REPORT

Run-on and Run-off Control System Plan
5 Year Update

San Miguel Electric Cooperative Power Plant

Ash Pile

Atascosa County, Texas

Submitted to:

San Miguel Electric Cooperative, Inc.

6200 FM 3387
Christine, TX 78012

Submitted by:

Golder Associates Inc.

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October 2021

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Golder Associates Inc. under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the Run-on and Run-off Control System Plan has been prepared in accordance with the requirements of Section 257.81 of the CCR Rule.

Patrick J. Behling, P.E.
Principal Engineer
Golder Associates Inc.
Firm Registration No. F-2578

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1.0 INTRODUCTION

San Miguel Electric Cooperative, Inc. (SMECI) owns and operates the San Miguel Power Plant (SMPP) located approximately 6 miles south of Christine, Texas in Atascosa County, Texas (Figure 1). The SMPP is a 440-megawatt, lignite-fired electric power plant that was placed into service in 1982. Coal Combustion Residuals (CCR) including fly ash, bottom ash and flue gas desulfurization (FGD) wastewater/solids are generated as part of SMPP operation. Fly ash and FGD solids are temporarily stored in the Ash Pile prior to transportation off-site for management in the adjacent SMECI Surface Lignite Mine. The Ash Pile is located adjacent to the SMPP generating unit (Figure 2).

The U.S. Environmental Protection Agency promulgated 40 C.F.R. Part 257, Subpart D (the CCR Rule) to establish technical requirements for new and existing CCR landfills and surface impoundments. The Ash Pile has been identified as an Existing CCR Landfill regulated under the CCR Rule.

Section 257.81(c) of the CCR Rule requires that a Run-On/Run-Off Control System Plan (RRCSP) be developed for all CCR Landfills. In accordance with Section 257.81(c)(3) of the CCR Rule, the initial RRCSP for the Ash Pile was completed and placed in the facility operating record in October 2016 (ERM, 2016). As specified in Section 257.81(c)(4), the RRCSP must be updated every five years from the completion date of the initial plan. Golder Associates Inc., member of WSP, was retained by SMECI to prepare this updated RRCSP for the Ash Pile.

1.1 CCR Landfill Run-on and Run-off Control System Plan Requirements

Section 257.81(c) of the CCR Rule specifies that a written run-on and run-off control system plan be prepared for each existing CCR landfill that describes the systems that have been designed and constructed to control run-on to and run-off from the landfill consistent with the requirements of the CCR Rule and recognized and generally accepted good engineering practices. The RRCSP must include, at a minimum, design, construction, operation, and maintenance information for the following:

- A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm; and
- A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm. Run-off from the active portion of the CCR unit must be managed in accordance with the requirements of 40 CFR 257.3–3 (prohibition against pollution of waters of the United States).

The RRCSP must be supported by appropriate engineering calculations and must be certified by a qualified professional engineer. The RRCSP must document how the run-on and run-off control system has been designed and constructed to comply with the requirements of Section 257.81 of the CCR Rule.

1.2 Description of Ash Pile

The CCR Rule defines CCR's such as fly ash, bottom ash, boiler slag, flue gas desulfurization (FGD) materials (gypsum), and related solids generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers. The Ash Pile is a temporary storage area used to stage a stabilized mixture of fly ash and FGD solids until the mixture can be transported off-site. The Ash Pile was designated as the "FGD Stacking Area" in the original plant construction documents (T&G, 1980). The Ash Pile covers an area of approximately one (1) acre.

The Ash Pile is a non-containerized accumulation of solid CCR that is placed on the land that began receiving CCR before October 19, 2015 and currently receives CCR. As a result, the Ash Pile meets the definition of an existing “CCR Pile” under Section 257.53. Under the CCR Rule, an existing CCR Pile is classified as an existing CCR landfill and must comply with the technical requirements for existing CCR Landfills, including preparation of an updated RRCSP.

1.3 SMPP TPDES Permit

The SMPP is authorized to discharge stormwater run-off from the Ash Pile, Lignite Storage Pile and adjacent areas under Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0002601000 which was issued on February 7, 2019 and expires on February 7, 2024. Stormwater run-off from these areas is collected and conveyed to the Lignite Yard Retention Pond (Retention Pond) located south of the Lignite Storage Pile (see Figure 2). The Retention Pond is designed to retain/evaporate most stormwater that drains to the Pond; however, in the event of elevated water levels in the Pond associated with a significant storm event, the TPDES Permit authorizes water from the Retention Pond to be discharged to a tributary of Souse Creek through Outfall 001. The volume of water discharged through Outfall 001 is described in the TPDES Permit as “intermittent and flow-variable” and the permit does not include a discharge flow limitation.

1.4 Previous RRCSP for Ash Pile

The Initial RRCSP for the Ash Pile was completed and placed in the facility operating record in October 2016 (ERM, 2016). A figure showing the drainage area upstream of the Retention Pond (including the Ash Pile) from the Initial RRCSP is reproduced in Appendix A.

