapping were areas of Stegall clay loam, 0 to 1 percent slopes, and small playas. The included soils make up less than 15 percent of the acreage.

Permeability is moderate, and the water-holding capacity is very low. Runoff is slow.

This soil is fertile, but it is droughty and its usefulness is limited by shallowness over caliche. It is used for native pasture. (Dryland capability unit VIIs–1; Shallow range site)

Kimbrough-Stegall complex, 0 to 3 percent slopes (KS).—The Kimbrough and Stegall soils of this complex have the profile described as typical of their respective series. Kimbrough loam makes up 75 to 85 percent of the acreage, and Stegall clay loam, 15 to 25 percent. Small playas, or sinkholes, dot the area. In most places there are about two sinkholes in each section. Included in mapping were areas of moderately deep loams and deep clay loams in swales and sinkholes. The included areas make up less than 15 percent of the acreage.

The Kimbrough soil occupies the higher part of the landscape. It is less productive than the Stegall soil.

The Stegall soil occurs in swales and depressions. It is subject to periodic flooding and is easily eroded by water if the vegetative cover is seriously depleted. Reestablishment of desirable forage species is difficult, because temperatures are high and rainfall is undependable.

This complex is used for native pasture and wildlife habitat. The sinkholes fill up with water after heavy rains and are a source of stock water for brief periods. (Kimbrough soil is in dryland capability unit VIIs–1 and Shallow range site; Stegall soil is in dryland capability unit VIs–4 and Clayey range site)

Kimbrough-Stegall loams, 0 to 3 percent slopes (KT).—The Kimbrough soil of this complex has the profile described as typical of the series. Kimbrough loam makes up about 60 to 80 percent of the acreage, and Stegall loam, 15 to 35 percent. Small playas, or sinkholes, dot the area. In most places there are about two sinkholes in each section. Included in mapping were areas of moderately deep loams and deep silty clay loams and areas of Simona soils. The included soils make up less than 10 percent of the acreage.

The Kimbrough soil occupies the higher part of the landscape. It is less productive than the Stegall soil.

The Stegall soil occurs in swales and depressions. It has a surface layer of brown to dark-brown loam about 5 inches thick. The subsoil is about 23 inches thick. The upper part is dark-brown to brown clay loam, and the lower part is reddish-brown sandy clay loam that is enriched by calcium carbonate. The underlying caliche is fractured, platy, and indurated.

The Stegall soil is subject to periodic flooding. It is easily eroded by water if the vegetative cover is seriously depleted. Reestablishment of desirable forage species is difficult because temperatures are high and rainfall is undependable.

This complex is used for native pasture and wildlife habitat. The sinkholes fill up with water after heavy rains and are a source of stock water for brief periods. (Kimbrough soil is in dryland capability unit VIIs–1 and Shallow range site; Stegall soil is in dryland capability unit VIs–4 and Bottomland range site)

Largo Series

The Largo series consists of deep, reddish-brown, calcareous, gently sloping soils that developed in alluvium derived from upland sedimentary material. These soils occur on alluvial fans. They are scattered throughout the eastern part of the Area.

Soils of the Largo series typically are reddish brown to a depth of more than 60 inches. The uppermost part is loam about 4 inches thick, the middle part is silt loam to a depth of about 47 inches, and the lower part is loam.

These soils have been slightly eroded by water. Deep, V-shaped gullies are common in the drainageways. Permeability is moderate, and the water-holding capacity is high. Runoff is medium. The organic-matter content is low, and fertility is moderate. Rainfall amounts to 10 to 14 inches annually, and the mean annual temperature is 60° to 64° F. The frost-free season is 200 to 217 days. Elevations range from 3,000 to 4,200 feet.

Largo soils are used for native pasture and wildlife habitat. The vegetation consists of black grama, blue grama, side-oats grama, tobosa, vine-mesquite, and creosotebush.

Typical profile of Largo loam, 1,730 feet north and 75 feet west of the SE. corner of sec. 29, T. 16 S., R. 28 E.

A1—0 to 4 inches, reddish-brown (5YR 5/3) loam, dark reddish brown (5YR 3/3) when moist; weak, medium, platy structure in the uppermost 1 inch grading to weak, medium and fine, subangular blocky; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine pores; plentiful fine and medium roots; common faint seams of lime and few soft concretions; strongly calcareous; mildly alkaline; abrupt boundary.

