HISTORY OF CONSTRUCTION

CFR 257.73(c)(1)

Bottom Ash Pond

Northeastern 3&4 Power Station
Oologah, Oklahoma

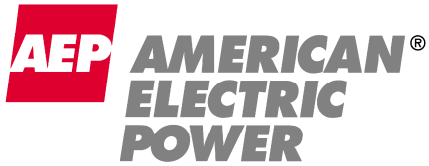
October, 2016

Prepared for: Public Service Company of Oklahoma

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215



GERS-16-008

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1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of the CCR rule section 257.73(c)(1).

2.0 DESCRIPTION OF CCR THE IMPOUNDMENT

The Northeastern 3&4 Power Station is located near the City of Oologah, Rogers County, Oklahoma. It is owned and operated by Public Service Company of Oklahoma (PSO). The facility operates one surface impoundment for storing CCR called the Bottom Ash Pond.

The embankment is about 4,200 feet long, encompassing about 72 acres with about 34 acres of surface water. The dam crest gradually increases in elevation from about 630 feet-msl at the north berm east of the auxiliary spillway, to about elevation 639 feet-msl at the south berm where it meets the coal storage area on the east side. The embankment was constructed across a first order tributary to Fourmile Creek leaving the site to the south where the embankment is at its highest, 38 feet from the crest to the toe of the dam. A railroad track extends the length of the crest, typically used to remove empty coal cars from the site.

3.0 SUMMARY OF OWNERSHIP 257.73(c)(1)(i)

[The name and address of the person(s) owning or operating the CCR unit: the name associated with the CCR unit: and the identification number of the CCR unit if one has been assigned by the state.]

The Northeastern Power Station is located at 7300 E Hwy 88, Oologah, Oklahoma 74053 in Rogers County Oklahoma. It is owned and operated by Public Service Company of Oklahoma (PSO). The facility operates one surface impoundment for storing CCR called the Bottom Ash Pond. The Dam Inventory of Oklahoma ID is OK30396.

4.0 LOCATION OF THE CCR UNIT 257.73 (c)(1)(ii)

[The location of the CCR unit identified on the most recent U.S. Geological Survey (USGS) 7 ½ minute or 15 minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available.]

A location map is included in Attachment A.

5.0 STATEMENT OF PURPOSE 257.73 (c)(1)(iii)

[A statement of the purpose for which the CCR unit is being used.]

The Bottom Ash Pond is a surface impoundment for the purpose of settling and storing CCR. The power station's site storm water drainage is also tributary to the pond.

6.0 NAME AND SIZE OF WATERSHED THE CCR UNIT IS LOCATED 257.73 (c)(1)(iv)

[The name and size in acres of the watershed within which the CCR unit is located.]

The Bottom Ash Pond is located with the Lower Verdigris watershed (HUC: 11070105) which has a listed acreage of approximately 444,742 acres. The Bottom Ash Pond tributary area consists of two drainage

areas. The total drainage area is approximately 199 acres. One area includes most of the power station area and the Bottom Ash Pond itself, and the second contributing drainage area consists of the coal pile and area east of the coal pile which is connected to the Bottom Ash Pond via a small channel.

7.0 DESCRIPTION OF THE FOUNDATION AND ABUTMENT MATERIALS 257.73(c)(1)(v)

[A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is located.]

The foundation materials of the Bottom Ash Pond consist of a thin layer of native soils overlaying limestone bedrock. The native soils are generally described as dark brown, gray and tan silty to sandy clay with trace amounts of gravel noted in some locations. Boring logs describe the bedrock as soft to medium medium-hard limestone with shale clay lenses. RQD values were between 86 and 100-percent for the limestone encountered. The abutments and foundation were prepared as described in Site Preparation Specification D-2 (See Attachment B).

8.0 DESCRIPTION OF EACH CONSTRUCTED ZONE OR STAGE OF THE CCR UNIT 257.73 (c)(1)(vi)

[A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.]

The Bottom Ash Pond was originally constructed in 1979. The original design drawings show the embankment is constructed of earthen fill. The embankment has an inner clay core which is keyed into the original ground. The embankment has an approximate top width of 30 feet. The embankment is at elevation 630 feet-msl at the auxiliary spillway, and increases in elevation along the west and south embankments to elevation 639 feet-msl at the east side of the south embankment. The tallest section of the north embankment is 19 feet at the auxiliary spillway, and the tallest section at the south embankment is 38 feet over the pre-existing stream. The inboard and outboard slopes were constructed with a 2.5 horizontal to 1 vertical slope. On top of the dike there is a railroad bed is located on the west and south embankments primarily used for moving empty coal cars. The original subsurface investigation is included in Attachment B and design drawings are included in Attachment C.

The project specifications required construction quality assurance (CQA) testing, however construction records including as-built plans and CQA records are not available. Several post-construction subsurface investigations have been completed (Standard Testing, 2010, and Terracon 2016). Results of those investigations including engineering properties are included in Attachment B. In general the borings indicate that the embankment soils ranged from sandy lean clays to fat clays.

A modification was made to the embankment since the original construction. Prior to September 2009, the slope along the eastern portion of the southern embankment was steepened in order to provide an access road along the embankment crest parallel to the railroad track. The slope angle along the upper 15 feet of the crest in this area (approximately 1,000 feet) is 1:1 instead of the 2.5:1 design slope (H:V). This area has been covered with a protective layer of riprap.

9.0 ENGINEERING STRUCTURES AND APPURTENANCES, 257.73 (c)(1)(vii)

[At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection…]

Detailed dimensional drawings are included in Attachment C. There is no principal spillway within the ash pond. The water level is controlled by pumping and recirculating water through the power station for reuse. There is an auxiliary spillway used for conveying water during extreme rainfall. The auxiliary spillway is a broad-crested weir, with a concrete chute and stilling basin. The overflow crest is 25-feet wide with a design invert elevation of 625.0 ft msl. The auxiliary spillway is located on the west side of the north embankment. Overflow from the spillway discharges to a low area on site. The low area is drained by two culverts under the adjacent railroad track, which discharge off site into a tributary to Fourmile Creek on the northeast side of the ash pond. Fourmile Creek is located along the south side of the ash pond, and discharges into the Verdigris River 1.5 miles downstream from the tributary. The downstream toe of the dam was designed with a toe drain along the west and south embankments. This drainage system consists of a 1.5-foot thick sand and gravel drainage blanket layer that extends along the dam subgrade from the toe to a distance of the height + 15ft away from the center of the embankment. The drainage blanket is connected to a gravel and sand bedding layer, 9-inches in thickness, at the toe that runs 12 feet up the slope from the toe and is overlain by 1-foot layer of riprap. The toe drain was designed to drain seepage from the dam at any point along its length: i.e., there are no seepage collection pipes to discharge seepage at specific locations. As a consequence, seepage will tend to collect and discharge at the lowest elevation along the toe. This area is near the western end of the south embankment at the location of the pre-existing natural streambed. Drainage is diverted around the Bottom Ash Pond by natural drainage channels and grass lined ditches.

Primarily the inboard slopes are protected by riprap with upper portions protected by grass vegetation. The outboard slopes primarily consist of grass vegetation and a riprap blanket that run 12 foot up the slope from the toe.

A map with instrumentation locations in provided in Attachment D.

10.0 SUMMARY OF POOL SURFACE ELEVATIONS, AND MAXIMUM DEPTH OF CCR, 257.73 (c)(1)(vii)

[…in addition to the normal operating pool surface elevation and the maximum pool elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment.]

The Bottom Ash Pond has been determined to be a Low Hazard potential CCR impoundment. Based on this hazard classification the design flood as determined by section 257.82(a)(3) to be the 100-year storm which corresponds to 8.85 inches in 24 hours for this site. An analysis was performed for the 40% PMF (Probable Maximum Flood), which looks at 40% of the runoff from PMP storm of 45.87 inches in 72 hours. This produces significantly more runoff than the 100-year storm and therefore exceeds the requirements of section 257.82(a)(3). The complete analysis is included in Attachment E.

	Bottom Ash Pond
Normal Pool Elevation	623.0
Maximum Pool Elevation following peak discharge from inflow design flood	625.15
Expected Maximum depth of CCR within impoundment	12 ft

11.0 FEATURES THAT COULD ADVERSELY AFFECT OPERATION DUE TO MALFUNCTION OR MIS-OPERATION 257.73 (c)(1)(vii)

[…and any identifiable natural or manmade features that could adversely affect operations of the CCR unit due to malfunction or mis-operation]

In the event of malfunction or mis-operation of any of the pond's appurtenances the ponds operations could be adversely affected. These structures include the pumping and recirculating system, the auxiliary spillway and influent sluicing piping and structures. See design drawings in Attachment C for location and details of all appurtenances.

12.0 DESCRIPTION OF THE TYPE, PURPOSE AND LOCATION OF EXISTING INSTRUMENTATION 257.73 (c)(1)(viii)

[A description of the type, purpose, and location of existing instrumentation.]

The Bottom Ash Pond has 2 piezometers located within the structure of the dam. These piezometers are read a minimum of every 30 days for the purpose of determining the phreatic water level within the dike. A location map is provided in Attachment D.

13.0 AREA – CAPACITY CURVES FOR THE CCR UNIT 257.73 (c)(1)(ix)

[Area-capacity curves for the CCR unit.]

The area capacity curves for the Bottom Ash Pond are described on Table 3 within the Hydrology and Hydraulic Analysis Report by Freese and Nichols, May 2011 in Attachment E.

14.0 DESCRIPTION OF EACH SPILLWAY AND DIVERSION 257.73 (c)(1)(x)

[A description of each spillway and diversion design features and capacities and calculations used in their determination.]

There is no principal spillway at the bottom of the ash pond. The water level is controlled by pumping and recirculating water through the power station for reuse. The auxiliary spillway is a broad-crested weir, with a concrete chute and stilling basin. The overflow crest is 25-feet wide with a design invert elevation of 625.0 ft msl. The auxiliary spillway is located on the west side of the north embankment.

Overflow from the spillway discharges to a low area on site. The low area is drained by two culverts under the adjacent railroad track, which discharge off site into a tributary to Fourmile Creek on the northeast side of the ash pond. Fourmile Creek is located along the south side of the ash pond, and discharges into the Verdigris River 1.5 miles downstream from the tributary. Drainage is diverted around the Bottom Ash Pond by natural drainage channels and grass lined ditches. Capacities and Calculations are included in Attachment E.

15.0 SUMMARY CONSTRUCTION SPECIFICATIONS AND PROVISIONS FOR SURVEILLANCE, MAINTENANCE AND REPAIR 257.73 (c)(1)(xi)

[The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.]

Construction of the Bottom Ash Pond was completed around 1979. Construction specifications were developed by Black and Vetch as part of the design of the impoundment are included in Attachment B.

As required by the CCR rules the Bottom Ash Pond is inspected at least every 7 days by a qualified person. Also as a requirement of the CCR rules the impoundment is also inspected annual by a professional engineer. Maintenance items are addressed as they are discovered as part of those inspections.

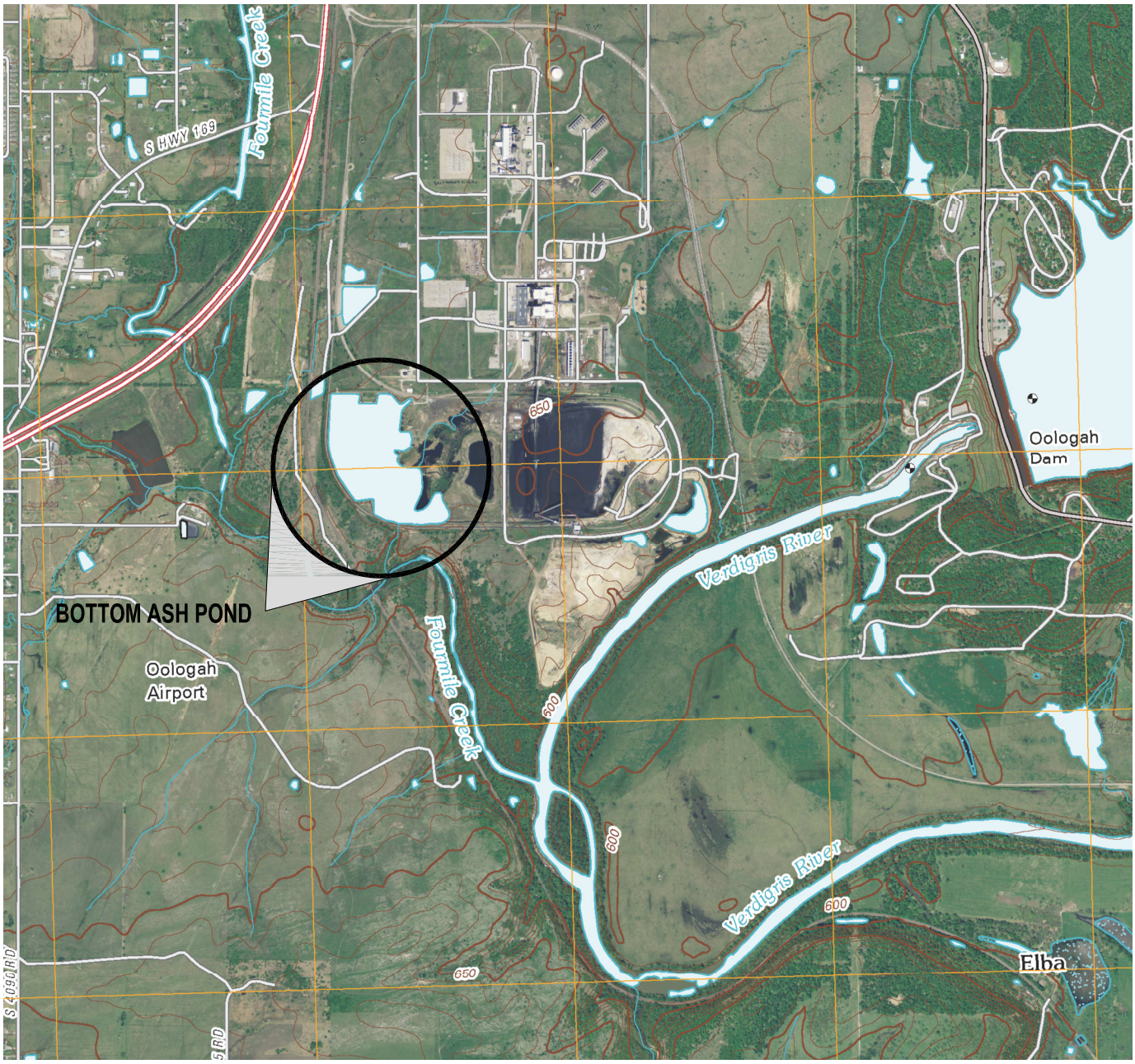
16.0 RECORD OR KNOWLEDGE OF STRUCTURAL INSTABILITY 257.73 (c)(1)(xii)

[Any record or knowledge of the structural instability of the CCR unit.]

To date there has been no known record or knowledge of structural instability of the CCR unit.

ATTACHMENT A

LOCATION MAP



1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

N
W E

THIS DRAWING IS CLASSIFIED AS:

AEP PUBLIC

REFERENCE AEP's CORPORATE INFORMATION SECURITY POLICY

PUBLIC SERVICE COMPANY OF OKLAHOMA

NORTHEASTERN 3&4 PLANT

OOLOGAH OKLAHOMA

UNIT:	DRAWING NUMBER:	REV:
34	LOCATION MAP	1
SCALE: 1"=2000'	CIVIL ENGINEERING	
DR:		
CH:		
SUP:		
ENG:		
DATE: July 27, 2016		

BOTTOM ASH POND

USGS TOPO MAP

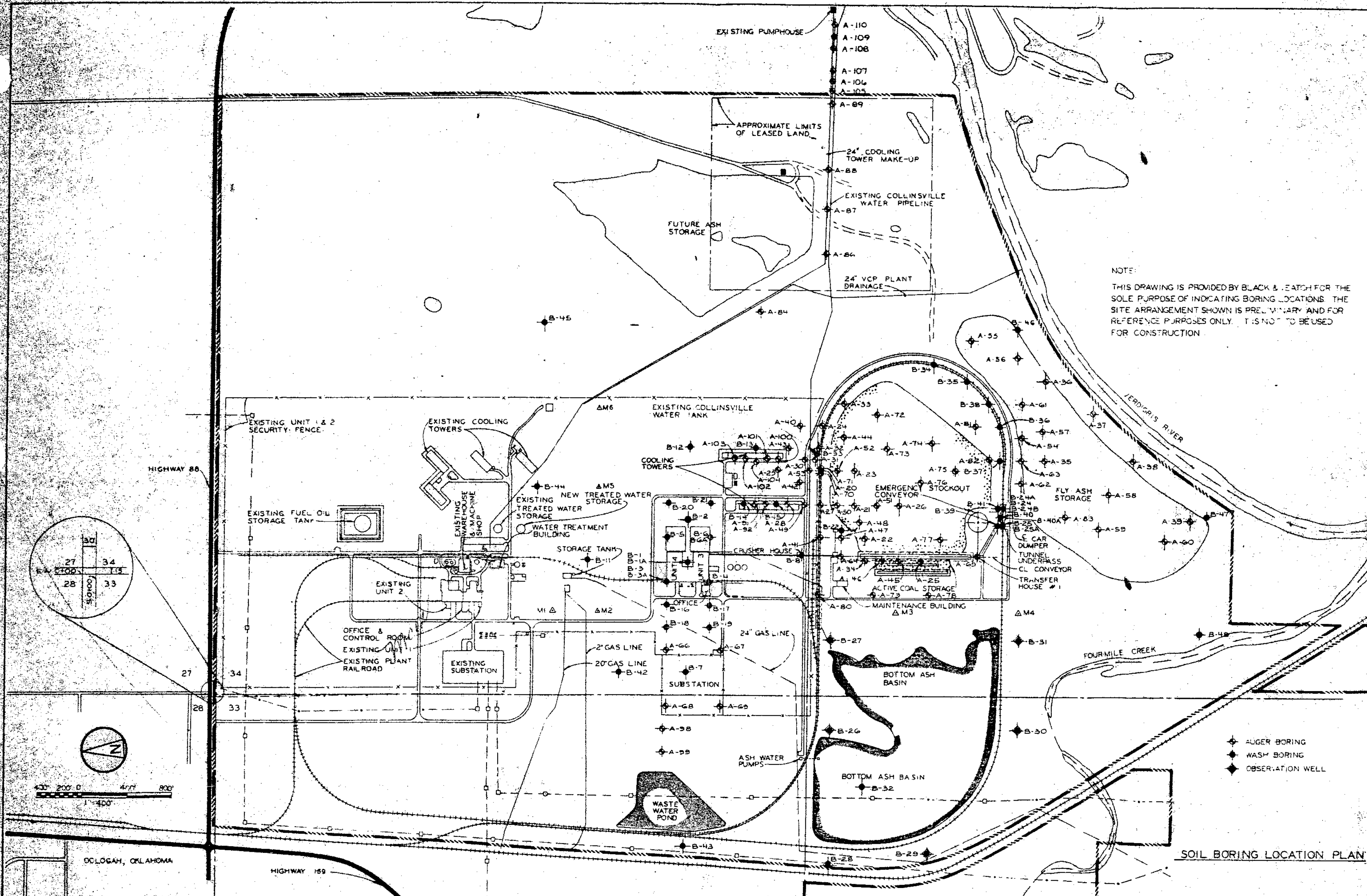
7.5-MINUTE SERIES

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

ATTACHMENT B

DESIGN DOCUMENTS


SOIL BORING LOCATION PLAN
NOTE:
THIS DRAWING IS PROVIDED BY BLACK & VEATCH FOR THE SOLE PURPOSE OF INDICATING BORING LOCATIONS. THE SITE ARRANGEMENT SHOWN IS PRELIMINARY AND FOR REFERENCE PURPOSES ONLY. IT IS NOT TO BE USED FOR CONSTRUCTION.
AUGER BORING
WASH BORING
OBSERVATION WELL
EXISTING PUMPHOUSE
APPROXIMATE LIMITS OF LEASED LAND
24" COOLING TOWER MAKE-UP
EXISTING COLLINSVILLE WATER PIPELINE
FUTURE ASH STORAGE
24" VCP PLANT DRAINAGE
VERDIGRIS RIVER
FLY ASH STORAGE
EXISTING COLLINSVILLE WATER TANK
EXISTING UNIT 1 & 2 SECURITY FENCE
EXISTING COOLING TOWERS
HIGHWAY 88
COOLING TOWERS
NEW TREATED WATER STORAGE
EXISTING TREATED WATER STORAGE
WATER TREATMENT BUILDING
EXISTING FUEL OIL STORAGE TANK
EXISTING WAREHOUSE & MACHINE SHOP
EXISTING UNIT 2
STORAGE TANK
CRUSHER HOUSE
EMERGENCY CONVEYOR
STOCKOUT
CAR DUMPER
TUNNEL UNDERPASS
CL CONVEYOR
TRANSFER HOUSE #1
ACTIVE COAL STORAGE
MAINTENANCE BUILDING
OFFICE & CONTROL ROOM
EXISTING UNIT 1
EXISTING PLANT RAILROAD
EXISTING SUBSTATION
2" GAS LINE
20" GAS LINE
24" GAS LINE
SUBSTATION
OFFICE
UNIT 4
UNIT 3
BOTTOM ASH BASIN
FOURMILE CREEK
ASH WATER PUMPS
WASTE WATER POND
OOLOGAH, OKLAHOMA
HIGHWAY 169
1" = 400'
400' 200' 0 400' 800'

BORING LOG

HOLE NO. A-73

PROJECT Northeast Power Station - Oologah, Oklahoma

SHEET 1 OF 1

HOLE LOCATION 60+00S, 22+00E.

DATE 1-14-75

GR. ELEV. 636.1 WATER TABLE None BORED BY Riddle LOGGED BY Drywater

(After 24 hours)

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
635.1	1.0		CLAY, Silty, Sandy, Dark Brown w/Small Gravel
			LIMESTONE
			NOTE: 1 Bag Sample (Qt) @ - 0'-1.0'

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

CONSULTING ENGINEERING • GEOLOGICAL INVESTIGATION • ENGINEERING INSPECTION

HEMPHILL CORPORATION

4834 SOUTH 83RD EAST AVENUE

OFFICE-(918) 622-5133 TULSA, OKLAHOMA 74145 AFTER HOURS 587-5822

BORING LOG

HOLE NO. A-78

PROJECT Northeast Power Station - Oologah, Oklahoma SHEET 1 OF 1

HOLE LOCATION 64+00S, 9+00E DATE 1-14-75

GR. ELEV. 610.3 WATER TABLE None (After 24 hours) BORED BY Riddle LOGGED BY Drywater

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
609.3	1.0		CLAY, Silty, Sandy, Dark Brown, Moist Soft
			LIMESTONE
			NOTE: 1 Bag Sample (Qt) @ - 0'-1.0'

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

CONSULTING ENGINEERING • GEOLOGICAL INVESTIGATION • ENGINEERING INSPECTION

HEMPHILL CORPORATION

4834 SOUTH 83RD EAST AVENUE

OFFICE-(918) 622-5133 TULSA, OKLAHOMA 74145 AFTER HOURS 587-5822

BORING LOG

HOLE NO. A-20

PROJECT Northeast Power Station - Oologah, Oklahoma

SHEET 1 OF 1

HOLE LOCATION 54+00S, 9+00E.

DATE 1-14-75

GR. ELEV. 635.4 WATER TABLE None (After 24 hours) BORED BY Riddle LOGGED BY Drywater

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
633.7	1.7		CLAY, Silty, Sandy, Dark Brown, Moist Soft
632.4	3.0		CLAY, Sandy, Tan, Moist, Stiff w/Small Gravel
			LIMESTONE

NOTE: 2 Bag Samples (Qt) @ -

0'-1.7', 1.7'-3.0'

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

CONSULTING ENGINEERING • GEOLOGICAL INVESTIGATION • ENGINEERING INSPECTION

HEMPHILL CORPORATION

4834 SOUTH 83RD EAST AVENUE

OFFICE-(918) 622-5133 TULSA, OKLAHOMA 74145 AFTER HOURS 587-5822

BORING LOG

HOLE NO. B-26

PROJECT Northeast Power Station - Oologah, Oklahoma **SHEET** 1 **OF** 1

HOLE LOCATION 55+00 S, 3+00W **DATE** 12-26-74

GR. ELEV. 627.9 **WATER TABLE** None **BORED BY** Summers **LOGGED BY** Drywater

Drilled with water

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
625.9	2.0		CLAY, Silty, Sandy, Dark Brown, Moist, Stiff
623.9	4.0		CLAY, Sandy, Reddish, Tan, Moist, Stiff
621.9	6.0		LIMESTONE, Gray
			LIMESTONE, Grayish w/Gray Shale Lenses and partings w/Calcite Crystals
			NOTE: 2.0' casing above surface 6.0' casing below surface Hole Diameter 6 7/8" Point of Change of Hole Diameter 6'0". Reference point elevation 630.4. Boring-casing annulus grouted back to surface. 8.0' of 5" PVC plastic pipe with cap set in hole.
607.9	20.0		Bottom of Hole

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY	RQD
6.0	10.0	100%	96%
10.0	15.0	100%	95%
15.0	20.0	100%	100%

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

NOTE: Hole flushed with clear water.

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TULSA, OKLAHOMA 74145

OFFICE-(918) 622-5133 AFTER HOURS 587-5822

BORING LOG

HOLE NO. B-27

PROJECT Northeast Power Station - Oologah, Oklahoma **SHEET** 1 **OF** 1

HOLE LOCATION 55+00 S, 5+00 E **DATE** 12/23-27/74

GR. ELEV. 628.0 **WATER TABLE** None **BORED BY** Summers **LOGGED BY** Drywater

(Drilled with water)

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
626.5	1.5		CLAY, Silty, Sandy, Dark Brown, Moist Stiff
624.5	3.5		LIMESTONE, Grayish
623.5	4.5		LIMESTONE, Grayish w/Tan, Clay Lenses
			LIMESTONE, Grayish w/Gray Shale Lenses and partings and Calcite Cyrstals
			NOTE: 2.0' casing above surface 3.5' casing below surface Hole Diameter 6 7/8" Point of Change of Hole Diameter 3'5". Reference point elevation 630.2. Boring-casing annulus grouted back to surface. 5.5' of 5" PVC plastic pipe with cap set in hole.
613.0	15.0		Bottom of Hole

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY	ROD
5.0	10.0	96%	96%
10.0	15.0	92%	92%

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

NOTE: Hole flushed with clear water.

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TULSA, OKLAHOMA 74145

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BORING LOG

HOLE NO. B-28

PROJECT Northeast Power Station - Oologah, Oklahoma — SHEET 1 OF 2

HOLE LOCATION 55+00 S, 15+00 W — DATE 12-23-74

GR. ELEV. 611.8 — WATER TABLE None — BORED BY Summers — LOGGED BY Drywater

(Drilled with water)

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
610.8	1.0		CLAY, Silty, Sandy, Dark Brown, Moist, Soft
608.8	3.0		LIMESTONE, Grayish w/Clay Lenses and Gray Shale Partings
605.5	6.3		LIMESTONE, Grayish w/Clay lenses and Gray Shale Partings
			LIMESTONE, Grayish w/Gray Shale Lenses partings and Calcite Crystals
	20.0		

NOTE: 2.0' casing above surface
3.0' casing below surface
Hole Diameter 6 7/8"
Point of change of hole diameter 3'0". Reference point elevation 613.2.

5.0' of PVC plastic pipe with cap set in hole. Boring-casing annulus grouted back to surface.

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY	RQD
5.0	10.0	86%	86%
10.0	15.0	100%	100%
15.0	20.0	100%	100%
20.0	22.0	90%	90%

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

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TULSA, OKLAHOMA 74145

OFFICE-(918) 622-5133 AFTER HOURS 587-5822

BORING LOG

HOLE NO. B-28

PROJECT Northeast Power Station - Oologah, Oklahoma

SHEET 2 OF 2

HOLE LOCATION 55+00 S, 15+00 W

DATE 12-26-74

GR. ELEV. 611.8 WATER TABLE None (Drilled with water) BORED BY Summers LOGGED BY Drywater

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
598.8	22.0		LIMESTONE, Grayish w/Gray Shale Lenses Partings and Calcite Cyrstals
			Bottom of Hole

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

CONSULTING ENGINEERING • GEOLOGICAL INVESTIGATION • ENGINEERING INSPECTION

HEMPHILL CORPORATION

4834 SOUTH 83RD EAST AVENUE

TULSA, OKLAHOMA 74145

OFFICE-(918) 622-5133 AFTER HOURS 587-5822

BORING LOG

HOLE NO. B-29

PROJECT Northeast Power Station - Oologah, Oklahoma **SHEET** 1 **OF** 2

HOLE LOCATION 64+00 S, 14+00 W **DATE** 12-23-74

GR. ELEV. 610.3 **WATER TABLE** None **BORED BY** Summers **LOGGED BY** Drywater

(Drilled with water)

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
608.8	1.5		CLAY, Silty, Sandy, Dark Brown, Moist Stiff
606.8	3.5		LIMESTONE, Grayish w/Clay Lenses
598.8	11.5		LIMESTONE, Grayish w/Clay lenses and Gray Shale partings and Calcite Crystals
	20.0		LIMESTONE, Grayish w/Gray Shale Lenses and Partings and Calcite Crystals

NOTE: 2.0' casing above surface
3.5' casing below surface
Hole Diameter 6 7/8"
Point of change of hole diameter 6 7/8". Reference point elevation 612.3.

5'5" of PVC plastic pipe with cap set in hole. Boring-casing annulus grouted back to surface.

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY	ROD
5.0	10.0	92%	92%
10.0	12.5	96%	96%
12.5	21.0	99%	98%

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

CONSULTING ENGINEERING • GEOLOGICAL INVESTIGATION • ENGINEERING INSPECTION

HEMPHILL CORPORATION

4834 SOUTH 83RD EAST AVENUE

OFFICE-(918) 622-5133 TULSA, OKLAHOMA 74145 AFTER HOURS 587-5822

BORING LOG

HOLE NO. B-29

PROJECT Northeast Power Station - Oologah, Oklahoma — SHEET 2 OF 2

HOLE LOCATION 64+00 S, 14+00 W — DATE 12-27-74

GR. ELEV. 610.3 — WATER TABLE None — BORED BY Summers — LOGGED BY Drywater

(Drilled with water)

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
			LIMESTONE, Grayish w/Gray Shale, Lenses and Partings and Calcite Crystals
584.3	26.0		Bottom of Hole

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY	ROD
21.0	26.0	98%	98%

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

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HEMPHILL CORPORATION

4834 SOUTH 83RD EAST AVENUE

TULSA, OKLAHOMA 74145

OFFICE-(918) 622-5133

AFTER HOURS 587-5822

BORING LOG

HOLE NO. B-30

PROJECT Northeast Power Station - Oologah, Oklahoma

SHEET 1 OF 1

HOLE LOCATION 72+00 S, 3+00 W

DATE 12/23&30/74

GR. ELEV. 611.3 WATER TABLE None BORED BY Summers LOGGED BY Drywater

(Drilled with water)

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
610.3	1.0		SILT, Clayey, Dark Brown, Very Moist, Soft
608.3	3.0		LIMESTONE, Grayish
			LIMESTONE, Grayish w/Tan, Clay Seams and Shale Partings w/Calcite Crystals and Solution Cavities
			NOTE: Water circulation lost @ 13.5'. Hole cut from 13.5' - 20.0' with 3 7/8" roller.
			NOTE: 2.0' casing above surface 3.0' casing **below** surface Hole Diameter 6 7/8" Point of Change of hole diameter 3.0'. Reference point elevation 613.4. 5' of 5" PFC w/cap set. Boring-casing annulus grouted back to surface. Hole flushed with clear water
591.3	20.0		Bottom of Hole

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY	ROD
5.0	10.0	96%	96%
10.0	13.5	91%	91%

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

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HEMPHILL CORPORATION

4834 SOUTH 83RD EAST AVENUE

TULSA, OKLAHOMA 74145

OFFICE-(918) 622-5133 AFTER HOURS 587-5622

BORING LOG

HOLE NO. B-31

PROJECT Northeast Power Station - Oologah, Oklahoma SHEET 1 OF 1

HOLE LOCATION 72+00 S, 5+00 E. DATE 12/23&30/74

GR. ELEV. 624.1 WATER TABLE None BORED BY Summers LOGGED BY Drywater
(Drilled with water)

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
623.1	1.0		SILT, Clayey, Sandy, Dark Brown, Very Moist, Soft
622.6	1.5		CLAY, Silty, Sandy, Tan, Moist
620.6	3.5		LIMESTONE, Grayish
618.6	5.5		LIMESTONE, Grayish w/Tan, Clay Lenses
609.1	15.0		LIMESTONE, Grayish, w/Gray Shale Lenses and Partings w/Calcite Crystals
			Bottom of Hole

NOTE: 2.0' casing above surface
3.5' casing below surface
Hole Diameter 6 7/8". Point of change of hole diameter 3.5'.
Reference point elevation 626.2.
5'5" of 5" PVC pipe w/cap set.
Boring-casing annulus grouted back to surface. Hole flushed with clear water.

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT

SHELBY TUBE SAMPLES

NO.	FROM	TO

CORING

FROM	TO	RECOVERY	ROD
5.0	10.0	96%	94%
10.0	15.0	100%	100%

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

CONSULTING ENGINEERING • GEOLOGICAL INVESTIGATION • ENGINEERING INSPECTION

HEMPHILL CORPORATION
4834 SOUTH 83RD EAST AVENUE
TULSA, OKLAHOMA 74145
OFFICE-(918) 622-5133 AFTER HOURS 587-5822

BORING LOG

HOLE NO. B-32

PROJECT Northeast Power Station - Oologah, Oklahoma

SHEET 1 OF 1

HOLE LOCATION 58+00 S, 8+00 W

DATE 12-20-74

GR. ELEV. 623.1 WATER TABLE None BORED BY Summers LOGGED BY Drywater

(Drilled with water)

ELEV.	DEPTH AND SCALE	LGND.	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
622.1	1.0		SILT, Clayey, Sandy, Dark Brown, Moist Soft
620.1	3.0		CLAY, Sandy, Reddish, Tan w/Gray, Moist Stiff w/Limestone Fragments
618.6	4.5		LIMESTONE, Grayish w/Tan Clay Lenses
			LIMESTONE, Grayish w/Gray Shale Lenses and Partings and Calcite Crystals
603.1	20.0		Bottom of Hole

CASING INFORMATION

SIZE	FT-RUN	FT-PULLED	FT-LEFT

DRILLING MUD

TYPE	NO. SACKS

PENETRATION TEST

FROM	TO	BLOWS/FT
3.0	3.0	50/0

SHELBY TUBE SAMPLES

NO.	FROM	TO
1	1.0	3.0

(Hand Penetrometer Average-3.75+TSF)

CORING

FROM	TO	RECOVERY	ROD
5.0	10.0	100%	100%
10.0	20.0	98%	98%

WATER LOSS

CEMENT (NO. SACKS)

REMARKS

CONSULTING ENGINEERING • GEOLOGICAL INVESTIGATION • ENGINEERING INSPECTION

HEMPHILL CORPORATION

4834 SOUTH 83RD EAST AVENUE

TULSA, OKLAHOMA 74145

OFFICE-(918) 622-5133

AFTER HOURS 587-5822

SPECIFICATIONS
AND
DOCUMENTS

PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION

SITE PREPARATION

SPECIFICATION 6571/6572 – D-2

CONTRACT ISSUE

MARTIN K. EBY CONSTRUCTION CO., INC.
P.O. Box 1679
610 North Main
Wichita, Kansas 67201

BLACK & VEATCH
Consulting Engineers
Kansas City, Missouri

1975

Section 2A - CLEARING, GRUBBING, AND RAZING

2A.1 GENERAL. This section covers clearing and grubbing for the plant site area within the limits indicated on the drawings.

Before clearing work is accepted, any regrowth of vegetation or tree shoots which have grown after initial cutting shall be cut and removed as specified in Article 2A.2. Tree shoots shall be removed to the level specified for tree removal in that area. All regrowth of vegetation shall be mowed, raked and burned. The finished work at the time of final acceptance shall leave completely cleared and grubbed areas as specified.

This section also covers razing of existing structures and facilities within the clearing limits.

2A.2 CLEARING AND GRUBBING. Clearing shall include clearing and removing all trees and stumps flush with the original ground surface; the cutting and removal of all brush, shrubs, debris and all vegetation to approximately flush with the ground surface; and the disposal of all cuttings and debris. Mowing will be considered adequate for the cutting of light vegetation.

Grubbing shall include the removal and disposal of all stumps and roots larger than 2 inches in diameter, including matted roots regardless of size. Grubbing shall extend to a minimum depth of 12 inches below the natural surrounding ground surface or as otherwise required by the detail specifications.

The Contractor shall not remove or damage trees outside the construction area limits specified to be cleared or grubbed.

Clearing operations shall be conducted without damage to trees which are designated to remain. Trees shall be protected and preserved as specified in Article 2B.9. Equipment utilized in the clearing and grubbing work shall be kept within the specified construction area limits.

2A.2.1 Limits of Work. The limits of the clearing and grubbing under this section shall include all areas to be graded within the limits of construction as indicated on the drawings including, but not limited to, the following:

Clearing and grubbing of all areas to be occupied by buildings as designated on the drawings

Clearing and grubbing of the entire coal storage area, the bottom ash storage area, the waste water pond and all areas designated as borrow areas

Clearing and grubbing of all areas to be occupied by roads and railroad.

Clearing and grubbing of all additional areas as indicated on the drawings

2A.2.2 Disposal of Waste. All logs, trees, stumps, roots, brush, tree trimmings and other materials resulting from clearing and grubbing operations shall become the property of the Contractor and shall be entirely removed from the property of the Company or shall be stacked and burned at locations acceptable to the Engineer. Disposal shall be such that upon completion the area shall be entirely void of all loose stumps, trimmings, brush, vegetation, and other debris.

All materials to be burned shall be piled and when in suitable condition shall be burned completely. All burning shall be so thorough that the materials are completely reduced to ashes. Piling for burning shall be done in such a manner and in such locations as to cause the least fire risk. Great care shall be taken to prevent the spread of fire. Fire guards of adequate width shall be provided wherever there is surface vegetation around any brush pile, by backfiring or other surface removal or by burying all surface vegetation within fire guard limits. No burning of trimmings or brush shall be done when the direction or velocity of the wind is such that there would be any danger of fire being carried to adjacent areas. Any and all governmental or statutory requirements or regulations relative to fire prevention in general and burning trimmings and brush in particular shall be complied with.

All burning of waste materials shall be by controlled burning under favorable atmospheric conditions and at such a time and manner to minimize smoke and air pollution to meet the requirements of regulatory authorities.

The disposal of noncombustible materials shall be the responsibility of the Contractor. Noncombustible materials shall be hauled off the site and shall be disposed of by and at the expense of the Contractor in a manner that will meet the requirements of regulatory authorities.

All vegetation cleared by mowing shall be raked into windrows and burned.

2A.3 EXISTING FENCES. All existing fences within the limits of construction shall be removed unless designated otherwise by the Engineer. Removal shall include the complete removal of posts and wire. Metal and wooden posts and wire shall be disposed of as specified for disposal of noncombustibles. Post holes shall be backfilled and lightly tamped.

2A.4 EXISTING DAMS. All existing dams so indicated on the drawings shall be removed. The earth materials of the dams shall be broken up and graded and compacted to blend in with the adjacent natural contours.

2A.5 EXISTING ROADS. Designated existing roads which are within the Company's property limits may be used as construction roads. All other existing roads within the construction area shall be closed and surface broken up and disposed of on the site at a location designated by the Engineer.

2A.6 EXISTING RAILROADS. Existing railroad spurs designated for removal shall be dismantled as specified hereinafter.

2A.6.1 Hardware. Existing track hardware, including rails, joint bars, and spikes shall be carefully removed and all reusable materials stockpiled as directed by the Engineer.

2A.6.2 Crossties. Existing wood crossties shall be removed and disposed of as specified hereinbefore.

2A.6.3 Roadbed. Ballast shall be removed from the existing roadbed and disposed of as directed by the Engineer. The rest of the roadbed shall be left in place or graded as indicated on the drawings or specified herein.

2A.7 EXISTING OIL AND GAS WELLS. Upon discovery of an existing oil or gas well, the Contractor shall immediately notify the Engineer of the location and condition of the well. The Engineer will subsequently assess the situation and will issue the proper instructions for the Contractor to proceed with his work.

At least one well is known to exist within the limits of construction and its location is identified on the drawings. This well has already been plugged by the Company.

2A.8 EXISTING DRAINAGE CULVERTS. The Contractor shall remove and dispose of all existing drainage culverts designated for removal by the Engineer.

Section 2B - EARTHWORK

2B.1 GENERAL. This section covers general earthwork and shall include the necessary preparation of the construction areas; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent construction; backfilling; pipe embedment; construction of fills and embankments; railroad upgrading; surfacing and grading; and other appurtenant work.

The Contractor shall locate and stake all existing underground utilities before any earthwork is started. Earthwork and blasting operations in the vicinity of these underground utilities shall be performed in a manner that will not damage these facilities.

2B.2 SHEETING AND SHORING. The stability of previously constructed structures and facilities shall not be impaired or endangered by excavation work. Previously constructed structures and facilities include both structures and facilities existing when this construction began and structures and facilities already provided under these specifications.

Hazardous and dangerous conditions shall be prevented and the safety of personnel shall be maintained. Adequate sheeting and shoring shall be provided as required to protect and maintain the stability of previously constructed structures and facilities and the sides of excavations and trenches until they are backfilled. Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure, and shall be rigid, maintaining shape and position under all circumstances.

2B.3 REMOVAL OF WATER. The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations and other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the construction to be provided therein under these specifications is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result. Ground water level shall be maintained at least 12 inches below the bottom of each excavation.

2B.4 BLASTING. The Contractor shall comply with the provisions of Section 2C regarding the use of explosives.

2B.5 CLASSIFICATION OF EXCAVATED MATERIALS. Classification of excavated materials will be made as follows:

a. Rock. Rock is defined as being limestone, hard shale or similar material in masses more than 1/2 cubic yard in volume; or in ledges 4 inches or more in thickness which would require blasting for excavation.

b. Earth. All material not classified as rock

The term "excavated materials", as used herein, shall mean either material removed by cutting or material deposited as fill.

Soil identification shall be in accordance with Table 1 of the Unified Soil Classification System which is bound herewith at the end of this section. Identification and classification shall be based upon visual examination and simple manual tests performed by qualified personnel furnished by the Contractor. Classification of material shall be subject to acceptance of the Engineer.

2B.6 FREEZING WEATHER RESTRICTIONS. Backfilling and construction of fills during freezing weather shall not be done except by permission of the Engineer. No earth material shall be placed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill or embankment.

2B.7 MAINTENANCE OF TRAFFIC. The Contractor shall conduct his work so as to interfere as little as possible with the Company's operations and the work of other contractors. Whenever it is necessary to cross obstruct, or close roads and parking areas, the Contractor shall provide and maintain suitable and safe bridges, detours, or other temporary expedients at his own expense.

2B.8 PROTECTION OF UNDERGROUND CONSTRUCTION. The Contractor shall locate, protect, shore, brace, support, and maintain all existing underground pipes, conduits, drains, and other underground construction which may be uncovered or otherwise be affected by the work.

2B.8.1 Protection of Existing Gas Piping. The Contractor will be required to construct road or railroad roadbeds above existing gas pipelines as indicated on the drawings. A minimum cover of 3 feet shall be maintained at all times for all grading and compaction operations at these locations.

Casing for the gas lines has been installed by the Company where deemed necessary.

2B.9 PRESERVATION OF TREES. Trees shall be preserved and protected as much as possible. Unless specifically authorized by the Engineer, trees shall be removed from only those areas which will be excavated, filled, or built upon. Consideration will be given to the removal of additional trees only where essential, in the opinion of the Engineer, for the safe, effective execution of the work.

Trees left standing shall be adequately protected from permanent damage by construction operations. Trimming of standing trees, where required, shall be as directed by the Engineer.

2B.10 STABILIZATION. Subgrades for structures and the bottom of trenches shall be firm, dense, and thoroughly compacted and consolidated.

Subgrades for structures and trench bottoms which are otherwise solid but which become mucky on top due to construction operations, shall be reinforced with one or more layers of crushed rock or gravel.

The finished elevation of stabilized structure subgrades shall not be above the subgrade elevations indicated on the drawings. Over excavation shall be replaced by concrete as directed by the Engineer and at the expense of the Contractor.

Not more than 1/2 inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe embedment material is placed thereon.

All stabilization work shall be performed by and at the expense of the Contractor.

2B.11 TESTING. All field and laboratory testing required to determine compliance with the compaction and moisture requirements of this section will be provided by a testing laboratory retained and paid for by the Company. The Contractor shall provide the services of one or more employees as necessary to assist the Company's field testing representative. The Contractor will be furnished one copy of the test results.

Maximum density for cohesive compacted materials placed under this section will be determined in accordance with ASTM D1557. The terms "maximum density" and "optimum moisture content" shall be as defined in ASTM D1557.

Relative density for noncohesive compacted materials placed under this section will be determined in accordance with ASTM D2049. The term "relative density" shall be as defined in ASTM D2049.

2B.12 SITE PREPARATION. Major clearing and grubbing work shall be performed as described in Section 2A. In addition, all subgrades for permanent construction, including subgrades for fills shall be stripped

of surface vegetation, sod, debris, and organic topsoil. Surface vegetation shall be removed complete with roots to a depth of not less than 4 inches below the ground surface.

All combustible and other waste materials shall be removed from the construction areas and disposed of by and at the expense of the Contractor. Fire regulations and other safety precautions shall be observed when waste materials are burned.

All organic topsoil which is free of trash, vegetation, rocks, and roots shall be stockpiled at locations selected by the Engineer for later use under these specifications and under separate specifications. The Contractor shall stockpile, for use under separate specifications, 10,000 cubic yards of organic topsoil in excess of the amount required under these specifications.

2B.13 ROADWAY AND RAILROAD ROADBEDS. Roadway and railroad roadbed construction shall include subgrade preparation, materials, placement and compaction, subgrade finishing, slope protection and maintenance of roadbed fills.

2B.13.1 Subgrade Preparation. The roadbed site shall be prepared as specified in Article 2B.12. Prior to placement of roadbed fill, part of the subgrade shall be removed, as indicated on the drawings, and backfilled with material suitable for embankment construction. The subgrade shall then be thoroughly compacted. After compaction, the areas shall be proof rolled by a single pass of a vibratory roller to test for uniformity and any loose soils detected shall be recompacted as specified for roadbed fills. No material shall be placed in the roadbed until the subgrade has been properly prepared and acceptable to the Engineer.

