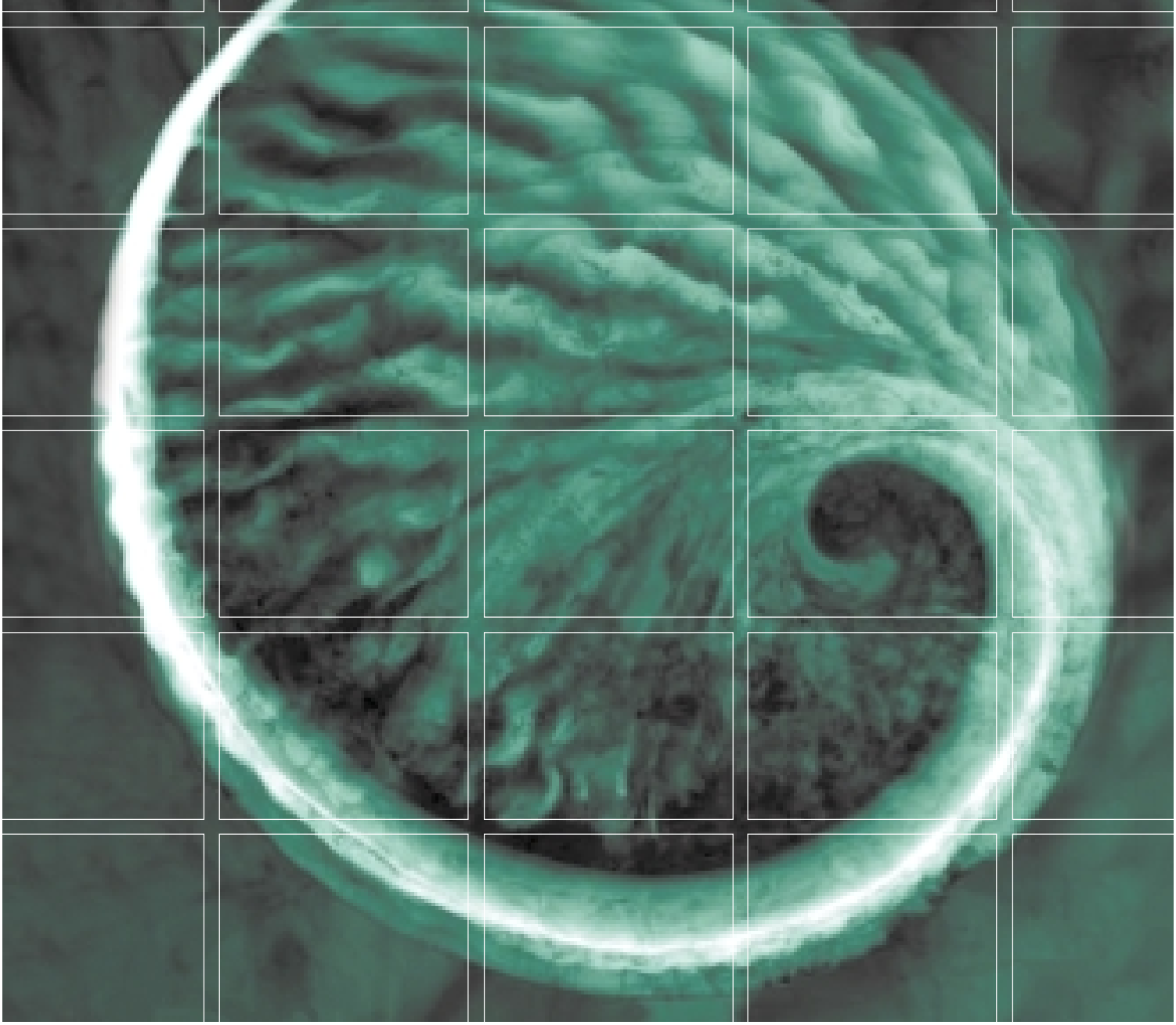

Ash Pile Stormwater Run-On and Run-Off Control System Plan

San Miguel Electric Cooperative, Inc.

Atascosa County, Texas

October 14, 2016

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San Miguel Electric Cooperative, Inc.

Ash Pile Stormwater Run-On and Run-Off Control System Plan

October 14, 2016

Project No. 0303548
Atascosa County, Texas

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1.0 INTRODUCTION

San Miguel Electric Cooperative, Inc. (San Miguel) owns and operates a 440-MW mine-mouth, lignite-fired power generating plant (the San Miguel Plant) and associated lignite-mining facilities. The San Miguel Plant is located approximately 6 miles south of Christine, Texas.

The San Miguel Plant began electric power generation during January 1982. San Miguel has wholesale power contracts to furnish power and energy to the South Texas Electric Cooperative, Inc. through the year 2037.

The San Miguel Plant generates coal combustion residuals (CCR) that are regulated under Title 40, Code of Federal Regulations, Part §257 (40 CFR Part §257)(the CCR Rule).

San Miguel owns and operates the Ash Pile for management of CCR at the Facility. In accordance with requirements in 40 CFR §257.81(c), this document is the stormwater run-on and run-off control system plan for the Ash Pile (the Ash Pile SWCSP).

1.1 Purpose and Scope

In accordance with 40 CFR §257.81(a), San Miguel will design, construct, operate, and maintain the Ash Pile stormwater run-on and run-off control systems capable of the following:

(1) Prevention of stormwater flow onto the active portion of the Ash Pile during the peak discharge from a 24-hour, 25-year storm; and

(2) Collection and control of at least the water volume resulting from a 24-hour, 25-year storm.