Key Findings from the Initial RRCSP can be summarized as follows:

- The drainage area upstream of the Retention Pond covers approximately 68.5 acres and consists of the following surface areas that generate stormwater run-off:

  - Ash or Lignite: 16.5 acres
  - Unpaved Areas: 46.4 acres
  - Paved Areas: 5.6 acres

  For the purposes of the Initial RRCSP, the drainage area was further divided into the following drainage subareas (see Appendix A):

SubArea No.	Ash or Lignite Area (acres)	Unpaved Area (acres)	Paved Area (acres)
1	0.1	0.0	1.3
2	0.1	0.2	0.1
3	0.0	6.4	3.7
5	0.1	1.3	0.0
7	2.5	6.8	0.3
9	5.5	18.6	0.1
10	8.2	13.1	0.1

- Run-off from the drainage area is conveyed to the Retention Pond through a series of ditches and culverts. The Initial RRCSP estimated peak stormwater flows from the various drainage subareas resulting from a 24-hour, 25-year storm and compared the peak flows to the estimated capacities of the ditches and culverts. Peak stormwater flows were calculated using the Rational Method with the following assumed run-off coefficients:

- Ash or Lignite: 0.35 (for Ash Pile or Lignite Storage Pile areas)
- Light Industrial: 0.65 (for unpaved areas/roads and grass-covered areas)
- Pavement/Roof: 0.90 (for paved roads and roof area run-off).

Tables summarizing drainage area hydrologic data, ditch/culvert hydraulic data and calculation results from the Initial RRCSP are reproduced in Appendix B.

- Hydraulic and hydrologic analysis of the drainage areas around and upstream of the Ash Pile indicated that there was no stormwater run-on to the Ash Pile due to peak stormwater flow resulting from the 24-hour, 25-year storm. Consequently, the Ash Pile stormwater run-on controls were in compliance with the requirements of Section 257.81(a)(1) of the CCR Rule.

- Hydraulic and hydrologic analysis of the drainage areas, drainage channels, and culverts upstream and downstream of the Ash Pile showed that peak stormwater run-off from the Ash Pile resulting from the 24-hour, 25-year storm was adequately conveyed to the Retention Pond in accordance with the SMPP TPDES Permit. Consequently, the Ash Pile stormwater run-off controls were in compliance with the requirements of Section 257.81(a)(2) of the CCR Rule.

2.0 UPDATED RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

The Updated RRCSP for the Ash Pile is described in this section as required under Section 257.81(c) of the CCR Rule.

2.1 Design Storm Event

In accordance with Sections 257.81(a)(1) and 257.81(a)(2) of the CCR Rule, the run-on and run-off control systems for the Ash Pile must be designed to prevent run-on into the Ash Pile and control run-off from the Ash Pile during the peak discharge from a 25-year, 24-hour storm. The 25-year, 24-hour storm for the Ash Pile and vicinity was estimated to be 7.89 inches based on the Point Precipitation Frequency Estimate Table from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 for Jourdanton, TX (NOAA, 2021, see Appendix C).

2.2 Updated Stormwater Drainage Area - Ash Pile and Vicinity

As described in Section 1.4 of this Report, a detailed evaluation of the stormwater drainage area in the vicinity of the Ash Pile was performed as part of the Initial RRCSP. Based on updated information provided by SMPP personnel, the following minor drainage subarea modifications have been made since the Initial RRSCP was completed:

SubArea No.	Ash or Lignite Area (acres)	Unpaved Area (acres)	Paved Area (acres)
1	0.1 (unchanged)	0.0 (unchanged)	0.8 (reduced from 1.3)
9	5.5 (unchanged)	18.9 (increased from 18.6)	0.1 (unchanged)

Updated drainage area information for the Ash Pile and vicinity is presented on Figure 3. Based on the reported subarea modifications, the total drainage area upstream of the Retention Pond has been reduced slightly to approximately 68.3 acres (from 68.5 acres) and consists of the following surface areas that generate stormwater run-off:

- Ash or Lignite: 16.5 acres (unchanged)
- Unpaved Areas: 46.7 acres (increased from 46.4 acres)
- Paved Areas: 5.1 acres (reduced from 5.6 acres)

The minor modifications to the drainage subareas changed the drainage area data that served as the basis for the calculations in the Initial RRCSP as follows:

- Total Drainage Area Upstream of Retention Pond: Reduced by Approximately 0.3 Percent
- Unpaved Areas: Increased by Approximately 0.6 Percent
- Paved Areas: Reduced by Approximately 9.0 Percent

Based on Golder's review of the hydraulic and hydrologic calculations in the Initial RRCSP, we conclude that these minor modifications do not materially change the findings of the Initial RRCSP.

2.3 Run-on Control System

The Initial RRCSP concluded that there was no stormwater run-on to the Ash Pile due to peak stormwater flow resulting from the 25-year, 24-hour storm. Based on Golder's review of the Initial RRCSP, the Ash Pile stormwater run-on controls are in compliance with the requirements of Section 257.81(a)(1) of the CCR Rule.

2.4 Run-off Control System

The Initial RRCSP concluded that peak stormwater run-off from the Ash Pile resulting from the 25-year, 24-hour storm was adequately conveyed to the Retention Pond in accordance with the SMPP TPDES Permit. Based on Golder's review of the Initial RRCSP, this conclusion is representative of stormwater run-off conditions for the Ash Pile and vicinity.

