REPORT

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

Sandow Unit No. 5
AX Landfill
Rockdale, Texas

Submitted to:

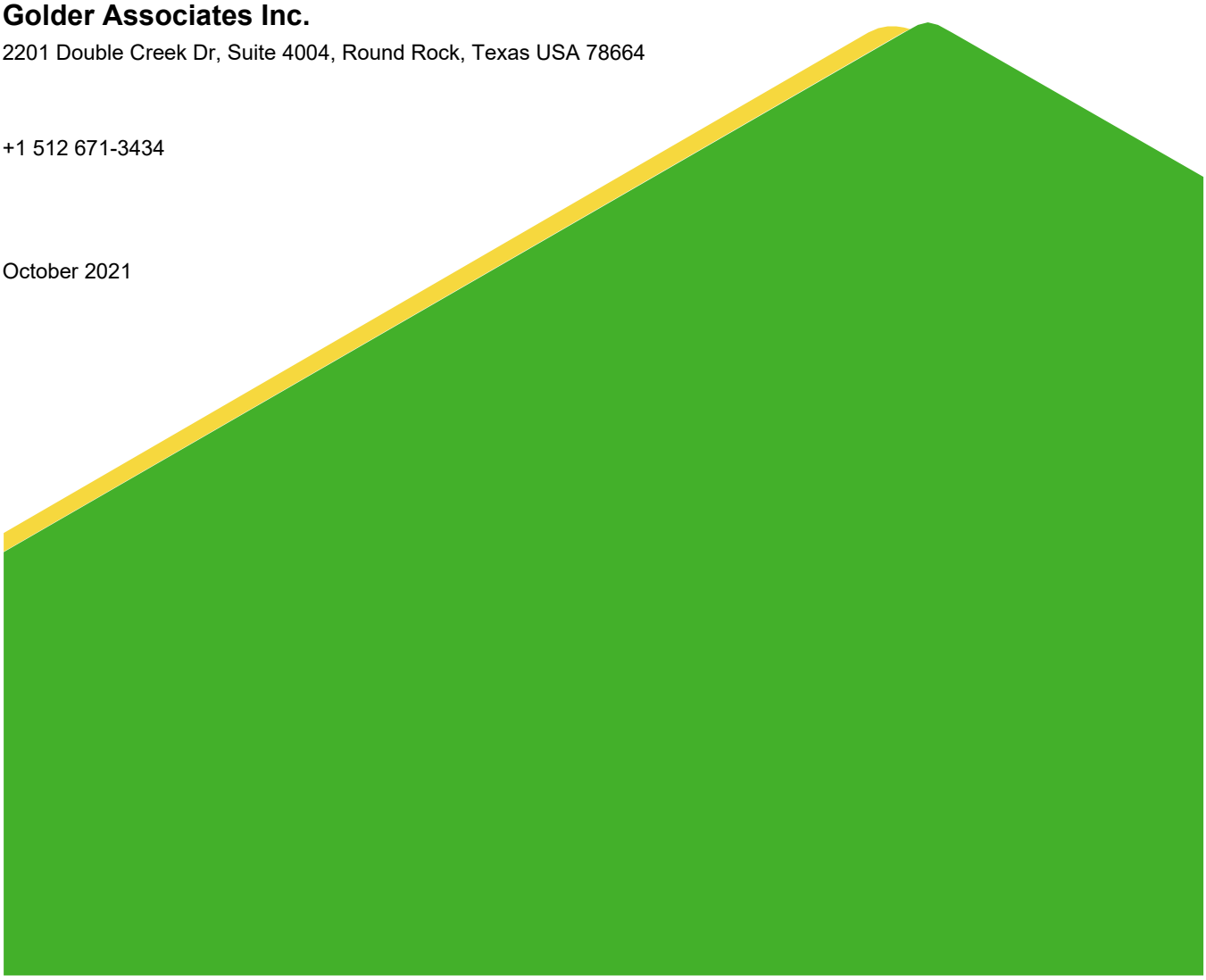
Luminant Generation Company, LLC
6555 Sierra Drive
Irving, TX 75039

Submitted by:

Golder Associates Inc.
2201 Double Creek Dr, Suite 4004, Round Rock, Texas USA 78664

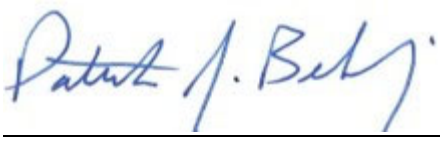
+1 512 671-3434

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 40 C.F.R. § 257.81 and 30 T.A.C. § 352.811.



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

Table of Contents

1.0 INTRODUCTION 1

1.1 CCR Landfill Run-on and Run-off Control System Plan Requirements 1

1.2 Description of AX Landfill 1

1.3 Previous RRCSP for AX Landfill 2

2.0 UPDATED RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN 3

2.1 Design Storm Event 3

2.2 Run-on Control System 3

2.2.1 Design and Construction 3

2.2.2 Operation and Maintenance 3

2.3 Run-off Control System 4

2.3.1 Design and Construction 4

2.3.2 Operation and Maintenance 6

2.4 Updates to Run-on and Run-off Control System Plan 6

3.0 REFERENCES 7

FIGURES

Figure 1 - Site Location Map
Figure 2 - Site Vicinity Map
Figure 3 - AX Landfill Site Plan
Figure 4 - Run-on Diversion Plan
Figure 5 - Run-off Control Plan

APPENDICES

APPENDIX A
NOAA Atlas 14 Precipitation Data – Rockdale, Texas

APPENDIX B
Cells 1, 2 and 2A Surface Areas

APPENDIX C
Run-off Containment Capacities

APPENDIX D
Run-off Volume Calculations

1.0 INTRODUCTION

Luminant Generation Company LLC (Luminant) formerly operated the Sandow 5 Generating Plant (Sandow 5) located approximately 7 miles southwest of Rockdale in Milam County, Texas (Figure 1). Sandow 5 was an approximately 581-megawatt, lignite-fired electric generation unit that was placed into service in 2009 and retired in early 2018. Coal Combustion Residuals (CCR) including fly ash and bed ash were generated as part of Sandow 5 operation and placed in the AX Landfill (AX LF) located approximately 7,500 feet south of Sandow 5 (Figure 2).

The U.S. Environmental Protection Agency promulgated 40 C.F.R. Part 257, Subpart D (the CCR Rule) and the Texas Commission on Environmental Quality (TCEQ) promulgated 30 T.A.C. Chapter 352 (which largely adopts the federal CCR Rule by reference) to establish technical requirements for new and existing CCR landfills and surface impoundments. On June 28, 2021, USEPA approved the majority of TCEQ's CCR program, which will now operate in lieu of the federal regulations. The AX LF at Sandow 5 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 and 30 T.A.C. 352.811 adopts this requirement by reference. In accordance with § 257.81(c)(3) of the CCR Rule, the initial RRCSP for the AX LF was completed and placed in the facility operating record in October 2016 (PBW, 2016). As specified in §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 Luminant to prepare this updated RRCSP for the AX LF.

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 § 257.81.

1.2 Description of AX Landfill

The AX LF consists of Cells 1, 2 and 2A and covers an area of approximately 150 acres. An existing site plan for the AX LF is shown on Figure 3. Cell 1 was constructed in 2013 and Cell 2 was constructed in 2015. A third landfill cell (Cell 2A) was constructed in 2016; however, Cell 2A never received any CCR or other non-hazardous waste.

The AX LF is constructed partially above and partially below grade and is surrounded by engineered earthen dikes that extend approximately 10 to 15 feet above surrounding grade. A geosynthetic liner system consisting of a 30-mil thick Geomembrane Supported Geosynthetic Clay Liner (GSGCL) underlain by 2 feet of soil exhibiting a minimum hydraulic conductivity of 5 X 10^{-5} cm/sec has been installed in the AX LF. The liner system is installed across the bottom of each cell, extends across the interior dikes, and extends up the inside sides of the perimeter dikes. The liner system is covered with an approximately 18-inch layer of protective soil to prevent damage to the liner during landfill operations. The base of the landfill is sloped toward a collection area for runoff from active landfill areas at the downgradient edge of the cell.

CCR has been placed within the perimeter dikes that surround Cells 1 and 2. CCR is placed no more than approximately 2 feet below the top of the dikes and the material is sloped upward toward the center of the landfill. Closure of the AX LF has not been initiated and Cells 1 and 2 are active. Cell 2A is also active; however, Cell 2A has never received any CCR or other non-hazardous waste.