AC—4 to 20 inches, reddish-brown (5YR 5/3) silt loam, reddish brown (5YR 4/3) when moist; weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky; slightly hard when dry, friable when moist, sticky and plastic when wet; many fine and medium pores; many very fine and fine roots; common faint seams of lime and few soft concretions; few limestone pebbles; strongly calcareous; mildly alkaline; gradual boundary.

C1—20 to 47 inches, reddish-brown (5YR 5/4) silt loam, reddish brown (5YR 4/4) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many fine and medium pores; few very fine roots; strongly calcareous; mildly alkaline; abrupt, wavy boundary.

HC2—47 to 65 inches +, reddish-brown (5YR 5/4) loam, reddish brown (5YR 4/4) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; about 5 percent gravel; strongly calcareous; mildly alkaline.

The thickness of the A1 horizon ranges from 3 to 6 inches. The color ranges from 5YR to 7.5YR in hue, from 5 to 6 in value, and from 3 to 6 in chroma. The texture includes very fine sandy loam, loam, and silt loam. The thickness of the AC horizon ranges from 4 to 20 inches. In places the color is higher in value and chroma than that of the A1 horizon. The texture ranges from very fine sandy loam to silt loam. The color of the C horizon ranges from 5YR to 2.5YR in hue, from 5 to 7 in value, and from 3 to 6 in chroma. The texture ranges from silt loam to loam and silty clay loam. This horizon contains thin strata of fine sandy loam and sandy clay loam, mixed with coarse fragments of caliche, sandstone, limestone, shale, and siltstone. In some profiles, gravel is scattered throughout and makes up about 5 percent of the soil mass.

Largo soils are associated with Stony land.

Largo loam, 1 to 5 percent slopes (LA).—This soil has the profile described as typical of the series. It occurs on upland alluvial fans in the eastern part of the Area. Included in mapping were areas of Largo silt loam, overflow, 0 to 1 percent slopes, and areas of Pajarito soils. The included areas make up less than 15 percent of the acreage.

This soil is slightly eroded. It is subject to water erosion if the vegetative cover is depleted, and good management is needed. In most of the drainageways, a large V-shaped gully occurs midway in the channel.

This soil is used for native pasture and wildlife habitat. It is fertile, and there are no root restrictions. (Dryland capability unit VIe–1; Loamy range site)

Largo silt loam, overflow, 0 to 1 percent slopes (LG).—This soil occurs on bottom lands throughout the central part of the Area. The surface layer consists of reddish-brown silt loam about 6 inches thick. The next layer, which extends to a depth of more than 60 inches, is stratified reddish-brown silt loam and silty clay loam. Included in mapping were areas of Largo loam, 1 to 5 percent slopes, and of Pajarito soils. The included areas make up less than 15 percent of the acreage.

This soil is subject to water erosion if the vegetative cover is depleted. Permeability is moderately slow below the surface layer.

This soil is used for native pasture and wildlife habitat. It is fertile, and there are no root restrictions. (Dryland capability unit VIe–1; Bottomland range site)

