STORMWATER TECHNICAL INFORMATION REPORT

BDH FORD DEALERSHIP

Project Location:

2140 N. Morton Street
Franklin, IN 46131

Prepared For:

BDH REALTY
8220 S. US 31
Indianapolis, IN 46227

Date:

AUGUST 11, 2021
Last Revised:

ASHTON L. FRITZ
REGISTERED
No.
PE10707583
STATE OF
INDIANA
PROFESSIONAL ENGINEER

Fritz Engineering Services, LLC

- CIVIL ENGINEERS
- LAND DEVELOPMENT CONSULTANTS
- DRAINAGE CONSULTANTS
- CERTIFIED FLOODPLAIN MANAGER

14020 Mississinewa Drive ■ Carmel, Indiana 46033 ■ Phone: 317.324.8695 ■ www.Fritz-Eng.com

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PROJECT DESCRIPTION

BDH Realty is proposing to reconstruct the existing Hubler Ford Dealership at the northwest corner of Ransdell Drive and N. Morton Street in Franklin, Indiana. The new dealership will be on the same site as the existing dealership but located further west on the property. Along with the proposed 27,500 sf dealership building will be associated utility services, private drives and associated infrastructure. This site is Lot 4 of the BDH Commercial Subdivision and is approximately 5.35 acres of the total overall development comprised of approximately 12 acres. Access to the site will be provided from two existing entrances on N. Morton Street and a new proposed entrance on Simon Road through the BDH Commercial Subdivision.

This analysis is provided as a supplement to the BDH Commercial Subdivsion and Carwash Development Plan application for the above referenced commercial subdivision. The overall project includes 4 commercial lots, including the dealership lot. A detention pond, Pond 1 is located north of the dealership site and will handle runoff from the northern three lots and drives. The dealership will include detention basin #2 which is a dry detention basin and will accept runoff from the dealership site only. Both detention facilities ultimately discharge to the US 31 roadside ditch. Therefore, the initial analysis provides the full detention design. This report provides onsite stormwater pipe sizing and a summary of the detention basin 2 results.

For reference, the project site is located at approximately latitude 39°30’10"N and longitude 86º04’10”W.

FEMA MAP OVERVIEW

The project site is located within the FEMA Community Panel Map #18081C0139E dated January 290, 2021. Review of the map indicates the site is located within the Flood Designation ‘Zone X’ (unshaded). Therefore, the site is not subject to Flood Control Ordinance requirements. The FEMA Map is included in Appendix B.

WATERSHED DESCRIPTION

The project site is located within the ‘Youngs Creek-Brewers/Canary Ditches‘ watershed as provided on the IndianaMap GIS system. The 14-digit Hydrologic Unit Codes (HUC) for this watershed Is 05120204090030.

SOILS OVERVIEW

The project site contains the soils listed in the following **Table**. The Hydrologic Soil Group (HSG) for each soil is also provided. The appropriate limits of each soil type are depicted in the Soils Map provided in Appendix C.

TABLE 1 – PROJECT SOILS

Soil Symbol	Soil Name, Description	HSG
YbvA, UbaA & Br	Brookston silty clay loam, Urban land complex	B
YclA, UcfA, & CrA	Crosby silty loam	C

ZONING INFORMATION

The site is within the corporate limits of the City of Franklin, Indiana. The underlying Zoning Classification is MXC and the site is located within the Gateway Overlay zone. The proposed uses are permitted in the noted Zoning District.