1.3 Previous RRCSP for AX Landfill

The Initial RRCSP for the AX LF was completed and placed in the Sandow 5 operating record in October 2016 (PBW, 2016). Key Findings from the Initial RRCSP can be summarized as follows:

- In accordance with § 257.81(a)(1), AX LF Cells 1, 2 and 2A were designed and constructed to prevent entry of storm water runoff (exclusive of direct rainfall from above) generated from a 25-year, 24-hour storm from areas outside the landfill. The landfill is surrounded by exterior earthen dikes that extend 10 to 15 feet or more above the surrounding grade. Storm water runoff generated from areas outside the landfill is diverted away from the landfill by the dikes and associated drainage ditches, swales and other surface features.

- In accordance with § 257.81(a)(2), AX LF Cells 1, 2 and 2A have been designed and constructed to contain the estimated volume of run-off from active landfill areas generated from a 25-year, 24-hour storm. Run-off estimates were evaluated for multiple possible landfill operating scenarios involving active and capped cells. The landfill is surrounded by earthen dikes that extend 10 to 15 feet or more above the surrounding grade, so precipitation that falls within the active areas of the landfill is contained and managed. The base of each landfill cell is sloped toward a collection area at the downgradient edge of the cell to assist in handling of rainfall accumulation. Run-off from active landfill areas that accumulates in the collection area is applied to the active landfill areas to control dust and/or is allowed to evaporate.

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

The Updated RRCSP for the AX LF is described in this section. In accordance with § 257.81(c), the RRCSP addresses run-on and run-off control for the active portions of the landfill (Cells 1, 2 and 2A). Run-on and runoff control systems for closed sections of the AX LF are described in the Closure Plan for the landfill.

2.1 Design Storm Event

In accordance with §§ 257.81(a)(1) and 257.81(a)(2), the run-on and run-off control systems for the AX LF must be designed to prevent run-on into the landfill and control run-off from the landfill during the peak discharge from a 25-year, 24-hour storm. The 25-year, 24-hour storm for the AX LF was estimated to be 8.19 inches based on the Point Precipitation Frequency Estimate Table from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 for Rockdale, TX (NOAA, 2021, see Appendix A).

2.2 Run-on Control System

The CCR Rule defines run-on as “any rainwater, leachate, or other liquid that drains overland onto any part of a CCR landfill or lateral expansion of a CCR landfill.” The run-on control system for AX LF Cells 1, 2 and 2A is described below.

2.2.1 Design and Construction

AX LF Cells 1, 2 and 2A have been designed and constructed to eliminate entry of any storm water runoff (exclusive of direct rainfall from above) from areas outside the landfill. The landfill is surrounded by exterior earthen dikes that extend 10 to 15 feet or more above the surrounding grade. As shown on Figure 4, storm water runoff generated from areas outside the landfill is diverted away from the landfill by the dikes and associated drainage ditches, swales and other surface features. In accordance with § 257.81(a)(1), the height of the exterior landfill dikes relative to the surrounding topography indicate that run-on from a 25-year 24-hour storm will be diverted around the landfill and not flow onto any part of the landfill actively receiving CCR.

2.2.2 Operation and Maintenance

Storm water drainage features along the exterior of AX LF Cells 1, 2 and 2A will be operated and maintained to ensure that proper storm water run-on control is maintained throughout the life of the landfill. Storm water run-on operation and maintenance activities implemented at the landfill include:

- The landfill is inspected on a weekly basis by a qualified person in accordance § 257.83(a) and annual by a professional engineer in accordance with § 257.83 (b). The weekly and annual inspections address the exterior dikes around the landfill and storm water run-on control features along the dikes and include:
    - Verification that storm water generated from areas outside the CCR placement areas is diverted around the landfill by the dikes and associated drainage ditches, swales and other drainage features.
    - Verification that the drainage ditches, swales and other drainage features do not contain significant accumulated sediments or other flow obstructions;
    - Identification of areas of dike or drainage feature erosion/scouring that require repair.
- Accumulated sediment/debris are removed, as required, from the drainage features to maintain adequate storm water drainage. Areas of erosion/scour are repaired through backfilling, grading/reshaping, seeding and related activities. Drainage features may be redesigned/reconfigured if erosion/scouring are observed repeatedly in certain areas.

- Inspection and maintenance activities are documented in inspection and maintenance records.

2.3 Run-off Control System

The CCR Rule defines run-off as “any rainwater, leachate, or other liquid that drains overland from any part of a CCR landfill or lateral expansion of a CCR landfill.” For the purposes of this RRCSP, the term “run-off” has been further classified into run-off from active landfill areas and run-off from capped landfill areas. The run-off control system for AX LF Cells 1, 2 and 2A is described below.

2.3.1 Design and Construction

AX LF Cells 1, 2 and 2A have been designed and constructed to contain precipitation that falls directly on the active portions of Cells 1, 2 and 2A. The landfill is surrounded by earthen dikes that extend 10 to 15 feet or more above the surrounding grade, so precipitation that falls within the active areas of the landfill is contained and managed as run-off from active areas. The base of each landfill cell is sloped toward a collection area at the downgradient edge of the cell to assist in handling of rainfall accumulation. The collection area for run-off from active areas in each cell will be the last section of the cell that receives CCR so that the collection area is available for containment of run-off from active areas during cell operations. Run-off from active landfill areas that accumulates in the collection area is applied to the active landfill areas to control dust and/or is allowed to evaporate. Run-off from active landfill areas will not be discharged from the landfill unless authorized by appropriate regulatory agencies.

Luminant continues to actively place CCR and/or non-CCR material in the AX LF. Cells 1, 2 and 2A may be closed/covered once the cells have been filled with CCR and/or non-CCR to the design capacities/elevations or sooner once the need no longer exists. While a landfill cell is active, all run-off from active landfill areas will be contained and managed. Once a cell or portion of a cell has been closed/capped (either with a permanent cap or with a temporary soil cover), precipitation that falls on the closed/capped area will be considered runoff from capped landfill areas and will be diverted away from the active areas of the landfill. Runoff from capped landfill areas will flow off of the closed/capped portions of the landfill and be diverted away from the landfill by the drainage ditches, swales and other surface features along the perimeter of the landfill.

Run-off estimates were evaluated for multiple possible landfill operating scenarios involving active and capped cells in the Initial RRCSP (PBW, 2016). To date, CCR has been placed within Cells 1 and 2 and Cell 2A has never received any CCR or other non-hazardous waste (see Figure 3). Run-off from the current configuration of the AX LF will be evaluated in this Updated RRCSP (see Figure 5 for the Run-off Control Plan for the AX LF under current conditions). Run-off from CCR in Cells 1 and 2 will be contained in the Cell 1 and 2 Run-off Collection Area, supplemented by Cell 2A as necessary.

Run-off Volume Calculation Procedures

In accordance with § 257.81(a)(2), Cells 1, 2 and 2A have been designed and constructed to contain the estimated volume of run-off from active landfill areas generated from a 25-year, 24-hour storm.

Run-off volumes were estimated using the Curve Number (CN) method as described in the USDA publication TR-55 - Urban Hydrology for Small Water Sheds (USDA-NRCS, 1986). A key component of the TR-55 procedure is identifying the appropriate CN used in the evaluations. Published CNs vary depending on material type, degree of saturation and other variables, ranging from 98 for impervious surfaces (concrete/asphalt pavement, etc.) to 50 or less for vegetated, well drained soils (USDA-NRCS, 1986). As described in the Initial RRCSP, a CN of 94 was

assumed for estimating run-off volumes generated from exposed fly ash/bed ash (PBW, 2016). A CN of 100 was assumed for direct precipitation on contact water collection areas in the landfill cells.

The surface areas of Cells 1, 2 and 2A used to calculate run-off volumes were determined using AutoCAD Civil 3D. Outputs from the Civil 3D models showing the surface area of each cell are reproduced in Appendix B. The calculated surface areas of the landfill areas under current conditions were as follows:

- Cells 1 and 2: 2,670,372 square feet (sf) or approximately 61.3 acres
- Cell 1 and 2 Run-off Collection Area: 133,526 sf or approximately 3.1 acres
- Cell 2A: 3,727,320 sf or approximately 85.6 acres

Run-off Containment Capacities

Run-off from CCR in Cells 1 and 2 will be contained in the Cell 1 and 2 Run-off Collection Area, supplemented by Cell 2A as necessary. The following run-off containment capacities for the Cell 1 and 2 Run-off Collection Area and for Cell 2A were calculated using AutoCAD Civil 3D (see Appendix C):

- Cell 1 and 2 Run-off Collection Area. The minimum elevation of the top of the interior dike between Cell 2 and Cell 2A is El. 475 (It should be noted that the minimum elevation of the exterior dikes of Cells 2 and 2A is El. 479.9 or approximately 5 feet higher than the interior dike between the two cells). The volume of run-off that can be contained in the Cell 1 and 2 Run-off Collection Area without overtopping the interior dike between Cells 2 and 2A is approximately 1,151,783 cubic feet (42,658.6 cubic yards).

