CORRESPONDENCE COVER SHEET
WASTE PERMITS DIVISION
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Date: March 3, 2025
Facility Name: Ruffino Road Type IX Registration Application
Permit or Registration No.: 40334

Nature of Correspondence:
☐ Initial/New
☒ Response/Revision*

*If Response/Revision, please provide previous TCEQ Tracking No.: 28586095 NOD4 Response - Attach III-7
(Previous TCEQ Tracking No. can be found in the Subject line of the TCEQ's response letter to your original submittal.)

This cover sheet should accompany all correspondences submitted to the Waste Permits Division and should be affixed to the front of your submittal as a cover page. Please check the appropriate box for the type of correspondence being submitted. For questions regarding this form, please contact the Waste Permits Division at (512) 239-2335.

Table 1 - Municipal Solid Waste

APPLICATIONS	REPORTS and RESPONSES
☐ New Notification	☐ Closure Report
☐ New Permit (including Subchapter T)	☐ Groundwater Alternate SRC Demonstration
☒ New Registration (including Subchapter T)	☐ Groundwater Corrective Action
☐ Major Amendment	☐ Groundwater Monitoring Report
☐ Minor Amendment	☐ Groundwater Statistical Evaluation
☐ Limited Scope Major Amendment	☐ Landfill Gas Corrective Action
☐ Notice Modification	☐ Landfill Gas Monitoring
☐ Non-Notice Modification	☐ Liner Evaluation Report
☐ Transfer/Name Change Modification	☐ Soil Boring Plan
☐ Temporary Authorization	☐ Special Waste Request
☐ Voluntary Revocation	☐ Other:
☐ Subchapter T Workplan	
☐ Other:	

Table 2 - Industrial & Hazardous Waste

APPLICATIONS	REPORTS and RESPONSES
☐ New	☐ Annual/Biennial Site Activity Report
☐ Renewal	☐ CfPT Plan/Result
☐ Post-Closure Order	☐ Closure Certification/Report
☐ Major Amendment	☐ Construction Certification/Report
☐ Minor Amendment	☐ CPT Plan/Result
☐ Class 3 Modification	☐ Extension Request
☐ Class 2 Modification	☐ Groundwater Monitoring Report
☐ Class 1 ED Modification	☐ Interim Status Change
☐ Class 1 Modification	☐ Interim Status Closure Plan
☐ Endorsement	☐ Soil Core Monitoring Report
☐ Temporary Authorization	☐ Treatability Study
☐ Voluntary Revocation	☐ Trial Burn Plan/Result
☐ 335.6 Notification	☐ Unsaturated Zone Monitoring Report
☐ Other:	☐ Waste Minimization Report
	☐ Other:

~~February 27~~March 3, 2025

Municipal Solid Waste Permits Section, MC124
Waste Permits Division
Texas Commission on Environmental Quality
12100 Park 35 Circle
Austin, TX 78753

Subject: NOD4 Response (Tracking No. 28586095)
Ruffino Road Type IX Landfill Mining Registration Application No. 40334
Closed City of Bellaire and City of West University Landfills
Houston, Harris County, Texas

Dear TCEQ:

On behalf of the City of Houston (COH), Tetra Tech is pleased to submit our response to TCEQ's Notice of Deficiency No. 4 dated December 20, 2024, Tracking No. 28586095. Our response documents will be posted to the TCEQ FTPS website under [redacted] three paper copies will be shipped to the TCEQ at the above address and one paper copy will be shipped to TCEQ Region 12 in Houston. Please replace pages in the original application with the pages provided in this NOD3 response.

NOD4 Issues and our responses are below:

NOD ID from NOD4	Citation in 30 TAC	Location in Application	Technical NOD4 Description	Response
94	30 TAC 330.61(j)	Part II Supplement, Section 2.4, General Geology and Soils Statement	Describe subsidence at the site and explain the validity of using 1993 groundwater levels for design. If necessary, update the discussion and calculations in other parts of the application to address subsidence, especially Part III Supplement, Section 3.3.C.1, Groundwater Protection and Attachment III-13, Sections 6.1, Seasonal High Water Determination and 6.5, Ballast.	Part II Supplement Section 2.5.1 states: "Groundwater conditions and groundwater protection are described in the Part III Supplement, Section 3.3.C.1." The following text was added to Part III Supplement Section 3.3.C.1 and Attachment III-13 (LQCP) Section 6.1: "Because we are using groundwater elevation data from 1993, we considered the effect that subsidence of the ground surface between 1993 and 2024 may have on groundwater levels used in our uplift calculations. According to the report GPS Observations (1993-2019) and Recent Land Subsidence in the Greater Houston Area by the Harris-Galveston Subsidence District and University of Houston, the subsidence at Monitoring Station PA41 (southwest Houston) between 1993 and 2019 was 9.07 cm and between 2019 and 2024 (using their average subsidence rate of 0.63 cm/year) was 3.78 cm for a total between 1993 and 2024 of 12.85 cm = 5.06 inches. On the basis of this data, we increased groundwater levels (piezometric

				surfaces) used in our Uplift Calculations by 0.5 feet (6 inches).” A new uplift/ballast calculation table was added to Attachment III-13 (LQCP) Section 6.5.
95	330.61(k)(1)	Part II Supplement, Section 2.4.4 and Part III Supplement, Section 3.3.C.1	Correct the references to "Attachments III-6.1 and III-6.2" to read "Attachments III-9 and III-10."	Attachment number corrections made to Supplement Sections 2.4.4 and 3.3.C.1.
48	330.63(d)(7)(A)(iii)	Part III Supplement, Attachment III-1, Section 3.1(A)(iii)	Restore the header row and first three rows of lab test results for the 2021 test pits.	Attachment III-1, Page 5: Header row and first three rows of lab test results for the 2021 test pits restored.
49	330.63(d)(7)(A)(vi)	Part III Supplement, Attachment III-1, Section 3.1(A)(vi) and Figures 5 and 6	Reference the surface topography as Figure 6. Reconcile the date of the topography in the text (2017) with the date (2018) on Figures 5 and 6.	Attachment III-1, Page 6: Reference to Figure 6 added and reference to the topo map dates corrected to 2018.
96	330.63(d)(7)(A)(i)	Part III Supplement, Attachment III-1, Section 4.0, Conclusion 3	Provide the estimated percentages of Grade 1, Grade 2, and Waste grade soils or remove Conclusion 3.	Attachment III-1, Page 8: Conclusion 3 removed.
3	330.57(g)(5) and 330.57(h)(4)(E)	Part III Supplement, Attachment III-13	Blank pages should be removed and page numbers following Section 8 should be consecutive.	Pages are consecutive and blank pages have been removed.
76 and 83	330.609(1) and 330.339	Part III Supplement, Attachment III-13, Section 2.5, Table 2-2, and Table B-3	Installation general. Clarify how protective cover installed without moisture/density specifications can be expected to support processing equipment and withstand normal traffic from the processing operations. Installation over geomembrane. Identify the specific TxDOT item that will be the protective cover material, e.g. Item 247	A new protective cover design is presented in Attachment III-13 Section 2.5, Table 2-2, and Table B-3, which is 12-inches of Flexible Base Type A or D, Grade 1-2, compacted according to TXDOT’s Item 247 to 100% of the maximum dry density at ±2 percent of the optimum moisture content as determined by TXDOT Tex-113-E and Tex-114-E. The middle layer is 12-inches of clean clay compacted to 95% of max dry density (ASTM D698), -1 to +3% of W_{opt}. The bottom layer (overlying the geotextile) is 12 inches of clean