DEVELOPMENT STANDARDS

The project site is located within the City of Franklin, Johnson County, Indiana. Therefore, the proposed drainage improvements are subject to the standards of design and construction of the City of Franklin. Runoff and detention sizing was provided in the overall BDH Commercial Subdivision and Car Wash design. The previous design is hereby incorporated by reference. . In accordance with the City of Franklin Subdivision Control Ordinance, the following shall be used as the basis of design:

TABLE 2 – FRANKLIN STORMWATER MANAGEMENT DESIGN PARAMETERS

	Franklin Subdivision Control Ordinance Design Parameter
Stormwater Measure	
Storm Sewers	• 10 year Peak Flow, Rational Method • Minimum pipe size, 12” • Minimum full flow velocity, 2.5 ft/s • Maximum full flow velocity, 15 ft/s • Preferred pipe material, RCP Class III

	Franklin Subdivision Control Ordinance Design Parameter

Detention	• 10 yr post developed released at 2 yr predeveloped
	• 100 yr post developed released at 10 yr predeveloped,
	• SCS Hydrograph Methods for storm durations of 1hr, 2hr, 3hr, 6hr, 12hr and 24hr
	• Dry Detention must have 1% bottom slope with underdrains
	• Max. bank slope of 4H:1V
	• Wet Pond
	    o minimum water surface area of 0.5 acres
	    o 6' safety ledge 18 inches below normal pool
	    o 25% of surface area shall have depth of 10'
	• Spillways required to pass 125% of 100 yr design storm peak inflow.
	• Freeboard of 2 feet required from peak flow through spillway to lowest top of bank

Inlets	• 10 yr Peak Flow, Rational Method • 50% clogged in sag conditions • No greater than 6 inches of ponding above grate
Swales	• Minimum of 1% flow line slope • Maximum of 7% flow line slope • Bank slopes of 4H:1V maximum

In addition to the above Franklin Standards, the proposed stormwater management systems will discharge into the N. Morton Street roadside ditch. This section of N. Morton Street is also US 31 and under Indiana Department of Transportation jurisdiction. As such, INDOT stormwater detention standards shall also apply as follows:

TABLE 3 – INDOT STORMWATER MANAGEMENT DESIGN PARAMETERS

	INDOT **Design Parameter from Indiana Design Manual, Section 203.5**
Stormwater Measure	
Detention	• 100 yr post developed released at 10 yr predeveloped, • Huff 50% Distribution required for hydrologic modeling • Minimum 1' of Freeboard above 100 yr peak stage • Detention Volume shall be entirely drained within 72hr

The combination of the two, Franklin & INDOT, will be used for the basis of this project's stormwater management design.

EXISTING CONDITIONS

The proposed development site is currently generally developed with a Hubler Ford dealership. Existing runoff analysis is provided in the overall BDH Commercial Subdivision report.

PROPOSED CONDITIONS

BDH Realty is proposing to redevelop the existing dealership. This project includes the design of the onsite stormwater conveyance related to the dealership redevelopment.

The following sections demonstrate how the proposed improvements are consistent with the City of Franklin Subdivision Control Ordinance and stormwater management standards. Runoff calculations for the proposed conditions are computed in Appendix using the minimum 5-minute Time of Concentration. A map of the proposed basins is provided in Appendix E.

STORMWATER DETENTION

As noted above, the proposed dealership redevelopment and associated stormwater detention was analyzed as part of the master plan. No further detention analysis is required as part of this project.

The following is a summary of the proposed runoff/release rates from the onsite dry detention basin.

TABLE 4 – DETENTION BASIN #2 DISCHARGE SUMMARY

	Peak Runoff/Discharge Rate, cfs				
Discharge Location/Basin Name	**2 yr**	**10 yr**	**25 yr**	**50 yr**	**100 yr**
DETENTION BASIN #2	1.67	2.39	2.74	3.04	3.33

Reference Appendix E for the model and proposed conditions drainage calculations.

Emergency Overflow Calculation:
In accordance with the design requirements for stormwater detention basins, an emergency overflow spillway is required. The spillway shall be capable of passing 125% of the peak 100 year inflow to the detention basin without producing erosive velocities. Based on the HydroCAD modeling, the peak 100 year inflow to the pond is 19.07 cfs. The following design calculations provide the weir sizing:

Weir Equation:

$$Q = c * (b - 0.2h) * h^{3/2}$$

Hydraflow Express was used to analyze the spillway for the peak flow of 17.98 x 125% = 22.48 cfs. The required length of weir is 30 feet with a resulting depth of 0.37 feet of flow over the spillway and a resulting 1.95 ft/s velocity which will not produce erosive conditions for grass covered spillway.