- Cell 2A and Cell 1 and 2 Run-off Collection Area. In the event the volume of runoff from Cells 1 and 2 exceeds the capacity of the Cell 1 and 2 Run-off Collection Area, the interior dike between Cells 2 and 2A will be overtopped and Cell 2A will provide additional contact water storage. The minimum elevation of the top of the exterior dikes for Cell 2 and Cell 2A is El. 479.9 and a minimum of 2 feet of freeboard will be maintained in the cells while storing contact water. Therefore, the maximum volume of run-off that can be contained in Cell 2A (combined with the Cell 1 and 2 Run-off Collection Area) was modelled using a maximum water surface elevation of El. 477.9 (2 feet of freeboard). The volume of run-off that can be contained in Cell 2A combined with the Cell 1 and 2 Run-off Collection Area at El. 477.9 is approximately 23,117,630 cubic feet (856,208.5 cubic yards).

Run-off Evaluation

Run-off volume estimates for the current configuration of the AX LF are shown in Appendix D. The estimated volume of run-off was compared to the run-off containment capacities to confirm that adequate run-off containment is provided for the 25-year, 24-hour storm (8.19 inches). When multiple cells/run-off collection areas are used to provide run-off containment, precipitation on the collection area/cell from a 25-year, 24-hour storm is added to the run-off volume from the active cell(s), since precipitation on the collection area/ cell itself must also be contained.

The results of the run-off evaluation can be summarized as follows:

- Cell 1 and 2 Run-off Collection Area Only. This evaluation scenario assumes run-off from Cells 1 and 2 is contained within the Cell 1 and 2 Run-off Collection Area Only. The volume of run-off and direct precipitation under this scenario is estimated to be approximately 1,753,621 cubic feet. The volume of run-off that can be contained in the Cell 1 and 2 Run-off Collection Area without overtopping the interior dike between Cells 2 and 2A is approximately 1,151,783 cubic feet. Since the volume of run-off is greater than the containment capacity, the interior dike between Cells 2 and 2A will be overtopped and contact water will flow into Cell 2A. The Cell 1 and 2 Run-off Collection Area alone cannot contain the run-off from

a 25-yr, 24-hr storm from Cells 1 and 2.

- Cell 2A and Cell 1 and 2 Run-off Collection Area. This evaluation scenario assumes run-off from Cells 1 and 2 is contained within the Cell 1 and 2 Run-off Collection Area and Cell 2A. The volume of run-off and direct precipitation under this scenario is estimated to be approximately 4,297,407 cubic feet. The volume of run-off that can be contained in Cell 2A combined with the Cell 1 and 2 Run-off Collection Area while maintaining 2 feet of freeboard below the top of the exterior dikes is approximately 23,117,630 cubic feet. Since the volume of run-off is less than the containment capacity, Cell 2A combined with the Cell 1 and 2 Run-off Collection Area is adequate to contain the run-off from a 25-yr, 24-hr storm from Cells 1 and 2.

2.3.2 Operation and Maintenance

The run-off containment features of AX LF Cells 1, 2 and 2A will be operated and maintained to ensure that proper run-off control is maintained throughout the life of the landfill. Run-off control operation and maintenance activities implemented at the landfill include:

- Run-off from active landfill areas is stored in the landfill cells for the shortest time practicable. Run-off accumulated in the collection area is applied to active areas of the landfill to control dust and/or is allowed to evaporate. Run-off from active landfill areas will not be discharged from the landfill unless authorized by appropriate regulatory agencies.

- The landfill is inspected on a weekly basis by a qualified person in accordance § 257.83(a) and annually by a professional engineer in accordance with § 257.83 (b). The weekly and annual inspections address the interior and exterior dikes at the landfill and include:

  - Verification that run-off from active areas is being contained in the landfill cells and a minimum of 2 feet of freeboard is maintained along the exterior dikes in areas where run-off is temporarily stored.

  - Inspection and maintenance activities are documented in inspection and maintenance records.

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

In accordance with § 257.81(c)(3), this Updated RRCSP must be placed in the Sandow 5 operating record no later than October 12, 2021. Subsequent RRCSPs must be completed every five years.

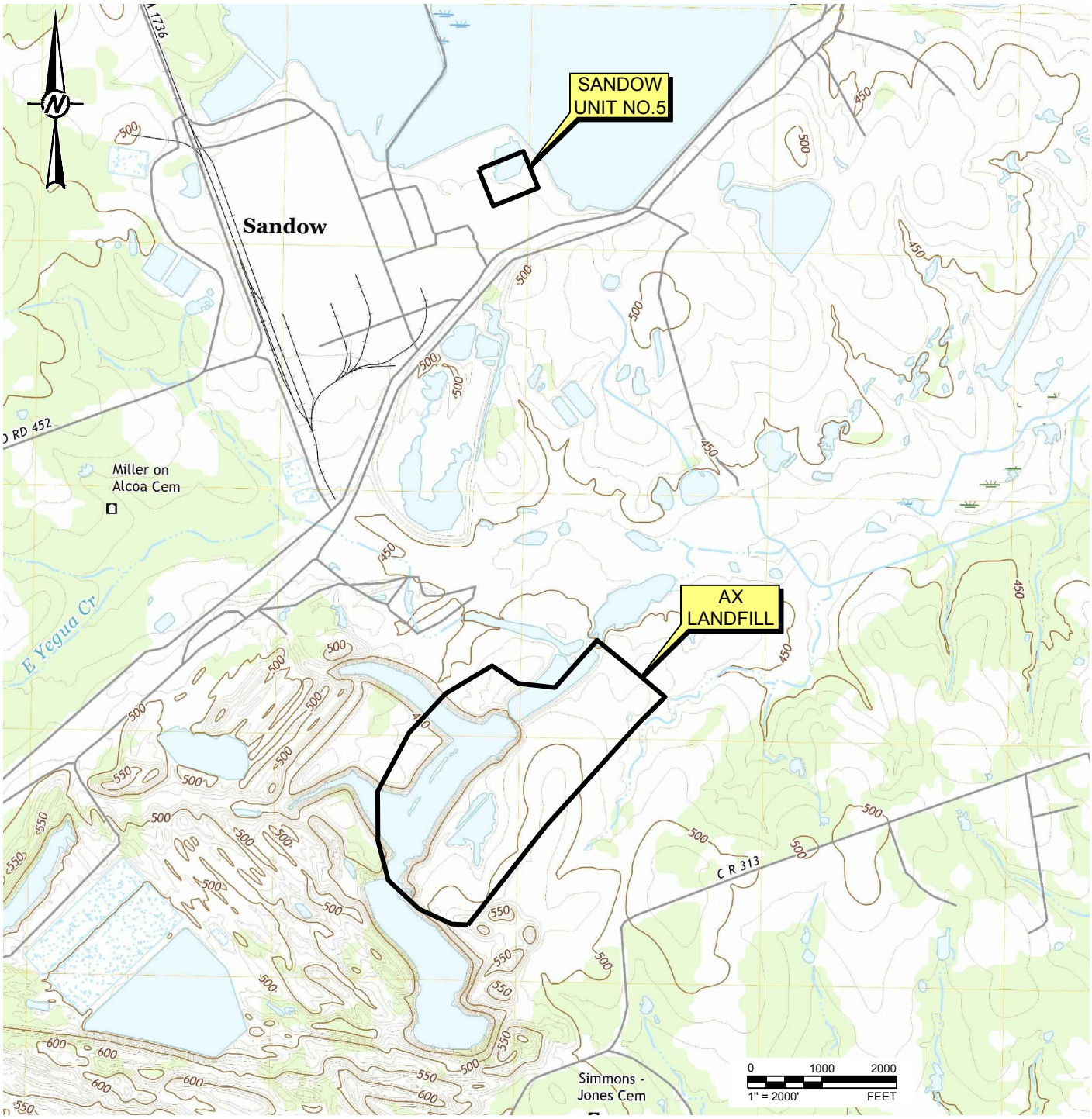
3.0 REFERENCES

Pastor, Behling & Wheeler, LLC (PBW), 2016. Run-on and Run-off Control System Plan – AX Landfill Cells 1, 2 and 2A, Sandow 5 Generating Plant, October.