In addition, Golder evaluated the potential effect of run-off from the Ash Pile and vicinity resulting from the 25-year, 24-hour storm on water levels in the Retention Pond. The evaluation was based on the following assumptions:

- The design operating level in the Retention Pond is managed to maintain a minimum 2-foot freeboard in the pond under normal operating conditions.
- The surface area of the Retention Pond that is available for water storage with a 2-foot freeboard is approximately 10 acres.
- The SMPP TPDES Permit authorizes water from the Retention Pond to be discharged through Outfall 001 in the event of elevated water levels in the Pond associated with a significant storm event.
- Evaporation from the Retention Pond is assumed to be negligible during the design storm event.

The water balance equation for the Retention Pond was assumed to be as follows:

$V_{RO} + V_P = SC + Discharge$, where:

V_{RO} = Estimated Run-off Volume

V_P = Estimated Direct Precipitation on Retention Pond

SC = Storage Capacity in Retention Pond Freeboard

Discharge = Discharge through Outfall 001 if Storage Capacity is Exceeded

Stormwater run-off volumes were calculated using the Rational Method:

$V_{RO} = CiA$, where:

V_{RO} = Estimated Run-off Volume (cf)

C = Rational Method Run-off Coefficient. Assumed Run-off Coefficients:

- Ash or Lignite: 0.35
- Unpaved Areas: 0.65
- Pavement/Roof: 0.90

i = Rainfall (ft). Assumed to be 7.98 inches (0.67 feet) for the 25-year, 24-hr design storm.

A = Stormwater Drainage Areas (sf). Assumed Drainage Areas:

- Ash or Lignite: 718,740 sf (16.5 acres)
- Unpaved Areas: 2,034,252 sf (46.7 acres)
- Paved Areas: 222,156 sf (5.1 acres)

The stormwater run-off volume from the Ash Pile and vicinity to the Retention Pond during the 25-year, 24-hr design storm (V_{RO}) is estimated to be:

V_{RO} = (0.67 ft) X ((718,740 sf X 0.35)+(2,034,252 sf X 0.65)+(222,156 sf X 0.90))

= (0.67 ft) X (251,559 sf + 1,322,264 sf + 199,940 sf)

= 1,188,421 cf

The volume of precipitation that falls directly on the Retention Pond during the 25-year, 24-hr design storm (V_P) is estimated to be:

V_P = 0.67 ft X 10 acres X 43,560 sf/acre

= 291,852 cf

The available storage capacity in the Retention Pond with 2-foot freeboard (SC) is estimated to be:

SC = 10 acres X 43,560 sf/acre X 2 feet

= 871,200 cf

From the water balance equation, the volume of stormwater run-off and direct precipitation during the 25-year, 24-hr design storm compares to freeboard storage capacity of the Retention Pond as follows:

Run-off and Direct Precipitation:	1,188,421 cf + 291,852 cf = 1,480,273 cf
Capacity of Retention Pond Freeboard:	871,200 cf

Since the volume of stormwater run-off and direct precipitation exceeds the freeboard storage capacity, a discharge from the Retention Pond through Outfall 001 as authorized under the SMPP TPDES Permit will occur during the 25-year, 24-hour storm.

Based on this evaluation, the Ash Pile stormwater run-off controls are in compliance with the requirements of Section 257.81(a)(2) of the CCR Rule.

2.5 Updates to Run-on and Run-off Control System Plan

In accordance with Section 257.81(c)(3) of the CCR Rule, this Updated RRCSP must be placed in the in the operating record for the SMPP no later than October 17, 2021. Subsequent RRCSPs must be completed every five years.

