30% Post-Construction Stormwater Management Plan Narrative

KCE MI 4

PREPARED FOR
KCE MI 4, LLC

DATE
November 2025

REFERENCE
0780143

DOCUMENT DETAILS

DOCUMENT TITLE	30% Post-Construction Stormwater Management Plan Narrative
DOCUMENT SUBTITLE	KCE MI 4
PROJECT NUMBER	0780143
DATE	November 2025
VERSION	01
AUTHOR	ERM
CLIENT NAME	KCE MI 4, LLC

DOCUMENT HISTORY

				ERM APPROVAL TO ISSUE		
VERSION	REVISION	AUTHOR	REVIEWED BY	NAME	DATE	COMMENTS
Version 01	000	Laura Lewis	Wayne Sicora	Gregory Sproull	D Month Year	

CONTENTS

LIST OF TABLES

LIST OF FIGURES

NO TABLE OF FIGURES ENTRIES FOUND.

ACRONYMS AND ABBREVIATIONS

Acronym	Description
BMP	Best Management Practice
CAD	Computer-aided design
CEI	Civil Engineers, Inc.
CF	Cubic feet
CFS	Cubic feet per second
CN	Curve number
DA	Drainage Area
EGLE	Michigan Department of Environment, Great Lakes, and Energy
FEMA	Federal Emergency Management Agency
HSG	Hydrologic soil group
min	minutes
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PCSM	Post Construction Stormwater Management
PE	Professional Engineer
POI	Point of interest

Acronym	Description
SCS	Soil Conservation Service (NRCS)
TR-20	Technical Release 20
TR-55	Technical Release 55
USDA	United States Department of Agriculture
USGS	United States Geological Survey

1. INTRODUCTION

This report presents a summary of post-construction stormwater management to be used for Special Land Use Permit Application support in Blendon Township for a proposed 100 Megawatt (MW) Battery Energy Storage System (BESS). The Project Area is located at 8284 88th Avenue in Ottawa County, Michigan (Tax Map ID: 70-13-08-300-022) and to be operated by KCE MI 4, LLC (KCE).

The Project Area is limited to a 11.9 acre limit of disturbance of a 40-acre private parcel with an off-site (but adjacent) connection to existing electrical infrastructure. The Van Buren substation is located immediately west of the Project Area (ID: 70-13-08-300-009), owned by Michigan Electric Transmission Co. A power corridor owned by Consumers Energy is located immediately south of the Project Area. Development of the Project will involve installation and operation of battery modules housed in containers, a small, dedicated substation, and associated support infrastructure (e.g., access roads, inverters).

The majority of the existing site is generally open space and woods. The proposed improvements will result in changes to the impervious area on site, leading to the need for the construction of stormwater mitigation measures. The current design plans outline the construction of two interconnected infiltration basins on-site for stormwater treatment of the proposed gravel pad area and a roadside vegetated swale that drains to a modified infiltration area for stormwater treatment of the proposed gravel access road. The basin and vegetated swale drainage areas and outlets will follow the natural drainage patterns of the site, ultimately draining to a low spot north of the Site. The design is based on the Ottawa County Water Resources Commissioner (OCWRC) Site Development Rules: Procedures and Design Standards for Stormwater Management. The basins and vegetated swale with a modified infiltration area treat the first flush volume for water quality, meet the channel runoff protection criteria by reducing the post-development peak rate and volume to below pre-development peak rate and volume for the 2-year, 24-hour storm, and will meet flood control criteria by limiting the release rate for the 100-year, 24-hour storm to 0.13 cubic feet per second (cfs)/acre. Consideration was also given to the existing soils on site, and further infiltration testing will be performed once the basin and vegetated swale locations are approved.

2. EXISTING CONDITIONS

The property is located east of 88th Avenue and north of Polk Street. All existing topographic information for the project area and immediate surrounding areas has been provided in the Plans Issued for Special Land Use Permitting. The existing site drains to point of interests (POIs) offsite, see **Enclosure 1**. The entire site ultimately drains to an unnamed tributary (UNT) to Bass River. During construction, Erosion and Sediment (E&S) Best Management Practices (BMPs), such as compost filter sock, sediment traps, temporary check dams, and rock construction entrance, shall be installed in order to reduce suspended solids released from the site. The project site is outside of the floodplain, in an Area of Minimal Flood Hazard as shown on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel. The project site is located

on the FEMA- FIRM, for Ottawa County, Michigan, with Map Number 26139C0240E (refer to **Appendix A**).

3. DESIGN BASIS AND ASSUMPTIONS

The site's drainage characteristics were modeled for existing and developed conditions in accordance with the OCWRC Site Development Rules Procedures and Design Standards for Stormwater Management (2021) that defines Ottawa County's standards and specifications for stormwater management practices implemented during land development. The runoff analysis calculations and watershed routing calculations were performed using the SCS TR-20 method in HydroCAD 10.20-7a and the Lower Grand River Organization of Watersheds (LGROW) Design Spreadsheets. These methods require the application of several assumptions to some of the input data. These assumptions consist of variables as applied to the pre- and post-development flow paths, soil conditions, above-site drainage areas, and ground cover conditions. This section discusses this input data, and the assumptions utilized.

3.1 MINIMUM REQUIRED STORMWATER STANDARDS

This Post Construction Stormwater Management (PCSM) Plan was designed to be consistent with Ottawa County stormwater requirements which meet permit obligations with the Michigan Department of Environment, Great Lakes, and Energy (EGLE). The Ottawa County stormwater requirements include standards for water quality, channel protection, flood control, and pretreatment. For water quality, the runoff generated from one inch of rain over the project site must be treated through BMPs designed to reduce Total Suspended Solids (TSS) loadings by 80%. For channel protection, the post-development runoff rate and volume shall not exceed the pre-development rate and volume for all storms up to and including the 2-year, 24-hour storm. Retention of the volume increase is required. To address flood control, detention and retention BMPs must store runoff from the 100-year storm with a maximum release rate of 0.13 cfs/acre. Pretreatment is required prior to discharging stormwater runoff to certain BMPs and can include forebays, vegetated filter strips, vegetated swales, and water quality devices. Additional requirements for hot spots and coldwater streams do not apply to this project.

Water quality, channel protection, and onsite retention and infiltration volume calculations are included in **Appendix B**.

The rainfall depths for each storm event are shown in **Table 1** per the LGROW Design Spreadsheets and OCWRC Site Development Rules.

TABLE 1 RAINFALL DATA

Storm	P (in)
1-year	2.25
2-year	2.59
10-year	3.91
25-year	4.95

Storm	P (in)
100-year	6.90

Source: NOAA Atlas 14, Volume 8, Version 2

3.2 SITE SOILS

Site soils information was taken from the United States Department of Agriculture – Natural Resources Conservation Service (USDA – NRCS) website. The soil classification and type located on the property are summarized in **Table 2**.

The soils within the project area were listed as Croswell sand, hydrologic soil group (HSG) type 'A', Plainfield sand , HSG type 'A', and Pipestone-Covert-Saugatuck sands, HSG type 'A/D', (see description below).

Per the USDA, Group A soils have a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

TABLE 2 SOIL CLASSIFICATION

Symbol	Series Name/Slope	HSG	Hydric?	Prime Farmland	Percent of Project Area
CrB	Croswell sand, 0 to 6 percent slopes	A	No	No	27.4%
PlfabB	Plainfield sand, lake plain, 0 to 6 percent slopes	A	No	No	66.1%
PpsaaA	Pipestone-Covert-Saugatuck sands, 0 to 3 percent slopes	A/D	No	No	6.5%

Source: USDA NRCS Custom Soil Resource Report for Ottawa County, Michigan

The approximate soil boundaries are shown on the Soils Map which is provided in **Appendix A**. The contractor should analyze the soils utilized during the construction process. Caution should be exercised in areas of poor soils. A qualified geotechnical engineer should be consulted during construction when unsuitable conditions occur. The recommended foundation design based on the soil findings shall supersede the USDA soil limitations listed above. The contractor should ensure that soils are not cut steeper than the design slopes and that fills are compacted in accordance with the site geotechnical report. Immediate seeding and mulching of disturbed areas will aid in soil stabilization and reduce soil erosion once vegetation is established.

3.3 ASSUMPTIONS

To model the pre-developed and post-developed runoff characteristics, several assumptions were made as follows:

- Acreage measurements (as applied to drainage areas and areas of ground cover) were determined by computer-aided drafting (CAD) and are approximated based on the

accuracy of the site mapping and the resulting interpolation of ground slopes, ground cover, and drainage patterns.

- The POI for the pre- and post-developed drainage areas was assumed to be located at approximately the same study point.
- The varying pre-development ground cover areas for grass cover, woods, and gravel land coverage were estimated from survey, aerial imagery, the United States Geological Survey (USGS) National Landcover Database, and from site observation.
- In accordance with TR-55 requirements, pre-development Curve Number (CN) values for 'fair' condition Grass Cover, 'good' condition Grass Cover, Woods, and existing gravel land cover with Type 'A' soils are 49, 39, 30, 88, respectively. CN values used for post-development Grass Cover, Meadow, Woods, and gravel land cover with Type 'C' soils are 39, 30, 30, and 88, respectively.

Other assumptions used in the calculations are discussed in the applicable sections of the report.

4. PRE-DEVELOPMENT HYDROLOGY

The site contains twelve sub-drainage areas that ultimately drain to three POIs offsite, as shown in **Enclosure 1**.

The existing pre-development land cover is based on information from survey, aerial imagery, the USGS National Landcover Database, and site observation. Land cover, hydrologic soil group, and curve number information for pre-development conditions within the sub-drainage areas are summarized in **Table 3**. The pre-development drainage area curve numbers were weighted as shown in **Appendix B**.

TABLE 3 PRE-DEVELOPMENT LAND COVER

POI	Sub-Drainage Area	Land Cover	Area	HSG	CN	Weighted CN
POI 1	SUB1	Grass Cover (Good)	0.55	A	39	32
		Woods (Good)	2.44	A	30	
	SUB2	Grass Cover (Good)	0.14	A	39	36
		Woods (Good)	0.08	A	30	
	SUB11	Grass Cover (Good)	0.88	A	39	37
		Woods (Good)	0.32	A	30	
POI 2	SUB3	Grass Cover (Good)	0.02	A	39	30
		Woods (Good)	1.15	A	30	
	SUB4	Grass Cover (Good)	0.81	A	39	35
		Woods (Good)	0.80	A	30	

POI	Sub-Drainage Area	Land Cover	Area	HSG	CN	Weighted CN
	SUB5	Grass Cover (Good)	0.75	A	39	32
		Woods (Good)	2.49	A	30	
	SUB6	Woods (Good)	0.78	A	30	30
	SUB7	Grass Cover (Good)	0.07	A	39	30
		Woods (Good)	1.35	A	30	
	SUB8	Woods (Good)	0.08	A	30	30
POI 3	SUB9	Grass Cover (Good)	0.53	A	39	35
		Woods (Good)	0.46	A	30	
	SUB10	Grass Cover (Good)	0.23	A	39	41
		Gravel	0.01	A	88	
POI 4	SUB12	Grass Cover (Good)	1.17	A	39	39
		Woods (Good)	0.05	A	30	

The pre-development drainage areas and time of concentration paths are shown on the enclosed Pre-Development Drainage Area Map.

5. POST-DEVELOPMENT HYDROLOGY

The post-development drainage areas are shown in **Enclosure 2**. SUB1 contains offsite drainage that is conveyed across the proposed access road through a culvert that discharges into a vegetated swale in SUB2. SUB2 ultimately drains to POI 1. SUB11 contains undetained area that will be restored to meadow condition after construction of the project and ultimately drains to POI 1. SUB3 contains the developed area surrounding the proposed infiltration areas. SUB4 contains undetained offsite drainage that does not make its way on to the developed site. SUB5 is the contributing drainage area to Infiltration Basin #1, which is contained with SUB6. Per the LGROW Spreadsheet guidance, BMPs such as retention basins should be contained within their own subdrainage areas. SUB7 is the contributing drainage area to Infiltration Basin #2, which is within SUB8. Infiltration Basin #2 is connected to Infiltration #1. Sub-drainage areas 3-8 ultimately drain to POI 2. SUB9 contains the proposed gravel access road and associated vegetated swale that runs along the road. This is routed to SUB10, which contains a modified infiltration area. SUB10 ultimately drains to POI 3. SUB12 contains undetained area that will be restored to meadow condition after construction of the project.

The basins and vegetated swale with a modified infiltration area treat the first flush volume for water quality, meet the channel runoff protection criteria by reducing the post-development peak rate and volume to below pre-development peak rate and volume for the 2-year, 24-hour storm,

and will meet flood control criteria by limiting the release rate for the 100-year, 24-hour storm to 0.13 cfs/acre.

Land cover, hydrologic soil group, and curve number information for post-development conditions are summarized in **Table 4**.

TABLE 4 POST-DEVELOPMENT LAND COVER

POI	Sub-Drainage Area	Land Cover	Area	HSG	CN	Weighted CN
POI 1	SUB1	Grass Cover (Good)	0.55	A	39	35
		Woods (Good)	1.88	A	30	
		Meadow	0.38	A	30	
		Gravel	0.18	A	88	
	SUB2	Meadow	0.22	A	30	30
	SUB11	Meadow	1.22	A	30	30
POI 2	SUB3	Meadow	1.17	A	30	30
	SUB4	Grass Cover (Good)	0.81	A	39	35
		Woods (Good)	0.52	A	30	
		Meadow	0.28	A	30	
	SUB5	Grass Cover (Good)	0.06	A	39	82
		Gravel	2.93	A	30	
		Meadow	0.25	A	30	
	SUB6	Meadow	0.78	A	30	30
	SUB7	Meadow	0.04	A	30	86
		Gravel	1.38	A	88	
	SUB8	Meadow	0.08	A	30	30
POI 3	SUB9	Meadow	0.42	A	30	63
		Gravel	0.57	A	88	
	SUB10	Meadow	0.15	A	30	52
		Gravel	0.09	A	88	
POI 4	SUB12	Meadow	1.12	A	30	30

5.1 CHANNEL PROTECTION VOLUME

According to the OCWRC Site Development Rules, the post-development runoff rate and volume shall not exceed the pre-development rate and volume for all storms up to and including the 2-

year, 24-hour storm. Retention of the volume increase is required. Increases in post-development runoff rates and volumes are managed by the proposed infiltration basins, swales, and modified infiltration area. Calculations for pre- and post-developed conditions are included in **Appendix B**. Compliance with the channel protection volume requirements is demonstrated in the LGROW Spreadsheets included in **Appendix B**. Pre- and post-development runoff volumes in cubic feet for each sub-drainage area are summarized in **Table 5.**

TABLE 5 2-YEAR RUNOFF VOLUMES

Sub-Drainage Area	Runoff Volumes for 2-year storm		
	Pre-Development (cubic feet)	Post-Development (cubic feet)	Required Channel Protection Volume (cubic feet)
SUB1	0	953	953
SUB2	0	0	0
SUB3	0	0	0
SUB4	0	0	0
SUB5	64	15,516	15,451
SUB6	0	0	0
SUB7	6	7,308	7,302
SUB8	0	0	0
SUB9	46	3,018	2,973
SUB10	53	477	424
SUB11	0	177	0
SUB12	0	0	0

The following tables demonstrate compliance with the channel protection volume requirements for each structural BMP and its respective drainage areas. Any unmet channel protection volume becomes upstream channel protection volume in the subsequent downstream sub-drainage areas. Credited channel protection volume shown is the sum of the volumes retained by each BMP, limited by the sum of the 2-year runoff volume from the sub-drainage areas and any unmet channel protection volume from upstream sub-drainage areas.

TABLE 6 CHANNEL PROTECTION VOLUME FROM STRUCTURAL BMPS: INFILTRATION BASINS #1 AND #2

Sub-Drainage Area	Description	Channel Protection Volume (cubic feet)			
		Required	Upstream	Credited	Unmet
SUB7	Sub-drainage area contributing to Infiltration Basin #2	7,308	0	0	7,308
SUB8	Infiltration Basin #2	0	7,308	4,742	2,565
SUB5	Sub-drainage area contributing to Infiltration Basin #1	15,516	0	0	15,516
SUB6	Infiltration Basin #1	0	18,081	18,081	0
SUB3	Sub-drainage area downstream of Infiltration Basin #1	0	0	0	0
Total		22,824		22,824	

TABLE 7 CHANNEL PROTECTION VOLUME FROM STRUCTURAL BMPS: BIOSWALE AND MODIFIED INFILTRATION AREA

Sub-Drainage Area	Description	Channel Protection Volume (cubic feet)			
		Required	Upstream	Credited	Unmet
SUB9	Sub-drainage area contributing to roadside bioswale	2,973	0	2,973	0
SUB10	Sub-drainage area contributing to modified infiltration area	424	0	424	0
Total		3,397		3,397	

TABLE 8 CHANNEL PROTECTION VOLUME FROM STRUCTURAL BMPS: BIOSWALE

Sub-Drainage Area	Description	Channel Protection Volume (cubic feet)			
		Required	Upstream	Credited	Unmet
SUB1	Sub-drainage area upstream of bioswale	953	0	0	953
SUB2	Sub-drainage area contributing to bioswale area	0	953	953	0
Total		953		953	

5.2 WATER QUALITY VOLUME

In order to comply with water quality volume requirements, the runoff generated from one inch of rain over the project site must be treated through BMPs designed to reduce TSS loadings by 80%. Compliance with these requirements is demonstrated in the LGROW spreadsheets included in **Appendix B**. The water quality volume is treated through the use of a vegetative filter strip, bioswales, and infiltration basins.

5.3 FLOOD CONTROL

To address flood control, detention and retention BMPs must store runoff from the 100-year storm with a maximum release rate of 0.13 cfs/acre. Compliance with these requirements is demonstrated in the LGROW spreadsheets included in **Appendix B**.

6. EROSION AND SEDIMENT POLLUTION CONTROL

A Soil Erosion and Sedimentation Control (SESC) permit will be submitted and approved by Ottawa County prior to construction. Following SESC approval, a Notice of Coverage (NOC) will be submitted to EGLE. No earthmoving activities will commence on this site until all applicable regulatory requirements have been met.