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

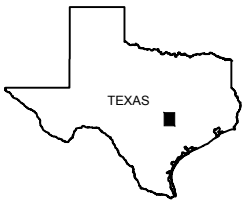
United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS), 1986. Urban Hydrology for Small Watersheds - TR-55, June.

FIGURES



REFERENCE(S)

BASE MAP FROM USGS.GOV, ALCOA LAKE, TX 7.5 MIN. USGS QUADRANGLE DATED 2019.



QUADRANGLE LOCATION

CLIENT

LUMINANT GENERATION COMPANY, LLC

PROJECT

SANDOW UNIT NO. 5
AX LANDFILL
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

TITLE

AX LANDFILL LOCATION MAP

CONSULTANT

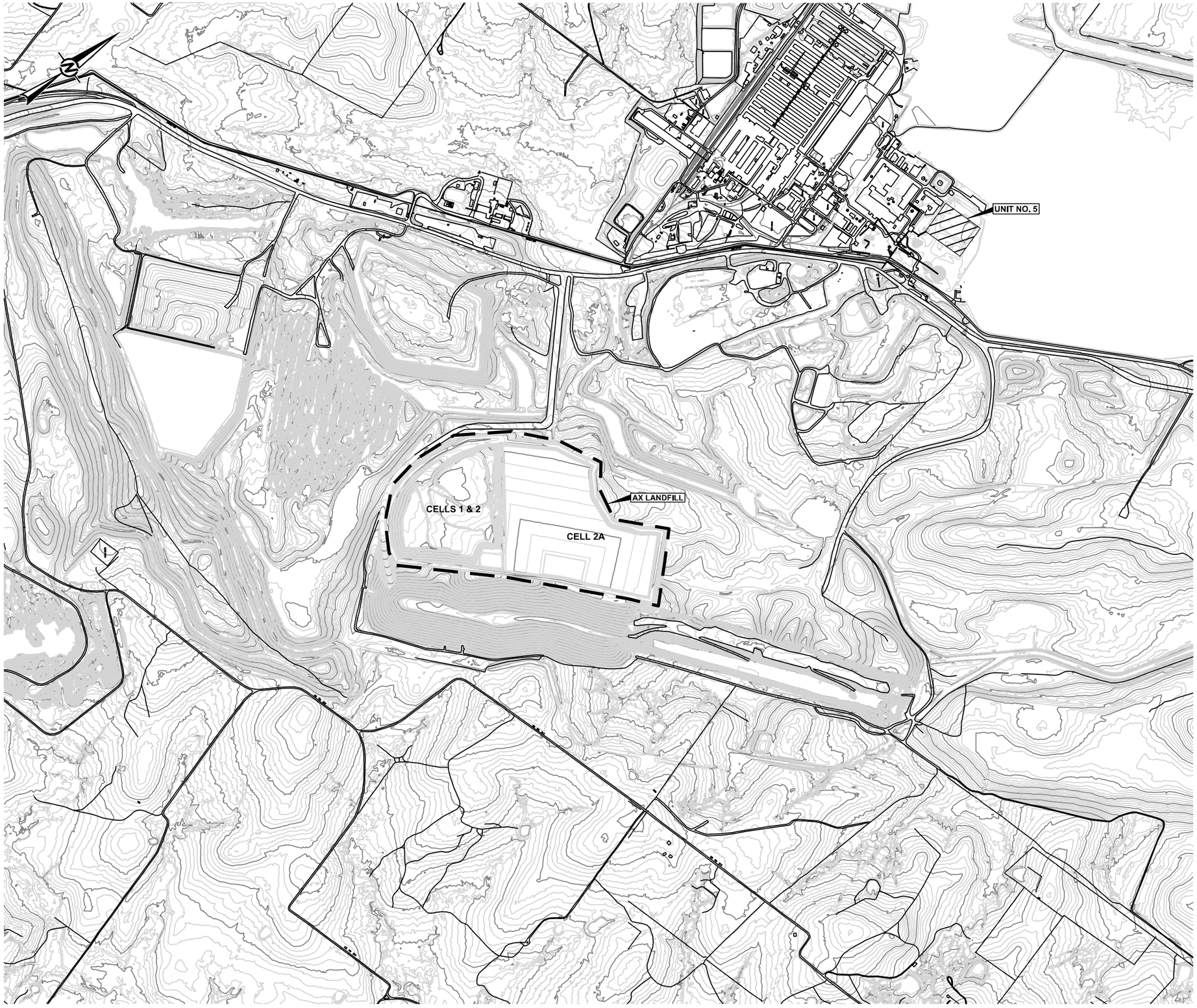
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-21
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO.	CONTROL	REV.	FIGURE
21465177		0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

0 1 in



NOTE(S)

1. EXISTING GRADE CONTOURS OUTSIDE OF CELLS 1, 2 AND 2A ARE CIRCA 2006 AND ARE SHOWN FOR REFERENCE ONLY. CONTOURS DO NOT NECESSARILY REFLECT EXISTING CONDITIONS.

0 750 1500
1" = 1500' FEET

CLIENT
LUMINANT GENERATION COMPANY, LLC

PROJECT
SANDOW UNIT NO. 5
AX LANDFILL
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

TITLE
AX LANDFILL VICINITY MAP

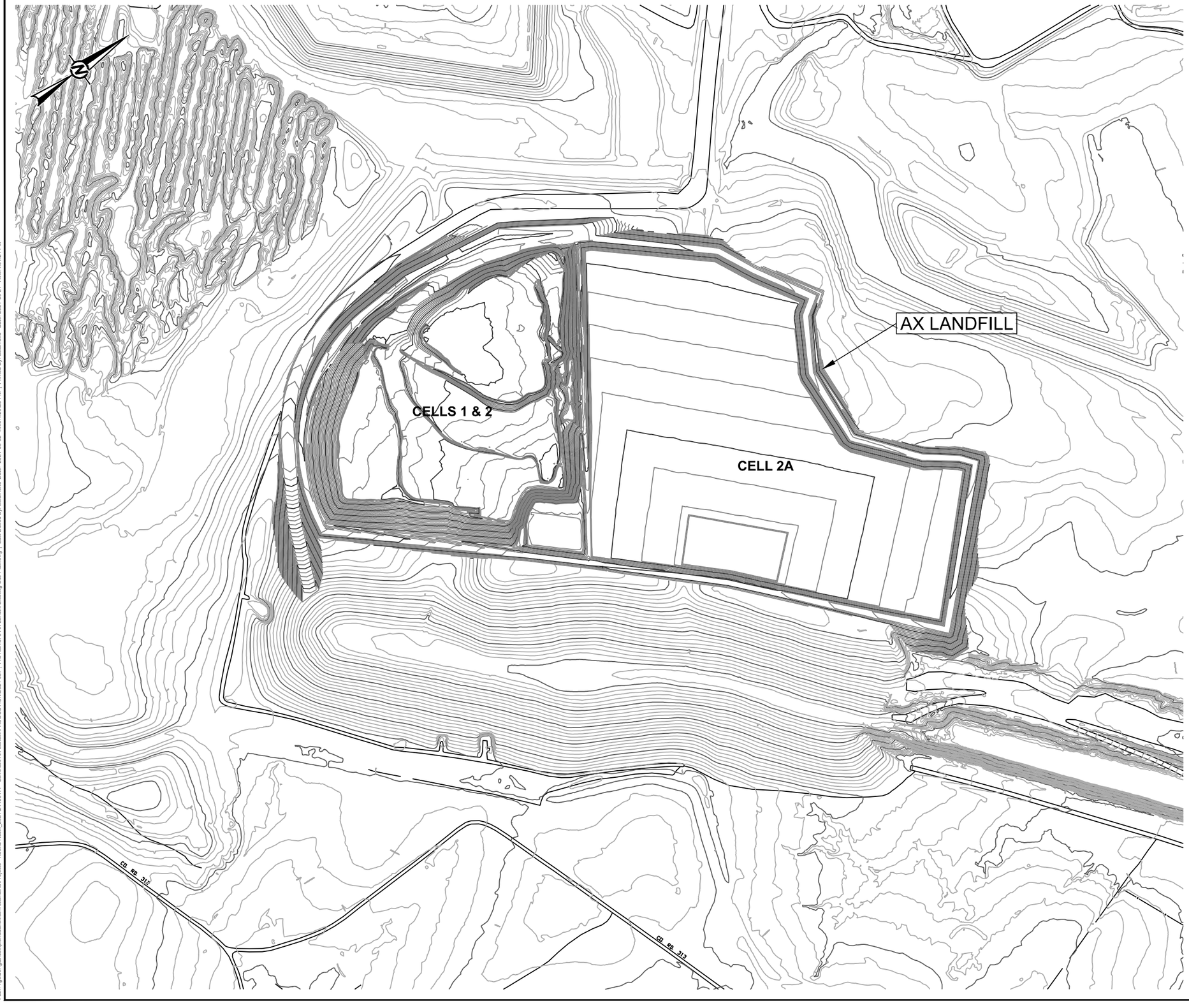
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-21
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO. 21465177 | CONTROL | REV. 0 | FIGURE 2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

1 in
0



NOTE(S)

1. EXISTING GRADE CONTOURS OUTSIDE OF CELLS 1,2 AND 2A ARE CIRCA 2006 AND ARE SHOWN FOR REFERENCE ONLY. CONTOURS DO NOT NECESSARILY REFLECT EXISTING CONDITIONS.