This plan documents how the Ash Pile stormwater run-on and run-off control systems have been designed and constructed to meet the applicable requirements in 40 CFR §257.81.

1.2 Definitions

This Ash Pile SWCSP includes terms defined consistent with parts of 40 CFR §257.53 (*i.e.*, 80 FR 21468, April 17, 2015; 80 FR 37988, July 2, 2015) and associated editions of the Federal Register as noted below.

- **Active portion** means that part of the CCR unit that has received or is receiving CCR or non-CCR waste and that has not completed closure in accordance with §257.102.

- **Coal combustion residuals (CCR)** means fly ash, bottom ash, boiler slag and flue gas desulfurization materials generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers
- **CCR landfill** means an area of land or an excavation that receives CCR and which is not a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground or surface coal mine, or a cave. For purposes of the Ash Pile SWCSP, a CCR landfill also includes sand and gravel pits and quarries that receive CCR, CCR piles, and any practice that does not meet the definition of a beneficial use of CCR
- **CCR pile or pile** means any non-containerized accumulation of solid, non-flowing CCR that is placed on the land. CCR that is beneficially used off-site is not a CCR pile
- **CCR unit** means any CCR landfill, CCR surface impoundment, or lateral expansion of a CCR unit, or a combination of more than one of these units, based on the context of the paragraph(s) in which it is used. This term includes both new and existing units, unless otherwise specified.
- **Existing CCR landfill** means a CCR landfill that receives CCR both before and after October 19, 2015, or for which construction commenced prior to October 19, 2015 and receives CCR on or after October 19, 2015. A CCR landfill has commenced construction if the owner or operator has obtained the federal, state, and local approvals or permits necessary to begin physical construction and a continuous on-site, physical construction program had begun prior to October 19, 2015.
- **Facility** means all contiguous land, and structures, other appurtenances, and improvements on the land, used for treating, storing, disposing, or otherwise conducting solid waste management of CCR. A facility may consist of several treatment, storage, or disposal operational units (*e.g.*, one or more landfills, surface impoundments, or combinations of them).
- **Run-off** means any rainwater, leachate, or other liquid that drains over land from any part of a CCR landfill or lateral expansion of a CCR landfill.
- **Run-on** means any rainwater, leachate, or other liquid that drains over land onto any part of a CCR landfill or lateral expansion of a CCR landfill.
- **Qualified professional engineer** means an individual who is licensed by a state as a Professional Engineer to practice one or more disciplines of engineering and who is qualified by education, technical knowledge and experience to make the specific technical certifications required under the CCR Rule. Professional engineers making these certifications must be currently licensed in the state where the CCR unit(s) is located.

1.3 Organization of the Plan

Section 2 describes the Ash Pile.

Section 3 describes technical analysis of the Ash Pile stormwater run-on and run-off control systems.

Section 4 describes management of stormwater run-off from the Ash Pile.

Section 5 describes documentation related to the Ash Pile SWCSP.

Section 6 describes future periodic update of the Ash Pile SWCSP.

Section 7 provides certification of the Ash Pile SWCSP.

Section 8 is a list of references cited in the Ash Pile SWCSP.

Appendix A provides engineering calculations which support the evaluation of the Ash Pile run-on and run-off control systems described in the Ash Pile SWCSP text.

2.0 ASH PILE DESCRIPTION

The Ash Pile is a temporary storage area, approximately one acre in size, used to stage a stabilized mixture of fly ash and flue gas desulfurization (FGD) scrubber waste treatment system sludge until it can be hauled off-site. The Ash Pile was designated the "FGD Stacking Area" in the original plant construction documents (T&G 1980).

The Ash Pile is a non-containerized accumulation of solid CCR that is placed on the land. The Ash Pile began receiving CCR before October 19, 2015 and currently receives CCR. Hence, in accordance with 40 CFR §257.53, the Ash Pile is classified as an active existing CCR landfill.

The Ash Pile is located generally northwest of the plant; see Figure 1.

3.0 STORMWATER RUN-OFF MANAGEMENT

In accordance with 40 CFR §257.81(a), run-off from the Ash Pile must be handled according to the requirements of the National Pollutant Discharge Elimination System (NPDES) under section 402 of the Clean Water Act. The NPDES program is administered in the State of Texas for facilities not engaged in petroleum exploration or production by the Texas Commission on Environmental Quality (TCEQ) via the Texas Pollutant Discharge Elimination System (TPDES) program.

San Miguel manages stormwater run-off from the Ash Pile via the Lignite Yard Retention Pond (LYRP) in accordance with the requirements of the San Miguel Plant TPDES permit issued by the TCEQ as Permit No. WQ002601000 (TCEQ 2015).

4.0 TECHNICAL ANALYSIS

Technical analysis demonstrating that the Ash Pile run-on and run-off control systems fulfill the requirements of 40 CFR 257.81 is described below.

Peak stormwater flow due to a 24-hour, 25-year storm was calculated using the rational formula with appropriate values of runoff coefficients, peak storm intensity, and corresponding areas that drain from the Ash Pile and adjoining areas to the Lignite Yard Retention Pond (LYRP). The LYRP is intended to retain stormwater that drains to the LYRP, although the TPDES permit allows discharge in the event of high level associated with a significant storm event.