In excavated roadbed areas, overburden shall be removed and the subgrade shall be shaped to the lines, grades and cross sections indicated on the drawings. If the subgrade is in overburden it shall be further removed to a depth of at least 24 inches and compacted to a minimum of 92 per cent of maximum density with moisture content between 0 to 4 per cent above optimum. This operation shall include any scarifying, reshaping and wetting required to obtain the specified moisture and density. After compaction the subgrade shall be proof rolled as previously specified. Soft or otherwise unsuitable material shall be removed from the subgrade and replaced with material specified hereinafter for roadbed fills.

Removal of the overburden to a depth of 24 inches may be waived by the Engineer if the insitu material has the specified moisture and density.

2B.13.1.1 Special Subgrade Preparation. Special subgrade preparation is required when any of the following conditions are encountered:

1. Continuous overburden cover consists only of topsoil.
2. Continuous overburden cover is less than 6 inches thick after stripping.
3. Overburden is not continuous and rock is exposed at the ground surface.

The special subgrade preparation shall consist of the following:

1. All overburden shall be removed.
2. Loose rock and overhanging ledges shall be removed.
3. The exposed rock surface shall be brushed clean.
4. Foundation area shall be wetted prior to placement of first lift.
5. The first lift shall be placed a minimum of one foot thick at a moisture content between 4 and 5 per cent above optimum.

Special subgrade preparation shall be limited to a distance of H plus 15 feet on either side of the embankment center line, where H is the height of the embankment as indicated on the drawings.

2B.13.2 Materials. To the maximum extent available, suitable earth materials obtained from excavations classified "excavated materials" shall be used for construction of roadbed fills. Additional material, if required, shall be obtained from borrow areas as designated on the drawings.

* All materials placed in roadbed fills shall be free from brush, stumps, logs, roots, debris, and organic or other objectionable material. No rocks or stones shall be placed in the upper 24 inches of any roadbed fill. Rocks or stones less than 4 inches in their greatest dimension may be incorporated in the remainder of the fill provided they are distributed so that they do not interfere with proper compaction.

All material within the finished subgrade, in both cut and fill sections, shall be material classified as Group CL, SC or GC as indicated on the Unified Soil Classification chart bound at the end of this section. Crushed rock material may also be used, provided it meets the requirements for maximum size and those of Article 2B.13.3 for compaction.

Roadway and railroad roadbeds indicated as impervious embankments shall meet the requirements specified in Article 2B.14.2.

** 2B.13.3 Placement and Compaction. All roadbed fill materials shall be placed in approximately horizontal layers not to exceed 8 inches in

* Refer to Item 6 of Addendum 1.
** Refer to Item 7 of Addendum 1.

* uncompacted thickness. Material deposited in windrows or piles by excavating or hauling equipment shall be spread and leveled before compaction.

Each layer of material being compacted shall be uniformly compacted using equipment and materials which will achieve the specified density and moisture content. The Contractor shall add water and harrow, disc, blade, or otherwise work the material in each layer as required to ensure uniform moisture content and adequate compaction. If the material fails to meet the specified density and moisture content requirements the lift shall be broken up and reprocessed until the specified requirements are met.

The upper portion of the finished subgrade shall consist of the upper 4 feet for railroad roadbeds and of the upper 2 feet for roadway roadbeds.

All material placed in the upper portion of the finished subgrade shall be compacted to a density of 95 per cent of maximum density at optimum moisture content. The final in-place moisture content shall be within a range of 0 to 4 per cent above optimum.

All material placed in roadbed fills below the upper portion of the finished subgrade shall be compacted to a density of 92 per cent of maximum density at optimum moisture content. The final in-place moisture content shall be within a range of 0 to 4 per cent above optimum.

2B.13.4 Subgrade Finishing. The finished subgrade shall be compacted to a true surface and no depression shall be left that will hold water or prevent proper drainage. The finished subgrade shall be within 0.1 foot of the elevation indicated on the drawings. Any deviation of the subgrade surface in excess of one inch as indicated by a 16 foot straightedge, or template cut to finished section, shall be corrected by loosening, adding or removing material, reshaping, and recompacting.

Drains and ditches along the subgrade shall be maintained as required for effective drainage. Whenever ruts of 2 inches or more in depth are formed, the subgrade shall be brought to grade, reshaped, and recompacted. Storage or stock piling of materials on the subgrade will not be permitted.

2B.13.5 Slope Protection. The slopes of all roadway and railroad roadbed areas shall be protected by placing 6 inches of topsoil and seeding as indicated on the drawings. Ditches, where required next to the roadbeds, shall have 3 inches of topsoil and shall be seeded. Seeding, fertilizing and mulching are covered in Section 2K.

All slope protection work shall be performed as soon after completion of the roadbed as possible.

* Refer to Item 7 of Addendum 1.

2B.13.6 Maintenance. Railroad and roadway finished subgrade shall be maintained throughout the work under these specifications. Roadway surfacing shall be as specified in Sections 2D and 2G and as indicated on the drawings. Railroad subballast shall be as specified in Sections 2D and 2F and as indicated on the drawings. Railroad trackwork will be performed under separate specifications.

2B.14 IMPERVIOUS EMBANKMENTS. Impervious embankment construction shall include subgrade preparation, materials, installation of drainage blanket, placement and compaction, subgrade finishing, slope protection with riprap or by seeding, and maintenance.

2B.14.1 Subgrade Preparation. The embankment site shall be prepared as specified in Article 2B.12. Prior to placement of embankment fill, part of the subgrade shall be removed, as indicated on the drawings, and backfilled with material suitable for embankment construction. The subgrade shall then be thoroughly compacted. After compaction, the areas shall be proof rolled by a single pass of a vibratory roller to test for uniformity and any loose soils detected shall be recompacted as specified. No material shall be placed in the embankment until the subgrade has been properly prepared and is acceptable to the Engineer.

Soft or otherwise unsuitable material shall be removed from the subgrade to the depth authorized by the Engineer and replaced with material hereinafter specified for impervious embankment.

If the impervious embankment is also a roadway, a railroad roadbed, or requires special subgrade preparation, the subgrade shall be further prepared as specified in Article 2B.13.1.

2B.14.2 Materials. To the maximum extent available, suitable earth materials obtained from excavations classified "excavated materials" shall be used for construction of the impervious embankments. Additional material, if any, shall be obtained from borrow areas as indicated on the drawings.

All material placed in the embankment fill, inner core and drainage blanket shall be free from trash, concrete and other foreign material.

* Classification of material to be used in the inner core shall be CL. Material to be used in the remainder of the embankment shall be CL, SC or GC. Crushed rock may also be used provided it meets the compaction requirements of Article 2B.14.3. Drainage blanket material, as well as material for riprap and riprap bedding shall meet the requirements of Section 2D.

Where the impervious embankment is also a roadway or railroad roadbed, materials shall conform to the requirements of Article 2B.13.2.

* Refer to Item 8 of Addendum 1.

2B.14.3 Placement and Compaction. The entire body of the fill, including upstream and downstream portions, shall be placed and carried up at the same rate, with provision being made to bond the layers of adjoining sections together. Where it is impractical, in the opinion of the Engineer, to carry up each layer of fill over the entire area at the same time, the slope of any existing fill, or the slope of the natural ground, against which new fill material is placed, shall be cut or plowed into benches having level beds and vertical sides, and each layer of new fill shall terminate in such a bench. In no case shall the horizontal width of the bench be less than the depth of the layer of fill to be bedded therein nor shall the vertical side of the bench be greater in height than one foot.

All fill material shall be placed in the embankment parallel to the axis of the embankment in approximately horizontal layers not to exceed 8 inches in uncompacted thickness over the prepared foundation or fill. The embankment fill shall be constructed by placing the material as indicated on the drawings. Proper equipment shall be used on each lift to remove mounds and ridges caused by dumping operations and to obtain uniform thickness prior to compacting, as well as to provide a reasonably smooth riding surface for equipment. After each layer has been properly spread, it shall be sprinkled or wetted if necessary to provide the required amount of water for proper compaction and worked to ensure uniform moisture content, after which the layer shall be compacted to the required density before the next layer is placed thereon. Combined excavation, hauling, and placing operations shall be such that the materials, when compacted in the embankment, will be blended sufficiently to secure the best practicable degree of compaction, impermeability, and stability.

The Contractor will be required to break up the earthfill materials, either at the place of excavation or on the embankment, to such maximum size as is determined necessary by the Engineer to secure the specified density of the material in the embankment. Equipment on the embankment shall spread out and not track each other to such an extent as to make ruts. The top surface of the fill shall be kept crowned, with grades not to exceed 2 per cent, to ensure free drainage toward the slopes. The rolled surface of each lift shall be roughened or loosened by scarifying to the satisfaction of the Engineer, before the succeeding layer is placed thereon, in order to provide the necessary bond between each lift.

Prior to and during the compacting operations, the material in each layer of the embankment shall have the best practicable moisture content, and the moisture content shall be uniform throughout the layer. To obtain the best practicable moisture content the Contractor will be required to perform such operations as are necessary. Supplementary water, as required, shall be added to the material on the earthfill. If

the fill material in borrow areas or other excavations contains an excess of moisture prior to excavation, the Contractor will be required to excavate drainage channels or perform such work as may be necessary to reduce the moisture content of the material. Working of the material on the embankment may be required to produce the required uniformity of water content.

Water required to bring the material to the moisture content necessary for maximum compaction shall be evenly applied and it shall be the Contractor's responsibility to secure a uniform moisture content throughout the layer by such methods as may be necessary. Compaction shall commence immediately after the layer has been brought to the uniform moisture content required, and shall continue, with or without additional watering, until each layer has been uniformly compacted to not less than the specified density. Density tests will be made as necessary. If the material fails to meet the density specified the compaction methods shall be altered to obtain the specified density.

In restricted areas successive passes of the compaction equipment need not overlap but uniform compaction is required. Where new material is placed adjacent to old material, either original ground or embankment fill, the old material shall be cut or broken by machine or hand methods until it shows the characteristic color of undried materials. The compaction equipment shall then work on both materials, bonding them together.

The embankment material including the inner core shall be compacted to a density of 92 per cent of maximum density at optimum moisture content. The final in-place moisture content shall be within a range of 0 to 4 per cent above optimum.

Where the impervious embankment is also a roadway or railroad roadbed, the compaction requirements of Article 2B.13.3 shall be met.

The drainage blanket, where required, shall be placed in horizontal layers not more than 6 inches in thickness, shall be compacted to 70 per cent relative density as determined by ASTM D2049 and shall have a compacted depth as indicated on the drawings.

Riprap and riprap bedding shall have minimum in-place depths as indicated on the drawings and shall conform to the requirements of Section 2E.

2B.14.4 Subgrade Finishing. Subgrade finishing shall be performed in accordance with the requirements of Article 2B.13.4.

2B.14.5 Slope Protection. The slopes of all impervious embankments shall be protected by placing riprap and riprap bedding or 6 inches of topsoil and seeding as indicated on the drawings. The downstream toes

of the embankments shall be protected with riprap and riprap bedding where indicated on the drawings. Seeding, fertilizing and mulching are covered in Section 2K. Riprap and riprap bedding are covered in Sections 2D and 2E.

All slope protection work shall be performed as soon after completion of the embankment as possible.

2B.14.6 Maintenance. The finished impervious embankment shall be maintained throughout the work under these specifications. Where the impervious embankment also serves as a railroad or roadway roadbed, the requirements of Article 2B.13.6 shall also apply.

2B.15 STACKER-RECLAIMER BERM. Construction of the stacker-reclaimer berm shall include subgrade preparation, materials, placement and compaction, subgrade finishing and soil cement application.

2B.15.1 Subgrade Preparation. The berm site shall be prepared as specified in Article 2B.12. Preparation of the subgrade shall be as specified in Article 2B.13.1.

2B.15.2 Materials. To the maximum extent available, suitable earth materials obtained from excavations classified "excavated materials" shall be used for construction of the stacker-reclaimer berm. Additional material, if any, shall be obtained from borrow areas as designated on the drawings.

All material placed in the embankment shall be free from trash, concrete, and other foreign material.

No rocks or stones shall be placed in the upper 24 inches of the embank-
* ment. ~~Rocks or stones less than 4 inches in their greatest dimension may be incorporated in the remainder of the embankment provided they are distributed so that they do not interfere with proper compaction.~~

All material within the finished subgrade shall meet the requirements of Article 2B.13.2.

2B.15.3 Placement and Compaction. All embankment fill material shall be placed and compacted as specified in Article 2B.13.3 for railroad roadbeds.

2B.15.4 Soil-cement. Soil-cement preparation, placing and compaction shall be as specified in Section 2H.

2B.16 GENERAL FILLS. Construction of general fills shall include materials, subgrade preparation, and placement and compaction.

* Deleted in accordance with Item 9 of Addendum 1.

2B.16.1 Materials. To the maximum extent available, suitable earth materials obtained from excavations classified "excavated materials" shall be used for construction of general fills. Additional material, if any, shall be obtained from borrow areas as indicated on the drawings.

* All materials placed in general fills shall be free from rocks and stones larger than 6 inches in their greatest dimension, brush, stumps, logs, roots, debris, and organic and other objectionable materials. No rocks or stones shall be placed in the upper 24 inches of any general fill. Rocks or stones less than 6 inches in their greatest dimension may be incorporated in the remainder of the fill provided they are distributed so that they do not interfere with proper compaction.

All onsite available earth material, except objectionable material specified above, may be utilized in construction of general fills including material classified as Groups CL, ML, SM-SC, ML-CL, CL-CH and SM.

2B.16.2 Subgrade Preparation. After preparation of the general fill site, the subgrade shall be leveled and rolled so surface materials of the subgrade will be as compact and well bonded with the first layer of the general fill as specified for subsequent layers.

** 2B.16.3 Placement and Compaction. All general fill materials shall be placed in approximately horizontal layers not to exceed 8 inches in uncompacted thickness. Material deposited in piles or windrows by excavating and hauling equipment shall be spread and leveled before compaction.

Each layer of material being compacted shall be uniformly compacted using equipment and methods which will achieve the specified density and moisture content. The Contractor shall add water and harrow, disc, blade, or otherwise work the material in each layer as required to ensure uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted by rolling or other acceptable methods to a density of 85 per cent of maximum density at optimum moisture content. The final in-place moisture content shall be within the limits of 2 per cent below to 5 per cent above optimum moisture. If the material fails to meet the moisture density requirements the lift shall be broken up and reprocessed until the specified requirements are met.

2B.17 COAL RETENTION BERM. Construction of the coal retention berm shall include subgrade preparation, materials, placement and compaction, subgrade finishing and soil cement application.

2B.17.1 Subgrade Preparation. The berm site shall be prepared as specified in Article 2B.12. Preparation of the subgrade shall be as specified in Article 2B.16.2.

* Refer to Item 10 of Addendum 1.
** Refer to Item 11 of Addendum 1.

2B.17.2 Materials. Materials placed in the coal retention berm shall be as specified in Article 2B.16.1.

2B.17.3 Placement and Compaction. All fill material shall be placed and compacted as specified in Article 2B.16.3.

2B.17.4 Soil-cement. Soil-cement preparation, placing and compaction shall be as specified in Section 2H.

2B.18 BORROW AREAS. To the maximum extent available, suitable earth and crushed rock materials obtained from excavations classified "excavated materials" shall be used for construction of roadway and railroad roadbeds, general fills, impervious embankments, stacker-reclaimer and coal retention berms, structure backfill and structural compaction. If additional earth material is necessary to complete earthwork under these specifications, the material shall be obtained from borrow areas designated on the drawings. Additional rock material shall be obtained from the area designated as quarry on the drawings.

The location, size, shape, depth, drainage and surfacing of all borrow areas shall be acceptable to the Engineer. Borrow areas shall be regular in shape, with finish graded surfaces when completed. Side slopes shall be three horizontal to one vertical, and shall be uniform for the
* entire length of any one side.

The quarry shall be extended for depth and size as required, but shall maintain a regular shape. Suitable clearance shall be provided from nearby embankments to guarantee their stability. The lowest lip of the quarry shall be no higher than Elevation 620'-0".

2B.19 STRUCTURE EXCAVATION. Excavation for structures shall be done to lines and elevations indicated on the drawings and to the limits required to perform the construction work. Machine excavation shall be controlled to prevent undercutting the proper subgrade elevations.

Work shall be done so that the construction areas will be as free as possible from obstructions and from interference with the transportation, storage, or handling of materials. Excavated materials free of trash, rocks, roots, and other foreign materials, and which meet the specified requirements, may be used as required for the fills, embankments, and backfills constructed under these specifications.

Vertical faces of excavations shall not be undercut to provide for extended footings.

2B.20 STRUCTURE BACKFILL. Backfill around and outside of structures shall be deposited in layers not to exceed 6 inches in uncompacted thickness and mechanically compacted, using platform type tampers, to at

* Refer to Item 12 of Addendum 1.

least 95 per cent of maximum density at optimum moisture content as determined by ASTM D698 when that test is appropriate, or to 70 per cent relative density as determined by ASTM D2049 when that test is appropriate. Compaction of structure backfill by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Compaction of structure backfill by inundation with water will not be permitted.

Material for structure backfill shall be composed of earth only and shall contain no wood, grass, roots, broken concrete, stones, trash, or debris of any kind.

No tamped, rolled, or otherwise mechanically compacted backfill shall be deposited or compacted in water.

All backfill material shall consist of loose earth having a moisture content such that the required density of the compacted soil will be obtained with the compaction method used. Moisture content shall be distributed uniformly and water for correction of moisture content shall be added sufficiently in advance so that proper moisture distribution and compaction will be obtained. Granular material shall be wet, not just damp, when compacted.

Particular care shall be taken to compact structure backfill which will be beneath pipes, drives, roads, or other surface construction or structures. In addition, wherever a trench will pass through structure backfill, the structure backfill shall be placed and compacted to an elevation at least 12 inches above the top of the pipe before the trench is excavated.

2B.21 COMPACTED ROCK FILL. Compacted rock fill materials shall be in accordance with the requirements of Section 2D. The rock fill shall be placed on undisturbed subgrade and compacted to maximum density. Compaction shall be performed with vibrating mechanical compactors unless otherwise acceptable to the Engineer.

Crushed rock for compacted rock fill shall be handled and placed in a manner that will prevent segregation of sizes. The fill material shall have the best practicable moisture content to achieve maximum density with the compaction methods used. The material shall be placed in horizontal layers not more than 6 inches in uncompacted thickness.

If concrete is to be placed on the compacted rock fill, the fill shall be finished with a thin layer of clean concrete sand to fill all voids and interstices and to obtain the required subgrade elevation. A polyethylene film moisture barrier shall be placed over the sand as specified in the cast-in-place concrete section.

2B.22 PIPE TRENCH EXCAVATION. The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work.

All trench excavation shall be open cut from the surface.

2B.22.1 Alignment and Grade. The alignment and grade or elevation of each pipeline shall be fixed and determined by means of batter boards and offset stakes unless otherwise accepted. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of the specification section covering installation of pipe.

2B.22.2 Limiting Trench Widths. Trenches shall be excavated to the width indicated on the drawings or, if not indicated, to a width which will provide adequate working space and pipe clearance for proper pipe installation, jointing, and embedment. However, the width of trench below an elevation 6 inches above the top of the pipe shall not be more than 18 inches greater than the outside diameter of the pipe unless otherwise indicated on the drawings.

Where necessary to reduce earth load on trench banks to prevent sliding and caving, banks may be cut back on slopes which shall not extend lower than one foot above the top of the pipe.

2B.22.3 Unauthorized Trench Widths. Where, for any reason, the width of the lower portion of the excavated trench exceeds the maximum specified, pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the expense of the Contractor.

2B.22.4 Mechanical Excavation. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand excavating methods shall be used.

All mechanical trenching equipment, its operating condition, and the manner of its operation, shall be subject to the Engineer's acceptance at all times.

2B.22.5 Trench Depth. Except where otherwise required for rock clearance or trench bottom stabilization, pipe trenches shall be excavated to the depth required for the installation of granular embedment pipe foundation material below the underside of the pipe as indicated on the sketch bound at the end of this section.

2B.22.6 Bell Holes. Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or

coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

2B.23 PIPE EMBEDMENT. Embedment materials both below and above the bottom of the pipe, classes of embedment to be used, and placement and compaction of embedment materials shall conform to the requirements indicated on the sketch attached at the end of this section, and to the following supplementary requirements.

Third-class granular embedment material shall be used for all drainage pipes and the cast iron water line. Granular embedment material shall be on-site crushed rock or gravel which shall have a gradation such that
* 95 per cent of the material shall pass a 1/2 inch sieve and not more than 5 per cent shall pass a No. 4 sieve.

2B.23.1 Placement and Compaction. Embedment material shall be spread on the trench bottom and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. The material shall be compacted with vibrating platform type compactors. Compactive effort and moisture content shall be adjusted to provide a firm but slightly yielding support for the pipe. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle.

After each pipe has been graded, aligned, and placed in final position on the bedding material, and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.

Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement. Embedment material shall be placed in layers of 8 inches or less and each layer shall be uniformly compacted. Granular embedment shall be compacted to 70 per cent of relative density as determined by ASTM D2049.

All tools used in the placement and compaction of the embedment of coated pipe shall be selected and used so that the pipe coating will not be damaged.

Third-class embedment shall extend not less than 1/6 of the outside diameter above the pipe bottom.

2B.24 TRENCH BACKFILL. All trench backfill above pipe embedment shall conform to the following requirements.

* Refer to Item 12 of Contractor's letter dated August 16, 1975.

2B.24.1 Compacted Backfill. Compacted backfill will be required for the full depth of the trench above the embedment.

Compacted backfill material shall meet the requirements specified hereinafter. Compacted backfill material shall be suitable job excavated material.

Compacted backfill material shall be finely divided and free from debris, organic material, and stones larger than 3 inches in greatest dimension. Compacted backfill material shall be placed in uniform layers not exceeding 8 inches in uncompacted thickness. Increased layer thickness may be permitted for noncohesive material if the Contractor demonstrates to the satisfaction of the Engineer that the specified compacted density will be obtained. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe. Trench backfill shall be compacted to not less than 90 per cent of maximum density. Backfill for trenches traversing subgrades of roads, railroads, parking areas, underground piping, underground electrical ducts and conduit, and other facilities subject to damage by settlement shall be compacted to not less than 95 per cent of maximum density. Moisture content of backfill material shall be adjusted as required to obtain the specified density with the compaction equipment used.

Cohesive backfill material shall be compacted to the densities specified hereinbefore as determined by ASTM D698. If noncohesive material is used, compaction shall be to 70 per cent relative density as determined by ASTM D2049.

2B.25 DUCT BANK TRENCHING. Trenches for duct banks shall be carefully dug to lines indicated on the drawings or at other locations acceptable to the Engineer, and to the exact depth required for the proper grade of the ducts with encasement. Wherever possible, the trenches shall be excavated to permit the duct bank to rest on undisturbed earth or rock. Where it is necessary to trench through backfill, the earth shall be well compacted before the duct bank is installed.

All trenches shall be wide enough to provide ample room for workmen engaged in handling and installing ducts. Where it is necessary to reduce the earth load on trench banks to prevent sliding or caving, such trench banks may be cut back on slopes which shall not extend lower than one foot above the top of the duct bank.

A small section of duct bank indicated on the drawings shall be installed and backfilled under these specifications. Installation of the duct bank shall be in conformance with the requirements of Section 2P. The remainder of the duct bank installation and trench backfill will be performed under separate specifications. The Contractor shall be responsible for the condition of all duct bank trenches excavated under this Contract until final acceptance of the work under these specifications.

Duct bank backfill shall be compacted backfill. Backfill material for duct banks shall be suitable job excavated material.

Compacted backfill material shall be finely divided and free from debris, organic material, and stones larger than 3 inches in greatest dimension. Compacted backfill material shall be placed in uniform layers not exceeding 8 inches in uncompacted thickness. Increased layer thickness may be permitted for noncohesive material if the Contractor demonstrates to the satisfaction of the Engineer that the specified compacted density will be obtained. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the duct bank. Trench backfill shall be compacted to not less than 95 per cent of maximum density. Moisture content of backfill material shall be adjusted as required to obtain the specified density with the compaction equipment used.

2B.26 PAVEMENT REMOVAL AND REPLACEMENT. Cuts in concrete and asphalt pavement shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances. Cutting shall be started with a concrete saw in a manner which will provide a clean groove at least 1-1/2 inches deep along each side of the trench.

Concrete and asphalt pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 6 inches in width at any point is left between the cut edge of the pavement and the top edge of the trench. Trench width at the bottom shall not be greater than at the top and no undercutting will be permitted. Pavement cuts shall be made to and between straight or accurately marked curved lines which, unless otherwise required, shall be parallel to the center line of the trench.

2B.27 MAINTENANCE AND RESTORATION OF FILLS, EMBANKMENTS, AND BACKFILLS. Fills, embankments and backfills that settle or erode before final acceptance of the work under these specifications, and structures and other facilities damaged by such settlement or erosion, shall be repaired. The settled or eroded areas shall be refilled, compacted, and graded to conform to the elevation indicated on the drawings or to the elevation of the adjacent ground surface. Damaged facilities shall be repaired in a manner acceptable to the Engineer.

2B.28 FINAL GRADING. After all construction work under these specifications has been completed, all ground surface areas disturbed by this construction or construction plant and operations shall be graded. The grading shall be finished to the contours and elevations indicated on the drawings or, if not indicated, to the matching contours and elevations of the original, undisturbed ground surface. In any event, the final grading shall provide smooth uniform surfacing and effective drainage of the ground areas.

Topsoil shall be furnished in the areas and to the depths indicated on the drawings for the soil erosion protection work. Topsoil shall be provided as specified under Article 2B.12.

2B.29 DISPOSITION OF MATERIALS. Excavated earth material shall be used to construct fills, embankments and backfills to the extent required. Excavated rock shall be crushed as specified in Section 2D. Surplus earth, if any, and materials which are not suitable for fills, embankments, and backfills shall be spoiled on the site in a manner and location as directed by the Engineer.

Materials shall be deposited in the disposal areas and leveled and compacted in 12 inch maximum layers. Compaction shall be by three passes of a bulldozer.

2B.30 RAILROAD UPGRADING. Railroad upgrading work on the existing railroad tracks indicated on the drawings shall be performed according to the following requirements.

2B.30.1 Existing Track Removal. Existing trackage removal shall be performed as specified in Article 2A.6.

2B.30.2 Roadbed Construction. The existing roadbed shall be regraded and constructed as specified in Article 2B.13.

2B.30.3 Trackage. Railroad trackage will be installed under separate specifications.

Section 2E - RIPRAP AND RIPRAP BEDDING

2E.1 GENERAL. This section covers procedures for the installation of dumped riprap and riprap bedding.

Riprap and riprap bedding shall be required at the locations indicated on the drawings. Thickness of riprap and riprap bedding shall be as indicated on the drawings.

2E.2 MATERIALS. Riprap and riprap bedding materials shall be in accordance with the requirements of Section 2D.

2E.3 PLACEMENT. Dumped riprap and riprap bedding materials shall be placed on slopes designated on the drawings. Earth slopes shall be compacted as specified in the section covering construction of the slope.

Where required by the drawings, a riprap bedding blanket shall be placed on the prepared slope or area to the full specified thickness of each layer in one operation, using methods which will not cause segregation of particle sizes within the bedding. The surface of the finished layer should be reasonably even and free from mounds or windrows. Additional layers of bedding material, when required, shall be placed in the same manner, using methods which will not cause mixture of the material in different layers.

Stone for riprap shall be placed on the prepared slope or area in a manner which will produce a reasonably well graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed in conformance with the lines, grades, and thicknesses indicated on the drawings. Riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

The larger stones shall be well distributed and the entire mass of stone shall conform to the gradation specified. All material placed as riprap protection shall be so placed and distributed that there will be no large accumulations of either the larger or smaller sizes of stone.

It is the intent of these specifications to produce fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Stone fragments in riprap shall be dumped and graded off in a manner which will insure that the larger rock fragments are uniformly distributed and that the smaller rock fragments fill the spaces between the large rock fragments. The result shall be a compact, uniform riprap layer of the specified thickness. Hand placing will be required only to the extent necessary to obtain the results specified above.

Section 2F - RAILROAD SUBBALLAST

2F.1 GENERAL. This section covers procedures for the construction of railroad subballast.

2F.2 TESTING. All field and laboratory testing required to determine compliance with the requirements of this section will be provided by the Company. The Contractor shall provide the services of one or more employees as necessary to assist the Company's field testing representative. The Contractor will be furnished one copy of the test results.

Maximum density for compacted materials placed under this section will be determined in accordance with ASTM D1557, Method A or C. The terms "maximum density" and "optimum moisture content" will be as defined in ASTM D1557.

At least one field density determination will be required for each 100 cubic yards of compacted material. Field samples will be taken at locations selected by the Engineer. If additional field control tests are necessary, in the opinion of the Engineer, such tests will be made.

Sampling of the subballast materials will be in accordance with ASTM D75.

2F.3 MATERIALS. Subballast materials shall be in accordance with the requirements of Section 2D.

2F.4 SUBGRADE PREPARATION. Prior to the placement of subballast, the subgrade shall be brought to the lines, grades, and cross section indicated on the drawings. Subgrade preparation is covered under Article 2B.13.

2F.5 APPLICATION. The material for subballast shall be handled and spread in a manner that will prevent segregation of sizes. The subballast shall be carefully and uniformly spread, and shall be compacted to the depth indicated on the drawings and to 97 per cent of maximum density. Water shall be added as required for maximum compaction with the equipment used.

The compacted subballast shall be free of ruts, depressions, and other surface disturbances and shall be finished to the lines, grades and cross section indicated on the drawings.

Section 2G - CRUSHED ROCK SURFACING

2G.1 GENERAL. This section covers construction procedures for crushed rock surfacing.

Major earthwork for roadways to be surfaced shall be as specified in Section 2B.

Surfaced areas shall be maintained by the Contractor until final acceptance of the work under these specifications.

2G.2 SUBGRADES. The preparation and protection of subgrades is covered in Article 2B.13. In no case shall any surfacing be placed on a muddy subgrade. Storage or stockpiling of materials on the subgrade will not be permitted.

2G.3 MATERIALS. Crushed rock surfacing materials shall be in accordance with the requirements of Section 2D.

Dust palliative materials shall conform to the following requirements:

Medium curing liquid asphalt	AASHTO M82, Grade MC-30 or Grade MC-70
Slow curing liquid asphalt	AASHTO M141, Grade SC-70
Emulsified asphalt	AASHTO M140, Grade SS-1

2G.4 APPLICATION. The surfacing shall be applied in two equal courses having a total compacted thickness of 8 inches. The base course shall be Type B aggregate and the surface course Type A aggregate.

The aggregate for each course shall be handled and spread in a manner that will prevent segregation of sizes. Each layer shall be carefully and uniformly spread, and when sufficiently deep to form a compacted layer of the specified thickness, it shall be rolled with at least four passes of a road type vibratory compactor or pneumatic tired roller until it is compacted to not less than 95 per cent of maximum density at optimum moisture content.

The completed road surfacing shall be free of ruts, depressions, and other surface irregularities and shall be finished to the lines, grades, and cross section indicated on the drawings.

2G.5 DUST PALLIATIVE. Liquid asphalt material shall be applied to the roads and areas so designated on the drawings to serve as a dust palliative. The asphalt material shall be either the slow curing, medium curing, or emulsified type, and shall be applied as directed by the Engineer at a rate not to exceed 0.5 gallons per square yard. If emulsified type asphalt is used, it should be diluted with at least five parts of water by volume.

2G.6 MAINTENANCE. Maintenance of gravel surface roads, storage and parking areas shall consist of daily inspection and periodic maintenance operations by the Contractor throughout the period utilized to complete the work under these specifications. Maintenance operations shall include loosening, adding, and removing material, grading, reshaping, recompacting, and reapplication of dust palliative as required to keep the surfaced areas in first-class condition.

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March 11, 2010

AEP / PSO Region 4 Engineering
3600 South Elwood Avenue
Tulsa, Oklahoma 74107

Attn: Mr. David R. Lee
Civil / Structural Engineer

Re: Final Geotechnical Investigation and Stability Evaluation of Bottom Ash Pond
AEP Northeast Station Units 3 & 4
Oologah, Oklahoma
Standard Testing Project No. 8309-3150

Dear Mr. Lee:

This letter report provides the results of geotechnical study for the referenced project. This study includes monitoring well installation, geotechnical drilling, laboratory testing, and slope stability analysis for the existing ash pond embankment. It is understood that the maximum height of the existing ash pond embankment is 30 feet. The train surcharge loading from your document review comment sheet dated March 3, 2010, is 140 tons per car with car length of 53 feet and loading width of 5 feet.

Narrative descriptions of our findings and recommendations are contained in the body of this report. A vicinity map, a site and boring location plan, the boring logs, and summary of laboratory test results are presented in Attachments "A" through "D" of this report.

Field Work

Monitoring Well Installation

Two (2) borings (B-3 & B-4) were dry drilled with a truck-mounted CME-55 rotary drilling unit equipped with 3.25" I.D. X 7.25" O.D. hollow stem augers (HSA) to the boring termination depths of 10 and 27 feet.

Two (2) 2-inch Schedule 40 PVC monitoring wells were then installed with 2 feet thick of cement grout at both B-3 (MW-1) and B-4 (MW-2), 10 feet thick at B-3 (MW-1) and 2 feet thick at B-4 (MW-2) of bentonite chip seal, 10 feet long at B-3 (MW-1) and 5 feet long at B-4 (MW-2) of Schedule 40

PVC with the slot size of 0.010 inch surrounded with 15 feet thick at B-3 (MW-1) and 6 feet thick at B-4 (MW-2) of 10/20 silica sand pack. Concrete was placed over cement grout at surface. J-Plug caps and locks were also provided for each well. The monitoring well construction diagram is presented in Attachment "E."

Geotechnical Drilling

Four (4) borings (B-1, B-2, B-5 & B-6) were dry drilled with a truck-mounted CME-55 rotary drilling unit equipped with 3.25" I.D. X 7.25" O.D. hollow stem augers (HSA). Standard penetration tests (SPT) used a 1.375" ID split spoon sampler driven by an automatic hammer utilizing a 140 lb. weight falling 30 inches.

Thirteen (13) standard penetration tests were performed in order to estimate the shear strengths of the soils in their natural state. The test was conducted as specified by ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils." The in-situ bearing strength is related to the N-value from this test. "N" is the number of blows required to drive a split-spoon sampler twelve inches, after a 6 inch seating, into undisturbed soil. The soil samples recovered in the split-spoon barrel were removed from the sample tool in the field, visually classified, and labeled according to boring number and depth. Results of the standard penetration tests are denoted at their respective depths on the boring logs.

Seven (7) thin-walled tube samples were taken in the sandy clay and clay soils, in accordance with ASTM D1587.

Laboratory Testing

Subsurface soil samples were visually classified by a geotechnical engineer according to color, texture, and plasticity.

Moisture content tests were performed on split spoon, thin-walled tube, and bag samples, in accordance with ASTM D2216, to determine the in-situ moisture conditions.

Density tests were performed on intact split spoon and thin-walled tube samples in accordance with AASHTO T233.

Atterberg limits tests were performed on seven (7) soil samples to determine the plasticity characteristics and swell potential of the soil. The tests were performed in accordance with ASTM D4318.

Sieve analyses were performed on eight (8) soil samples, in accordance with ASTM D422, for aid in soil classification. These soils were classified according to the Unified Soil Classification System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) soil classification system.

An unconsolidated-undrained (UU) multi-stage triaxial shear test was conducted on one (1) thin-walled tube sample from Boring B-5 at a depth of 8 to 10 feet, in accordance with ASTM D 2850. This test was conducted to determine the angle of internal friction and cohesion of soils representative of those at site. The triaxial test graphical result is presented in Attachment "D" and the angle of internal friction (phi) and cohesion (c) of soils are denoted on the boring log.

Triaxial Shear Test Results				
Boring No.	Soil Description	Depth (feet)	Cohesion, *c* (psi)	Internal friction angle, ϕ (deg)
B-5	Clay	8 - 10	4.8	2.5

Three (3) permeability tests were conducted on three (3) undisturbed thin-walled tube samples from Boring B-1 and B-5 at depths ranging from 8 to 20 feet. This test was performed in accordance with ASTM D5084. The permeability value, "k", was calculated based on the constant-head test which can be expressed as follows:

$$k = \frac{QL}{Ath}$$

Where:

k = permeability
Q = quantity of flow, taken as the average of inflow and outflow
L = length of specimen along path of flow
A = cross-section area of specimen
t = interval of time over which the flow Q occurs
h = difference in hydraulic head across the specimen

The permeability test reports are included in Attachment "D" and the "k" values of the tested samples are denoted at their respective depths on the boring logs.

Permeability Test Results			
Boring No.	Soil Description	Depth (feet)	Permeability (cm/sec)
B-1	Sandy Clay	8 - 10	$2.0X10^{-8}$
B-5	Clay	13 - 15	$1.8X10^{-8}$
	Clay	18 - 20	$1.6X10^{-8}$

Slope Stability Analysis

Using the Methods of Slices with the consideration of train surcharge, and based on the typical soil types of sandy clay and clay with the cohesion of 1075.5 psf and 1296.5 psf, the internal friction angle of 18 degrees and 13 degrees respectively, an average soil unit weight of 124 pcf, and a typical slope height of 30 feet, the analysis results in the computed factors of safety of 1.74 to 1.87 for the 2.5:1 slope. For permanent slopes, a minimum acceptable factor of safety is generally considered to be 1.5. Therefore, these soil conditions can support the designed slope of 2.5:1. The typical cross-section for the analysis is presented in Attachment "F."

We appreciate the opportunity to provide this service on your project. If you have any questions concerning the contents of this letter report, or if we can be of further service, please call us at (405) 528-0541.

Respectfully submitted,
STANDARD TESTING AND ENGINEERING COMPANY

Jieliang Pan, P.E.
Geotechnical Engineer

Ming-Cheng Peter Shau, P.E.
Manager, Geotechnical Services

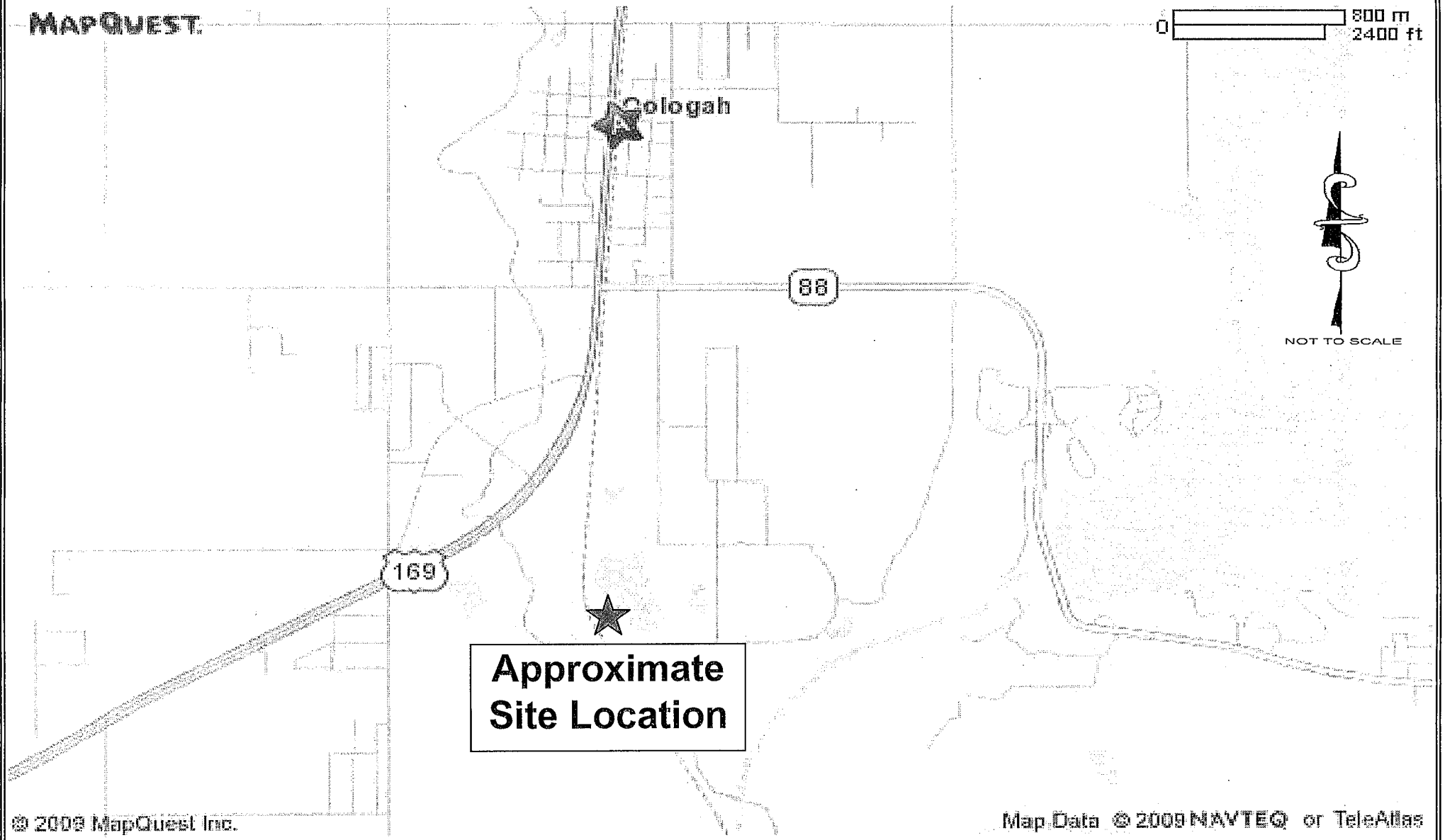
Certificate of Authorization No. 77
Expiration 6/30/11

Attachments (27 pages)

ATTACHMENT A

Vicinity Map

Site and Boring Location Plan



Vicinity Map

Project Name:	Final Geotechnical Investigation and Stability Evaluation of Bottom Ash Pond
Project Location:	Oologah, Oklahoma
Project No.:	8309-3150

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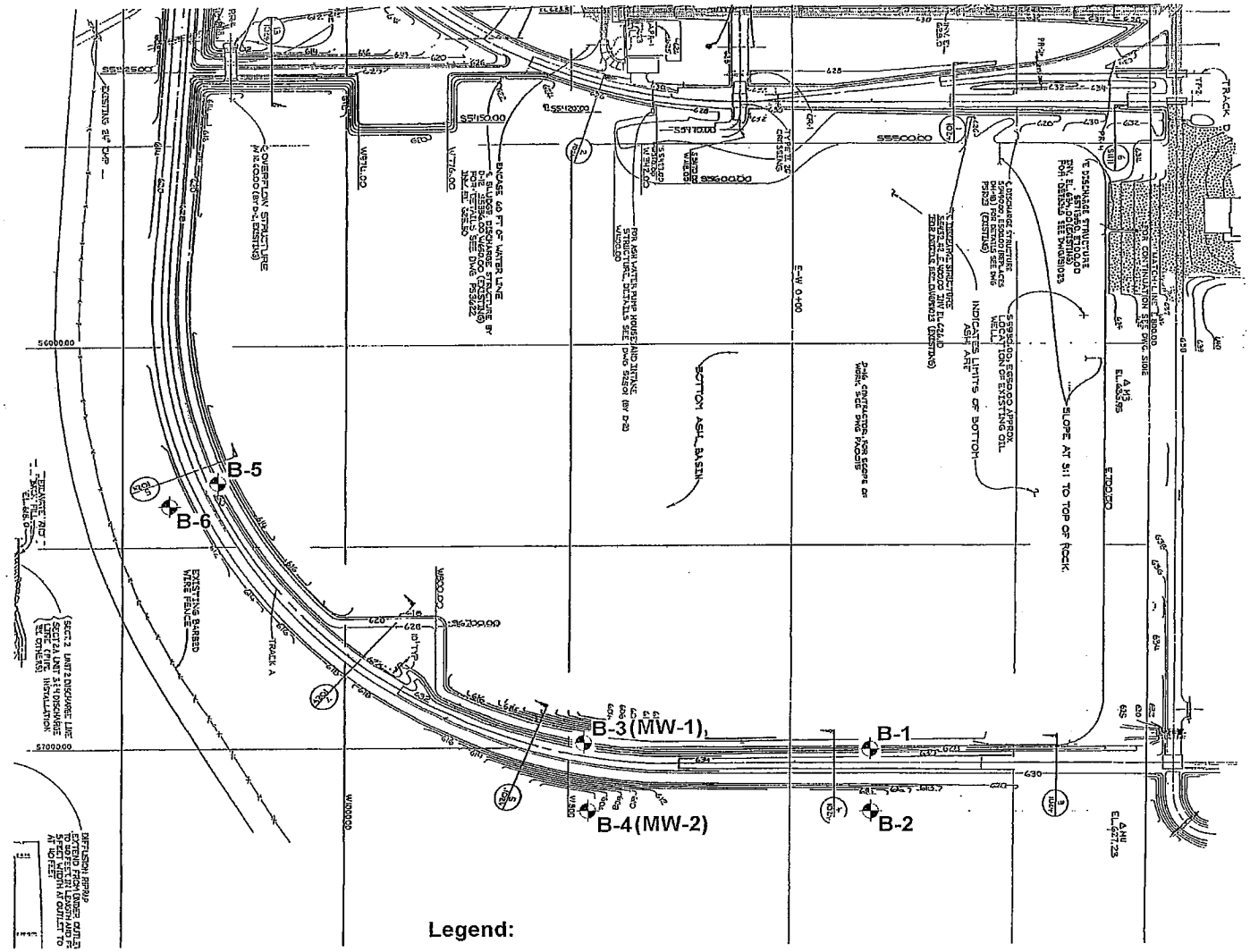

Scale refers to the full size drawing

Legend:

- ⊕ - Approximate Boring Location

MW - Monitoring Well

Site and Boring Location Plan

Project Name:	Final Geotechnical Investigation and Stability Evaluation of Bottom Ash Pond
Project Location:	Oologah, Oklahoma
Project No.:	8309-3150

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ATTACHMENT B

Boring Logs

Key to Symbols

Definition of Descriptive Terms

STANDARD TESTING AND ENGINEERING COMPANY — GEOTECHNICAL SERVICES

SOIL BORING LOG

Boring No. B-1

Project: Final Geo. Inv. and Stability Evaluation of Bottom Ash Pond
Project No.: 8309-3150
Project Location: Oologah, Oklahoma
Date Drilled.: 1/13/10
Boring Location: East on crest of embankment
Project Engineer: Jieliang Pan, P.E.
Drill Method: CME-55 w/ 3.25" I.D. HSA
Field Logger: Jieliang Pan, P.E.
Surface Elevation: 635.45 feet
Water Depth: Dry @ Completion
Remarks: Boring coordinates: S 7016.566; E 213.839