Please refer to the Erosion and Sediment Control Report and Plans Issued for Special Land Use Permitting for more information.

7. POST-CONSTRUCTION STORMWATER MANAGEMENT

The post construction stormwater management design and the overall site development was conceptualized to preserve the integrity of the receiving streams while maintaining and protecting the physical, biological, and chemical qualities of the receiving surface waters.

Physical properties, or rate and volume, will be managed by demonstrating a decrease in peak rate and volume for the site. Biological properties, or thermal impacts, will be managed through providing shade and are discussed in greater detail in Section 7.2.

7.1 PROPOSED BMP'S

7.1.1 INFILTRATION BASINS

Two interconnected infiltration basins are proposed for stormwater treatment of the proposed gravel pad. The infiltration basins are designed to provide retention and treat the water quality volume. The design infiltration rate used for both basins is 3.6 inches/hour. The design infiltration rate used is based on the rate provided in the OCWRC Site Development Rules for Sandy, Type A soils. Further infiltration testing shall be done in accordance with the OCWRC Site Development Rules prior to final design. Water will sheet flow over the gravel pad and pass through the vegetated filter strip that is proposed on the north edge of the pad. Water will then sheet flow into the infiltration basins. Infiltration Basin #1 provides an emergency overflow outlet for storms greater than the 100-year storm as shown in Plans Issued for Special Land Use Permitting.

Please refer to **Appendix B** for basin design calculations and **Appendix C** for rip rap sizing calculations.

7.1.2 VEGETATED FILTER STRIP

One vegetated filter strip is proposed along the northern edge of the gravel pad. This BMP will provide pretreatment of the stormwater prior to the infiltration basins.

7.1.3 VEGETATED SWALE/BIOSWALE

One infiltrative vegetated swale or bioswale is proposed along the proposed gravel access road to treat its surface runoff. In addition, a bioswale is proposed downstream of the culvert that crosses the access road near the gravel pad. This bioswale treats drainage from SUB1 and SUB2.

7.1.4 MODIFIED INFILTRATION AREA

One modified infiltration area is proposed downstream of the vegetated swale that runs along the access road. This infiltration area treats drainage from SUB9 and SUB10. It will be two-feet deep and have an engineered soil mix with 30% voids to promote infiltration.

7.2 POTENTIAL THERMAL IMPACTS TO SURFACE WATERS

The stormwater flowing across gravel surfaces will enter an infiltration basin, which will infiltrate the water and not allow for discharge downstream for storms up to and including the 100-year storm. Stormwater will be flowing across vegetated areas before it leaves the site.

7.3 CONCLUSION

If the plan is implemented as described, impacts to the biological, chemical, and physical properties of downstream surface waters will be mitigated.

8. PLAN PREPARERS AND SIGNATURE BLOCK

I, Wayne T. Sicora, P.E., hereby certify that this report was prepared under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Michigan. To the best of my knowledge and belief, this stormwater management plan substantially meets the applicable design standards and criteria of the Ottawa County Water Resources Commissioner Site Development Rules: Procedures and Design Standards for Stormwater Management.

9. REFERENCES

Ottawa County Water Resources Commissioner. 2021. *Site Development Rules: Procedures and Design Standards for Stormwater Management.*

Michigan Department of Environment, Great Lakes, and Energy. 2017. *EGLE Nonpoint Source Best Management Practices Manual.*

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed 11/25.

APPENDIX A SOILS REPORT, FEMA MAP, AND PRECIPITATION DATA

United States Department of Agriculture

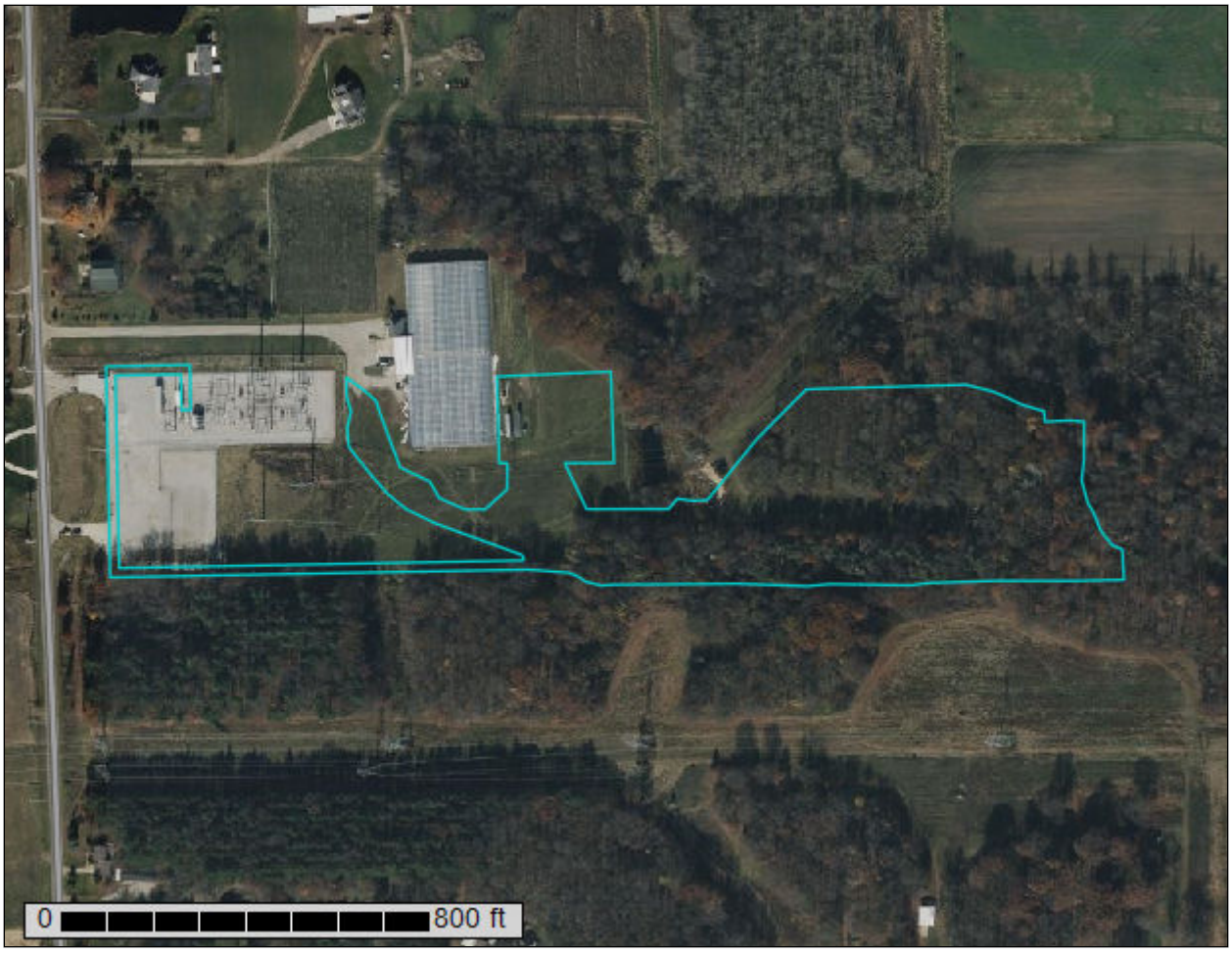
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Ottawa County, Michigan

Limit of Disturbance



July 14, 2025

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Map Scale: 1:3,710 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

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 1:15,800.

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: Ottawa County, Michigan
Survey Area Data: Version 19, Aug 28, 2024

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

Date(s) aerial images were photographed: Oct 4, 2022—Nov 7, 2022

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
CrB	Croswell sand, 0 to 6 percent slopes	3.3	27.4%
PlfabB	Plainfield sand, lake plain, 0 to 6 percent slopes	7.9	66.1%
PpsaaA	Pipestone-Covert-Saugatuck sands, 0 to 3 percent slopes	0.8	6.5%
Totals for Area of Interest		**11.9**	**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

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Ottawa County, Michigan

CrB—Croswell sand, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6ggq
Elevation: 600 to 1,000 feet
Mean annual precipitation: 30 to 36 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 140 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Croswell

Setting

Landform: Outwash plains, lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy lacustrine deposits

Typical profile

H1 - 0 to 2 inches: sand
H2 - 2 to 8 inches: sand
H3 - 8 to 14 inches: sand
H4 - 14 to 24 inches: sand
H5 - 24 to 60 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F097XA006MI - Moist Acidic Sandy Flatwoods
Hydric soil rating: No

Minor Components

Au gres

Percent of map unit: 5 percent

Landform: Outwash plains, lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F097XA006MI - Moist Acidic Sandy Flatwoods
Hydric soil rating: No

Rubicon

Percent of map unit: 5 percent
Landform: Lake plains, outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F097XA004MI - Dry Sandy Lake Plain
Hydric soil rating: No

PlfabB—Plainfield sand, lake plain, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2w4kc
Elevation: 580 to 750 feet
Mean annual precipitation: 30 to 41 inches
Mean annual air temperature: 43 to 52 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Plainfield, lake plain, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plainfield, Lake Plain

Setting

Landform: Nearshore zones (relict)
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear
Parent material: Sandy glaciolacustrine deposits

Typical profile

A - 0 to 8 inches: sand
Bw - 8 to 27 inches: sand
BC - 27 to 35 inches: sand
C - 35 to 80 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 0.1 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F097XA004MI - Dry Sandy Lake Plain
Hydric soil rating: No

Minor Components

Brems

Percent of map unit: 8 percent
Landform: Nearshore zones (relict)
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F097XA006MI - Moist Acidic Sandy Flatwoods
Hydric soil rating: No

Kaleva

Percent of map unit: 4 percent
Landform: Nearshore zones (relict)
Landform position (two-dimensional): Shoulder, backslope, summit
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear
Ecological site: F097XA004MI - Dry Sandy Lake Plain
Hydric soil rating: No

Brethren

Percent of map unit: 2 percent
Landform: Nearshore zones (relict)
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F097XA006MI - Moist Acidic Sandy Flatwoods
Hydric soil rating: No

Spinks

Percent of map unit: 1 percent
Landform: Nearshore zones (relict)
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope

Down-slope shape: Convex, linear
Across-slope shape: Linear
Ecological site: F097XA004MI - Dry Sandy Lake Plain
Hydric soil rating: No

PpsaaA—Pipestone-Covert-Saugatuck sands, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2rfgv
Elevation: 580 to 780 feet
Mean annual precipitation: 33 to 36 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 129 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Pipestone and similar soils: 50 percent
Covert and similar soils: 20 percent
Saugatuck and similar soils: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pipestone

Setting

Landform: Outwash plains, nearshore zones (relict)
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciolacustrine deposits

Typical profile

A - 0 to 2 inches: sand
E - 2 to 4 inches: sand
Bs1 - 4 to 13 inches: sand
Bs2 - 13 to 19 inches: sand
BC - 19 to 28 inches: fine sand
C - 28 to 80 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (1.56 to 14.17 in/hr)
Depth to water table: About 6 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)

Available water supply, 0 to 60 inches: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A/D
Ecological site: F097XA006MI - Moist Acidic Sandy Flatwoods
Hydric soil rating: No

Description of Covert

Setting

Landform: Outwash plains, nearshore zones (relict)
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Talf, rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciolacustrine deposits

Typical profile

A - 0 to 8 inches: sand
E - 8 to 13 inches: sand
Bs1 - 13 to 18 inches: fine sand
Bs2 - 18 to 29 inches: sand
BC - 29 to 47 inches: fine sand
C - 47 to 80 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (1.56 to 14.17 in/hr)
Depth to water table: About 18 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A/D
Ecological site: F097XA006MI - Moist Acidic Sandy Flatwoods
Hydric soil rating: No

Description of Saugatuck

Setting

Landform: Nearshore zones (relict), outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciolacustrine deposits

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material

A - 1 to 8 inches: sand
E - 8 to 13 inches: fine sand
Bhsm - 13 to 17 inches: sand
Bs - 17 to 20 inches: fine sand
BC - 20 to 32 inches: fine sand
C - 32 to 80 inches: fine sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 6 to 21 inches to ortstein
Drainage class: Somewhat poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.02 to 0.14 in/hr)
Depth to water table: About 6 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 1.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: D
Ecological site: F097XA006MI - Moist Acidic Sandy Flatwoods
Hydric soil rating: No

Minor Components

Kingsville

Percent of map unit: 10 percent
Landform: Nearshore zones (relict), outwash plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F097XA008MI - Wet Sandy Flatwoods
Hydric soil rating: Yes

Antung

Percent of map unit: 2 percent
Landform: Outwash plains, nearshore zones (relict)
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F097XA030MI - Mucky Depression
Hydric soil rating: Yes

Jebavy

Percent of map unit: 2 percent
Landform: Outwash plains, nearshore zones (relict)
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F097XA007MI - Wet Acidic Sandy Flatwoods
Hydric soil rating: Yes

Plainfield, high ecological site

Percent of map unit: 1 percent
Landform: Dunes, outwash plains, beach ridges
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F097XA004MI - Dry Sandy Lake Plain
Hydric soil rating: No

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86°W 42°56'28.23"N

85°56'14.16"W 42°52'16.88"N

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR DRAFT FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS

- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD

- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS

- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES

- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES

- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

LINK> </CLR>for official maps and additional

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by USDA, Farm Service Agency (FSA). This information was derived from NAIP, dated April 11, 2018.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **11/21/2025 2:19 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards. This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date.

SCALE

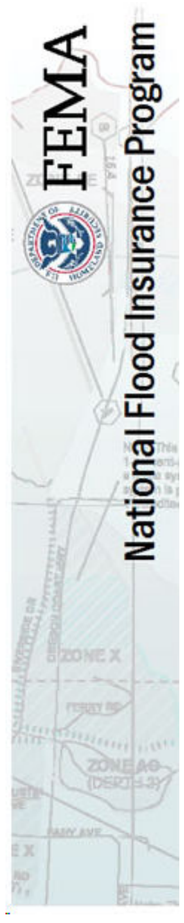
Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: No elevation features on this FIRM
For information about the specific vertical datum for elevation features, datum conversions, or vertical monuments used to create this map, please see the Flood Insurance Study (FIS) Report for your community at https://msc.fema.gov

N

1 inch = 1,000 feet 1:12,000

0 500 1,000 2,000 3,000 4,000 Feet

0 105 210 420 630 840 Meters



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

PANEL **240** OF **356**

Panel Contains:

COMMUNITY	NUMBER	PANEL
TOWNSHIP OF BLENDON	261005	0240

MAP NUMBER
26139C0240E
EFFECTIVE DATE
December 16, 2011

B. Rainfall

The rainfall duration-frequency table provided in **Table 10** shall be used with the Rational Method to determine rainfall intensity for rainfall duration equal to the time-of-concentration. Divide the rainfall amount by the duration in hours to obtain the rainfall intensity.

The 24-hour rainfall amounts provided in **Table 10** shall be used with the Runoff Curve Number Method.

An MSE4 rainfall distribution shall be used when a unit hydrograph approach is used (e.g. WinTR-55 computer program).

Table 10 – Rainfall Amounts (inches)

Duration	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
24-hr	2.25	2.59	3.26	3.91	4.95	5.87	6.90
12-hr	1.94	2.26	2.86	3.44	4.35	5.15	6.03
6-hr	1.66	1.93	2.44	2.93	3.69	4.35	5.07
3-hr	1.39	1.62	2.05	2.45	3.07	3.59	4.16
2-hr	1.24	1.45	1.84	2.19	2.73	3.17	3.66
1-hr	1.00	1.18	1.49	1.78	2.20	2.56	2.94
30-min	0.77	0.91	1.15	1.36	1.68	1.94	2.22
15-min	0.55	0.64	0.81	0.96	1.19	1.37	1.57
10-min	0.45	0.53	0.67	0.79	0.97	1.12	1.28
5-min	0.30	0.36	0.46	0.54	0.66	0.77	0.88

Source: NOAA (2013). *Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 8, Version 2.0*. Rainfall amounts from: West Olive, Michigan.

APPENDIX B WATER QUALITY, CHANNEL PROTECTION, AND FLOOD CONTROL CALCULATIONS

LGROW DESIGN SPREADSHEETS : SUBS 1 AND 2

LGROW Design Spreadsheet
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Version 3.4

Instructions

1) After opening the spreadsheet you will need to enable the use of an embedded macro. Look for security warning above and click "Enable Content."
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5) The spreadsheet can be used to model a single discharge point from the site including structural BMPs in series or parallel.

Project Description

Development Name	KCE MI-4	**Design Firm**	Environmental Resources Managemer
Address/Location	8287 88th Ave, Zeeland, MI 49464	**Engineer**	Wayne Sicora, P.E.
Developer/Owner	KCE MI4, LLC	**Date**	11/25/2025

Run Sub-drainage areas for upstream offsite drainage to culvert across access road; bioswale

	Select if Yes	Notes
Drainage District	☐	
Watershed Policy	☐	
Redevelopment/Addition	☐	
MS4	☐	
Hotspot	☐	
Coldwater Stream	☐	

Sensitive Areas

Description	Notes
Wetlands	Impacts to wetlands are avoided.