Inspection of San Miguel Plant drawings, aerial photos, and on-site observation indicated the following surface cover types and corresponding rational formula stormwater run-off coefficients in the drainage areas draining from the Ash Pile and adjoining areas:

- Ash or Lignite: 0.35 (for Ash Pile or lignite storage pile areas);
- Light Industrial: 0.65 (for unpaved areas, including laydown, unpaved roads, and grass-covered areas); and
- Pavement/Roof: 0.9 (for paved roads and roof area runoff).

The rainfall intensity for each sequential drainage area draining the Ash Pile was calculated using the following rainfall intensity-duration-frequency (IDF) formula (Equation No. 4-21, TXDOT 2016):

$$I = b/(t_c+d)^e$$

where:

I = intensity, inches per hour
b = county-specific coefficient (TXDOT 2016)
d = county-specific coefficient (TXDOT 2016)
e = county-specific coefficient (TXDOT 2016)
t_c = time of concentration for the corresponding drainage area, minutes

Coefficients "b", "d", and "e" have been determined by county in Texas for storms with a specified return period. Values for Atascosa County obtained from the United States Geological Survey and are compiled in the Texas Department of Transportation (TXDOT) Hydraulic Design Manual (TXDOT 2016). Those values were used in this analysis to calculate the design storm intensity for each drainage area at the respective time of concentration (t_c). Input data and results of calculations are shown in Table 1.

The minimum time of concentration for the most upstream drainage area was assumed to be 10 minutes as recommended in the TXDOT Hydraulic Design Manual. The time of concentration for each subsequent drainage area was calculated based on the upstream time of concentration, the length of the upstream reach, and the calculated upstream peak stormwater flow velocity.

The area of each drainage area and sub-area surface cover type in each drainage area upstream and downstream of the Ash Pile was determined using a combination of San Miguel Plant drawings, aerial imagery, and site observation; see Figure 1 and Table 1.

The depth of flow at the design peak stormwater flow rate in each open channel conveyance reach was assumed to be the normal depth calculated using the Manning formula for the corresponding channel reach bottom width, side slopes, Manning's roughness coefficient, and profile slope.

The upstream submergence of each culvert at the design peak stormwater flow rate was calculated based on the total head loss assuming pipe-full flow at the outlet using the Manning formula with the corresponding number of pipes, pipe diameter, Manning's roughness coefficient, and pipe profile slope. Where that upstream submergence would be above the plant access road under which the culvert conveys stormwater, the plant access road was assumed to act as a broadcrested weir, with the design stormwater flow split between the culvert(s) and the overflow to balance the submergence level on the upstream end of the culverts.

The open channel and culvert (and overflow, if needed due to culvert submergence) depths were determined by using trial values adjusted until the calculated peak flow rate equaled the hydrologic design peak stormwater flow rate for the corresponding time of concentration and drainage area.

A summary of the drainage area hydrologic data and calculation results are shown in Table 1. A summary of the open channel and culvert conveyance component hydraulic data and calculation results are shown in Table 2. The Ash Pile drainage area and conveyance data and calculation results are summarized on Figure 1.

4.1 STORMWATER RUN-ON CONTROL SYSTEMS TECHNICAL ANALYSIS

Hydraulic and hydrologic analysis of the drainage areas around and upstream of the Ash Pile shows that there is no stormwater run-on to the Ash Pile due to the peak stormwater flow during the design 24-hour, 25-year storm.

Consequently, the Ash Pile stormwater run-on controls comply with requirements in 40 CFR 257.81(a)(1).

4.2 STORMWATER RUN-OFF CONTROL SYSTEMS TECHNICAL ANALYSIS

Hydraulic and hydrologic analysis of the drainage areas, drainage channels, and culverts upstream and downstream of the Ash Pile shows that stormwater run-off from the Ash Pile due to the peak stormwater flow during the design 24-hour, 25-year storm is conveyed to the design containment, the Lignite Yard Retention Pond (LYRP). Stormwater from these areas is allowed to drain into the LYRP in accordance with the San Miguel Plant TPDES Permit and 40 CFR §257.81(a).

Consequently, the Ash Pile stormwater run-off controls comply with requirements in 40 CFR 257.81(a)(2).

5.0 NOTIFICATION AND RECORD KEEPING

San Miguel will issue notifications, implement recordkeeping, and post the Ash Pile SWCSP to the San Miguel Plant internet site accessible to the public in accordance with 40 CFR §257.105, 40 CFR §257.106, and 40 CFR §257.107.

5.1 NOTIFICATIONS

San Miguel will notify the Executive Director of the TCEQ, the State Director as defined in 40 CFR §257,105(d), and in accordance with 40 CFR §257.106(g)(3), when the initial and periodic Ash Pile SWCSP is available in the San Miguel Plant Operating Record and publically accessible internet site.

In accordance with TCEQ instructions related to CCR units in Texas, San Miguel will send each notification to the TCEQ via internet electronic mail to:

CCRNotify@tceq.texas.gov

5.2 RECORDKEEPING

San Miguel will maintain record of this initial Ash Pile SWCSP by October 17, 2016 in accordance with 40 CFR §257.81(d) and 105(g)(3) and for a period of five years thereafter. San Miguel will also maintain record of future periodic updates for a period of five years.

5.3 SAN MIGUEL PLANT INTERNET SITE

San Miguel will post the following documents on the San Miguel Plant internet site accessible to the public in accordance with 40 CFR §257.107(g)(3) within 30 days of placing the document in the Operating Record and for a period of five years thereafter:

- the initial Ash Pile SWCSP; and
- each update of the Ash Pile SWCSP.

