

Storm Water Calculations for

Culver's Vienna Twp, MI

Job No. 220423

July 30, 2026

Design Parameters

Detention Basin with Outlet:

- Treat the first 0.9 inch of rainfall runoff
- Retain the volume increase between post and pre-development volumes for the 2-year storm event
- Detain the 100-year storm event, using the release rates no more than 0.2 cfs/acre.
- Maximum basin side slopes of 4:1
- Emergency overflow for the 10-year design flow
- Minimum freeboard of 1 foot

Storm Sewer Design:

- Storm Sewer design is for a 10-year design storm using the Rational method for analysis
- Minimum pipe velocity of 2.5 ft/sec
- Maximum pipe velocity of 10.0 ft/sec
- HGL below rim

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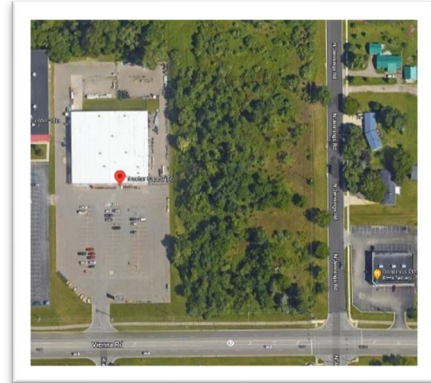
Storm Water Narrative For
Culver's, Vienna Twp, MI
Project #220423

Project Description:

The owner proposes to develop 1.56 acres of a 5.9-acre property into a fast casual restaurant with drive through. The site is currently vacant. The topography slopes from south to north.

Based on the NRCS Soil Survey, the area consists of loamy fine sand with a Hydraulic Soil Group A. The water table is more than 80 inches below existing grade.

The proposed design collects the runoff and routes it to the proposed detention basin along the northwest edge of the property.



Basis of Design Information

The design is in accordance with the Genesee County Storm Water and Flood Control Design Standard Requirements dated June 2018.

The basin has been sized to accommodate the required first flush, the channel protection volume, and the 100-year storm event for the proposed development and the future development of the vacant land east of the restaurant. A rationale runoff coefficient of 0.85 was utilized for the future development. The majority of the water stored will infiltrate into the ground water since we are not to increase the storm water volume released for the 2-year storm event. An emergency overflow spillway can accommodate the 10-year storm event. There is a minimum of 1 foot of freeboard above the required storage volume. Side slopes are proposed at 1:4.

The table below provides a summary of required and provided design parameters for the basin.

Detention Basin	Required	Provided
Water Quality Volume (cf)	6,273	14,732
Channel Protection Volume (cf)	13,916	14,732
Flood Control Volume (cf)	17,774	30,840
Peak Water Elevation (ft)	699.00	700.00

Pipe Design:

The storm water pipes for the site were sized using the Rational Method for the 10-year storm event. The pipe design maintains a minimum velocity of 2.5 ft/second and a minimum diameter of 12 inches. Smooth lined corrugated plastic pipe is the proposed material for the storm sewer. Erosion control will be provided at all pipe outlets.

Custom Soil Resource Report Soil Map



Custom Soil Resource Report

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features

 Blowout

 Borrow Pit

 Clay Spot

 Closed Depression

 Gravel Pit

 Gravelly Spot

 Landfill

 Lava Flow

 Marsh or swamp

 Mine or Quarry

 Miscellaneous Water

 Perennial Water

 Rock Outcrop

 Saline Spot

 Sandy Spot

 Severely Eroded Spot

 Sinkhole

 Slide or Slip

 Sodic Spot

 Spoil Area

 Stony Spot

 Very Stony Spot

 Wet Spot

 Other

 Special Line Features

Water Features

 Streams and Canals

Transportation

 Rails

 Interstate Highways

 US Routes

 Major Roads

 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Genesee County, Michigan
Survey Area Data: Version 18, Aug 29, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 29, 2020—Aug 12, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
ArA	Arkport loamy fine sand, 0 to 2 percent slopes	2.1	39.3%
ArB	Arkport loamy fine sand, 2 to 6 percent slopes	2.9	53.9%
DrA	Del Rey silt loam, 0 to 2 percent slopes	0.4	6.8%
Totals for Area of Interest		5.4	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