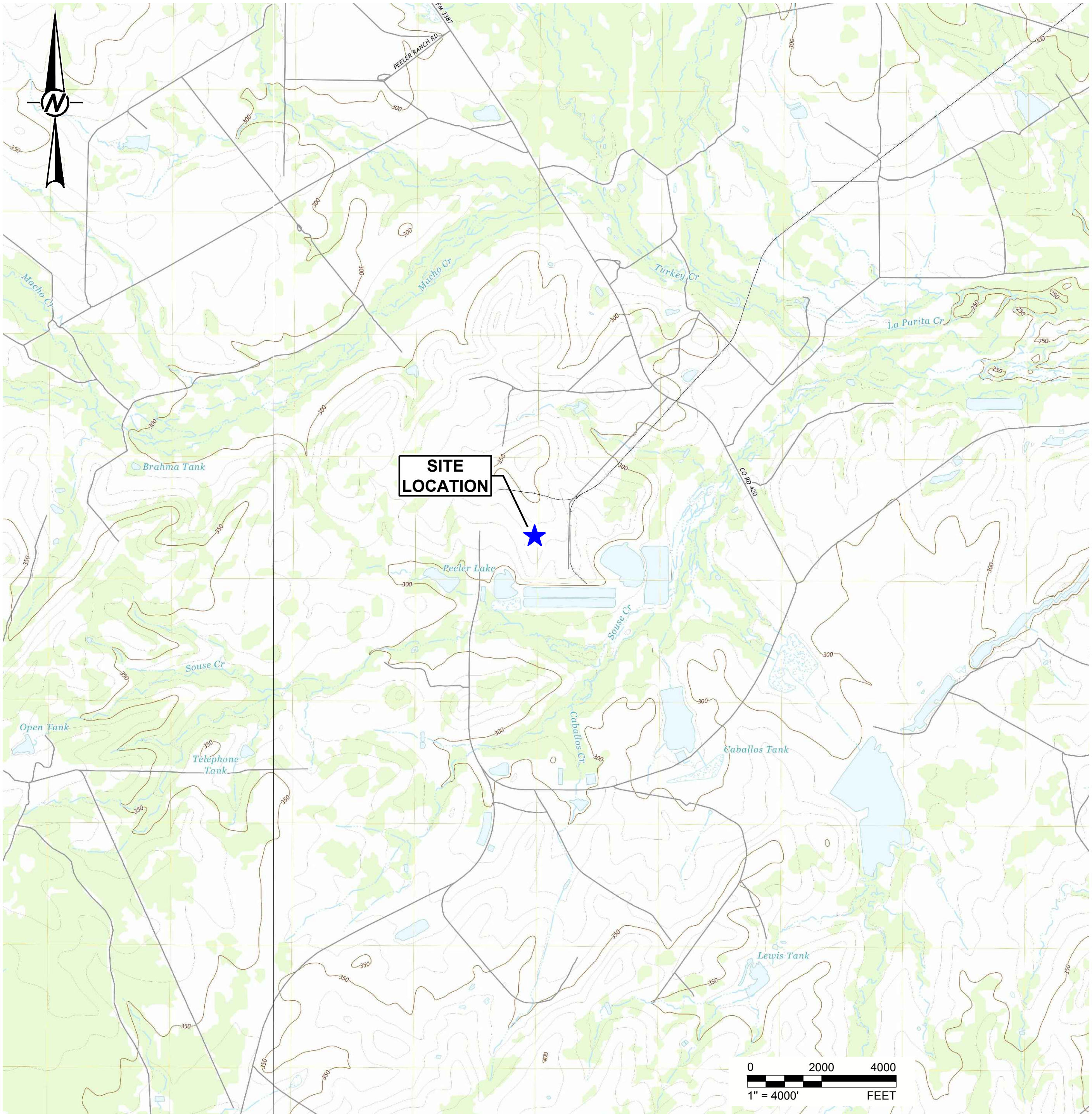
3.0 REFERENCES

Environmental Resources Management (ERM), 2016. Ash Pile Stormwater Run-On and Run-Off Control System Plan, San Miguel Electric Cooperative, Inc., Atascosa County, Texas, October 14.

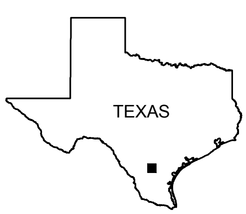
National Oceanic and Atmospheric Administration (NOAA), 2021. Atlas 14 – Point Precipitation Frequency Estimates Website, Jourdanton, Texas. September.

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

FIGURES



REFERENCE(S)
BASE MAP TAKEN FROM USGS.GOV, CROSS NE AND CABALLOS CREEK, TX 7.5 MIN. USGS QUADRANGLE DATED 2019.



QUADRANGLE LOCATIONS

CLIENT
SAN MIGUEL ELECTRIC COOPERATIVE, INC.

PROJECT
ASH PILE
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

TITLE
SITE LOCATION MAP

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-20
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO.	CONTROL	REV.	FIGURE
21455682		0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
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Path: \\golder.gds\complexdata\office\Texarkana\Projects - Round Rock_2021\21455682 - SMEC\PRODUCTION\A - 2021 Ash Pile Run-on Control Plan Update\ | File Name: 1-Site Location Map.dwg

LEGEND

APPROX. PLANT BOUNDARY

CCR UNIT

0 250 500

1" = 500' FEET

REFERENCE(S)

BASE MAP TAKEN FROM TNRIS.ORG, ATASCOSA CO., 2015 PHOTOGRAPHY.
MONITORING WELL LOCATIONS FROM FIGURE 1 - CCR UNIT GROUNDWATER MONITORING SYSTEM, ERM, 10/16/2017.

CLIENT
SAN MIGUEL ELECTRIC COOPERATIVE, INC.

PROJECT
ASH PILE
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

TITLE
SITE PLAN

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-20
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO.	CONTROL	REV.	FIGURE
21455682		0	2