Elev./Depth Feet	Symbol	Samples	SPT Blows/ Increment	Soil Description	Dry Density (pcf)	% Passing #200 Sieve
635 / 0				6" Blk. COAL DUST		31.8
			4/6" 4/6"	Dk. Gray SILTY SAND V. Moist, Nonplastic, Loose USCS: SM; AASHTO: A-2-4		
			2/6" 3/6" 4/6"	Lt. Brn. & Lt. Gray SILTY CLAY WITH SAND Moist, Low Plasticity, Firm USCS: CL-ML; AASHTO: A-4(3)	115	74.3
			1/6"	LL=24, PI=7		
630 / 5			3/6" 4/6" 4/6"	Lt. Brn. & Lt. Gray SANDY CLAY w/ Trace Gravel Moist, Med. Plasticity, Firm	108	
				w/ Trace Gravel Permeability Test: k=2.0E-8 cm/sec (8 to 10 ft.)	118	
625 / 10			3/6" 4/6" 5/6"	w/ Trace Gravel, Stiff USCS: CL; AASHTO: A-6(7) LL=33, PI=17	113	60.7
				w/ Trace Gravel	108	
620 / 15			2/6" 3/6" 4/6"	Lt. Brn. & Lt Gray & Reddish Brn.	105	
				Reddish Brn., w/ Gravel	108	
615 / 20			50/1"	(ROCK) Gray LIMESTONE Sl. Moist, Tr. Plasticity, Medium Hard		
610 / 25						
605 / 30						

Moisture/Plasticity
PL — LL
10 20 30 40 50 60
Water Content, % -
10 20 30 40 50 60

STANDARD TESTING AND ENGINEERING COMPANY

GEOTECHNICAL SERVICES

SOIL BORING LOG

Boring No. B-2

Project: Final Geo. Inv. and Stability Evaluation of Bottom Ash Pond
Project No.: 8309-3150
Project Location: Oologah, Oklahoma
Date Drilled.: 1/13/10
Boring Location: East on downstream toe of embankment
Project Engineer: Jieliang Pan, P.E.
Drill Method: CME-55 w/ 3.25" I.D. HSA
Field Logger: Jieliang Pan, P.E.
Surface Elevation: 615.30 feet
Water Depth: Dry @ Completion
Remarks: Boring coordinates: S 7115.188; E 208.355

Elev./Depth Feet	Symbol	Samples	SPT Blows/ Increment	Soil Description	Dry Density (pcf)	% Passing #200 Sieve	Moisture/Plasticity
615 — 0				Brn. CLAY WITH SAND w/ Trace Gravel Moist, Med. Plasticity, Soft USCS: CL; AASHTO: A-6(13) LL=38, PI=21	100	71.7	PL — LL 10 20 30 40 50 60 Water Content, % - 10 20 30 40 50 60
			4/6" 50/5.1"	Dk. Brn. & Grayish Brn. SANDY CLAY V. Moist, Fl. Low Plasticity, Soft			
610 — 5				(ROCK) Gray LIMESTONE Sl. Moist, Tr. Plasticity, Soft			
605 — 10							
600 — 15							
595 — 20							
590 — 25							
585 — 30							

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GEOTECHNICAL SERVICES

SOIL BORING LOG

Boring No. B-5

Project: Final Geo. Inv. and Stability Evaluation of Bottom Ash Pond
Project No.: 8309-3150
Project Location: Oologah, Oklahoma
Date Drilled.: 1/14/10
Boring Location: West on crest of embankment
Project Engineer: Jieliang Pan, P.E.
Drill Method: CME-55 w/ 3.25" I.D. HSA
Field Logger: Jieliang Pan, P.E.
Surface Elevation: 631.56 feet
Water Depth: Dry @ Completion
Remarks: Boring coordinates: S 6295.809; E -1316.211

Elev./Depth Feet	Symbol	Samples	SPT Blows/ Increment	Soil Description	Dry Density (pcf)	% Passing #200 Sieve
0				Gray CRUSHED STONE (Railway Bed)		
630			6/6" 4/6" 3/6"	Lt. Brn. & Lt. Gray CLAYEY SAND w/ Trace Gravel V. Moist, Fl. High Plasticity, Loose USCS: SC; AASHTO: A-2-7(4) LL=46, PI=28	113 104	34.7
5			3/6" 6/6" 7/6"	Lt. Brn. & Lt. Gray SANDY CLAY w/ Trace Gravel Moist, Med. Plasticity, Firm Stiff USCS: CL; AASHTO: A-7-6(10) LL=41, PI=22	112	57.9
625				Lt. Brn. & Gray CLAY Moist, Fl. High Plasticity, Stiff Triaxial Test:	103	
10			2/6" 4/6" 6/6"	c=4.8 psi, phi=2.5 deg (8 to 10 ft.) Lt. Brn. & Gray & Brn. & Reddish Brn. CLAY USCS: CL; AASHTO: A-7-6(28) LL=48, PI=27	101	94.6
620				Brn. & Reddish Brn. Permeability Test: k=1.8E-8 cm/sec (13 to 15 ft.)	105	
15			2/6" 3/6" 5/6"	Lt. Brn. & Lt Gray, Firm	107	
615				Permeability Test: k=1.6E-8 cm/sec (18 to 20 ft.)	102	
20			3/6" 4/6" 5/6"	Stiff	100	
610				(ROCK) Gray LIMESTONE Sl. Moist, Tr. Plasticity, Soft		
25						
605						
30						
600						

Moisture/Plasticity
PL LL
10 20 30 40 50 60
Water Content, % -
10 20 30 40 50 60

STANDARD TESTING AND ENGINEERING COMPANY

GEOTECHNICAL SERVICES

SOIL BORING LOG

Boring No. B-6

Project: Final Geo. Inv. and Stability Evaluation of Bottom Ash Pond
Project No.: 8309-3150
Project Location: Oologah, Oklahoma
Date Drilled.: 1/13/10
Boring Location: West on downstream toe of embankment
Project Engineer: Jieliang Pan, P.E.
Drill Method: CME-55 w/ 3.25" I.D. HSA
Field Logger: Jieliang Pan, P.E.
Surface Elevation: 611.60 feet
Water Depth: Dry @ Completion
Remarks: Boring coordinates: S 6325.333; E -1384.301

Elev./Depth Feet	Symbol	Samples	SPT Blows/ Increment	Soil Description	Dry Density (pcf)	% Passing #200 Sieve	Moisture/Plasticity
610 (0)			4/6" 39/6" 50/3.5"	Brn. CLAY WITH SAND w/ Trace Gravel V. Moist, Med. Plasticity, Soft			PL | LL 10 20 30 40 50 60 Water Content, % - ● 10 20 30 40 50 60
				Dk. Brn. & Brn. FAT CLAY WITH SAND V. Moist, Fl. High Plasticity, Soft USCS: CH; AASHTO: A-7-6(18) LL=50, PI=27	93	70.6	
605 (5)				(ROCK) Gray LIMESTONE Sl. Moist, Tr. Plasticity, Soft			
600 (10)							
595 (15)							
590 (20)							
585 (25)							
580 (30)							

STANDARD TESTING AND ENGINEERING COMPANY GEOTECHNICAL SERVICES

KEY TO SYMBOLS

Symbol Description

STRATA SYMBOLS


Coal Dust


Silty Sand


Silty Clay with Sand


Sandy Clay


Limestone


Lean Clay with Sand


Crushed Stone


Clayey Sand with Gravel


Lean Clay

Soil Samplers


Bulk sample taken from auger flights, ASTM D1452


Standard Penetration Test, ASTM D1586


Undisturbed Thin-Walled Tube (Shelby tube), ASTM D1587

DEFINITION OF DESCRIPTIVE TERMS

Consistency of Cohesive Soils (at moisture content near plastic limit):

- Very Soft - Easily penetrated 4" to 6" by fist; tall core will sag under its own weight.
- Soft - Easily molded by fingers.
- Firm - Can be penetrated 2" to 3" by thumb with moderate effort, imprinted with fingers.
- Stiff - Readily indented by thumb but penetrated only with great effort.
- Very Stiff - Readily indented by thumbnail, imprinted very slightly with pressure from fingers.
- Hard - Indented with difficulty by thumbnail, cannot be imprinted with fingers.

Density of Cohesionless Soils:

- Very Loose - less than 4 SPT "N" value corrected for overburden.
- Loose - 5 to 10 SPT "N" value corrected for overburden.
- Medium Dense - 11 to 30 SPT "N" value corrected for overburden.
- Dense - 31 to 50 SPT "N" value corrected for overburden.
- Very Dense - 51 to 50/6" SPT "N" value corrected for overburden.
- Hard - less than 6" penetration in 50 SPT "N" blows corrected for overburden (cemented).

Hardness of Rock:

- Very Soft - can be scratched readily by fingernail
- Soft - can be grooved readily by knife or pick
- Medium - can be grooved 0.05" deep by firm pressure of knife
- Moderately Hard - can be scratched by knife
- Hard - can be scratched by knife or pick only with difficulty
- Very Hard - cannot be scratched by knife or sharp pick

Other Terms Descriptive of Consistency:

- Brittle - Ruptures with little deformation
- Friable - Crumbles or pulverizes easily.
- Elastic - Returns to original length after small deformation.
- Spongy - Is very porous, loose and elastic.
- Sticky - Adheres or sticks to tools or hands.

In Situ Moisture Descriptions:

- Dry - powdery
- Slightly Moist - water not readily absorbed by paper
- Moist - water readily absorbed by paper
- Very Moist - water condenses on sample tray
- Wet - water drips from sample

Degree of Plasticity When Moist to Very Moist:

- Nonplastic - cannot be rolled into a ball
- Trace of Plasticity - can be rolled into a ball but not into a 1/8" thread
- Low Plasticity - barely holds its shape when rolled into a 1/8" thread
- Fairly Low Plasticity - 1/8" thread quickly ruptures when bent
- Medium Plasticity - 1/8" thread withstands considerable deformation without rupture.
- Fairly High Plasticity - difficult to rupture a 1/8" thread by bending.
- High Plasticity - can be kneaded without rupture; greasy texture.

Abbreviations:

V. - Very	Dk. - Dark	Blk. - Black
Tr. - Trace	Lt. - Light	Brn. - Brown
Fl. - Fairly	Med. - Medium	
Sl. - Slightly		

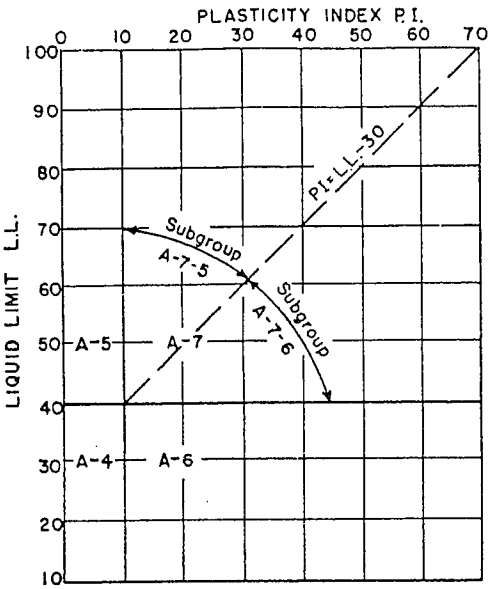
ATTACHMENT C

AASHTO Soil Classification System

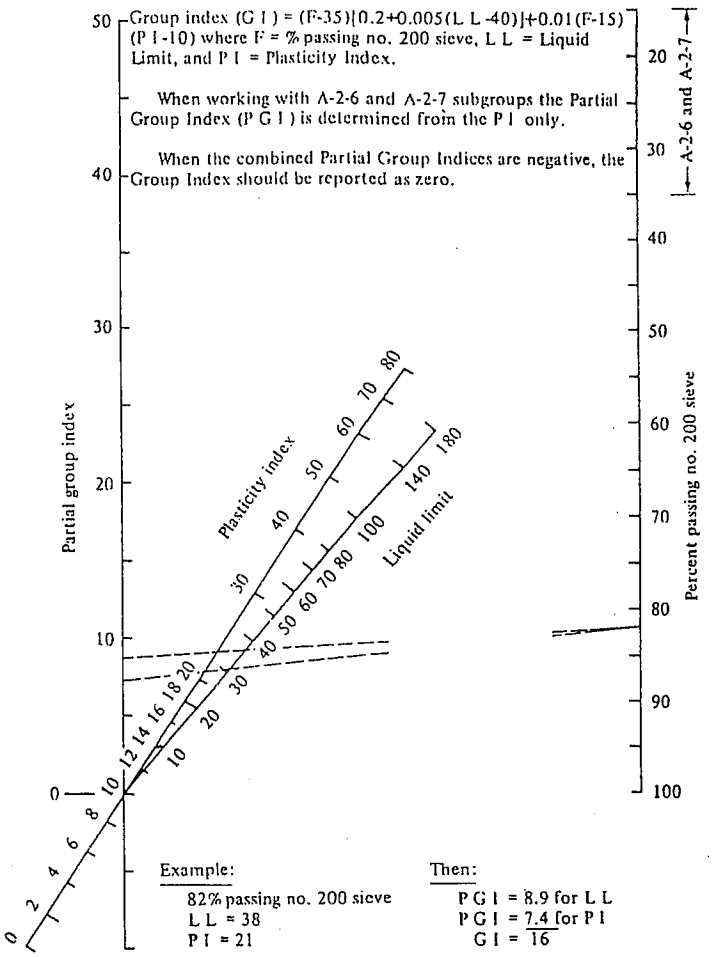
Unified Soil Classification System

Soil Classification System — American Association of State Highway and Transportation Officials

The tables and charts given below are from AASHTO Designation: M 145-83, The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes. More detailed information as to the background and application of the system may be obtained from the report.



Liquid-limit and plasticity-index ranges for the A-4, A-5, A-6 and A-7 subgrade groups.



Group index chart

Classification of Soils and Soil-Aggregate Mixtures (with Suggested Subgroups)

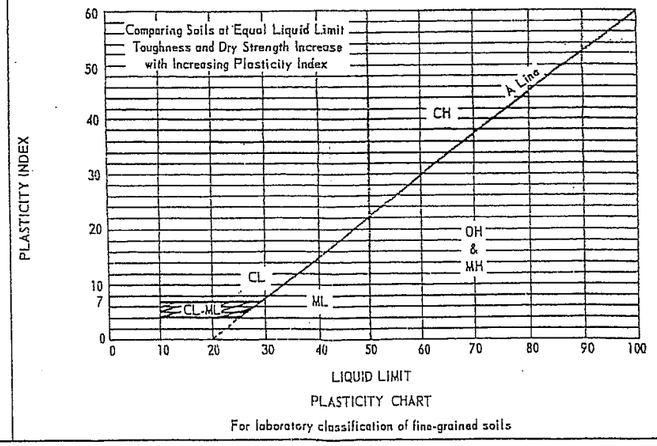
General classification	Granular materials (35 per cent or less passing No. 200)							Silt-clay materials (More than 35 per cent passing No. 200)			
Group classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5; A-7-6
Sieve analysis: Per cent passing:											
No. 10	50 max.	—	—	—	—	—	—	—	—	—	—
No. 40	30 max.	50 max.	51 min.	—	—	—	—	—	—	—	—
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40:											
Liquid limit	—		—	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		NP	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.*
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as subgrade	Excellent to good							Fair to poor			

*P.I. of A-7-5 subgroup is equal to or less than L.L. minus 30. P.I. of A-7-6 subgroup is greater than L.L. minus 30

UNIFIED SOIL CLASSIFICATION
(Including Identification and Description)

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 3 inches and basing fractions on estimated weights)			Information Required for Describing Soils	Laboratory Classification Criteria
1	2		3	4	5			6	7
Coarse-grained Soils: More than half of material is larger than No. 200 sieve size. 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 classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size)	Gravels with (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.				Not meeting all gradation requirements for GW
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).				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.
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).			Give typical name; indicate approximate percentages of sand and gravel, maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.	Atterberg limits above "A" line with PI greater than 7
	Sands: More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size)	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and Substantial amounts of all intermediate particle sizes.				$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3
			SP	Poorly-graded sands, gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.			Example: Silty sand, gravelly; about 20% hard, angular gravel particles 1/2-in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).	Not meeting all gradation requirements for SW
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).				Atterberg limits below "A" line or PI less than 4 / Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).				Atterberg limits above "A" line with PI greater than 7
					Identification Procedures on Fraction Smaller than No. 40 Sieve Size				
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)		
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.	Silts and Clays: Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses.	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% — Borderline cases requiring use of dual symbols.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium		
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight		
	Silts and Clays: Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.	
			CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High		
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium	Example: Clayey silt, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes, firm and dry in place, loess, (ML).	
Highly Organic Soils			Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.				

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



PLASTICITY CHART

For laboratory classification of fine-grained soils

(1) Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder. (2) All sieve sizes on this chart are U. S. standard.

FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 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 size, prepare a pat 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 pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat 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 pat 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 fines 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 pat of soil to the consistency of putty, adding water if necessary. Allow the pat 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 measrue 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.

Toughness (Consistency near plastic limit)

After removing particles larger than the 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, January 1952

ATTACHMENT D

Summary of Laboratory Test Results

SUMMARY OF LABORATORY TEST RESULTS

Client: AEP / PSO Region 4 Engineering

Date: March 11, 2010

Project: Bottom Ash Pond Slope Repair, Oologah, Oklahoma

Project No.: 8309-3150

Boring No.	Sample I.D.	Depth (ft.)	Moisture Content (%)	Dry Density (pcf)	Atterberg Limits (% Moisture)			Sieve Analysis (% Passing)									Soil Classification	
					LL	PL	PI	1"	3/4"	1/2"	3/8"	#4	#10	#40	#100	#200	USCS	AASHTO
B-1	A	0.5-1.5	24.5		Nonplastic			100	100	100	100	100	96	72	47	31.8	SM	A-2-4
	B	1.5-3	18.5															
	C	3-5	21.2	115	24	17	7	100	100	100	100	100	100	99	91	74.3	CL-ML	A-4(3)
	D	5-6.5	16.8	108														
	E	8-10	14.8	118														
	F	10-11.5	15.0	113	33	16	17	100	91	88	88	88	88	87	77	60.7	CL	A-6(7)
	G	13-15	19.9	108														
	H	15-16.5	20.5	105														
	I	18-19	19.9	108														
B-2	A	0-1.5	20.0		38	17	21	100	100	97	96	94	90	87	79	71.7	CL	A-6(13)
	B	1.5-2	24.5	100														
B-5	A	1.5-3	14.3	113	46	18	28	100	95	95	86	75	62	54	41	34.7	SC	A-2-7(4)
	B	3-5	22.8	104														
	C	5-6.5	20.4	112	41	19	22	100	100	100	100	100	78	77	66	57.9	CL	A-7-6(10)
	D	8-10	20.5	103														
	E	10-11.5	23.3	101	48	21	27	100	100	100	100	100	100	100	98	94.6	CL	A-7-6(28)
	F	13-15	22.5	105														

STANDARD TESTING AND ENGINEERING COMPANY

GEOTECHNICAL SERVICES

SUMMARY OF LABORATORY TEST RESULTS

Client: AEP / PSO Region 4 Engineering

Date: March 11, 2010

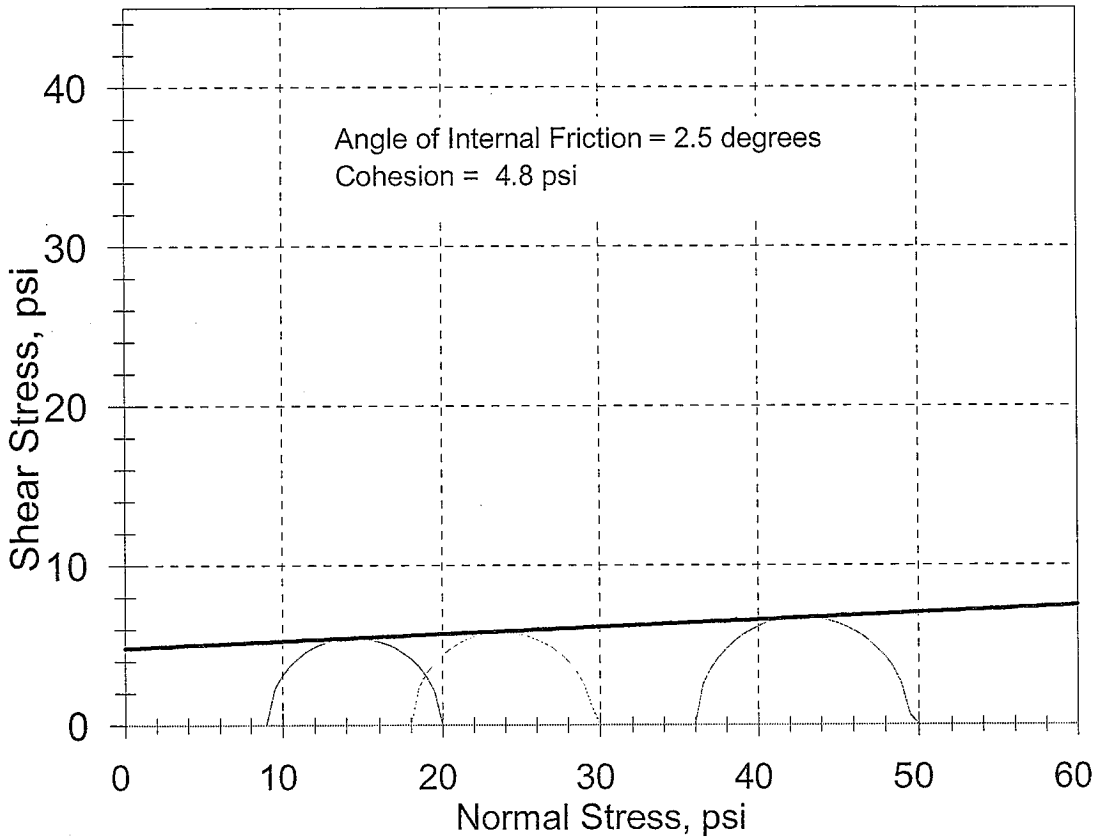
Project: Bottom Ash Pond Slope Repair, Oologah, Oklahoma

Project No.: 8309-3150

Boring No.	Sample I.D.	Depth (ft.)	Moisture Content (%)	Dry Density (pcf)	Atterberg Limits (% Moisture)			Sieve Analysis (% Passing)									Soil Classification	
					LL	PL	PI	1"	3/4"	1/2"	3/8"	#4	#10	#40	#100	#200	USCS	AASHTO
B-5 (cont.)	G	15-16.5	21.4	107														
	H	18-20	21.4	102														
	I	20-21.5	25.4	100														
B-6	A	0-1.5	28.8															
	B	1.5-2.5	30.3	93	50	23	27	100	100	100	100	96	79	75	73	70.6	CH	A-7-6(18)

Triaxial Compression Test Results

8309-3150, Boring B-5 @ 8-10 ft.



STANDARD TESTING AND ENGINEERING COMPANY
GEOTECHNICAL SERVICES

CORPORATE OFFICE and CENTRAL LABORATORY
3400 N. Lincoln Blvd., Oklahoma City, OK 73105 (405) 528-0541
CA77 Exp. 06/30/07

Area Offices

5358 S. 125th E. Ave., Ste. B	Tulsa, OK 74134	(918) 459-2700
902 Trails West Loop	Enid, OK 73703	(580) 237-3130
202 SE "J" Ave.	Lawton, OK 73501	(580) 353-0872

Report Date: March 11, 2010
Project: Final Geo. Inv. and Stability Evaluation of Bottom Ash Pond
Location: Oologah, Oklahoma

Date Sampled Janunary 13, 2010
Sampled By: Johnny Jarman
Quantity Represented: Lt. Brn. & Lt. Gray SANDY CLAY

REPORT: MEASUREMENT OF HYDRAULIC CONDUCTIVITY
LAB NO: 8309-3150
Test Method: ASTM D5084

TEST RESULTS

Sample I.D.: B-1E (8-10')
Sample Preparation: Undisturbed
Specific Gravity: 2.750 (assumed)

Sample Parameters	Initial @ 14.7 psia	Final @ 72.0 psia
Diameter, cm	7.247	7.275
Height, cm	4.528	4.545
Moisture, %	23.8	26.1
Dry Unit Weight, pcf	101.0	99.8
Saturation, %	93.6	100.0

Test Parameters

Type of Permeant:	Deaired Water
Back Pressure, psig:	55.0
Maximum Effective Consolidation Stress, psig:	5.0
Minimum Effective Consolidation Stress, psig:	3.0
Hydraulic Gradient:	31.0

Average Hydraulic Conductivity (permeability): **2.0×10^{-8}** cm/sec

STANDARD TESTING AND ENGINEERING COMPANY
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202 SE "J" Ave.	Lawton, OK 73501	(580) 353-0872

Report Date: March 11, 2010
Project: Final Geo. Inv. and Stability Evaluation of Bottom Ash Pond
Location: Oologah, Oklahoma

Date Sampled: Janunary 14, 2010
Sampled By: Johnny Jarman
Quantity Represented: Brn. & Reddish Brn. CLAY

REPORT: MEASUREMENT OF HYDRAULIC CONDUCTIVITY

LAB NO: 8309-3150
Test Method: ASTM D5084

TEST RESULTS

Sample I.D.: B-5F (13-15')
Sample Preparation: Undisturbed
Specific Gravity: 2.685 (assumed)

Sample Parameters	Initial @ 14.7 psia	Final @ 72.0 psia
Diameter, cm	7.255	7.282
Height, cm	5.295	5.315
Moisture, %	17.5	18.8
Dry Unit Weight, pcf	112.5	111.3
Saturation, %	95.9	100.0

Test Parameters

Type of Permeant:	Deaired Water
Back Pressure, psig:	55.0
Maximum Effective Consolidation Stress, psig:	5.0
Minimum Effective Consolidation Stress, psig:	3.0
Hydraulic Gradient:	26.5

Average Hydraulic Conductivity (permeability): **1.8×10^{-8}** cm/sec

STANDARD TESTING AND ENGINEERING COMPANY
GEOTECHNICAL SERVICES

CORPORATE OFFICE and CENTRAL LABORATORY
3400 N. Lincoln Blvd., Oklahoma City, OK 73105 (405) 528-0541
CA77 Exp. 06/30/07

Area Offices

5358 S. 125th E. Ave., Ste. B	Tulsa, OK 74134	(918) 459-2700
902 Trails West Loop	Enid, OK 73703	(580) 237-3130
202 SE "J" Ave.	Lawton, OK 73501	(580) 353-0872

Report Date: March 11, 2010
Project: Final Geo. Inv. and Stability Evaluation of Bottom Ash Pond
Location: Oologah, Oklahoma

Date Sampled: Janunary 14, 2010
Sampled By: Johnny Jarman
Quantity Represented: Lt. Brn. & Lt. Gray CLAY

REPORT: MEASUREMENT OF HYDRAULIC CONDUCTIVITY

LAB NO: 8309-3150
Test Method: ASTM D5084

TEST RESULTS

Sample I.D.: B-5H (18-20')
Sample Preparation: Undisturbed
Specific Gravity: 2.668 (assumed)

Sample Parameters	Initial @ 14.7 psia	Final @ 72.0 psia
Diameter, cm	7.280	7.276
Height, cm	5.396	5.393
Moisture, %	17.6	19.1
Dry Unit Weight, pcf	110.1	110.3
Saturation, %	91.7	100.0

Test Parameters

Type of Permeant:	Deaired Water
Back Pressure, psig:	55.0
Maximum Effective Consolidation Stress, psig:	5.0
Minimum Effective Consolidation Stress, psig:	3.0
Hydraulic Gradient:	26.1

Average Hydraulic Conductivity (permeability): **1.6×10^{-8}** cm/sec

ATTACHMENT E

Monitoring Well Construction Diagrams

STANDARD TESTING
AND ENGINEERING COMPANY

WELL NUMBER B-3 (MW-1)

CLIENT AEP/ PSO Region 4 Engineering
PROJECT NAME Geo. Inv. and Stability Evaluation of Bottom Ash Pond
PROJECT NUMBER 8309-3150
PROJECT LOCATION AEP NE Station Units 3 & 4, Oologah, Oklahoma
DATE STARTED 1/14/10 COMPLETED 1/14/10
GROUND ELEVATION 635.15 ft HOLE SIZE 3.25"
DRILLING CONTRACTOR Standard Testing Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING -
LOGGED BY Johnny Jarman CHECKED BY Jieliang Pan
AT END OF DRILLING -
NOTES Weather: Cloudy; Boring Coordinates: S 7010.566/E -371.054
-hrs AFTER DRILLING -

DEPTH (ft)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
5	AU S-1	No groundwater was encountered during drilling		Light Brown CLAY Slightly Moist, Medium Plasticity	4-ft Steel Casing; 3-ft by 3-ft with about 6-inch Concrete Pad Poured at Surface. (0-2' Cement Grout)
				5.0 — 630.2	
10	AU S-2			Light Brown CLAY Moist, Medium Plasticity	Bentonite Chips; 10' thick
				10.0 — 625.2	
15	AU S-3				
	AU S-4			Light Brown CLAY Moist, Medium Plasticity	
20				20.0 — 615.2	Sand Pack; 15' thick
25	AU S-5				10-ft Screen (Slot Size 0.010-inch, Schedule 40 PVC)
	AU S-6			Light Brown CLAY Moist to Very Moist, Medium Plasticity	
				27.0 — 608.2	Bottom of Borehole @ 27'; Total Length of Casing = 29.5'
	AU S-7			30.0 — 605.2	

Bottom of hole at 27.0 feet.

STANDARD TESTING
AND ENGINEERING COMPANY

WELL NUMBER B-4 (MW-2)

CLIENT AEP/ PSO Region 4 Engineering
PROJECT NAME Geo. Inv. and Stability Evaluation of Bottom Ash Pond
PROJECT NUMBER 8309-3150
PROJECT LOCATION AEP NE Station Units 3 & 4, Oologah, Oklahoma
DATE STARTED 1/14/10 **COMPLETED** 1/14/10
GROUND ELEVATION 603.52 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Standard Testing Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING -
LOGGED BY Johnny Jarman **CHECKED BY** Jieliang Pan
AT END OF DRILLING 5.0 ft / Elev 598.5 ft
NOTES Weather: Cloudy; Boring Coordinates: S 7122.093/E -459.39
-hrs AFTER DRILLING -

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
	AU S-1		Dark Brown CLAY Moist to Very Moist , Medium Plasticity	4-ft Steel Casing; 3-ft by 3-ft with about 6-inch concrete pad poured at surface. (0-2' Cement Grout)
1.5			602.0	
			LIMESTONE Moist to Very Moist	
2.5				Bentonite Chips; 2' thick
5.0	AU S-2			Sand Pack; 6' thick
7.5				5-ft screen (Slot Size 0.010-inch, Schedule 40 PVC)
10.0			10.0 593.5 Bottom of hole at 10.0 feet.	Bottom of Borehole @ 10.0'; Total Length of Casing = 12.5'

GENERAL BH / TP / WELL 8309-3150WELL.GPJ GINT US.GDT 3/11/10

Site Characterization Report

Northeastern Power Station, Bottom Ash Pond
Oolagah, Oklahoma

January 18, 2016
Terracon Project No. 04155186

Prepared for:
American Electric Power
Columbus, Ohio

Prepared by:
Terracon Consultants, Inc.
Tulsa, Oklahoma

January 18, 2016

Terracon

American Electric Power (AEP)
1 Riverside Plaza
Columbus, Ohio 43215

Attn: Mr. Mohammed A. Ajlouni, Ph.D., P.E.
Civil/ Geotechnical Engineering
P: (614) 716-2939
E: maajlouni@aep.com

Re: Site Characterization Report
Northeastern Power Station, Bottom Ash Pond
Oolagah, Oklahoma
Terracon Project No. 04155186

Dear Mr. Ajlouni:

Terracon Consultants, Inc. (Terracon) has completed the drilling and testing services for the Northeastern Power Station, Bottom Ash Pond in Oolagah, Oklahoma. Our services were performed in general accordance with Terracon Proposal No. PN4150555 dated September 23, 2015. This report presents a brief description of our services and includes a site location map, boring location plan, a boring log, and laboratory test results.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.
Cert. of Auth. #CA-4531 exp. 6/30/17

Saba M. Gebretsadik
Staff Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
BRADLEY MARK WATTS
16526
OKLAHOMA
1/18/16

Bradley M. Watts, P.E.
Oklahoma No: 16526

SMG:BMW:lo
Enclosures
Addressee (1 via US Mail and 1 via email)

TABLE OF CONTENTS

SITE CHARACTERIZATION REPORT
NORTHEASTERN POWER STATION, BOTTOM ASH POND
OOLAGAH, OKLAHOMA

Terracon Project No. 04155186
January 18, 2016

1.0 BORING LAYOUT

The boring location was staked in the field by Terracon's representative in coordination with AEP personnel. The approximate site location and boring location are shown on Exhibits A-1 and A-2, respectively.

2.0 DRILLING

As requested, we drilled one (1) boring, designated B-1, for the project. The boring was drilled to a depth of approximately 25 feet below the existing ground surface. The boring was drilled with an ATV-mounted rotary drill rig using continuous flight solid-stem augers to advance the borehole. The log of the boring is presented in Appendix A.

Terracon observed and recorded groundwater levels while drilling and immediately after boring completion. As shown in the lower left corner of the boring log, groundwater was not encountered in the boring during our field exploration.

The groundwater level observations made during our exploration provide an indication of the groundwater conditions at the time the boring was drilled. Our observation occurred over the short duration of the boring. Due to the relatively low permeability of the clay encountered at this site, a relatively long period of time may be necessary for a groundwater level to develop and stabilize in these materials. Therefore, our groundwater observation does not necessarily mean that the boring terminated above groundwater. Fluctuations in groundwater levels could occur throughout the year depending upon variations in the amount of rainfall, runoff, evaporation, and other hydrological factors not apparent at the time the boring was performed. The possibility of groundwater fluctuations should be considered when developing the design and construction plans for the project intended at this site.

3.0 SAMPLING

Samples were obtained by the split-barrel and thin-walled tube sampling procedures. The split-barrel sampling procedure uses a standard 2-inch, O.D. split-barrel sampling spoon that is driven into the bottom of the boring with a 140-pound drive hammer falling 30 inches. The number of blows required to advance the sampling spoon the last 12 inches, or less, of an 18-inch sampling interval or portion thereof, is recorded as the standard penetration resistance

value, N. The N value is used to estimate the in-situ relative density of cohesionless soils, and to a lesser degree of accuracy, the consistency of cohesive soils and hardness of weathered bedrock. The thin-walled sampling procedure uses a standard 3-inch, O.D. tube (Shelby tube) that is hydraulically pushed into the bottom of the boring to recover a relatively undisturbed sample of clayey soils.

The sampling depths, penetration distances, and N values are reported on the boring log. The samples were tagged for identification, sealed to reduce moisture loss and returned to the laboratory for further examination, classification and testing.

4.0 LABORATORY TESTING

Select soil/rock samples obtained from the site were tested for the following engineering properties:

- Water content
- Atterberg limits
- Grain size distribution
- Dry density
- Consolidated Undrained (CU) triaxial compression tests

Our scope of services included performing 3-point CU triaxial compression tests on two Shelby tubes. However, the samples extruded from the Shelby tubes had sufficient length of undisturbed recovery to run only two points. Per direction from AEP, we performed the test on two points per sample.

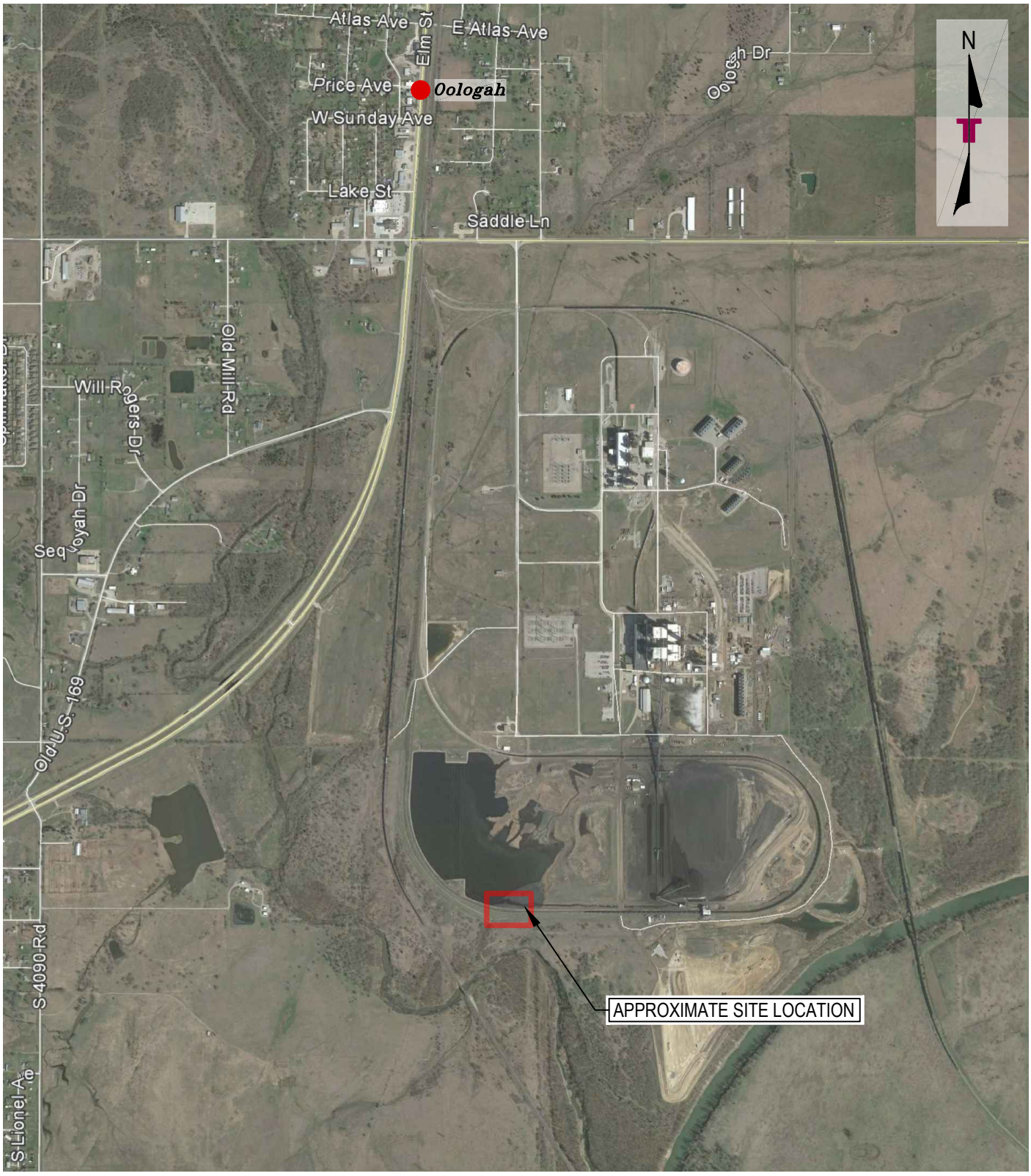
The laboratory test results are presented on the boring log next to the respective samples in Appendix A. Triaxial compression test reports and grain size distribution reports are provided in Appendix B. Laboratory tests were performed in general accordance with the applicable ASTM, local or other accepted standards.

5.0 BORING LOG

A field log of the boring was prepared by a Terracon field geologist. The log included visual classifications of the materials encountered during drilling as well as the field geologist's interpretation of the subsurface conditions between samples. The samples obtained in the field were reviewed and visually classified in our laboratory by a Terracon engineer. The final boring log included with this report represents the engineer's interpretation of the field log and include modifications based on laboratory observation and tests of the samples.

Soil classification was based on the Unified Soil Classification System (USCS) presented in Appendix C. Bedrock materials were classified according to the General Notes and described using commonly accepted geotechnical terminology.

APPENDIX A
FIELD EXPLORATION



1500 0 500 1000 1500

APPROXIMATE SCALE IN FEET

Project Mngr: SMG	Project No. 04155186	Terracon Consulting Engineers and Scientists	SITE LOCATION MAP
Drawn By: JM	Scale: SEE BAR SCALE	9522 EAST 47TH PLACE, UNIT D TULSA, OKLAHOMA 74145	GEOTECHNICAL EXPLORATION
Checked By: SMG	File No. 04155186	PH. (918) 250-0461 FAX. (918) 250-4570	NORTHEASTERN POWER STATION, BOTTOM ASH POND
Approved By: BMW	Date: JAN 2016		OOLAGAH, OKLAHOMA

EXHIBIT NO. A-1

N

LEGEND
BORING LOCATION

400 0 100 200 300 400

APPROXIMATE SCALE IN FEET

DIAGRAM IS FOR GENERAL LOCATION ONLY,
AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Mngr:	SMG
Drawn By:	JM
Checked By:	SMG
Approved By:	BMW

Project No.	04155186
Scale:	SEE BAR SCALE
File No.	04155186
Date:	JAN 2016

Terracon
Consulting Engineers and Scientists
9522 EAST 47TH PLACE, UNIT D TULSA, OKLAHOMA 74145
PH. (918) 250-0461 FAX. (918) 250-4570

BORING LOCATION PLAN

GEOTECHNICAL EXPLORATION
NORTHEASTERN POWER STATION, BOTTOM ASH POND
OOLAGAH, OKLAHOMA

EXHIBIT NO.
A-2

BORING LOG NO. B-1

PROJECT: Northeastern Power Station, Bottom Ash Pond

CLIENT: American Electric Power

SITE: US-169 and OK-88
Oolagah, Oklahoma

LOCATION See Exhibit A-2

Latitude: 36.41852° Longitude: -95.70573°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.0										
	3" Black gravel and sand **FILL - LEAN CLAY**, with gravel and sand, yellowish-brown and brown				16	2-3-5 N=8	1500 (HP)	13		
					6	3-4-4 N=8	1500 (HP)	13		
3.5	**FILL - FAT CLAY**, with gravel, yellowish-brown and gray				18	2-4-4 N=8	4000 (HP)	23		
		5			12		4500 (HP)		54-18-36	77
					18	1-2-2 N=4	2500 (HP)	22		
8.0	**FILL - FAT CLAY**, trace gravel and sand, yellowish-brown				18	3-6-4 N=10	4000 (HP)	18		
		10			13	3-2-5 N=7	3500 (HP)	25		
11.0	**FILL - SANDY FAT CLAY**, reddish-brown with black				9	2-3-4 N=7	3000 (HP)	27		
					18	3-4-6 N=10	6500 (HP)	23		
		15			10		2000 (HP)		55-17-38	65
16.5	**FILL - FAT CLAY**, thin roots and trace wet soil, light olive-brown and gray				18	2-3-3 N=6	5500 (HP)	25		
						3-4-6 N=10	5500 (HP)	21		
		20			21		6500 (HP)			
21.5	**FILL - FAT CLAY**, trace wet soil, olive and gray with reddish-brown				18	3-4-5 N=9	6000 (HP)	27		
23.0	**FILL - FAT CLAY**, tree bark, reddish-brown				18	4-6-8 N=14	5000 (HP)	26		
24.5										
24.9	**LIMESTONE+**				4	50/4"		22		
	Boring Terminated at 24.9 Feet									

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

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Power Auger

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

Consolidated Undrained triaxial compression tests performed on Shelby Tube samples collected at 5 to 6.5' and 15 to 16.5'. See Appendix B for test results.