0 300 600
1" = 600' FEET

CLIENT
LUMINANT GENERATION COMPANY, LLC

PROJECT
SANDOW UNIT NO. 5
AX LANDFILL
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

TITLE
AX LANDFILL EXISTING SITE PLAN

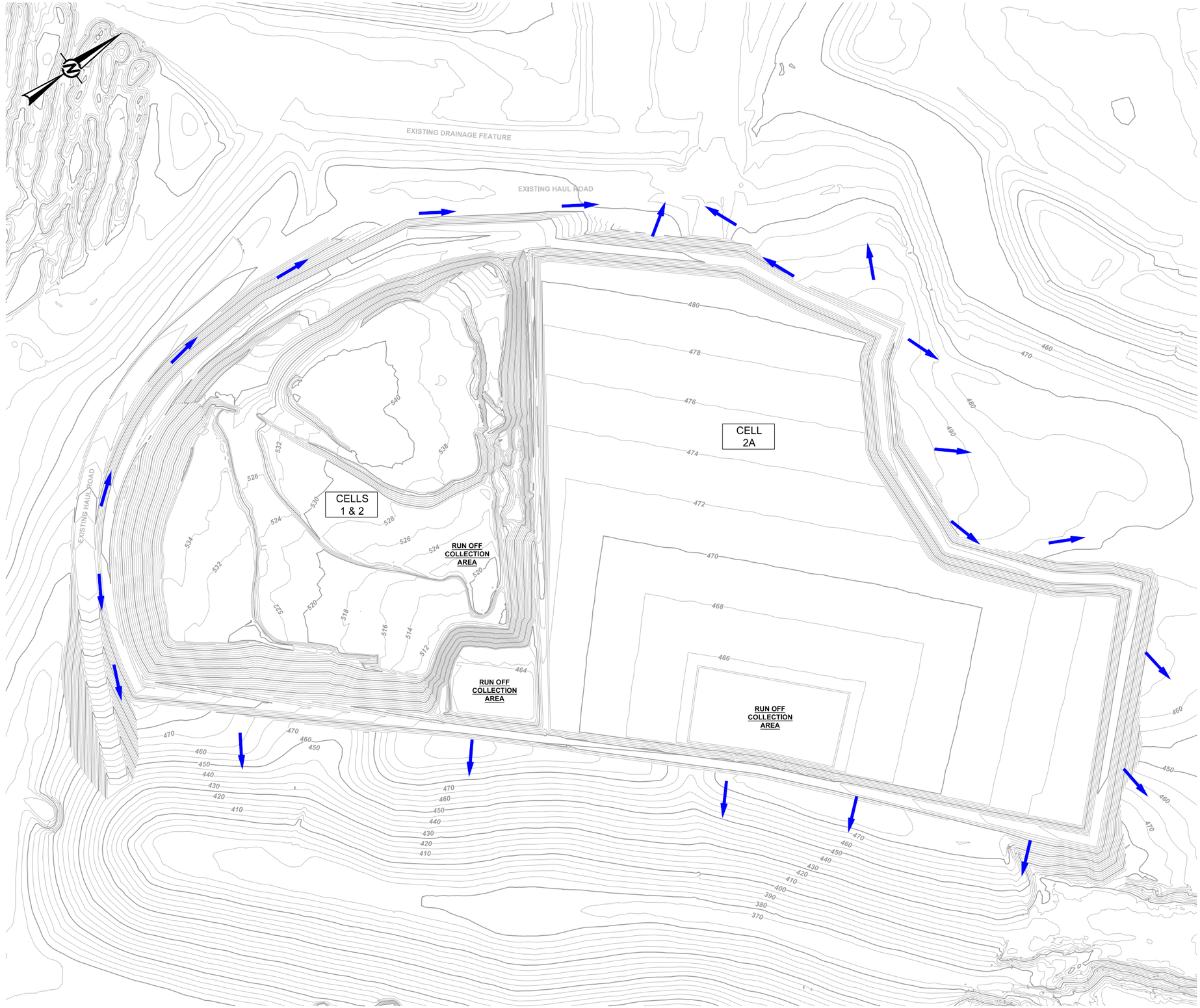
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-21
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO.	CONTROL	REV.	FIGURE
21465177		0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

1 in
0



LEGEND

- GRADE CONTOUR - 2 FT INTERVAL
- GRADE CONTOUR - 10 FT INTERVAL
- STORMWATER FLOW DIRECTION

0 200 400
1" = 400' FEET

CLIENT
LUMINANT GENERATION COMPANY, LLC

PROJECT
SANDOW UNIT NO. 5
AX LANDFILL
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

TITLE
AX LANDFILL RUN-ON DIVERSION PLAN

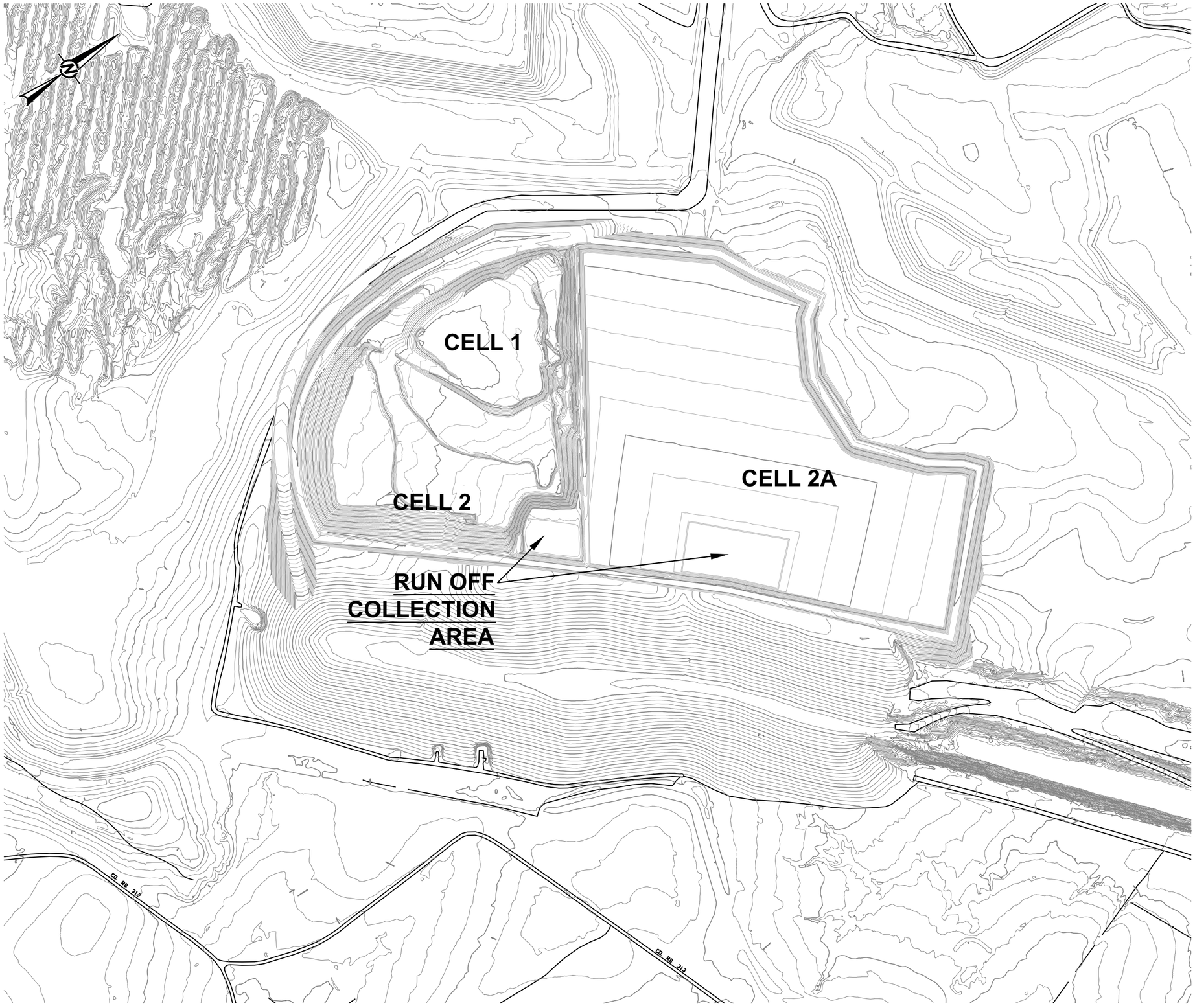
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-21
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO.	CONTROL	REV.	FIGURE
21465177		0	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Path: \\golder.gds\complexdata\office\Texarkana\Projects - Round Rock, 2021\21465177 - Luminant AX Landfill\PRODUCTION\2021-09\ | File Name: 4-AX Landfill Run-On Diversion Plan.dwg | Last Edited By: adiamond Date: 2021-09-03 Time:2:11:14 PM | Printed By: adiamond Date: 2021-09-21 Time:4:12:56 PM