STORMWATER PIPE DESIGN

Calculations for onsite stormwater infrastructure including pipe sizing for the 10-year Rational Method peak runoffs are provided for the commercial outlots in Appendix E. The pipe sizing calculations for each outlot will be provided at the time of development however, connection points to each lot have been provided to convey runoff from each developed lot to the detention pond.

SUMMARY

BDH Realty is proposing to reconstruct the existing Hubler Ford Dealership at the northwest corner of Ransdell Drive and N. Morton Street in Franklin, Indiana. The new dealership will be on the same site as the existing dealership but located further west on the property. Along with the proposed 27,500 sf dealership building will be associated utility services, private drives and associated infrastructure. This site is Lot 4 of the BDH Commercial Subdivision and is approximately 5.35 acres of the total overall development comprised of approximately 12 acres. Access to the site will be provided from two existing entrances on N. Morton Street and a new proposed entrance on Simon Road.

This report demonstrates that the proposed project improvements meet the stormwater design parameters, and no further stormwater detention or water quality measures are necessary.

As a result of the onsite drainage analysis, the proposed improvements are not anticipated to have adverse impacts on the surrounding or downstream drainage systems.

REFERENCES

1. Johnson County Soils Map (Web Soil Survey)
2. FEMA Flood Insurance Rate Maps, FEMA Website
3. Indiana Drainage Handbook
4. Franklin Subdivision Control Ordinance & Stormwater Technical Standards
5. INDOT – Indiana Design Manual