WATER LEVEL OBSERVATIONS

Not Encountered While Drilling

Not Encountered After Boring

Terracon
9522 East 47th Place, Unit D
Tulsa, Oklahoma

Boring Started: 12/2/2015 Boring Completed: 12/2/2015

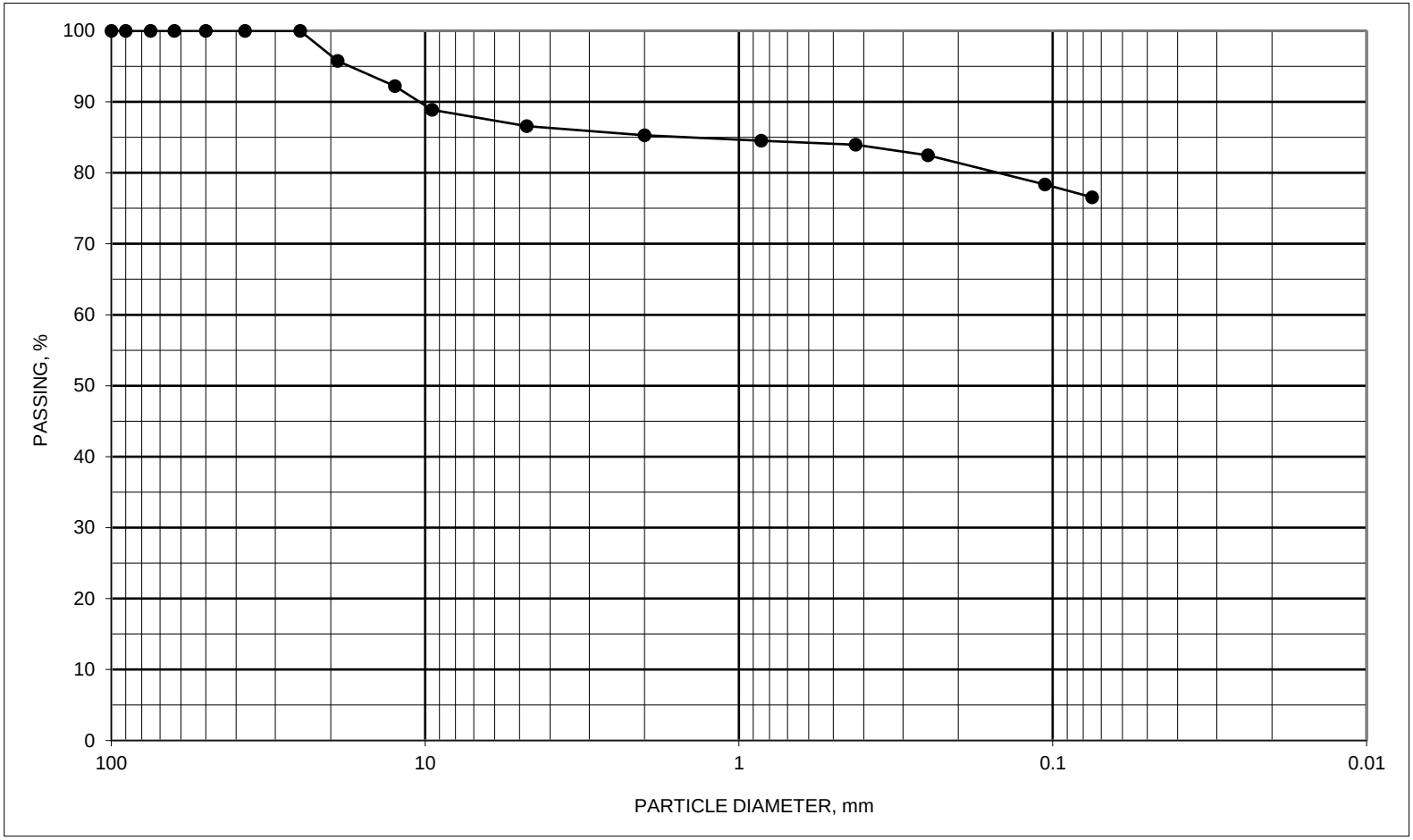
Drill Rig: ATV 380 Driller: TJ

Project No.: 04155186 Exhibit: A-3

APPENDIX B

LABORATORY TEST RESULTS

SIEVE SIZE	DIAMETER, mm	PASS, %
4"	100.0	100
3.5"	90.0	100
3"	75.0	100
2.5"	63.0	100
2"	50.0	100
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	96
1/2"	12.5	92
3/8"	9.50	89
#4	4.75	87
#10	2.00	85
#20	0.850	85
#40	0.425	84
#60	0.250	82
#140	0.106	78
#200	0.075	76.6



ASTM D1140 / C117 #200 WASH SIEVE AND C136 SIEVE ANALYSIS

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	USCS SYMBOL	NAT M%	ATTERBERG LIMITS LL	PL	PI
B-1	4	5 TO 6.5	FAT CLAY WITH GRAVEL BROWN & YELLOWISH BROWN	CH		54	18	36

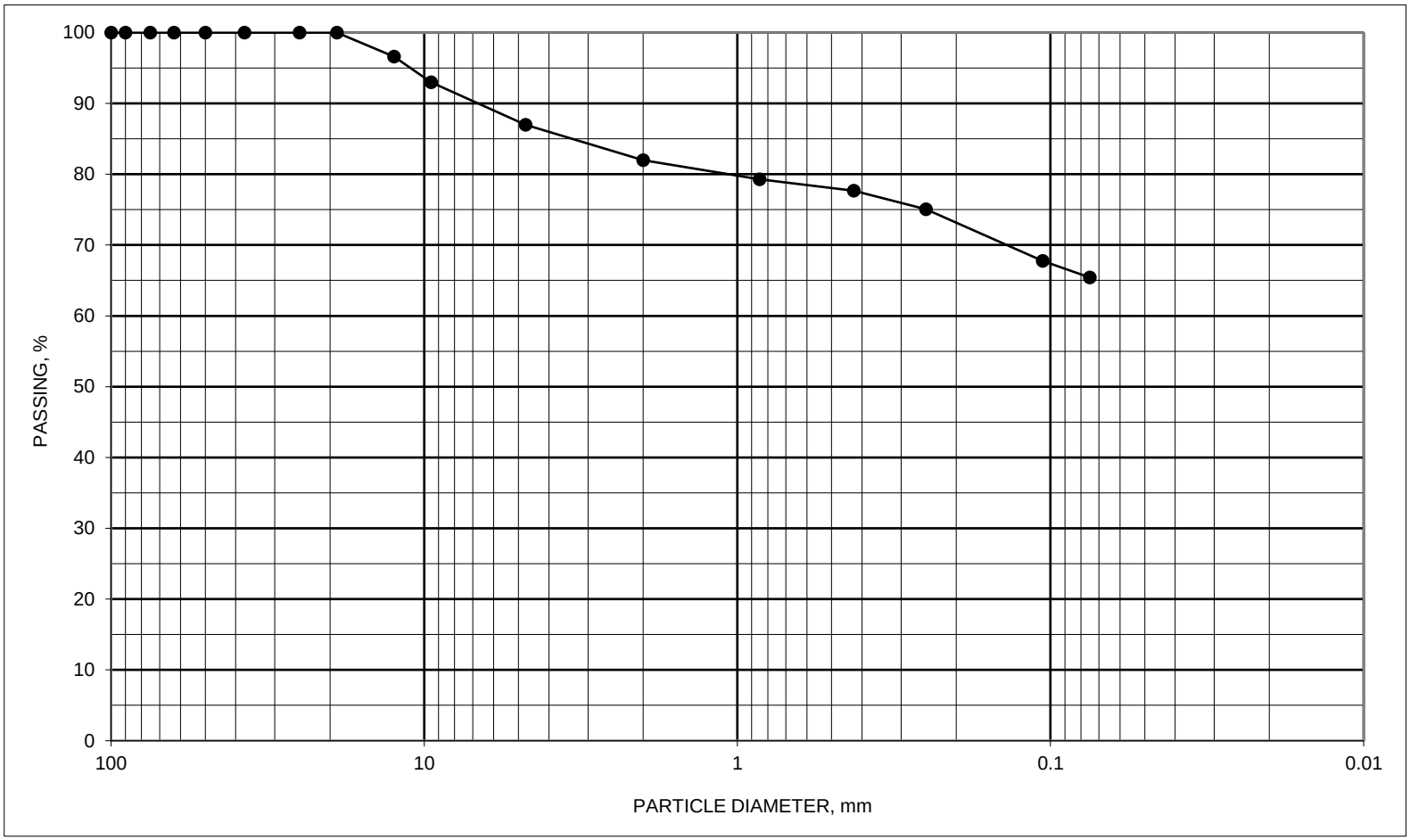
PROJECT NORTHEASTERN POWER STATION, BOTTOM ASH POND

JOB NO. 04155186 DATE 12/28/2015

N:\CM\LAB_DATA\00 Projects in Progress\2015 Projects in Progress\04155186 Lab Data\[04155186 200 Wash Plot B1-4-5.0.xlsx]REPORT

Terracon

SIEVE SIZE	DIAMETER, mm	PASS, %
4"	100.0	100
3.5"	90.0	100
3"	75.0	100
2.5"	63.0	100
2"	50.0	100
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	97
3/8"	9.50	93
#4	4.75	87
#10	2.00	82
#20	0.850	79
#40	0.425	78
#60	0.250	75
#140	0.106	68
#200	0.075	65.4



ASTM D1140 / C117 #200 WASH SIEVE AND C136 SIEVE ANALYSIS

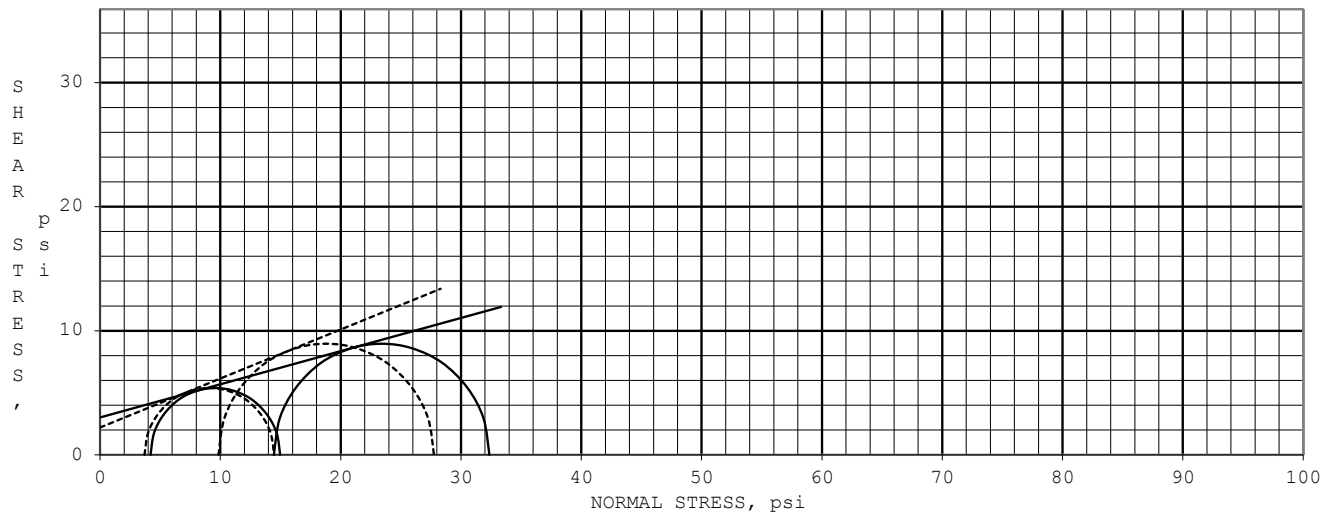
BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	USCS SYMBOL	NAT M%	ATTERBERG LIMITS LL	PL	PI
B-1	10	15 TO 16.5	SANDY FAT CLAY BROWN & DARK BROWN	CH		55	17	38

PROJECT NORTHEASTERN POWER STATION, BOTTOM ASH POND

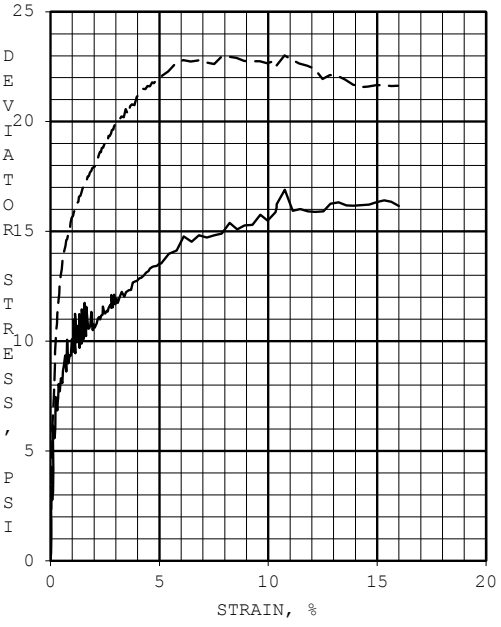
JOB NO. 04155186 DATE 12/28/2015

N:\CM\LAB_DATA\00 Projects in Progress\2015 Projects in Progress\04155186 Lab Data\[04155186 200 Wash Plot B1-4-5.0.xlsx]REPORT

Terracon



	EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	**21.6**	COHESION, psi	**2.2**
	TOTAL STRESS ——	ANGLE OF INTERNAL FRICTION, deg	**15.0**	COHESION, psi	**3.0**



SPECIMEN ID:		A	B	
INITIAL	WATER CONTENT, %	22.3	21.7	
	DRY DENSITY, pcf	106.4	106.2	
	SATURATION, %	104	101	
	VOID RATIO	0.58	0.58	
BEFORE SHEAR	WATER CONTENT, %	21.4	20.5	
	DRY DENSITY, pcf	106.6	108.2	
	SATURATION (B PARAMETER)	0.95	0.96	
	VOID RATIO	0.58	0.55	
	FINAL BACK PRESSURE, psi	100.0	100.0	
MINOR PRINCIPAL STRESS, psi		4.2	14.4	
EFFECTIVE STRESS PEAK AT % STRAIN		2.0	2.0	
EFF. DEVIATOR STRESS AT PEAK STRAIN, psi		10.8	17.9	
TOTAL STRESS PEAK AT % STRAIN		2.0	2.0	
TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi		10.8	17.9	
ULTIMATE DEVIATOR STRESS (15% STR), psi		16.3	21.7	
TIME TO 50% PRIMARY CONSOLIDATION, min		32.00	73.00	
STRAIN RATE, % / hour		0.25	0.25	
INITIAL DIAMETER, inch		1.365	1.365	
INITIAL HEIGHT, inch		2.811	2.832	
AREA AFTER CONSOLIDATION, inch2		1.456	1.438	

CONTROLLED - STRAIN TEST

SAMPLE TYPE: 3" SHELBY TUBE

DESCRIPTION OF SPECIMENS:
FAT CLAY WITH GRAVEL, BROWN & YELLOWISH BROWN

LL	PL	PI	Gs
54	18	36	2.69 EST.

PROJECT NO. 04155186

LABORATORY: TERRACON - LENEXA

DATE: 12/29/2015

PROJECT: NORTHEASTERN POWER STATION
BOTTOM ASH POND

BORING #: B-1

SAMPLE #: 4

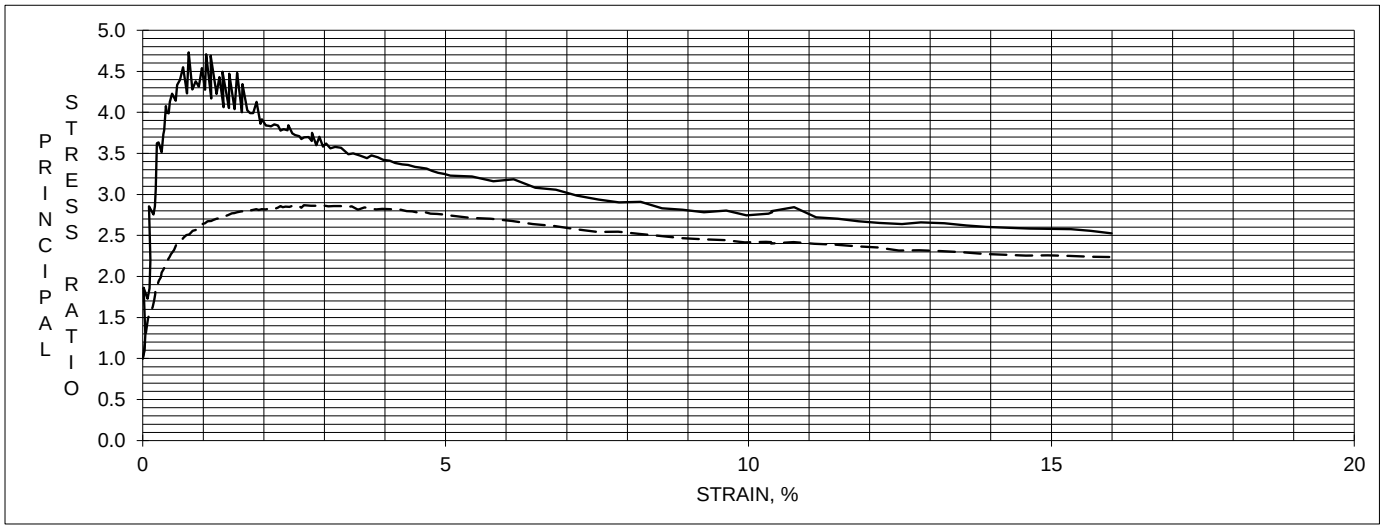
DEPTH, feet: 5.0 - 6.5

PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS

Terracon

NORTHEASTERN POWER STATION

04155186	B-1	4	5.0 - 6.5



FAILURE SKETCH

SPECIMEN A

FAILURE SKETCH

SPECIMEN B

FAILURE SKETCH

SPECIMEN C

REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.

EFFECTIVE STRESS FAILURE DATA BASED ON 2 % STRAIN.

EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.

TOTAL STRESS FAILURE DATA BASED ON 2 % STRAIN.

TOTAL STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.

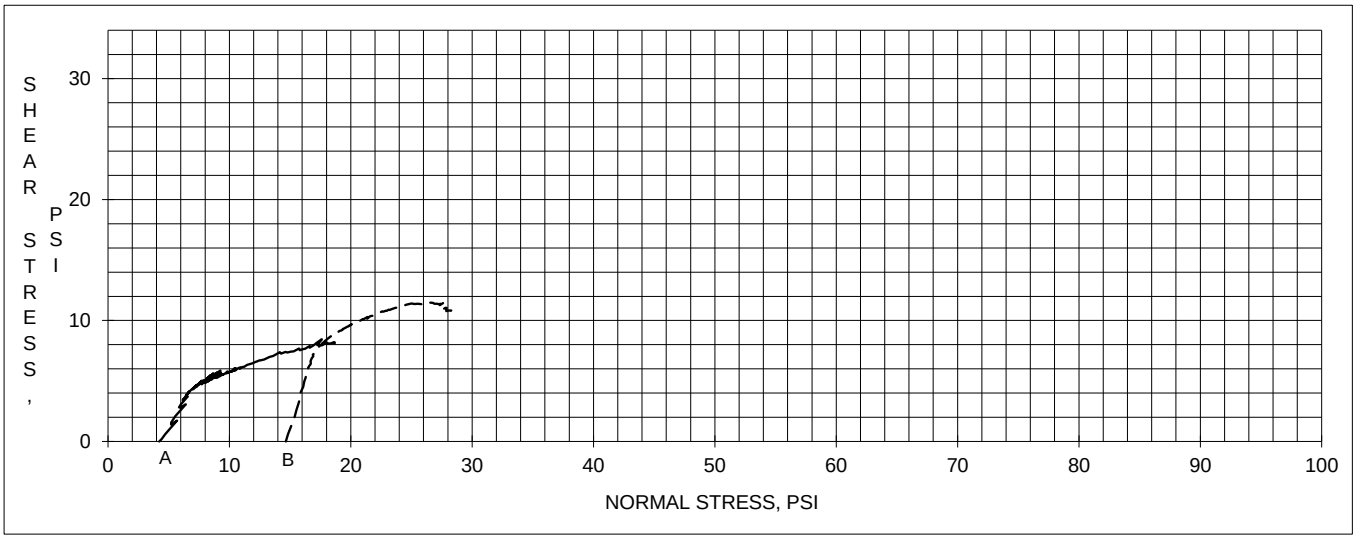
DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.

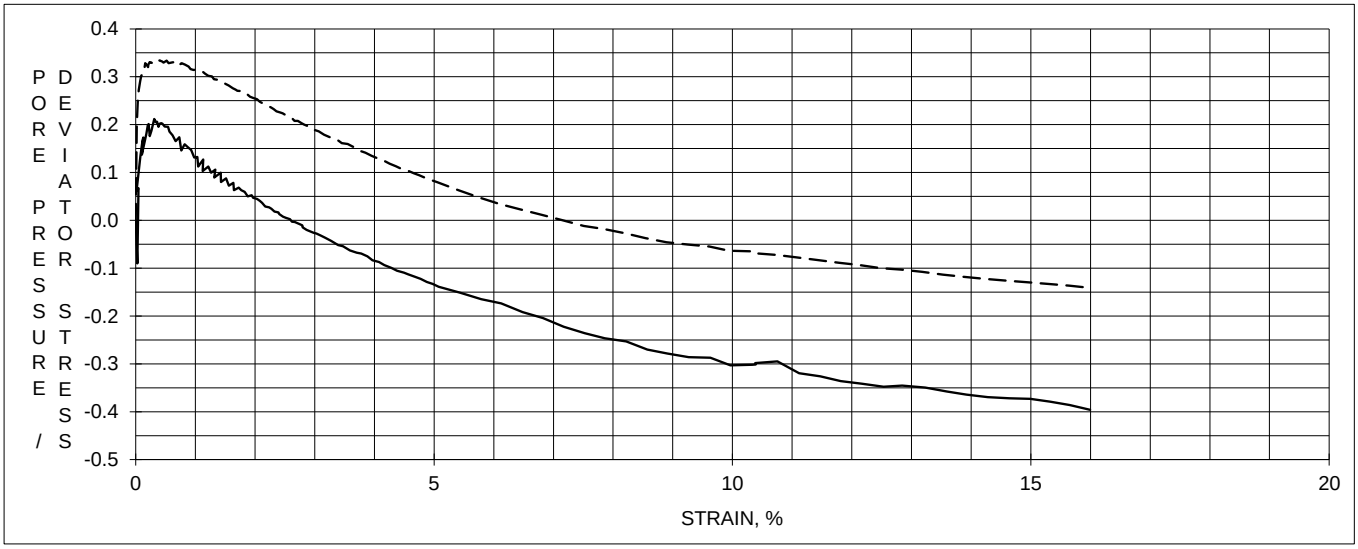
AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A

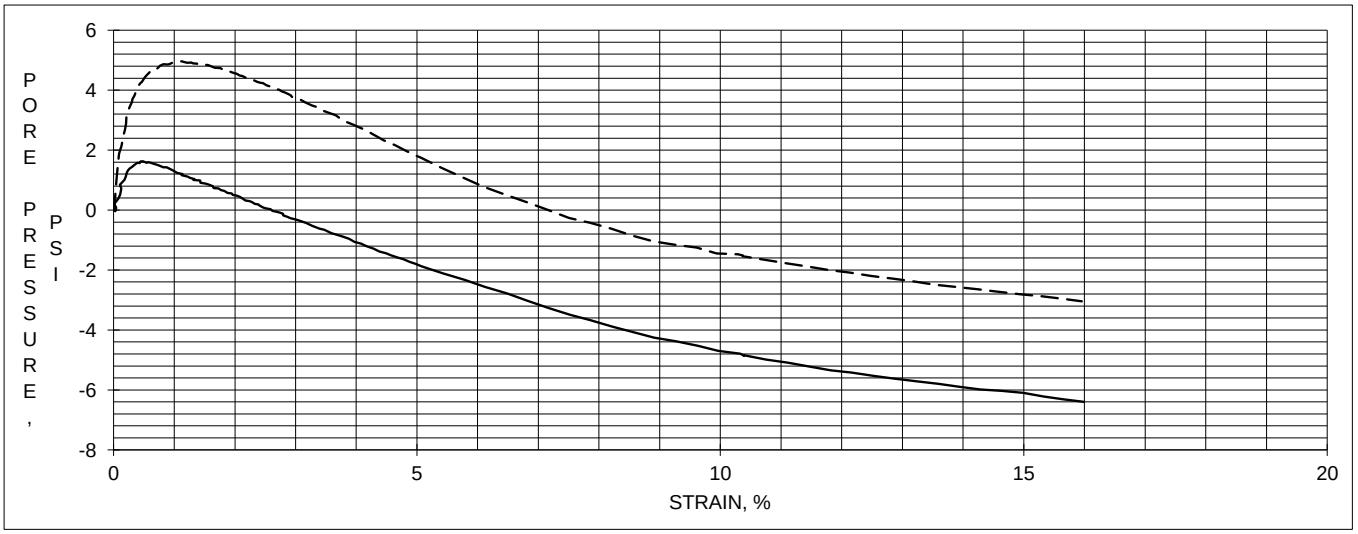
Terracon

NORTHEASTERN POWER STATION

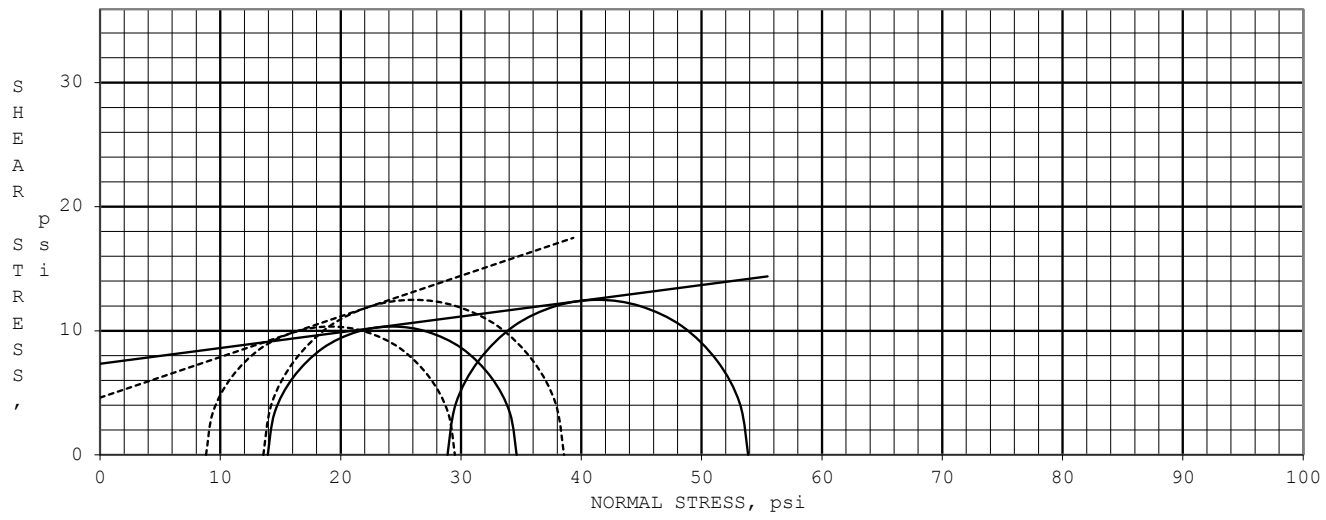
04155186	B-1		4	5.0 - 6.5



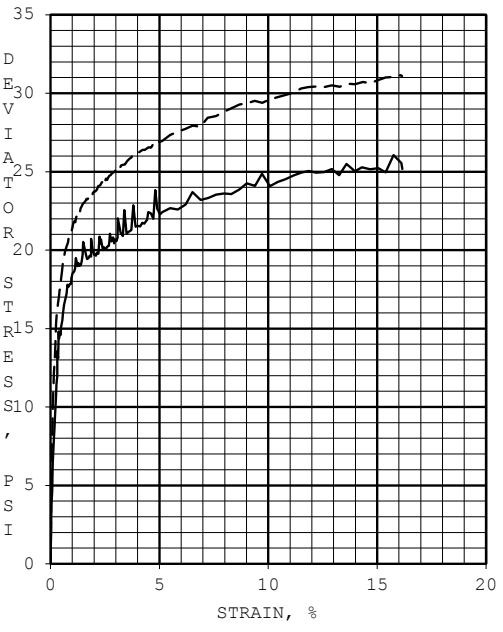




Terracon



	EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	**18.1**	COHESION, psi	**4.6**
	TOTAL STRESS ——	ANGLE OF INTERNAL FRICTION, deg	**7.2**	COHESION, psi	**7.3**



	SPECIMEN ID:	A	B	
INITIAL	WATER CONTENT, %	19.3	21.1	
	DRY DENSITY, pcf	104.6	106.1	
	SATURATION, %	87	98	
	VOID RATIO	0.60	0.58	
BEFORE SHEAR	WATER CONTENT, %	21.6	19.9	
	DRY DENSITY, pcf	106.0	109.0	
	SATURATION (B PARAMETER)	0.95	0.96	
	VOID RATIO	0.58	0.53	
	FINAL BACK PRESSURE, psi	100.2	101.3	
	MINOR PRINCIPAL STRESS, psi	13.9	28.9	
	EFFECTIVE STRESS PEAK AT % STRAIN	3.0	3.0	
	EFF. DEVIATOR STRESS AT PEAK STRAIN, psi	20.7	25.0	
	TOTAL STRESS PEAK AT % STRAIN	3.0	3.0	
	TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi	20.7	25.0	
	ULTIMATE DEVIATOR STRESS (15% STR), psi	25.1	30.8	
	TIME TO 50% PRIMARY CONSOLIDATION, min	6.90	7.90	
	STRAIN RATE, % / hour	2.16	2.16	
	INITIAL DIAMETER, inch	1.374	1.363	
	INITIAL HEIGHT, inch	2.825	2.814	
	AREA AFTER CONSOLIDATION, inch2	1.469	1.429	

CONTROLLED - STRAIN TEST

SAMPLE TYPE: 3" SHELBY TUBE

DESCRIPTION OF SPECIMENS:
SANDY FAT CLAY, BROWN & DARK BROWN

LL	PL	PI	Gs
55	17	38	2.68 EST.

PROJECT NO. 04155186

PROJECT: NORTHEASTERN POWER STATION
BOTTOM ASH POND

BORING #: B-1

LABORATORY: TERRACON - LENEXA

SAMPLE #: 10

DATE: 12/28/2015

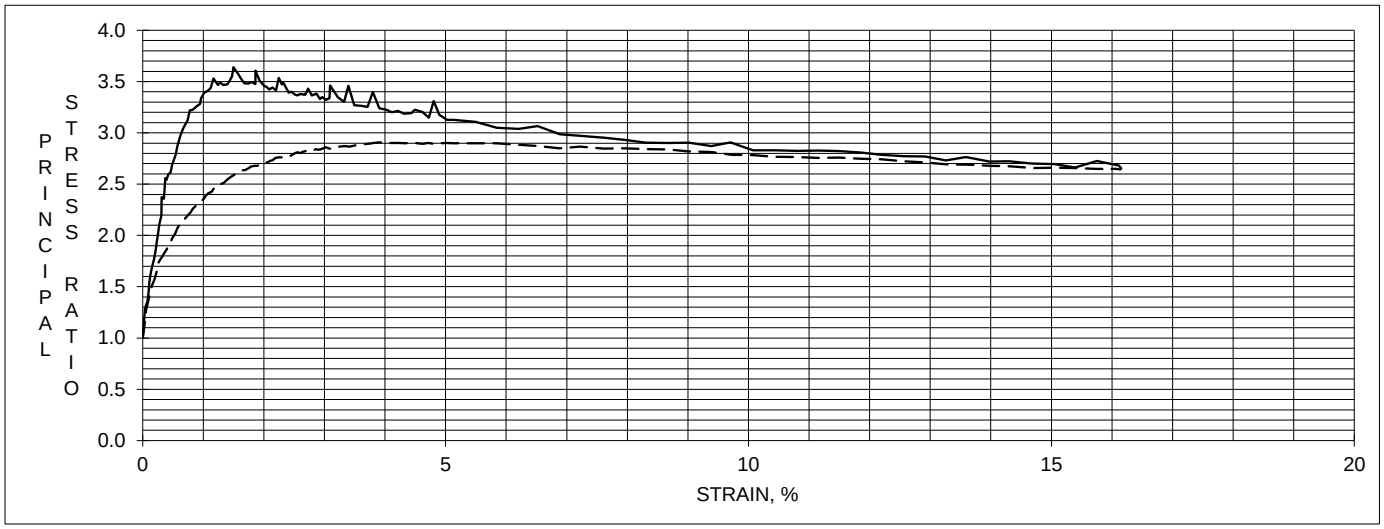
DEPTH, feet: 15.0 - 16.5

PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS

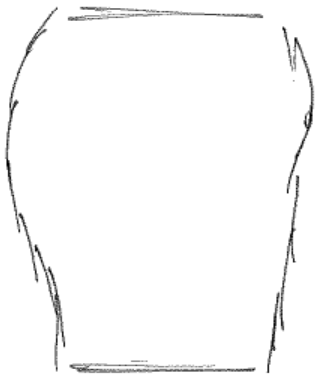
Terracon

NORTHEASTERN POWER STATION

04155186	B-1	10	15.0 - 16.5

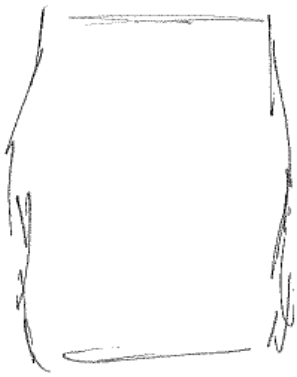


FAILURE SKETCH



SPECIMEN A

FAILURE SKETCH



SPECIMEN B

FAILURE SKETCH

SPECIMEN C

REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.

EFFECTIVE STRESS FAILURE DATA BASED ON 3 % STRAIN.

EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT 3 % STRAIN.

TOTAL STRESS FAILURE DATA BASED ON 3 % STRAIN.

TOTAL STRESS MOHR'S CIRCLES DRAWN AT 3 % STRAIN.

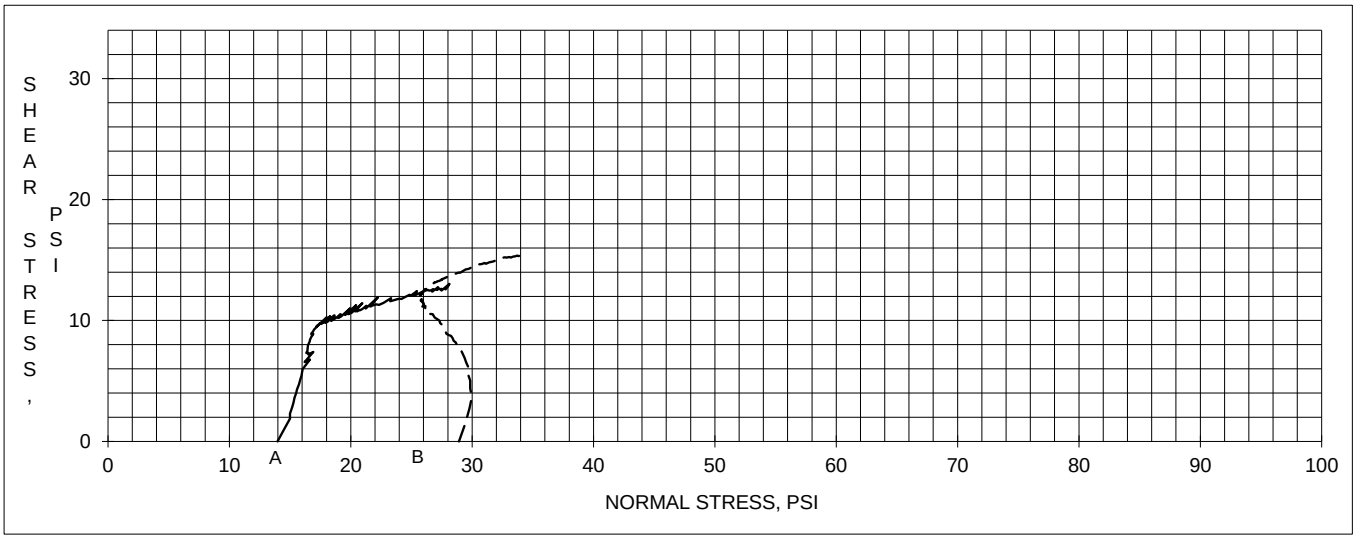
DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.

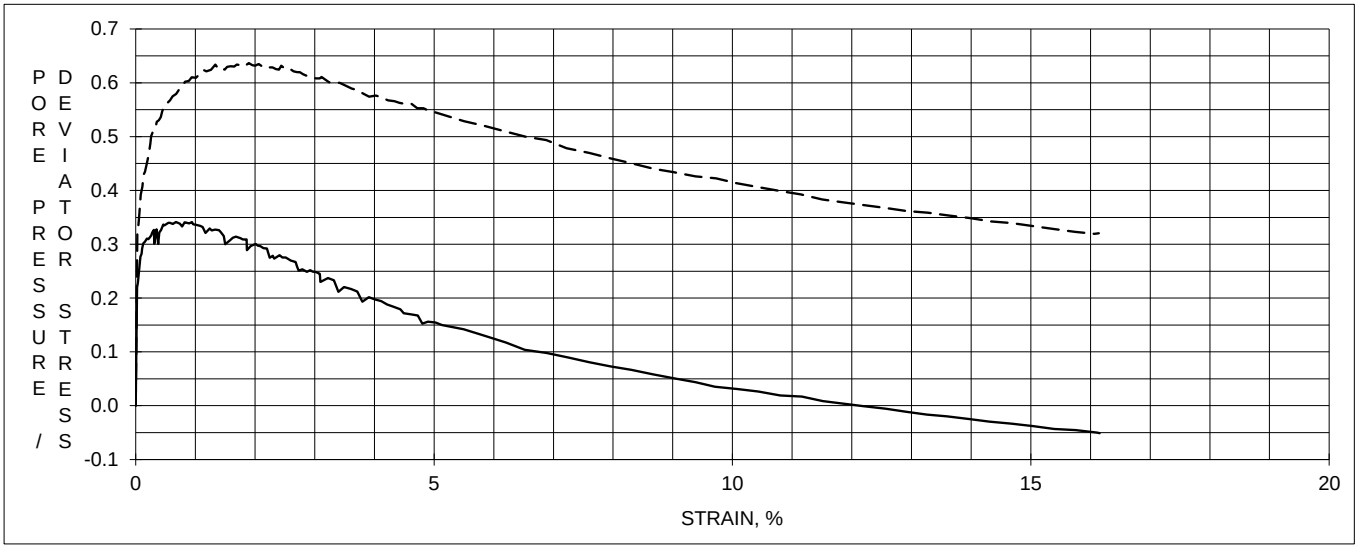
AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A

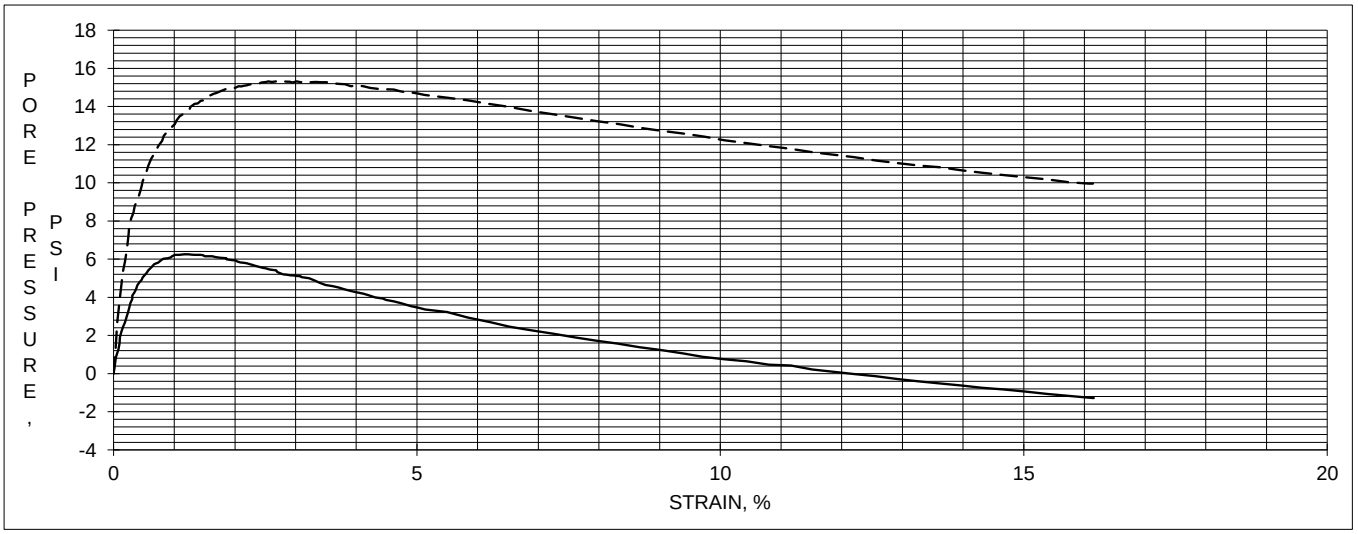
Terracon

NORTHEASTERN POWER STATION

04155186	B-1	10	15.0 - 16.5







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APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING


Auger


Split Spoon


Shelby Tube


Macro Core


Ring Sampler


Rock Core


Grab Sample


No Recovery

WATER LEVEL


Water Initially Encountered


Water Level After a Specified Period of Time


Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

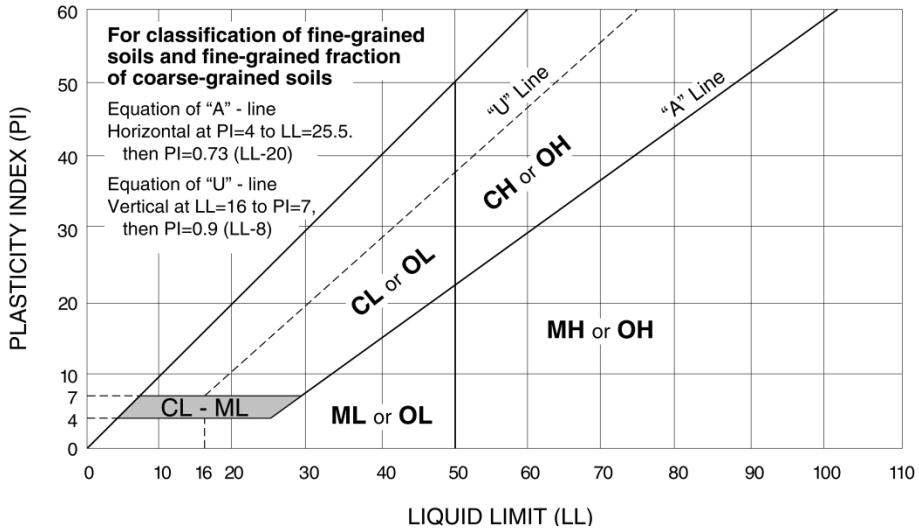


Exhibit C-2

GENERAL NOTES

Sedimentary Rock Classification

DESCRIPTIVE ROCK CLASSIFICATION:

	Sedimentary rocks are composed of cemented clay, silt and sand sized particles. The most common minerals are clay, quartz and calcite. Rock composed primarily of calcite is called limestone; rock of sand size grains is called sandstone, and rock of clay and silt size grains is called mudstone or claystone, siltstone, or shale. Modifiers such as shaly, sandy, dolomitic, calcareous, carbonaceous, etc. are used to describe various constituents. Examples: sandy shale; calcareous sandstone.
LIMESTONE	Light to dark colored, crystalline to fine-grained texture, composed of $CaCo_3$, reacts readily with HCl.
DOLOMITE	Light to dark colored, crystalline to fine-grained texture, composed of $CaMg(CO_3)_2$, harder than limestone, reacts with HCl when powdered.
CHERT	Light to dark colored, very fine-grained texture, composed of micro-crystalline quartz ($Si0_2$), brittle, breaks into angular fragments, will scratch glass.
SHALE	Very fine-grained texture, composed of consolidated silt or clay, bedded in thin layers. The unlaminated equivalent is frequently referred to as siltstone, claystone or mudstone.
SANDSTONE	Usually light colored, coarse to fine texture, composed of cemented sand size grains of quartz, feldspar, etc. Cement usually is silica but may be such minerals as calcite, iron-oxide, or some other carbonate.
CONGLOMERATE	Rounded rock fragments of variable mineralogy varying in size from near sand to boulder size but usually pebble to cobble size (½ inch to 6 inches). Cemented together with various cementing agents. Breccia is similar but composed of angular, fractured rock particles cemented together.

PHYSICAL PROPERTIES:

DEGREE OF WEATHERING

Slight	Slight decomposition of parent material on joints. May be color change.
Moderate	Some decomposition and color change throughout.
High	Rock highly decomposed, may be extremely broken.

HARDNESS AND DEGREE OF CEMENTATION

Limestone and Dolomite:

Hard	Difficult to scratch with knife.
Moderately Hard	Can be scratched easily with knife, cannot be scratched with fingernail.
Soft	Can be scratched with fingernail.

Shale, Siltstone and Claystone

Hard	Can be scratched easily with knife, cannot be scratched with fingernail.
Moderately Hard	Can be scratched with fingernail.
Soft	Can be easily dented but not molded with fingers.

Sandstone and Conglomerate

Well Cemented	Capable of scratching a knife blade.
Cemented	Can be scratched with knife.
Poorly Cemented	Can be broken apart easily with fingers.

BEDDING AND JOINT CHARACTERISTICS

Bed Thickness	Joint Spacing	Dimensions
Very Thick	Very Wide	>10′
Thick	Wide	3′ - 10′
Medium	Moderately Close	1′ - 3′
Thin	Close	2″ - 1′
Very Thin	Very Close	.4″ - 2″
Laminated	—	.1″ - .4″

Bedding Plane	A plane dividing sedimentary rocks of the same or different lithology.
Joint	Fracture in rock, generally more or less vertical or transverse to bedding, along which no appreciable movement has occurred.
Seam	Generally applies to bedding plane with an unspecified degree of weathering.

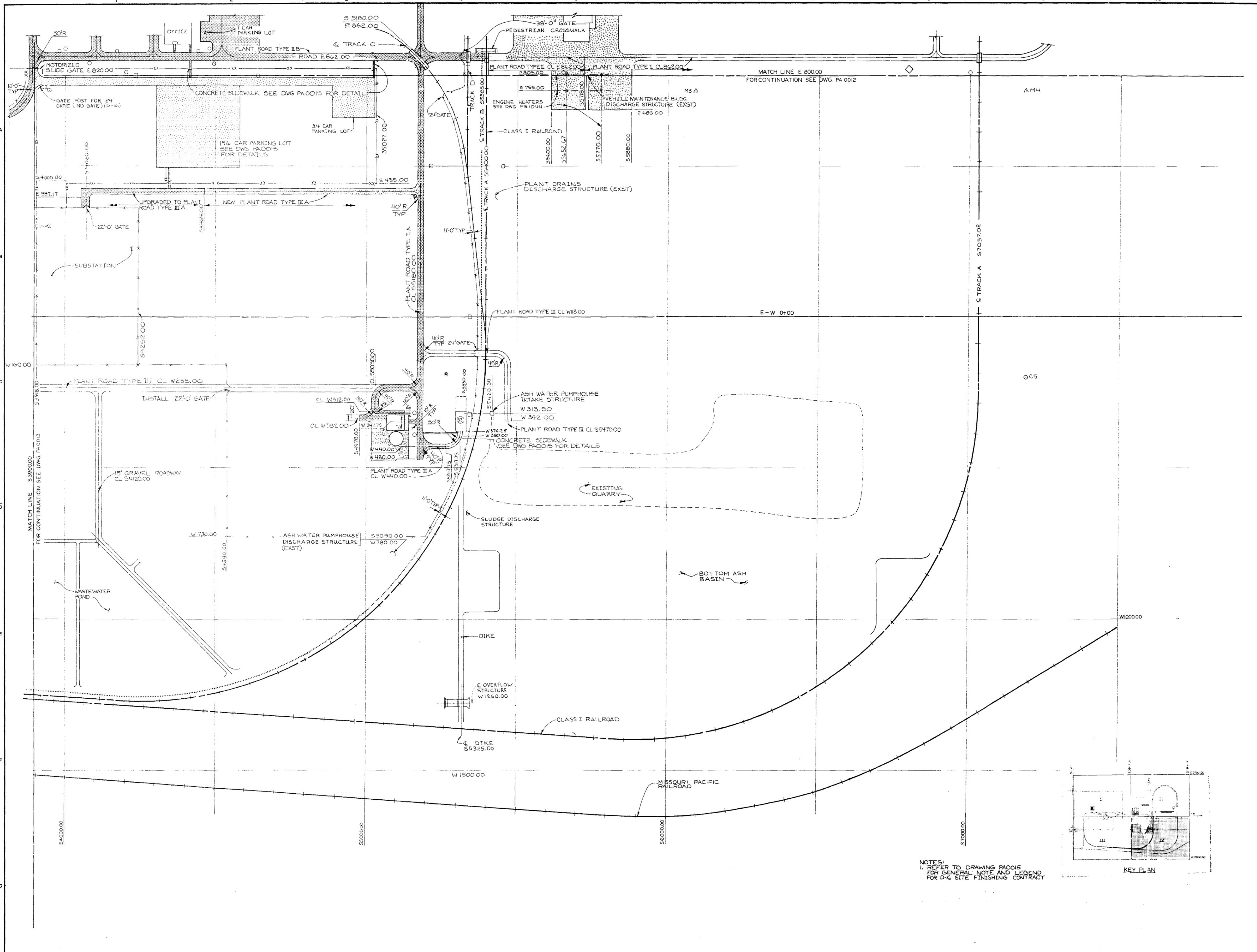
SOLUTION AND VOID CONDITIONS

Solid	Contains no voids.
Vuggy (Pitted)	Rock having small solution pits or cavities up to ½ inch diameter, frequently with a mineral lining.
Porous	Containing numerous voids, pores, or other openings, which may or may not interconnect.
Cavernous	Containing cavities or caverns, sometimes quite large.