6.0 REVISION AND CERTIFICATION OF THE ASH PILE SWCSP

San Miguel will revise the Ash Pile SWCSP in accordance with requirements in 40 CFR §257.81(c).

6.1 Optional Amendment of the Ash Pile SWCSP

In accordance with 40 CFR §257.81(c)(2), San Miguel may amend the Ash Pile SWCSP at any time. Amendments to the plan will be placed in the Facility's operating record and on the San Miguel CCR Web Site and notifications will be made as required by 40 CFR §257.105(g)(3), 106(g)(3), and 107(g)(3).

6.2 Required Amendment of the Ash Pile SWCSP

In accordance with 40 CFR §257.81(c)(2), San Miguel must amend the Ash Pile SWCSP whenever there is a change in conditions that would substantially affect the Ash Pile SWCSP then in effect.

6.3 Periodic Revision of the Ash Pile SWCSP

In accordance with requirements in 40 CFR §257.81(c)(4), San Miguel will prepare periodic revision of this Ash Pile SWCSP at five–year intervals.

The date of completing this initial Ash Pile SWCSP will be the basis for establishing the deadline to complete the first subsequent revision of the Ash Pile SWCSP.

San Miguel may complete this initial Ash Pile SWCSP or and any required revision of the Ash Pile SWCSP prior to the required deadline provided that San Miguel places the completed Ash Pile SWCSP in the San Miguel Plant operating record within a reasonable amount of time.

In each case, the deadline for completing a subsequent revision of the Ash Pile SWCSP will be based on the date of completing the previous Ash Pile SWCSP.

For purposes of compliance with 40 CFR §257.81(c)(4), San Miguel will have completed a periodic revision of the Ash Pile SWCSP when San Miguel has placed the updated Ash Pile SWCSP in the San Miguel Plant operating record in accordance with 40 CFR §257.105(g)(3).

6.4 Certification of Each Issue of the Ash Pile SWCSP

San Miguel will obtain certification of each amendment and revision of the Ash Pile SWCSP by a qualified professional engineer stating that the amended or revised Ash Pile SWCSP achieves the requirements in 40 CFR §257.81.

7.0 *PROFESSIONAL ENGINEER CERTIFICATION*

In accordance with 10 CFR §257.81(c)(5), San Miguel obtained the following certification by a qualified professional engineer stating that this Ash Pile SWCSP achieves the requirements in 40 CFR §257.81.

Certification for this initial Ash Pile SWCSP is provided below.

> *I hereby certify that I have reviewed the Ash Pile Stormwater Run-On and Run-off Control System Plan for the San Miguel Electric Plant located in Atascosa County, Texas, and being familiar with the provisions of 40 CFR Part §257.81, attest that this Ash Pile Stormwater Run-On and Run-off Control System Plan meets the requirements of 40 CFR Part §257.81.*

Seal:

E. Doyon Main, P.E.
Printed Name of Licensed Professional Engineer

Signature of Licensed Professional Engineer

10/4/2016
Date

8.0 REFERENCES

Information used as sources of information for preparation of this Ash Pile StormWater Run-On and Run-Off Control System Plan are listed below.

TCEQ 2015 — *Permit to Discharge Wastes,* TPDES Permit No. WQ0002601000, EPA I.D. No. TX0090611, Texas Commission on Environmental Quality, issued June 30, 2015.