APPENDICES

APPENDIX A – LOCATION MAP

APPENDIX B – FEMA MAP

APPENDIX C – SOILS DATA & MAP

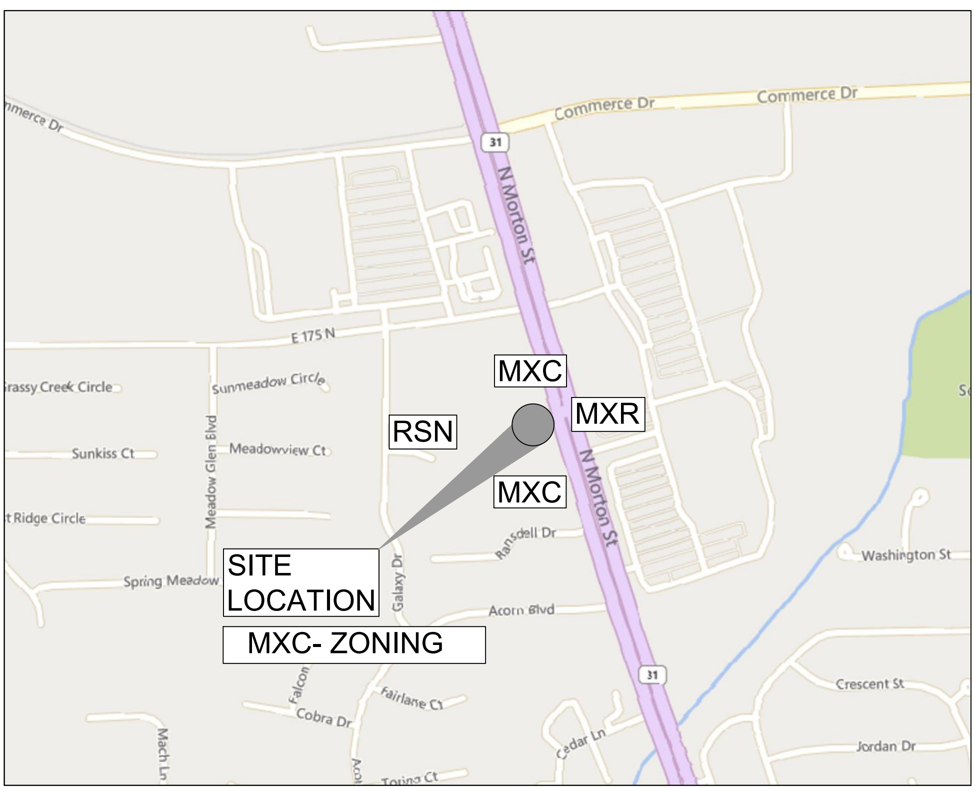
APPENDIX D – EXISTING DRAINAGE ANALYSIS

APPENDIX E – PROPOSED DRAINAGE ANALYSIS

APPENDIX F – SUPPORT DOCUMENTATION

APPENDIX A – LOCATION MAP

SITE LOCATION MAP



SITE VICINITY & ZONING MAP

APPENDIX B – FEMA MAP

National Flood Hazard Layer FIRMette

FEMA

86°4'28"W 39°30'23"N

86°3'51"W 39°29'55"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR 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
- B 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/28/2021 at 1:38 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.