			"Flexible Base", and provide a gradation table. Maintenance. Clarify whether the protective cover of the processing pad will require watering or chemical applications for dust suppression during operations.	clay spread with low ground pressure equipment, uncompacted. Regarding dust control, the following was added to Table 2-2: "Following Processing Pad construction and during operations, the protective cover will be watered, treated with dust-suppressant chemicals if necessary, and cleaned to achieve maximum control of dust emissions. The owner/operator will have portable watering equipment available to control dust from the pad surface, loading and unloading of material, and processing equipment."
97	330.339(b)(2)(B), 330.337(f) and (j)(1)	Part III Supplement, Attachment III-13, Section 6.2	Provide the methods and tests described in 30 TAC 330.337(f) to ensure that a clay liner and any required ballast will not and do not undergo uplift until excavation and any subsequent ballasting are complete. Define a milestone for turning off the dewatering system related to the presence of waste and the potential for leachate or contaminated water to enter the excavation being dewatered.	Attachment III-13 LQCP Sections 6.2, 6.4, and 6.5 were revised including a new Uplift and Ballast Calculation table in Section 6.5. The owner commits to installing and operating a dewatering system including piezometers to monitor the lowered piezometric surface. Calculations in the table estimate resisting pressure from buried waste ballast and liner weight to determine the max excavation depth before starting the dewatering system, which will lower the piezometric surface in the silty sand layer to achieve FS=1.5 against uplift following removal of all waste. BERs will be submitted after waste removal from each landfill area and the dewatering system turned off after TCEQ approval. An Excavation Plan signed and sealed by a Texas PE describing dewatering system design, operation, and monitoring will be submitted to the TCEQ before excavation begins and maintained in the site operating record.
98	330.337(e)	Part III Supplement, Attachment III-13, Section 6.3	Discuss the stability of landfill mining excavation slopes in soil. The stability of the processing pad does not need to be discussed. Provide for maintaining a copy of the professional	The text in Section 6.3 was revised as follows: "Side slopes of excavations in buried waste shall be benched, or if sloped, no steeper than 34 degrees (1V:1.5H) if higher than four feet (per OSHA 1926.652).

			engineer's excavation plan in the site operating record and sending a copy to the TCEQ for information.	Excavations in waste four feet deep or less, if properly dewatered, are not required to be sloped back or braced and may remain open for short periods of time. Side slopes of excavations in soil shall not exceed 1V:3H. This ratio provides a slope that is stable in similar Houston-area soils based on Tetra Tech experience. If excavation slopes in waste or soil begin to slough, they shall be either braced or sloped back to a stable condition. A copy of the Excavation Plan signed and sealed by a licensed Texas Professional Engineer shall be submitted to the TCEQ before excavation begins and maintained in the site operating record. The plan will describe dewatering system design, operation, and monitoring."
99	330.337	Part III Supplement, Attachment III-13, Sections 6.5	Considering the range of groundwater levels observed at the site and that the waste currently acting as ballast will be removed from the existing landfills, ballast evaluation reports will be required for the landfill units being excavated but will not be required for the processing pad.	This text was added to Attachment III-13 LQCP Section 6.5. "Ballast evaluation reports (BER) will be submitted to the TCEQ after waste removal from each landfill area or more frequently as determined by the TCEQ for the landfill units being excavated but will not be required for the processing pad."
100	330.341(d)	Part III Supplement, Attachment III-13, Section 7.2	Interim status reports will be required for the processing pad at a frequency of every six months until landfill excavation and waste processing are complete.	This text was added to Attachment III-13 LQCP Section 7.2 "Interim status reports will be required for the processing pad at a frequency of every six months until landfill excavation and waste processing are complete."

101	330.209	Part IV Supplement, Section 4.3	Remove the phrase “if approved by the TCEQ” from the first sentence. Remove the word “unless” from the end of the second paragraph.	The text “if approved by the TCEQ” and “unless” was removed from Section 4.3
	330.207(b) and 330.227	Part IV Supplement, Section 4.0	Email request from Robert Pedersen on 2/20/25 to provide the Processing Pad containment calculations	Processing Pad containment calculations in a table were added to Part IV Supplement Section 4.0 and replaced the table in the Attachment III-7 Drainage Calculations

Revisions to our original submittal are indicated by “striking out” the text that was replaced and making the new text red. Attachment 1 to this letter contains the revised redline version and Attachment 2 contains the revised unmarked version. Locations of revised sections are indicated in the table of contents below:

Form TCEQ-20714	Correspondence Cover Sheet (precedes this letter)	**revised**
Cover Letter (this document)		**revised**
Application Cover Page and Table of Contents		**revised**
Form TCEQ-20876	Application for MSW Landfill Mining Registration	**revised**
Part I Supplement and Attachments	General Information	
Part II Supplement and Attachments	Existing Conditions	**revised**
Part III Supplement and Attachments	Site Development Plan	**revised**
Part IV Supplement and Attachments	Site Operating Plan	**revised**
MSW Application Checklist		

Please call me at 936-202-0746 with any questions.

Sincerely,

Jim Norstrom, P.E., Senior Project Manager

Attachments
1. Relined Pages
2. Unmarked Pages

cc:
- TCEQ Region 12 Office - 5425 Polk St., Ste. H, Houston, TX 77023-1452
- Mr. Paresh Lad – City of Houston Public Works, 611 Walker Street, Houston, TX 77002
- Mr. Connor Houghton, PE – Quiddity Engineering, 6330 West Loop South, No. 150, Bellaire, TX 77401

Attachment 1 Redlined Pages

Attachment III-7 to Part III

Drainage Calculations

Prepared for:

City of Houston Public Works - Transportation and Drainage Operations

611 Walker Street, Houston, Texas 77002

Prepared by:

STATE OF TEXAS
JAMES M. NORSTROM
57016
LICENSED
PROFESSIONAL ENGINEER
03/03/25
TETRA TECH, INC.
FIRM REGISTRATION NO. F-3924

TBPELS Registration No. F-3924

1500 CityWest Boulevard, Suite 1000, Houston, TX 77042

936-202-0746

Original Submittal April 2023

Revised June 2024

~~Revised~~ November 2024, February 2025

Drainage Calculations

TABLE OF CONTENTS

STATE OF TEXAS
JAMES M. NORSTROM
57016
LICENSED
PROFESSIONAL ENGINEER
03/03/25
TETRA TECH, INC.
FIRM REGISTRATION NO. F-3924

1.0 INTRODUCTION

The facility was designed and constructed, and will be operated, to comply with the requirements of §330.303. The design of the facility will manage run-on and runoff during the peak discharge of a 25- year rainfall event and will prevent the off-site discharge of waste and feedstock material, including, but not limited to, in-process and/or processed materials. Surface water drainage in and around the facility will be controlled to minimize surface water running onto, into, and from the treatment area.

The drainage design is discussed in the Part III Supplement, Section 3.2. The pre-development drainage subareas drawings are Attachment III-8. Calculations are presented in this report. Using the following parameters:

- Design precipitation depth for the 25-year, 24-hour storm event
- Time of concentration
- Rainfall intensity
- Measurements of six drainage sub-areas onsite
- For each sub-area and the design storm:
    - Peak flows
    - Runoff volume
    - Drainage velocity

Post-development drainage parameters were not calculated because excavations to remove waste will detain stormwater and be pumped as necessary by the excavation contractor. Earthen berms will be necessary to:

1. Contain water in the bottom of excavations that has been in contact with waste (contaminated water) for proper collection, storage, and disposal
2. Divert stormwater from entering excavations

Required berm heights for various configurations of upslope runoff areas and waste excavation geometries are presented below. Diversion and containment berms will be constructed from compacted clay and protected from erosion. Berms will be installed around excavations as needed to divert water. As shown on Attachment III-4, the Processing Pad will have a complete perimeter berm. See Attachment III-4.1 for an example internal berm configuration in a waste excavation.