NOTE(S)

1. EXISTING GRADE CONTOURS OUTSIDE OF CELLS 1,2 AND 2A ARE CIRCA 2006 AND ARE SHOWN FOR REFERENCE ONLY. CONTOURS DO NOT NECESSARILY REFLECT EXISTING CONDITIONS.

0 300 600
1" = 600' FEET

CLIENT
LUMINANT GENERATION COMPANY, LLC

PROJECT
SANDOW UNIT NO. 5
AX LANDFILL
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

TITLE
AX LANDFILL RUN-OFF CONTROL PLAN

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-21
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO. 21465177 | CONTROL | REV. 0 | FIGURE 5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

1 in
0

Path: \\golder.gds\complexdata\office\Texarkana\Projects - Round Rock\ 20212146577 - Luminant AX Landfill\PRODUCTION\2021-09\ | File Name: 5-AX Landfill Run-Off Control Plan.dwg | Last Edited By: adiamond Date: 2021-09-03 Time:3:14:31 PM | Printed By: adiamond Date: 2021-09-21 Time:4:24:04 PM

APPENDIX A

NOAA Atlas 14 Precipitation Data – Rockdale, Texas

NOAA Atlas 14, Volume 11, Version 2
Location name: Rockdale, Texas, USA*
Latitude: 30.5505°, Longitude: -97.0633°
Elevation: m/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** (0.340-0.592)	**0.521** (0.399-0.684)	**0.641** (0.489-0.843)	**0.740** (0.555-0.986)	**0.873** (0.634-1.20)	**0.974** (0.689-1.37)	**1.07** (0.741-1.56)	**1.18** (0.791-1.75)	**1.31** (0.854-2.03)	**1.42** (0.898-2.24)
10-min	**0.714** (0.541-0.943)	**0.831** (0.636-1.09)	**1.02** (0.781-1.35)	**1.18** (0.887-1.58)	**1.40** (1.02-1.92)	**1.56** (1.11-2.21)	**1.72** (1.19-2.50)	**1.88** (1.26-2.80)	**2.08** (1.35-3.20)	**2.23** (1.41-3.52)
15-min	**0.901** (0.682-1.19)	**1.04** (0.800-1.37)	**1.28** (0.977-1.69)	**1.48** (1.11-1.97)	**1.74** (1.26-2.38)	**1.94** (1.37-2.73)	**2.13** (1.47-3.09)	**2.33** (1.57-3.47)	**2.60** (1.69-4.00)	**2.80** (1.77-4.43)
30-min	**1.27** (0.963-1.68)	**1.47** (1.13-1.93)	**1.80** (1.37-2.36)	**2.06** (1.55-2.75)	**2.42** (1.76-3.32)	**2.69** (1.90-3.79)	**2.95** (2.04-4.28)	**3.24** (2.18-4.82)	**3.62** (2.35-5.58)	**3.92** (2.48-6.19)
60-min	**1.65** (1.25-2.18)	**1.92** (1.47-2.52)	**2.36** (1.80-3.11)	**2.73** (2.05-3.63)	**3.22** (2.33-4.41)	**3.58** (2.53-5.05)	**3.96** (2.73-5.74)	**4.37** (2.94-6.50)	**4.93** (3.21-7.61)	**5.38** (3.41-8.51)
2-hr	**2.00** (1.52-2.62)	**2.37** (1.82-3.07)	**2.97** (2.27-3.88)	**3.48** (2.62-4.61)	**4.19** (3.06-5.71)	**4.74** (3.37-6.64)	**5.33** (3.69-7.66)	**5.97** (4.03-8.82)	**6.89** (4.49-10.5)	**7.64** (4.85-12.0)
3-hr	**2.19** (1.67-2.86)	**2.64** (2.02-3.39)	**3.34** (2.56-4.34)	**3.95** (2.99-5.22)	**4.83** (3.54-6.56)	**5.53** (3.94-7.71)	**6.28** (4.36-8.99)	**7.11** (4.81-10.4)	**8.32** (5.44-12.7)	**9.32** (5.93-14.5)
6-hr	**2.50** (1.92-3.26)	**3.09** (2.36-3.91)	**3.98** (3.06-5.13)	**4.77** (3.63-6.26)	**5.94** (4.38-8.03)	**6.90** (4.95-9.58)	**7.97** (5.56-11.3)	**9.17** (6.23-13.4)	**10.9** (7.18-16.5)	**12.4** (7.94-19.1)
12-hr	**2.80** (2.16-3.62)	**3.52** (2.68-4.38)	**4.58** (3.54-5.86)	**5.56** (4.26-7.26)	**7.05** (5.22-9.47)	**8.30** (5.98-11.4)	**9.73** (6.82-13.7)	**11.4** (7.77-16.5)	**13.9** (9.17-20.8)	**16.1** (10.3-24.5)
24-hr	**3.12** (2.42-4.01)	**3.98** (3.03-4.90)	**5.22** (4.05-6.63)	**6.39** (4.92-8.29)	**8.19** (6.10-10.9)	**9.72** (7.05-13.3)	**11.5** (8.10-16.1)	**13.6** (9.31-19.5)	**16.8** (11.1-24.9)	**19.6** (12.6-29.6)
2-day	**3.54** (2.76-4.53)	**4.53** (3.47-5.55)	**5.95** (4.64-7.53)	**7.30** (5.65-9.42)	**9.36** (7.01-12.4)	**11.1** (8.10-15.1)	**13.1** (9.29-18.2)	**15.5** (10.7-22.0)	**19.1** (12.7-28.0)	**22.2** (14.3-33.1)
3-day	**3.84** (3.00-4.89)	**4.90** (3.77-6.00)	**6.44** (5.05-8.12)	**7.89** (6.12-10.1)	**10.1** (7.57-13.3)	**11.9** (8.71-16.1)	**14.0** (9.95-19.4)	**16.5** (11.3-23.2)	**20.1** (13.4-29.3)	**23.2** (15.0-34.5)
4-day	**4.10** (3.22-5.22)	**5.21** (4.03-6.38)	**6.82** (5.36-8.59)	**8.32** (6.47-10.7)	**10.6** (7.96-13.9)	**12.5** (9.12-16.8)	**14.6** (10.4-20.1)	**17.1** (11.8-24.0)	**20.7** (13.8-30.0)	**23.8** (15.4-35.2)
7-day	**4.74** (3.74-6.01)	**5.91** (4.62-7.27)	**7.66** (6.05-9.61)	**9.24** (7.21-11.8)	**11.6** (8.74-15.1)	**13.5** (9.90-18.1)	**15.6** (11.1-21.3)	**18.0** (12.5-25.2)	**21.6** (14.4-31.0)	**24.5** (16.0-36.0)
10-day	**5.28** (4.17-6.66)	**6.49** (5.12-8.00)	**8.35** (6.62-10.5)	**9.99** (7.82-12.7)	**12.4** (9.36-16.1)	**14.3** (10.5-19.1)	**16.4** (11.7-22.3)	**18.8** (13.0-26.1)	**22.2** (14.9-31.8)	**25.1** (16.4-36.6)
20-day	**6.86** (5.45-8.62)	**8.19** (6.56-10.2)	**10.3** (8.26-12.9)	**12.1** (9.54-15.3)	**14.6** (11.1-18.9)	**16.5** (12.2-21.8)	**18.6** (13.3-25.0)	**20.8** (14.5-28.6)	**23.9** (16.1-33.9)	**26.4** (17.3-38.2)
30-day	**8.19** (6.53-10.2)	**9.60** (7.76-12.0)	**12.0** (9.61-14.9)	**13.9** (11.0-17.5)	**16.5** (12.5-21.1)	**18.4** (13.6-24.1)	**20.3** (14.6-27.3)	**22.4** (15.7-30.7)	**25.3** (17.1-35.6)	**27.6** (18.1-39.5)
45-day	**10.1** (8.08-12.6)	**11.6** (9.48-14.6)	**14.3** (11.6-17.8)	**16.4** (13.0-20.6)	**19.1** (14.6-24.5)	**21.1** (15.6-27.6)	**23.0** (16.6-30.8)	**25.0** (17.6-34.1)	**27.6** (18.7-38.7)	**29.6** (19.5-42.3)
60-day	**11.8** (9.48-14.7)	**13.5** (11.0-16.9)	**16.4** (13.3-20.4)	**18.7** (14.8-23.4)	**21.6** (16.5-27.5)	**23.6** (17.5-30.7)	**25.5** (18.4-33.9)	**27.4** (19.3-37.2)	**29.9** (20.2-41.6)	**31.7** (20.8-44.9)