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. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX C – SOILS DATA & MAP

Soil Map—Johnson County, Indiana

Map Scale: 1:1,550 if printed on A landscape (11" x 8.5") sheet.

0 20 40 80 120 Meters

0 50 100 200 300 Feet

N

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: Johnson County, Indiana
Survey Area Data: Version 28, Jun 4, 2020

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

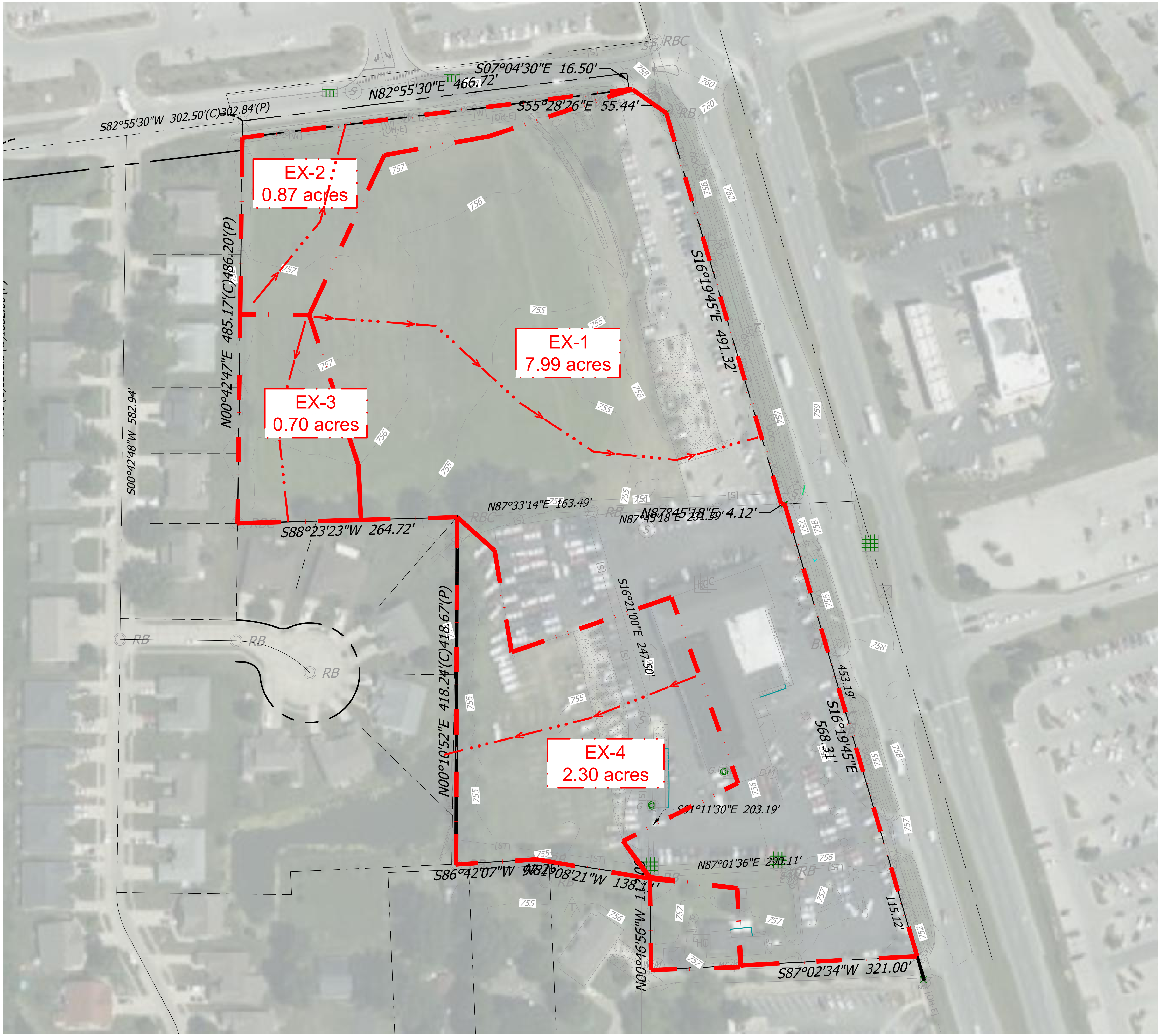
Date(s) aerial images were photographed: Jul 27, 2019—Sep 26, 2019