Channel Protection Volume Basis

Pre-development Land Use Definition	Existing	Notes
Not Required	☐	
Provided Offsite	☐	
Alternative Approach	☐	

Subcatchment Connectivity

Number of Subcatchments 2

Subcatchment Name	Downstream Subcatchment	Subcatchment Description
Sub1	Sub2	Upland undisturbed area and portion of gravel turnaround/road Sub 1 on DA map
Sub2	none	Bioswale, Sub 2 on DA map

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Subcatchment Hydrology Summary

Subcatchment Name	Existing			Developed		
	Area [ac]	% Impervious	Average CN	Area [ac]	% Impervious	Average CN
Sub1	2.99	0%	32	2.99	0%	35
Sub2	0.22	0%	36	0.22	0%	30
Site Totals and Averages:	**3.21**	**0%**	**32**	**3.21**	**0%**	**35**

Channel Protection Volume from Structural BMPs

Subcatchment Name	Channel Protection Volume [cft]			
	Required	Upstream	Credited	Unmet
Sub1	953	0	0	953
Sub2	0	953	953	0
Total	**953**		**953**	

Percent of Channel Protection Volume met by Onsite Retention	**100**
Required Extended Detention Volume [cft]	**0**
Required Extended Detention Release Rate [cfs]	**0.000**
1-year Existing Peak Discharge [cfs]	0.00

Water Quality Volume and TSS Removal

Subcatchment Name	Water Quality Volume [cft]	Volume Met	TSS			
			Generated	Upstream	Total	Removed
Sub1	640	No	640	0	640	0
Sub2	0	Yes	0	640	640	570
Total	**640**	**Yes**	**640**			**570**
					TSS Removal Efficiency [%]	**89**
					80% TSS removal met?	**Yes**

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Sub1: Upland undisturbed area and portion of gravel turnaround/road Sub 1 on DA

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Open spaces (grass cover) - good	A	0.55	acre	39	30
Woods - good	A	2.44	acre	30	30
		2.99	acre	32	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
EXIST: Open spaces (grass cover) - good	A	0.55	acre	39	
EXIST: Woods - good	A	1.88	acre	30	
N-BMP: Native revegetation: Meadow	A	0.38	acre	30	
DIST: Gravel	A	0.18	acre	88	
Notes:		2.99	acre	35	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	765	953	1,803	2,774	6,655

Channel Protection Volume

Click here for documentation

Required Channel Protection Volume

		2-year Runoff Volumes [cft] Developed	Pre-developed
Is Channel Protection Volume required? If no, provide reason.	Yes		
Required this Subcatchment [cft]	**953**	953	0
Unmet from Upstream Subcatchments [cft]	**0**		
Required Channel Protection Volume [cft]	**953**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
				N.A.	
				N.A.	
				N.A.	
				N.A.	
Totals		**0**			**0**
				Credited Channel Protection Volume	**0**
Notes:				**Percentage of Channel Protection Volume Met by Retention**	**0%**

Water Quality Volume

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		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.18	0.18		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**640**	**TSS Generated this Subcatchment**		**640**
Volume from Upstream Subcatchments [cft]	**0**	**TSS from Upstream Subcatchments**		**0**
Water Quality Volume to be Treated [cft]	**640**	**TSS to be Treated**		**640**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	Third-Party	Effective	TSS Removed
					0
					0
					0
					0
					0
Released Water Volume [cft]	**640**			**Total TSS Removed**	**0**
Water Quality Volume met?	**No**			**TSS Remaining**	**640**
Notes:				**TSS Removal Efficiency [%]**	**0**

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Sub2: Bioswale, Sub 2 on DA map

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Open spaces (grass cover) - good	A	0.14	acre	39	30
Woods - good	A	0.08	acre	30	30
		0.22	acre	36	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
S-BMP: Meadow	A	0.22	acre	30	
Notes:		0.22	acre	30	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	0	0	0	3	156

Channel Protection Volume

Click here for documentation

Required Channel Protection Volume

		2-year Runoff Volumes [cft]	
Is Channel Protection Volume required? If no, provide reason.	Yes	Developed	Pre-developed
Required this Subcatchment [cft]	**0**	0	0
Unmet from Upstream Subcatchments [cft]	**953**		
Required Channel Protection Volume [cft]	**953**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
Bioswale	350	3,093	3.60	29.46	4,654
				N.A.	
				N.A.	
				N.A.	
Totals		**3,093**			**4,654**

Credited Channel Protection Volume	**953**
Percentage of Channel Protection Volume Met by Retention	**100%**

Notes:

Water Quality Volume

Click here for documentation

		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.00	0.00		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**0**	**TSS Generated this Subcatchment**		**0**
Volume from Upstream Subcatchments [cft]	**640**	**TSS from Upstream Subcatchments**		**640**
Water Quality Volume to be Treated [cft]	**640**	**TSS to be Treated**		**640**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	TSS Removal Efficiency Third-Party	TSS Removal Efficiency Effective	TSS Removed
RET: Bioswale	640	89		89	570
					0
					0
					0
					0
Released Water Volume [cft]	**0**			**Total TSS Removed**	**570**
Water Quality Volume met?	**Yes**			**TSS Remaining**	**71**
				TSS Removal Efficiency [%]	**89**

Notes:

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Time-of-Concentration

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	Worksheet	User	Value Used
Existing [hr]	0.42		**0.42**
Developed [hr]	0.40		**0.40**

Method Selected: Worksheet

Notes:

Flood Control Volume

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Detention - Routing Method

Design Storm	100-year
Total Contributing Area [ac]	3.21
Developed Peak Discharge [cfs]	0.14

Allowable Discharge Worksheet		Select
Standard Discharge [cfs] - 0.13 [cfs/ac]	0.42	◉
Alternate Discharge [cfs]		○

Developed runoff volume is less than existing for flood control event. An alternate discharge may be allowed.

Credited BMP Retention Volume	Volume Retained ← This should normally be set to "Volume Retained"
Detention Required?	No
Allowable Discharge [cfs]	**0.42**
Required Storage Volume [cft]	**0**
Time to Drain [hrs]	

Calculate Detention Storage Volume

No Emergency Overflow Routes ☐

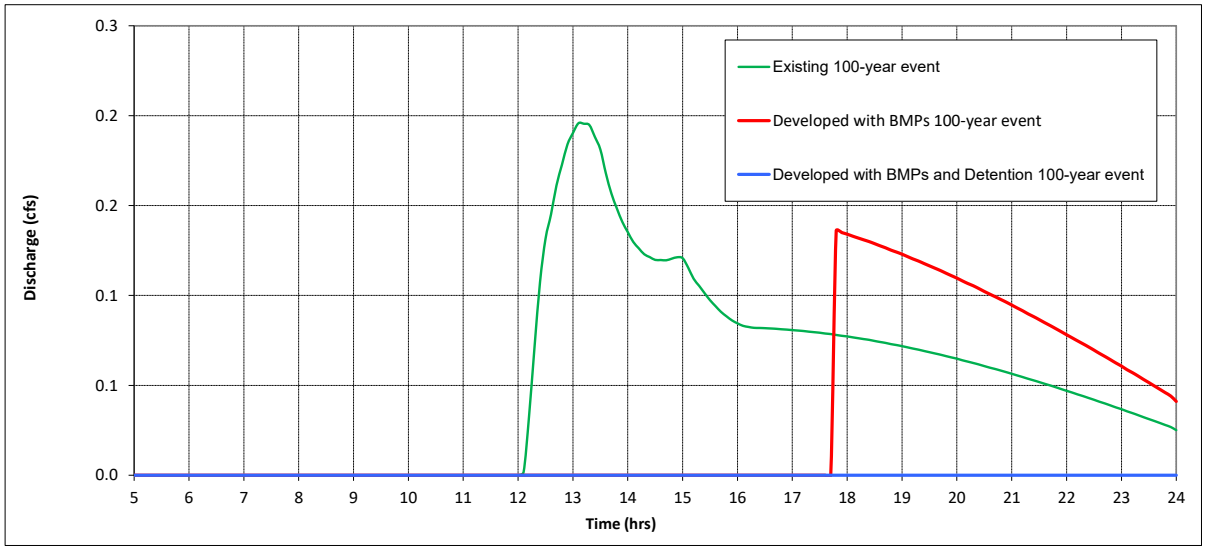
Retention - Summary of Volumes

Design Storm	100-year
Site Runoff Volume [cft]	6,811
BMP Storage Volume [cft]	3,093
BMP Infiltrating Volume [cft]	1,561
Total Volume Provided [cft]	4,654
Runoff Volume Retained by BMPs [cft]	4,654
Unretained Runoff Volume [cft]	2,157

Required Storage Volume [cft]: Minimum "BMP Storage Volume" that results in zero "Unretained Runoff Volume"

Notes:

Hydrograph



Plot Event: 100-year

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Results Summary

Volume Units: cft

Rainfall

Source and Distribution	24-hour, NOAA Atlas 14 at West Olive, MI, NRCS MSE4				
Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Rainfall Depth [in]	2.25	2.59	3.91	4.95	6.90

Pre-settlement Land Use

Time-of-Concentration [hr]	0.42				
Average Runoff [in]	0.00	0.00	0.00	0.00	0.20
Peak Discharge [cfs]	0.00	0.00	0.00	0.00	0.09
Runoff Volume [cft]	0	0	0	40	2,273

Existing Land Use

Time-of-Concentration [hr]	0.42				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.00	0.00	0.01	0.04	0.31
Peak Discharge [cfs]	0.00	0.00	0.00	0.02	0.20
Runoff Volume [cft]	0	0	93	507	3,620

Developed Land Use

Time-of-Concentration [hr]	0.40				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.07	0.08	0.15	0.24	0.58
Peak Discharge [cfs]	0.03	0.03	0.06	0.09	0.42
Runoff Volume [cft]	765	953	1,803	2,776	6,811
Volume Retained by BMPs [cft]	765	953	1,803	2,776	4,654
BMP Volume Credited to Detention [cft]	765	953	1,803	2,776	4,654
Volume Released [cft]	0	0	0	0	2,157
Peak Discharge Released [cfs]	0.00	0.00	0.00	0.00	0.14

Developed with BMPs and Detention

Peak Discharge Released [cfs]	N.A.	N.A.	N.A.	N.A.	N.A.
Maximum Volume Detained [cft]	N.A.	N.A.	N.A.	N.A.	N.A.

LGROW DESIGN SPREADSHEETS : SUBS 3, 5-8

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Project Description

Development Name	KCE MI-4	**Design Firm**	Environmental Resources Managemer
Address/Location	8287 88th Ave, Zeeland, MI 49464	**Engineer**	Wayne Sicora, P.E.
Developer/Owner	KCE MI4, LLC	**Date**	11/25/2025

Run Sub-drainage areas to Infiltration Basins #1 and #2

	Select if Yes	Notes
Drainage District	☐	
Watershed Policy	☐	
Redevelopment/Addition	☐	
MS4	☐	
Hotspot	☐	
Coldwater Stream	☐	

Sensitive Areas

Description	Notes
Wetlands	Wetland impacts are avoided.

Channel Protection Volume Basis

Pre-development Land Use Definition	Existing	Notes
Not Required	☐	
Provided Offsite	☐	
Alternative Approach	☐	

Subcatchment Connectivity

Number of Subcatchments 5

Subcatchment Name	Downstream Subcatchment	Subcatchment Description
Sub1	Sub2	DA to Infiltration Basin #2, Sub 7 on DA map
Sub2	Sub4	Infiltration Basin #2, Sub 8 on DA map
Sub3	Sub4	DA to Infiltration Basin #1, Sub 5 on DA map
Sub4	Sub5	Infiltration Basin #1, Sub 6 on DA map
Sub5	none	Undisturbed area surrounding Inilftration Basins, Sub 3 on DA map

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Subcatchment Hydrology Summary

Subcatchment Name	Existing			Developed		
	Area [ac]	% Impervious	Average CN	Area [ac]	% Impervious	Average CN
Sub1	1.42	0%	30	1.42	0%	86
Sub2	0.08	0%	30	0.08	0%	30
Sub3	3.24	0%	32	3.24	0%	83
Sub4	0.78	0%	30	0.78	0%	30
Sub5	1.17	0%	30	1.17	0%	30
Site Totals and Averages:	**6.69**	**0%**	**31**	**6.69**	**0%**	**67**

Channel Protection Volume from Structural BMPs

Subcatchment Name	Channel Protection Volume [cft]			
	Required	Upstream	Credited	Unmet
Sub1	7,308	0	0	7,308
Sub2	0	7,308	4,742	2,565
Sub3	15,516	0	0	15,516
Sub4	0	18,081	18,081	0
Sub5	0	0	0	0
Total	**22,824**		**22,824**	

Percent of Channel Protection Volume met by Onsite Retention	**100**
Required Extended Detention Volume [cft]	**0**
Required Extended Detention Release Rate [cfs]	**0.000**
1-year Existing Peak Discharge [cfs]	0.00

Water Quality Volume and TSS Removal

Subcatchment Name	Water Quality Volume [cft]	Volume Met	TSS			
			Generated	Upstream	Total	Removed
Sub1	4,909	Yes	4,909	0	4,909	3,976
Sub2	0	No	0	933	933	802
Sub3	10,430	Yes	10,430	0	10,430	8,448
Sub4	0	Yes	0	2,113	2,113	1,880
Sub5	0	Yes	0	232	232	0
Total	**15,339**	**Yes**	**15,339**			**15,106**
					TSS Removal Efficiency [%]	**98**
					80% TSS removal met?	**Yes**

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Sub1: DA to Infiltration Basin #2, Sub 7 on DA map

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Woods - good	A	1.35	acre	30	30
Open spaces (grass cover) - good	A	0.07	acre	39	30
		1.42	acre	30	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
N-BMP: Native revegetation: Meadow	A	0.04	acre	30	
DIST: Gravel	A	1.38	acre	88	
Notes:		1.42	acre	86	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	5,862	7,308	13,252	18,142	27,562

Channel Protection Volume

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Required Channel Protection Volume

		2-year Runoff Volumes [cft]	
Is Channel Protection Volume required? If no, provide reason.	Yes	Developed	Pre-developed
Required this Subcatchment [cft]	**7,308**	7,308	0
Unmet from Upstream Subcatchments [cft]	**0**		
Required Channel Protection Volume [cft]	**7,308**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
				N.A.	
				N.A.	
				N.A.	
				N.A.	
Totals		**0**			**0**

Credited Channel Protection Volume	**0**
Percentage of Channel Protection Volume Met by Retention	**0%**

Notes:

Water Quality Volume

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		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	1.38	1.38		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**4,909**	**TSS Generated this Subcatchment**		**4,909**
Volume from Upstream Subcatchments [cft]	**0**	**TSS from Upstream Subcatchments**		**0**
Water Quality Volume to be Treated [cft]	**4,909**	**TSS to be Treated**		**4,909**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	TSS Removal Efficiency Third-Party	TSS Removal Efficiency Effective	TSS Removed
PASS: Vegetated Filter Strip	4,909	81		81	3,976
					0
					0
					0
					0

Released Water Volume [cft]	**4,909**	**Total TSS Removed**	**3,976**
Water Quality Volume met?	**Yes**	**TSS Remaining**	**933**
		TSS Removal Efficiency [%]	**81**

Notes:

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Sub2: Infiltration Basin #2, Sub 8 on DA map

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Woods - good	A	0.08	acre	30	30
		0.08	acre	30	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
S-BMP: Meadow	A	0.08	acre	30	
Notes:		0.08	acre	30	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	0	0	0	1	57

Channel Protection Volume

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Required Channel Protection Volume

		2-year Runoff Volumes [cft]	
Is Channel Protection Volume required? If no, provide reason.	Yes	Developed	Pre-developed
Required this Subcatchment [cft]	**0**	0	0
Unmet from Upstream Subcatchments [cft]	**7,308**		
Required Channel Protection Volume [cft]	**7,308**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
Retention Basin	899	2,444	3.60	9.06	4,742
				N.A.	
				N.A.	
				N.A.	
Totals		**2,444**			**4,742**
				Credited Channel Protection Volume	**4,742**
Notes:				**Percentage of Channel Protection Volume Met by Retention**	**100%**

Water Quality Volume

Click here for documentation

		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.00	0.00		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**0**	**TSS Generated this Subcatchment**		**0**
Volume from Upstream Subcatchments [cft]	**4,909**	**TSS from Upstream Subcatchments**		**933**
Water Quality Volume to be Treated [cft]	**4,909**	**TSS to be Treated**		**933**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	TSS Removal Efficiency Third-Party	TSS Removal Efficiency Effective	TSS Removed
RET: Retention Basin	4,742	89		86	802
					0
					0
					0
					0
Released Water Volume [cft]	**167**			**Total TSS Removed**	**802**
Water Quality Volume met?	**No**			**TSS Remaining**	**131**
Notes:				**TSS Removal Efficiency [%]**	**86**

LGROW Design Spreadsheet
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Sub3: DA to Infiltration Basin #1, Sub 5 on DA map

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Open spaces (grass cover) - good	A	0.75	acre	39	30
Woods - good	A	2.49	acre	30	30
		3.24	acre	32	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
DIST: Open spaces (grass cover) - good	A	0.05	acre	39	
DIST: Gravel	A	2.93	acre	88	
N-BMP: Native revegetation: Meadow	A	0.26	acre	30	
Notes:		3.24	acre	83	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	12,446	15,516	28,144	38,555	58,776

Channel Protection Volume

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Required Channel Protection Volume

		2-year Runoff Volumes [cft]	
Is Channel Protection Volume required? If no, provide reason.	Yes	Developed	Pre-developed
Required this Subcatchment [cft]	**15,516**	15,516	0
Unmet from Upstream Subcatchments [cft]	**0**		
Required Channel Protection Volume [cft]	**15,516**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
				N.A.	
				N.A.	
				N.A.	
				N.A.	
Totals		**0**			**0**

Credited Channel Protection Volume	**0**
Percentage of Channel Protection Volume Met by Retention	**0%**

Notes:

Water Quality Volume

Click here for documentation

		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	2.93	2.93		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.05			

Required Volume this Subcatchment [cft]	**10,430**	**TSS Generated this Subcatchment**	**10,430**
Volume from Upstream Subcatchments [cft]	**0**	**TSS from Upstream Subcatchments**	**0**
Water Quality Volume to be Treated [cft]	**10,430**	**TSS to be Treated**	**10,430**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	TSS Removal Efficiency Third-Party	TSS Removal Efficiency Effective	TSS Removed
PASS: Vegetated Filter Strip	10,431	81		81	8,448
					0
					0
					0
					0

Released Water Volume [cft]	**10,430**	**Total TSS Removed**	**8,448**
Water Quality Volume met?	**Yes**	**TSS Remaining**	**1,982**
		TSS Removal Efficiency [%]	**81**

Notes:

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Sub4: Infiltration Basin #1, Sub 6 on DA map

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Woods - good	A	0.78	acre	30	30
		0.78	acre	30	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
S-BMP: Meadow	A	0.78	acre	30	
Notes:		0.78	acre	30	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	0	0	0	10	552