Terracon

ATTACHMENT C

DESIGN DRAWINGS



OFFICE
7 CAR PARKING LOT
S 5180.00
E 862.00
38'-0" GATE
PEDESTRIAN CROSSWALK
℄ TRACK C
PLANT ROAD TYPE I B
℄ ROAD E862.00
50'R
MOTORIZED SLIDE GATE E820.00
10'-0" TYP
GATE POST FOR 24' GATE (NO GATE) (D-16)
CONCRETE SIDEWALK. SEE DWG PA0015 FOR DETAIL
34 CAR PARKING LOT
196 CAR PARKING LOT SEE DWG PA0015 FOR DETAILS
S5027.00
24' GATE
TRACK D
℄ TRACK B S5385.00
℄ TRACK A S5400.00
CLASS I RAILROAD
PLANT ROAD TYPE I CL E862.00
PLANT ROAD TYPE I CL862.00
E 755.00
ENGINE HEATERS SEE DWG PS1044
VEHICLE MAINTENANCE BLDG. DISCHARGE STRUCTURE (EXST)
E 685.00
S5600.00
S5652.67
S5718.00
S5770.00
S5880.00
MATCH LINE E 800.00
FOR CONTINUATION SEE DWG. PA 0012
M3
M4
S4005.00
E 997.17
E 435.00
UPGRADED TO PLANT ROAD TYPE III A
NEW PLANT ROAD TYPE III A
40'R TYP
22'-0" GATE
SUBSTATION
PLANT DRAINS DISCHARGE STRUCTURE (EXST)
11'-0" TYP
PLANT ROAD TYPE I A CL S5180.00
℄ TRACK A S7037.02
PLANT ROAD TYPE III CL W118.00
E-W 0+00
40'R TYP
24' GATE
S4252.00
W160.00
PLANT ROAD TYPE III CL W235.00
INSTALL 22'-0" GATE
CL S5020.00
C5
CL W312.00
CL W332.00
ASH WATER PUMPHOUSE INTAKE STRUCTURE
W 313.50
W 342.00
PLANT ROAD TYPE III CL S5470.00
W 374.25
W 390.00
CONCRETE SIDEWALK SEE DWG PA0015 FOR DETAILS
50'R
W440.00
W480.00
PLANT ROAD TYPE III A CL W440.00
MATCH LINE S3900.00 FOR CONTINUATION SEE DWG. PA0013
15' GRAVEL ROADWAY CL S4120.00
EXISTING QUARRY
SLUDGE DISCHARGE STRUCTURE
W 730.00
ASH WATER PUMPHOUSE DISCHARGE STRUCTURE (EXST)
S5090.00
W780.00
WASTEWATER POND
BOTTOM ASH BASIN
W1000.00
DIKE
℄ OVERFLOW STRUCTURE W1260.00
CLASS I RAILROAD
℄ DIKE S5325.00
W 1500.00
MISSOURI PACIFIC RAILROAD
S4000.00
S5000.00
S6000.00
S7000.00
KEY PLAN

NOTES:
1. REFER TO DRAWING PA0015 FOR GENERAL NOTE AND LEGEND FOR D-16 SITE FINISHING CONTRACT

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP
11-3-78	ADDED 15' ROAD @ WWT	13	JR	JG		4-27-76	REVISED AS CIRCLED	8	JR			1-13-83	CONFORMED TO CONSTRUCTION RECORDS	17	JR		
10-5-78	ADDED WWT ROAD	12	JR			4-9-76	REVISED AS CIRCLED	7	JC			6-15-82	ISSUED FOR CONSTRUCTION, SPEC D-16	16	SB		
10-19-77	REVISED SUBSTATION FENCE LOCATION	11	LR			3-12-76	REVISED AS CIRCLED	6	CB			5-21-82	ISSUED FOR ADDENDUM 1, SPEC D-16	15	SB	DE	
11-12-76	REVISED AS CIRCLED	10	JM			1-16-76	GENERAL REVISIONS	5	CB			5-6-82	ISSUED FOR BIDS, SPEC D-16	14	SB		
10-8-76	REVISED AS CIRCLED	9	JM			11-4-75	GENERAL REVISIONS	4	CB								

SCALE: 1"=100'

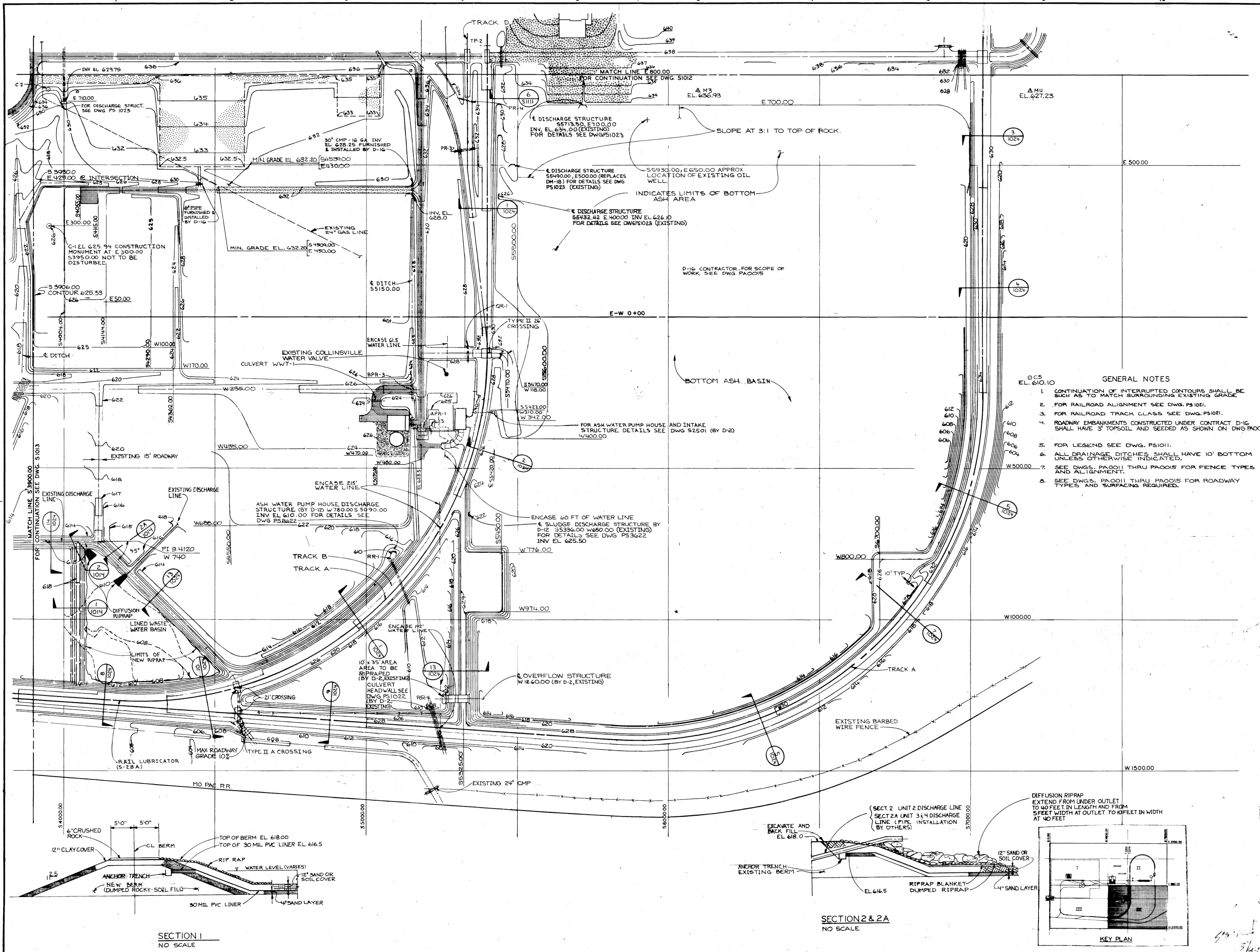
DEPT HEAD CLM
DES ENGR
CHECKED
DRAWN KDJ

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF OKLAHOMA.
SIGNED
DATE 8/29/75 REG. NO. 8872

BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT 6571/6572

PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION-UNITS 3 & 4
PLOT ARRANGEMENT
PLANT SITE AREA IV

B & V DWG NO. PA0014
REV. NO. 17
PSO DWG. NO. 85045-E
SHT. 0014



GENERAL NOTES

1. CONTINUATION OF INTERRUPTED CONTOURS SHALL BE SUCH AS TO MATCH SURROUNDING EXISTING GRADE.
2. FOR RAILROAD ALIGNMENT SEE DWG. PS1021.
3. FOR RAILROAD TRACK CLASS SEE DWG. PS1021.
4. ROADWAY EMBANKMENTS CONSTRUCTED UNDER CONTRACT D-16 SHALL HAVE 3" TOPSOIL AND SEEDED AS SHOWN ON DWG PA0015.
5. FOR LEGEND SEE DWG. PS1011.
6. ALL DRAINAGE DITCHES SHALL HAVE 10' BOTTOM UNLESS OTHERWISE INDICATED.
7. SEE DWGS. PA0011 THRU PA0015 FOR FENCE TYPES AND ALIGNMENT.
8. SEE DWGS. PA0011 THRU PA0015 FOR ROADWAY TYPES AND SURFACING REQUIRED.

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP
11-12-76	REVISED AS CIRCLED	13	JM		
10-8-76	REVISED AS CIRCLED	12	JM		
8-11-76	REVISED AS CIRCLED	11	ES		
5-14-76	REVISED AS CIRCLED	10	BM		
3-12-76	REVISED AS CIRCLED	9	CB		
1-13-83	CONFORMED TO CONSTRUCTION RECORDS	21	JR		
6-15-82	ISSUED FOR CONSTRUCTION, SPEC D-16	20	SB		
5-21-82	ISSUED FOR ADDENDUM 1, SPEC D-16	19	SB	DE	
5-6-82	ISSUED FOR BIDS, SPEC D-16	18	SB		
8-14-80	ISSUED FOR BIDS; 1	17	TW		DE
11-3-78	ADDED ROADWAY & CULVERT	16	JR	JG	
10-5-78	REVISED AS CIRCLED	15	JR		
9-22-78	ISSUED FOR BIDS, SPEC D-12	14	JR		

SCALE: 1" = 100'

DEPT HEAD CLM
CHECKED TD
DRAWN KDJ

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF OKLAHOMA

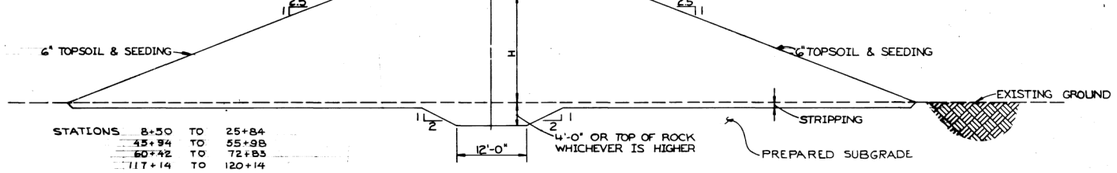
SIGNED [signature]
DATE 9/29/75 REG. NO. 8892

BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT 6571/6572

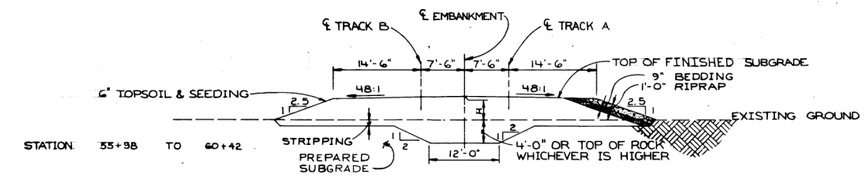
PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION - UNITS 3 & 4

SITE GRADING
PLANT SITE AREA IV

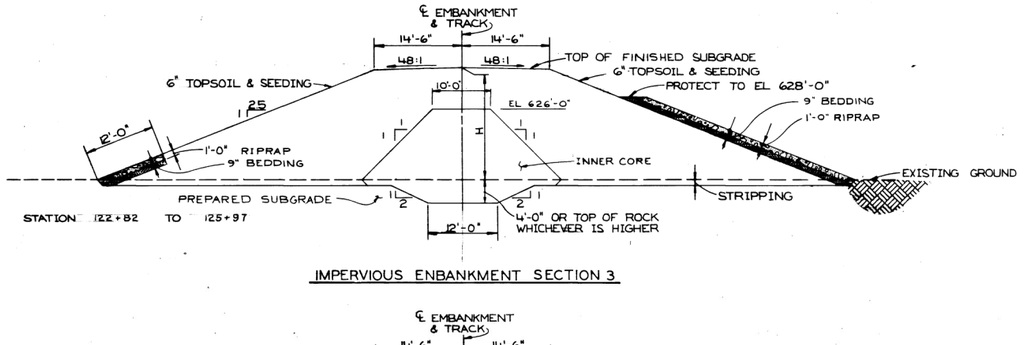
B&V DWG NO. PS1014
REV. 21
PSO DWG. NO. 85127-E
SHT. 1014



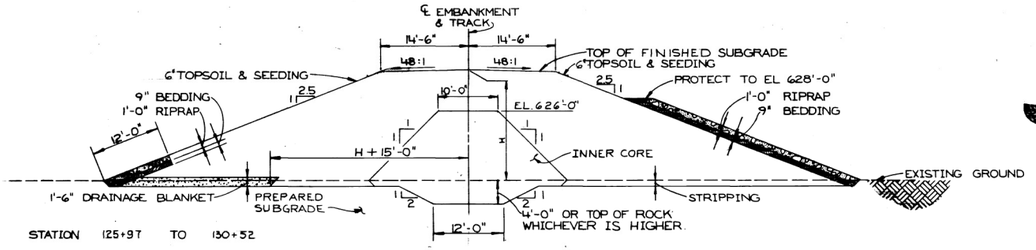
TYPICAL SECTION 1



TYPICAL SECTION 2



IMPERVIOUS ENBANKMENT SECTION 3



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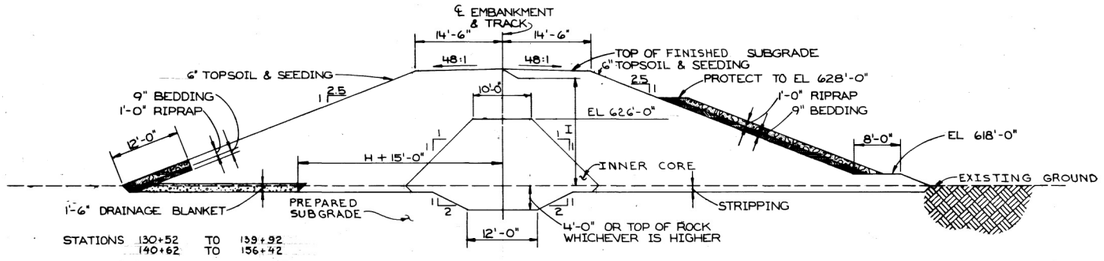

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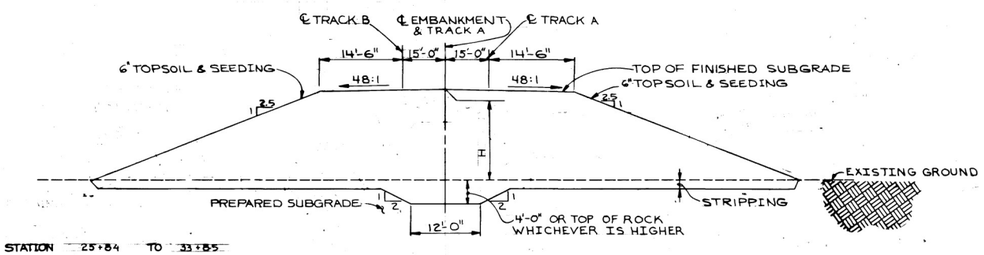
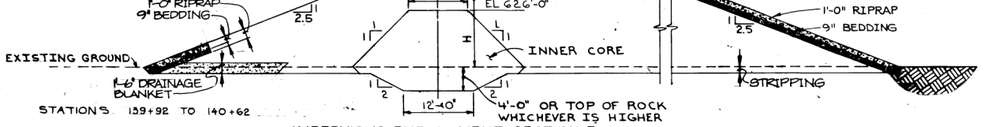
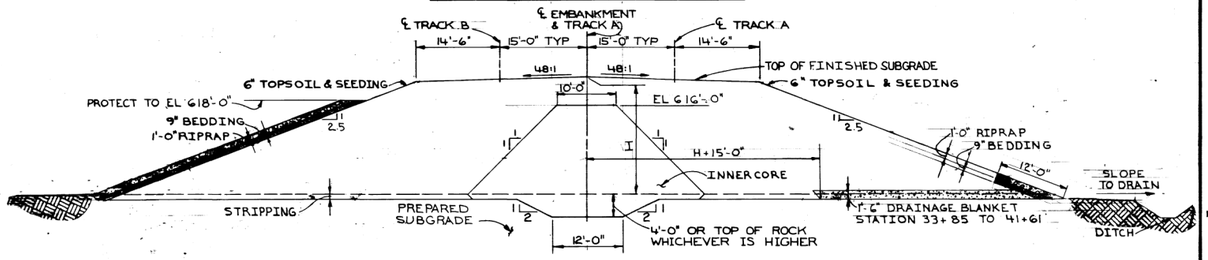


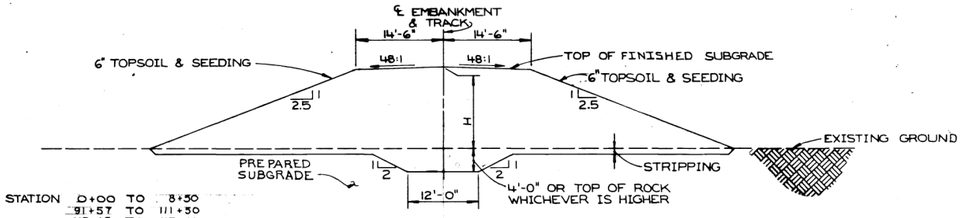
IMPERVIOUS EMBANKMENT SECTION 6



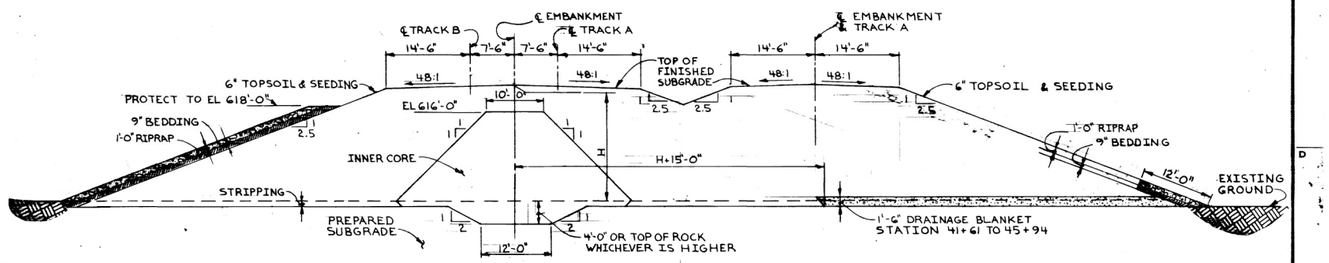
IMPERVIOUS ENBANKMENT SECTION 7



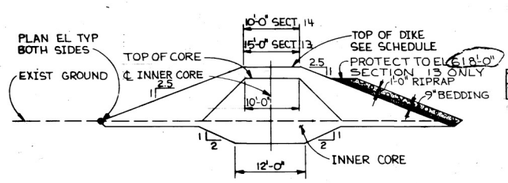
IMPERVIOUS ENBANKMENT SECTION 8



TYPICAL SECTION 9



IMPERVIOUS ENBANKMENT SECTION 10

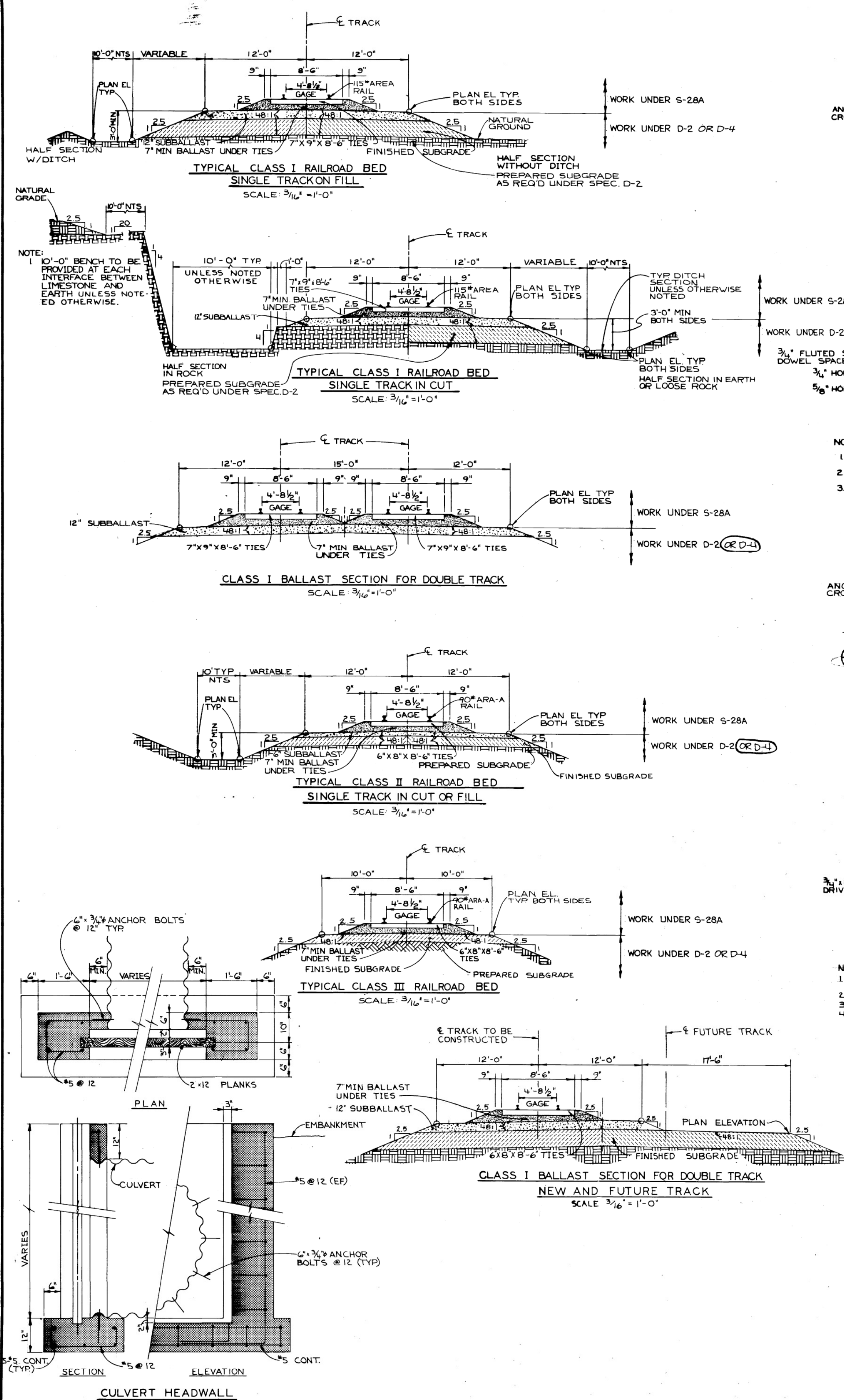


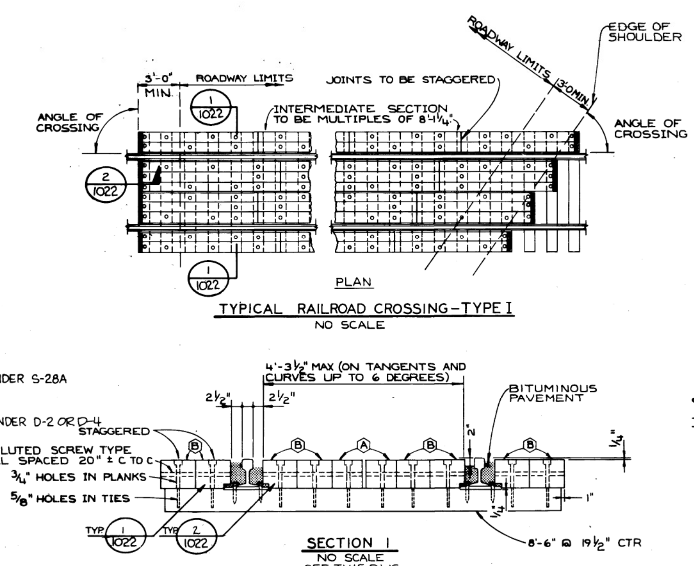
SECTION 13 & 14 SCHEDULE		
	WASTE WATER POND	BOTTOM ASH POND
TOP DIKE	EL 618.0	EL 629.0
TOP CORE	EL 616.0	EL 626.0

IMPERVIOUS EMBANKMENT SECTION 13 & 14

GENERAL NOTES

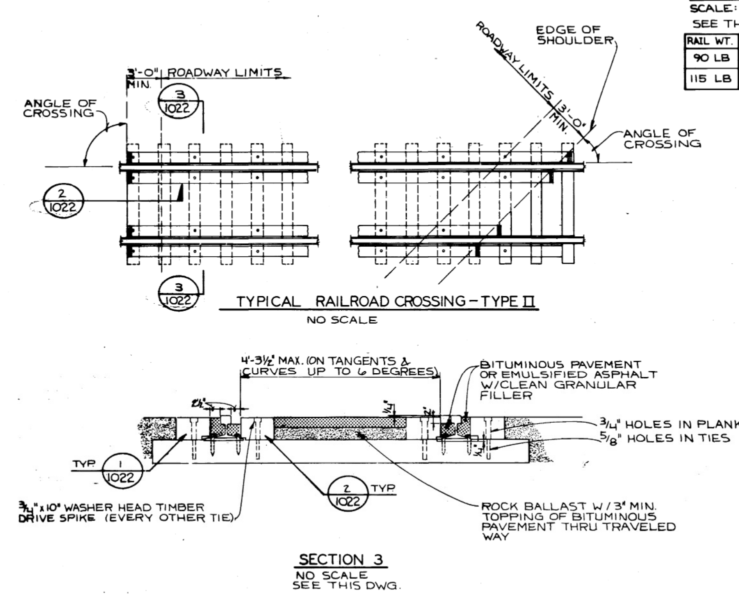
1. EACH SECTION IS FACING TOWARD INCREASING STATION NUMBER.
2. FINISHED AND PREPARED SUBGRADE SHALL BE CONSTRUCTED AS REQUIRED BY SPECIFICATION D-2.





NOTES:

1. (A) 6 7/8" X 7 3/4" PLANKS (115 AREA RAIL) 5 1/4" X 7 3/4" PLANKS (90 ARA-A RAIL)
2. (B) 6 7/8" X 8 3/4" PLANKS (115 AREA RAIL) 5 1/4" X 8 3/4" PLANKS (90 ARA-A RAIL)
3. ANY PREBORED HOLES NOT USED SHOULD BE PLUGGED AND SEALED.



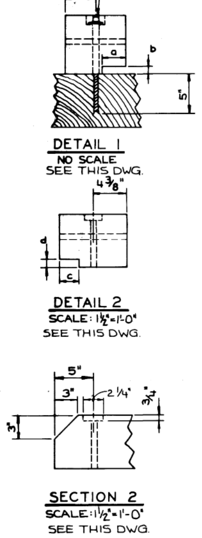
NOTES FOR SECTION 3 ONLY:

1. LENGTH OF END PLANKS MAY VARY, BUT NOT LESS THAN 3 TIE SPACES PLUS 1/2 WIDTH OF TIE. INCREASE LENGTH OF PLANKING IF NECESSARY.
2. PROVIDE INTERLOCKING NOTCHES ON ENDS OF ALL PLANKS EXCEPT BEVELED END OF OUTSIDE PLANK.
3. INTERLOCKED JOINTS TO BE CENTERED OVER TIE.
4. LENGTH OF INTERMEDIATE PLANKS TO BE 8'-5 1/4"

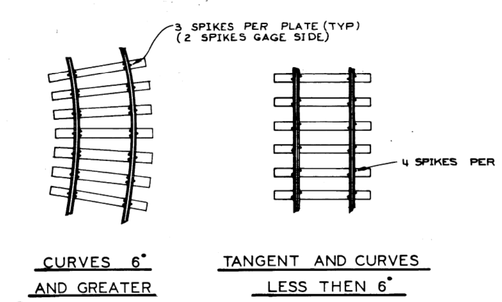
RAILROAD CROSSING NOTES

1. PLANKS TO BE PREFRAMED CREOSOTED RED OAK, GUM, MAPLE, OR BIRCH.
2. PLANKS TO BE PREDRILLED WITH 3/4" HOLES.
3. TIES WITHIN LIMITS OF CROSSING SHALL BE SAWED, PRE-ADZED, CREOSOTED AND TIE PLATED.
4. TIE SPACING SHALL BE 19 1/2".
5. FIELD DRILL 5/8" HOLES INTO TIES TO ACCOMMODATE LENGTH OF DRIVE SPIKES.
6. WHERE UNAVOIDABLE ADZING AND CUTTING OF MATERIAL IS NECESSARY, TREAT CUT SURFACES WITH CREOSOTE, TREAT HOLES DRILLED IN FIELD WITH CREOSOTE.
7. RAIL ANCHORS NORMALLY LOCATED WITHIN LIMITS OF CROSSING MAY BE DIVIDED EQUALLY ON ADJACENT APPROACH RAILS.
8. TRACK BETWEEN ENDS OF PLANKING AND SHOULDER LINE OF HIGHWAY SHALL BE FILLED WITH BALLAST MATERIAL.
9. WHERE PRACTICABLE, NO JOINTS SHALL BE PERMITTED IN THE CROSSING NOR WITHIN 6 FEET OF THE ENDS OF THE CROSSING. JOINTS WHICH ARE UNAVOIDABLE WITHIN THESE LIMITS SHALL BE PRESSURE WELDED OR LAID TIGHT AND FROZEN. BUILD UP RAIL ENDS AND GRIND TO EQUAL HEIGHT WHERE REQUIRED.
10. EMULSIFIED ASPHALT WILL BE APPLIED AT A RATE OF 1 GALLON PER SQUARE YARD OVER BOTH THE FIRST 3" LIFT OF BALLAST AND ALSO OVER THE BALLAST SECTION WHEN DRESSED, PRIOR TO PLACING IN SERVICE. INSTALLATION WILL BE SEALED WITH A LIGHT COATING OF EMULSIFIED ASPHALT AND SPRINKLED WITH CLEAN SAND, CHAT OR SCREENING.

3/4" X 10" WASHER HD. TIMBER DRIVE SPIKE (90 LB RAIL)
3/4" X 12" WASHER HD. TIMBER DRIVE SPIKE (112 LB RAIL AND HEAVIER)



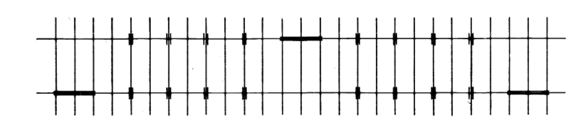
RAIL WT.	a	b	c	d
90 LB	2"	1"	7/8"	1/2"
115 LB	3 1/2"	1 1/16"	2 1/2"	1"



ALL CLASS TRACKS

WOOD TIE SPIKING DETAIL

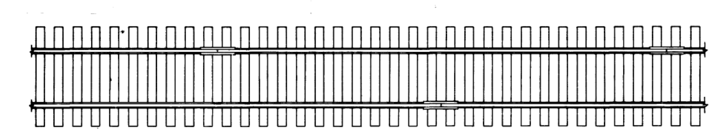
SCALE: 3/16" = 1'-0"



8 FORWARD AND 8 BACK-UP RAIL ANCHORS PER RAIL LENGTH (39' RAIL LENGTH)

TYPICAL RAIL ANCHOR DETAIL

SCALE: 3/16" = 1'-0"



NOTES:

1. TIE SPACING ACCORDING TO SPECIFICATION 6571-S-28A.
2. JOINT BAR ACCORDING TO SPECIFICATION 6571-S-28A.
3. RAIL WEIGHT ACCORDING TO TYPICAL SECTION THIS DWG.
4. TIE SIZE ACCORDING TO TYPICAL SECTION THIS DWG.
5. SEE WOOD TIE SPIKING DETAIL FOR SPIKE DISTRIBUTION.

TYPICAL TRACKAGE

ALL CLASSES

NO SCALE

GENERAL NOTES

1. TIES, RAILS AND TRACK HARDWARE TO BE FURNISHED AND INSTALLED UNDER CONTRACT S-28A.
2. BALLAST TO BE FURNISHED AND STOCKPILED UNDER CONTRACT D-2, AND INSTALLED UNDER S-28A.
3. FOR FINISHED SUBGRADE DETAILS, SEE DWG. PS1024.

Scanned 5/99

2-12-82	CONFORMED TO CONSTRUCTION RECORDS	8	8-20-75 REVISED AND ISSUED FOR BID - SPEC S-28A
5-14-76	REVISED AS CIRCLED	7	7-17-75 REVISED AND ISSUED FOR ADDENDUM 1 - SPEC D-2
3-12-76	DWG NO. AND REF. DWG NOS.	6	6-13-75 REVISED AND ISSUED FOR BID - SPEC D-2
9-29-75	GENERAL REVISIONS	5	5-8-75 ISSUED FOR PSO REVIEW
8-25-75	REV & ISSUED FOR CONTRACT & CONSTR - SPEC D-2	4	DATE — REVISIONS AND RECORD OF ISSUE

SCALE: AS NOTED

DATE 8/29/75

BLACK & VEATCH CONSULTING ENGINEERS

PROJECT 6571/6572

PUBLIC SERVICE COMPANY OF OKLAHOMA

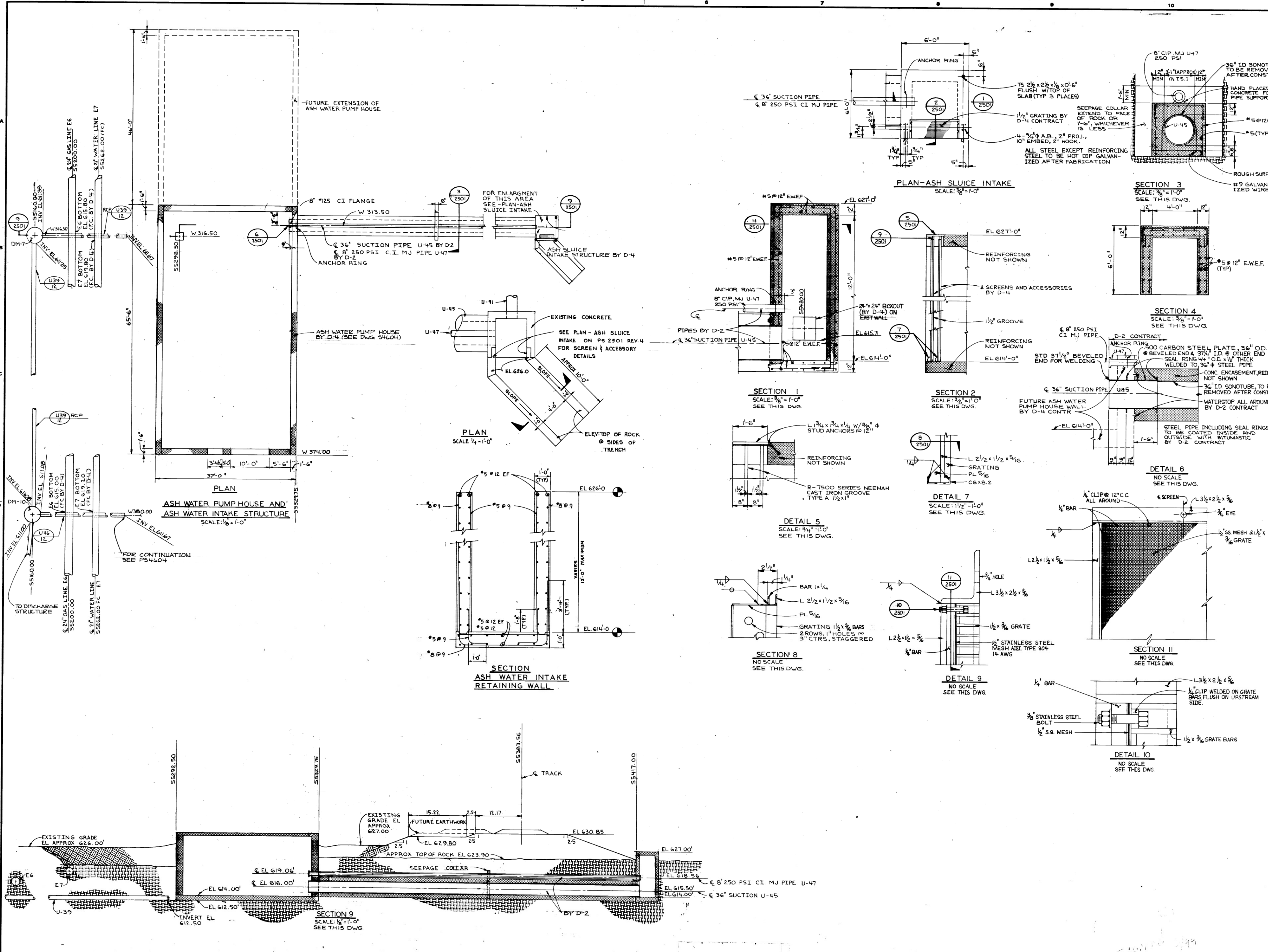
NORTHEASTERN STATION - UNITS 3 & 4

MISCELLANEOUS RAILROAD DETAILS

PS1022

85127-E

SHT. 1022



5-14-76	REVISED AS CIRCLED	3	FH			
3-12-76	REVISED AS CIRCLED	2	CB			
1-14-76	ISSUED FOR CONSTRUCTION	1				
11-11-75	ISSUED FOR PSO REVIEW	0	JR			
2-12-82	CONFORMED TO CONSTRUCTION RECORDS	5				
10-8-76	REVISED AS CIRCLED	4	JM			
DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP	

SCALE: AS NOTED

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF OKLAHOMA

DATE 1/16/76 REG. NO. 10732

DEPT HEAD CLM — DRAWN GWH

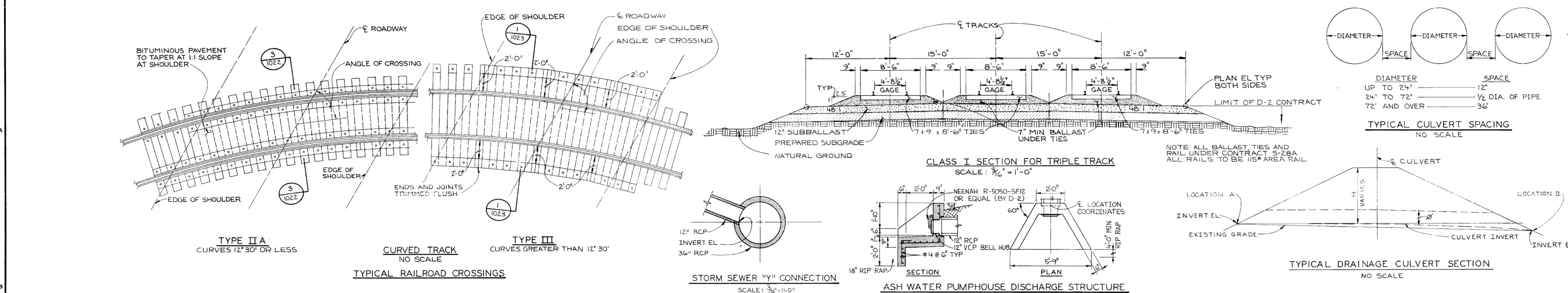
BLACK & VEATCH CONSULTING ENGINEERS

PROJECT 6571/6572

PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION-UNITS 3 & 4

MISCELLANEOUS YARD STRUCTURES
PLAN SECTIONS AND DETAILS

DWG NO. PS2501
REV 5
85127-E
SH. 2501



DRAINAGE CULVERT LIST

FURNISH	INSTALL	CULVERT NO.	CENTERLINE LOCATION SOUTH	CENTERLINE LOCATION E-W	Ø DIAM.	NO. OF UNITS	NOTES	SIZE GAGE	SIZE CORR. SIZE	SIZE LGTH.	END TYPE	INVERT ELEV. LOCATION A	INVERT ELEV. LOCATION B
D-2	D-2	ER-1	315.00	E 1180.95	42	2		16	3x1	60	2	643.20	642.30
D-2	D-2	ER-2	922.00	E 1165.00	24	2		18	STD	48	1	636.70	636.50
D-2	D-2	ER-3	971.00	E 1140.00	12	1		18	STD	46	1	637.70	637.00
D-2	D-2	ER-4	962.00	E 1231.00	24	2		18	STD	28	1	637.00	636.80
D-2	D-2	AC-1	3159.00	E 1250.00	48	3		16	3x1	56	2	634.80	634.00
D-2	D-2	TR-1	3310.00	E 1107.00	48	3		16	3x1	52	3	633.80	633.00
D-2	D-2	PR-1	3302.00	E 1060.00	48	3		16	3x1	55	2	632.80	632.00
D-2	D-2	PR-2	5093.00	E 934.00	18	1		18	STD	64	1	633.50	633.00
D-2	D-2	CTR-1	4562.00	E 1772.00	24	1		18	STD	57	1	639.00	638.50
D-2	D-2	MR-1	5033.00	E 862.00	24	1		18	STD	75	1	631.50	631.00
D-2	D-2	MR-2	6972.00	E 862.00	36	4	ASB BONDED	16	3x1	78	1	627.00	626.00
D-2	D-2	MAR-1	3300.00	E 649.00	48	3		16	3x1	76	2	628.50	628.00
D-2	D-2	CPR-1	3366.00	E 36.00	36	3		16	3x1	48	3	625.00	624.50
D-2	D-2	BPR-1	2800.00	W 235.00	36	1		16	3x1	50	3	619.70	619.20
D-2	D-2	BPR-2	3870.00	W 235.00	42	6	RELOCATED FROM EXIST			60	3	616.40	615.40
D-2	D-2	BPR-3	5150.00	W 235.00	42	1	RELOCATED FROM EXIST			54	3	623.00	622.40
D-2	D-2	BPR-4	5118.75	W 288.00	12	1		18	STD	46	3	623.50	623.00
D-2	D-2	QR-1	5040.00	W 118.00	24	1		18	STD	54	3	627.00	626.40
D-2	D-2	TP-1	5264.00	E 1080.00	12	1		18	STD	76	3	633.20	632.80
D-2	D-2	TP-2	5435.00	E 862.00	12	1		18	STD	76	3	631.80	631.30
D-2	D-2	RR-1	5110.00	W 871.00	60	1		14	3x1	146	2	610.00	608.5
D-2	D-2	PR-3	5335.00	E 553.00	18	1		16	STD	55	3	631.00	630.50
D-2	D-2	PR-4	5332.00	E 702.00	18	1		18	STD	50	3	633.00	632.70
D-2	D-2	RR-4	5231.00	W 1355.00	60	2		14	3x1	140	2	607.90	606.40
D-2	D-2	RR-5	1015.00	W 1047.00	24	2		16	STD	65	3	623.00	622.70
D-2	D-2	LR-1	6911.00	E 2875.00	36	2		16	3x1	60	1	607.80	607.30
D-2	D-2	RR-3	6815.00	E 2730.00	36	1		14	3x1	155	1	612.00	610.00
D-2	D-2	PR-5	700.00	W 765.00	18	1		16	STD	40	1	626.00	625.70
D-2	D-2	APR-1	5180.00	W 268.00	24	1		18	STD	75	1	622.80	622.00
D-2	D-2	MR-3	5535.00	E 894.00	18	1		16	STD	48	1	635.00	634.20
D-2	D-2	MR-4	6925.00	E 885.00	18	2	ASB BONDED	18	STD	62	1	633.00	632.00
D-2	D-2	MR-5	7215.00	E 885.00	12	1		18	STD	75	3	631.00	630.00
D-12	D-12	WWT-2	5152.25	W 347.75	50x31	1	METAL ARCH	12	3x1	44	3	622.20	622.00
D-4	D-4	BC-6	5335.00	E 940.00	6'x2'-3"	1	FOR DETAILS SEE			50'		632.50	631.30
D-4	D-4	BC-5	5180.00	E 1084.37	6'x2'-3"	1	DWG PS1043			75'		633.44	633.22
D-2	D-2	BC-1	700.80	W 60.00	6'x6'	4	FOR BC DETAILS SEE			60'		625.90	625.40
D-2	D-2	BC-2	1340.00	W 235.00	6'x6'	4	THIS DWG			60'		619.90	619.40
D-2	D-2	BC-3	2985.00	W 1193.00	6'x6'	5	SEE THIS DWG.			100'		609.00	608.00
D-4	D-4	BC-4	4524.00	E 1287.00	6'x2'-3"	1	SEE DWG PS1043			46'			