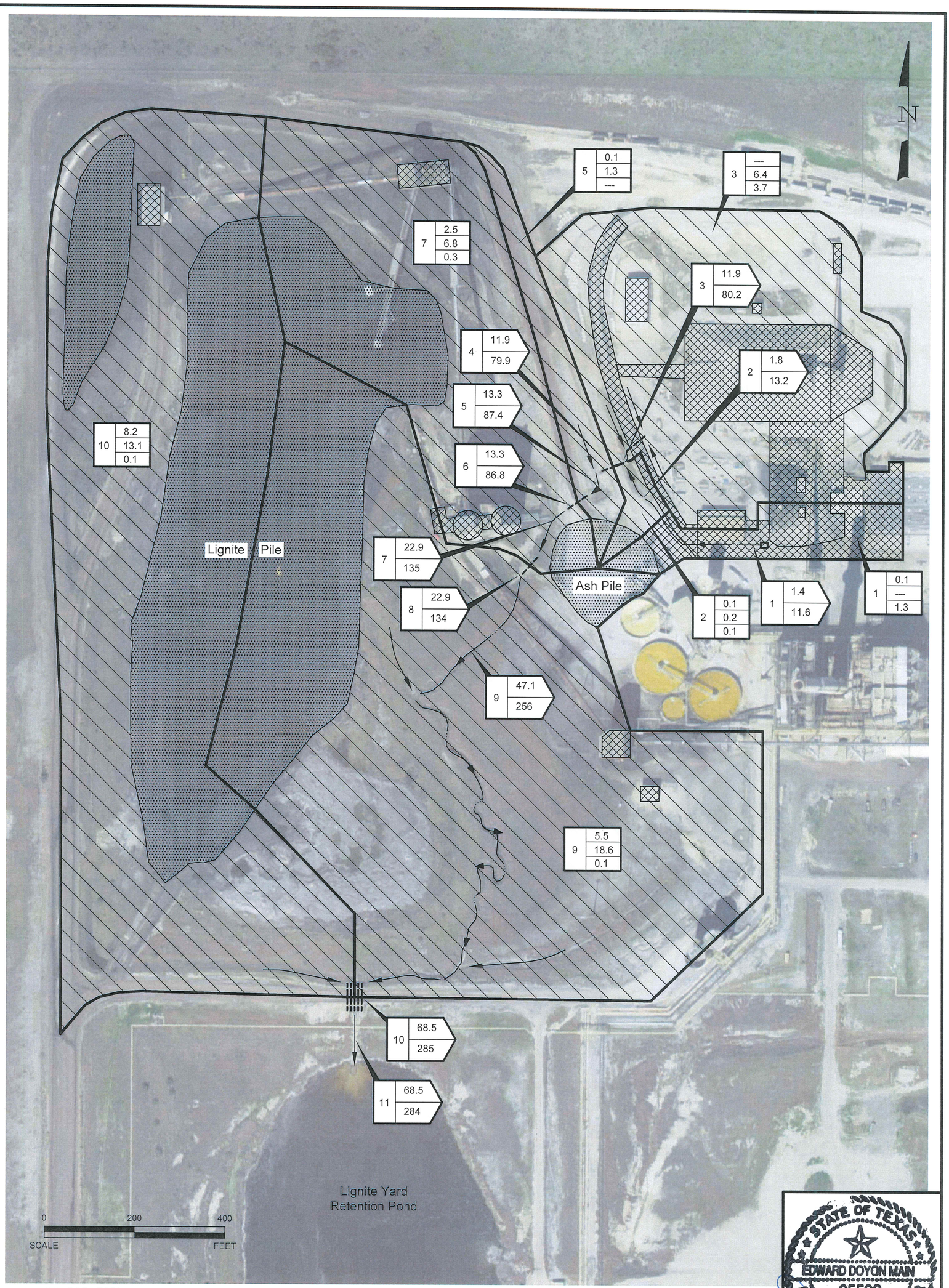
T&G 1980 — *Site Plan Section No. 6, San Miguel Plant Unit No. 1*, Drawing No, 1-C-35 Rev 16, Tippet & Gee, Inc., April 1, 1977, revised August 6, 1980.

TXDOT 2016 — *Hydraulic Design Manual,* Texas Department of Transportation, Revised July 2016.

Figures

October 2016
Project No. 0303548

Environmental Resources Management
206 East 9th Street, Suite 1700
Austin, Texas 78701
(512) 459-4700



AERIAL SOURCE: ESRI.

LEGEND

- DRAINAGE AREA BOUNDARY
- ASH OR LIGNITE
- LIGHT INDUSTRIAL (UNPAVED)
- PAVEMENT/ROOF (PAVED)

DRAINAGE AREA NO.
- ASH OR LIGNITE AREA (ACRES)
- UNPAVED AREA (ACRES)
- PAVED AREA (ACRES)

CHANNEL OR CULVERT SEGMENT NO.
- CUMULATIVE AREA (ACRES)
- DESIGN PEAK RUNOFF (CFS)

STATE OF TEXAS
EDWARD DOYON MAIN
65502
REGISTERED
PROFESSIONAL ENGINEER

Environmental Resources Management

FIGURE 1
25-YEAR PEAK DESIGN STORM DRAINAGE AREA MAP
Ash Pile CCR Landfill Run-On and
Run-Off Control System Plan
San Miguel Electric Cooperative, Inc.
Atascosa County, Texas

DESIGN: COJ	DRAWN: CAK	CHKD.: EDM
DATE: 10/11/2016	SCALE: AS SHOWN	REV.:

ERM

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ERM-Southwest, Inc. TX PE Firm No. 2393

Tables

October 2016
Project No. 0303548

Environmental Resources Management
206 East 9th Street, Suite 1700
Austin, Texas 78701
(512) 459-4700

TABLE 1

25-Year Peak Stormwater Runoff Hydrology

Ash Pile Stormwater Run-On and Run-Off Control System Plan
San Miguel Electric Cooperative, Inc., Atascosa County, Texas