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
Br	Brookston silty clay loam, 0 to 2 percent slopes	0.1	1.2%
UbaA	Urban land-Brookston complex, 0 to 2 percent slopes	1.9	32.6%
UcfA	Urban land-Crosby silt loam complex, fine-loamy subsoil, 0 to 2 percent slopes	2.8	46.1%
YbvA	Brookston silty clay loam-Urban land complex, 0 to 2 percent slopes	1.2	20.1%
YclA	Crosby silt loam, fine-loamy subsoil-Urban land complex, 0 to 2 percent slopes	0.0	0.0%
Totals for Area of Interest		**6.0**	**100.0%**

APPENDIX D – EXISTING DRAINAGE ANALYSIS



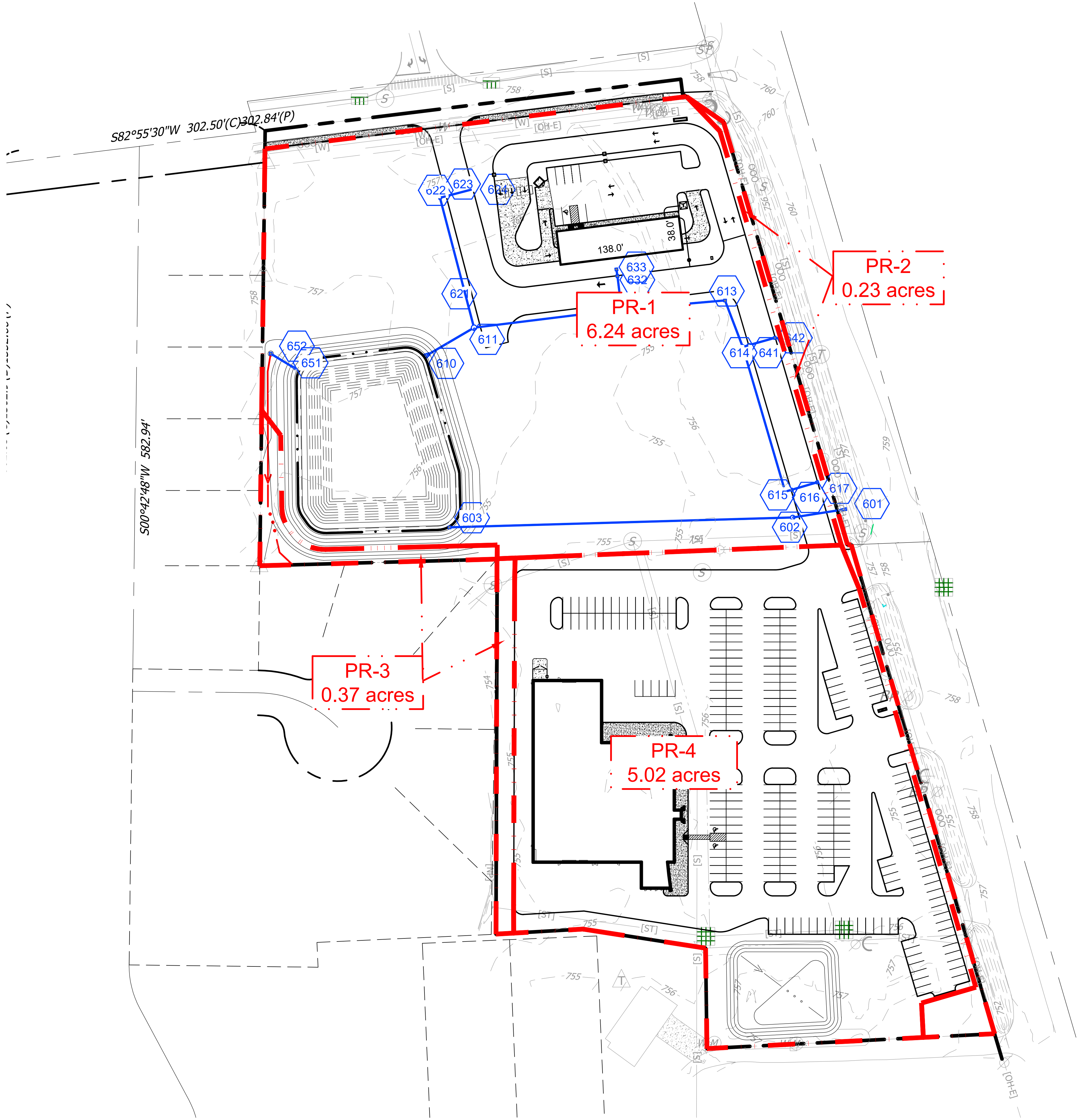
Fritz Engineering
Services, LLC

14020 Mississinewa Drive
Carmel, Indiana 46033
P: 317.324.8695 F: 317.324.8695
www.Fritz-Eng.com

SHEET NAME / NO.

EXISTING BASIN MAP

EXH-1



0 80' 160'

SCALE: 1" = 80'