FOR CONTINUATION OF CULVERT LIST SEE DWG PS1043

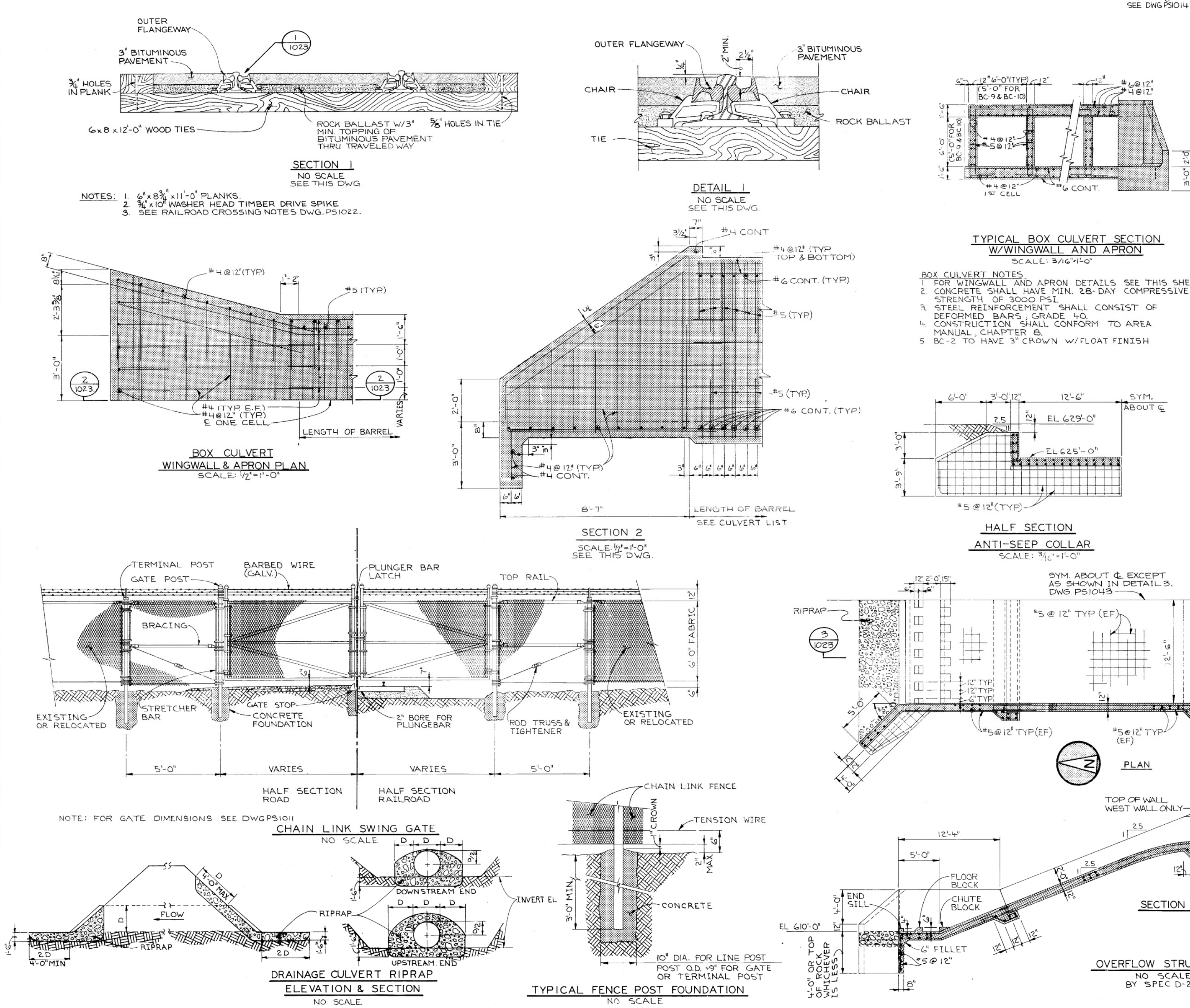
LEGEND

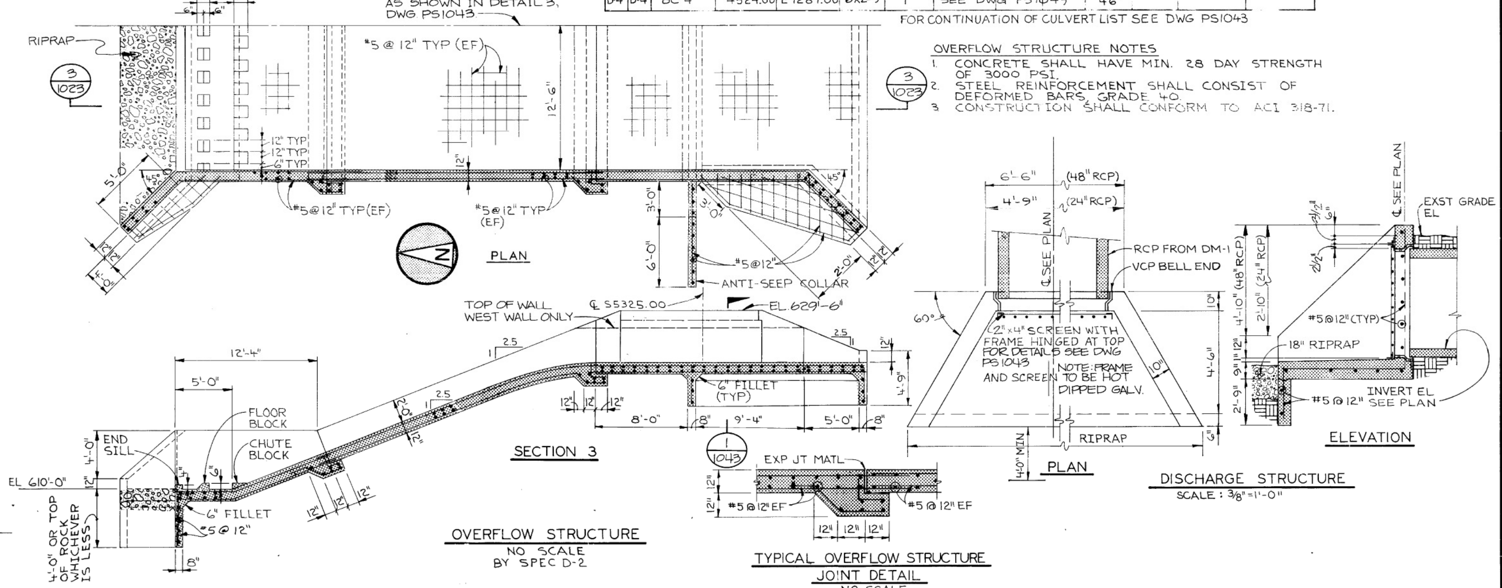
- ER - ENTRANCE ROAD
- AC - ACCESS ROAD
- TR - TEMPORARY RR
- PR - PLANT RR
- CTR - COOLING TOWER ROAD
- MR - MAINTENANCE ROAD
- MAR - MAIN ACCESS ROAD
- CPR - CONSTR PARKING RD.
- BPR - BATCH PLANT ROAD
- QR - QUARRY ROAD
- TP - TEMPORARY CULVERT
- RR - COAL RAILROAD
- LR - LOOP ROAD
- BC - BOX CULVERT
- APR - ASH PUMP ROAD

STD CORRUGATION 2 2/3" x 1/2"

END TYPES:
1 = BEVELED
2 = FLARED
3 = SQUARE

NOTE: END SECTIONS INCLUDED IN PIPE LENGTH





DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP
11-3-78	ADDED CULVERT WWT-1 & REVISED LOCATION BC-5	13	JR	JG	
6-15-76	REVISED MR-4 INVERT ELEV.	12	JM	TD	
5-14-76	REVISED AS CIRCLED	11	GH	TD	
4-27-76	REVISED AS CIRCLED	10	TD		
3-31-76	REVISED OVERFLOW STRUCTURE	9	PH	LR	
3-12-76	REVISED AS CIRCLED	8		TD	
1-16-76	GENERAL REVISIONS	7	CB	TD	
11-4-75	GENERAL REVISIONS	6	CB		
9-29-75	GENERAL REVISIONS	5	CB		
8-29-75	REV & ISSUED FOR CONTRACT & CONST-SPEC D2	4		TD	
2-12-82	CONFORMED TO CONSTRUCTION RECORDS	14			

SCALE: AS NOTED

DEPT HEAD CLM | DES ENGR | CHECKED TD | DRAWN SJR

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF OKLAHOMA

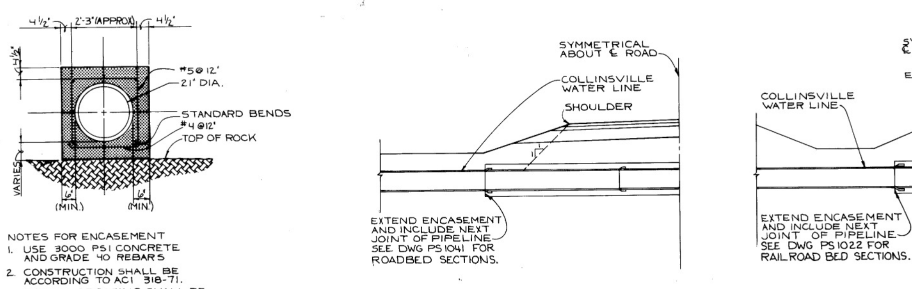
SIGNED ____ DATE ____ REG. NO. ____

BLACK & VEATCH CONSULTING ENGINEERS
PROJECT 6571/6572

PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION-UNITS 3 & 4

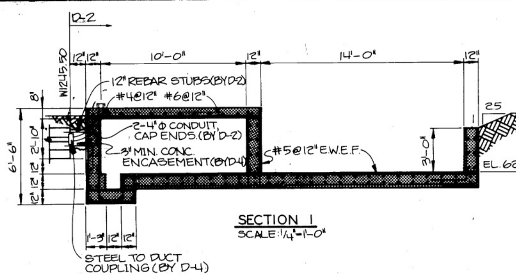
MISCELLANEOUS RAILROAD AND SITE GRADING DETAILS

B&V DWG NO. PS1023
FSO DWG. NO. 85127-E
SHT. 1023



NOTES FOR ENCASEMENT
1. USE 3000 PSI CONCRETE AND GRADE 40 REBARS
2. CONSTRUCTION SHALL BE ACCORDING TO ACI 318-71.
3. BOTTOM OF CASING SHALL BE POURED TO TOP OF ROCK.
4. ALL LONGITUDINAL REINFORCING SHALL BE #4 BARS PLACED AS SHOWN.

COLLINSVILLE WATER LINE ENCASEMENT DETAILS
NO SCALE



SECTION 1
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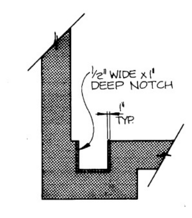

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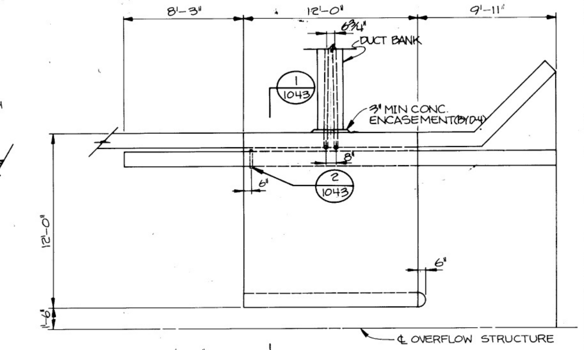
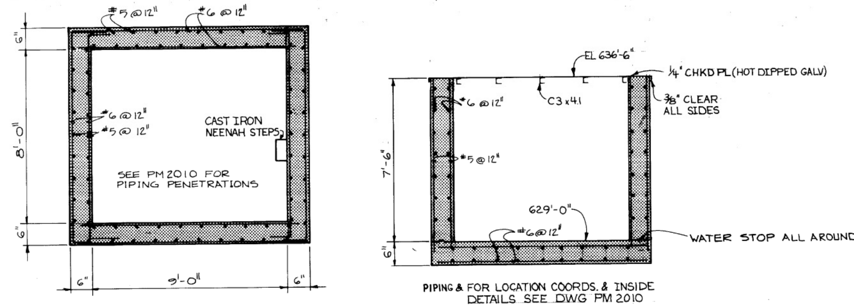


DETAIL 3
SCALE: 1/4"=1'-0"

HOSE HOUSE LIST					
NO.	CORNER LOCATION SOUTH	CORNER LOCATION E. OR W.	ELEVATION	FURNISH	INSTALL
1					
2	3919.00	E 1066.00			D-6
3	3919.00	E 1488.00			D-6
4	4472.00	E 888.00			D-6
5	4504.00	E 1532.00			D-6
6	4805.00	E 1609.00			D-6
7	4805.00	E 1732.50			D-6
8	5530.00	E 1282.00			D-6
9	5200.00	E 1091.00			D-6
10	6165 .00	E 1198.50			D-6
11	6598.00	E 1210.00			D-6
12	6973.00	E 1673.00			D-6
13	4650.00	E 2067.50			D-6
14	4650.00	E 2191.00			D-6

YARD & FIRE HYDRANT LIST					
NO.	CENTERLINE LOCATION SOUTH	CENTERLINE LOCATION E. OR W.	ELEVATION	FURNISH	INSTALL
FH 1	4542.00	E1083.00	633.58	B/M B-30A (FH 1 – FH 27)	D-4
FH 2	4475.00	E 886.00	631.50		D-4
FH 3	NOT USED				
FH 4	4075.00	E 886.00	629.50		D-4
FH 5	3909.00	E 1066.00	637.58		D-4
FH 6	3909.00	E1250.00	637.58		D-4
FH 7	3909.00	E1660.00	637.58		D-4
FH 8	3980.00	E1492.00	636.00		D-4
FH 9	4170.00	E1463.50	637.50		D-4
FH10	4420.00	E1492.00	637.50		D-4
FH11	4502.00	E1262.50	636.50		D-4
FH12	4790.00	E1615.00	638.58		D-4
FH13	4790.00	E1735.00	639.58		D-4
FH14	5040.00	E1615.00	639.58		D-4
FH15	5040.00	E1735.00	639.58		D-4
FH16	5200.00	E1106.00	637.50		D-4
FH17	5550.00	E1083.00	639.50		D-4
FH18	5527.00	E1279.50	644.50		D-4
FH19	5880.00	E1207.00	641.50		D-4
FH20	6170.00	E1077.00	641.50		D-4
FH21	6583.00	E1210.00	641.50		D-4
FH22	6857.75	E1170.00	637.75		D-4
FH23	6956.00	E1665.00	637.75		D-4
FH24	4635.00	E2185.00	638.58		D-4
FH25	4635.00	E2065.00	638.58		D-4
FH26	4885.00	E2185.00	638.58		D-4
FH27	4885.00	E2065.00	638.58		D-4
YH 1	4695.50	E1645.00		D-4	D-4
YH 2	4605.00	E1895.00		D-4	D-4
YH 3	4540.50	E2154.00		D-4	D-4
FH28	S4160.00	E1282.00			

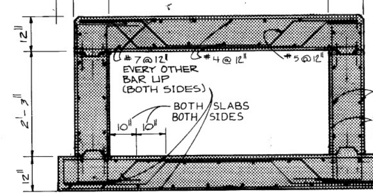


PLAN

PIPING & FOR LOCATION COORDS. & INSIDE DETAILS SEE DWG PM 2010

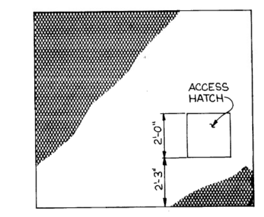
ELEVATION

BOILER DRAIN VALVE PIT
SCALE 3/8"=1'-0"

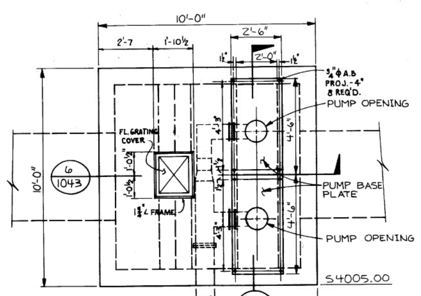


ASH LINE BOX CULVERT

NOTES FOR CONSTRUCTION OF BOX CULVERT
1. CONCRETE CONSTRUCTION ACCORDING TO ACI-318-71
2. MAINTAIN 2" COVER ON ALL STEEL EXCEPT 3" @ BOTTOM OF BOTTOM SLAB
3. FOR WINGWALL AND APRON DETAILS SEE THIS SHEET

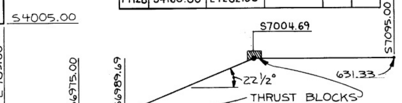


PLAN
CHECKERED PLATE

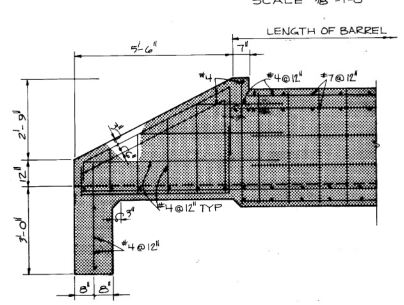


PLAN

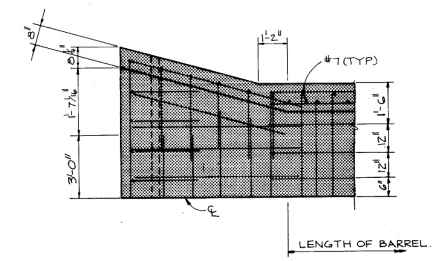
SITE RUNOFF PUMP PIT STRUCTURE
SCALE: 3/8"=1'-0"



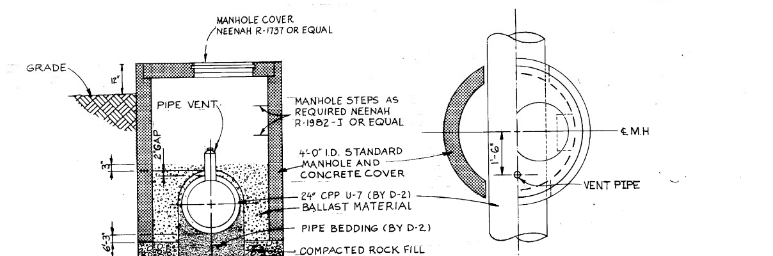
U-42 VERT PROFILE
NO SCALE



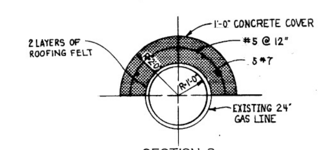
ASH LINE BOX CULVERT WINGWALL
SCALE: 1/2"=1'-0"



ASH LINE BOX CULVERT APRON
SCALE: 1/2"=1'-0"

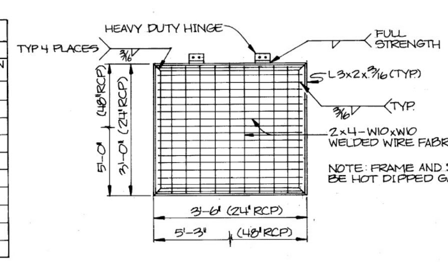


MAKE UP WATER MANHOLE
SCALE: 1/2"=1'-0"

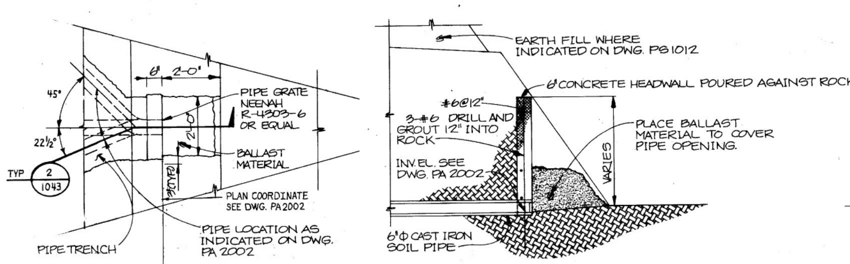


SECTION 3
SCALE 1/2"=1'-0"

DRAINAGE CULVERT LIST (CONT. FROM DWG. PS1023)													
FURNISH	INSTALL	CULVERT NO.	CENTERLINE LOCATION SOUTH	CENTERLINE LOCATION E-W	Ø DIAM.	NO. OF UNIT	NOTES	SIZE GAGE	SIZE CORR. SIZE	SIZE LGTH	END TYPE	INVERT ELEV. LOCATION A	INVERT ELEV. LOCATION B
D-4	D-4	CTR-2	4524.00	E2028	24"	1		18	STD	70'	1	639.50	639.00
D-4	D-4	CTR-3	4775.00	E1772.00	12"	1		18	STD	55'	1	641.50	641.00
D-4	D-4	CTR-4	4576.00	E1630.00	24"	1		18	STD	65'	1	638.00	637.50
D-4	D-4	BC-9	6920.00	E1545.00	5'x5'	2	FOR BC	DETAILS SEE		35'		629.60	629.50
D-4	D-4	BC-10	6905.00	E1772.00	5'x5'	2	DWG. PS	1023		25'		629.80	629.70
D-4	D-4	TR-2	3659.00	E1210.00	12"	1		16	STD	91'	3	637.10	636.90
D-4	D-4	TR-5	4780.00	E1200.00	12"	1		16	STD	80	3	636.20	635.80
		PR6-6	5335.0	970.	12	1						633.25	632.75
		PR7-7	5300.0	810	12	1						634.0	633.5



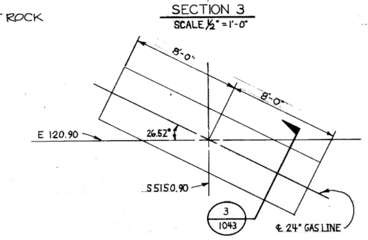
DETAIL OF FRAME AND SCREEN AT DISCHARGE STRUCTURE
SEE DWG PS1023
SCALE: 3/4"=1'-0"



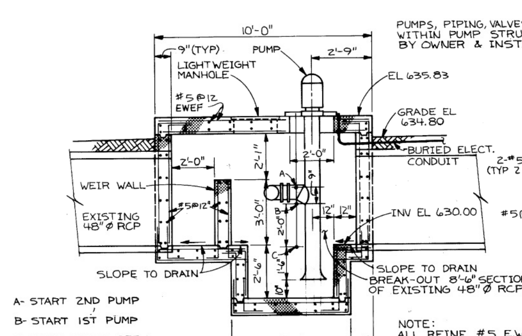
PLAN

SECTION 2

TRENCH DRAIN HEADWALL
SCALE 1/2"=1'-0"



CONCRETE COVER FOR E-6
SCALE 1/4"=1'-0"

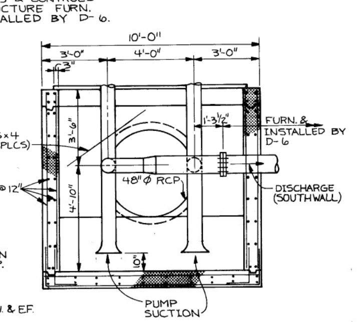


PUMPS, PIPING, VALVES & CONTROLS WITHIN PUMP STRUCTURE FURN. BY OWNER & INSTALLED BY D-6.

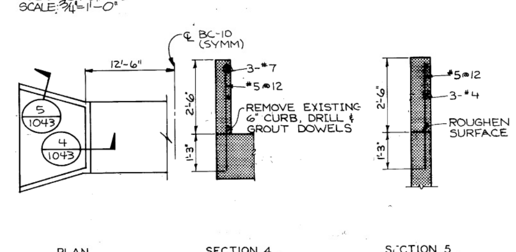
A- START 2ND PUMP
B- START 1ST PUMP
C- SHUT PUMPS OFF

NOTE:
ALL REINF. #5 E.W. & E.F.

SECTION 6, LOOKING NORTH
SCALE: 3/8"=1'-0"
SEE THIS DWG



SECTION 7, LOOKING EAST
SCALE: 3/8"=1'-0"
SEE THIS DWG

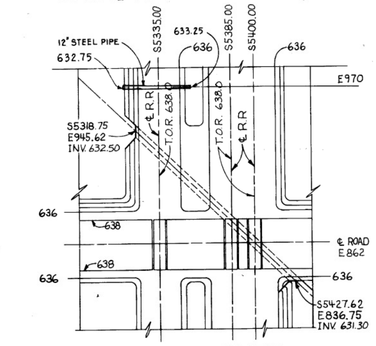


PLAN
NO SCALE

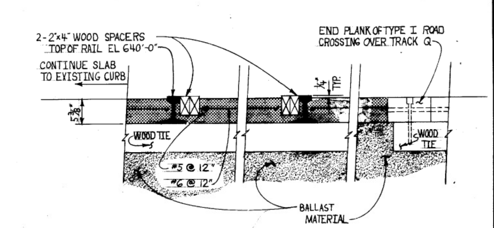
SECTION 4
SCALE: 1/2"=1'-0"

SECTION 5
SCALE: 1/2"=1'-0"

BOX CULVERT 10 COAL RETENTION WALL



ASH LINE BOX CULVERT
SCALE 1"=40'



CONCRETE ROAD CROSSING
SCALE: 1"=1'-0"

NO.	DATE	REVISIONS AND RECORD OF ISSUE	BY	CK	APP
13	2-12-82	CONFORMED TO CONSTRUCTION RECORDS			
12	4-14-80	REVISED STORM WATER PUMP PIT	CWS		
11	3-6-80	ADDED STORM WATER PUMP PIT.	CWS		
10	1-21-77	REVISED AS CIRCLED	RS		
9	11-12-76	REVISED AS CIRCLED	JM		
8	10-8-76	REVISED AS CIRCLED	JM		
7	6-25-76	REVISED AS CIRCLED	JM		
6	6-1-76	REVISED AS CIRCLED	FH		
5	5-14-76	REVISED AS CIRCLED	FH		
4	4-27-76	REVISED AS CIRCLED	CB		
3	4-9-76	REVISED AS CIRCLED	ES		
2	3-31-76	REVISED OVERFLOW STRUCTURE	FH	LR	
1	3-12-76	REVISED AS CIRCLED	DD		
0	1-16-76	ISSUED FOR CONSTRUCTION			

SCALE: AS NOTED

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF OKLAHOMA.
DATE 1/6/76 REG. NO. 10238

DEPT. HEAD CLM
CHECKED JC

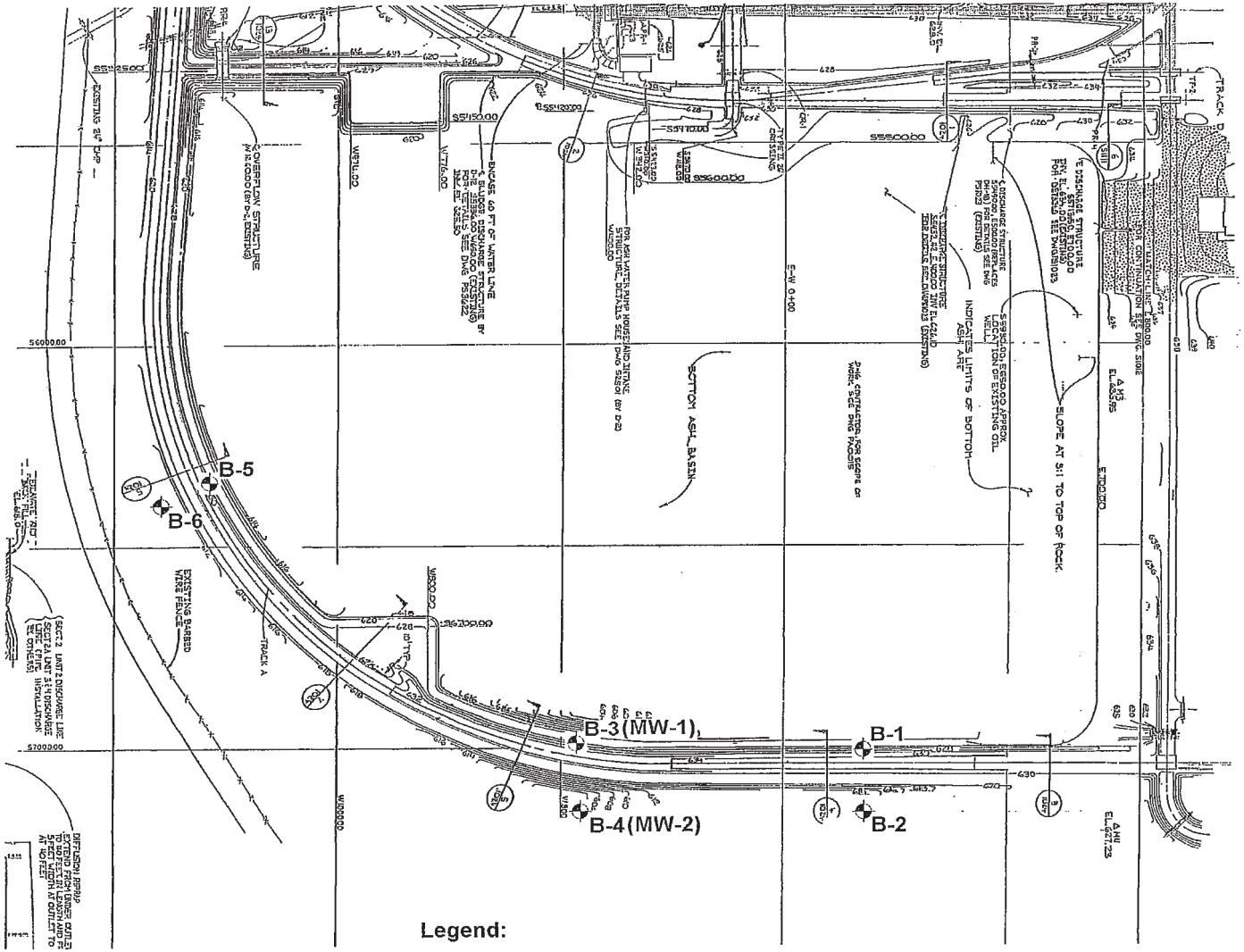
BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT 6571/6572

PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION-UNITS 3 & 4
MISCELLANEOUS SECTIONS AND DETAILS

DWG NO. PS1043
REV. NO. 13
85127-E
SHT. 1043

ATTACHMENT D

INSTRUMENTATION LOCATION MAP



Scale refers to the full size drawing

Legend:

- Approximate Boring Location

MW - Monitoring Well

Site and Boring Location Plan

Project Name:	Final Geotechnical Investigation and Stability Evaluation of Bottom Ash Pond
Project Location:	Oologah, Oklahoma
Project No.:	8309-3150

STANDARD TESTING AND ENGINEERING COMPANY

ATTACHMENT E

HYDROLOGY AND HYDROLOGIC REPORT

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

Hydrologic Analysis of Northeastern 3 &4 Power Station Bottom Ash Pond

American Electric Power Company

Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109
817-735-7300

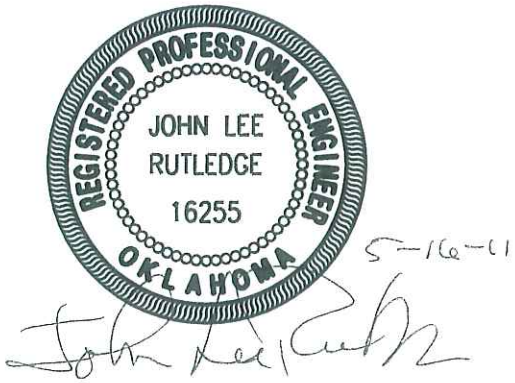
AEP11201

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

Hydrologic Analysis of Northeastern 3 &4 Power Station Bottom Ash Pond

American Electric Power Company



Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109
817-735-7300

AEP11201

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

In April of 2011, Freese and Nichols, Inc., (FNI) was retained by American Electric Power (AEP) to perform various hydrologic and hydraulic calculations to determine the hydraulic adequacy of the Bottom Ash Pond for the Northeastern 3 & 4 Power Station located near Oologah, Oklahoma. This report summarizes the results of the analysis for the 10-year, 100-year, and 40% PMF events.

The Ash Pond is situated immediately southwest of the Power Plant and west of Oologah Dam. The general location of the power plant and associated reservoirs is shown in Figure 1.

FN PROJECT NO.	AEP11201
FILE NAME	H:\WR_DESIGN\FIGURES\Figure1_LocationMap.mxd
DATUM & COORDINATE SYSTEM	NAD83 STATE PLANE OKLAHOMA NORTH (FT)
DATE CREATED	APRIL 2011
PREPARED BY	JPM

FREESE AND NICHOLS

4055 International Plaza, Suite 200
Fort Worth, TX 76109-4895
817-735-7300

0 0.5 1 2 Miles

NORTHEASTERN 3 & 4 ASH POND

LOCATION MAP

N

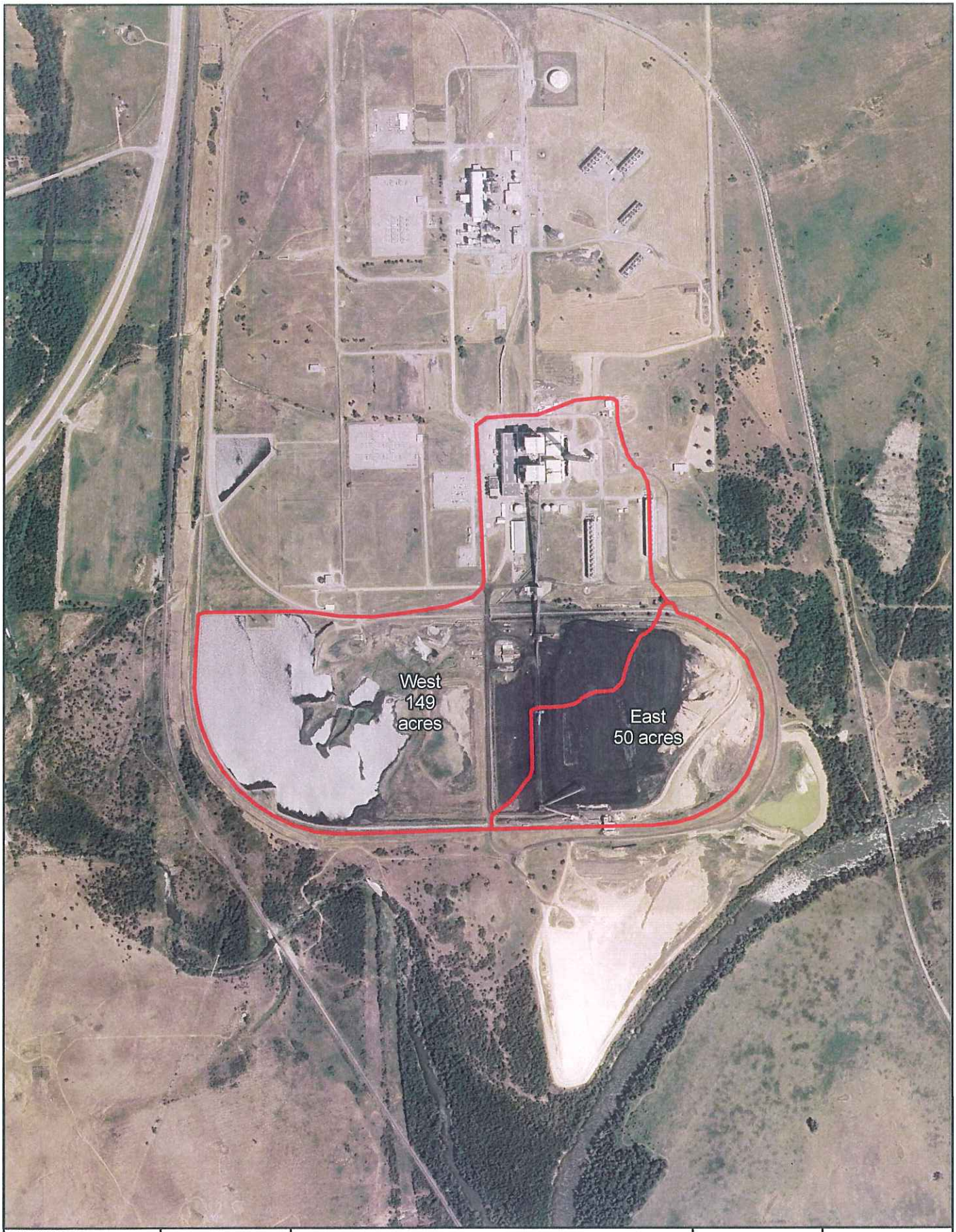
FIGURE 1

2.0 HYDROLOGIC MODEL DEVELOPMENT

2.1 BASIN DELINEATION & CONNECTIVITY

The hydrologic model for the Northeastern 3 & 4 Power Station Bottom Ash Pond was created in HEC-HMS[1] and consisted of two total drainage basins, as shown in Figure 2. The total drainage area modeled is approximately 0.31 square miles, or 199 acres. One basin represents the area that includes most of the power plant facilities and the Bottom Ash Pond itself, while the other represents the area that includes the coal pile and the area east of the coal pile, which is connected to the Bottom Ash Pond via a small channel. The basins were delineated from one-foot contours generated from a March 2010 survey[2] of the area and supplemented with the National Elevation Dataset (NED) 10-meter resolution Digital Elevation Model (DEM).

The Northeastern 3 & 4 Power Station Bottom Ash Pond is connected to multiple segments of the overall plant system and has several inflows and outflows that are assumed to be constant. Stormwater from a retention basin at the fly ash landfill, known as Basin C, is pumped to the bottom ash pond at a maximum rate of 4,000 gpm or 8.91 cfs. Inflow from pumping operations at Basin C, as well as from drains at Units 1, 2, 3, and 4, contribute a combined 6.3 MGD, or 9.75 cfs. The on-site wastewater treatment facility has capacity to pump approximately 1000 gpm, or 2.23 cfs. This capacity is used to regulate the normal pool elevation. Additionally, during emergency or high flood situations, flow may be diverted to the plant's cooling towers at a rate of 2.0 MGD, or 3.09 cfs.



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DATE CREATED	APRIL 2011
PREPARED BY	JPM

FREESE NICHOLS
4055 International Plaza, Suite 200
Fort Worth, TX 76109-4895
817-735-7300

0 500 1,000 2,000 Feet

N

NORTHEASTERN 3&4 ASH POND

DRAINAGE BASIN MAP

FIGURE 2

2.2 HYDROLOGIC PARAMETERS

The HEC-HMS model incorporates the NRCS Curve Number and Unit Hydrograph methods for each basin. In this model, the curve numbers were based on hydrologic soil classifications and land cover. The instantaneous runoff effect of open water surfaces was accounted for in the development of the curve numbers. The soils dataset was obtained from the NRCS Soil Survey Geographic Database[3] (SSURGO), and land use classification was determined from National Agriculture Imagery Program[4] (NAIP) 2010 aerial imagery of the site. Spatial information about soil types and land use classifications is presented in Figures 3 and 4, respectively. Table 1 provides the matrix used in determining the curve number for each basin. All soils in the basin are in Hydrologic Soil Group D. The curve numbers shown in Table 1 represent only these soils and are for Antecedent Moisture Condition (AMC) II. These values were incorporated in the model for the frequency storm events, such as the 10-year storm event. For the PMP events, a higher curve number with AMC III was used to simulate a worst-case scenario with the ground fully saturated.

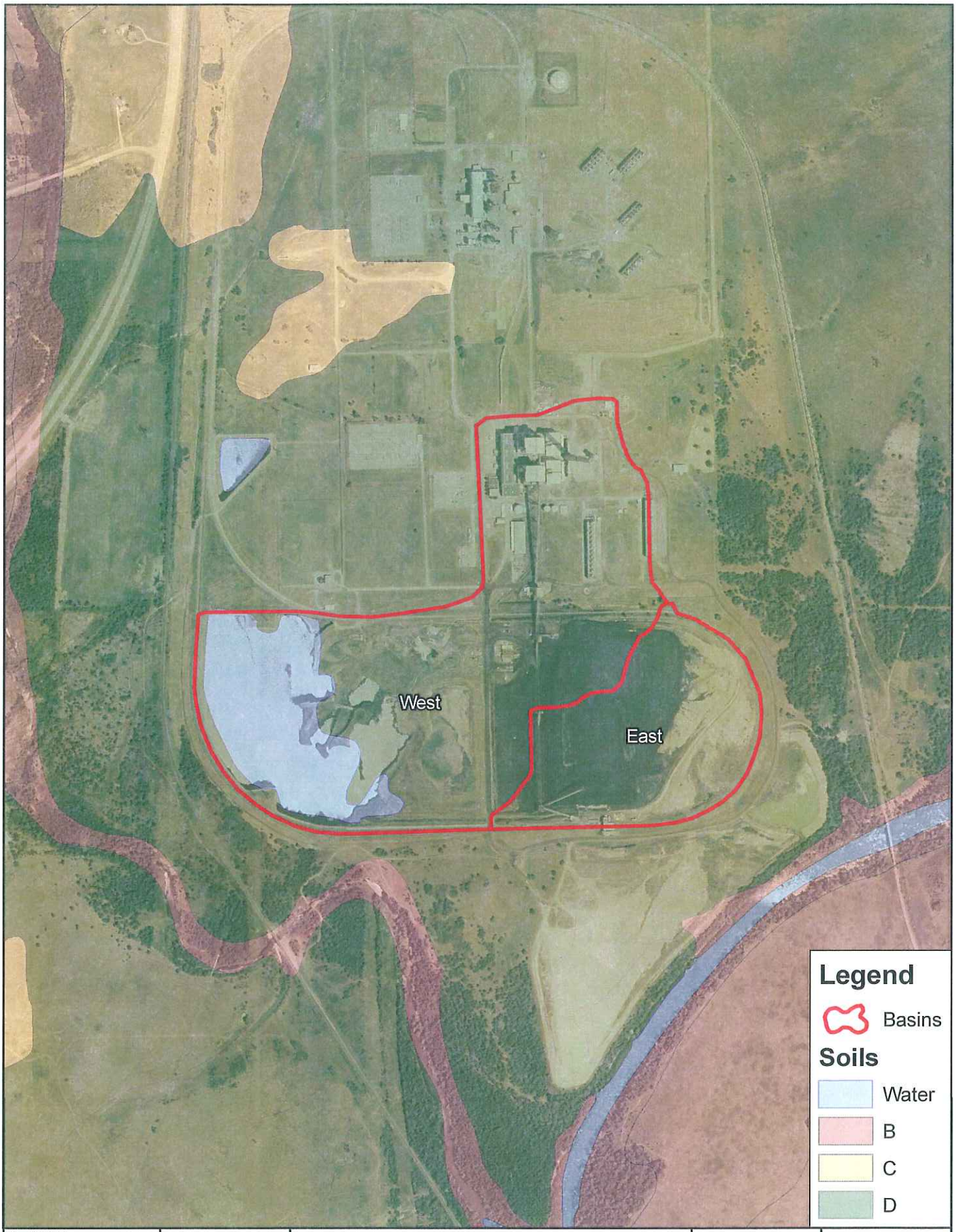
Table 1 – Curve Number Calculation Matrix

Land Use Classification	Curve Number (AMC II)
Water	100
Open Space	89
Industrial	93
Coal Pile	94

The only input into HEC-HMS for the NRCS Dimensionless Unit Hydrograph is a lag time, which is calculated based on basin conditions, such as hydraulic length and average slope, according to the NRCS TR-55 Method. Table 2 provides a summary of the hydrologic parameters for each basin.

Table 2 – Basin Parameters

Basin	Area (mi^2)	Lag Time (min)	Curve Number (AMC II)	Curve Number (AMC III)
West	0.246	14.75	94.1	97.4
East	0.078	11.99	92.7	96.7



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DATE CREATED	APRIL 2011
PREPARED BY	JPM

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4055 International Plaza, Suite 200
Fort Worth, TX 76109-4895
817-735-7300

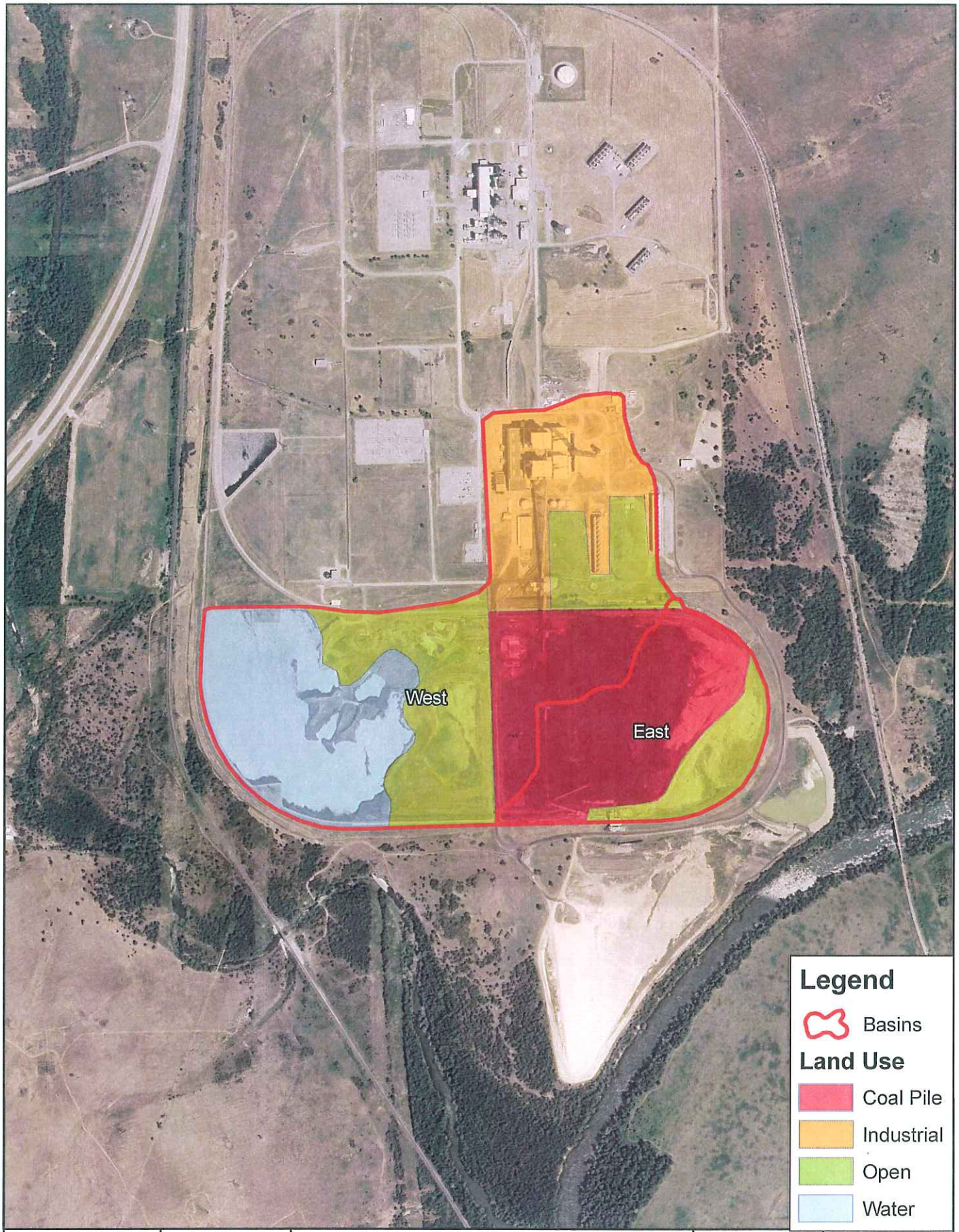
0 500 1,000 2,000 Feet

N

NORTHEASTERN 3&4 ASH POND

HYDROLOGIC SOIL CLASSIFICATIONS

FIGURE 3



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DATE CREATED	APRIL 2011
PREPARED BY	JPM

FREESE AND NICHOLS
4055 International Plaza, Suite 200
Fort Worth, TX 76109-4895
817-735-7300

0 500 1,000 2,000 Feet

N

NORTHEASTERN 3&4 ASH POND

LAND COVER DATA

FIGURE 4

2.3 ELEVATION-STORAGE DATA

Elevation-storage data for the reservoir was approximated with the NED 10-meter DEM to calculate the available storage up to the nominal top of dam elevation of 630.0 ft-msl. This data is considered an approximation based on the best available information because the general topography of the reservoir has changed, and continues to change, with both sedimentation and excavation and grading of the bottom ash material. The elevation-storage relationship was used in the hydrologic model for routing both the frequency storm events and the PMF and is shown in Table 3 below.

Table 3 – Elevation-Storage Data

Elevation (ft-msl)	Storage (acre-ft)
600.0	0
620.0	72
621.0	93
622.0	117
623.0	147
624.0	183
625.0	223
626.0	266
627.0	311
628.0	360
629.0	412
630.0	469

2.4 DISCHARGE RATING CURVES

The dam has a single spillway structure located on the northwest corner of the embankment. Information regarding the dimensions and elevations of the spillway was taken from a combination of original construction drawings and detailed descriptions from AEP personnel. The principal spillway for the Bottom Ash Pond consists of a broad-crested weir with a total length of 24 feet and crest elevation of 625.0 ft-msl. There is also a 1-foot square notch with crest elevation of 624.0 ft-msl; however, this notch has been filled with concrete and no longer contributes to the discharge capacity of the spillway. A 10-foot section of the spillway is covered by a concrete lid. The spillway discharges down a chute with a slope of 2.5:1 and into a stilling basin with chute blocks. Immediately downstream of the stilling basin is a small

depressed area contained by the railroad embankment. Two 48-inch HDPE culverts run under the railroad embankment. The original culverts were 60-inch corrugated metal pipe (CMP) culverts, but HDPE slip-liners were recently installed. The overall spillway system, including these downstream culverts, was modeled with a steady-state HEC-RAS[5] model. The HEC-RAS model accounts for submergence of the tailwater from the downstream culverts, which will significantly restrict flow through the spillway. The discharge rating curve for the spillway is shown in Table 4. A photograph of the spillway is shown in Figure 5, along with a photograph of the downstream stilling basin and culverts in Figure 6. Detailed calculations for the discharge rating curve are included in Appendix B.