Genesee County, Michigan

ArA—Arkport loamy fine sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 68df
Elevation: 730 to 840 feet
Mean annual precipitation: 31 to 32 inches
Mean annual air temperature: 47 to 47 degrees F
Frost-free period: 137 to 179 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Arkport and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arkport

Setting

Landform: Outwash plains, deltas on lake plains
Landform position (three-dimensional): Rise, talf
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Loamy glaciolacustrine deposits

Typical profile

Ap - 0 to 7 inches: loamy fine sand
E1 - 7 to 12 inches: loamy fine sand
E2 - 12 to 28 inches: loamy fine sand
B/E - 28 to 33 inches: very fine sandy loam
E and Bt - 33 to 80 inches: stratified very fine sand to very fine sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.60 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Ecological site: F099XY006MI - Cool Dry Sandy Ridge
Hydric soil rating: No

Minor Components

Minoa

Percent of map unit: 5 percent

Custom Soil Resource Report

Landform: Deltas on lake plains, swales on outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: F099XY005MI - Cool Moist Sandy Depression
Hydric soil rating: No

Lamson

Percent of map unit: 5 percent
Landform: Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F099XY012MI - Cool Wet Sandy Depression
Hydric soil rating: Yes

ArB—Arkport loamy fine sand, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 68dg
Elevation: 730 to 960 feet
Mean annual precipitation: 31 to 32 inches
Mean annual air temperature: 47 to 47 degrees F
Frost-free period: 137 to 179 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Arkport and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arkport

Setting

Landform: Outwash plains, knolls on till plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits

Typical profile

Ap - 0 to 7 inches: loamy fine sand
E1 - 7 to 12 inches: loamy fine sand
E2 - 12 to 28 inches: loamy fine sand
B/E - 28 to 33 inches: very fine sandy loam
E and Bt - 33 to 80 inches: stratified very fine sand to very fine sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained

Custom Soil Resource Report

Runoff class: Very low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.60 to 20.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2e

Hydrologic Soil Group: A

Ecological site: F099XY006MI - Cool Dry Sandy Ridge

Hydric soil rating: No

Minor Components

Minoa

Percent of map unit: 10 percent

Landform: Deltas, swales on till plains, outwash plains

Landform position (three-dimensional): Rise

Down-slope shape: Linear

Across-slope shape: Convex

Ecological site: F099XY005MI - Cool Moist Sandy Depression

Hydric soil rating: No

DrA—Del Rey silt loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 68fb

Elevation: 690 to 910 feet

Mean annual precipitation: 31 to 32 inches

Mean annual air temperature: 47 to 47 degrees F

Frost-free period: 137 to 179 days

Farmland classification: Prime farmland if drained

Map Unit Composition

Del rey and similar soils: 90 percent

Minor components: 10 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Del Rey

Setting

Landform: Flats on lake plains

Landform position (three-dimensional): Rise

Down-slope shape: Linear

Across-slope shape: Convex

Parent material: Clayey glaciolacustrine deposits and/or till

Typical profile

Ap - 0 to 9 inches: sandy loam

E - 9 to 15 inches: silt loam

Bt - 15 to 28 inches: silty clay loam

BC - 28 to 32 inches: silty clay loam

C - 32 to 80 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Somewhat poorly drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: About 6 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 30 percent

Available water supply, 0 to 60 inches: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2w