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Services, LLC
14020 Mississinewa Drive
Carmel, Indiana 46033
P: 317.324.8695 F: 317.324.8695
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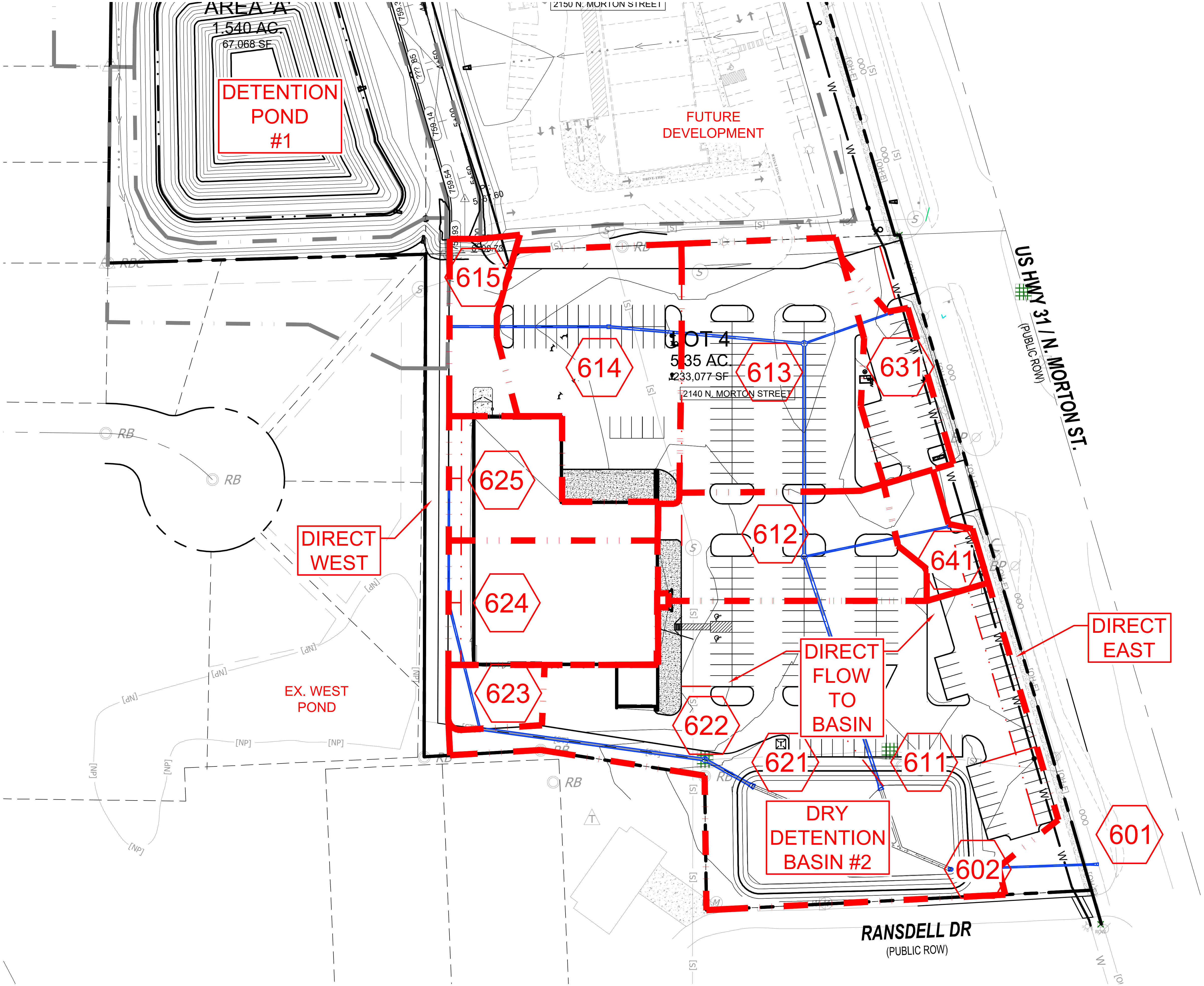
SHEET NAME / NO.

PROPOSED DETENTION BASIN MAP

EXH-2

APPENDIX E – PROPOSED DRAINAGE ANALYSIS



Fritz Engineering *Services, LLC*
14020 Mississinewa Drive
Carmel, Indiana 46033
P: 317.324.8695 F: 317.324.8695
www.Fritz-Eng.com

SHEET NAME / NO.
PROPOSED STORM BASIN MAP
EXH-3

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STORM SEWER DESIGN CALCULATIONS
RATIONAL METHOD PEAK RUNOFF

PROJECT NAME: ***BDH FORD DEALERSHIP***
FES PROJECT #: ***2006004***
DATE: ***8/11/21***

DESIGN STORM: 10 Year

STRUCTURE		BASINS							COMPOSITE BASINS				TRAVEL
UP	DOWN	BASIN #	c	A (acres)	c*A	Tc (min)	I (in/hr)	Q (cfs)	SUM (c*A)	Tc (min)	I (in/hr)	Q (cfs)	TIME (min)
641	612	641	0.85	0.11 Ac.	0.10	6 min.	5.92 in/hr	0.57 cfs	0.10	6 min.	5.92 in/hr	0.57 cfs	0.9 min.
631	613	631	0.72	0.19 Ac.	0.13	6 min.	5.92 in/hr	0.79 cfs	0.13	6 min.	5.92 in/hr	0.79 cfs	0.5 min.
625	624	625	0.89	0.28 Ac.	0.25	5 min.	6.12 in/hr	1.54 cfs	0.25	5 min.	6.12 in/hr	1.54 cfs	0.6 min.
624	623	624	0.90	0.41 Ac.	0.37	5 min.	6.12 in/hr	2.26 cfs	0.62	6 min.	5.92 in/hr	3.68 cfs	0.5 min.
623	622	623	0.85	0.09 Ac.	0.08	5 min.	6.12 in/hr	0.49 cfs	0.70	7 min.	5.73 in/hr	4.02 cfs	1.2 min.
622	621	622	0.25	0.00 Ac.	0.00	5 min.	6.12 in/hr	0.00 cfs	0.70	9 min.	5.38 in/hr	3.78 cfs	0.3 min.
615	614	615	0.85	0.16 Ac.	0.14	5 min.	6.12 in/hr	0.84 cfs	0.14	5 min.	6.12 in/hr	0.84 cfs	1.0 min.
614	613	614	0.76	0.69 Ac.	0.53	5 min.	6.12 in/hr	3.23 cfs	0.66	6 min.	5.92 in/hr	3.93 cfs	0.9 min.
613	612	613	0.75	0.72 Ac.	0.54	5 min.	6.12 in/hr	3.28 cfs	1.33	7 min.	5.73 in/hr	7.64 cfs	0.8 min.
612	611	612	0.75	0.45 Ac.	0.34	5 min.	6.12 in/hr	2.07 cfs	1.77	8 min.	5.55 in/hr	9.83 cfs	0.8 min.