Table 4 – Discharge Rating Curve

Elevation (ft-msl)	Total Discharge (cfs)
625.0	0
625.5	25
626.0	71
626.5	131
627.0	199
627.5	279
628.0	367
628.5	462
629.0	507
629.5	518
630.0	529

Figure 5 – Bottom Ash Pond Spillway

Figure 6 – Downstream Basin with Culverts

2.5 FREQUENCY MODEL RESULTS

The 10-year frequency – or 10% annual chance – storm event was analyzed for the Northeastern 3 & 4 Power Station Ash Pond. The hydrologic model described in the preceding sections was implemented in analyzing this event. Curve numbers were set to Antecedent Moisture Condition II, and initial abstractions were calculated automatically by HEC-HMS. These assumptions represent normal conditions, as would be expected prior to a storm event of this nature. The precipitation data was obtained from the National Oceanic and Atmospheric Administration's Technical Memorandum NWS HYDRO-35[6] and Technical Paper 40.[7] These values are presented in Table 5. Each storm event was assumed to have a duration of 24 hours.

Table 5 – Frequency Precipitation Depths

Frequency (yrs)	Precipitation (in)							
	5 min	15 min	60 min	2 hr	3 hr	6 hr	12 hr	24hr
1	0.39	0.81	1.50	1.77	1.96	2.27	2.76	3.22
5	0.56	1.19	2.34	2.88	3.17	3.76	4.52	5.17
10	0.62	1.32	2.72	3.26	3.67	4.39	5.22	6.09
25	0.71	1.52	3.17	3.81	4.25	5.12	6.10	7.08
50	0.79	1.68	3.56	4.20	4.77	5.71	6.84	7.92
100	0.86	1.84	4.04	4.71	5.35	6.41	7.63	8.85

These precipitation depths serve as input data into the hydrologic model, and were routed through the model as described previously. Normal engineering assumptions would assume that flood routings were started at the lowest spillway crest elevation. However, the power plant operation policy calls for the normal pool of the reservoir to be maintained at elevation 623.0 ft-msl. This water level is regulated with pumping to the on-site wastewater treatment facility, and, in emergency situations, flow may be diverted to the plant's cooling towers. For comparison, the 10-year storm event was computed with initial elevations at both the normal pool and spillway crest. The results of the 10-year storm are shown in Table 6.

Table 6 – 10-Year Frequency Model Results

Initial Elevation (ft-msl)	Peak Elevation (ft-msl)	Peak Inflow (cfs)	Peak Outflow (cfs)
623.0	625.28	798	14
625.0	626.28	798	104

2.6 PMF MODEL RESULTS

The Probable Maximum Flood (PMF) is defined as the greatest flood to be expected, and the Probable Maximum Precipitation (PMP) is theoretically the greatest depth of rainfall for a given duration that is physically possible over a given size storm area at a particular geographic location. Generally, the rainfall depth is calculated for the ten square miles of the watershed which receive the highest intensity rainfall.

Hydrometeorological Report No. 52 (HMR-52),[8] developed by the U.S. Army Corps of Engineers, was used to determine the rainfall for each basin. PMP estimates were taken from Hydrometeorological Report No. 51[9] and distributed according to HMR-52 to obtain average rainfall depths over the various drainage areas.

HMR-52 calculates rainfall depths for storm durations ranging from five minutes to seventy-two hours. Table 7 lists the point rainfall depths calculated by HMR-52 for storm durations from one hour to 72 hours. Because the total drainage area is less than ten square miles, the same rainfall depths were applied to both basins.HMR-52 also produces a 72-hour, critically stacked temporal distribution by arranging the incremental rainfall depths to produce the rainfall hyetograph shown in Figure 7.

Table 7 – HMR-52 Point Rainfall Depths

Storm Duration (hr)	Depth (in)
1	15.58
2	19.55
3	22.66
6	28.56
12	34.52
24	39.21
48	43.47
72	45.87

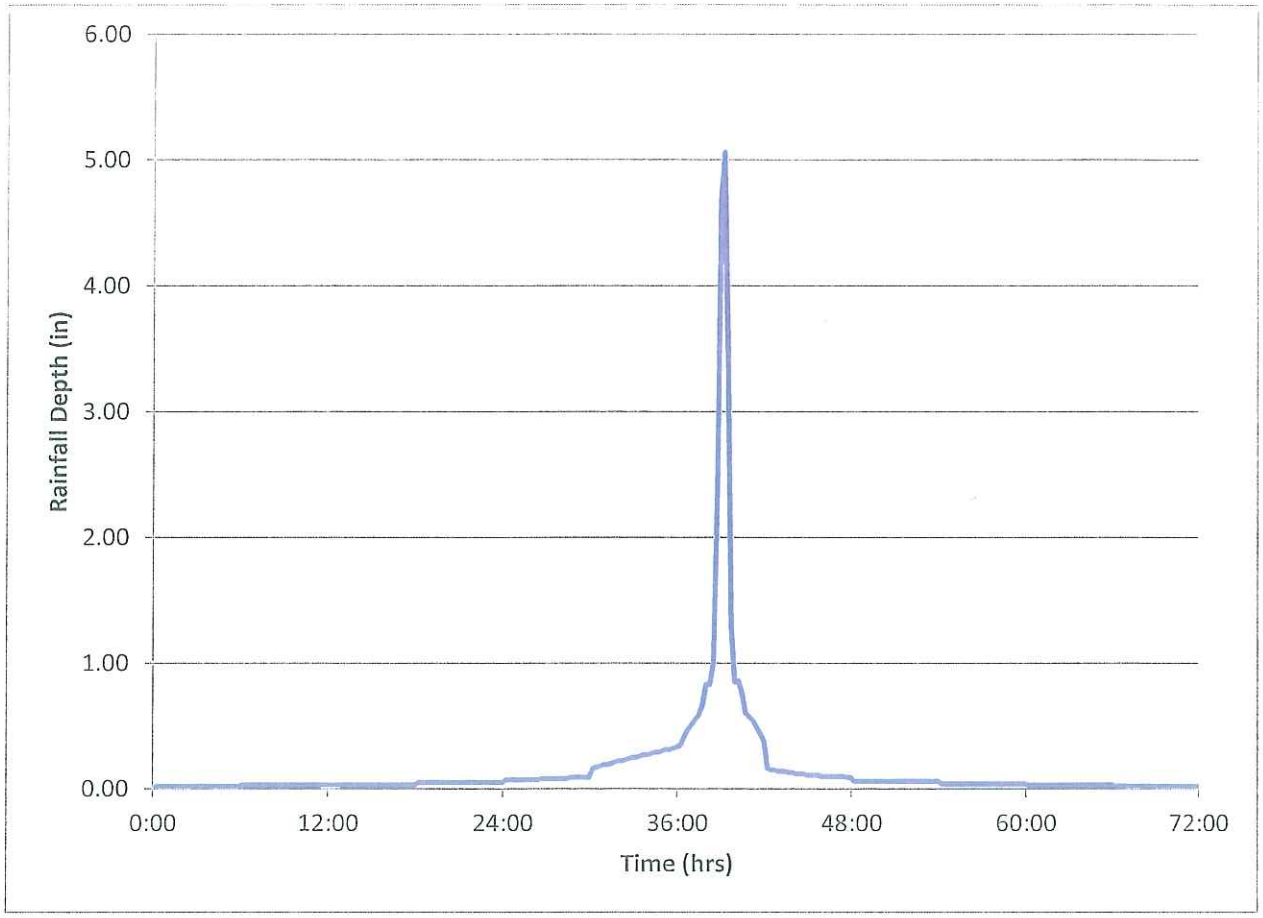


Figure 7 – PMP Rainfall Hyetograph

The PMF was modeled, as described previously, with flood routing started at both elevation 623.0 ft-msl and elevation 625.0 ft-msl. According to the Oklahoma Water Resources Board (OWRB) [10] regulations, the Bottom Ash Pond dam is classified as a small-size dam. The hazard classification may be either low or significant depending on the effects of a dam breach on a railroad bridge downstream. For this analysis, the hazard classification was assumed to be significant. This assumption will be evaluated upon completion of the breach analysis. A dam with a hazard classification of significant is required to pass 40% of the PMF to be in compliance with the OWRB regulations. Table 8 contains the results of these PMF model runs.

Table 8 – 0.4 PMF Model Results

Initial Elevation (ft-msl)	Peak Elevation (ft-msl)	Peak Inflow (cfs)	Peak Outflow (cfs)
623.0	627.87	1,490	344
625.0	628.15	1,490	396

3.0 SUMMARY AND CONCLUSIONS

Based on the results of the hydrologic analysis, the Bottom Ash Pond Dam is hydraulically adequate for the 40% PMF event. Table 9 lists the pertinent elevation data for the dam, including the top of dam elevation and spillway crest elevation. Comparing these elevations to the maximum water surface elevations shown in Table 10 indicates that the dam would safely contain all flood events up to, and including, the 40% PMF. Additionally, while the normal pool elevation is maintained at elevation 623.0 ft-msl by pumping operations, the spillway is engaged during the 10-year storm event.

Table 9 – Pertinent Dam Information

Top of Dam (ft-msl)	Spillway Crest (ft-msl)	Operating Level (ft-msl)
630.0	625.0	623.0

Table 10 – Summary of Results

Initial Elevation (ft-msl)	10-year	0.4 PMF
623.0	625.28	627.87
625.0	626.28	628.15

It should be noted that these results reflect the best understanding of existing conditions and could be significantly affected by major changes to the reservoir. The assumptions in this analysis represent average reservoir conditions. In its current condition, the Bottom Ash Pond associated with the Northeastern 3 & 4 Power Station is deemed to be hydraulically adequate for any storm event up to, and including, the 40% PMF. Pertinent drawings for existing conditions are included in Appendix C.

Appendix A
References

References

1. U.S. Army Corps of Engineers, Hydrologic Engineering Center: *Hydrologic Modeling System HEC-HMS - User's Manual Version 3.5*, Davis, California, August 2010.

2. Henderson Aerial Survey, Inc. *Northeastern Plant*. [computer map]. 1"=50'. Grove City, Ohio, March 31, 2010.

3. "Soil Data Mart." *NRCS Soil Survey Geographic (SSURGO) Database*. <http://soildatamart.nrcs.usda.gov>.

4. U.S. Department of Agriculture, Aerial Photography Field Office: *National Agriculture Imagery Program*, Salt Lake City, UT, 2010. <http://gis.apfo.usda.gov/arcgis/services>.

5. U.S. Army Corps of Engineers, Hydrologic Engineering Center: *River Analysis System - User's Manual Version 4.1*, Davis, California, January 2010.

6. U.S. Department of Commerce, National Oceanic and Atmospheric Administration: *Technical Memorandum NWS HYDRO-35, Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States*, Silver Spring, MD, June 1977.

7. U.S. Department of Commerce, Weather Bureau: *Technical Paper No. 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years*, Washington, D.C., May 1961.

8. U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Army, Corps of Engineers: *Hydrometeorological Report No. 52, Application of Probable Maximum Precipitation Estimates, United States East of the 105th Meridian*, Washington, D.C., 1982.

9. U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Army, Corps of Engineers: *Hydrometeorological Report No. 51, Probable Maximum Precipitation Estimates, United States East of the 105th Meridian*, Washington, D.C., 1978.

10. Oklahoma Water Resources Board, Dam Safety Program: *Hazard Potential Classification: Guidelines for Dams in Oklahoma*. January 2011.

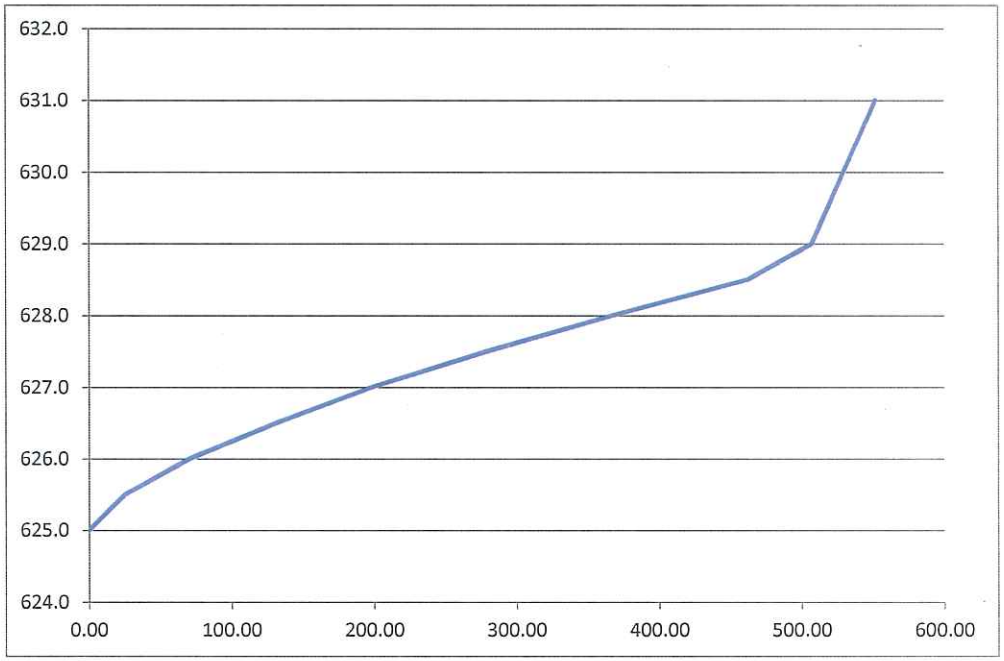
Appendix B
Discharge Rating Curve Calculations and Hydrologic Parameters

Discharge Rating Curve
Overflow Structure

Elevation [ft-msl]	Discharge [cfs]
625.0	0.00
625.5	24.86
626.0	70.65
626.5	131.08
627.0	198.65
627.5	279.03
628.0	367.27
628.5	461.54
629.0	506.74
629.5	517.98
630.0	529.21
630.5	540.45
631.0	551.69
631.5	562.92

RAS Results	
Elevation [ft-msl]	Discharge [cfs]
625	0
625.07	1
625.2	10
625.44	20
625.81	50
626.27	100
627.01	200
627.63	300
628.18	400
628.7	500
633.15	600
640.02	700

**Accounts for Discharge in DS Culverts*

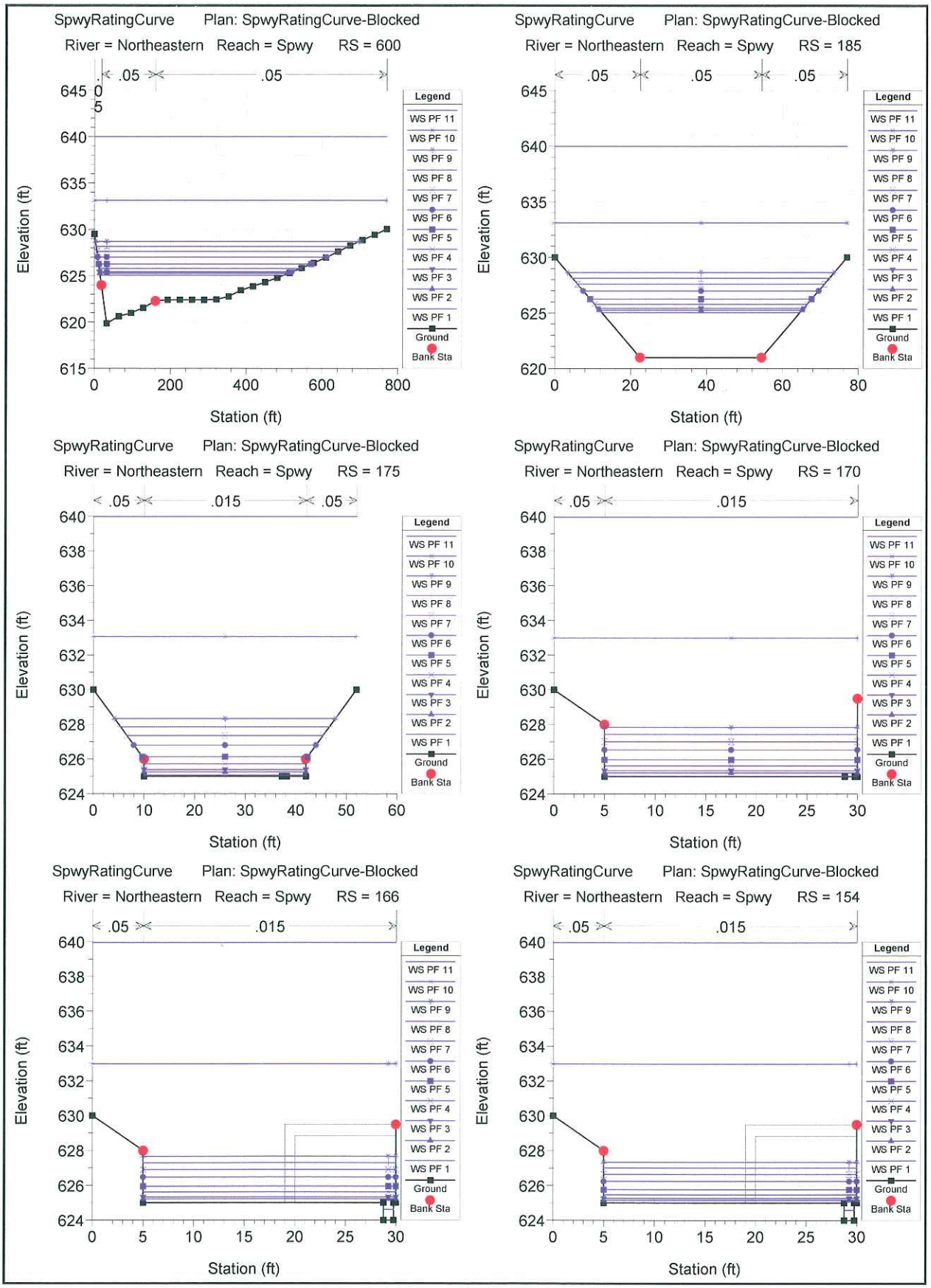


HEC-RAS Plan: SPRC_BL River: Northeastern Reach: Spwy

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Spwy	600	PF 1	1.00	619.86	625.07		625.07	0.000000	0.00	1231.66	484.24	0.00
Spwy	600	PF 2	10.00	619.86	625.28		625.28	0.000000	0.01	1336.14	498.46	0.00
Spwy	600	PF 3	20.00	619.86	625.44		625.44	0.000000	0.02	1416.77	508.75	0.00
Spwy	600	PF 4	50.00	619.86	625.81		625.81	0.000000	0.04	1606.45	532.03	0.00
Spwy	600	PF 5	100.00	619.86	626.27		626.27	0.000001	0.07	1859.02	560.46	0.01
Spwy	600	PF 6	200.00	619.86	627.01		627.01	0.000001	0.11	2290.88	603.90	0.01
Spwy	600	PF 7	300.00	619.86	627.63		627.63	0.000002	0.14	2674.13	637.24	0.01
Spwy	600	PF 8	400.00	619.86	628.18		628.19	0.000002	0.17	3035.76	666.36	0.01
Spwy	600	PF 9	500.00	619.86	628.70		628.70	0.000003	0.19	3386.70	695.48	0.01
Spwy	600	PF 10	600.00	619.86	633.15		633.15	0.000000	0.11	6765.67	770.65	0.01
Spwy	600	PF 11	700.00	619.86	640.02		640.02	0.000000	0.07	12057.71	770.65	0.00
Spwy	185	PF 1	1.00	621.00	625.07		625.07	0.000000	0.01	171.72	52.36	0.00
Spwy	185	PF 2	10.00	621.00	625.28		625.28	0.000001	0.06	182.96	53.42	0.01
Spwy	185	PF 3	20.00	621.00	625.44		625.44	0.000002	0.12	191.57	54.22	0.01
Spwy	185	PF 4	50.00	621.00	625.81		625.81	0.000010	0.27	211.60	56.04	0.02
Spwy	185	PF 5	100.00	621.00	626.27		626.27	0.000028	0.48	237.89	58.33	0.04
Spwy	185	PF 6	200.00	621.00	627.00		627.01	0.000069	0.81	282.07	62.01	0.06
Spwy	185	PF 7	300.00	621.00	627.61		627.63	0.000107	1.08	320.80	65.05	0.07
Spwy	185	PF 8	400.00	621.00	628.16		628.18	0.000140	1.31	357.11	67.79	0.09
Spwy	185	PF 9	500.00	621.00	628.67		628.69	0.000169	1.50	392.17	70.33	0.10
Spwy	185	PF 10	600.00	621.00	633.13		633.15	0.000039	0.98	731.89	77.00	0.05
Spwy	185	PF 11	700.00	621.00	640.01		640.01	0.000011	0.69	1261.22	77.00	0.03
Spwy	175	PF 1	1.00	625.00	625.07		625.07	0.000792	0.46	2.17	32.00	0.31
Spwy	175	PF 2	10.00	625.00	625.26		625.28	0.000917	1.21	8.29	32.00	0.42
Spwy	175	PF 3	20.00	625.00	625.40		625.44	0.000852	1.55	12.89	32.00	0.43
Spwy	175	PF 4	50.00	625.00	625.73		625.80	0.000755	2.14	23.35	32.00	0.44
Spwy	175	PF 5	100.00	625.00	626.14		626.26	0.000694	2.74	36.58	32.71	0.45
Spwy	175	PF 6	200.00	625.00	626.81		626.99	0.000597	3.45	59.45	36.03	0.45
Spwy	175	PF 7	300.00	625.00	627.36		627.60	0.000544	3.94	80.27	38.82	0.45
Spwy	175	PF 8	400.00	625.00	627.87		628.15	0.000502	4.30	100.48	41.34	0.45
Spwy	175	PF 9	500.00	625.00	628.34		628.66	0.000466	4.59	120.62	43.71	0.44
Spwy	175	PF 10	600.00	625.00	633.07		633.14	0.000032	2.17	359.78	52.00	0.13
Spwy	175	PF 11	700.00	625.00	639.99		640.01	0.000005	1.35	719.30	52.00	0.06
Spwy	170	PF 1	1.00	625.00	625.03	625.03	625.06	0.020524	1.35	0.74	25.00	1.39
Spwy	170	PF 2	10.00	625.00	625.22		625.27	0.002461	1.79	5.59	25.00	0.67
Spwy	170	PF 3	20.00	625.00	625.35		625.43	0.002331	2.31	8.64	25.00	0.69
Spwy	170	PF 4	50.00	625.00	625.63		625.79	0.002041	3.18	15.73	25.00	0.71
Spwy	170	PF 5	100.00	625.00	625.98		626.24	0.001952	4.10	24.41	25.00	0.73
Spwy	170	PF 6	200.00	625.00	626.54		626.96	0.001790	5.18	38.60	25.00	0.73
Spwy	170	PF 7	300.00	625.00	627.02		627.57	0.001730	5.95	50.41	25.00	0.74
Spwy	170	PF 8	400.00	625.00	627.44		628.11	0.001686	6.55	61.06	25.00	0.74
Spwy	170	PF 9	500.00	625.00	627.85		628.61	0.001636	7.02	71.21	25.00	0.73
Spwy	170	PF 10	600.00	625.00	633.00		633.13	0.000090	2.95	220.04	30.00	0.18
Spwy	170	PF 11	700.00	625.00	639.96		640.01	0.000019	1.83	428.79	30.00	0.08
Spwy	166	PF 1	1.00	624.00	624.62	624.32	624.66	0.001489	1.62	0.62	1.00	0.36
Spwy	166	PF 2	10.00	624.00	625.22	625.13	625.26	0.001714	1.58	6.35	24.00	0.54
Spwy	166	PF 3	20.00	624.00	625.34	625.24	625.42	0.001992	2.16	9.25	24.00	0.61
Spwy	166	PF 4	50.00	624.00	625.62	625.47	625.78	0.002088	3.13	16.00	24.00	0.67
Spwy	166	PF 5	100.00	624.00	625.95	625.77	626.23	0.002305	4.19	23.87	24.00	0.74
Spwy	166	PF 6	200.00	624.00	626.48	626.25	626.95	0.002386	5.47	36.57	24.00	0.78
Spwy	166	PF 7	300.00	624.00	626.92	626.65	627.55	0.002464	6.39	46.98	24.00	0.80
Spwy	166	PF 8	400.00	624.00	627.31	627.01	628.09	0.002509	7.10	56.34	24.00	0.82
Spwy	166	PF 9	500.00	624.00	627.67	627.34	628.59	0.002546	7.70	64.96	24.00	0.82
Spwy	166	PF 10	600.00	624.00	632.99	627.64	633.13	0.000235	3.08	209.47	30.00	0.18
Spwy	166	PF 11	700.00	624.00	639.96	627.94	640.01	0.000041	1.86	418.55	30.00	0.08
Spwy	154	PF 1	1.00	624.00	624.60	624.32	624.64	0.001636	1.68	0.60	1.00	0.38
Spwy	154	PF 2	10.00	624.00	625.17	625.13	625.23	0.003413	1.94	5.15	24.00	0.74
Spwy	154	PF 3	20.00	624.00	625.27	625.24	625.38	0.003801	2.63	7.59	24.00	0.82
Spwy	154	PF 4	50.00	624.00	625.48	625.47	625.73	0.004764	4.03	12.41	24.00	0.99
Spwy	154	PF 5	100.00	624.00	625.77	625.77	626.18	0.004351	5.11	19.58	24.00	1.00
Spwy	154	PF 6	200.00	624.00	626.25	626.25	626.90	0.004034	6.46	30.95	24.00	1.00
Spwy	154	PF 7	300.00	624.00	626.65	626.65	627.50	0.003873	7.39	40.61	24.00	1.00
Spwy	154	PF 8	400.00	624.00	627.01	627.01	628.03	0.003766	8.11	49.34	24.00	1.00
Spwy	154	PF 9	500.00	624.00	627.34	627.34	628.53	0.003732	8.73	57.26	24.00	1.00
Spwy	154	PF 10	600.00	624.00	632.99	627.64	633.13	0.000236	3.08	209.38	30.00	0.18
Spwy	154	PF 11	700.00	624.00	639.96	627.94	640.01	0.000041	1.86	418.53	30.00	0.08
Spwy	152	PF 1	1.00	624.00	624.59		624.64	0.001663	1.69	0.59	1.00	0.39
Spwy	152	PF 2	10.00	624.00	625.15	625.12	625.22	0.004604	2.10	4.76	25.00	0.85
Spwy	152	PF 3	20.00	624.00	625.24	625.23	625.37	0.004957	2.82	7.08	25.00	0.94
Spwy	152	PF 4	50.00	624.00	625.47	625.46	625.71	0.004456	3.92	12.75	25.00	0.97
Spwy	152	PF 5	100.00	624.00	625.78	625.74	626.15	0.003840	4.90	20.39	25.00	0.96
Spwy	152	PF 6	200.00	624.00	626.23	626.22	626.85	0.003684	6.31	31.68	25.00	0.99

HEC-RAS Plan: SPRC_BL River: Northeastern Reach: Spwy (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Spwy	152	PF 7	300.00	624.00	626.63	626.60	627.43	0.003411	7.18	41.81	25.00	0.98
Spwy	152	PF 8	400.00	624.00	626.98	626.94	627.95	0.003332	7.92	50.49	25.00	0.98
Spwy	152	PF 9	500.00	624.00	627.29	627.26	628.43	0.003299	8.57	58.36	25.00	0.99
Spwy	152	PF 10	600.00	624.00	632.99		633.13	0.000095	2.94	220.82	30.00	0.18
Spwy	152	PF 11	700.00	624.00	639.96		640.01	0.000020	1.82	429.76	30.00	0.08
Spwy	151	PF 1	1.00	624.00	624.59		624.63	0.001680	1.70	0.59	1.00	0.39
Spwy	151	PF 2	10.00	624.00	625.12	625.12	625.22	0.007571	2.44	4.10	25.00	1.06
Spwy	151	PF 3	20.00	624.00	625.23	625.23	625.37	0.006126	3.01	6.64	25.00	1.03
Spwy	151	PF 4	50.00	624.00	625.46	625.46	625.71	0.004890	4.03	12.40	25.00	1.01
Spwy	151	PF 5	100.00	624.00	625.74	625.74	626.15	0.004453	5.13	19.48	25.00	1.02
Spwy	151	PF 6	200.00	624.00	626.22	626.22	626.85	0.003789	6.37	31.41	25.00	1.00
Spwy	151	PF 7	300.00	624.00	626.59	626.59	627.43	0.003686	7.35	40.80	25.00	1.01
Spwy	151	PF 8	400.00	624.00	626.94	626.94	627.95	0.003540	8.08	49.53	25.00	1.01
Spwy	151	PF 9	500.00	624.00	627.26	627.26	628.43	0.003449	8.69	57.54	25.00	1.01
Spwy	151	PF 10	600.00	624.00	632.99		633.12	0.000117	2.99	200.65	25.00	0.19
Spwy	151	PF 11	700.00	624.00	639.95		640.01	0.000029	1.87	374.86	25.00	0.08
Spwy	114	PF 1	1.00	610.00	610.08		610.08	0.000854	0.52	1.92	25.00	0.33
Spwy	114	PF 2	10.00	610.00	610.22		610.27	0.002417	1.78	5.62	25.00	0.66
Spwy	114	PF 3	20.00	610.00	610.34		610.43	0.002505	2.36	8.46	25.00	0.72
Spwy	114	PF 4	50.00	610.00	610.59	610.49	610.77	0.002574	3.41	14.65	25.00	0.79
Spwy	114	PF 5	100.00	610.00	611.22		611.39	0.000952	3.28	30.49	25.00	0.52
Spwy	114	PF 6	200.00	610.00	613.17		613.27	0.000189	2.52	79.22	25.00	0.25
Spwy	114	PF 7	300.00	610.00	616.21		616.27	0.000057	1.93	155.31	25.00	0.14
Spwy	114	PF 8	400.00	610.00	620.63		620.67	0.000022	1.51	265.76	25.00	0.08
Spwy	114	PF 9	500.00	610.00	626.30		626.33	0.000011	1.23	407.61	25.00	0.05
Spwy	114	PF 10	600.00	610.00	633.07		633.09	0.000007	1.04	576.75	25.00	0.04
Spwy	114	PF 11	700.00	610.00	639.98		640.00	0.000005	0.93	749.56	25.00	0.03
Spwy	109	PF 1	1.00	610.00	610.07	610.03	610.08	0.001103	0.56	1.78	25.00	0.37
Spwy	109	PF 2	10.00	610.00	610.17	610.17	610.26	0.005799	2.32	4.32	25.00	0.98
Spwy	109	PF 3	20.00	610.00	610.27	610.27	610.41	0.005192	2.95	6.78	25.00	1.00
Spwy	109	PF 4	50.00	610.00	610.49	610.49	610.75	0.004480	4.04	12.37	25.00	1.01
Spwy	109	PF 5	100.00	610.00	611.21		611.38	0.000967	3.29	30.35	25.00	0.53
Spwy	109	PF 6	200.00	610.00	613.17		613.27	0.000189	2.53	79.19	25.00	0.25
Spwy	109	PF 7	300.00	610.00	616.21		616.27	0.000057	1.93	155.31	25.00	0.14
Spwy	109	PF 8	400.00	610.00	620.63		620.67	0.000022	1.51	265.76	25.00	0.08
Spwy	109	PF 9	500.00	610.00	626.30		626.33	0.000011	1.23	407.60	25.00	0.05
Spwy	109	PF 10	600.00	610.00	633.07		633.09	0.000007	1.04	576.75	25.00	0.04
Spwy	109	PF 11	700.00	610.00	639.98		640.00	0.000005	0.93	749.56	25.00	0.03
Spwy	100	PF 1	1.00	610.00	610.03	610.03	610.04	0.014233	1.03	0.97	38.00	1.13
Spwy	100	PF 2	10.00	610.00	610.13	610.13	610.19	0.006803	2.06	4.85	38.00	1.02
Spwy	100	PF 3	20.00	610.00	610.21	610.21	610.31	0.005602	2.56	7.80	38.00	1.00
Spwy	100	PF 4	50.00	610.00	610.38	610.38	610.57	0.004696	3.49	14.31	38.00	1.00
Spwy	100	PF 5	100.00	610.00	611.28	610.60	611.35	0.000330	2.05	48.89	39.41	0.32
Spwy	100	PF 6	200.00	610.00	613.21	610.95	613.25	0.000060	1.62	134.10	49.04	0.16
Spwy	100	PF 7	300.00	610.00	616.24	611.24	616.26	0.000014	1.21	293.06	53.00	0.09
Spwy	100	PF 8	400.00	610.00	620.65	611.51	620.66	0.000004	0.94	526.73	53.00	0.05
Spwy	100	PF 9	500.00	610.00	626.31	611.75	626.32	0.000002	0.77	827.16	53.00	0.03
Spwy	100	PF 10	600.00	610.00	633.08	611.98	633.08	0.000001	0.66	1185.60	53.00	0.02
Spwy	100	PF 11	700.00	610.00	639.99	612.19	639.99	0.000000	0.59	1551.88	53.00	0.02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River = Northeastern Reach = Spwy RS = 600
.05 .05
Elevation (ft)
Station (ft)
Legend
WS PF 11
WS PF 10
WS PF 9
WS PF 8
WS PF 7
WS PF 6
WS PF 5
WS PF 4
WS PF 3
WS PF 2
WS PF 1
Ground
Bank Sta
SpwyRatingCurve Plan: SpwyRatingCurve-Blocked
River = Northeastern Reach = Spwy RS = 185
.05 .05 .05
Elevation (ft)
Station (ft)
SpwyRatingCurve Plan: SpwyRatingCurve-Blocked
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Elevation (ft)
Station (ft)
SpwyRatingCurve Plan: SpwyRatingCurve-Blocked
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Station (ft)
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Station (ft)
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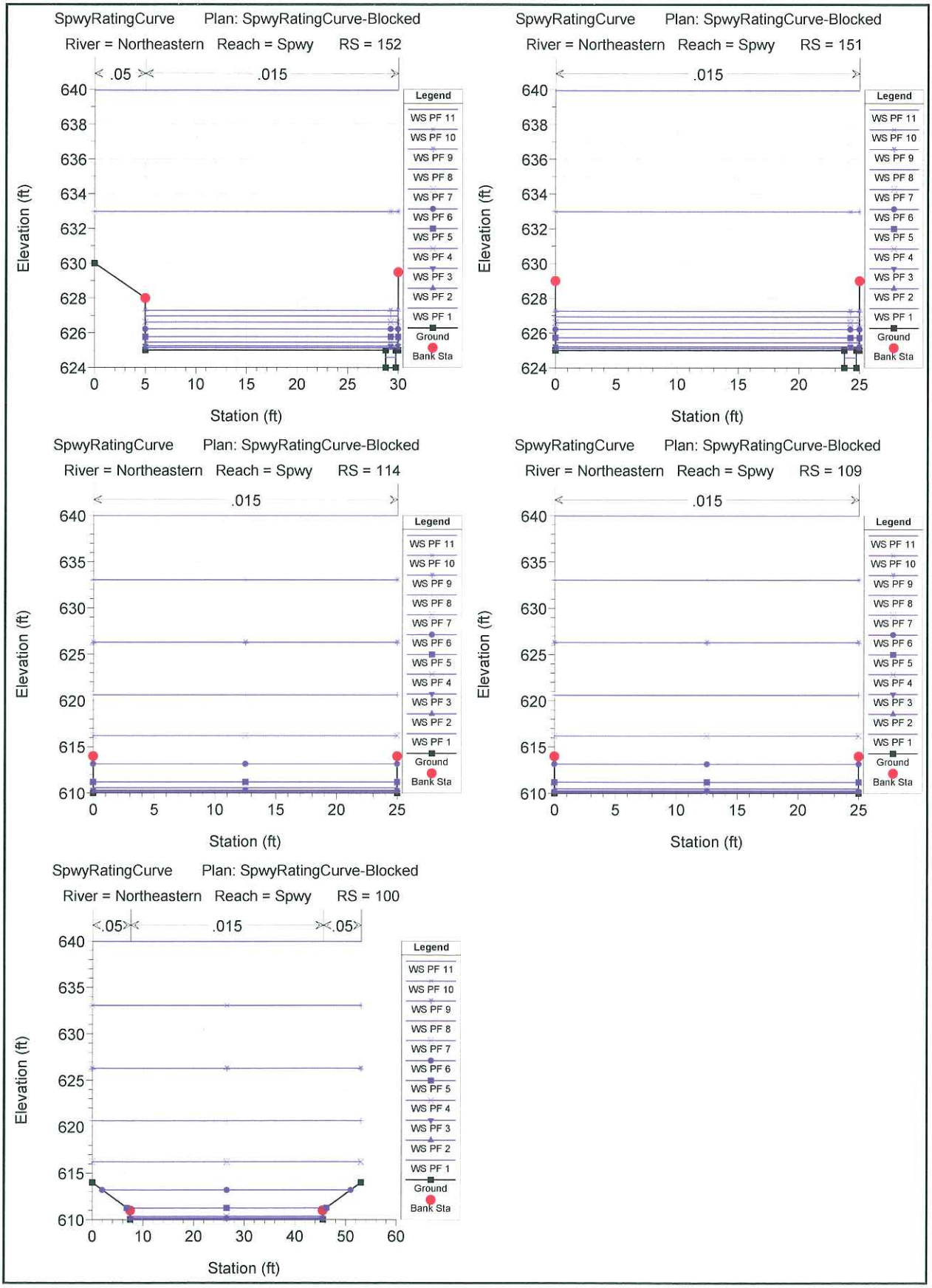
Elevation (ft)
Station (ft)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River = Northeastern Reach = Spwy RS = 152
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.015
Elevation (ft)
Station (ft)
Legend
WS PF 11
WS PF 10
WS PF 9
WS PF 8
WS PF 7
WS PF 6
WS PF 5
WS PF 4
WS PF 3
WS PF 2
WS PF 1
Ground
Bank Sta
SpwyRatingCurve Plan: SpwyRatingCurve-Blocked
River = Northeastern Reach = Spwy RS = 151
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Elevation (ft)
Station (ft)
SpwyRatingCurve Plan: SpwyRatingCurve-Blocked
River = Northeastern Reach = Spwy RS = 114
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Elevation (ft)
Station (ft)
SpwyRatingCurve Plan: SpwyRatingCurve-Blocked
River = Northeastern Reach = Spwy RS = 109
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Elevation (ft)
Station (ft)
SpwyRatingCurve Plan: SpwyRatingCurve-Blocked
River = Northeastern Reach = Spwy RS = 100
.05
.015
.05
Elevation (ft)
Station (ft)

BASIN LAG TIME CALCULATION (Existing)

USING NRCS TR55 METHOD TO COMPUTE TIME OF CONCENTRATION

Existing Conditions

Project Data:		Comments:
PROJECT	Northeastern Station	
LOCATION	Oologah, OK	
DATE	Apr-11	
BASIN COND.		
BY:	JPM	
WSHED NAME	West	

SHEET FLOW: (100' MAX)

Land Use Undeveloped	n value	% Land use	Inc n
Conc.,gravel,asphalt,bare soil	0.015	0	0
Grass Short Prairie	0.15	0	0
Maintained Grass	0.03	0	0
Woods Light Underbrush	0.4	0	0
Woods Dense underbrush	0.8	0	0

based on information for imperviousness from Corps of Engineers

Land Use	% Conc	% Grass	n value	% Land Use	Inc n
Low D. Residential (1+ Acres)	25	75	0.21375	0	0
Med. D. Residential (1/3 Acres)	41	59	0.17135	0	0
High D. Residential (1/4 Acres)	47	53	0.15545	0	0
Multifamily	70	30	0.0945	0	0
Mobile Home Parks	20	80	0.227	0	0
C.B.D.	95	5	0.02825	0	0
Strip Commercial	90	10	0.0415	0	0
Shopping Center	95	5	0.02825	0	0
Instutional-Schools	40	60	0.174	0	0
Industrial	90	10	0.0415	100	0.0415
Highway ROW	35	65	0.18725	0	0
Public Utilities	60	40	0.121	0	0
Vacant urban land and	6	84	0.2361	0	0
Parks	0	0	0	0	
Other	0	0	0	0	0
		TOTAL		100	0.0415

LENGTH	100	FT.	MAX 100'
2 YR. 24 HOUR PRECIP	4.02	IN.	
SLOPE	0.01	FT/FT	

$$T_1 = 0.007 \times \frac{(n \times L)^{0.8}}{R^{0.5} \times S^{0.4}}$$

SHALLOW CONCENTRATED FLOW

1=PAVED 2=UNPAVED	2		
LENGTH	1010.04	FT	
SLOPE	0.0050	FT/FT	
COMPUTED VELOCITY FROM FIGURE 3.1=	1.131		

$$T_2 = \frac{L}{60 \times V}$$

CHANNEL FLOW

			TOPWIDTH	40
XSECT AREA=	125.000	SQ FT	BOTTOM	10
			DEPTH	5
WETTED PERIMETER	41.623	FT		
SLOPE	0.0063	FT/FT		
MANNINGS N	0.04			
COMPUTED VELOCITY	6.159	FT/S		
LENGTH	2060.49	FT		

$$V = \frac{1.49 \times \left(\frac{a}{P_w}\right)^{\frac{2}{3}} \times s^{\frac{1}{2}}}{n}$$

$$T_6 = \frac{L}{60 \times V}$$

	Conditions	Adjusted	NRCS Method	Selected
WATERSHED NUMBER	West	Tc (Min)	Tc (Min)	Tc (Min)
SHEET FLOW	Max 30 Min	30.0	4.13	4.13
SHALLOW CONCENTRATED FLOW			14.88	14.88
CHANNEL FLOW			5.58	5.58
TOTAL			24.59	24.59
			Lag (Hrs) =	0.25

$$T_c = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Lag (min) = 14.75

BASIN LAG TIME CALCULATION (Existing)

USING NRCS TR55 METHOD TO COMPUTE TIME OF CONCENTRATION

Existing Conditions

Project Data:		Comments:
PROJECT	Northeastern Station	
LOCATION	Oologah, OK	
DATE	Apr-11	
BASIN COND.		
BY:	JPM	
WSHED NAME	East	

SHEET FLOW: (100' MAX)

Land Use Undeveloped	n value	% Land use	Inc n
Conc.,gravel,asphalt,bare soil	0.015	0	0
Grass Short Prairie	0.15	100	0.15
Maintained Grass	0.03	0	0
Woods Light Underbrush	0.4	0	0
Woods Dense underbrush	0.8	0	0

based on information for imperviousness from Corps of Engineers

Land Use	% Conc	% Grass	n value	% Land Use	Inc n
Low D. Residential (1+ Acres)	25	75	0.21375	0	0
Med. D. Residential (1/3 Acres)	41	59	0.17135	0	0
High D. Residential (1/4 Acres)	47	53	0.15545	0	0
Multifamily	70	30	0.0945	0	0
Mobile Home Parks	20	80	0.227	0	0
C.B.D.	95	5	0.02825	0	0
Strip Commercial	90	10	0.0415	0	0
Shopping Center	95	5	0.02825	0	0
Instutional-Schools	40	60	0.174	0	0
Industrial	90	10	0.0415	0	0
Highway ROW	35	65	0.18725	0	0
Public Utilities	60	40	0.121	0	0
Vacant urban land and	6	84	0.2361	0	0
Parks	0	0	0	0	
Other	0	0	0	0	0
		TOTAL		100	0.15

LENGTH	100	FT.	MAX 100'
2 YR. 24 HOUR PRECIP	4.02	IN.	
SLOPE	0.2	FT/FT	

$$T_1 = 0.007 \times \frac{(n \times L)^{0.8}}{R^{0.5} \times S^{0.4}}$$

CHANNEL FLOW -- 1

			TOPWIDTH	30
XSECT AREA=	60.000	SQ FT	BOTTOM	10
			DEPTH	3
WETTED PERIMETER	30.881	FT		
SLOPE	0.0018	FT/FT		
MANNINGS N	0.04			
COMPUTED VELOCITY	2.478	FT/S		
LENGTH	1643.35	FT		

$$V = \frac{1.49 \times \left(\frac{a}{p_w}\right)^{\frac{2}{3}} \times s^{\frac{1}{2}}}{n}$$

$$T_6 = \frac{60 \times L}{60 \times V}$$

CHANNEL FLOW -- 2

			TOPWIDTH	40
XSECT AREA=	137.500	SQ FT	BOTTOM	15
			DEPTH	5
WETTED PERIMETER	41.926	FT		
SLOPE	0.0052	FT/FT		
MANNINGS N	0.04			
COMPUTED VELOCITY	5.912	FT/S		
LENGTH	1934.24	FT		

$$V = \frac{1.49 \times \left(\frac{a}{p_w}\right)^{\frac{2}{3}} \times s^{\frac{1}{2}}}{n}$$

$$T_6 = \frac{L}{60 \times V}$$

	Conditions	Adjusted	NRCS Method	Selected
WATERSHED NUMBER	East	Tc (Min)	Tc (Min)	Tc (Min)
SHEET FLOW	Max 30 Min	30.0	3.48	3.48
CHANNEL FLOW -- 1			11.05	11.05
CHANNEL FLOW -- 2			5.45	5.45
TOTAL			19.98	19.98
			Lag (Hrs) =	0.20

$$T_c = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Lag (min) = 11.99

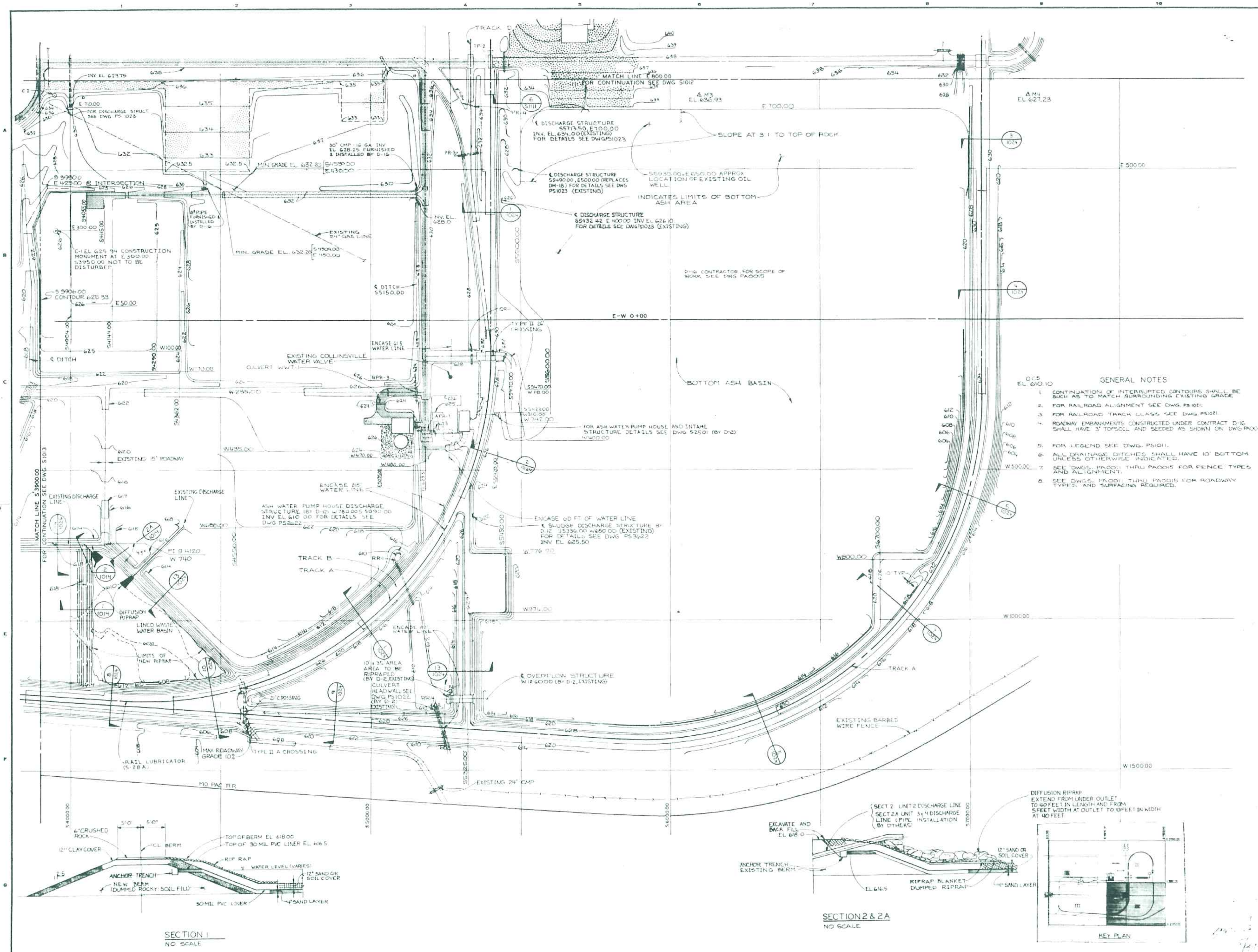
Curve Number

Basin	Land Use	CN	Area (ac)	Inc. CN	
West	Water	100	46.86	31.40	
West	Open Space - Poor	89	46.38	27.66	
West	Industrial	93	32.50	20.25	
West	Coal Pile	94	23.51	14.80	
					AMC III
		Total	**149.25**	**94.11**	**97.35**