	Input	Input		Fixed Input			Initial Only Input	Input	Input	Input		Input	Input	Input						Hydr
				Run-Off Coefficient			Upstream	i 24-hr/25-yr (Atascosa Co., Texas)				Increment Area			Cumulative Area				Calc	Calc
Reach	Upstream Sta.	Dnstream Sta.	Reach	Paved	Unpaved	Ash	Tc	b	d	e	i	Ash	Unpaved	Paved	Ash	Unpaved	Paved	Total	Peak Q	Peak V
No.	100-ft Sta.	100-ft Sta.	lf	in/in	in/in	in/in	min	in.	min	-----	in/hr	ac	ac	ac	ac	ac	ac	ac	cfs	fps
1	22 + 55	20 + 15	240	0.90	0.65	0.35	10.0	127.14	12.24	0.83	9.65	0.1	0.0	1.3	0.1	0.0	1.3	1.4	11.6	2.3
2	20 + 15	19 + 55	60	0.90	0.65	0.35	11.8	127.14	12.24	0.83	9.06	0.1	0.2	0.1	0.2	0.2	1.4	1.8	13.2	3.1
3	19 + 55	19 + 25	30	0.90	0.65	0.35	12.1	127.14	12.24	0.83	8.96	0.0	6.4	3.7	0.2	6.6	5.1	11.9	80.2	5.7
4	19 + 25	18 + 70	55	0.90	0.65	0.35	12.2	127.14	12.24	0.83	8.93				0.2	6.6	5.1	11.9	79.9	8.1
5	18 + 70	18 + 10	60	0.90	0.65	0.35	12.3	127.14	12.24	0.83	8.90	0.1	1.3	0.0	0.3	7.9	5.1	13.3	87.4	4.3
6	18 + 10	17 + 10	100	0.90	0.65	0.35	12.5	127.14	12.24	0.83	8.83				0.3	7.9	5.1	13.3	86.8	9.2
7	17 + 10	16 + 50	60	0.90	0.65	0.35	12.7	127.14	12.24	0.83	8.77	2.5	6.8	0.3	2.8	14.7	5.4	22.9	135.1	4.9
8	16 + 50	15 + 50	100	0.90	0.65	0.35	12.9	127.14	12.24	0.83	8.71				2.8	14.7	5.4	22.9	134.1	11.8
9	15 + 50	1 + 50	1,400	0.90	0.65	0.35	13.0	127.14	12.24	0.83	8.67	5.5	18.6	0.1	8.3	33.3	5.5	47.1	255.8	3.0
10	1 + 50	1 + 0	50	0.90	0.65	0.35	20.7	127.14	12.24	0.83	6.96	8.2	13.1	0.1	16.5	46.4	5.6	68.5	285.2	5.9
11	1 + 0	0 + 0	100	0.90	0.65	0.35	20.8	127.14	12.24	0.83	6.94				16.5	46.4	5.6	68.5	284.2	4.5

ABBREVIATIONS AND ACRONYMS

ac	acres	e	(variable)	in/hr	inches per hour	Sta.	calculated
b	(variable)	fps	feet per second	in/in	inches per inch	Tc	time of concentration
cfs	cubic feet per second	hr	hours	lf	linear feet	V	velocity
d	(variable)	i	intensity	min	minutes	yr	years
Dnstream	downstream	in.	inches	Q	flow rate		

TABLE 2

25-Year Peak Stormwater Runoff Hydraulics

Ash Pile Stormwater Run-On and Run-Off Control System Plan
San Miguel Electric Cooperative, Inc., Atascosa County, Texas