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Degree of limitation for disposal fields for septic tanks and tile systems	Highway location	Dikes and levees
	Topsoil	Road fill			
Gypsum land: GA, GC, GR, Gs. (For Cottonwood part of GC and Gs, see Cottonwood series; for Reeves part of GR, see Reeves series.)	Poor: little or no soil.	Poor: gypsiferous material.	Severe: crevieed material that may allow pollution of water supply.	Gypsiferous material; little or no soil.	Not applicable
Harkey: Ha, Hk	Fair to good if fertilized.	Poor to fair	Slight to moderate: moderate permeability.	Features favorable	Features favorable
Karro: KA, KL, Kr, Ku, Kv.	Fair in uppermost 10 inches if fertilized.	Fair	Slight to moderate: moderate permeability.	Features favorable	Features favorable
Kermit: KM (For Berino part of KM, see Berino series.)	Poor: drifting sand.	Good if soil binder is added.	Slight: drifting sand.	Loose sand hinders hauling; drifting sand; embankments highly erodible when exposed.	Not applicable
Kimbrough: KO, KS, KT. (For Stegall part of KS and KT, see Stegall series.)	Fair in uppermost 9 inches.	Poor: surface is good, but hard caliche occurs below a depth of 9 inches.	Severe: fractured caliche at a depth below 9 inches; danger of pollution.	Hard caliche at a depth of 9 inches.	Hard caliche at a depth of 9 inches.
Largo: LA, LG, LN (For Stony land part of LN, see Stony land.)	Poor to fair: moderately slow intake rate; erodible.	Poor	Severe: the overflow phase is subject to flooding; moderate permeability.	Overflow phase is subject to periodic flooding; exposed embankments are highly erodible.	Unstable; level grade necessary.
Likes: LS	Poor: sandy	Very good	Slight: gently sloping.	Loose sand hinders hauling; embankments are highly erodible.	Unstable; sandy material; level grade and soil binder are necessary.
Limestone rock land: LT.	Poor: rock outcrops.	Unsuitable	Not applicable	Limestone bedrock at or near the surface; slopes are more than 25 percent.	Not applicable
Mobeetie: MO	Poor: erodible	Fair	Slight: gently sloping.	Exposed embankments are highly erodible.	Unstable; subject to piping; level grade and protective soil binder are necessary.
Pajarito: PA, PD (For Dune land part of PD, see Dune land.)	Poor: sandy	Good to a depth of 3 feet; fair below 3 feet.	Slight: moderately rapid permeability.	Loose sand hinders hauling; drifting sand; exposed embankments are highly erodible.	Unstable; sandy material; level grade and protective soil binder are necessary.

See footnote at end of table.

interpretations—Continued

Farm ponds and embankments	Irrigation	Leveling and benching	Foundations for low buildings [1]	Pipelines	Hydrologic group
Not applicable	Not applicable	Not applicable	Poor shear strength and bearing capacity.	Special treatment needed for gypsum salts; varying hardness of gypsiferous rocks.	C
Features favorable	If cultivated, the sandy loam type is susceptible to wind erosion.	If cultivated, the sandy loam type is susceptible to wind erosion.	Fair bearing capacity and shear strength.	Features favorable	B
Features favorable	Susceptible to crusting; high lime content.	Features favorable	Moderate bearing capacity.	Special treatment needed for gypsum salts generally below a depth of 3 feet.	B
Not applicable	Not applicable	Not applicable	Good suitability if soil is confined.	Subject to blowouts	A
Not applicable	Not applicable	Not applicable	Good suitability; hard caliche at a depth of 9 inches.	Hard caliche at a depth of 9 inches.	D
Unstable; good for core material.	Susceptible to water erosion.	Overflow phase is susceptible to periodic flooding.	Fair to poor bearing capacity and shear strength; low to high shrink-swell potential; overflow phase is susceptible to periodic flooding.	Features favorable	C
Not applicable	Rapid intake rate; sprinkler system needed; susceptible to wind erosion.	Susceptible to wind erosion.	Good suitability if confined.	Features favorable	A
Not applicable	Not applicable	Not applicable	Good suitability; blasting required for excavations.	Limestone bedrock at or near the surface; steep.	D
Moderately pervious; susceptible to piping.	Rapid intake rate; sprinkler system needed; susceptible to wind erosion.	Not applicable	Features favorable	Features favorable	B
Not applicable	Rapid intake rate; sprinkler system needed; dune topography; susceptible to wind erosion.	Very sandy; susceptible to soil blowing.	Good suitability if confined.	Features favorable	A

TABLE 4.—*Estimated properties and characteristics*

[Properties are not estimated for Dune land, Limestone rock land, Rock land, Stony and Rough broken land, and Stony land, because the soil material is too variable for reliable evaluation]