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

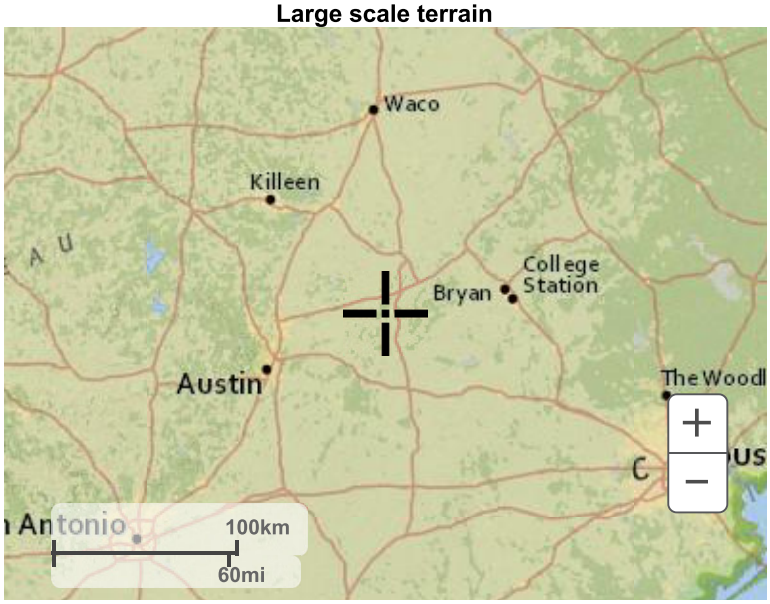
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper 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.

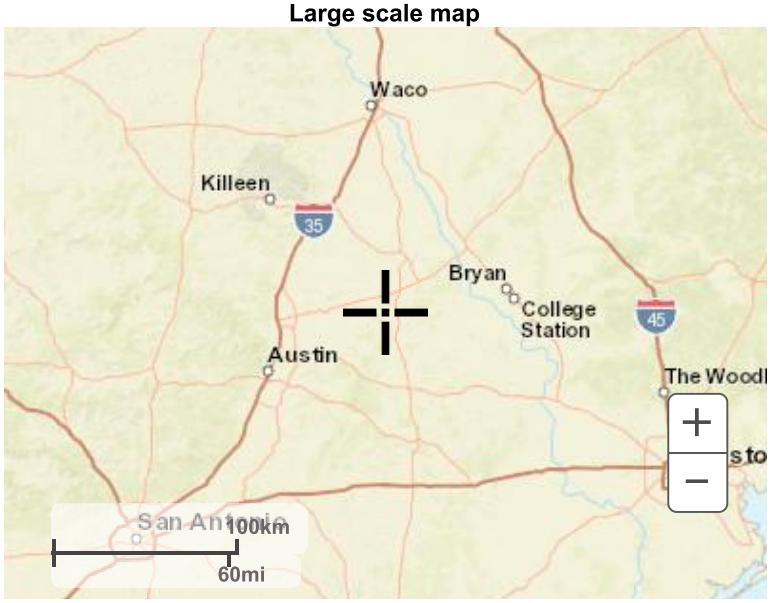
Back to Top

PF graphical

Large scale terrain



Large scale map



Large scale aerial

[Back to Top](#)

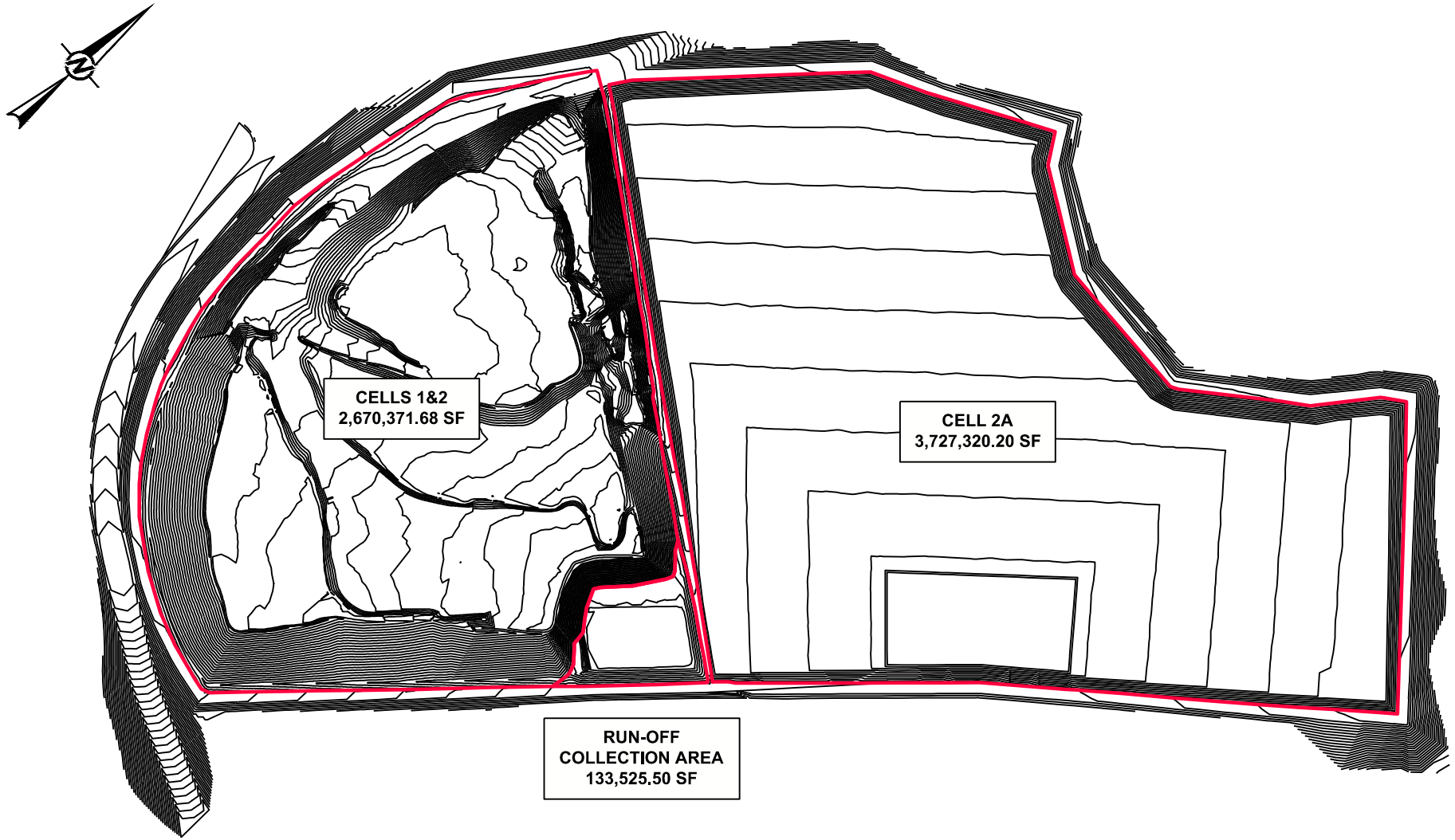
Could not retrieve elevation data due to Cross-Origin permissions.