Open Channel	From Hydro				Input	Input			Input	Input	Input			Input	Trial		Trial Calc														Hydro	Goal = 0	
	Reach No.	Upstream Sta. 100-ft Sta.	Dnstream Sta. 100-ft Sta.	Reach lf	Manning's n -----	Channel Slope ft/ft	Slope dh ft		Left Side Slope H:V	Bottom Width ft W	Right Side Slope H:V	Wetted Area sf	Wetted Perimeter lf	Sum of km ft/ft	Trial Dn vf	Trial EGL Slope ft/ft	Q at Trial HGL cfs	V at Trial Dn fps	hv at Trial Dn ft	hm at Trial Dn ft	hf at Trial Dn ft	EGL Slope ft/ft	Trial Calc Peak Q cfs								Calc Peak Q cfs	Delta Q cfs	Calc Peak V fps
	1	22 + 55	20 + 15	240	0.035	0.0250	6.00		33.0	0.0	33.0	5.12	26.01	0.0	0.39	0.0250	11.6	2.3	0.08	0.00	6.00	0.0250	11.6								11.6	0.0	2.3
Open Channel	From Hydro				Input	Input			Input	Input	Input			Input	Trial		Trial Calc														Hydro	Goal = 0	
	Reach No.	Upstream Sta. 100-ft Sta.	Dnstream Sta. 100-ft Sta.	Reach lf	Manning's n -----	Channel Slope ft/ft	Slope dh ft		Left Side Slope H:V	Bottom Width ft W	Right Side Slope H:V	Wetted Area sf	Wetted Perimeter lf	Sum of km ft/ft	Trial Dn vf	Trial EGL Slope ft/ft	Q at Trial HGL cfs	V at Trial Dn fps	hv at Trial Dn ft	hm at Trial Dn ft	hf at Trial Dn ft	EGL Slope ft/ft	Trial Calc Peak Q cfs								Calc Peak Q cfs	Delta Q cfs	Calc Peak V fps
	2	20 + 15	19 + 55	60	0.035	0.0250	1.50		3.0	12.0	3.0	4.33	14.11	0.0	0.33	0.0250	13.2	3.1	0.14	0.00	1.50	0.0250	13.2								13.2	0.0	3.1
Open Channel	From Hydro				Input	Input			Input	Input	Input			Input	Trial		Trial Calc														Hydro	Goal = 0	
	Reach No.	Upstream Sta. 100-ft Sta.	Dnstream Sta. 100-ft Sta.	Reach lf	Manning's n -----	Channel Slope ft/ft	Slope dh ft		Left Side Slope H:V	Bottom Width ft W	Right Side Slope H:V	Wetted Area sf	Wetted Perimeter lf	Sum of km ft/ft	Trial Dn vf	Trial EGL Slope ft/ft	Q at Trial HGL cfs	V at Trial Dn fps	hv at Trial Dn ft	hm at Trial Dn ft	hf at Trial Dn ft	EGL Slope ft/ft	Trial Calc Peak Q cfs								Calc Peak Q cfs	Delta Q cfs	Calc Peak V fps
	3	19 + 55	19 + 25	30	0.035	0.0250	0.75		3.0	12.0	3.0	14.07	17.99	0.0	0.95	0.0250	80.2	5.7	0.50	0.00	0.75	0.0250	80.2								80.2	0.0	5.7
Culvert	From Hydro				Input	Input		Input	Input	Input	Input			Input	Trial		Trial Calc							Input							Hydro	Goal = 0	
	Reach No.	Upstream Sta. 100-ft Sta.	Dnstream Sta. 100-ft Sta.	Reach lf	Manning's n -----	Culvert Slope ft/ft	Slope dh ft	Culvert Barrels ea	Culvert Diameter in. I.D.	Outlet Subm. vf	Outlet km ft/ft	Wetted Area sf	Wetted Perimeter lf	Inlet km ft/ft	Upstream Subm. vf	Trial EGL Slope ft/ft	Q at Culv S cfs	V at Peak Q fps	hv at Peak Q ft	hm at Peak Q ft	hf at Peak Q ft	EGL Peak Q ft/ft	Culvert Peak Q cfs	Overflow Subm. vf	Overflow Depth vf	Overflow Width ft W	Overflow Peak Q cfs	Total Trial Peak Q cfs	Calc Peak Q cfs	Delta Q cfs	Calc Peak V fps
	4	19 + 25	18 + 70	55	0.035	0.0182	1.00	2	30	0.0	1.0	4.91	7.85	0.5	2.78	0.0688	40.0	8.1	1.03	1.54	3.78	0.0688	79.9	3.00	0.00	50.0	0.0	79.9	79.9	0.0	8.1
Open Channel	From Hydro				Input	Input			Input	Input	Input			Input	Trial		Trial Calc														Hydro	Goal = 0	
	Reach No.	Upstream Sta. 100-ft Sta.	Dnstream Sta. 100-ft Sta.	Reach lf	Manning's n -----	Channel Slope ft/ft	Slope dh ft		Left Side Slope H:V	Bottom Width ft W	Right Side Slope H:V	Wetted Area sf	Wetted Perimeter lf	Sum of km ft/ft	Trial Dn vf	Trial EGL Slope ft/ft	Q at Trial HGL cfs	V at Trial Dn fps	hv at Trial Dn ft	hm at Trial Dn ft	hf at Trial Dn ft	EGL Slope ft/ft	Trial Calc Peak Q cfs								Calc Peak Q cfs	Delta Q cfs	Calc Peak V fps
	5	18 + 70	18 + 10	60	0.035	0.0100	0.60		3.0	12.0	3.0	20.41	20.14	0.0	1.29	0.0100	87.4	4.3	0.28	0.00	0.60	0.0100	87.4								87.4	0.0	4.3
Culvert	From Hydro				Input	Input		Input	Input	Input	Input			Input	Trial		Trial Calc							Input							Hydro	Goal = 0	
	Reach No.	Upstream Sta. 100-ft Sta.	Dnstream Sta. 100-ft Sta.	Reach lf	Manning's n -----	Culvert Slope ft/ft	Slope dh ft	Culvert Barrels ea	Culvert Diameter in. I.D.	Outlet Subm. vf	Outlet km ft/ft	Wetted Area sf	Wetted Perimeter lf	Inlet km ft/ft	Upstream Subm. vf	Trial EGL Slope ft/ft	Q at Culv S cfs	V at Peak Q fps	hv at Peak Q ft	hm at Peak Q ft	hf at Peak Q ft	Net EGL Peak Q ft/ft	Culvert Peak Q cfs	Overflow Subm. vf	Overflow Depth vf	Overflow Width ft W	Overflow Peak Q cfs	Total Trial Peak Q cfs	Calc Peak Q cfs	Delta Q cfs	Calc Peak V fps
	6	18 + 10	17 + 10	100	0.025	0.0100	1.00	1	30	0.0	1.0	4.91	7.85	0.5	3.46	0.0446	45.1	17.7	4.85	7.28	4.46	0.0446	45.1	3.00	0.46	50.0	41.7	86.8	86.8	0.0	9.2
Open Channel	From Hydro				Input	Input			Input	Input	Input			Input	Trial		Trial Calc														Hydro	Goal = 0	
	Reach No.	Upstream Sta. 100-ft Sta.	Dnstream Sta. 100-ft Sta.	Reach lf	Manning's n -----	Channel Slope ft/ft	Slope dh ft		Left Side Slope H:V	Bottom Width ft W	Right Side Slope H:V	Wetted Area sf	Wetted Perimeter lf	Sum of km ft/ft	Trial Dn vf	Trial EGL Slope ft/ft	Q at Trial HGL cfs	V at Trial Dn fps	hv at Trial Dn ft	hm at Trial Dn ft	hf at Trial Dn ft	EGL Slope ft/ft	Trial Calc Peak Q cfs								Calc Peak Q cfs	Delta Q cfs	Calc Peak V fps
	7	17 + 10	16 + 50	60	0.035	0.0100	0.60		3.0	12.0	3.0	27.61	22.33	0.0	1.63	0.0100	135.1	4.9	0.37	0.00	0.60	0.0100	135.1								135.1	0.0	4.9
Culvert	From Hydro				Input	Input		Input	Input	Input	Input			Input	Trial		Trial Calc							Input							Hydro	Goal = 0	
	Reach No.	Upstream Sta. 100-ft Sta.	Dnstream Sta. 100-ft Sta.	Reach lf	Manning's n -----	Culvert Slope ft/ft	Slope dh ft	Culvert Barrels ea	Culvert Diameter in. I.D.	Outlet Subm. vf	Outlet km ft/ft	Wetted Area sf	Wetted Perimeter lf	Inlet km ft/ft	Upstream Subm. vf	Trial EGL Slope ft/ft	Q at Culv S cfs	V at Peak Q fps	hv at Peak Q ft	hm at Peak Q ft	hf at Peak Q ft	Net EGL Peak Q ft/ft	Culvert Peak Q cfs	Overflow Subm. vf	Overflow Depth vf	Overflow Width ft W	Overflow Peak Q cfs	Total Trial Peak Q cfs	Calc Peak Q cfs	Delta Q cfs	Calc Peak V fps
	8	16 + 50	15 + 50	100	0.020	0.0100	1.00	1	30	0.0	1.0	4.91	7.85	0.5	3.69	0.0469	57.8	27.3	11.60	17.39	4.69	0.0469	57.8	3.00	0.69	50.0	76.4	134.1	134.1	0.0	11.8
Open Channel	From Hydro				Input	Input			Input	Input	Input			Input	Trial		Trial Calc														Hydro	Goal = 0	
	Reach No.	Upstream Sta. 100-ft Sta.	Dnstream Sta. 100-ft Sta.	Reach lf	Manning's n -----	Channel Slope ft/ft	Slope dh ft		Left Side Slope H:V	Bottom Width ft W	Right Side Slope H:V	Wetted Area sf	Wetted Perimeter lf	Sum of km ft/ft	Trial Dn vf	Trial EGL Slope ft/ft	Q at Trial HGL cfs	V at Trial Dn fps	hv at Trial Dn ft	hm at Trial Dn ft	hf at Trial Dn ft	EGL Slope ft/ft	Trial Calc Peak Q cfs								Calc Peak Q cfs	Delta Q cfs	Calc Peak V fps
	9	15 + 50	1 + 50	1,400	0.050	0.0050	7.00		6.0	16.0	6.0	83.97	48.09	0.0	2.64	0.0050	255.8	3.0	0.14	0.00	7.00	0.0050	255.8								255.8	0.0	3.0