Soil series and map symbols	Depth to bedrock, hard caliche, or gypsum	Depth from surface	Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Electrical conductivity (Ec × 10³)	Corrosivity (Untreated steel pipe)	Shrink-swell potential
			USDA texture	Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)						
	Inches	*Inches*							*Inches per hour*	*Inches per inch of soil*	*pH*	*Mmho./cm. at 25° C.*		
Active dune land: AD	More than 60.	0–60	Fine sand	SP	A–3	100	100	0–5	>10. 0	0. 06–0. 08	6. 6–7. 3	0–1. 0	Low	Low.
Anthony: AE, Aa, Ah	More than 60.	0–60	Stratified sandy loam and loamy sand.	SM	A–1 or A–2	100	100	15–25	2. 5–5. 0	0. 10–0. 12	7. 4–7. 8	0–1. 0	Low	Low.
Arno: AH, Ak, An (For Harkey part of AH and Ak, see Harkey series.)	More than 60.	0–14 14–60	Silty clay loam Silty clay	CL CH	A–6 A–7	100 100	100 100	90–95 90–95	0. 05–0. 20 0. 05–0. 20	0. 18–0. 20 0. 15–0. 17	7. 9–8. 4 7. 9–8. 4	4. 0–8. 0 8. 0–12. 0	High High	Moderate. High.
Atoka: Ao, At	20 to 36.	0–8 8–33 33	Loam Loam and light clay loam Hard, fractured caliche.	ML CL	A–4 A–6	100 100	100 100	60–75 70–80	0. 8–2. 5 0. 8–2. 5	0. 16–0. 18 0. 17–0. 19	7. 4–7. 8 7. 4–7. 8	0–2. 0 0–2. 0	Moderate Moderate	Low to moderate. Moderate.
Berino: BA, BB, BD, BP (For Pajarito part of BP, see Pajarito series; the Dune land part of BD is too variable for reliable evaluation.)	More than 60.	0–17 17–50	Loamy fine sand and fine sand Sandy clay loam	SM SC	A–2 A–6	100 100	100 100	10–20 35–45	5. 0–10. 0 0. 2–0. 8	0. 06–0. 08 0. 14–0. 16	6. 6–7. 3 6. 6–7. 3	0–1. 0 0–4. 0	Low Moderate	Low. Moderate.
Bippus	More than 60.	0–48 48	Silty clay loam and clay loam Weakly cemented caliche.	CL	A–6	100	100	85–95	0. 2–0. 8	0. 18–0. 20	7. 4–8. 4	0–4. 0	Moderate	Moderate.
Cacique: CA	12 to 36.	0–17 17–24 24	Loamy sand and sandy loam Sandy clay loam Indurated, fractured caliche.	SM SC	A–2 A–6	100 100	100 100	20–35 35–50	5. 0–10. 0 0. 8–2. 5	0. 10–0. 12 0. 14–0. 16	6. 6–7. 3 6. 6–7. 3	0–1. 0 0–4. 0	Low Moderate	Low. Moderate.
Cottonwood: CR (For Reeves part of CR, see Reeves series.)	Soft to hard gypsum below a depth of 9 inches.	0–9 9	Loam Gypsum.	ML–CL	A–4	100	100	60–75	0. 8–2. 5	0. 16–0. 18	6. 6–7. 8	8. 0–15. 0	High	Low to moderate.
Dev: DP (For Pima part of DP, see Pima series.)	More than 60.	0–15 15–60	Gravelly loam Very gravelly loam	GM GP	A–1 or A–2 A–1	35–75 15–45	30–70 10–40	15–20 5–10	0. 8–2. 5 >10. 0	0. 11–0. 13 0. 06–0. 08	7. 4–7. 8	0–2. 0 0–1. 0	Moderate Low	Low. Low.
Ector: EC, Ef, ER (For Reagan part of ER, see Reagan series.)	1 to 18.	0–6 6	Stony loam Limestone bedrock.	SM–ML	A–4	55–85	50–80	40–60	0. 8–2. 5	0. 11–0. 13	7. 4–7. 8	0–4. 0	Moderate	Low.
Gypsum land: GA, GC, GR, Gs (For Cottonwood part of GC and Gs, see Cottonwood series; for Reeves part of GR, see Reeves series.)	Soft or hard gypsum at a depth of 0 to 10 inches.	0–19 19	Gypsiferous earth Gypsum.	ML	A–4	100	100	60–70	0. 8–2. 5	0. 16–0. 18	6. 6–7. 8	>15. 0	High	Low.
Harkey: Ha, Hk	More than 60.	0–87	Very fine sandy loam, loam, and silt loam.	ML	A–4	100	100	60–75	0. 8–2. 5	0. 17–0. 19	7. 4–7. 8	2. 0–12. 0	Moderate to high.	Low.
Karro: KA, KL, Kr, Ku, Kv	More than 60.	0–20 24–60	Loam Clay loam	ML–CL CL	A–4 A–6	100 100	100 100	60–75 70–80	0. 8–2. 5 0. 8–2. 5	0. 16–0. 18 0. 18–0. 20	7. 9–8. 4 7. 9–8. 4	4. 0–10. 0 8. 0–15. 0	High High	Moderate. Moderate.
Kermit: KM (For Berino part of KM, see Berino series.)	More than 60.	0–60	Fine sand	SP–SM	A–3	100	100	5–10	>10. 0	0. 06–0. 08	6. 6–7. 3	0–1. 0	Low	Low.
Kimbrough: KO, KS, KT (For Stegall part of KS and KT, see Stegall [illegible])	2 to 15.	0–9 9	Loam Caliche.	ML	A–4	95–100	90–95	50–65	0. 8–2. 5	0. 16–0. 18	6. 6–7. 8	0–4. 0	Moderate	Low.
Lan[illegible] [illegible] part of LN is too [illegible] reliable evaluation.)	More than 60.	0–65	Stratified loam and silt loam	ML–CL	A–4	100	100	60–70	0. 8–2. 5	0. 17–0. 19	7. 4–7. 8	0–4. 0	Moderate	Low to moderate.
Likes: LS	More than 60.	0–60	Loamy fine sand	SM	A–1	98	97	10–20	5–10. 0	0. 08–0. 10	6. 6–7. 8	0–1. 0	Low	Low.
Mobeetie: MO	More than 60.	0–60	Fine sandy loam	SM	A–4	100	100	40–50	2. 5–5. 0	0. 13–0. 15	7. 4–8. 4	0–1. 0	Low	Low.