2.0 DRAINAGE PARAMETERS

NOAA's Hydrometeorological Design Studies Center Precipitation Frequency Data Center (PFDC) (PF Map: Contiguous US (noaa.gov)) is the source of the 25-year, 24-hour design storm water depth for the proposed landfill mining project site.

As shown in the following table, the 25-year, 24-hour design storm water depth for the Ruffino Road site is 11.6 inches (NOAA-14 website on 11/20/24).

An excavation bottom slope of one percent is used. Excavation bottoms will be very close to the top of the old landfill clay liners. Borings show that the top of clay liner may be flat, so our one percent slope represents localized grading as needed to convey stormwater to shallow channels and sumps where water can be removed by pumping.

NOAA Atlas 14, Volume 11, Version 2
Location name: Houston, Texas, USA*
Latitude: 29.7304°, Longitude: -95.3697°
Elevation: 42 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	0.498 (0.377-0.658)	0.586 (0.447-0.764)	0.727 (0.553-0.954)	0.846 (0.635-1.13)	1.01 (0.735-1.39)	1.14 (0.807-1.61)	1.28 (0.879-1.85)	1.42 (0.954-2.11)	1.62 (1.05-2.50)	1.78 (1.13-2.81)
10-min	0.789 (0.597-1.04)	0.929 (0.708-1.21)	1.16 (0.879-1.52)	1.35 (1.01-1.79)	1.61 (1.18-2.22)	1.82 (1.29-2.58)	2.04 (1.41-2.96)	2.26 (1.52-3.36)	2.55 (1.65-3.92)	2.77 (1.75-4.38)
15-min	1.01 (0.762-1.33)	1.18 (0.899-1.54)	1.46 (1.11-1.92)	1.69 (1.27-2.26)	2.02 (1.47-2.77)	2.27 (1.61-3.20)	2.53 (1.75-3.67)	2.82 (1.89-4.19)	3.20 (2.08-4.94)	3.52 (2.22-5.56)
30-min	1.45 (1.10-1.91)	1.69 (1.29-2.20)	2.07 (1.58-2.72)	2.40 (1.80-3.19)	2.84 (2.06-3.89)	3.18 (2.25-4.48)	3.54 (2.44-5.14)	3.95 (2.66-5.89)	4.55 (2.96-7.02)	5.04 (3.19-7.96)
60-min	1.90 (1.44-2.51)	2.24 (1.70-2.92)	2.78 (2.11-3.64)	3.23 (2.42-4.30)	3.86 (2.80-5.28)	4.35 (3.07-6.12)	4.87 (3.36-7.06)	5.48 (3.69-8.17)	6.41 (4.17-9.90)	7.19 (4.55-11.4)
2-hr	2.29 (1.75-3.01)	2.80 (2.12-3.57)	3.57 (2.72-4.64)	4.26 (3.21-5.64)	5.27 (3.84-7.18)	6.09 (4.33-8.54)	7.02 (4.86-10.1)	8.12 (5.48-12.0)	9.81 (6.40-15.1)	11.3 (7.15-17.7)
3-hr	2.50 (1.91-3.27)	3.14 (2.36-3.94)	4.07 (3.11-5.26)	4.94 (3.74-6.52)	6.25 (4.58-8.50)	7.35 (5.25-10.3)	8.63 (5.99-12.4)	10.1 (6.85-15.0)	12.5 (8.14-19.1)	14.5 (9.21-22.7)
6-hr	2.88 (2.21-3.74)	3.75 (2.81-4.61)	4.97 (3.81-6.36)	6.16 (4.69-8.07)	7.99 (5.91-10.8)	9.59 (6.90-13.4)	11.5 (8.00-16.4)	13.7 (9.26-20.0)	17.1 (11.2-26.0)	20.0 (12.8-31.1)
12-hr	3.32 (2.56-4.28)	4.41 (3.30-5.34)	5.92 (4.56-7.52)	7.41 (5.67-9.65)	9.72 (7.23-13.1)	11.8 (8.51-16.4)	14.2 (9.93-20.1)	17.0 (11.6-24.8)	21.3 (14.0-32.3)	25.1 (16.1-38.9)
24-hr	3.80 (2.95-4.88)	5.13 (3.85-6.16)	6.96 (5.40-8.78)	8.78 (6.75-11.4)	11.6 (8.69-15.6)	14.1 (10.3-19.6)	17.1 (12.0-24.1)	20.5 (14.0-29.6)	25.6 (16.9-38.5)	29.9 (19.3-46.2)
2-day	4.34 (3.39-5.53)	5.97 (4.49-7.08)	8.20 (6.39-10.3)	10.4 (8.06-13.4)	13.9 (10.5-18.7)	17.0 (12.5-23.5)	20.6 (14.6-28.9)	24.5 (16.8-35.2)	29.9 (19.8-44.7)	34.4 (22.2-52.8)
3-day	4.74 (3.72-6.02)	6.52 (4.93-7.72)	8.96 (7.01-11.2)	11.4 (8.83-14.6)	15.1 (11.5-20.3)	18.6 (13.7-25.5)	22.4 (15.9-31.3)	26.4 (18.1-37.8)	31.9 (21.2-47.5)	36.4 (23.6-55.6)
4-day	5.08 (3.99-6.42)	6.91 (5.26-8.19)	9.46 (7.42-11.8)	12.0 (9.30-15.3)	15.8 (12.0-21.1)	19.3 (14.3-26.5)	23.2 (16.5-32.4)	27.3 (18.8-39.0)	32.9 (21.8-48.8)	37.3 (24.2-57.0)
7-day	5.83 (4.60-7.35)	7.74 (5.95-9.20)	10.4 (8.22-12.9)	13.0 (10.2-16.5)	17.0 (13.0-22.6)	20.6 (15.2-28.0)	24.5 (17.5-34.0)	28.6 (19.8-40.7)	34.3 (22.9-50.6)	38.8 (25.2-58.9)
10-day	6.48 (5.13-8.14)	8.44 (6.54-10.1)	11.2 (8.88-13.9)	13.9 (10.9-17.6)	17.9 (13.7-23.7)	21.5 (15.9-29.2)	25.4 (18.2-35.2)	29.5 (20.5-41.9)	35.2 (23.5-51.8)	39.6 (25.8-60.1)
20-day	8.59 (6.83-10.7)	10.6 (8.41-12.8)	13.7 (10.9-16.9)	16.5 (13.0-20.7)	20.6 (15.7-26.8)	24.0 (17.8-32.2)	27.6 (19.8-38.0)	31.5 (22.0-44.5)	36.9 (24.8-54.1)	41.2 (26.9-62.1)
30-day	10.4 (8.29-12.9)	12.5 (10.0-15.2)	15.8 (12.7-19.5)	18.7 (14.8-23.5)	22.8 (17.4-29.5)	26.1 (19.3-34.8)	29.5 (21.2-40.4)	33.2 (23.2-46.8)	38.3 (25.8-56.1)	42.4 (27.8-63.7)
45-day	13.0 (10.4-16.1)	15.3 (12.4-18.7)	19.1 (15.4-23.5)	22.2 (17.6-27.7)	26.5 (20.2-34.1)	29.7 (22.1-39.4)	33.0 (23.8-45.1)	36.5 (25.6-51.2)	41.2 (27.8-60.0)	44.8 (29.4-67.1)
60-day	15.4 (12.4-19.0)	17.9 (14.6-21.9)	22.1 (17.9-27.1)	25.4 (20.2-31.6)	29.9 (22.9-38.4)	33.2 (24.7-43.9)	36.4 (26.3-49.6)	39.7 (27.9-55.6)	44.0 (29.8-63.9)	47.2 (31.0-70.4)

[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

The minimum (most conservative) Time of Concentration (t_c) from TXDOT guidance is 10 minutes. Using a 10-minute time of concentration and the following table, Rainfall Intensity is determined.