Channel Protection Volume

Click here for documentation

Required Channel Protection Volume

		2-year Runoff Volumes [cft]	
Is Channel Protection Volume required? If no, provide reason.	Yes	Developed	Pre-developed
Required this Subcatchment [cft]	**0**	0	0
Unmet from Upstream Subcatchments [cft]	**18,081**		
Required Channel Protection Volume [cft]	**18,081**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
Retention Basin	13,199	36,770	3.60	9.29	70,939
				N.A.	
				N.A.	
				N.A.	
Totals		**36,770**			**70,939**
				Credited Channel Protection Volume	**18,081**
Notes:				**Percentage of Channel Protection Volume Met by Retention**	**100%**

Water Quality Volume

Click here for documentation

		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.00	0.00		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**0**	**TSS Generated this Subcatchment**		**0**
Volume from Upstream Subcatchments [cft]	**10,597**	**TSS from Upstream Subcatchments**		**2,113**
Water Quality Volume to be Treated [cft]	**10,597**	**TSS to be Treated**		**2,113**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	TSS Removal Efficiency Third-Party	TSS Removal Efficiency Effective	TSS Removed
RET: Retention Basin	70,939	89		89	1,880
					0
					0
					0
					0
Released Water Volume [cft]	**0**			**Total TSS Removed**	**1,880**
Water Quality Volume met?	**Yes**			**TSS Remaining**	**232**
Notes:				**TSS Removal Efficiency [%]**	**89**

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Sub5: Undisturbed area surrounding Inilftration Basins, Sub 3 on DA map

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Open spaces (grass cover) - good	A	0.02	acre	39	30
Woods - good	A	1.15	acre	30	30
		1.17	acre	30	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
N-BMP: Native revegetation: Meadow	A	1.17	acre	30	
Notes:		1.17	acre	30	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	0	0	0	14	829

Channel Protection Volume

Click here for documentation

Required Channel Protection Volume

		2-year Runoff Volumes [cft]	
Is Channel Protection Volume required? If no, provide reason.	Yes	Developed	Pre-developed
Required this Subcatchment [cft]	**0**	0	0
Unmet from Upstream Subcatchments [cft]	**0**		
Required Channel Protection Volume [cft]	**0**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
				N.A.	
				N.A.	
				N.A.	
				N.A.	
Totals		**0**			**0**
				Credited Channel Protection Volume	**0**
Notes:				**Percentage of Channel Protection Volume Met by Retention**	**100%**

Water Quality Volume

Click here for documentation

		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.00	0.00		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**0**	**TSS Generated this Subcatchment**		**0**
Volume from Upstream Subcatchments [cft]	**0**	**TSS from Upstream Subcatchments**		**232**
Water Quality Volume to be Treated [cft]	**0**	**TSS to be Treated**		**232**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	TSS Removal Efficiency Third-Party	TSS Removal Efficiency Effective	TSS Removed
					0
					0
					0
					0
					0
Released Water Volume [cft]	**0**			**Total TSS Removed**	**0**
Water Quality Volume met?	**Yes**			**TSS Remaining**	**232**
Notes:				**TSS Removal Efficiency [%]**	**0**

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Time-of-Concentration

Click here for documentation

	Worksheet	User	Value Used
Existing [hr]	0.72		**0.72**
Developed [hr]	0.79		**0.79**

Method Selected: Worksheet

Notes:

Flood Control Volume

Click here for documentation

Detention - Routing Method

Design Storm	100-year
Total Contributing Area [ac]	6.69
Developed Peak Discharge [cfs]	0.87

Allowable Discharge Worksheet		Select
Standard Discharge [cfs] - 0.13 [cfs/ac]	0.87	◉
Alternate Discharge [cfs]		○

Credited BMP Retention Volume	Volume Retained ← This should normally be set to "Volume Retained"
Detention Required?	No
Allowable Discharge [cfs]	**0.87**
Required Storage Volume [cft]	**0**
Time to Drain [hrs]	

Calculate Detention Storage Volume

No Emergency Overflow Routes ☐

Retention - Summary of Volumes

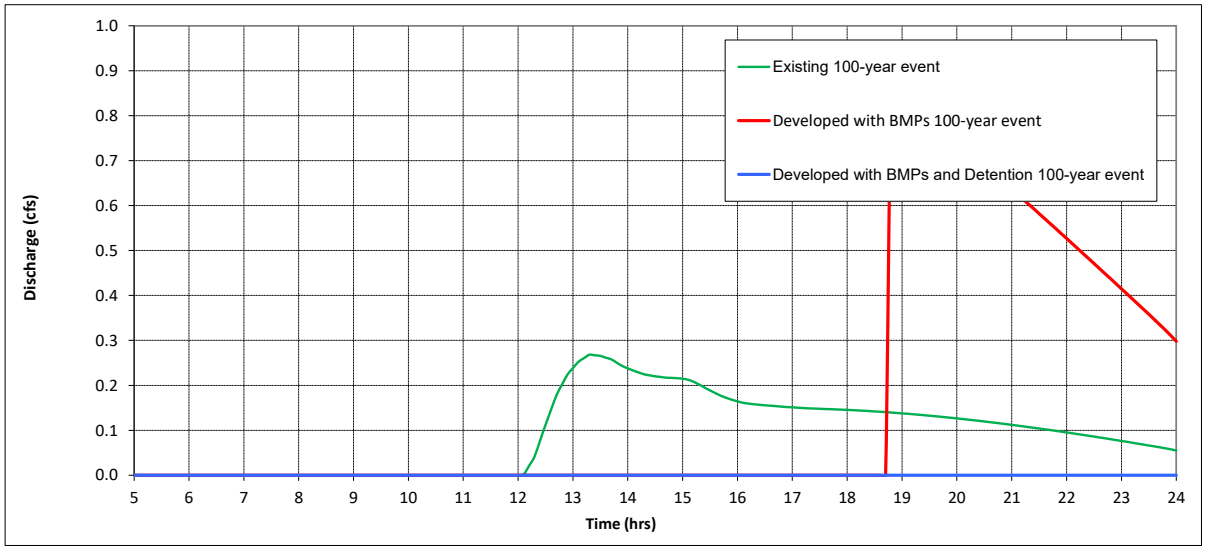
Design Storm	100-year
Site Runoff Volume [cft]	87,775
BMP Storage Volume [cft]	39,214
BMP Infiltrating Volume [cft]	36,468
Total Volume Provided [cft]	75,682
Runoff Volume Retained by BMPs [cft]	75,682
Unretained Runoff Volume [cft]	12,093

Required Storage Volume [cft]:

Minimum "BMP Storage Volume" that results in zero "Unretained Runoff Volume"

Notes:

Hydrograph



Plot Event: 100-year

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Results Summary

Volume Units: cft

Rainfall

Source and Distribution	24-hour, NOAA Atlas 14 at West Olive, MI, NRCS MSE4				
Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Rainfall Depth [in]	2.25	2.59	3.91	4.95	6.90

Pre-settlement Land Use

Time-of-Concentration [hr]	0.72				
Average Runoff [in]	0.00	0.00	0.00	0.00	0.20
Peak Discharge [cfs]	0.00	0.00	0.00	0.00	0.16
Runoff Volume [cft]	0	0	0	83	4,738

Existing Land Use

Time-of-Concentration [hr]	0.72				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.00	0.00	0.00	0.03	0.26
Peak Discharge [cfs]	0.00	0.00	0.00	0.02	0.27
Runoff Volume [cft]	0	0	113	652	6,377

Developed Land Use

Time-of-Concentration [hr]	0.79				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.75	0.94	1.70	2.34	3.61
Peak Discharge [cfs]	0.58	0.71	2.75	4.81	9.06
Runoff Volume [cft]	18,308	22,824	41,396	56,722	87,775
Volume Retained by BMPs [cft]	18,308	22,824	41,396	56,708	75,682
BMP Volume Credited to Detention [cft]	18,308	22,824	41,396	56,708	75,682
Volume Released [cft]	0	0	0	14	12,093
Peak Discharge Released [cfs]	0.00	0.00	0.00	0.01	0.87

Developed with BMPs and Detention

Peak Discharge Released [cfs]	N.A.	N.A.	N.A.	N.A.	N.A.
Maximum Volume Detained [cft]	N.A.	N.A.	N.A.	N.A.	N.A.

LGROW DESIGN SPREADSHEETS : SUB 4

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Version 3.4

Instructions

1) After opening the spreadsheet you will need to enable the use of an embedded macro. Look for security warning above and click "Enable Content."
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3) To clear all input data entered in a worksheet, click the Clear Worksheet button at the top of the page and hit the delete key.
4) Comments are indicated by red triangles in cells. Further direction is provided in the LGROW Design Spreadsheet Tutorial.
5) The spreadsheet can be used to model a single discharge point from the site including structural BMPs in series or parallel.

Project Description

Development Name	KCE MI-4	**Design Firm**	Environmental Resources Managemer
Address/Location	8287 88th Ave, Zeeland, MI 49464	**Engineer**	Wayne Sicora, P.E.
Developer/Owner	KCE MI4, LLC	**Date**	11/25/2025

Run Sub drainage area for offsite undetained drainage

	Select if Yes	Notes
Drainage District	☐	
Watershed Policy	☐	
Redevelopment/Addition	☐	
MS4	☐	
Hotspot	☐	
Coldwater Stream	☐	

Sensitive Areas

Description	Notes

Channel Protection Volume Basis

	Existing	Notes
Pre-development Land Use Definition		
Not Required	☐	
Provided Offsite	☐	
Alternative Approach	☐	

Subcatchment Connectivity

Number of Subcatchments 1

Subcatchment Name	Downstream Subcatchment	Subcatchment Description
Sub1	none	Sub 4 on DA map

LGROW Design Spreadsheet
Ottawa County Water Resources Commissioner

Subcatchment Hydrology Summary

Subcatchment Name	Existing			Developed		
	Area [ac]	% Impervious	Average CN	Area [ac]	% Impervious	Average CN
Sub1	1.61	0%	35	1.61	0%	35
Site Totals and Averages:	**1.61**	**0%**	**35**	**1.61**	**0%**	**35**

Channel Protection Volume from Structural BMPs

Subcatchment Name	Channel Protection Volume [cft]			
	Required	Upstream	Credited	Unmet
Sub1	0	0	0	0
Total	**0**		**0**	

Percent of Channel Protection Volume met by Onsite Retention	**0**
Required Extended Detention Volume [cft]	**0**
Required Extended Detention Release Rate [cfs]	**0.000**
1-year Existing Peak Discharge [cfs]	0.00

Water Quality Volume and TSS Removal

Subcatchment Name	Water Quality Volume [cft]	Volume Met	TSS			
			Generated	Upstream	Total	Removed
Sub1	0	Yes	0	0	0	0
Total	**0**	**Yes**	**0**			**0**
					TSS Removal Efficiency [%]	**0**
					80% TSS removal met?	**No**

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Sub1: Sub 4 on DA map

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Open spaces (grass cover) - good	A	0.81	acre	39	30
Woods - good	A	0.80	acre	30	30
		1.61	acre	35	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
EXIST: Woods - good	A	0.52	acre	30	
EXIST: Open spaces (grass cover) - good	A	0.81	acre	39	
N-BMP: Native revegetation: Meadow	A	0.28	acre	30	
Notes:		1.61	acre	35	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	0	0	109	569	2,721

Channel Protection Volume

Click here for documentation

Required Channel Protection Volume

		2-year Runoff Volumes [cft]	
Is Channel Protection Volume required? If no, provide reason.	Yes	Developed	Pre-developed
Required this Subcatchment [cft]	**0**	0	0
Unmet from Upstream Subcatchments [cft]	**0**		
Required Channel Protection Volume [cft]	**0**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
				N.A.	
				N.A.	
				N.A.	
				N.A.	
Totals		**0**			**0**
				Credited Channel Protection Volume	**0**
Notes:				**Percentage of Channel Protection Volume Met by Retention**	**100%**

Water Quality Volume

Click here for documentation

		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.00	0.00		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**0**	**TSS Generated this Subcatchment**		**0**
Volume from Upstream Subcatchments [cft]	**0**	**TSS from Upstream Subcatchments**		**0**
Water Quality Volume to be Treated [cft]	**0**	**TSS to be Treated**		**0**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	TSS Removal Efficiency Third-Party	TSS Removal Efficiency Effective	TSS Removed
					0
					0
					0
					0
					0
Released Water Volume [cft]	**0**			**Total TSS Removed**	**0**
Water Quality Volume met?	**Yes**			**TSS Remaining**	**0**
Notes:				**TSS Removal Efficiency [%]**	**0**

LGROW DESIGN SPREADSHEETS : SUBS 9 AND 10

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Instructions

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4) Comments are indicated by red triangles in cells. Further direction is provided in the LGROW Design Spreadsheet Tutorial.
5) The spreadsheet can be used to model a single discharge point from the site including structural BMPs in series or parallel.

Project Description

Development Name	KCE MI-4	**Design Firm**	Environmental Resources Managemer
Address/Location	8287 88th Ave, Zeeland, MI 49464	**Engineer**	Wayne Sicora, P.E.
Developer/Owner	KCE MI4, LLC	**Date**	11/25/2025

Run Subdrainage area for access road, bioswale to modified infiltration area

	Select if Yes	Notes
Drainage District	☐	
Watershed Policy	☐	
Redevelopment/Addition	☐	
MS4	☐	
Hotspot	☐	
Coldwater Stream	☐	

Sensitive Areas

Description	Notes

Channel Protection Volume Basis

	Existing	Notes
Pre-development Land Use Definition		
Not Required	☐	
Provided Offsite	☐	
Alternative Approach	☐	

Subcatchment Connectivity

Number of Subcatchments 2

Subcatchment Name	Downstream Subcatchment	Subcatchment Description
Sub1	Sub2	Sub 9
Sub2	none	Sub 10

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Subcatchment Hydrology Summary

Subcatchment Name	Existing			Developed		
	Area [ac]	% Impervious	Average CN	Area [ac]	% Impervious	Average CN
Sub1	0.99	0%	35	0.99	0%	63
Sub2	0.24	0%	41	0.24	0%	52
Site Totals and Averages:	**1.23**	**0%**	**36**	**1.23**	**0%**	**61**

Channel Protection Volume from Structural BMPs

Subcatchment Name	Channel Protection Volume [cft]			
	Required	Upstream	Credited	Unmet
Sub1	3,018	0	3,018	0
Sub2	424	0	424	0
Total	**3,442**		**3,442**	

Percent of Channel Protection Volume met by Onsite Retention	**100**
Required Extended Detention Volume [cft]	**0**
Required Extended Detention Release Rate [cfs]	**0.000**
1-year Existing Peak Discharge [cfs]	0.00

Water Quality Volume and TSS Removal

Subcatchment Name	Water Quality Volume [cft]	Volume Met	TSS			
			Generated	Upstream	Total	Removed
Sub1	2,028	Yes	2,028	0	2,028	1,805
Sub2	320	Yes	320	223	543	483
Total	**2,348**	**Yes**	**2,348**			**2,288**
					TSS Removal Efficiency [%]	**97**
					80% TSS removal met?	**Yes**

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Sub1: Sub 9

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Open spaces (grass cover) - good	A	0.53	acre	39	30
Woods - good	A	0.46	acre	30	30
		0.99	acre	35	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
N-BMP: Native revegetation: Meadow	A	0.42	acre	30	
DIST: Gravel	A	0.57	acre	88	
Notes:		0.99	acre	63	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	2,421	3,018	5,474	7,498	11,670

Channel Protection Volume

Click here for documentation

Required Channel Protection Volume

		2-year Runoff Volumes [cft] Developed	Pre-developed
Is Channel Protection Volume required? If no, provide reason.	Yes		
Required this Subcatchment [cft]	**3,018**	3,018	0
Unmet from Upstream Subcatchments [cft]	**0**		
Required Channel Protection Volume [cft]	**3,018**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
Bioswale	2,523	15,270	3.60	20.17	24,839
				N.A.	
				N.A.	
				N.A.	
Totals		**15,270**			**24,839**

Credited Channel Protection Volume	**3,018**
Percentage of Channel Protection Volume Met by Retention	**100%**

Notes:

Water Quality Volume

Click here for documentation

		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.57	0.57		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**2,028**	**TSS Generated this Subcatchment**		**2,028**
Volume from Upstream Subcatchments [cft]	**0**	**TSS from Upstream Subcatchments**		**0**
Water Quality Volume to be Treated [cft]	**2,028**	**TSS to be Treated**		**2,028**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	Third-Party	Effective	TSS Removed
RET: Bioswale	2,028	89		89	1,805
					0
					0
					0
					0

Released Water Volume [cft]	**0**	**Total TSS Removed**	**1,805**
Water Quality Volume met?	**Yes**	**TSS Remaining**	**223**
Notes:		**TSS Removal Efficiency [%]**	**89**

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Sub2: Sub 10

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Open spaces (grass cover) - good	A	0.23	acre	39	30
Gravel	A	0.01	acre	88	30
		0.24	acre	41	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
N-BMP: Native revegetation: Meadow	A	0.15	acre	30	
DIST: Gravel	A	0.09	acre	88	
Notes:		0.24	acre	52	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	382	477	864	1,185	1,902

Channel Protection Volume

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Required Channel Protection Volume

		2-year Runoff Volumes [cft]	
		Developed	Pre-developed
Is Channel Protection Volume required? If no, provide reason.	Yes		
Required this Subcatchment [cft]	**424**	477	53
Unmet from Upstream Subcatchments [cft]	**0**		
Required Channel Protection Volume [cft]	**424**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
Bioretention / Rain Garden	674	716	3.60	3.54	1,797
				N.A.	
				N.A.	
				N.A.	
Totals		**716**			**1,797**
				Credited Channel Protection Volume	**424**
Notes:				**Percentage of Channel Protection Volume Met by Retention**	**100%**

Water Quality Volume

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		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.09	0.09		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**320**	**TSS Generated this Subcatchment**		**320**
Volume from Upstream Subcatchments [cft]	**0**	**TSS from Upstream Subcatchments**		**223**
Water Quality Volume to be Treated [cft]	**320**	**TSS to be Treated**		**543**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	TSS Removal Efficiency Third-Party	TSS Removal Efficiency Effective	TSS Removed
RET: Bioretention/Rain Garden	320	89		89	483
					0
					0
					0
					0
Released Water Volume [cft]	**0**			**Total TSS Removed**	**483**
Water Quality Volume met?	**Yes**			**TSS Remaining**	**60**
Notes:				**TSS Removal Efficiency [%]**	**89**

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Time-of-Concentration

Click here for documentation

	Worksheet	User	Value Used
Existing [hr]	0.22		**0.22**
Developed [hr]	1.80		**1.80**

Method Selected: Worksheet

Notes:

Flood Control Volume

Click here for documentation

Detention - Routing Method

Design Storm	100-year
Total Contributing Area [ac]	1.23
Developed Peak Discharge [cfs]	0.01

Allowable Discharge Worksheet		Select
Standard Discharge [cfs] - 0.13 [cfs/ac]	0.16	◉
Alternate Discharge [cfs]		○

Developed runoff volume is less than existing for flood control event. An alternate discharge may be allowed.