[US Department of Commerce](#)
[National Oceanic and Atmospheric Administration](#)
[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

APPENDIX B

Cells 1, 2 and 2A Surface Areas



0 250 500
1" = 500' FEET

SURFACE AREAS

GOLDER
MEMBER OF WSP

APPENDIX C

Run-off Containment Capacities

Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
VS-CELLS 1&2 POND RUNOFF STORAGE VOLUME	**1.000**	**1.000**	133930.23 Sq. Ft.	0.42 Cu. Yd.	42659.06 Cu. Yd.	42658.64 Cu. Yd.<Fill>
Totals			133930.23 Sq. Ft.	0.42 Cu. Yd.	42659.06 Cu. Yd.	42658.64 Cu. Yd.<Fill>

0 250 500
1" = 500' FEET

CELLS 1&2 POND RUNOFF STORAGE VOLUME
ELEV. 475.0

GOLDER
MEMBER OF WSP

Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
VS-CELL 2A RUNOFF STORAGE VOLUME-TOTAL	1.000	1.000	3231151.51 Sq. Ft.	0.00 Cu. Yd.	856208.54 Cu. Yd.	856208.54 Cu. Yd.<Fill>
Totals			3231151.51 Sq. Ft.	0.00 Cu. Yd.	856208.54 Cu. Yd.	856208.54 Cu. Yd.<Fill>

0 250 500

1" = 500' FEET

GOLDER
MEMBER OF WSP

CELL 2A RUNOFF STORAGE VOLUME
ELEV. 477.9

APPENDIX D

Run-off Volume Calculations

APPENDIX D1

LUMINANT GENERATION COMPANY, LLC
SANDOW UNIT 5
AX LANDFILL - CURRENT CONDITIONS
RUN-OFF CALCULATIONS - CONTAINMENT PROVIDED BY CELL 1 AND 2 RUNOFF COLLECTION AREA ONLY

Definitions

Run-off from active landfill areas:	storm water that comes into contact with waste
Run-off from capped landfill areas:	storm water that falls outside of an active waste management area and does not come into contact with waste

Assumptions

1) Cell 1 and Cell 2 contain ash and are not capped. Cell 2A is active, but does not contain waste
2) Run-off is generated on Cells 1 and 2. Direct Precipitation on Cells 1 and 2 Run-off Collection Area
3) Run-off contained in Cells 1 and 2 Runoff Collection Area Only
4) Run-off water volume based on a 25-year, 24-hr storm
5) Storm water runoff volumes are estimated using the Curve Number method as described in USDA's Urban Hydrology for Small Water Sheds (TR-55)

Area that Generates Run-off

Cell 1 and 2 Surface Area:	2,670,372	sf
Cell 1 and 2 Surface Area:	61.3	acres
Cell 1 and 2 Collection Area Surface Area:	133,526	sf
Cell 1 and 2 Collection Area Surface Area:	3.1	acres
Total Surface Area:	2,803,898	sf

Design Rainfall

25-Yr, 24-Hr Storm (NOAA Atlas 14) 8.19 in

Curve Numbers

Assumptions:
- For exposed fly and bed ash, use CN = 94
- For direct precipitation, use CN = 100

Calculate Weighted Curve Number for Site

Description	Area (sf)	CN	Area X CN
Exposed Fly/Bed Ash (Cells 1 and 2)	2,670,372	94	251,014,968
Direct Precipitation (Cell1/2 Coll. Area)	133,526	100	13,352,600
	2,803,898		264,367,568

Weighted Curve Number = (Sum of CN X A) /(Total Area)
Weighted Curve Number = 94.3

APPENDIX D1

LUMINANT GENERATION COMPANY, LLC
SANDOW UNIT 5
AX LANDFILL - CURRENT CONDITIONS
RUN-OFF CALCULATIONS - CONTAINMENT PROVIDED BY CELL 1 AND 2 RUNOFF COLLECTION AREA ONLY

Calculate Run-Off Volume Using TR-55 Procedures

1) Calculate Potential Retention of Water (S). Assume this represents water adsorbed by ash and protective cover (non free water)

S = (1000/CNW)-10

where: S = Potential Retention of Water, inches
CN = Curve Number for Site

S = 0.61 inches

2) Calculate Depth of Runoff (Q)

Q = [(P-0.2S)^2]/[P-0.8S)]

where: Q = Depth of run-off generated, inches
S = Potential Retention of Water, inches
P = Design rainfall, inches

Q = 7.51 inches

3) Calculate Volume of Run-off

V = Q X A

where: Q = depth of run-off generated, ft
A = Total Area, sf

Q = 7.51 inches
Q = 0.63 feet
Area = 2,803,898 sf

Total Run-off Volume:	**1,753,621 cf**

APPENDIX D2

LUMINANT GENERATION COMPANY, LLC
SANDOW UNIT 5
AX LANDFILL - CURRENT CONDITIONS
RUN-OFF CALCULATIONS - CONTAINMENT PROVIDED BY CELL 1 AND 2 RUNOFF COLLECTION AREA AND CELL 2A

Definitions

Run-off from active landfill areas:	storm water that comes into contact with waste
Run-off from capped landfill areas:	storm water that falls outside of an active waste management area and does not come into contact with waste

Assumptions

1) Cell 1 and Cell 2 contain ash and are not capped. Cell 2A is active, but does not contain waste
2) Run-off is generated on Cells 1 and 2. Direct Precipitation on Cell 2A and Cells 1 and 2 Run-off Collection Area
3) Run-off contained in Cells 1 and 2 Runoff Collection Area and in Cell 2A
4) Run-off water volume based on a 25-year, 24-hr storm
5) Storm water runoff volumes are estimated using the Curve Number method as described in USDA's Urban Hydrology for Small Water Sheds (TR-55)

Area that Generates Run-off

Cell 1 and 2 Surface Area:	2,670,372	sf
Cell 1 and 2 Surface Area:	61.3	acres
Cell 1 and 2 Collection Area Surface Area:	133,526	sf
Cell 1 and 2 Collection Area Surface Area:	3.1	acres
Cell 2A Surface Area:	3,727,320	sf
Cell 2A Surface Area:	85.6	acres
Total Surface Area:	6,531,218	sf

Design Rainfall

25-Yr, 24-Hr Storm (NOAA Atlas 14) 8.19 in

Curve Numbers

Assumptions:

- For exposed fly and bed ash, use CN = 94
- For direct precipitation, use CN = 100

Calculate Weighted Curve Number for Site

Description	Area (sf)	CN	Area X CN
Exposed Fly/Bed Ash (Cells 1 and 2)	2,670,372	94	251,014,968
Direct Precipitation (Cell1/2 Coll. Area)	133,526	100	13,352,600
Direct Precipitation (Cell 2A)	3,727,320	100	372,732,000
	6,531,218		637,099,568

Weighted Curve Number = (Sum of CN X A) /(Total Area)

Weighted Curve Number = 97.5

APPENDIX D2

LUMINANT GENERATION COMPANY, LLC
SANDOW UNIT 5
AX LANDFILL - CURRENT CONDITIONS
RUN-OFF CALCULATIONS - CONTAINMENT PROVIDED BY CELL 1 AND 2 RUNOFF COLLECTION AREA AND CELL 2A

Calculate Run-Off Volume Using TR-55 Procedures

1) Calculate Potential Retention of Water (S). Assume this represents water adsorbed by ash and protective cover (non free water)

S = (1000/CNW)-10

where: S = Potential Retention of Water, inches
CN = Curve Number for Site

S = 0.25 inches

2) Calculate Depth of Runoff (Q)

Q = [(P-0.2S)^2]/[P-0.8S)]

where: Q = Depth of run-off generated, inches
S = Potential Retention of Water, inches
P = Design rainfall, inches

Q = 7.90 inches

3) Calculate Volume of Run-off

V = Q X A

where: Q = depth of run-off generated, ft
A = Total Area, sf

Q = 7.90 inches
Q = 0.66 feet
Area = 6,531,218 sf

Total Run-off Volume:	**4,297,407 cf**

golder.com