The three columns under the heading "Classification" show soil texture as it is classified both by soil scientists and by engineers.

The estimated percentages of soil material passing sieves No. 4, No. 10, and No. 200 reflect the normal range for the series. As the grain-size distribution of any soil varies considerably, it should not be assumed that the range shown in the table will be applicable to all samples of a specified soil, nor that the engineering classification will invariably be as shown.

The rates of permeability given in table 4 are based on the movement of water through the soil in its undisturbed state. They were estimated by comparison with soils of known permeability. Permeability is expressed in terms of inches per hour.

Available moisture capacity, measured in inches per inch of soil depth, is the approximate amount of capillary water in the soil available for plant growth after all free water has drained away.

Reaction refers to the degree of acidity or alkalinity of a soil, expressed in pH values. A soil having a pH value of 7 is neutral in reaction. The pH value gives an indication of the corrosiveness of the soils and the protection needed for pipelines and other engineering structures.

Salinity affects not only the suitability of a soil for crops, but also its stability when used as a construction material and its corrosiveness to other materials. Estimates of salinity are based on estimates of electrical conductivity of saturated soil extract.

Shrink-swell potential is an indication of the volume change to be expected when the moisture content of soil material changes. In general, soils that have a high shrink-swell potential present hazards to the maintenance of engineering structures.

Some of the nearly level to gently sloping soils of the Arno, Cottonwood, Harkey, Reeves, and Pima series have a seasonal high water table. In some areas of these soils, the water table fluctuates between depths of about 1 foot and 3 feet during the irrigation season or in years when rainfall is above normal.

Periodic flooding occurs in swales and on the lower parts of flood plains of soils of the Arno, Bippus, Cottonwood, Dev, Harkey, Largo, Reeves, and Stegall series. On soils other than those of the Arno, Pima, and Reeves series, floodwaters seldom stand more than a few hours. Flooded areas of these soils are sometimes under water 1 or 2 days, but serious damage is infrequent.

Engineering interpretations

Table 5 gives estimates of the suitability of the soils for specified uses and lists soil properties that might present hazards for such use. Generally, the soils of the Eddy Area are not suitable as sources of sand and gravel, but some areas of Dev and Ector soils yield gravelly material suitable for crushing. Grassed or sodded waterways are not common in this Area, because rainfall is too low to maintain a good plant cover and use of irrigation water for this purpose is not economical.

The ratings of the soils as a source of topsoil are based on use of the soil as topdressing on road slopes and dams. A good rating is given to a soil, such as Reagan loam, that is fertile and tillable and generally not subject to erosion.

The suitability of a soil for road fill depends largely on the texture of the material and on its natural water content. Compaction characteristics, erodibility, depth to bedrock, and presence of coarse fragments within the normal depth of road excavation are features that should be considered. Highly plastic soil material with high natural water content is rated as poor. Soils that have a high proportion of silt and fine sand are rated poor to fair because they are difficult to compact, slow to revegetate, and easily eroded on steep embankments.