Credited BMP Retention Volume	Volume Retained ← This should normally be set to "Volume Retained"
Detention Required?	No
Allowable Discharge [cfs]	0.16
Required Storage Volume [cft]	0
Time to Drain [hrs]	

Calculate Detention Storage Volume

No Emergency Overflow Routes ☐

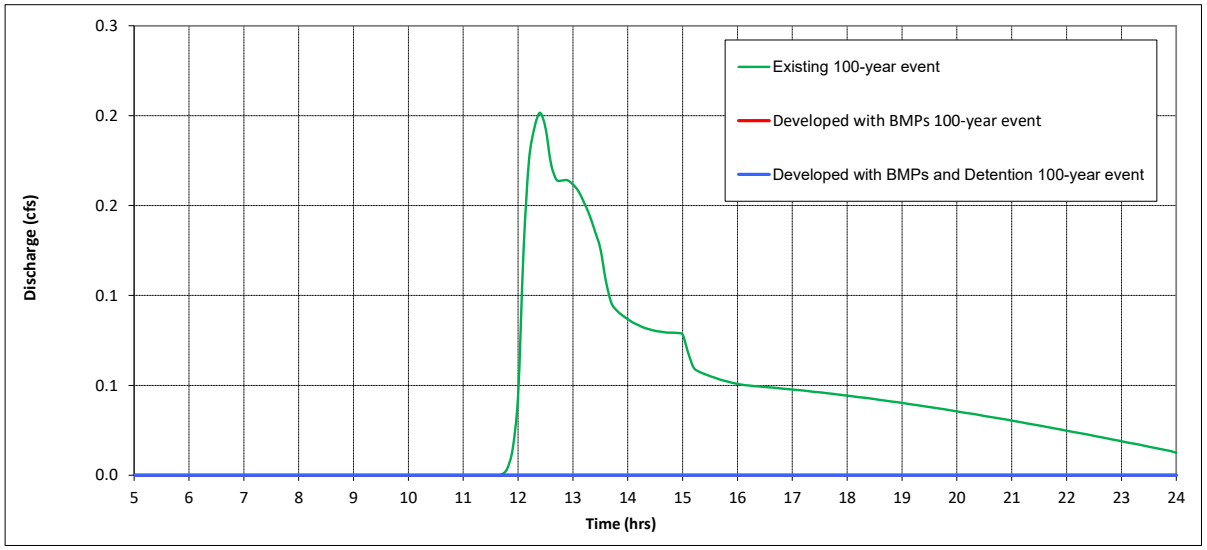
Retention - Summary of Volumes

Design Storm	100-year
Site Runoff Volume [cft]	13,572
BMP Storage Volume [cft]	15,986
BMP Infiltrating Volume [cft]	10,651
Total Volume Provided [cft]	26,637
Runoff Volume Retained by BMPs [cft]	13,467
Unretained Runoff Volume [cft]	105

Required Storage Volume [cft]: Minimum "BMP Storage Volume" that results in zero "Unretained Runoff Volume"

Notes:

Hydrograph



Plot Event: 100-year

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Ottawa County Water Resources Commissioner

Results Summary

Volume Units	cft

Rainfall

Source and Distribution	24-hour, NOAA Atlas 14 at West Olive, MI, NRCS MSE4				
Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Rainfall Depth [in]	2.25	2.59	3.91	4.95	6.90

Pre-settlement Land Use

Time-of-Concentration [hr]	0.22				
Average Runoff [in]	0.00	0.00	0.00	0.00	0.20
Peak Discharge [cfs]	0.00	0.00	0.00	0.00	0.04
Runoff Volume [cft]	0	0	0	15	871

Existing Land Use

Time-of-Concentration [hr]	0.22				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.01	0.01	0.04	0.15	0.57
Peak Discharge [cfs]	0.00	0.00	0.01	0.02	0.20
Runoff Volume [cft]	42	53	199	661	2,547

Developed Land Use

Time-of-Concentration [hr]	1.80				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.63	0.78	1.42	1.94	3.04
Peak Discharge [cfs]	0.08	0.10	0.27	0.44	0.89
Runoff Volume [cft]	2,804	3,495	6,338	8,683	13,572
Volume Retained by BMPs [cft]	2,804	3,495	6,338	8,683	13,467
BMP Volume Credited to Detention [cft]	2,804	3,495	6,338	8,683	13,467
Volume Released [cft]	0	0	0	0	105
Peak Discharge Released [cfs]	0.00	0.00	0.00	0.00	0.01

Developed with BMPs and Detention

Peak Discharge Released [cfs]	N.A.	N.A.	N.A.	N.A.	N.A.
Maximum Volume Detained [cft]	N.A.	N.A.	N.A.	N.A.	N.A.

LGROW DESIGN SPREADSHEETS : SUB 11

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Version 3.4

Instructions

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4) Comments are indicated by red triangles in cells. Further direction is provided in the LGROW Design Spreadsheet Tutorial.
5) The spreadsheet can be used to model a single discharge point from the site including structural BMPs in series or parallel.

Project Description

Development Name	KCE MI-4	**Design Firm**	Environmental Resources Managemer
Address/Location	8287 88th Ave, Zeeland, MI 49464	**Engineer**	Wayne Sicora, P.E.
Developer/Owner	KCE MI4, LLC	**Date**	11/25/2025

Run Sub-drainage area for staging area to be restored to meadow condition

	Select if Yes	Notes
Drainage District	☐	
Watershed Policy	☐	
Redevelopment/Addition	☐	
MS4	☐	
Hotspot	☐	
Coldwater Stream	☐	

Sensitive Areas

Description	Notes

Channel Protection Volume Basis

	Existing	Notes
Pre-development Land Use Definition		
Not Required	☐	
Provided Offsite	☐	
Alternative Approach	☐	

Subcatchment Connectivity

Number of Subcatchments 1

Subcatchment Name	Downstream Subcatchment	Subcatchment Description
Sub1	none	Sub 11 on DA Map; undetained area restored to meadow

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Ottawa County Water Resources Commissioner

Subcatchment Hydrology Summary

Subcatchment Name	Existing			Developed		
	Area [ac]	% Impervious	Average CN	Area [ac]	% Impervious	Average CN
Sub1	1.20	0%	37	1.20	0%	30
Site Totals and Averages:	**1.20**	**0%**	**37**	**1.20**	**0%**	**30**

Channel Protection Volume from Structural BMPs

Subcatchment Name	Channel Protection Volume [cft]			
	Required	Upstream	Credited	Unmet
Sub1	0	0	0	0
Total	**0**		**0**	

Percent of Channel Protection Volume met by Onsite Retention	**0**
Required Extended Detention Volume [cft]	**0**
Required Extended Detention Release Rate [cfs]	**0.000**
1-year Existing Peak Discharge [cfs]	0.00

Water Quality Volume and TSS Removal

Subcatchment Name	Water Quality Volume [cft]	Volume Met	TSS			
			Generated	Upstream	Total	Removed
Sub1	0	Yes	0	0	0	0
Total	**0**	**Yes**	**0**			**0**
					TSS Removal Efficiency [%]	**0**
					80% TSS removal met?	**No**

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Sub1: Sub 11 on DA Map; undetained area restored to meadow

Runoff

Click here for documentation

Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Open spaces (grass cover) - good	A	0.88	acre	39	30
Woods - good	A	0.32	acre	30	30
		1.20	acre	37	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
N-BMP: Native revegetation: Meadow	A	1.20	acre	30	
Notes:		1.20	acre	30	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	0	0	0	15	850

Channel Protection Volume

Click here for documentation

Required Channel Protection Volume

		2-year Runoff Volumes [cft] Developed	Pre-developed
Is Channel Protection Volume required? If no, provide reason.	Yes		
Required this Subcatchment [cft]	**0**	0	0
Unmet from Upstream Subcatchments [cft]	**0**		
Required Channel Protection Volume [cft]	**0**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
				N.A.	
				N.A.	
				N.A.	
				N.A.	
Totals		**0**			**0**
				Credited Channel Protection Volume	**0**
Notes:				**Percentage of Channel Protection Volume Met by Retention**	**100%**

Water Quality Volume

Click here for documentation

		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.00	0.00		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**0**	**TSS Generated this Subcatchment**		**0**
Volume from Upstream Subcatchments [cft]	**0**	**TSS from Upstream Subcatchments**		**0**
Water Quality Volume to be Treated [cft]	**0**	**TSS to be Treated**		**0**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	Third-Party	Effective	TSS Removed
					0
					0
					0
					0
					0
Released Water Volume [cft]	**0**			**Total TSS Removed**	**0**
Water Quality Volume met?	**Yes**			**TSS Remaining**	**0**
Notes:				**TSS Removal Efficiency [%]**	**0**

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Time-of-Concentration

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	Worksheet	User	Value Used
Existing [hr]	0.23		**0.23**
Developed [hr]	0.33		**0.33**

Method Selected: Worksheet

Notes:

Flood Control Volume

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Detention - Routing Method

Design Storm	100-year
Total Contributing Area [ac]	1.20
Developed Peak Discharge [cfs]	0.03

Allowable Discharge Worksheet		Select
Standard Discharge [cfs] - 0.13 [cfs/ac]	0.16	◉
Alternate Discharge [cfs]		○

Developed runoff volume is less than existing for flood control event. An alternate discharge may be allowed.

Credited BMP Retention Volume	Volume Retained ← This should normally be set to "Volume Retained"
Detention Required?	No
Allowable Discharge [cfs]	**0.16**
Required Storage Volume [cft]	**0**
Time to Drain [hrs]	

Calculate Detention Storage Volume

No Emergency Overflow Routes ☐

Retention - Summary of Volumes

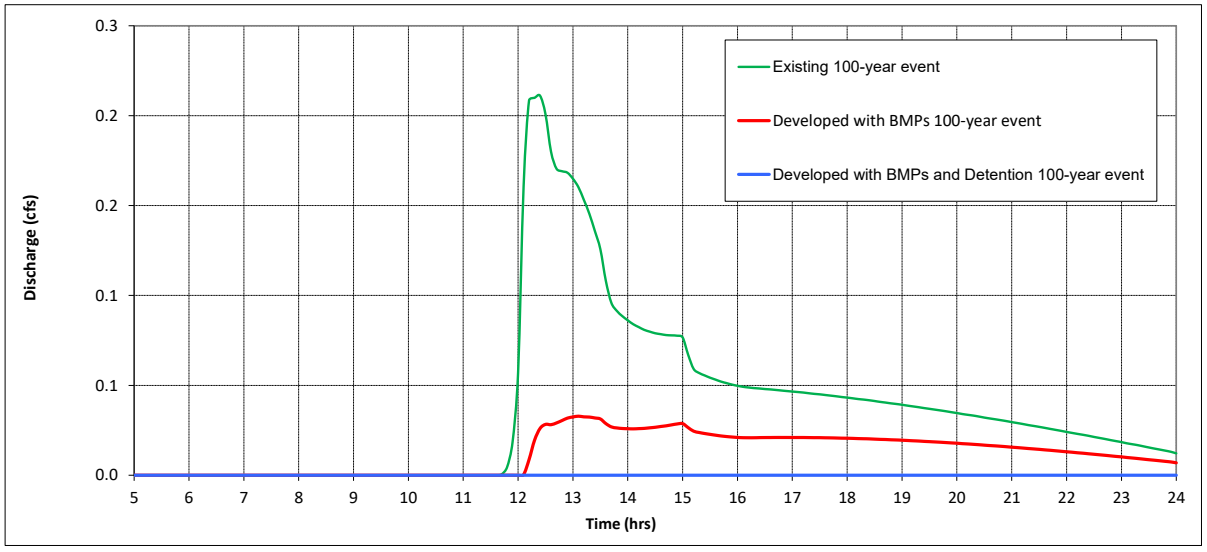
Design Storm	100-year
Site Runoff Volume [cft]	850
BMP Storage Volume [cft]	0
BMP Infiltrating Volume [cft]	0
Total Volume Provided [cft]	0
Runoff Volume Retained by BMPs [cft]	0
Unretained Runoff Volume [cft]	850

Required Storage Volume [cft]:

Minimum "BMP Storage Volume" that results in zero "Unretained Runoff Volume"

Notes:

Hydrograph



Plot Event: 100-year

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Results Summary

Volume Units	cft

Rainfall

Source and Distribution	24-hour, NOAA Atlas 14 at West Olive, MI, NRCS MSE4				
Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Rainfall Depth [in]	2.25	2.59	3.91	4.95	6.90

Pre-settlement Land Use

Time-of-Concentration [hr]	0.23				
Average Runoff [in]	0.00	0.00	0.00	0.00	0.20
Peak Discharge [cfs]	0.00	0.00	0.00	0.00	0.03
Runoff Volume [cft]	0	0	0	15	850

Existing Land Use

Time-of-Concentration [hr]	0.23				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.00	0.00	0.03	0.14	0.59
Peak Discharge [cfs]	0.00	0.00	0.00	0.02	0.21
Runoff Volume [cft]	0	0	119	611	2,568

Developed Land Use

Time-of-Concentration [hr]	0.33				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.00	0.00	0.00	0.00	0.20
Peak Discharge [cfs]	0.00	0.00	0.00	0.00	0.03
Runoff Volume [cft]	0	0	0	15	850
Volume Retained by BMPs [cft]	0	0	0	0	0
BMP Volume Credited to Detention [cft]	0	0	0	0	0
Volume Released [cft]	0	0	0	15	850
Peak Discharge Released [cfs]	0.00	0.00	0.00	0.00	0.03

Developed with BMPs and Detention

Peak Discharge Released [cfs]	N.A.	N.A.	N.A.	N.A.	N.A.
Maximum Volume Detained [cft]	N.A.	N.A.	N.A.	N.A.	N.A.

ERM

LGROW DESIGN SPREADSHEETS : SUB 12

LGROW Design Spreadsheet
Ottawa County Water Resources Commissioner

Version 3.4

Instructions

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4) Comments are indicated by red triangles in cells. Further direction is provided in the LGROW Design Spreadsheet Tutorial.
5) The spreadsheet can be used to model a single discharge point from the site including structural BMPs in series or parallel.

Project Description

Development Name	KCE MI-4	**Design Firm**	Environmental Resources Managemer
Address/Location	8287 88th Ave, Zeeland, MI 49464	**Engineer**	Wayne Sicora, P.E.
Developer/Owner	KCE MI4, LLC	**Date**	11/25/2025

Run Sub-drainage area for staging area to be restored to meadow condition

	Select if Yes	Notes
Drainage District	☐	
Watershed Policy	☐	
Redevelopment/Addition	☐	
MS4	☐	
Hotspot	☐	
Coldwater Stream	☐	

Sensitive Areas

Description	Notes

Channel Protection Volume Basis

	Existing	Notes
Pre-development Land Use Definition		
Not Required	☐	
Provided Offsite	☐	
Alternative Approach	☐	

Subcatchment Connectivity

Number of Subcatchments 1

Subcatchment Name	Downstream Subcatchment	Subcatchment Description
Sub1	none	Sub 12 on DA Map; undetained area restored to meadow

LGROW Design Spreadsheet
Ottawa County Water Resources Commissioner

Subcatchment Hydrology Summary

Subcatchment Name	Existing			Developed		
	Area [ac]	% Impervious	Average CN	Area [ac]	% Impervious	Average CN
Sub1	1.22	0%	39	1.22	0%	30
Site Totals and Averages:	**1.22**	**0%**	**39**	**1.22**	**0%**	**30**

Channel Protection Volume from Structural BMPs

Subcatchment Name	Channel Protection Volume [cft]			
	Required	Upstream	Credited	Unmet
Sub1	0	0	0	0
Total	**0**		**0**	

Percent of Channel Protection Volume met by Onsite Retention	**0**
Required Extended Detention Volume [cft]	**0**
Required Extended Detention Release Rate [cfs]	**0.000**
1-year Existing Peak Discharge [cfs]	0.00

Water Quality Volume and TSS Removal

Subcatchment Name	Water Quality Volume [cft]	Volume Met	TSS			
			Generated	Upstream	Total	Removed
Sub1	0	Yes	0	0	0	0
Total	**0**	**Yes**	**0**			**0**
					TSS Removal Efficiency [%]	**0**
					80% TSS removal met?	**No**

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Sub1: Sub 12 on DA Map; undetained area restored to meadow

Runoff

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Existing Land Use	HSG	Area	Units	Curve Number Existing	Curve Number Pre-settlement
Open spaces (grass cover) - good	A	1.17	acre	39	30
Woods - good	A	0.05	acre	30	30
		1.22	acre	39	30

Developed Land Use	HSG	Area	Units	Curve Number	Notes
N-BMP: Native revegetation: Meadow	A	1.22	acre	30	
Notes:		1.22	acre	30	

Subcatchment Runoff Volume for Developed Land Use

Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Volume from this Subcatchment [cft]	0	0	0	15	864

Channel Protection Volume

Click here for documentation

Required Channel Protection Volume

		2-year Runoff Volumes [cft]	
Is Channel Protection Volume required? If no, provide reason.	Yes	Developed	Pre-developed
Required this Subcatchment [cft]	**0**	0	0
Unmet from Upstream Subcatchments [cft]	**0**		
Required Channel Protection Volume [cft]	**0**		

Structural BMPs used to meet Channel Protection Volume

Structural BMP	A Infiltration Area [sqft]	V Storage Volume [cft]	i Design Infiltration Rate [in/hr]	Drain Time [hr]	Volume Retained [cft]
				N.A.	
				N.A.	
				N.A.	
				N.A.	
Totals		**0**			**0**
				Credited Channel Protection Volume	**0**
Notes:				**Percentage of Channel Protection Volume Met by Retention**	**100%**

Water Quality Volume

Click here for documentation

		Paved [ac]	Pitched Roofs [ac]	Flat Roofs/Unpaved [ac]
Sum of Directly Connected Impervious Area [ac]	0.00	0.00		
Sum of Directly Connected Disturbed Pervious Area [ac]	0.00			
Required Volume this Subcatchment [cft]	**0**	**TSS Generated this Subcatchment**		**0**
Volume from Upstream Subcatchments [cft]	**0**	**TSS from Upstream Subcatchments**		**0**
Water Quality Volume to be Treated [cft]	**0**	**TSS to be Treated**		**0**

TSS Accounting

BMPs Used in Treatment Train	Treated Water Volume [cft]	TSS Removal Efficiency Tabulated	TSS Removal Efficiency Third-Party	TSS Removal Efficiency Effective	TSS Removed
					0
					0
					0
					0
					0
Released Water Volume [cft]	**0**			**Total TSS Removed**	**0**
Water Quality Volume met?	**Yes**			**TSS Remaining**	**0**
Notes:				**TSS Removal Efficiency [%]**	**0**

LGROW Design Spreadsheet
Ottawa County Water Resources Commissioner

GVMC

Time-of-Concentration

Click here for documentation

	Worksheet	User	Value Used
Existing [hr]	0.22		**0.22**
Developed [hr]	0.29		**0.29**

Method Selected: Worksheet

Notes:

Flood Control Volume

Click here for documentation

Detention - Routing Method

Design Storm	100-year
Total Contributing Area [ac]	1.22
Developed Peak Discharge [cfs]	0.03

Allowable Discharge Worksheet		Select
Standard Discharge [cfs] - 0.13 [cfs/ac]	0.16	◉
Alternate Discharge [cfs]		○

Developed runoff volume is less than existing for flood control event. An alternate discharge may be allowed.