Basin	Land Use	CN	Area (ac)	Inc. CN	
East	Open Space - Poor	89	12.68	22.63	
East	Coal Pile	94	37.19	70.10	
					AMC III
		Total	**49.87**	**92.73**	**96.70**

** All soils are Hydrologic Soil Group D*

Appendix C
Pertinent Drawings



DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP
11-12-76	REVISED AS CIRCLED	13	JM		
10-8-76	REVISED AS CIRCLED	12	JM		
8-11-76	REVISED AS CIRCLED	11	ES		
5-14-76	REVISED AS CIRCLED	10	BM		
3-12-76	REVISED AS CIRCLED	9	CB		
1-13-83	CONFORMED TO CONSTRUCTION RECORDS	21	JR		
6-15-82	ISSUED FOR CONSTRUCTION SPEC D-16	20	SB		
5-21-82	ISSUED FOR ADDENDUM 1 SPEC D-16	19	SB	DE	
5-6-82	ISSUED FOR BIDS SPEC D-16	18	SB		
8-14-80	ISSUED FOR BIDS; 1	17	TW		DE
11-3-78	ADDED ROADWAY & CULVERT	16	JR	JG	
10-5-78	REVISED AS CIRCLED	15	JR		
9-22-76	ISSUED FOR BIDS, SPEC D-12	14	JR		

DEPT HEAD CLM — CHECKED KDJ

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF OKLAHOMA

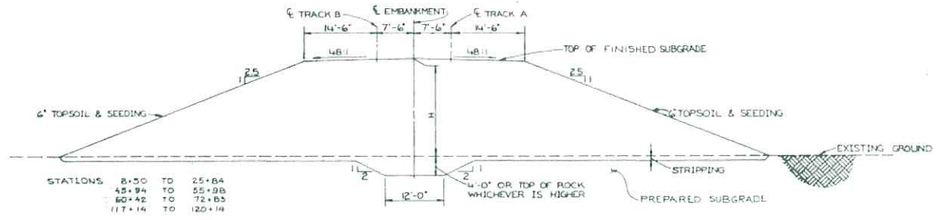
DATE 2/29/75 REG. NO. 8892

BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT 6571/6572

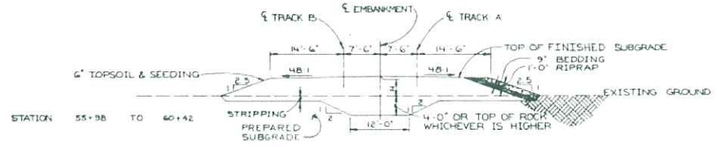
PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION - UNITS 3 & 4

SITE GRADING
PLANT SITE AREA IV

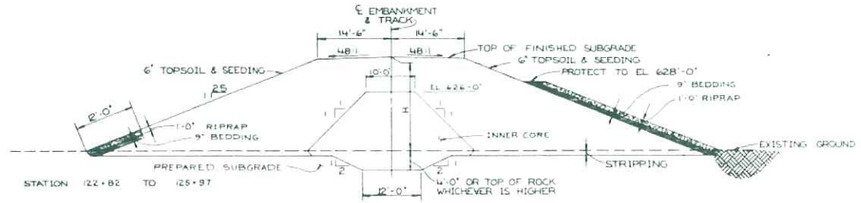
B&V DWG NO. PS1C14
REV 21
PSO DWG NO. 85127-E



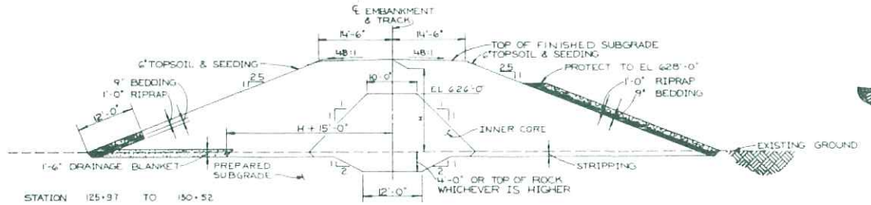
TYPICAL SECTION 1



TYPICAL SECTION 2



IMPERVIOUS ENBANKMENT SECTION 3



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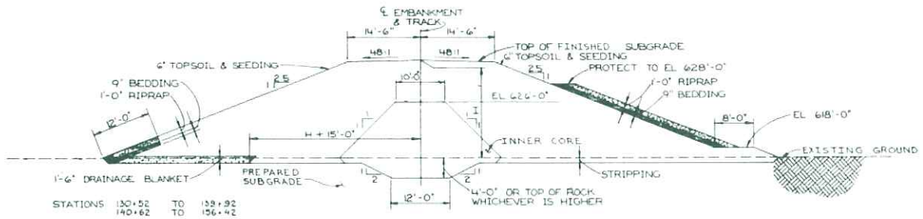

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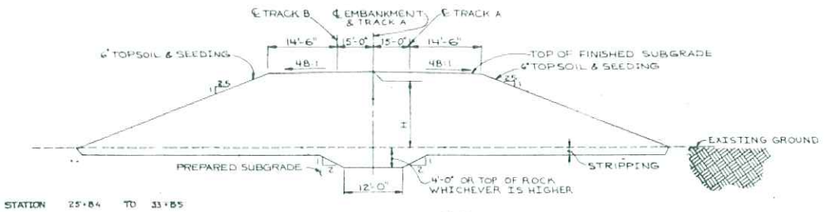

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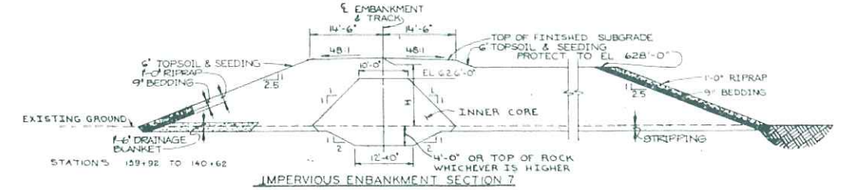

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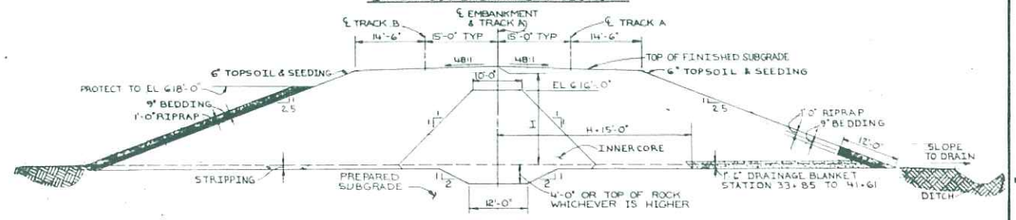
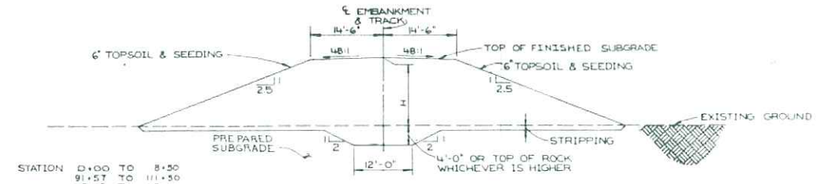
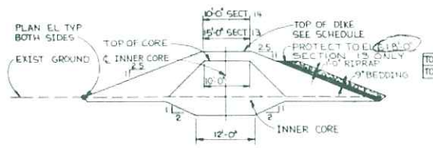


IMPERVIOUS ENBANKMENT SECTION 8



TYPICAL SECTION 9

IMPERVIOUS ENBANKMENT SECTION 10



IMPERVIOUS EMBANKMENT SECTION 13 & 14

SECTION 13 & 14 SCHEDULE		
	WASTE WATER POND	BOTTOM ASH POND
TOP DIKE	EL 618.0	EL 629.0
TOP CORE	EL 616.0	EL 626.0

GENERAL NOTES

1. EACH SECTION IS FACING TOWARD INCREASING STATION NUMBER.
2. FINISHED AND PREPARED SUBGRADE SHALL BE CONSTRUCTED AS REQUIRED BY SPECIFICATION D-2.

NO.	DATE	REVISIONS AND RECORD OF ISSUE	BY	CK	APP
8	JR	6-29-76	REV & ISSUED FOR CONTRACT & CONST. SPEC D-2	3	NH	JD	
7	PH	6-17-76	REVISED & ISSUED FOR ADDENDUM 1 - SPEC D-2	2	TD		
6	TD	6-1976	REVISED & ISSUED FOR BIDS, SPEC. D-2	1	TD		
5	CB	5-1976	ISSUED FOR PSO REVIEW	0	TD		
4	JR	2-1976	GENERAL REVISIONS				
3	JR	12-1975	GENERAL REVISIONS				
2	JR	10-1975	CONFORMED TO CONSTRUCTION RECORDS				

SCALE: 1"=10'

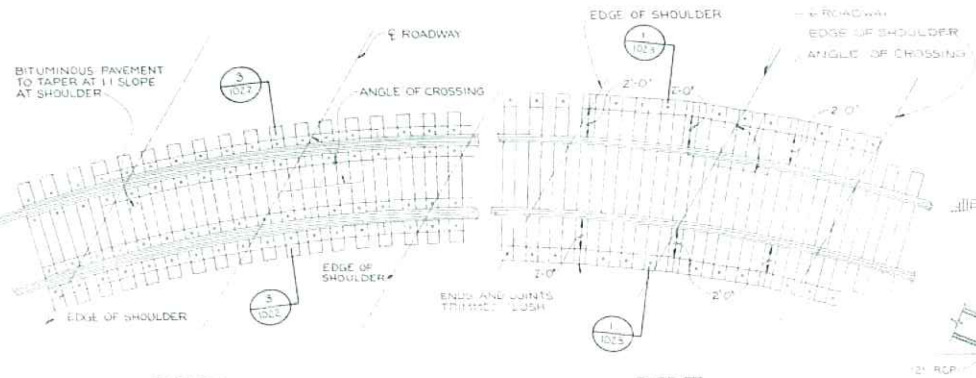
I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF OKLAHOMA.
DATE 12/24/75 REG. NO. 8842

BLACK & VEATCH CONSULTING ENGINEERS
PROJECT 6571/6572

PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION-UNITS 3 & 4

EMBANKMENT DETAILS

PSO DWG. NO. PS1024
REV. 8
B&V DWG. NO. 85127-E

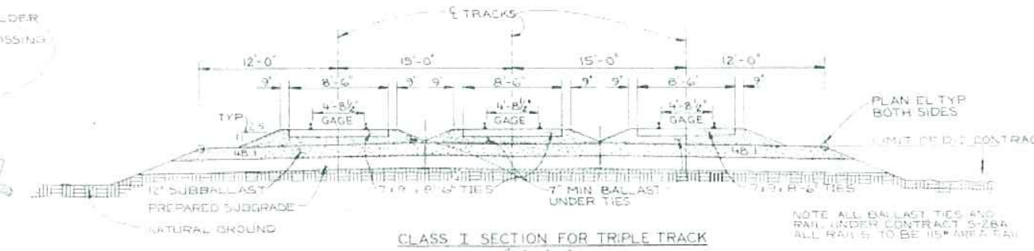


TYPE II A
CURVES 12°30' OR LESS

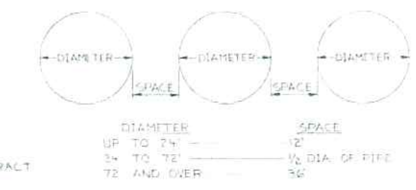
CURVED TRACK
NO SCALE

TYPE III
CURVES GREATER THAN 12°30'

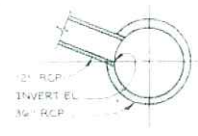
TYPICAL RAILROAD CROSSINGS



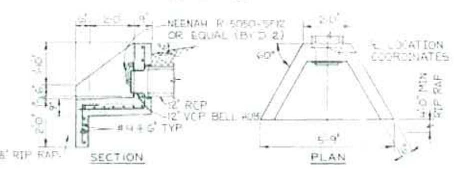
CLASS I SECTION FOR TRIPLE TRACK
SCALE 3/16"=1'-0"



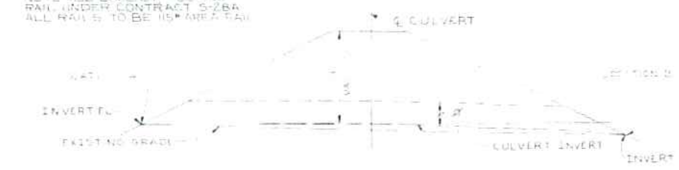
TYPICAL CULVERT SPACING
NO SCALE



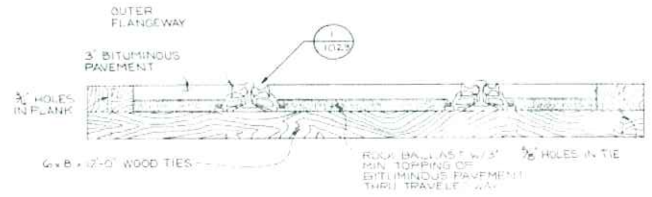
STORM SEWER "Y" CONNECTION



ASH WATER PUMPHOUSE DISCHARGE STRUCTURE
SCALE: 3/8"=1'-0"

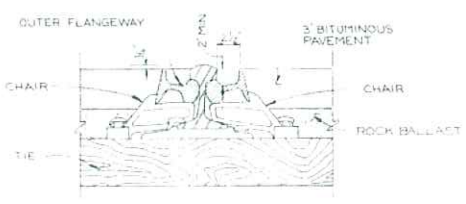


TYPICAL DRAINAGE CULVERT SECTION
NO SCALE

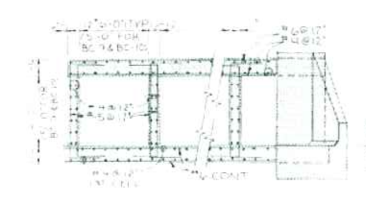


SECTION 1
NO SCALE

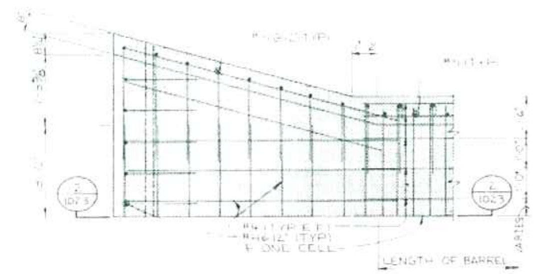
NOTES: 1. 6"x8 1/2"... PLANKS
2. 3/4"x10" WASHER HEAD TIMBER DRIVE SPIKE
3. SEE RAILROAD CROSSING NOTES DWG



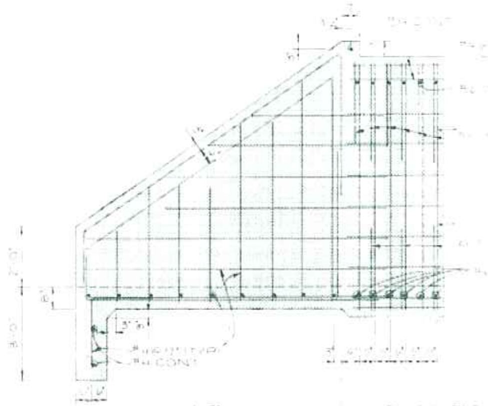
DETAIL 1
NO SCALE



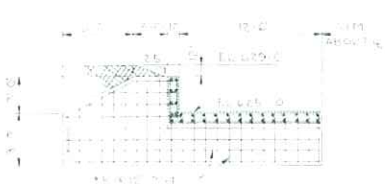
TYPICAL BOX CULVERT SECTION
W/WINGWALL AND APRON



BOX CULVERT
WINGWALL & APRON PLAN



SECTION 2
SEE THIS DWG



HALF SECTION
ANTI-SEEP COLLAR

		CULVERT NO	CENTERLINE LOCATION SOUTH	CENTERLINE LOCATION E-W	Ø DIAM	NO OF UNITS	NOTES	SIZE GAGE	SIZE CORR SIZE	SIZE LGTH	END TYPE	INVERT ELEV LOCATION A	INVERT ELEV LOCATION B
D2	D2	ER-[illegible]	[illegible]	E 1583.95	42	2		16	3x1	60	2	643.20	642.50
D2	D2	ER-[illegible]	922.00	E 1165.00	24	2		16	STD	48	1	[illegible]	[illegible]
D2	D2	ER-3	971.00	E 1140.00	[illegible]			16	[illegible]	42	1	[illegible]	[illegible]
D2	D2	ER-4	962.00	E 1216.00	24			16	STD	28	1	[illegible]	[illegible]
D2	D2	[illegible]	[illegible]	E 1250.00	48			16	3x1	56	2	[illegible]	[illegible]
D2	D2	[illegible]	3310.00	E 1107.00	48			16	[illegible]	52	3	633.80	633.00
D2	D2	[illegible]	3302.00	E 1160.00	48			16	[illegible]	56	2	632.80	632.00
D2	D2	[illegible]	1093.00	934.00	18			16	STD	24	1	[illegible]	[illegible]
D2	D2	TER	4562.00	E 1772.00	24			16	STD	[illegible]	1	[illegible]	[illegible]
D2	D2	[illegible]	[illegible]	[illegible]	24			16		75	1	[illegible]	[illegible]
D2	D2	[illegible]	4275.00	[illegible]	36		ASBBONDED	16	3x1	78	1	622.00	628.00
D2	D2	[illegible]	3300.00	[illegible]	48			16	3x1	[illegible]	1	[illegible]	628.00
D2	D2	[illegible]	1566.00	W 36.00	36			16	3x1	48	3	[illegible]	624.50
D2	D2	[illegible]	2850.00	W [illegible]	36			16	3x1	60	3	[illegible]	[illegible]
D2	D2	[illegible]	1572.00	[illegible]	42		RELOCATED FROM EXIST			60	3	[illegible]	[illegible]
D2	D2	[illegible]	5160.00	[illegible]	[illegible]		RELOCATED FROM EXIST			58	3	[illegible]	[illegible]
D2	D2	[illegible]	5108.75	[illegible]	12			16	STD	42	3	[illegible]	623.00
D2	D2	[illegible]	[illegible]	[illegible]	24			16	STD	56	3	[illegible]	[illegible]
D2	D2	[illegible]	[illegible]	[illegible]	12			16	STD	[illegible]	3	633.20	632.80
D2	D2	[illegible]	[illegible]	802.00	[illegible]			16	STD	76	3	[illegible]	[illegible]
D2	D2	[illegible]	[illegible]	[illegible]	60			[illegible]	[illegible]	196	2	[illegible]	[illegible]
D2	D2	RR-3	[illegible]	[illegible]	18			16	STD	56	3	[illegible]	[illegible]
D2	D2	[illegible]	[illegible]	[illegible]	18			16	STD	50	3	[illegible]	[illegible]
D2	D2	[illegible]	723.00	W 1555.00	60	2		[illegible]	[illegible]	140	2	607.90	606.40
D2	D2	RR-1	1015.00	W 1047.00	24			16	STD	65	3	[illegible]	[illegible]
D2	D2	[illegible]	[illegible]	E 2875.00	36			16	3x1	[illegible]	1	607.80	607.30
D2	D2	RR-3	6815.00	E 2730.00	36			[illegible]	[illegible]	155	1	612.00	[illegible]
D2	D2	[illegible]-5	[illegible]	W 765.00	[illegible]			[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
D2	D2	[illegible]	5180.00	W 268.00	24			16	STD	75	1	[illegible] 2.80	622.00
D2	D2	MR-3	5535.00	E 824.00	18			16	STD	48		635.00	634.20
D2	D2	MR-4	[illegible]	E 885.00	18	2	ASB BONDED	16	STD	42	1	633.00	632.00
D2	D2	MR-[illegible]	[illegible]	E 885.00	12			16	STD	36	1	[illegible]	[illegible]
D2	D2	WWT-2	5162.76	W 841.75	50x31		METAL ARCH	12	3x1	44	3	622.20	622.00
D4	D4	B[illegible]	5535.00	E 940.00	[illegible]		FOR DETAILS SEE			50'		632.50	631.30
D4	D4	B[illegible]	[illegible]	[illegible]	[illegible]		DWG PS1043			75'		633.44	633.22
D2	D2	B[illegible]	[illegible]	[illegible]	[illegible]	4	FOR B[illegible] DETAILS			40		625.90	625.40
D2	D2	BC-7	540.00	W 235.00	6x6	4	THIS DWG			40		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible] DWG			100'		609.00	608.00
D4	D4	BC-[illegible]	[illegible]	E 1287.00	[illegible]		SEE DWG PS1043			[illegible]			

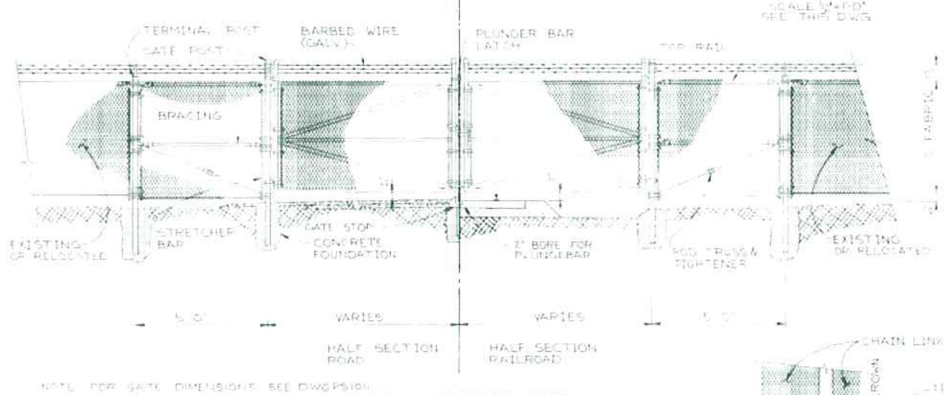
FOR CONTINUATION OF CULVERT LIST SEE DWG PS1043

LEGEND
ER ENTRANCE ROAD
AR ACCESS ROAD
TR TEMPORARY RR
RR [illegible] RR
[illegible] COOLING TOWER ROAD
MR MAINTENANCE ROAD
[illegible]
[illegible] PARKING RD
BPR BATCH PLANT ROAD
[illegible]
[illegible] TEMPORARY CULVERT
[illegible]
[illegible]
[illegible]
ARE ASH PUMP ROAD

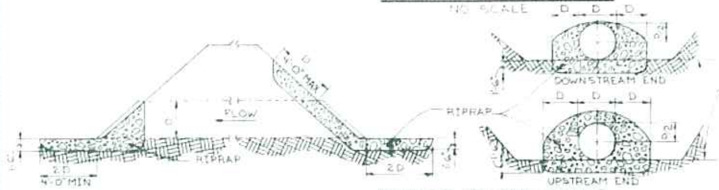
END TYPES:
1 BEVELED
2 FLARED
3 SQUARE

NOTE:
END SECTIONS INCLUDED IN PIPE LENGTH

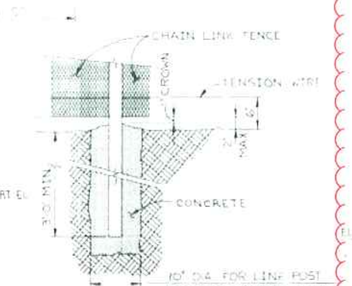
OVERFLOW STRUCTURE NOTES
1. CONCRETE SHALL HAVE MIN 28 DAY STRENGTH OF 3000 PSI
2. STEEL REINFORCEMENT SHALL CONSIST OF DEFORMED BARS, GRADE 40



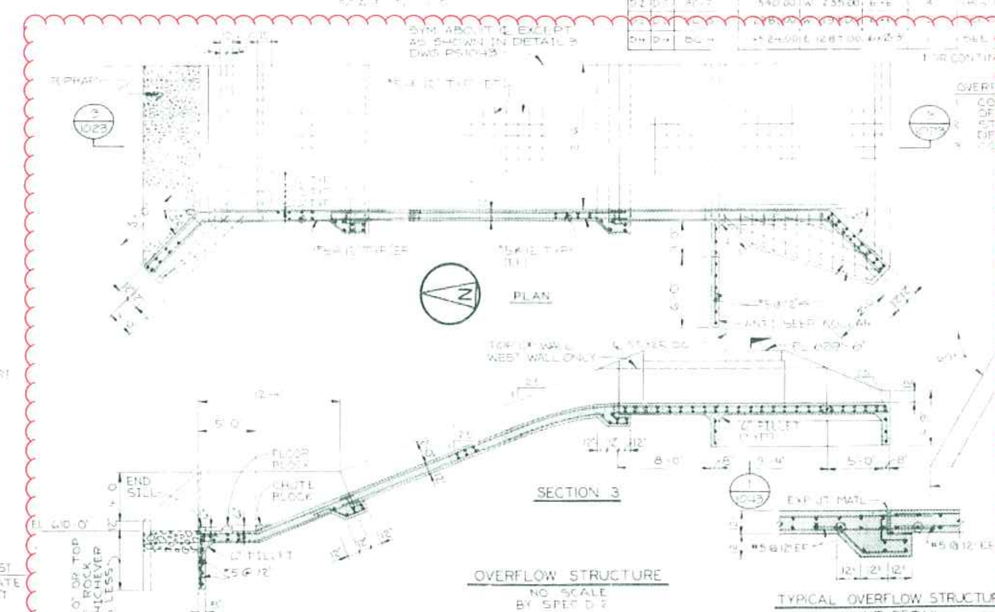
CHAIN LINK SWING GATE
NO SCALE



DRAINAGE CULVERT RIPRAP
ELEVATION & SECTION
NO SCALE

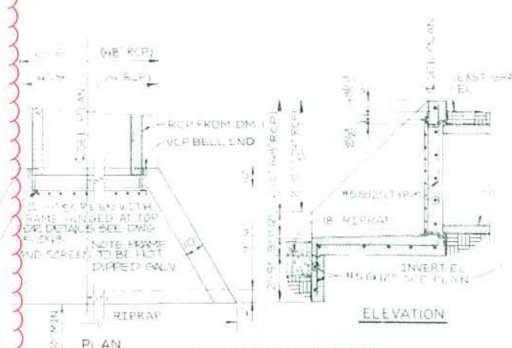


TYPICAL FENCE POST FOUNDATION



OVERFLOW STRUCTURE
NO SCALE
BY SPEC D-2

TYPICAL OVERFLOW STRUCTURE JOINT DETAIL
NO SCALE



DISCHARGE STRUCTURE

11-3-78	ADDED CULVERT WWT-2 & REVISED LOCATION BC-8	13	1-11-78	REVISED AS CIRCLED	8
6-5-78	REVISED MR-4 INVERT ELEV	12	1-19-78	GENERAL REVISIONS	7
5-14-76	REVISED AS CIRCLED	11	11-14-75	GENERAL REVISIONS	6
4-27-76	REVISED AS CIRCLED	10	7-29-75	GENERAL REVISIONS	5
3-2-76	REVISED OVERFLOW STRUCTURE	9	4-29-75	REV & ISSUED FOR CONTRACT & CONST SPEC D2	4

2-12-82 CONFORMED TO CONSTRUCTION RECORDS — 14

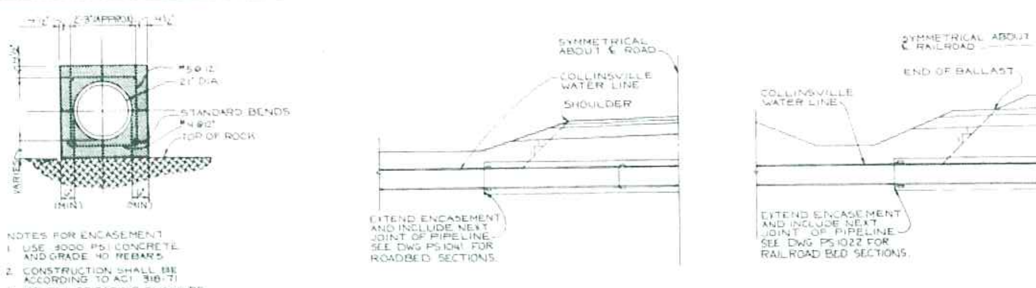
REVISIONS AND RECORD OF ISSUE

SCALE: AS NOTED

BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT 6571/6572

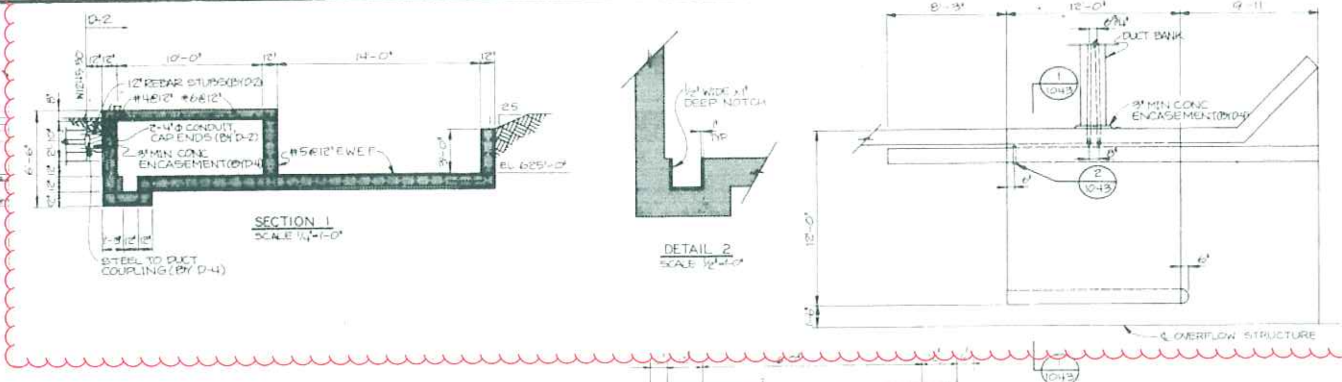
PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION-UNITS 3 & 4
MISCELLANEOUS RAILROAD AND SITE GRADING DETAILS

PS1023
85127-E
SHT 1023



NOTES FOR ENCASEMENT
1. USE 3000 PSI CONCRETE AND GRADE 40 REBARS
2. CONSTRUCTION SHALL BE ACCORDING TO ACI 318-71
3. BOTTOM OF CASING SHALL BE POURED TO TOP OF ROCK
4. ALL LONGITUDINAL REINFORCING SHALL BE #4 BARS PLACED AS SHOWN.

COLLINSVILLE WATER LINE ENCASEMENT DETAILS
NO SCALE



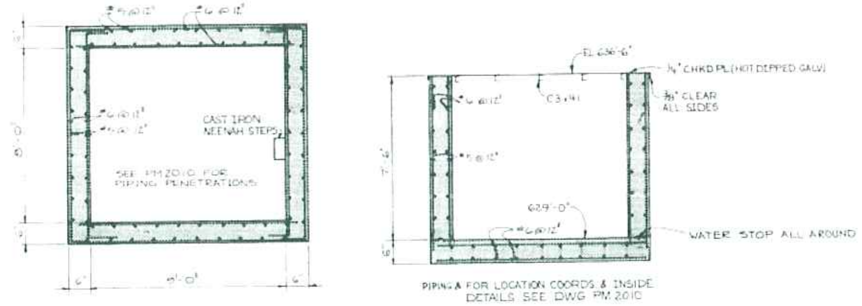
SECTION 1
SCALE 1/4"=1'-0"

DETAIL 2
SCALE 1/2"=1'-0"

DETAIL 3
SCALE 1/4"=1'-0"

HOSE HOUSE LIST					
NO.	CORNER LOCATION SOUTH	CORNER LOCATION E OR W	ELEVATION	FURNISH	INSTALL
1					
2	3919.00	E 1066.00			D-6
3	3919.00	E 1488.00			D-6
4	4472.00	E 888.00			D-6
5	4504.00	E 1532.00			D-6
6	4805.00	E 1609.00			D-6
7	4805.00	E 1732.50			D-6
8	5530.00	E 1282.00			D-6
9	5200.00	E 1091.00			D-6
10	6165.00	E 1198.50			D-6
11	6598.00	E 1210.00			D-6
12	6973.00	E 1673.00			D-6
13	4650.00	E 2067.50			D-6
14	4650.00	E 2191.00			D-6

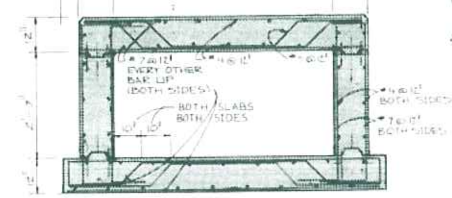
YARD & FIRE HYDRANT LIST					
NO	CENTERLINE LOCATION SOUTH	CENTERLINE LOCATION E OR W	ELEVATION	FURNISH	INSTALL
FH 1	4542.00	E 1083.00	633.58	B/M B-30A (FH 1–FH 27)	D-4
FH 2	4475.00	E 886.00	631.50		D-4
FH 3	NOT USED				
FH 4	4075.00	E 886.00	629.50		D-4
FH 5	3909.00	E 1066.00	637.58		D-4
FH 6	3909.00	E 1250.00	637.58		D-4
FH 7	3909.00	E 1460.00	637.58		D-4
FH 8	3980.00	E 1492.00	636.00		D-4
FH 9	4170.00	E 1463.50	637.50		D-4
FH 10	4420.00	E 1492.00	637.50		D-4
FH 11	4502.00	E 1262.50	636.50		D-4
FH 12	4790.00	E 1615.00	638.58		D-4
FH 13	4790.00	E 1735.00	639.58		D-4
FH 14	5040.00	E 1615.00	639.58		D-4
FH 15	5040.00	E 1735.00	639.58		D-4
FH 16	5200.00	E 1106.00	637.50		D-4
FH 17	5550.00	E 1083.00	639.50		D-4
FH 18	5527.00	E 1279.50	644.50		D-4
FH 19	5880.00	E 1207.00	641.50		D-4
FH 20	6170.00	E 1077.00	641.50		D-4
FH 21	6583.00	E 1210.00	641.50		D-4
FH 22	6857.75	E 1170.00	637.75		D-4
FH 23	6956.00	E 1665.00	637.75		D-4
FH 24	4635.00	E 2185.00	638.58		D-4
FH 25	4635.00	E 2065.00	638.58		D-4
FH 26	4885.00	E 2185.00	638.58		D-4
FH 27	4885.00	E 2065.00	638.58		D-4
YH 1	4695.50	E 1645.00		D-4	D-4
YH 2	4605.00	E 1895.00		D-4	D-4
YH 3	4540.50	E 2154.00		D-4	D-4
FH 28	5460.00	E 1282.00			



PLAN

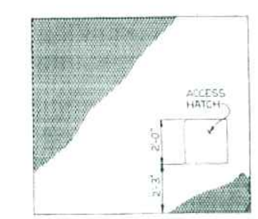
ELEVATION

BOILER DRAIN VALVE PIT
SCALE 3/8"=1'-0"

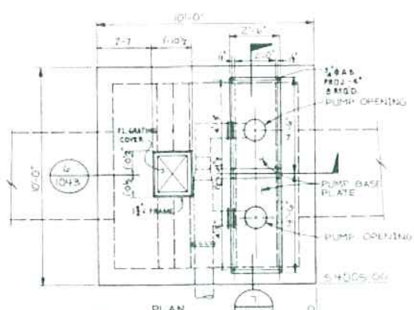


ASH LINE BOX CULVERT

NOTES FOR CONSTRUCTION OF BOX CULVERT
1. CONCRETE CONSTRUCTION ACCORDING TO ACI 318-71
2. MAINTAIN 2" COVER ON ALL STEEL EXCEPT 3" AT BOTTOM OF BOTTOM SLAB
3. FOR WINGWALL AND APRON DETAILS SEE THIS SHEET

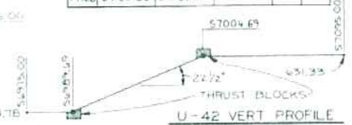


PLAN
CHECKERED PLATE

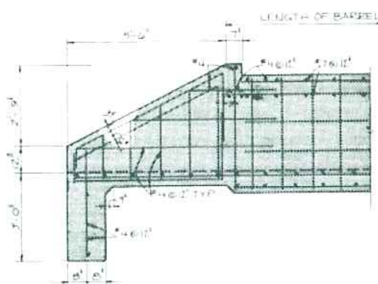


PLAN

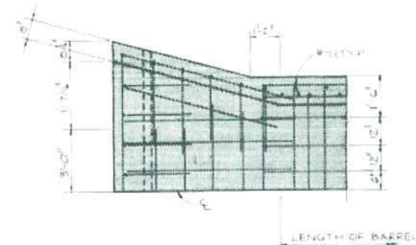
SITE RUNOFF PUMP PIT STRUCTURE
SCALE 3/8"=1'-0"



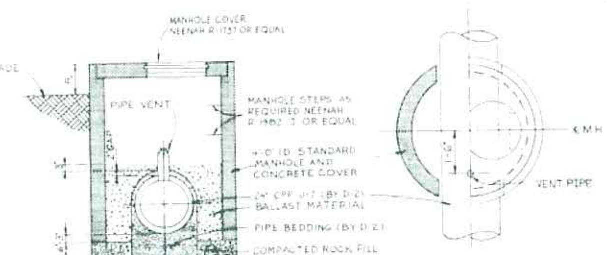
U-42 VERT PROFILE
NO SCALE



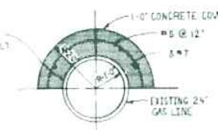
ASH LINE BOX CULVERT WINGWALL
SCALE 1/2"=1'-0"



ASH LINE BOX CULVERT APRON
SCALE 1/2"=1'-0"

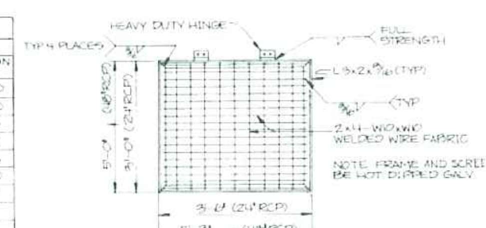


MAKE UP WATER MANHOLE
SCALE 1/2"=1'-0"

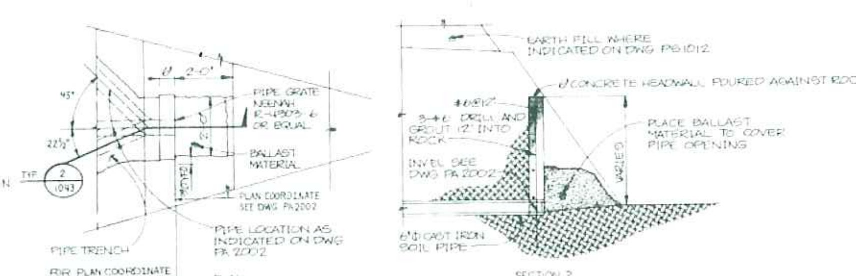


SECTION 3
SCALE 1/2"=1'-0"

DRAINAGE CULVERT LIST (CONT FROM DWG PS1023)														
FURNISH	INSTALL	CULVERT NO	CENTERLINE LOCATION SOUTH	CENTERLINE LOCATION E-W	Ø DIAM	NO OF UNIT	NOTES	SIZE GAGE	SIZE CORR SIZE	SIZE LGTH	END TYPE	INVERT ELEV LOCATION A	INVERT ELEV LOCATION B
D-4	D-4	CTR-2	4524.00	E 2028	24"	1		18	STD	70'	1	639.50	639.00
D-4	D-4	CTR-3	4775.00	E 1112.00	12"	1		18	STD	55'	1	641.50	641.00
D-4	D-4	CTR-4	4576.00	E 1630.00	24"	1		18	STD	65'	1	638.00	637.50
D-4	D-4	BC-9	6920.00	E 1545.00	5'x5'	2	FOR BC DETAILS SEE			35'		629.60	629.50
D-4	D-4	BC-10	6905.00	E 1772.00	5'x5'	2	DWG PS1023			25'		629.80	629.70
D-4	D-4	TR-2	3659.00	E 1200.00	12"	1		16	STD	91'	3	637.10	636.90
D-4	D-4	TR-5	4780.00	E 1200.00	12"	1		16	STD	80'	3	636.20	635.80
		PR6-6	5335.0	970	12	1						633.75	632.75
		PR7-7	5300.0	810	12	1						634.0	633.5



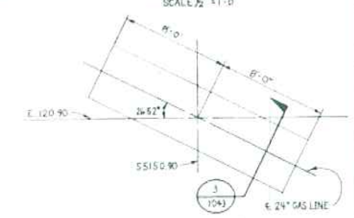
DETAIL OF FRAME AND SCREEN AT DISCHARGE STRUCTURE
SEE DWG PS1023
SCALE 3/4"=1'-0"



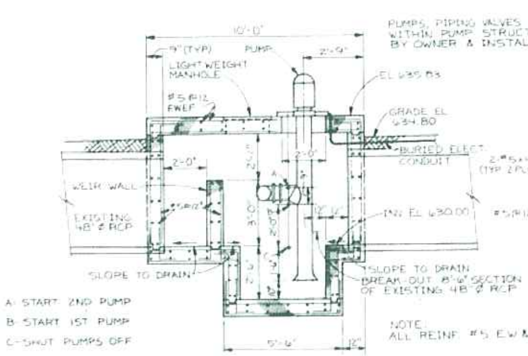
PLAN

SECTION 2

TRENCH DRAIN HEADWALL
SCALE 1/2"=1'-0"



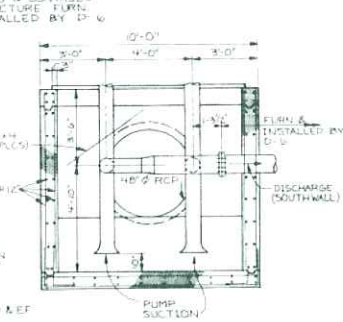
CONCRETE COVER FOR E-6
SCALE 1/4"=1'-0"



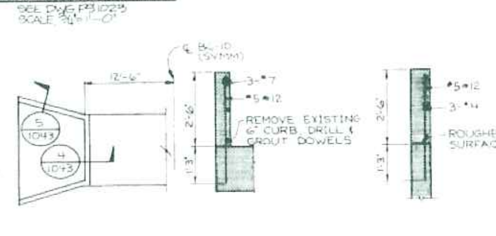
A- START 2ND PUMP
B- START 1ST PUMP
C- SHUT PUMPS OFF

NOTE
ALL REINF #5 EW & EF

SECTION 6, LOOKING NORTH
SCALE 3/8"=1'-0"
SEE THIS DWG



SECTION 7, LOOKING EAST
SCALE 3/8"=1'-0"
SEE THIS DWG

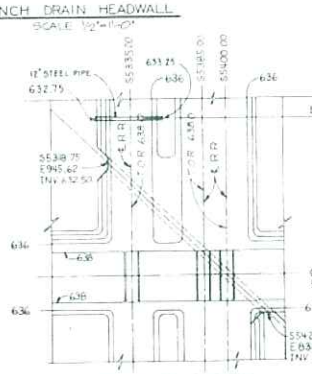


PLAN
NO SCALE

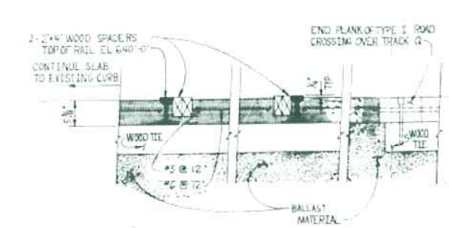
SECTION 4
SCALE 1"=1'-0"

SECTION 5
SCALE 1"=1'-0"

BOX CULVERT 10 COAL RETENTION WALL



ASH LINE BOX CULVERT
SCALE 1"=40'



CONCRETE ROAD CROSSING
SCALE 1"=1'-0"

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP
2-11-82	CONFORMED TO CONSTRUCTION RECORDS	13			
4-14-80	REVISED STORM WATER PUMP PIT	12	CVS		
3-6-80	ADDED STORM WATER PUMP PIT	11	CVS		
1-21-77	REVISED AS CIRCLED	10	RS		
11-12-76	REVISED AS CIRCLED	9	JM		
10-8-76	REVISED AS CIRCLED	8	JM		
6-23-76	REVISED AS CIRCLED	7	JM		
6-1-76	REVISED AS CIRCLED	6	FH		
5-14-76	REVISED AS CIRCLED	5	FH		
4-27-76	REVISED AS CIRCLED	4	CB		
4-9-76	REVISED AS CIRCLED	3	ES		
3-31-76	REVISED OVERFLOW STRUCTURE	2	FH	LR	
3-12-76	REVISED AS CIRCLED	1	DO		
1-16-76	ISSUED FOR CONSTRUCTION	0			

SCALE AS NOTED

DRAWN CLM — CHECKED — DESIGN JC

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF OKLAHOMA

DATE 1/6/76 REG. NO. 10238

BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT 6571/6572

PUBLIC SERVICE COMPANY OF OKLAHOMA
NORTHEASTERN STATION-UNITS 3 & 4

MISCELLANEOUS SECTIONS AND DETAILS

PS1043

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85127-E

SHT. 1043