Rainfall Intensity-Duration-Frequency Coefficients for Texas

Based on United States Geological Survey (USGS) Scientific Investigations Report 2004–5041
"Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas"

1. Select English or SI Units
English

2. Select or Enter a County
Harris

3. Enter a Time of Conc.
Select Units
10 min

Coefficient	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)
e	0.7939	0.7855	0.7829	0.7774	0.7727	0.772
b (in.)	57.73	73.87	86.47	102.23	116.88	136.33
d (min)	9.48	10.46	11.27	12.32	12.95	14.08
Intensity (in./hr)	5.47	6.90	7.90	9.14	10.38	11.69

(Spreadsheet Release Date: August 31, 2015; data table reshuffle by Asquith July 14, 2016)

Peak Flow for existing conditions is obtained from the following formula:

$$Q = CIA$$

Where

- Q = flow in cubic feet per second (cfs)
- C = runoff coefficient $C = C_r + C_i + C_v + C_s = 0.10 + 0.10 + 0.05 + 0.08 = 0.33$
- I = rainfall intensity = 9.14 inches / hour
- A = area contributing runoff to the discharge point (or sheet flow)

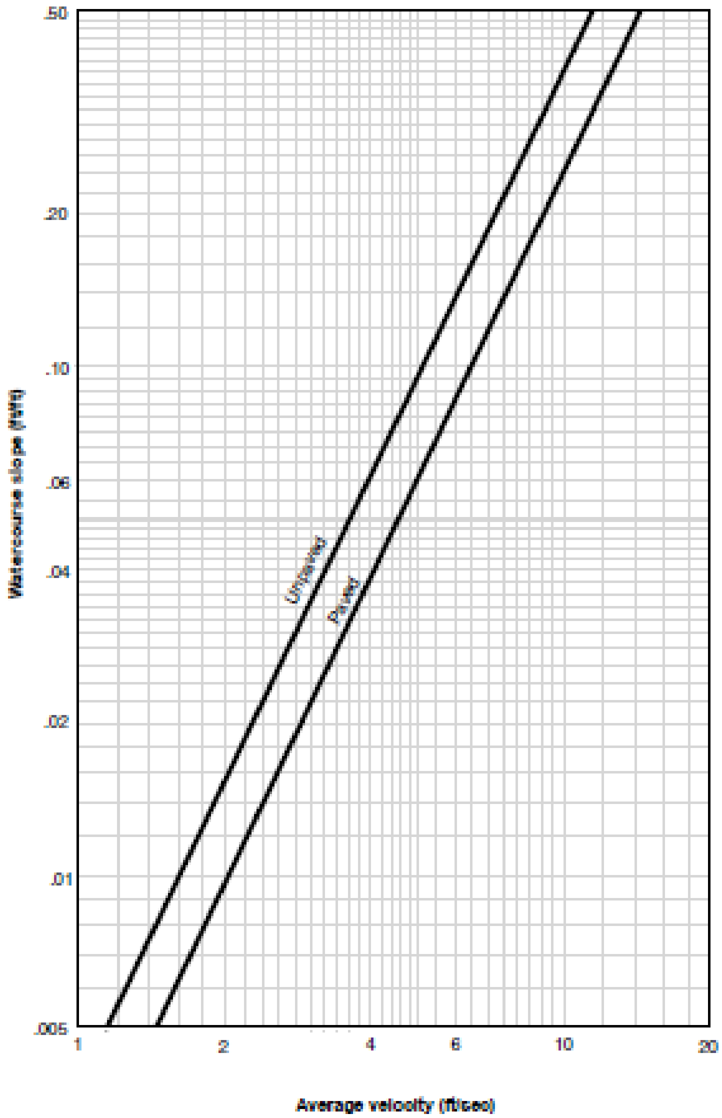
3.0 DRAINAGE SUB-AREA FLOW RATE, VOLUME, AND VELOCITY

Drainage sub-area acres, flow rate, runoff volume, and velocity are presented in the following table.

Drainage Sub-Area Flow, Volume, Velocity					
Drainage Area	Drainage Sub-Area Area, acres	Typical Surface Slope	Flow, ft^3/sec (Q)	Water Volume from Design Storm, acre-ft	Runoff Velocity, feet/sec (from TR-55 graph)
1	6.5	0.020	19.61	2.07	2.18
2	19.4	0.009	58.51	6.19	1.47
3	31.6	0.012	95.31	10.08	1.78
4	41.9	0.020	126.38	13.37	2.18
5	24.6	0.007	74.20	7.85	1.35
6	19.7	0.026	59.42	6.28	2.60
Notes:					
C =	0.33				
I =	9.14	in/hr			
Design Storm					
Rainfall Depth	11.6	in			
R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)					

Discharge velocity is obtained from the following graph when knowing the typical drainage area slope.

Average velocities for estimating travel time for shallow concentrated flow



(210-VI-TR-55, Second Ed., June 1986)

4.0 DIVERSION BERM GEOMETRIES (AT EXCAVATION RIM)

Stormwater Diversion Berm Summary Sheet							
Surface Slope (outside excavations) = 2 Percent							
Area Sloping Toward Excavation Width, Ft (W)	Area Sloping Toward Excavation Length, Ft (L)	Area Sloping Toward Excavation, Ft^2 ($A_{drainage}$)	Area Sloping Toward Excavation, Acres ($A_{drainage}$)	Diverted Stormwater Storage Volume Required, Ft^3 ($V_{required}$)	Average Depth of Water in Diverted Stormwater Storage Area, Ft (D_{avg})	Diverted Stormwater Storage Area Slope, ft/ft (S)	Diversion Berm Height Required, Ft (H_{berm})
200	150	30,000	0.69	29,000	1.0	0.02	2.97
400	150	60,000	1.38	58,000	1.0	0.02	2.97
600	150	90,000	2.07	87,000	1.0	0.02	2.97
800	150	120,000	2.75	116,000	1.0	0.02	2.97

Notes:

R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)

$A_{drainage}$ = Drainage Area flowing toward top of excavation

$V_{required}$ = Volume of stormwater required to be stored behind berm = $A_{drainage}$ x R

D_{avg} = Average depth of diverted stormwater stored behind berm at top of excavation = $V_{required}$ / (L x W)

H_{berm} = Required height of berm = ((L/2) x S) + D_{avg} + H_{FB}

where: H_{FB} = freeboard = 0.5 ft, S = slope of area sloping toward top of excavation = 0.02 ft/ft

5.0 CONTAINMENT BERM GEOMETRIES (CONTAMINATED WATER IN EXCAVATIONS)

Containment Berm Summary Sheet

Bottom of Excavation has 1 Percent Slope

Waste Excavation Working Face Area (exposed waste), **Ft^2** **($A_{working\ face}$)**	**Waste Excavation Working Face Area, acres ($A_{working\ face}$)**	**Storage Area Width, Ft (W)**	**Storage Area Length, Ft (L)**	**Contact Water Storage Area** (working face to containment berm), **Ft^2** **($A_{storage}$)**	**Drainage Area, Ft^2 ($A_{drainage}$)**	**Contact Water Storage Volume Required, Ft^3 ($V_{required}$)**	**Average Depth of Liquid in Storage Area, Ft (D_{avg})**	**Storage Area Bottom Slope, ft/ft (S)**	**Containment Berm Height Required, Ft (H_{berm})**
5,600	0.13	100	100	10,000	12,800	12,373	1.2	0.01	2.24
8,400	0.19	150	150	22,500	26,700	25,810	1.1	0.01	2.40
11,200	0.26	200	200	40,000	45,600	44,080	1.1	0.01	2.60
16,800	0.39	300	300	90,000	98,400	95,120	1.1	0.01	3.06