Credited BMP Retention Volume	Volume Retained ← This should normally be set to "Volume Retained"
Detention Required?	No
Allowable Discharge [cfs]	0.16
Required Storage Volume [cft]	0
Time to Drain [hrs]	

Calculate Detention Storage Volume

No Emergency Overflow Routes ☐

Retention - Summary of Volumes

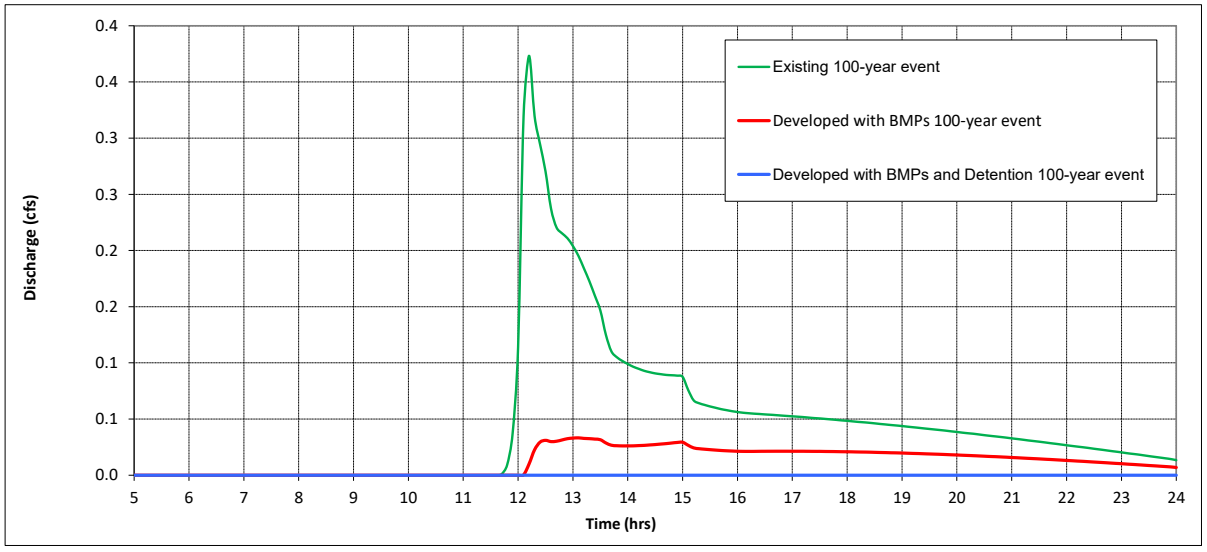
Design Storm	100-year
Site Runoff Volume [cft]	864
BMP Storage Volume [cft]	0
BMP Infiltrating Volume [cft]	0
Total Volume Provided [cft]	0
Runoff Volume Retained by BMPs [cft]	0
Unretained Runoff Volume [cft]	864

Required Storage Volume [cft]:

Minimum "BMP Storage Volume" that results in zero "Unretained Runoff Volume"

Notes:

Hydrograph



Plot Event: 100-year

LGROW Design Spreadsheet
Ottawa County Water Resources Commissioner

Results Summary

Volume Units	cft

Rainfall

Source and Distribution	24-hour, NOAA Atlas 14 at West Olive, MI, NRCS MSE4				
Rainfall Frequency	1-year	2-year	10-year	25-year	100-year
Rainfall Depth [in]	2.25	2.59	3.91	4.95	6.90

Pre-settlement Land Use

Time-of-Concentration [hr]	0.22				
Average Runoff [in]	0.00	0.00	0.00	0.00	0.20
Peak Discharge [cfs]	0.00	0.00	0.00	0.00	0.04
Runoff Volume [cft]	0	0	0	15	864

Existing Land Use

Time-of-Concentration [hr]	0.22				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.00	0.00	0.04	0.18	0.71
Peak Discharge [cfs]	0.00	0.00	0.01	0.04	0.37
Runoff Volume [cft]	0	0	158	808	3,148

Developed Land Use

Time-of-Concentration [hr]	0.29				
Percent Impervious	0%	0%	0%	0%	0%
Average Runoff [in]	0.00	0.00	0.00	0.00	0.20
Peak Discharge [cfs]	0.00	0.00	0.00	0.00	0.03
Runoff Volume [cft]	0	0	0	15	864
Volume Retained by BMPs [cft]	0	0	0	0	0
BMP Volume Credited to Detention [cft]	0	0	0	0	0
Volume Released [cft]	0	0	0	15	864
Peak Discharge Released [cfs]	0.00	0.00	0.00	0.00	0.03

Developed with BMPs and Detention

Peak Discharge Released [cfs]	N.A.	N.A.	N.A.	N.A.	N.A.
Maximum Volume Detained [cft]	N.A.	N.A.	N.A.	N.A.	N.A.

APPENDIX C STORMWATER BMP SIZING

KCE MI 4 - Infiltration Basin Volumes

Infiltration Basin #1 Volume	
Elevation (ft)	**Cumulative Storage (cf)**
635.00	0
635.50	7,647
636.00	17,589
636.50	29,274
636.80*	36,770
637.00**	41,975
637.50	55,707
638.00	70,482

*Infiltration Basin #1 outlet elevation.

**Infiltration Basin #1 emergency outlet elevation.

Infiltration Basin #2 Volume	
Elevation (ft)	**Cumulative Storage (cf)**
635.00	0
635.50	507
636.00	1,139
636.50	1,910
637.00	2,832
637.50	3,918
638.00	5,179

Summary for Pond 71P: IB-1

Inflow Area = 5.520 ac, 0.00% Impervious, Inflow Depth = 0.77" for 2-year event
Inflow = 8.89 cfs @ 11.95 hrs, Volume= 0.352 af
Outflow = 1.35 cfs @ 12.26 hrs, Volume= 0.352 af, Atten= 85%, Lag= 18.6 min
Discarded = 1.35 cfs @ 12.26 hrs, Volume= 0.352 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link 69L : POI 2
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link 69L : POI 2

Routing by Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.01 hrs
Peak Elev= 635.36' @ 12.26 hrs Surf.Area= 16,219 sf Storage= 5,273 cf

Plug-Flow detention time= 30.4 min calculated for 0.352 af (100% of inflow)
Center-of-Mass det. time= 30.4 min (851.8 - 821.3)

Volume	Invert	Avail.Storage	Storage Description
#1	635.00'	70,482 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
635.00	13,199	0	0	13,199
636.00	22,381	17,589	17,589	22,393
637.00	26,447	24,386	41,975	26,496
638.00	30,619	28,508	70,482	30,711

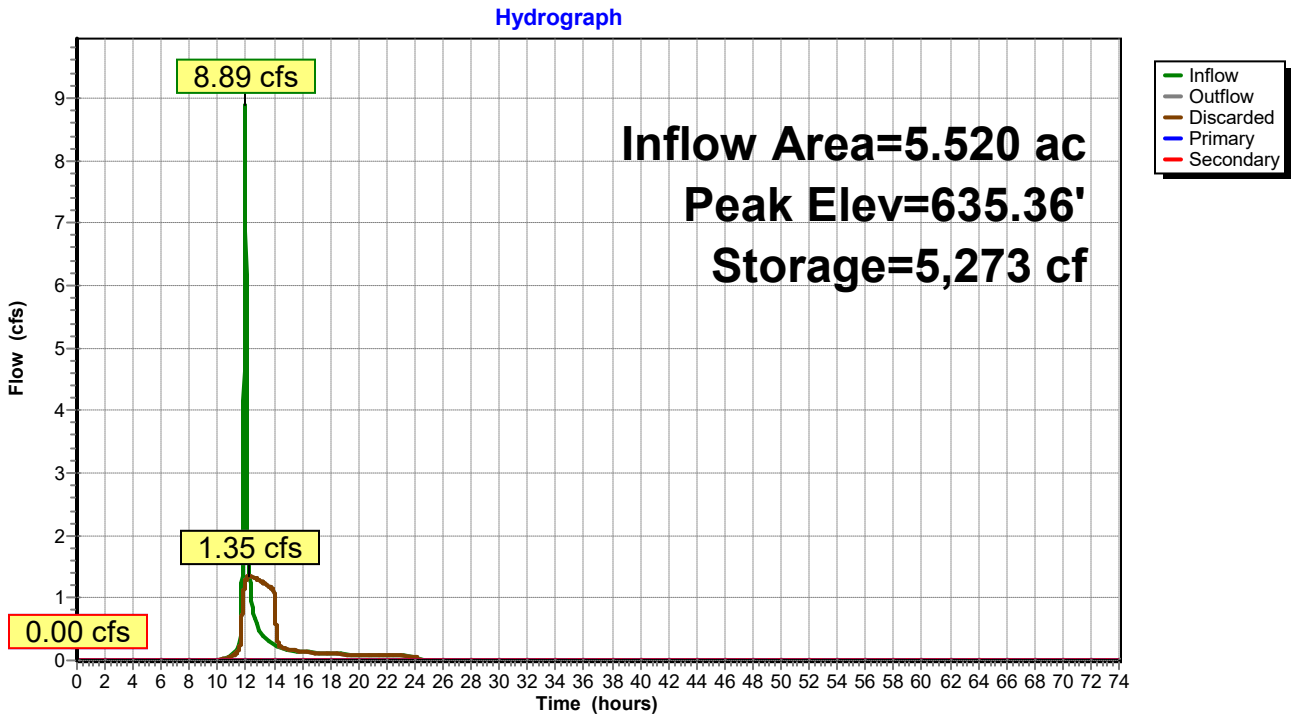
Device	Routing	Invert	Outlet Devices
#1	Primary	635.30'	**15.0" Round Culvert** L= 30.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 635.30' / 635.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Device 1	636.80'	**48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	635.00'	**3.600 in/hr Exfiltration over Surface area**
#4	Secondary	637.00'	**8.0' long + 3.0 '/' SideZ x 50.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=1.35 cfs @ 12.26 hrs HW=635.36' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 1.35 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=635.00' (Free Discharge)
└**1=Culvert** (Controls 0.00 cfs)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=635.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 71P: IB-1


Hydrograph
8.89 cfs
1.35 cfs
0.00 cfs
Inflow Area=5.520 ac
Peak Elev=635.36'
Storage=5,273 cf
Inflow
Outflow
Discarded
Primary
Secondary
Flow (cfs)
Time (hours)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74
0 1 2 3 4 5 6 7 8 9

Summary for Pond 71P: IB-1

Inflow Area = 5.520 ac, 0.00% Impervious, Inflow Depth = 3.80" for 100-year event
Inflow = 36.39 cfs @ 11.94 hrs, Volume= 1.750 af
Outflow = 2.44 cfs @ 12.64 hrs, Volume= 1.750 af, Atten= 93%, Lag= 42.2 min
Discarded = 2.15 cfs @ 12.64 hrs, Volume= 1.736 af
Primary = 0.29 cfs @ 12.64 hrs, Volume= 0.014 af
Routed to Link 69L : POI 2
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link 69L : POI 2

Routing by Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.01 hrs
Peak Elev= 636.84' @ 12.64 hrs Surf.Area= 25,758 sf Storage= 37,701 cf

Plug-Flow detention time= 164.5 min calculated for 1.750 af (100% of inflow)
Center-of-Mass det. time= 164.5 min (953.4 - 788.9)

Volume	Invert	Avail.Storage	Storage Description
#1	635.00'	70,482 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
635.00	13,199	0	0	13,199
636.00	22,381	17,589	17,589	22,393
637.00	26,447	24,386	41,975	26,496
638.00	30,619	28,508	70,482	30,711

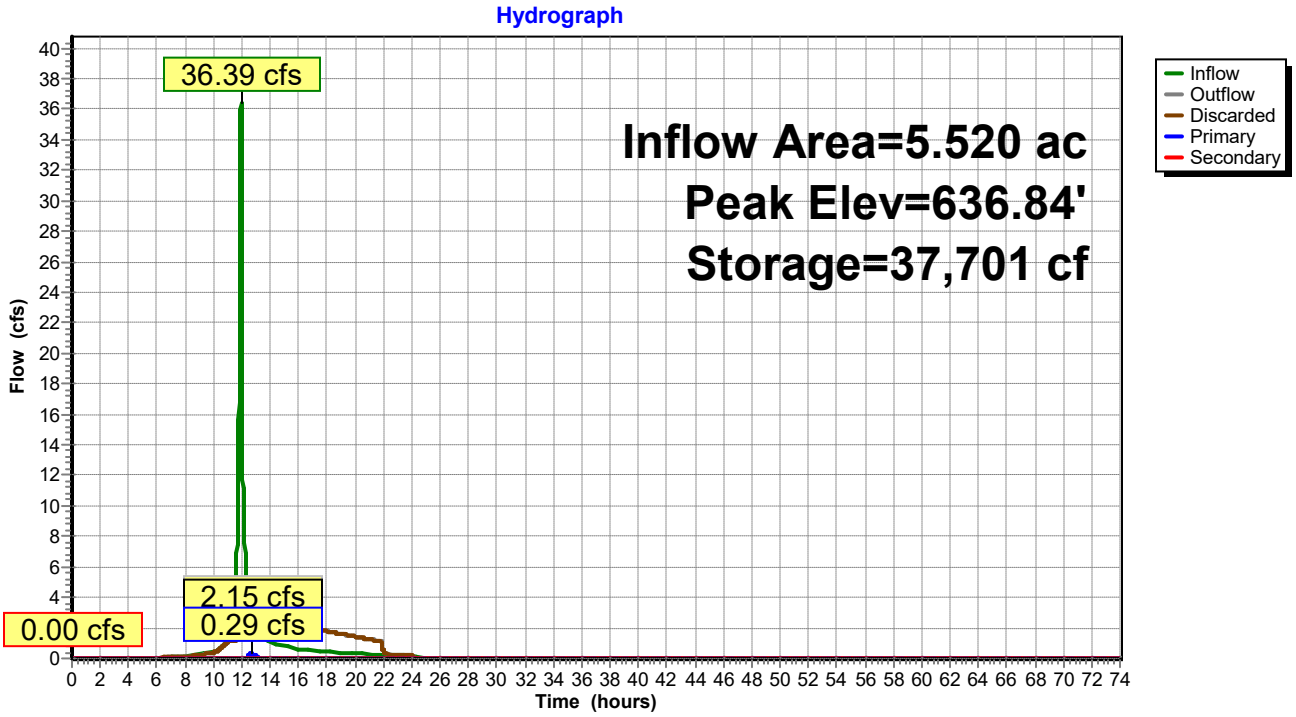
Device	Routing	Invert	Outlet Devices
#1	Primary	635.30'	**15.0" Round Culvert** L= 30.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 635.30' / 635.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Device 1	636.80'	**48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	635.00'	**3.600 in/hr Exfiltration over Surface area**
#4	Secondary	637.00'	**8.0' long + 3.0 '/' SideZ x 50.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=2.15 cfs @ 12.64 hrs HW=636.84' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 2.15 cfs)

Primary OutFlow Max=0.28 cfs @ 12.64 hrs HW=636.84' (Free Discharge)
└**1=Culvert** (Passes 0.28 cfs of 5.58 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 0.28 cfs @ 0.62 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=635.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 71P: IB-1


Hydrograph
36.39 cfs
2.15 cfs
0.29 cfs
0.00 cfs
Inflow Area=5.520 ac
Peak Elev=636.84'
Storage=37,701 cf
Inflow
Outflow
Discarded
Primary
Secondary
Flow (cfs)
Time (hours)

Summary for Pond 34P: IB-2

Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 1.25" for 2-year event
Inflow = 3.72 cfs @ 11.94 hrs, Volume= 0.156 af
Outflow = 2.57 cfs @ 11.99 hrs, Volume= 0.156 af, Atten= 31%, Lag= 3.2 min
Discarded = 0.18 cfs @ 11.99 hrs, Volume= 0.091 af
Primary = 2.38 cfs @ 11.99 hrs, Volume= 0.065 af
Routed to Pond 71P : IB-1

Routing by Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.01 hrs
Peak Elev= 636.33' @ 11.99 hrs Surf.Area= 1,584 sf Storage= 1,624 cf