Hydrologic Soil Group: C/D

Ecological site: F098XA011MI - Moist Loamy Drift Plains

Hydric soil rating: No

Minor Components

Lenawee

Percent of map unit: 5 percent

Landform: Depressions on lake plains

Landform position (three-dimensional): Talf

Down-slope shape: Linear

Across-slope shape: Linear

Ecological site: F098XA012MI - Wet Loamy Depressions

Hydric soil rating: Yes

Allendale

Percent of map unit: 5 percent

Landform: Flats on lake plains

Landform position (three-dimensional): Rise

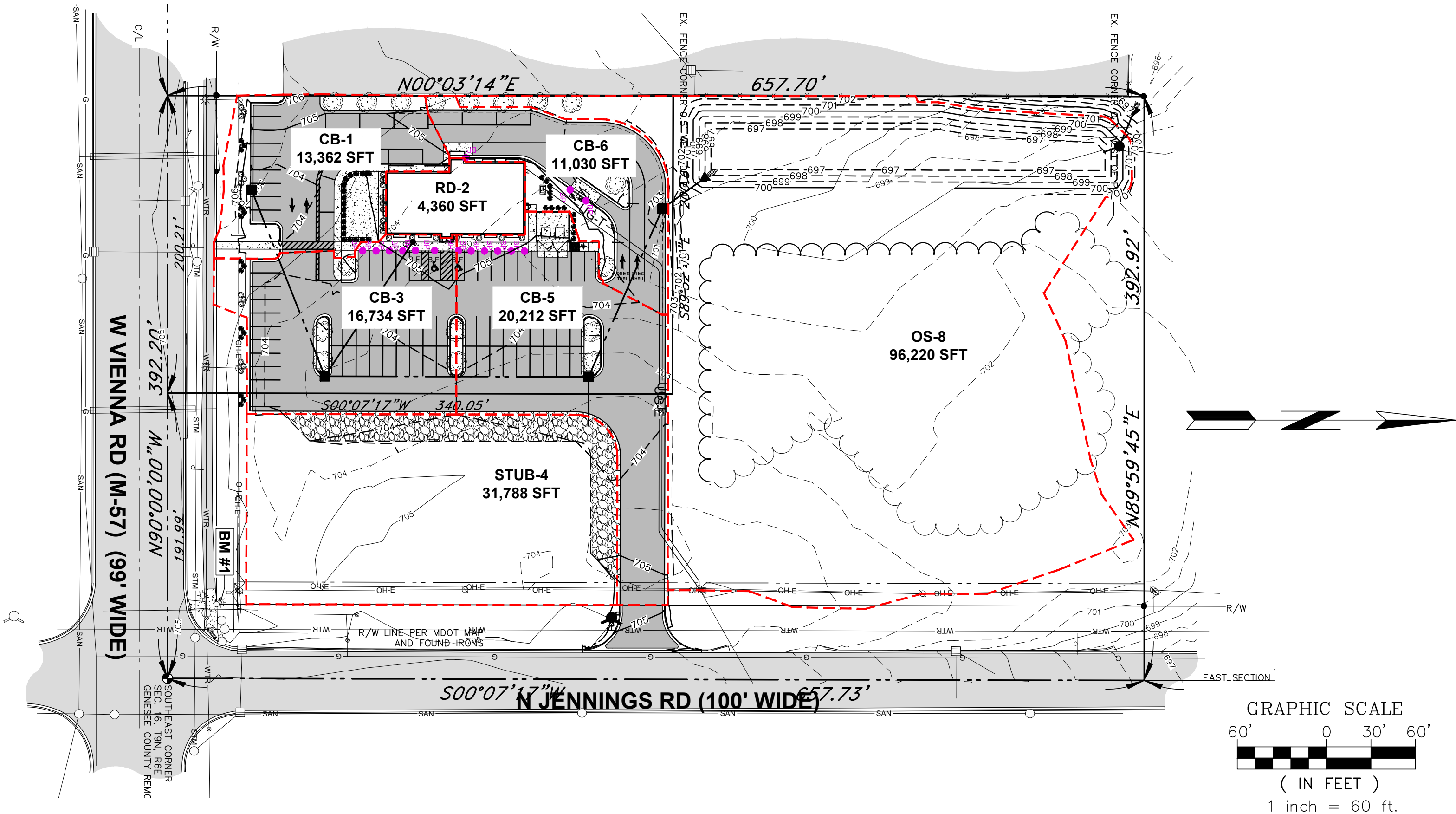
Down-slope shape: Linear

Across-slope shape: Convex

Ecological site: F098XA017MI - Moist Acidic Drift Flats

Hydric soil rating: No

PROPOSED DRAINAGE MAP

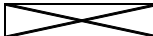
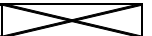