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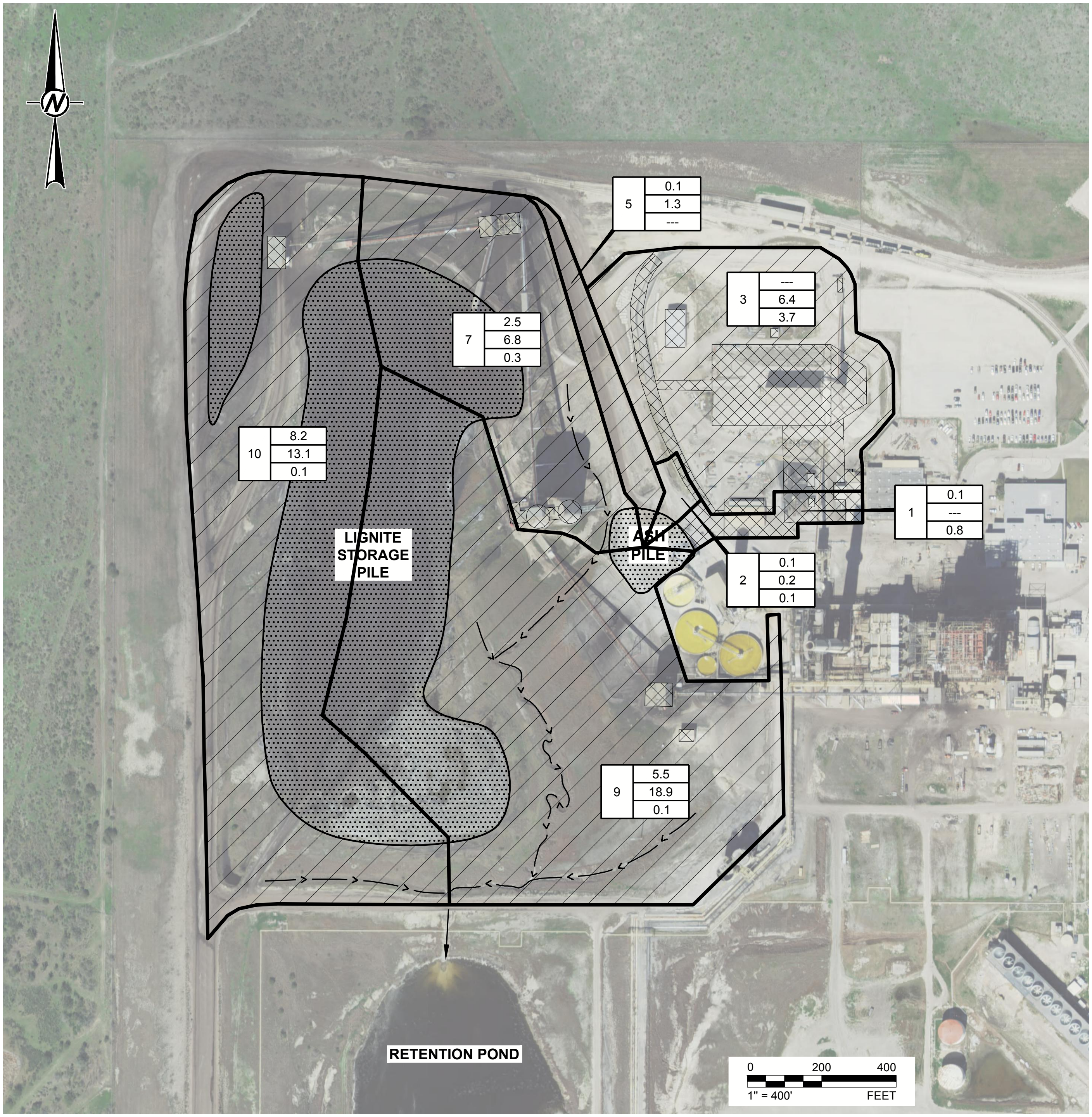

LEGEND

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)

REFERENCE(S)

BASE MAP TAKEN FROM TNRIS.ORG, ATASCOSA CO., 2015 PHOTOGRAPHY.

CLIENT
SAN MIGUEL ELECTRIC COOPERATIVE, INC.

PROJECT
ASH PILE
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

TITLE
UPDATED STORM DRAINAGE AREA MAP

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-20
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO.	CONTROL	REV.	FIGURE
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