Plug-Flow detention time= 31.7 min calculated for 0.156 af (100% of inflow)
Center-of-Mass det. time= 31.7 min (857.9 - 826.1)

Volume	Invert	Avail.Storage	Storage Description
#1	635.00'	5,179 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

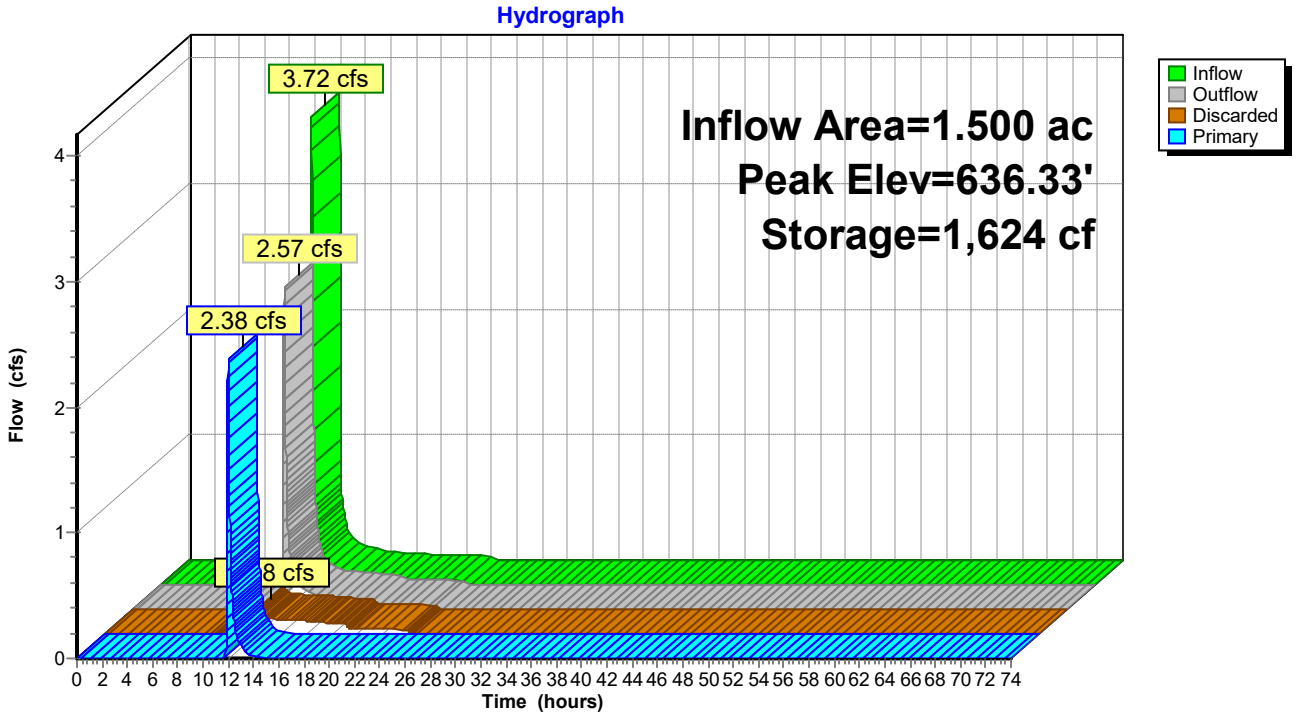
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
635.00	899	0	0	899
636.00	1,398	1,139	1,139	1,412
637.00	2,005	1,692	2,832	2,036
638.00	2,707	2,347	5,179	2,759

Device	Routing	Invert	Outlet Devices
#1	Primary	635.50'	**15.0" Round Culvert** L= 72.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 635.50' / 635.00' S= 0.0069 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Discarded	635.00'	**3.600 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 632.50'

Discarded OutFlow Max=0.18 cfs @ 11.99 hrs HW=636.32' (Free Discharge)
↑**2=Exfiltration** (Controls 0.18 cfs)

Primary OutFlow Max=2.38 cfs @ 11.99 hrs HW=636.32' (Free Discharge)
↑**1=Culvert** (Barrel Controls 2.38 cfs @ 3.93 fps)

Pond 34P: IB-2


Hydrograph
3.72 cfs
2.57 cfs
2.38 cfs
8 cfs
Inflow Area=1.500 ac
Peak Elev=636.33'
Storage=1,624 cf
Inflow
Outflow
Discarded
Primary
Flow (cfs)
0
1
2
3
4
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74
Time (hours)

Summary for Pond 34P: IB-2

Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 5.00" for 100-year event
Inflow = 13.82 cfs @ 11.94 hrs, Volume= 0.625 af
Outflow = 9.53 cfs @ 11.99 hrs, Volume= 0.625 af, Atten= 31%, Lag= 3.3 min
Discarded = 0.43 cfs @ 11.99 hrs, Volume= 0.190 af
Primary = 9.10 cfs @ 11.99 hrs, Volume= 0.435 af
Routed to Pond 71P : IB-1

Routing by Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.01 hrs
Peak Elev= 638.75' @ 11.99 hrs Surf.Area= 2,707 sf Storage= 5,179 cf

Plug-Flow detention time= 26.4 min calculated for 0.625 af (100% of inflow)
Center-of-Mass det. time= 26.4 min (813.7 - 787.3)

Volume	Invert	Avail.Storage	Storage Description
#1	635.00'	5,179 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

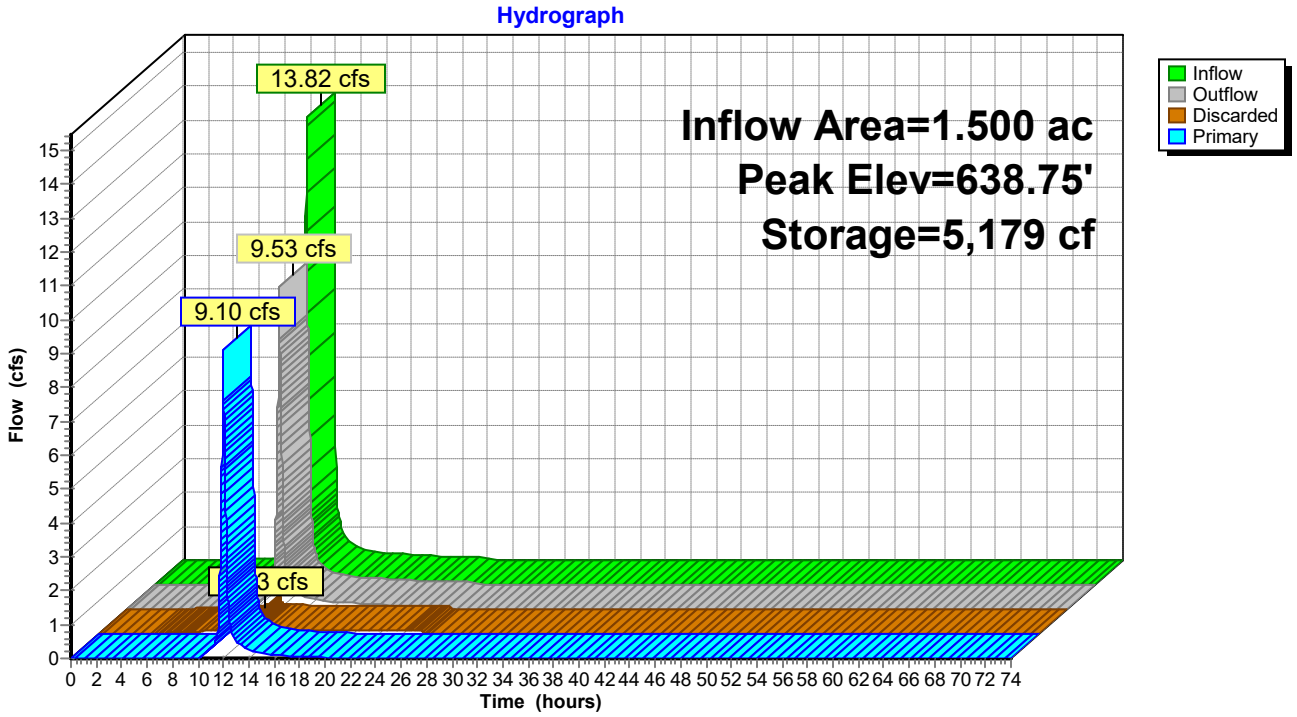
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
635.00	899	0	0	899
636.00	1,398	1,139	1,139	1,412
637.00	2,005	1,692	2,832	2,036
638.00	2,707	2,347	5,179	2,759

Device	Routing	Invert	Outlet Devices
#1	Primary	635.50'	**15.0" Round Culvert** L= 72.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 635.50' / 635.00' S= 0.0069 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Discarded	635.00'	**3.600 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 632.50'

Discarded OutFlow Max=0.43 cfs @ 11.99 hrs HW=638.75' (Free Discharge)
2=Exfiltration (Controls 0.43 cfs)

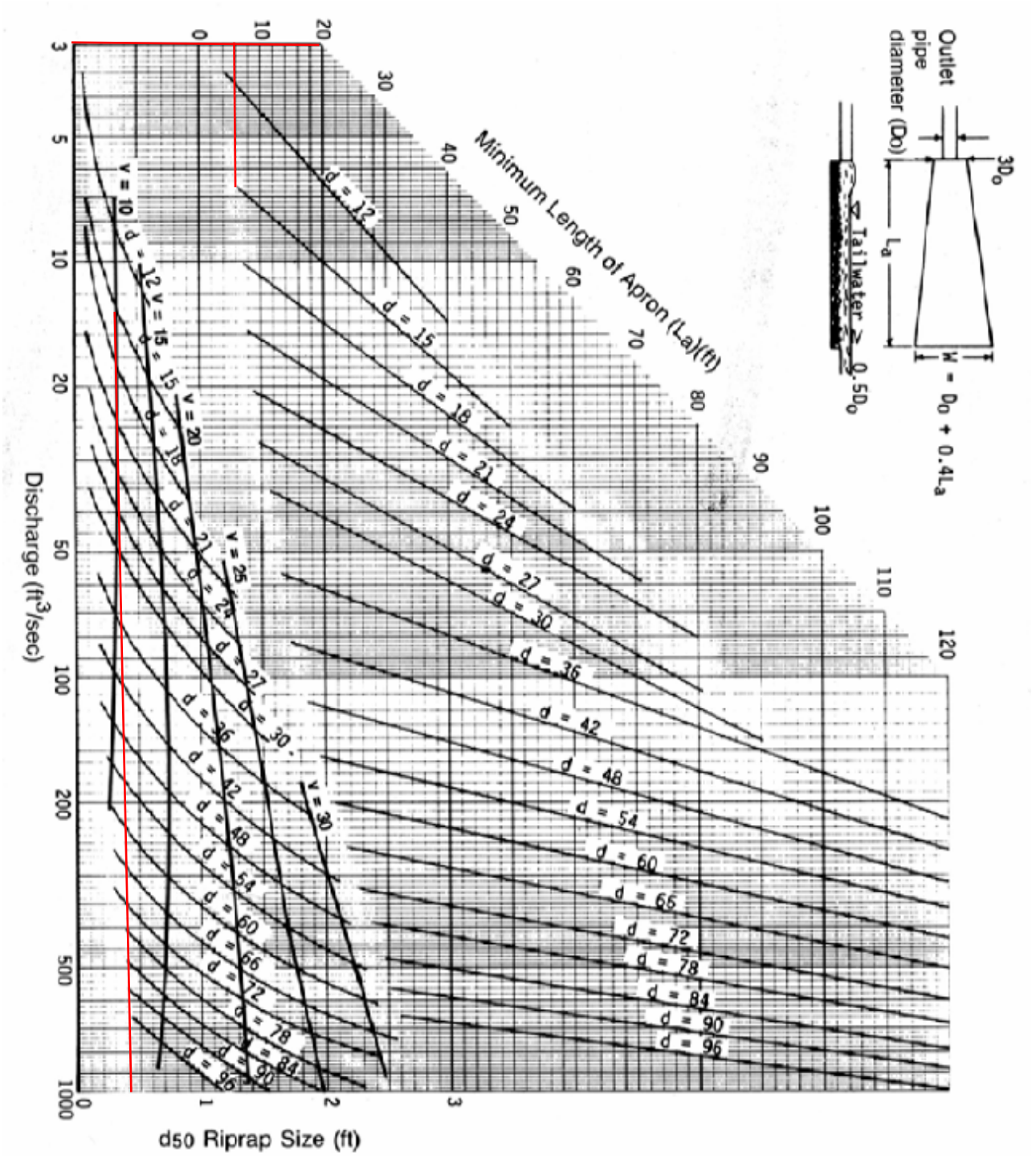
Primary OutFlow Max=9.09 cfs @ 11.99 hrs HW=638.75' (Free Discharge)
1=Culvert (Barrel Controls 9.09 cfs @ 7.41 fps)

Pond 34P: IB-2


Hydrograph
13.82 cfs
9.53 cfs
9.10 cfs
3 cfs
Inflow Area=1.500 ac
Peak Elev=638.75'
Storage=5,179 cf
Inflow
Outflow
Discarded
Primary
Flow (cfs)
Time (hours)

APPENDIX D RIP RAP CALCULATIONS

Figure 2. Outlet Protection Design—Maximum Tailwater Condition
Design of Outlet Protection from a Round Pipe Flowing Full, Maximum Tailwater Condition: Tw ≥ 0.5Do) (USDA - NRCS)

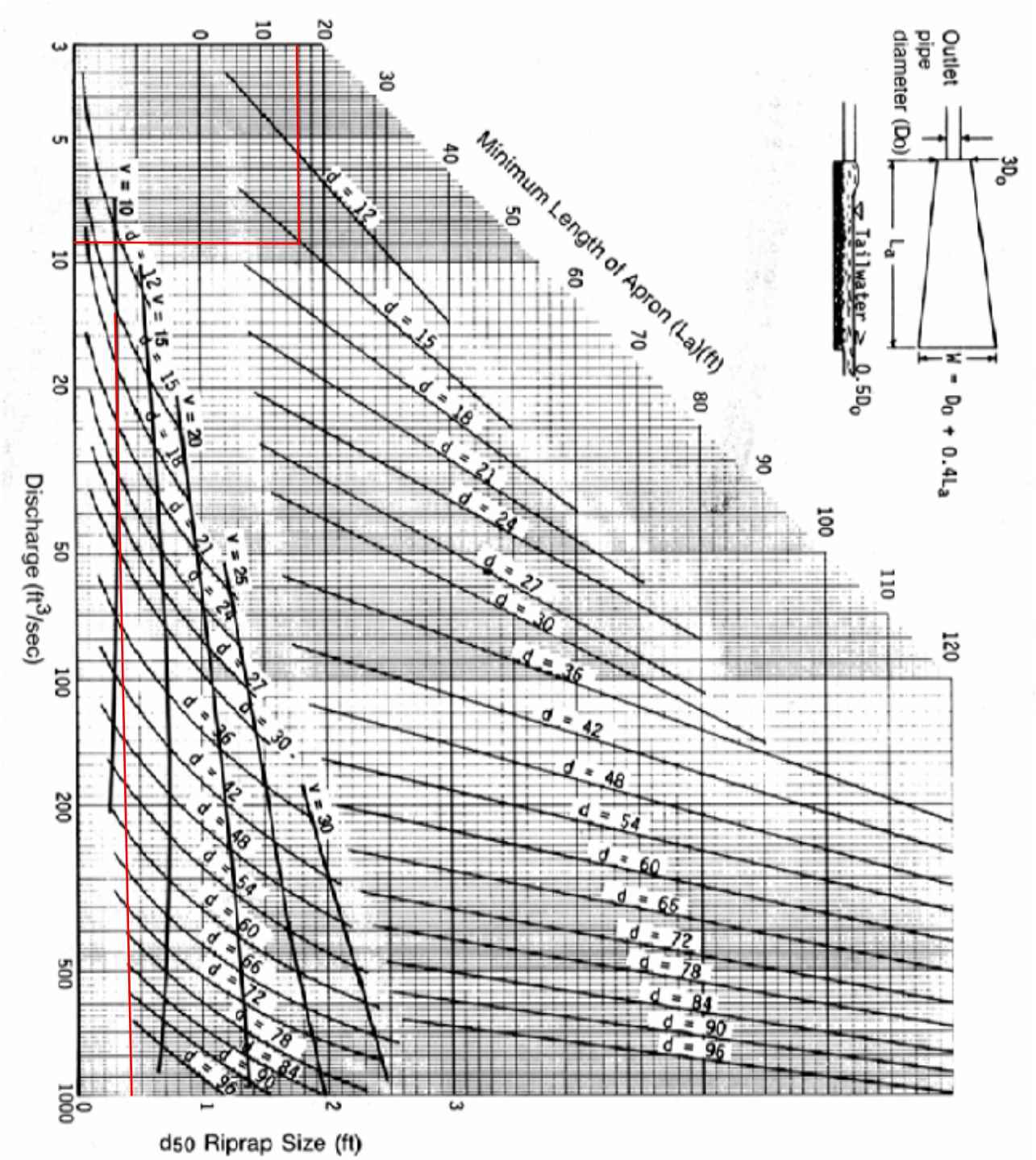


Riprap Apron #1
D=15"
Q=0.67 cfs
V=0.82 fps

Use 9" of 4" rock with a length of 6'.

d_{50} (in)	d_{max} (in)	Minimum Blanket Thickness (in)
4	6	9
6	9	14
9	14	20
12	18	27
15	22	32
18	27	32
21	32	38
24	36	43

Figure 2. Outlet Protection Design—Maximum Tailwater Condition
Design of Outlet Protection from a Round Pipe Flowing Full, Maximum Tailwater Condition: Tw ≥ 0.5Do) (USDA - NRCS)