Notes:

R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)

$A_{drainage}$ = Drainage Area = C x $A_{working\ face}$ + $A_{storage}$

where: C = infiltration / abstraction reduction factor = 0.5

$V_{required}$ = Volume of contact water storage required = $A_{drainage}$ x R

D_{avg} = Average depth of liquid in storage area = $V_{required}$ / (L x W)

H_{berm} = Required height of Berm = ((L/2) x S) + D_{avg} + H_{FB}

where: H_{FB} = freeboard = 0.5 ft, S = slope of storage area bottom = 0.01 ft/ft

6.0 CONTAINMENT BERM GEOMETRIES (CLEAN WATER IN EXCAVATIONS)

Containment Berm Summary Sheet (Clean Water Containment in Excavations)

Bottom of Excavation has 1 Percent Slope

Soil Excavation Working Face Area (exposed waste), Ft^2 ($A_{working\ face}$)	Soil Excavation Working Face Area, acres ($A_{working\ face}$)	Storage Area Width, Ft (W)	Storage Area Length, Ft (L)	Clean Water Storage Area (working face to containment berm), Ft^2 ($A_{storage}$)	Drainage Area, Ft^2 ($A_{drainage}$)	Clean Water Storage Volume Required, Ft^3 ($V_{required}$)	Average Depth of Liquid in Storage Area, Ft (D_{avg})	Storage Area Bottom Slope, ft/ft (S)	Containment Berm Height Required, Ft (H_{berm})
28,000	0.64	100	200	20,000	34,000	32,867	1.6	0.01	3.14
33,600	0.77	200	200	40,000	56,800	54,907	1.4	0.01	2.87
50,400	1.16	300	300	90,000	115,200	111,360	1.2	0.01	3.24
72,800	1.67	300	500	150,000	186,400	180,187	1.2	0.01	4.20

Notes:

R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)

$A_{drainage}$ = Drainage Area = C x $A_{working\ face}$ + $A_{storage}$

where: C = infiltration / abstraction reduction factor = 0.5

$V_{required}$ = Volume of clean water storage required = $A_{drainage}$ x R

D_{avg} = Average depth of liquid in storage area = $V_{required}$ / (L x W)

H_{berm} = Required height of Berm = ((L/2) x S) + D_{avg} + H_{FB}

where: H_{FB} = freeboard = 0.5 ft, S = slope of storage area bottom = 0.01 ft/ft

7.0 PROCESSING PAD CONTAINMENT BERM CALCULATIONS

The calculations below determine that the required height of the containment berm surrounding the processing pad is 2.~~0~~ 5 feet considering the 25-year 24-hours storm, worst case spill (presumed to be four full frac tanks), and freeboard required by TCEQ regulations.

Processing Pad Summary Sheet (400' x 500' pad south of West University Landfill)
Bottom of Excavation has 1 Percent Slope

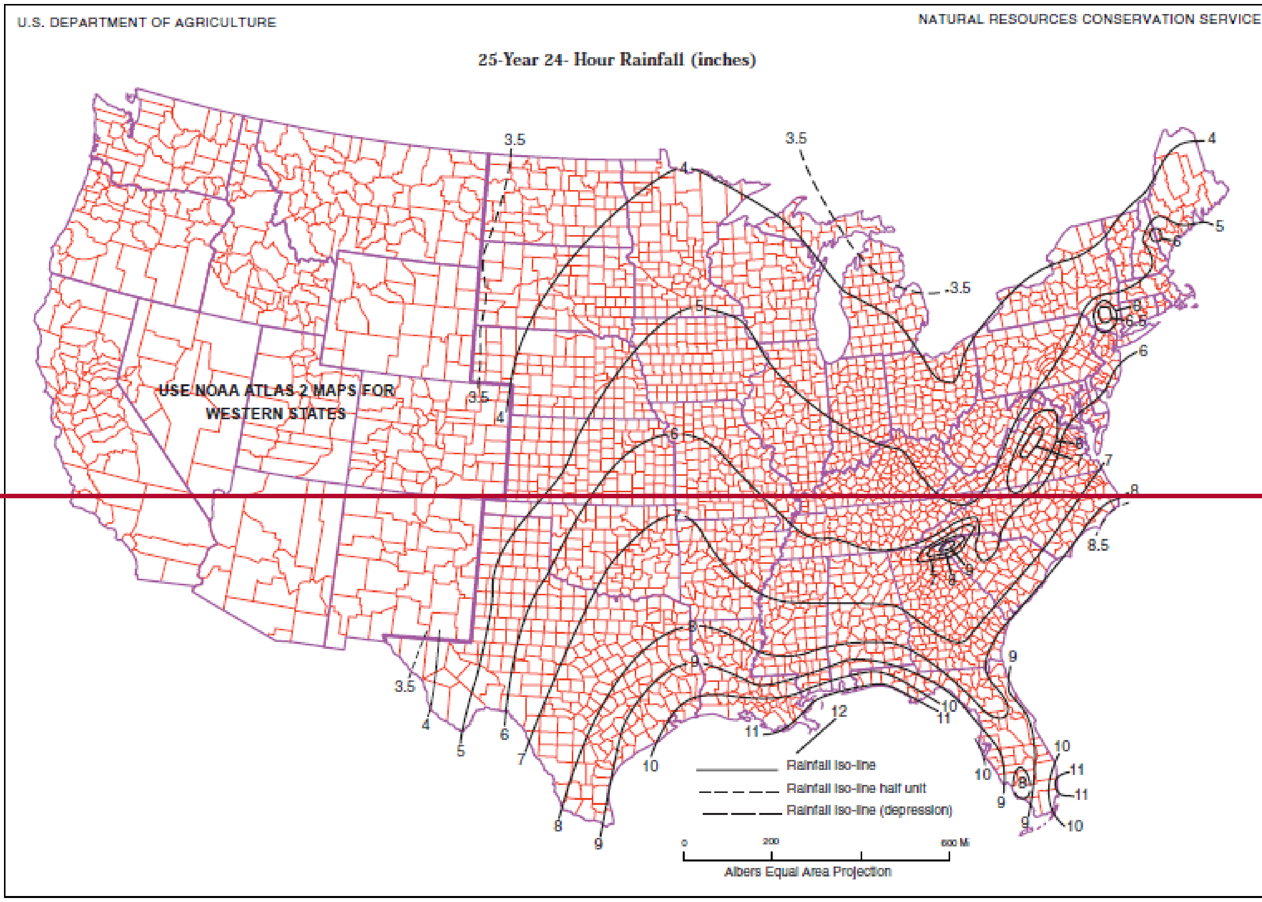
Processing Pad Width, Ft (W)	Processing Pad Length, Ft (L)	Processing Pad Area (Within containment berms), Ft^2	Volume of Water Collected in Processing Pad from 25-year, 24-hour storm, Ft^3	Depth of Water on Processing Pad from 25-yr 24-hr storm, Ft	Volume of Worst Case Spill Presumed to be 4 frac tanks, Gallons	Volume of Worst Case Spill Presumed to be 4 frac tanks, Ft3	Depth of Liquid on Processing Pad from Worst Case Spill, Ft	Freeboard Required by 30 TAC 207(b), Ft.	Containment Berm Height Required Considering 25 yr 24 hr Storm, Worst Case Spill, and Freeboard, Ft
400	500	200,000	193,333	1.0	84,000	11,230	0.1	1.0	2.0

Notes:
R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)
30 TAC 330.207(b) requires 1 foot of freeboard
30 TAC 330.227 requires containment of worst case spill precipitation from a 25-year, 24-hour storm.
1 cubic foot of liquid = 7.48 gallons

Processing Pad Containment Calculations (400' x 500' pad south of West University Landfill)