WEIGHTED "C"

Calculated by: YS
 Checked by: MDC

Date: 7/24/2026 Project Name: Culver's - Vienna
 Date: 7/29/2026 Project # 220423

							10 Year	100 Year		
							Pavement: c =	0.95	0.97	
							Gravel : c =	0.85	0.91	
							Green Space / Lawn: c =	0.25	0.30	
							Water Surface: c =	1.00	1.00	
Structure	Area (sft)	Area (acres)	Hard Surface (sft)	Hard Surface (acres)	Gravel Surface (acres)	RIM (feet)	10 Year CALC "C"	10 Year C X A	100 Year CALC "C"	100 Year C X A
CB-1	13,362	0.31	9,884	0.23		703.40	0.77	0.24	0.80	0.24
RD-2	4,360	0.10	4,360	0.10		705.50	0.95	0.10	0.97	0.10
CB-3	16,734	0.38	14,657	0.34		702.90	0.86	0.33	0.89	0.34
STUB-4	31,788	0.73	27,020	0.62		N/A	0.85	0.62	0.87	0.63
CB-5	20,212	0.46	18,444	0.42		702.90	0.89	0.41	0.91	0.42
CB-6	11,030	0.25	7,803	0.18		702.70	0.75	0.19	0.77	0.20
FE-7		0.00	0	0.00		N/A	0.00	0.00	0.00	0.00
OS-8	96,220	2.21	0	0.00		699.90	0.25	0.55	0.30	0.66
FE-9		0.00		0.00		N/A	0.00	0.00	0.00	0.00

Dev Totals = 4.45 1.89 0.00   1.88 1.94

Weighted C_w = 0.42 0.44

Rainfall

Location: Vienna
State: MI
Source: NOAA Atlas 14
Return Period: 10 year

Calculated by: YS
Date: 7/24/2026

Time	Hours	Mins	Rainfall (in)	Intensity (in/hr)
5 mins	0.083	5	0.50	5.98
10 mins	0.167	10	0.73	4.38
15 mins	0.25	15	0.89	3.56
30 mins	0.5	30	1.29	2.58
1 hrs	1	60	1.70	1.70
2 hrs	2	120	2.12	1.06
3 hrs	3	180	2.36	0.79
6 hrs	6	360	2.71	0.45
12 hrs	12	720	2.98	0.25
24 hrs	24	1440	3.34	0.14

Return Period: 100 year

Time	Hours	Mins	Rainfall (in)	Intensity (in/hr)
5 mins	0.083	5	0.79	9.42
10 mins	0.167	10	1.15	6.90
15 mins	0.25	15	1.40	5.60
30 mins	0.5	30	2.03	4.06
1 hrs	1	60	2.75	2.75
2 hrs	2	120	3.47	1.74
3 hrs	3	180	3.93	1.31
6 hrs	6	360	4.62	0.77
12 hrs	12	720	5.14	0.43
24 hrs	24	1440	5.78	0.24

STORM SEWER COMPUTATION SHEET

Calculated by: YS Date: July 24, 2026
Checked by: MC Date: July 29, 2026

Pipe Design Storm 10 Yr. Frequency

Project Name: Culver's - Vienna
Project # 220423

Minimum Time of Concentration: 20 minutes
Minimum Cover: 2.5 feet
Min. Pipe elev change at structure: 0.0 feet
Pipe Material Used: PE
Manning "n" value: 0.012