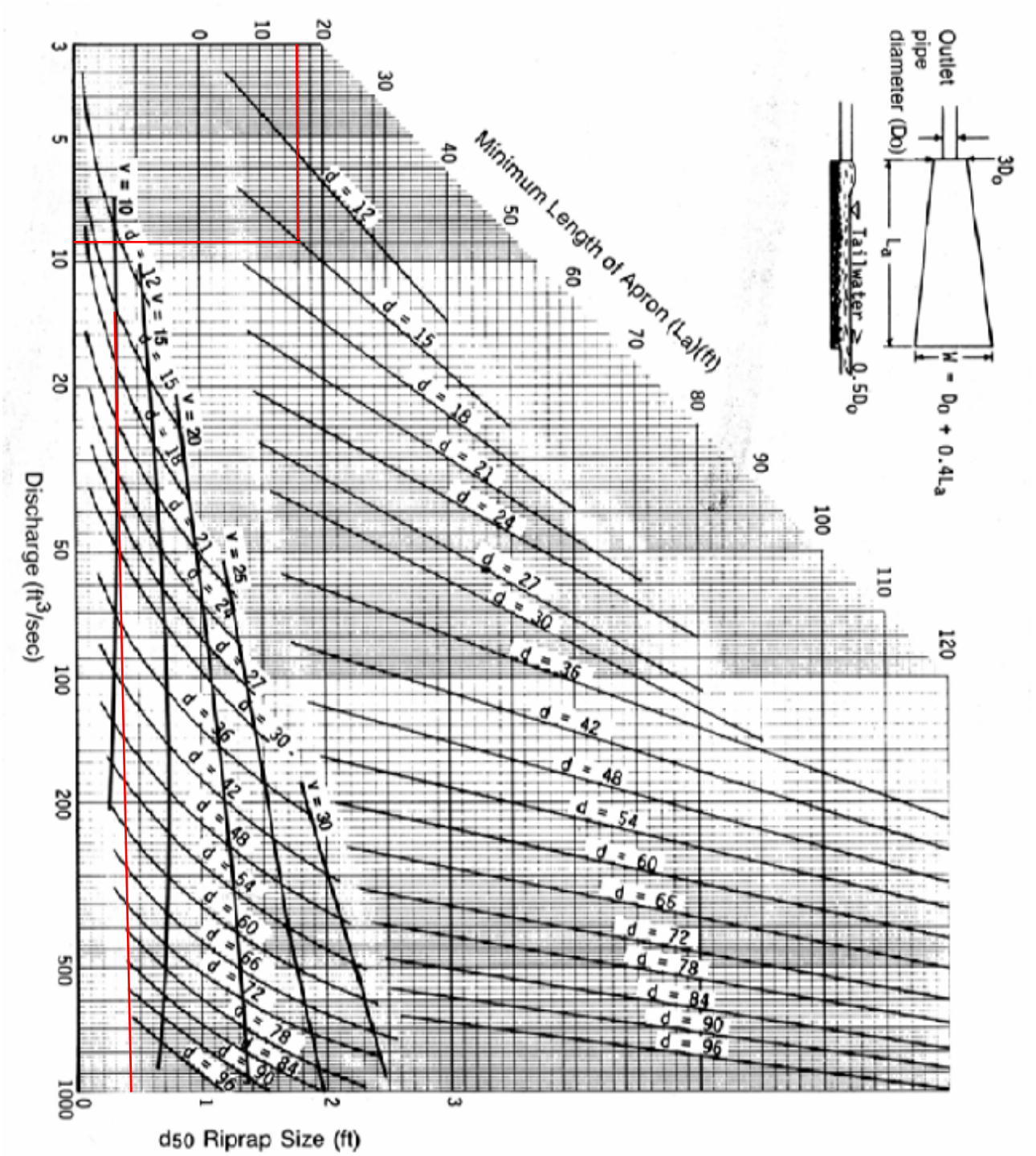


Riprap Apron #2
D=15"
Q=9.09 cfs
V=7.41 fps

Use 9" of 4" rock with a length of 16'.

d_{50} (in)	d_{max} (in)	Minimum Blanket Thickness (in)
4	6	9
6	9	14
9	14	20
12	18	27
15	22	32
18	27	32
21	32	38
24	36	43

Figure 2. Outlet Protection Design—Maximum Tailwater Condition
Design of Outlet Protection from a Round Pipe Flowing Full, Maximum Tailwater Condition: Tw ≥ 0.5Do) (USDA - NRCS)

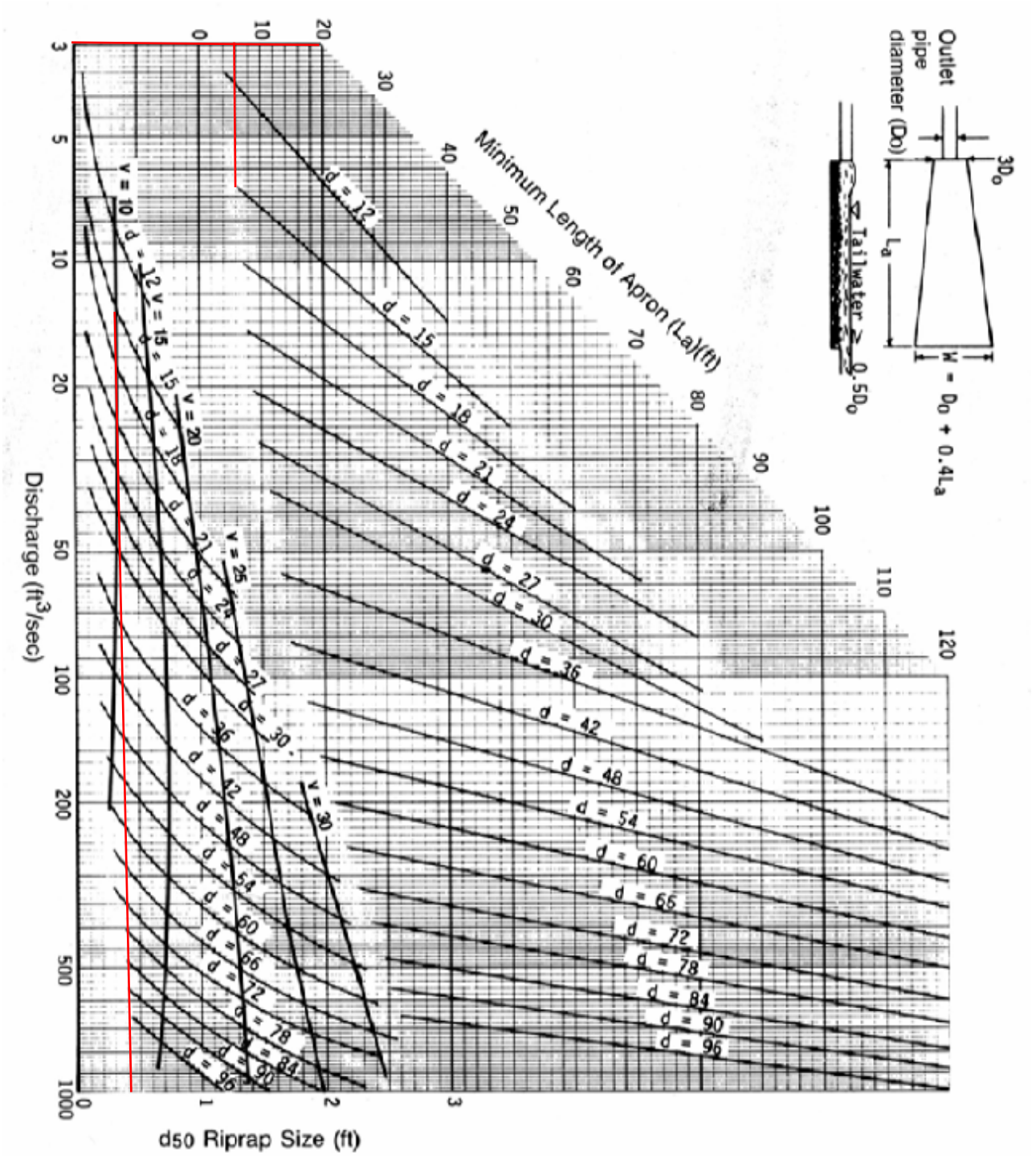


Riprap Apron #3
D=15"
Q=9.09 cfs
V=7.41 fps

Use 9" of 4" rock with a length of 16'.

d_{50} (in)	d_{max} (in)	Minimum Blanket Thickness (in)
4	6	9
6	9	14
9	14	20
12	18	27
15	22	32
18	27	32
21	32	38
24	36	43

Figure 2. Outlet Protection Design—Maximum Tailwater Condition
Design of Outlet Protection from a Round Pipe Flowing Full, Maximum Tailwater Condition: Tw ≥ 0.5Do) (USDA - NRCS)

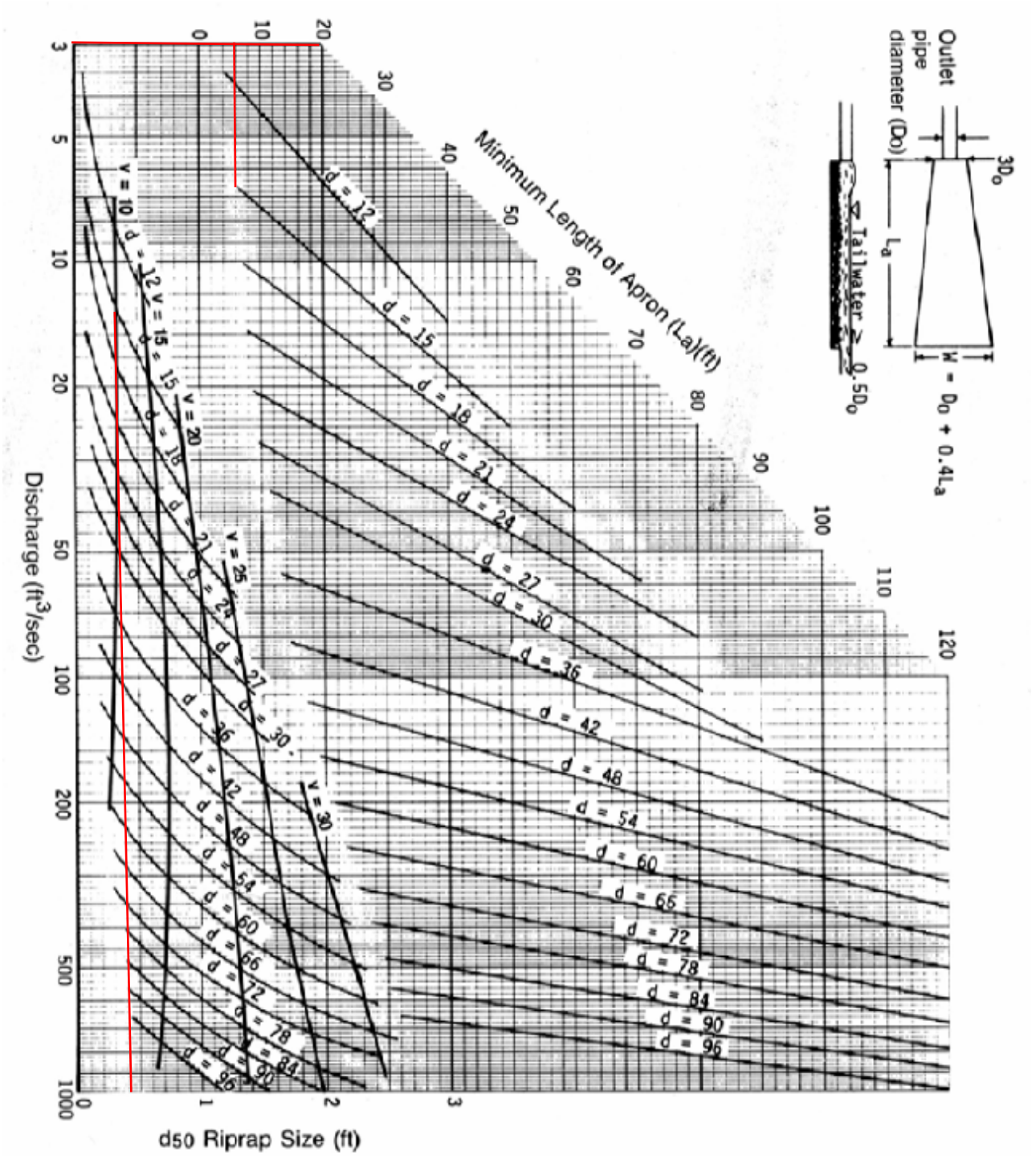


Riprap Apron #4
D=15"
Q=0.42 cfs
V=2.46 fps

Use 9" of 4" rock with a length of 6'.

d_{50} (in)	d_{max} (in)	Minimum Blanket Thickness (in)
4	6	9
6	9	14
9	14	20
12	18	27
15	22	32
18	27	32
21	32	38
24	36	43

Figure 2. Outlet Protection Design—Maximum Tailwater Condition
Design of Outlet Protection from a Round Pipe Flowing Full, Maximum Tailwater Condition: Tw ≥ 0.5Do) (USDA - NRCS)



Riprap Apron #5
D=15"
Q=0.42 cfs
V=2.46 fps

Use 9" of 4" rock with a length of 6'.

d_{50} (in)	d_{max} (in)	Minimum Blanket Thickness (in)
4	6	9
6	9	14
9	14	20
12	18	27
15	22	32
18	27	32
21	32	38
24	36	43

ENCLOSURE 1 – EXISTING SUB-DRAINAGE AREA MAP

LEGEND

- SOIL BOUNDARY LINE
- EXISTING CONTOURS
- PROPOSED CONTOURS
- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- LAND COVER: GRASS
- LAND COVER: GRAVEL
- LAND COVER: WOODS
- EXISTING TREE LINE
- POINT OF INTEREST (POI)

SCALE 1"=100'
0 100 200 300 FEET

Rev.	Date	Description	By	Chk

ERM

OVERALL EXISTING CONDITIONS DRAINAGE AREA MAP		DISCIPLINE NO. C
KCE MI 4 KCE MI 4, LLC BLENDON TOWNSHIP, OTTAWA COUNTY, MICHIGAN		REV. A
SCALE 1" = 100' DATE DRAWN 11/25/2025	DESIGNED BY JB DRAWN BY JB	PROJECT NUMBER 0780170 / SHEET NO. 1

Environmental Resources Management, Inc.

FILE PATH: C:\Users\laura.fritz\OneDrive - ERM\Key Capture Energy (KCE) - KCE MI 4 (0780143) 1\Project Work\Engineering\CAD\Working Files\10% Plans\KCE MI 4 Stormwater_updates_recover.dwg OVERVIEW PRE POI, PRINTED ON 11/21/2025 BY Laura Lewis

N

SUB11

SUB10

POI 3

SUB12

POI 4

SUB2

POI 1

SUB3

SUB8

SUB6

SUB5

SUB7

SUB9

SUB1

SUB4

PlfabB

CrB

PpsaaA

LEGEND

- SOIL BOUNDARY LINE
- EXISTING CONTOURS
- PROPOSED CONTOURS
- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- LAND COVER: GRASS
- LAND COVER: GRAVEL
- LAND COVER: WOODS
- EXISTING TREE LINE

SCALE 1"=60'

0 60 120 180 FEET

Rev.	Date	Description	By	Chk

ERM

EXISTING CONDITIONS DRAINAGE AREA MAP

DISCIPLINE NO. C

KCE MI 4
KCE MI 4, LLC
BLENDON TOWNSHIP, OTTAWA COUNTY, MICHIGAN

REV. A

SCALE	DESIGNED BY	PROJECT NUMBER	SHEET NO.
1" = 60'	JB	0780170	2
DATE DRAWN 11/25/2025	DRAWN BY JB		

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FILE PATH: C:\Users\laura.fritz\OneDrive - ERM\Key Capture Energy (KCE) - KCE MI 4 (0780143) 1\Project Work\Engineering\CAD\Working Files\10% Plans\KCE MI 4 Stormwater_updates_lacover.dwg PRE DA MAP - PRINTED ON 11/21/2025 BY Laura Lewis

ENCLOSURE 2 – PROPOSED SUB-DRAINAGE AREA MAP

POI 2
SUB3
SUB10
PlfabB
SUB11
POI 3
SUB12
POI 4
SUB2
SUB6
SUB5
SUB8
POI 1
SUB7
SUB1
SUB4
PpsaaA
SUB9

LEGEND

- SOIL BOUNDARY LINE
- EXISTING CONTOURS
- PROPOSED CONTOURS
- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- LAND COVER: GRASS
- LAND COVER: GRAVEL
- LAND COVER: WOODS
- LAND COVER: MEADOW
- LAND COVER: STORMWATER BMP
- EXISTING TREE LINE
- POINT OF INTEREST (POI)

SCALE 1"=100'
0 100 200 300 FEET

Rev.	Date	Description	By	Chk

ERM

OVERALL PROPOSED CONDITIONS DRAINAGE AREA MAP

DISCIPLINE NO. C

KCE MI 4
KCE MI 4, LLC
BLENDON TOWNSHIP, OTTAWA COUNTY, MICHIGAN

REV. A

SCALE	DESIGNED BY	PROJECT NUMBER	SHEET NO.
1" = 100'	JB	0780170	3
DATE DRAWN 11/25/2025	DRAWN BY JB		

Environmental Resources Management, Inc.

N

SUB10

POI 3

SUB11

SUB12

POI 4

SUB2

POI 1

SUB3

SUB6

SUB5

SUB8

SUB7

SUB4

SUB1

SUB9

PlfabB

PpsaaA

625 629 630 635 636 637 638 639 640 641 644

OH

AUX

LEGEND

- SOIL BOUNDARY LINE
- EXISTING CONTOURS
- PROPOSED CONTOURS
- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- LAND COVER: GRASS
- LAND COVER: GRAVEL
- LAND COVER: WOODS
- LAND COVER: MEADOW
- LAND COVER: STORMWATER BMP
- EXISTING TREE LINE

SCALE 1"=60'

0 60 120 180 FEET

Rev.	Date	Description	By	Chk

ERM

PROPOSED CONDITIONS DRAINAGE AREA MAP

DISCIPLINE NO. C

KCE MI 4
KCE MI 4, LLC
BLENDON TOWNSHIP, OTTAWA COUNTY, MICHIGAN

REV. A

SCALE	DESIGNED BY	PROJECT NUMBER	SHEET NO.
1" = 60'	JB	0780170	4
DATE DRAWN 11/25/2025	DRAWN BY JB		

Environmental Resources Management, Inc.

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