TABLE 2

25-Year Peak Stormwater Runoff Hydraulics

Ash Pile Stormwater Run-On and Run-Off Control System Plan
San Miguel Electric Cooperative, Inc., Atascosa County, Texas

Culvert	From Hydro				Input	Input		Input	Input	Input	Input			Input	Trial		Trial Calc							Input					Hydro	Goal = 0	
	Reach	Upstream Sta.	Dnstream Sta.	Reach	Manning's n	Culvert Slope	Slope dh	Culvert Barrels	Culvert Diameter	Outlet Subm.	Outlet km	Wetted Area	Wetted Perimeter	Inlet km	Upstream Subm.	Trial EGL Slope	Q at Culv S	V at Peak Q	hv at Peak Q	hm at Peak Q	hf at Peak Q	Net EGL Peak Q	Culvert Peak Q	Overflow Subm.	Overflow Depth	Overflow Width	Overflow Peak Q	Total Trial Peak Q	Calc Peak Q	Delta Q	Calc Peak V
	No.	100-ft Sta.	100-ft Sta.	lf	-----	ft/ft	ft	ea	in. I.D.	vf	ft/ft	sf	lf	ft/ft	vf	ft/ft	cfs	fps	ft	ft	ft	ft/ft	cfs	vf	vf	ft W	cfs	cfs	cfs	cfs	fps
	10	1 + 50	1 + 0	50	0.013	0.0100	0.50	5	42	0.0	1.0	9.62	11.00	0.5	-0.34	0.0032	285.2	5.9	0.55	0.82	0.16	0.0032	285.2	4.00	0.00	50.0	0.0	285.2	285.2	0.0	5.9
Open Channel	From Hydro				Input	Input			Input	Input	Input			Input	Trial		Trial Calc												Hydro	Goal = 0	
	Reach	Upstream Sta.	Dnstream Sta.	Reach	Manning's n	Channel Slope	Slope dh		Left Side Slope	Bottom Width	Right Side Slope	Wetted Area	Wetted Perimeter	Sum of km	Trial Dn	Trial EGL Slope	Q at Trial HGL	V at Trial Dn	hv at Trial Dn	hm at Trial Dn	hf at Trial Dn	EGL Slope	Trial Calc Peak Q						Calc Peak Q	Delta Q	Calc Peak V
	No.	100-ft Sta.	100-ft Sta.	lf	-----	ft/ft	ft		H:V	ft W	H:V	sf	lf	ft/ft	vf	ft/ft	cfs	fps	ft	ft	ft	ft/ft	cfs						cfs	cfs	fps
	11	1 + 0	0 + 0	100	0.035	0.0050	0.50		3.0	20.0	3.0	63.78	35.27	0.0	2.36	0.0050	284.2	4.5	0.31	0.00	0.50	0.0050	284.2						284.2	0.0	4.5

ABBREVIATIONS AND ACRONYMS

Calc	calculated	Dnstream	downstream	H:V	horizontal-to-vertical ratio	in.	inches	Q	flow rate	vf	vertical feet
cfs	cubic feet per second	EGL	energy grade line	hf	friction head loss	km	sum of minor head loss coefficient	S	slope		
Culv	culvert	fps	feet per second	hm	minor head loss	lf	linear feet	sf	square feet		
dh	height difference	ft	feet	hv	velocity head	n	roughness coefficient	Sta.	station		
Dn	normal depth	ft W	feet width	I.D.	inside diameter	No.	number	Subm.	submergence		