0 1 in

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APPENDIX A

Drainage Area Map from 2016 Initial RRCSP

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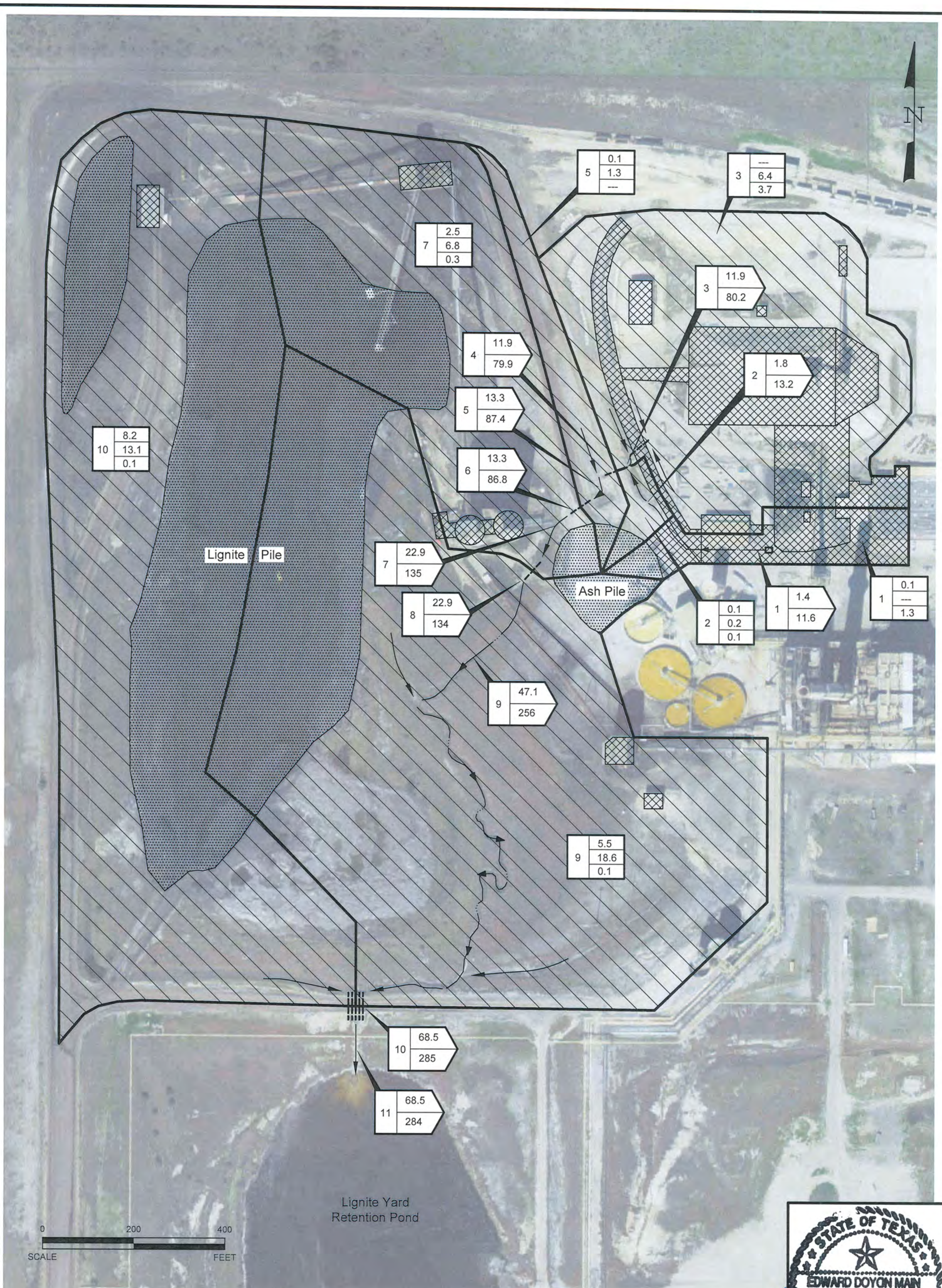

AERIAL SOURCE: ESRI.

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
10/14/2016

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

ERM

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

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

APPENDIX B

Hydrologic and Hydraulic Calculations from 2016 Initial RRCSP

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

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

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

	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
Open Channel	From Hydro				Input	Input		Input	Input	Input			Input	Trial		Trial Calc							Hydro	Goal = 0	
	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

	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
Open Channel	From Hydro				Input	Input		Input	Input	Input			Input	Trial		Trial Calc							Hydro	Goal = 0	
	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

	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
Open Channel	From Hydro				Input	Input		Input	Input	Input			Input	Trial		Trial Calc							Hydro	Goal = 0	
	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

	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 Slope 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
Culvert	From Hydro				Input	Input		Input	Input	Input	Input			Input	Trial		Trial Calc							Input					Hydro	Goal = 0	
	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

	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
Open Channel	From Hydro				Input	Input		Input	Input	Input			Input	Trial		Trial Calc							Hydro	Goal = 0	
	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

	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
Culvert	From Hydro				Input	Input		Input	Input	Input	Input			Input	Trial		Trial Calc							Input					Hydro	Goal = 0	
	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

	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
Open Channel	From Hydro				Input	Input		Input	Input	Input			Input	Trial		Trial Calc							Hydro	Goal = 0	
	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

	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
Culvert	From Hydro				Input	Input		Input	Input	Input	Input			Input	Trial		Trial Calc							Input					Hydro	Goal = 0	
	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

	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
Open Channel	From Hydro				Input	Input		Input	Input	Input			Input	Trial		Trial Calc							Hydro	Goal = 0	
	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	Reach No.	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
	From Hydro				Input	Input		Input	Input	Input	Input			Input	Trial		Trial Calc							Input					Hydro	Goal = 0	
	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	Reach No.	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
	From Hydro				Input	Input			Input	Input	Input			Input	Trial		Trial Calc												Hydro	Goal = 0	
	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
cfs cubic feet per second
Culv culvert
dh height difference
Dn normal depth
Dnstream downstream
EGL energy grade line
fps feet per second
ft feet
ft W feet width
H:V horizontal-to-vertical ratio
hf friction head loss
hm minor head loss
hv velocity head
I.D. inside diameter
in. inches
km sum of minor head loss coefficient
lf linear feet
n roughness coefficient
No. number
Q flow rate
S slope
sf square feet
Sta. station
Subm. submergence
vf vertical feet