Processing Pad Area (Within containment berms), Ft^2	Estimate of Pad Area Occupied by Material Piles (15k cy) & Equipment, Ft^2	Area Occupied by Two Frac Tanks, Ft^2	Volume of Water Collected in Processing Pad from 25-year, 24-hour storm, Ft^3	Depth of Water on Processing Pad from 25-yr 24-hr storm, Ft	Volume of Worst Case Spill Presumed to be 2 frac tanks, Gallons	Depth of Liquid on Processing Pad from Worst Case Spill, Ft	Freeboard Required by 30 TAC 207(b), Ft.	Containment Berm Height Required Considering 25 yr 24 hr Storm, Worst Case Spill, and Freeboard, Ft
186,725	40,500	714	180,501	1.2	42,000	0.3	1	2.5

Notes:
Berm height above pad floor = 2.5 ft.
R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)
30 TAC 330.207(b) requires 1 foot of freeboard
30 TAC 330.227 requires containment of worst case spill plus precipitation from a 25-year, 24-hour storm.
Pad design capacity for excavated or processed material = 15,000 cu. yds. Estimated average pile height is 10 ft.
Processing equipment will be track-mounted and occupy negligible volume from the pad surface to 2.5-ft height.
Bottom of Excavation has 1 Percent Slope
1 cubic foot of liquid = 7.48 gallons



(210-VI-TR-55, Second Ed., June 1986)

Attachment 2 Unmarked Pages

Attachment III-7 to Part III

Drainage Calculations

Prepared for:

City of Houston Public Works - Transportation and Drainage Operations

611 Walker Street, Houston, Texas 77002

Prepared by:

TETRA TECH

STATE OF TEXAS
JAMES M. NORSTROM
57016
LICENSED
PROFESSIONAL ENGINEER
03/03/25
TETRA TECH, INC.
FIRM REGISTRATION NO. F-3924

TBPELS Registration No. F-3924

1500 CityWest Boulevard, Suite 1000, Houston, TX 77042

936-202-0746

Original Submittal April 2023

Revised June 2024

November 2024, February 2025

Drainage Calculations

TABLE OF CONTENTS

1.0 INTRODUCTION

The facility was designed and constructed, and will be operated, to comply with the requirements of §330.303. The design of the facility will manage run-on and runoff during the peak discharge of a 25- year rainfall event and will prevent the off-site discharge of waste and feedstock material, including, but not limited to, in-process and/or processed materials. Surface water drainage in and around the facility will be controlled to minimize surface water running onto, into, and from the treatment area.

The drainage design is discussed in the Part III Supplement, Section 3.2. The pre-development drainage subareas drawings are Attachment III-8. Calculations are presented in this report. Using the following parameters:

- Design precipitation depth for the 25-year, 24-hour storm event
- Time of concentration
- Rainfall intensity
- Measurements of six drainage sub-areas onsite
- For each sub-area and the design storm:
  - Peak flows
  - Runoff volume
  - Drainage velocity

Post-development drainage parameters were not calculated because excavations to remove waste will detain stormwater and be pumped as necessary by the excavation contractor. Earthen berms will be necessary to:

1. Contain water in the bottom of excavations that has been in contact with waste (contaminated water) for proper collection, storage, and disposal
2. Divert stormwater from entering excavations

Required berm heights for various configurations of upslope runoff areas and waste excavation geometries are presented below. Diversion and containment berms will be constructed from compacted clay and protected from erosion. Berms will be installed around excavations as needed to divert water. As shown on Attachment III-4, the Processing Pad will have a complete perimeter berm. See Attachment III-4.1 for an example internal berm configuration in a waste excavation.

2.0 DRAINAGE PARAMETERS

NOAA's Hydrometeorological Design Studies Center Precipitation Frequency Data Center (PFDC) (PF Map: Contiguous US (noaa.gov)) is the source of the 25-year, 24-hour design storm water depth for the proposed landfill mining project site.

As shown in the following table, the 25-year, 24-hour design storm water depth for the Ruffino Road site is 11.6 inches (NOAA-14 website on 11/20/24).

An excavation bottom slope of one percent is used. Excavation bottoms will be very close to the top of the old landfill clay liners. Borings show that the top of clay liner may be flat, so our one percent slope represents localized grading as needed to convey stormwater to shallow channels and sumps where water can be removed by pumping.

NOAA Atlas 14, Volume 11, Version 2
Location name: Houston, Texas, USA*
Latitude: 29.7304°, Longitude: -95.3697°
Elevation: 42 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	0.498 (0.377-0.658)	0.586 (0.447-0.764)	0.727 (0.553-0.954)	0.846 (0.635-1.13)	1.01 (0.735-1.39)	1.14 (0.807-1.61)	1.28 (0.879-1.85)	1.42 (0.954-2.11)	1.62 (1.05-2.50)	1.78 (1.13-2.81)
10-min	0.789 (0.597-1.04)	0.929 (0.708-1.21)	1.16 (0.879-1.52)	1.35 (1.01-1.79)	1.61 (1.18-2.22)	1.82 (1.29-2.58)	2.04 (1.41-2.96)	2.26 (1.52-3.36)	2.55 (1.65-3.92)	2.77 (1.75-4.38)
15-min	1.01 (0.762-1.33)	1.18 (0.899-1.54)	1.46 (1.11-1.92)	1.69 (1.27-2.26)	2.02 (1.47-2.77)	2.27 (1.61-3.20)	2.53 (1.75-3.67)	2.82 (1.89-4.19)	3.20 (2.08-4.94)	3.52 (2.22-5.56)
30-min	1.45 (1.10-1.91)	1.69 (1.29-2.20)	2.07 (1.58-2.72)	2.40 (1.80-3.19)	2.84 (2.06-3.89)	3.18 (2.25-4.48)	3.54 (2.44-5.14)	3.95 (2.66-5.89)	4.55 (2.96-7.02)	5.04 (3.19-7.96)
60-min	1.90 (1.44-2.51)	2.24 (1.70-2.92)	2.78 (2.11-3.64)	3.23 (2.42-4.30)	3.86 (2.80-5.28)	4.35 (3.07-6.12)	4.87 (3.36-7.06)	5.48 (3.69-8.17)	6.41 (4.17-9.90)	7.19 (4.55-11.4)
2-hr	2.29 (1.75-3.01)	2.80 (2.12-3.57)	3.57 (2.72-4.64)	4.26 (3.21-5.64)	5.27 (3.84-7.18)	6.09 (4.33-8.54)	7.02 (4.86-10.1)	8.12 (5.48-12.0)	9.81 (6.40-15.1)	11.3 (7.15-17.7)
3-hr	2.50 (1.91-3.27)	3.14 (2.36-3.94)	4.07 (3.11-5.26)	4.94 (3.74-6.52)	6.25 (4.58-8.50)	7.35 (5.25-10.3)	8.63 (5.99-12.4)	10.1 (6.85-15.0)	12.5 (8.14-19.1)	14.5 (9.21-22.7)
6-hr	2.88 (2.21-3.74)	3.75 (2.81-4.61)	4.97 (3.81-6.36)	6.16 (4.69-8.07)	7.99 (5.91-10.8)	9.59 (6.90-13.4)	11.5 (8.00-16.4)	13.7 (9.26-20.0)	17.1 (11.2-26.0)	20.0 (12.8-31.1)
12-hr	3.32 (2.56-4.28)	4.41 (3.30-5.34)	5.92 (4.56-7.52)	7.41 (5.67-9.65)	9.72 (7.23-13.1)	11.8 (8.51-16.4)	14.2 (9.93-20.1)	17.0 (11.6-24.8)	21.3 (14.0-32.3)	25.1 (16.1-38.9)
24-hr	3.80 (2.95-4.88)	5.13 (3.85-6.16)	6.96 (5.40-8.78)	8.78 (6.75-11.4)	11.6 (8.69-15.6)	14.1 (10.3-19.6)	17.1 (12.0-24.1)	20.5 (14.0-29.6)	25.6 (16.9-38.5)	29.9 (19.3-46.2)
2-day	4.34 (3.39-5.53)	5.97 (4.49-7.08)	8.20 (6.39-10.3)	10.4 (8.06-13.4)	13.9 (10.5-18.7)	17.0 (12.5-23.5)	20.6 (14.6-28.9)	24.5 (16.8-35.2)	29.9 (19.8-44.7)	34.4 (22.2-52.8)
3-day	4.74 (3.72-6.02)	6.52 (4.93-7.72)	8.96 (7.01-11.2)	11.4 (8.83-14.6)	15.1 (11.5-20.3)	18.6 (13.7-25.5)	22.4 (15.9-31.3)	26.4 (18.1-37.8)	31.9 (21.2-47.5)	36.4 (23.6-55.6)
4-day	5.08 (3.99-6.42)	6.91 (5.26-8.19)	9.46 (7.42-11.8)	12.0 (9.30-15.3)	15.8 (12.0-21.1)	19.3 (14.3-26.5)	23.2 (16.5-32.4)	27.3 (18.8-39.0)	32.9 (21.8-48.8)	37.3 (24.2-57.0)
7-day	5.83 (4.60-7.35)	7.74 (5.95-9.20)	10.4 (8.22-12.9)	13.0 (10.2-16.5)	17.0 (13.0-22.6)	20.6 (15.2-28.0)	24.5 (17.5-34.0)	28.6 (19.8-40.7)	34.3 (22.9-50.6)	38.8 (25.2-58.9)
10-day	6.48 (5.13-8.14)	8.44 (6.54-10.1)	11.2 (8.88-13.9)	13.9 (10.9-17.6)	17.9 (13.7-23.7)	21.5 (15.9-29.2)	25.4 (18.2-35.2)	29.5 (20.5-41.9)	35.2 (23.5-51.8)	39.6 (25.8-60.1)
20-day	8.59 (6.83-10.7)	10.6 (8.41-12.8)	13.7 (10.9-16.9)	16.5 (13.0-20.7)	20.6 (15.7-26.8)	24.0 (17.8-32.2)	27.6 (19.8-38.0)	31.5 (22.0-44.5)	36.9 (24.8-54.1)	41.2 (26.9-62.1)
30-day	10.4 (8.29-12.9)	12.5 (10.0-15.2)	15.8 (12.7-19.5)	18.7 (14.8-23.5)	22.8 (17.4-29.5)	26.1 (19.3-34.8)	29.5 (21.2-40.4)	33.2 (23.2-46.8)	38.3 (25.8-56.1)	42.4 (27.8-63.7)
45-day	13.0 (10.4-16.1)	15.3 (12.4-18.7)	19.1 (15.4-23.5)	22.2 (17.6-27.7)	26.5 (20.2-34.1)	29.7 (22.1-39.4)	33.0 (23.8-45.1)	36.5 (25.6-51.2)	41.2 (27.8-60.0)	44.8 (29.4-67.1)
60-day	15.4 (12.4-19.0)	17.9 (14.6-21.9)	22.1 (17.9-27.1)	25.4 (20.2-31.6)	29.9 (22.9-38.4)	33.2 (24.7-43.9)	36.4 (26.3-49.6)	39.7 (27.9-55.6)	44.0 (29.8-63.9)	47.2 (31.0-70.4)