Gravity Pipe Flow: $Q = 1.486/n \cdot A \cdot R^{2/3} \cdot S^{1/2}$

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Notes:			Area (INPUT @ 2) (ACRES)	C For Input @ Col. 2	C x A	SUM OF C x A	Time of Conc. Tc (min)	Rainfall Intensity "I" (in/hr)	Design Flow Σ CxA x I (cfs)	Pipe Diameter (in)	Slope of Energy Grade Line (%)	Actual Pipe Slope (%)	Gravity Full Flow Discharge (cfs)	Gravity Full Flow Velocity (fps)	Pipe Length (ft)	Travel Time (min)	Pipe Invert Elevation		Rim Elevation		HGL Elevation	
	Structure ID																Upper End	Lower End	Upper End	Lower End	Upper End	Lower End
	From	To																				
	CB-1	CB-3	0.31	0.77	0.24	0.24	20.0	3.23	0.76	12	0.04%	0.37%	2.35	3.00	135	0.75	699.90	699.40	703.40	702.90	700.45	700.40
	RD-2	CB-3	0.10	0.95	0.10	0.10	20.0	3.23	0.31	6	0.26%	2.41%	0.94	4.81	108	0.37	702.50	699.90	705.50	702.90	700.57	700.29
	CB-3	CB-5	0.38	0.86	0.33	0.66	20.0	3.23	2.14	12	0.31%	0.37%	2.35	2.99	178	0.99	699.40	698.74	702.90	702.90	700.29	699.74
	STUB-4	CB-5	0.73	0.85	0.62	0.62	20.0	3.23	1.99	12	0.27%	0.32%	2.18	2.78	33	0.20	698.85	698.74	N/A	702.90	699.83	699.74
	CB-5	CB-6	0.46	0.89	0.41	1.69	20.0	3.23	5.47	18	0.24%	0.28%	6.02	3.41	124	0.61	698.74	698.40	702.90	702.70	699.44	699.15
	CB-6	FE-7	0.25	0.75	0.19	1.88	20.0	3.23	6.08	18	0.29%	0.34%	6.64	3.75	37	0.16	698.40	698.27	702.70	N/A	0.11	0.00
	OS-8	FE-9							6.78	12	3.10%	1.00%	3.86	4.91	28	0.09	697.00	696.72	699.90	N/A	698.59	697.72

Required Detention Basin Volume Calculation

Project Name: Culver's - Vienna
 Project Number: 220423
 Date: July 24, 2026
 Subcatchment: Basin

Required Water Quality:

Simple Method $Q_v = R_v * 0.9 * A$
 Rainfall: 0.9 in
 Volumetric Runoff Coefficient (Rv): 0.43 = 0.05 + 0.009 * % impervious
 Proposed Developed Drainage Area: 4.45 acres
Required Water Quality Volume: 6,273 cft

Required Channel Protection Volume:

Runoff Curve Number Method (SCS Runoff Curve Number Method)

COVER DESCRIPTION	Area (acres)	Area (%)	HYDROLOGIC SOIL GROUP				CN			
			A	B	C	D		S	Q (in)	V (cft)
			100%	0.0%	0.0%	0.0%				
Existing										
Lawn areas - Good	0.00	0%	39	61	74	80	0.0	0.00	0.00	0
Gravel	0.00	0%	76	85	89	91	0.0	0.00	0.00	0
Woods	2.24	100%	30	55	70	77	30.0	23.33	0.00	0
Pavement, roof	0.00	0%	98	98	98	98	0.0	0.00	0.00	0
	2.24									0
Proposed										
Lawn areas - Good	0.35	16%	39	61	74	80	39.0	15.64	0.00	0
Woods	0.00	0%	30	55	70	77	0.0	0.00	0.00	0
Paved parking, roof	1.89	84%	98	98	98	98	98.0	0.20	2.03	13,916
Gravel surface	0.00	0%	88	93	94	95	0.0	0.00	0.00	0
	2.24									13,916