APPENDIX C

NOAA Atlas 14 Precipitation Data – Jourdanton, Texas

NOAA Atlas 14, Volume 11, Version 2
Location name: Jourdanton, Texas, USA*
Latitude: 28.7042°, Longitude: -98.4766°
Elevation: 329.57 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.449** (0.340-0.593)	**0.526** (0.404-0.691)	**0.655** (0.499-0.861)	**0.759** (0.570-1.01)	**0.900** (0.655-1.24)	**1.01** (0.713-1.42)	**1.11** (0.765-1.60)	**1.21** (0.813-1.79)	**1.34** (0.868-2.05)	**1.43** (0.903-2.24)
10-min	**0.714** (0.540-0.943)	**0.838** (0.642-1.10)	**1.04** (0.796-1.37)	**1.21** (0.910-1.62)	**1.44** (1.05-1.98)	**1.61** (1.14-2.27)	**1.78** (1.23-2.57)	**1.93** (1.30-2.87)	**2.13** (1.38-3.26)	**2.27** (1.43-3.56)
15-min	**0.908** (0.688-1.20)	**1.06** (0.810-1.39)	**1.31** (0.996-1.72)	**1.51** (1.13-2.01)	**1.79** (1.30-2.46)	**2.00** (1.42-2.82)	**2.21** (1.53-3.20)	**2.41** (1.62-3.57)	**2.67** (1.73-4.09)	**2.85** (1.81-4.48)
30-min	**1.29** (0.974-1.70)	**1.49** (1.15-1.96)	**1.84** (1.40-2.42)	**2.12** (1.59-2.83)	**2.50** (1.82-3.43)	**2.79** (1.97-3.93)	**3.07** (2.12-4.43)	**3.35** (2.25-4.97)	**3.72** (2.41-5.69)	**3.99** (2.52-6.26)
60-min	**1.66** (1.26-2.19)	**1.94** (1.49-2.55)	**2.42** (1.85-3.18)	**2.80** (2.11-3.74)	**3.33** (2.41-4.55)	**3.71** (2.63-5.22)	**4.10** (2.83-5.92)	**4.50** (3.03-6.67)	**5.04** (3.28-7.73)	**5.45** (3.45-8.57)
2-hr	**1.97** (1.50-2.58)	**2.37** (1.82-3.07)	**3.02** (2.32-3.94)	**3.57** (2.70-4.72)	**4.32** (3.16-5.87)	**4.90** (3.48-6.83)	**5.50** (3.81-7.87)	**6.15** (4.15-9.02)	**7.06** (4.60-10.7)	**7.78** (4.94-12.1)
3-hr	**2.13** (1.63-2.78)	**2.61** (2.01-3.36)	**3.39** (2.61-4.39)	**4.05** (3.07-5.33)	**4.97** (3.64-6.72)	**5.69** (4.06-7.89)	**6.45** (4.49-9.18)	**7.30** (4.94-10.6)	**8.50** (5.56-12.8)	**9.49** (6.04-14.6)
6-hr	**2.40** (1.85-3.12)	**3.02** (2.33-3.83)	**3.98** (3.08-5.12)	**4.82** (3.68-6.30)	**6.03** (4.45-8.09)	**7.01** (5.03-9.63)	**8.06** (5.63-11.3)	**9.25** (6.29-13.3)	**11.0** (7.21-16.3)	**12.4** (7.93-18.9)
12-hr	**2.69** (2.08-3.46)	**3.41** (2.62-4.25)	**4.50** (3.50-5.74)	**5.49** (4.22-7.12)	**6.95** (5.17-9.26)	**8.16** (5.90-11.1)	**9.51** (6.68-13.2)	**11.0** (7.53-15.7)	**13.3** (8.75-19.5)	**15.2** (9.73-22.8)
24-hr	**2.99** (2.33-3.82)	**3.82** (2.94-4.69)	**5.04** (3.94-6.37)	**6.18** (4.78-7.95)	**7.89** (5.91-10.4)	**9.34** (6.80-12.7)	**11.0** (7.75-15.1)	**12.8** (8.79-18.0)	**15.6** (10.3-22.6)	**17.8** (11.5-26.4)