[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

The minimum (most conservative) Time of Concentration (t_c) from TXDOT guidance is 10 minutes. Using a 10-minute time of concentration and the following table, Rainfall Intensity is determined.

Rainfall Intensity-Duration-Frequency Coefficients for Texas

Based on United States Geological Survey (USGS) Scientific Investigations Report 2004–5041
"Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas"

1. Select English or SI Units: English

2. Select or Enter a County: Harris

3. Enter a Time of Conc. Select Units: 10 min

Coefficient	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)
e	0.7939	0.7855	0.7829	0.7774	0.7727	0.772
b (in.)	57.73	73.87	86.47	102.23	116.88	136.33
d (min)	9.48	10.46	11.27	12.32	12.95	14.08
Intensity (in./hr)	5.47	6.90	7.90	9.14	10.38	11.69

(Spreadsheet Release Date: August 31, 2015; data table reshuffle by Asquith July 14, 2016)

Peak Flow for existing conditions is obtained from the following formula:

$$Q = CIA$$

Where

- Q = flow in cubic feet per second (cfs)
- C = runoff coefficient $C = C_r + C_i + C_v + C_s = 0.10 + 0.10 + 0.05 + 0.08 = 0.33$
- I = rainfall intensity = 9.14 inches / hour
- A = area contributing runoff to the discharge point (or sheet flow)

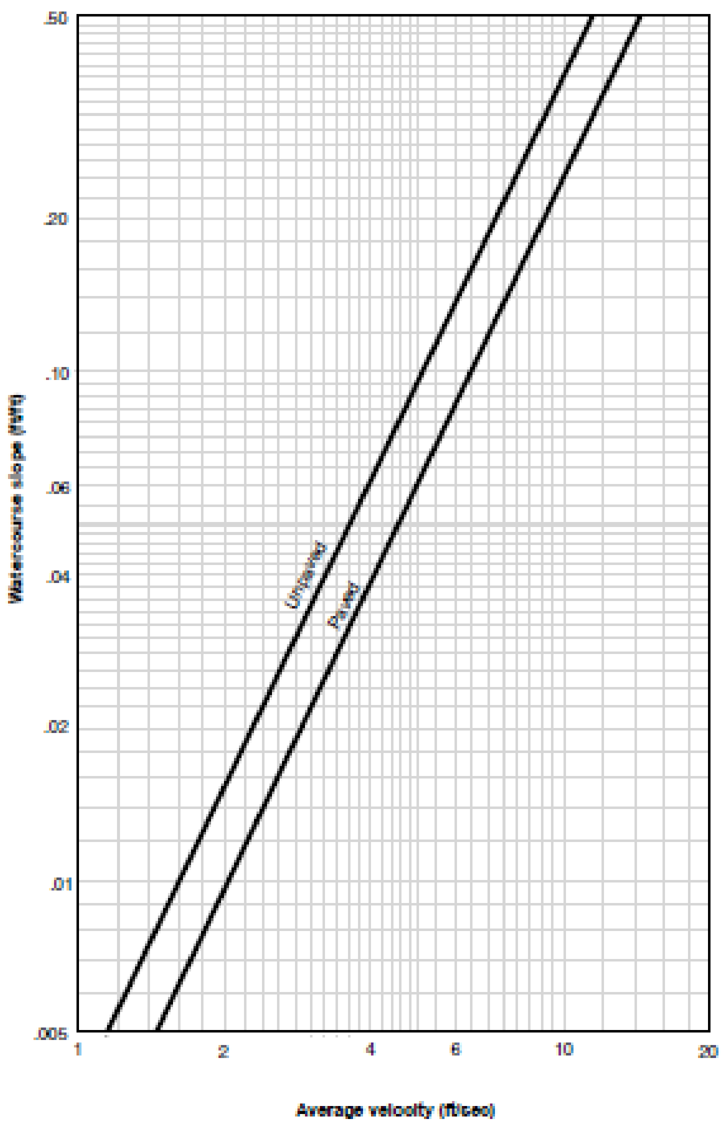
3.0 DRAINAGE SUB-AREA FLOW RATE, VOLUME, AND VELOCITY

Drainage sub-area acres, flow rate, runoff volume, and velocity are presented in the following table.