Potential Max Retention (inches), $S = 1000/CN - 10 =$
 Rainfall (inches), $P =$ 2.26
 Surface Runoff (inches), $Q = (P - 0.2S)^2 / (P + 0.8S) =$
 $Q = 0$ if $P \leq 0.2 * S$
 Total Runoff Volume, $V =$ 0 13,916 cft
Required Channel Protection Volume: 13,916 cft

Required Flood Control:

Rainfall Interval: 100 year storm
 Proposed Drainage Area: 4.45 acres
 Runoff Coefficient (C): 0.44
 Allowed Release Rate: 0.20 cfs/acre
 Max. Allowable Offsite Discharge: 0.89 cfs

Time Duration		Rainfall Intensity		Qin (cfs)	Qout (cfs)	Required Storage (cft)
Minutes	Time (hr)	I (in/hr)	R (in)			
5	0.08	9.42	0.79	18.23	0.89	5,202
10	0.17	6.90	1.15	13.35	0.89	7,478
15	0.25	5.60	1.40	10.84	0.89	8,953
30	0.50	4.06	2.03	7.86	0.89	12,542
60	1.0	2.75	2.75	5.32	0.89	15,957
120	2.0	1.735	3.47	3.36	0.89	17,771
180	3.0	1.310	3.93	2.54	0.89	17,774
360	6.0	0.770	4.62	1.49	0.89	12,976
720	12.0	0.428	5.14	0.83	0.89	(2,612)
1440	24.0	0.241	5.78	0.47	0.89	(36,574)

Required Safety Factor: 1.00
Required Flood Control Volume: 17,774 cft

Provided Detention Basin Volume Calculation

Project Name: Culver's - Vienna
 Project Number: 220423

Date: July 24, 2026
 Subcatchment: Basin

Storage Provided - Total

	Elevation	Area (sft)	Volume (cft)	Cumulative Volume (cft)	Req Volume (cft)
Bottom of Basin	697.00	6,630	0	0	
Water Quality Vol.	697.90	8,771	6,930	6,930	6,273
	698.00	9,009	889	7,820	
Bank Protection Vol.	698.70	10,742	6,913	14,732	13,916
	698.90	11,236	2,198	16,930	
Flood Control Vol.	699.00	11,484	1,136	18,066	17,774
	700.00	14,063	12,774	30,840	
	701.00	16,743	15,403	46,243	
Total Storage Provided =				30,840 cft	
Total Storage Required =				17,774	

Basin Elevations

Basin Bottom: 697.00
 Water Quality: 697.90
 Channel Protection: 698.70
 Flood Control: 699.00
 Outlet Rim: 701.00

Max Release Flood = 0.89 cfs

Outlet Design

$$Q = C * A_h * (2 * g * H)^{1/2}$$

	Sediment	Bank Erosion	Flood Control
C=	0.60		
Outlet Dia. (in)=	0.00	0.00	4.00
Area / hole (sft)=	0.0000	0.0000	0.0873
# of Holes=	0	0	3
g (ft / s^2)=	32.2		

Stage	Sediment Control		Bank Erosion		Flood Control		Total Flow (cfs)
	Head (ft)	Flow (cfs)	Head (ft)	Flow (cfs)	Head (ft)	Flow (cfs)	
Water Quality:	0.90	0.00					0.00
Bank Protect:	1.70	0.00	0.80	0.00			0.00
Flood Control:	2.00	0.00	0.30	0.00	0.47	0.86	0.86

Emergency Spillway:

Q (design):
 Runoff Coeff (C) = 0.42
 I10 (in / hr) = 3.56
 Area (ac) = 4.45
Q (design) = 6.75 cfs

Q (proposed): $Q = 0.75 * C * m * H^{2.5} + C * L * H^{3/2}$
 C = 2.6
 m = 4 for 1:4 slope of trap weir
 Width (at base; ft) = 10.00
 H (ft) = 0.38
Q (cfs) = 6.78