Suitability of the soils for disposal fields for septic tanks and tile systems is shown in the table in terms of the degree of limitation for such use. A rating of slight indicates no unfavorable features. Characteristics and qualities considered are permeability, ground-water level, slope, overflow hazard, depth to impervious material, and the possibility of polluting the water supply.

The entire profile was evaluated in making these estimations of the soils for use as highway locations. The ratings are for undisturbed soil without artificial drainage. It was assumed that the surface soil would be removed in construction for use as topsoil wherever feasible. Significant factors considered are the content of organic matter, salts, stones, and rock outcrops; the depth to hard rock or caliche; the suitability of the soil for embankments; the stability of the soil and the ease of handling; the hazards of flooding and erosion; the plasticity of the soils; and topography. Frost heave was not considered, because the soils seldom freeze.

Significant factors considered in rating the soils for use in constructing dikes and levees are stability of the soils when wet and their workability when used in construction.

The characteristics of the soils that affect suitability for constructing farm ponds and irrigation reservoirs are the amount of seepage to be expected and the depth to an inhibiting layer, such as bedrock, caliche, or gypsiferous material. The characteristics and qualities considered in determining suitability of the soils for embankments are the same as those for dikes and levees.

The factors that affect irrigation are depth of tillable soil, texture, intake rate, permeability, water-holding capacity, soil reaction, and topography. The availability of suitable irrigation water is not considered. The characteristics and qualities considered in determining suitability of the soils for leveling and benching are the same as those for irrigation.

The properties considered in rating the soils as to their suitability for building foundations are bearing capacity, shrink-swell potential, and shear strength.

The ratings of suitability of the soils for pipelines is based mainly on soil depth and rockiness and on the content of salts.

The soils are classified in the table according to their hydrologic group. These are groups of soils having similar rates of infiltration by water, even when wetted, and similar rates of water transmission within the soil. There are four hydrologic groups:

GROUP A consists of soils that have a high infiltration rate even when thoroughly wetted, chiefly deep, well-drained to excessively drained sand, gravel, or both. These soils have a high rate of water transmission and a low runoff potential.

GROUP B consists of soils that have a moderate infiltration rate when thoroughly wetted and that are chiefly moderately deep to deep, moderately well drained to well drained, and moderately fine textured to moderately coarse textured. These soils have a moderate rate of water transmission.

GROUP C consists of soils that have a slow rate of infiltration when thoroughly wetted, chiefly soils that have a layer that impedes downward movement of water and soils that are moderately fine textured to fine textured. These soils have a slow rate of transmission.

GROUP D consists of soils that have a very slow rate of infiltration when thoroughly wetted, chiefly clay soils that have a high swelling potential, soils that have a permanently high water table, soils that have a claypan or clay layer at or near the surface, and shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission.

Engineering test data

Table 6 gives data obtained by laboratory testing of samples of selected soils of the Area. The soils tested were sampled at several locations. The engineering characteristics of a soil at a specific location are indicated by these test data, but variations in properties can be expected at other locations. Even for those soils sampled in more than one location, the test data probably do not show the maximum range in characteristics that affect engineering.

Engineering classification systems

Two systems of classifying soils for engineering purposes are in general use. Classification of the soils of the Eddy Area according to both of these systems is given in this survey.

The Unified system of soil classification was developed by the Waterways Experiment Station, Corps of Engineers (*15*). In this system, soil classification is based on the identification of soils according to texture and plasticity and their performance as construction material. In the Unified system SW and SP are clean sands, SM and SC are sands with fines of silt and clay, ML and CL are silts and clays with low liquid limit, and MH and CH are silts and clays with high liquid limit. If soils are on the borderline between two classifications, a joint classification symbol is used, for example, ML–CL.

The system used by the American Association of State Highway Officials (AASHO) (*2*) is based on field performance of soils in highways. In this system, soil materials are classified into seven principal groups, designated A–1 through A–7. The best materials for use in highway subgrades (gravelly soils of high bearing capacity) are classified as A–1, and the poorest (clayey soils having low strength when wet) are classified A–7. The relative engineering values of the soils within each group are indicated by group index numbers. Group indexes range from 0 for the best material to 20 for the poorest.

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