Drainage Sub-Area Flow, Volume, Velocity					
Drainage Area	Drainage Sub-Area Area, acres	Typical Surface Slope	Flow, ft^3/sec (Q)	Water Volume from Design Storm, acre-ft	Runoff Velocity, feet/sec (from TR-55 graph)
1	6.5	0.020	19.61	2.07	2.18
2	19.4	0.009	58.51	6.19	1.47
3	31.6	0.012	95.31	10.08	1.78
4	41.9	0.020	126.38	13.37	2.18
5	24.6	0.007	74.20	7.85	1.35
6	19.7	0.026	59.42	6.28	2.60
Notes:					
C =	0.33				
I =	9.14	in/hr			
Design Storm					
Rainfall Depth	11.6	in			
R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)					

Discharge velocity is obtained from the following graph when knowing the typical drainage area slope.

Average velocities for estimating travel time for shallow concentrated flow



(210-VI-TR-55, Second Ed., June 1986)

4.0 DIVERSION BERM GEOMETRIES (AT EXCAVATION RIM)

Stormwater Diversion Berm Summary Sheet

Surface Slope (outside excavations) = 2 Percent

Area Sloping Toward Excavation Width, Ft (W)	Area Sloping Toward Excavation Length, Ft (L)	Area Sloping Toward Excavation, Ft^2 ($A_{drainage}$)	Area Sloping Toward Excavation, Acres ($A_{drainage}$)	Diverted Stormwater Storage Volume Required, Ft^3 ($V_{required}$)	Average Depth of Water in Diverted Stormwater Storage Area, Ft (D_{avg})	Diverted Stormwater Storage Area Slope, ft/ft (S)	Diversion Berm Height Required, Ft (H_{berm})
200	150	30,000	0.69	29,000	1.0	0.02	2.97
400	150	60,000	1.38	58,000	1.0	0.02	2.97
600	150	90,000	2.07	87,000	1.0	0.02	2.97
800	150	120,000	2.75	116,000	1.0	0.02	2.97

Notes:

R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)

$A_{drainage}$ = Drainage Area flowing toward top of excavation

$V_{required}$ = Volume of stormwater required to be stored behind berm = $A_{drainage}$ x R

D_{avg} = Average depth of diverted stormwater stored behind berm at top of excavation = $V_{required}$ / (L x W)

H_{berm} = Required height of berm = ((L/2) x S) + D_{avg} + H_{FB}

where: H_{FB} = freeboard = 0.5 ft, S = slope of area sloping toward top of excavation = 0.02 ft/ft

5.0 CONTAINMENT BERM GEOMETRIES (CONTAMINATED WATER IN EXCAVATIONS)

Containment Berm Summary Sheet
Bottom of Excavation has 1 Percent Slope

Waste Excavation Working Face Area (exposed waste), Ft^2 ($A_{working\ face}$)	Waste Excavation Working Face Area, acres ($A_{working\ face}$)	Storage Area Width, Ft (W)	Storage Area Length, Ft (L)	Contact Water Storage Area (working face to containment berm), Ft^2 ($A_{storage}$)	Drainage Area, Ft^2 ($A_{drainage}$)	Contact Water Storage Volume Required, Ft^3 ($V_{required}$)	Average Depth of Liquid in Storage Area, Ft (D_{avg})	Storage Area Bottom Slope, ft/ft (S)	Containment Berm Height Required, Ft (H_{berm})
5,600	0.13	100	100	10,000	12,800	12,373	1.2	0.01	2.24
8,400	0.19	150	150	22,500	26,700	25,810	1.1	0.01	2.40
11,200	0.26	200	200	40,000	45,600	44,080	1.1	0.01	2.60
16,800	0.39	300	300	90,000	98,400	95,120	1.1	0.01	3.06

Notes:
R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)
$A_{drainage}$ = Drainage Area = C x $A_{working\ face}$ + $A_{storage}$
where: C = infiltration / abstraction reduction factor = 0.5
$V_{required}$ = Volume of contact water storage required = $A_{drainage}$ x R
D_{avg} = Average depth of liquid in storage area = $V_{required}$ / (L x W)
H_{berm} = Required height of Berm = ((L/2) x S) + D_{avg} + H_{FB}
where: H_{FB} = freeboard = 0.5 ft, S = slope of storage area bottom = 0.01 ft/ft

6.0 CONTAINMENT BERM GEOMETRIES (CLEAN WATER IN EXCAVATIONS)

Containment Berm Summary Sheet (Clean Water Containment in Excavations)

Bottom of Excavation has 1 Percent Slope

Soil Excavation Working Face Area (exposed waste), Ft^2 ($A_{working\ face}$)	Soil Excavation Working Face Area, acres ($A_{working\ face}$)	Storage Area Width, Ft (W)	Storage Area Length, Ft (L)	Clean Water Storage Area (working face to containment berm), Ft^2 ($A_{storage}$)	Drainage Area, Ft^2 ($A_{drainage}$)	Clean Water Storage Volume Required, Ft^3 ($V_{required}$)	Average Depth of Liquid in Storage Area, Ft (D_{avg})	Storage Area Bottom Slope, ft/ft (S)	Containment Berm Height Required, Ft (H_{berm})
28,000	0.64	100	200	20,000	34,000	32,867	1.6	0.01	3.14
33,600	0.77	200	200	40,000	56,800	54,907	1.4	0.01	2.87
50,400	1.16	300	300	90,000	115,200	111,360	1.2	0.01	3.24
72,800	1.67	300	500	150,000	186,400	180,187	1.2	0.01	4.20

Notes:

R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)

$A_{drainage}$ = Drainage Area = C x $A_{working\ face}$ + $A_{storage}$

where: C = infiltration / abstraction reduction factor = 0.5

$V_{required}$ = Volume of clean water storage required = $A_{drainage}$ x R

D_{avg} = Average depth of liquid in storage area = $V_{required}$ / (L x W)

H_{berm} = Required height of Berm = ((L/2) x S) + D_{avg} + H_{FB}

where: H_{FB} = freeboard = 0.5 ft, S = slope of storage area bottom = 0.01 ft/ft

7.0 PROCESSING PAD CONTAINMENT BERM CALCULATIONS

The calculations below determine that the required height of the containment berm surrounding the processing pad is 2.5 feet considering the 25-year 24-hours storm, worst case spill (presumed to be four full frac tanks), and freeboard required by TCEQ regulations.

Processing Pad Containment Calculations (400' x 500' pad south of West University Landfill)

Processing Pad Area (Within containment berms), Ft^2	Estimate of Pad Area Occupied by Material Piles (15k cy) & Equipment, Ft^2	Area Occupied by Two Frac Tanks, Ft^2	Volume of Water Collected in Processing Pad from 25-year, 24-hour storm, Ft^3	Depth of Water on Processing Pad from 25-yr 24-hr storm, Ft	Volume of Worst Case Spill Presumed to be 2 frac tanks, Gallons	Depth of Liquid on Processing Pad from Worst Case Spill, Ft	Freeboard Required by 30 TAC 207(b), Ft.	Containment Berm Height Required Considering 25 yr 24 hr Storm, Worst Case Spill, and Freeboard, Ft
186,725	40,500	714	180,501	1.2	42,000	0.3	1	2.5

Notes:

Berm height above pad floor = 2.5 ft.

R = 25-year, 24-hour storm depth = 11.6 in. (NOAA 14 on 11/20/24)

30 TAC 330.207(b) requires 1 foot of freeboard

30 TAC 330.227 requires containment of worst case spill plus precipitation from a 25-year, 24-hour storm.

Pad design capacity for excavated or processed material = 15,000 cu. yds. Estimated average pile height is 10 ft.

Processing equipment will be track-mounted and occupy negligible volume from the pad surface to 2.5-ft height.

Bottom of Excavation has 1 Percent Slope

1 cubic foot of liquid = 7.48 gallons