2-day	**3.32** (2.61-4.21)	**4.29** (3.31-5.21)	**5.69** (4.47-7.13)	**7.01** (5.46-8.96)	**9.02** (6.82-11.9)	**10.8** (7.89-14.5)	**12.7** (9.01-17.3)	**14.8** (10.2-20.6)	**17.8** (11.8-25.5)	**20.3** (13.1-29.6)
3-day	**3.56** (2.81-4.50)	**4.61** (3.57-5.58)	**6.12** (4.83-7.64)	**7.54** (5.89-9.58)	**9.68** (7.35-12.7)	**11.5** (8.49-15.4)	**13.6** (9.66-18.4)	**15.8** (10.9-21.8)	**18.9** (12.6-26.8)	**21.5** (13.9-31.1)
4-day	**3.77** (2.99-4.75)	**4.85** (3.78-5.88)	**6.42** (5.09-8.00)	**7.89** (6.18-9.99)	**10.1** (7.66-13.1)	**12.0** (8.81-15.9)	**14.0** (10.00-18.9)	**16.3** (11.2-22.3)	**19.5** (13.0-27.5)	**22.0** (14.3-31.7)
7-day	**4.28** (3.40-5.36)	**5.39** (4.26-6.55)	**7.06** (5.63-8.75)	**8.57** (6.75-10.8)	**10.8** (8.23-13.9)	**12.7** (9.36-16.7)	**14.7** (10.5-19.7)	**17.0** (11.8-23.1)	**20.3** (13.6-28.3)	**23.0** (14.9-32.7)
10-day	**4.70** (3.75-5.86)	**5.84** (4.64-7.10)	**7.58** (6.07-9.38)	**9.14** (7.22-11.5)	**11.4** (8.70-14.6)	**13.3** (9.82-17.3)	**15.3** (11.0-20.4)	**17.6** (12.3-23.8)	**20.9** (14.0-29.1)	**23.7** (15.4-33.4)
20-day	**5.91** (4.75-7.31)	**7.17** (5.80-8.76)	**9.19** (7.43-11.3)	**10.9** (8.67-13.6)	**13.3** (10.2-16.9)	**15.2** (11.3-19.6)	**17.2** (12.4-22.6)	**19.5** (13.6-26.1)	**22.8** (15.3-31.2)	**25.4** (16.6-35.5)
30-day	**6.90** (5.57-8.50)	**8.28** (6.76-10.1)	**10.5** (8.56-12.9)	**12.4** (9.90-15.4)	**15.0** (11.5-18.8)	**16.9** (12.6-21.7)	**18.9** (13.7-24.8)	**21.2** (14.9-28.2)	**24.4** (16.5-33.2)	**27.0** (17.7-37.4)
45-day	**8.27** (6.71-10.2)	**9.86** (8.10-12.1)	**12.5** (10.2-15.3)	**14.6** (11.7-18.0)	**17.6** (13.5-22.0)	**19.7** (14.7-25.2)	**22.0** (15.9-28.5)	**24.4** (17.2-32.2)	**27.6** (18.7-37.3)	**30.2** (19.9-41.4)
60-day	**9.49** (7.72-11.6)	**11.3** (9.30-13.8)	**14.2** (11.7-17.4)	**16.7** (13.4-20.5)	**20.0** (15.4-24.9)	**22.4** (16.8-28.5)	**24.9** (18.1-32.2)	**27.4** (19.4-36.0)	**30.8** (20.9-41.4)	**33.5** (22.0-45.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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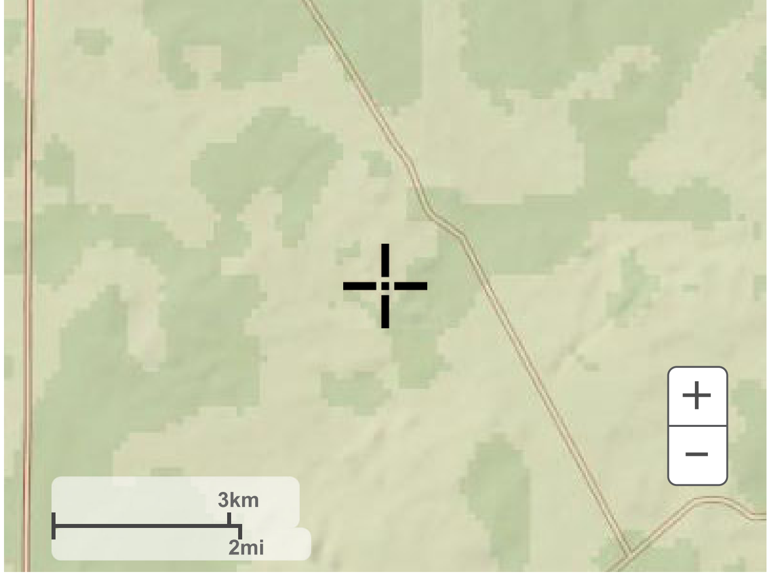
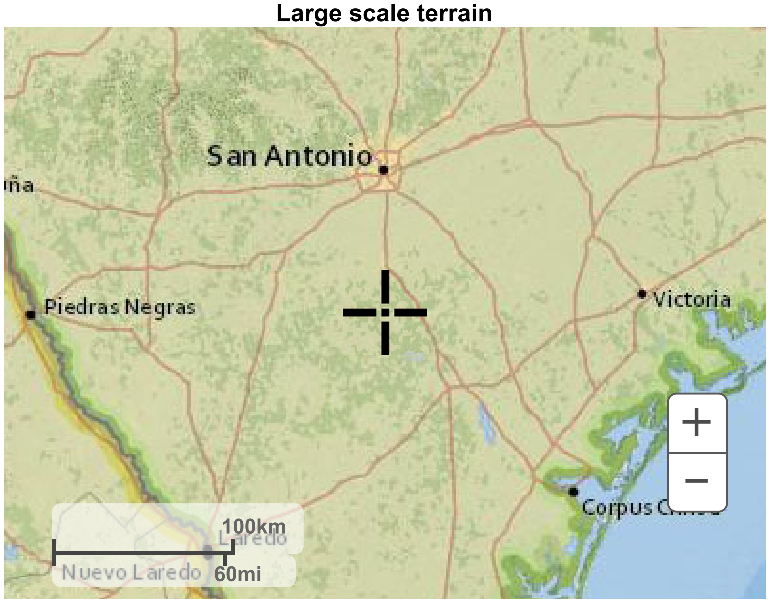
PF graphical



Large scale terrain



Large scale map

Large scale aerial

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