Fritz Engineering Services, LLC

STORM SEWER DESIGN CALCULATIONS

PIPE SIZING CALCULATIONS

PROJECT NAME: ***BDH FORD DEALERSHIP***
FES PROJECT #: ***2006004***
DATE: ***8/11/2021***

DESIGN STORM: 10 Year

STRUCTURE UP	STRUCTURE DOWN	DESIGN Q (cfs)	L (ft)	DIA. (in)	SLOPE %	MTRL	MANN. COEFF. n	CAP. Q (cfs)	FULL VEL. (ft/s)	ACTUAL DEPTH (in)	ACTUAL VEL. (ft/s)	RIM ELEV. UP	RIM ELEV. DOWN	INVERT ELEV. UP	INVERT ELEV. DOWN	COVER (ft) UP	COVER (ft) DOWN
641	612	0.57	123 LF	12 in.	0.31%	RCP	0.013	1.99 cfs	2.53 ft/s	4.4 in.	2.2 ft/s	757.16	756.99	754.00	753.62	2.0	2.2
631	613	0.79	77 LF	12 in.	0.31%	RCP	0.013	1.97 cfs	2.51 ft/s	5.3 in.	2.4 ft/s	756.73	756.41	753.60	753.37	2.0	1.9
625	624	1.54	104 LF	12 in.	0.31%	RCP	0.013	1.99 cfs	2.53 ft/s	7.9 in.	2.8 ft/s	758.19	758.19	755.00	754.68	2.0	2.3
624	623	3.68	108 LF	15 in.	0.35%	RCP	0.013	3.83 cfs	3.12 ft/s	11.7 in.	3.6 ft/s	758.19	757.96	754.43	754.05	2.3	2.5
623	622	4.02	189 LF	24 in.	0.15%	RCP	0.013	8.79 cfs	2.80 ft/s	11.3 in.	2.7 ft/s	757.96	757.23	752.85	752.57	2.9	2.4
622	621	3.78	45 LF	24 in.	0.15%	RCP	0.013	8.79 cfs	2.80 ft/s	10.8 in.	2.7 ft/s	757.23		752.57	752.50	2.4	
615	614	0.84	133 LF	15 in.	0.25%	RCP	0.013	3.24 cfs	2.64 ft/s	5.1 in.	2.2 ft/s	758.23	757.05	754.31	753.98	2.5	1.7
614	613	3.93	163 LF	18 in.	0.20%	RCP	0.013	4.71 cfs	2.67 ft/s	12.4 in.	3.0 ft/s	757.05	756.41	753.78	753.45	1.6	1.3
613	612	7.64	177 LF	24 in.	0.25%	RCP	0.013	11.34 cfs	3.61 ft/s	14.2 in.	3.8 ft/s	756.41	756.99	753.05	752.61	1.1	2.2
612	611	9.83	202 LF	24 in.	0.25%	RCP	0.013	11.34 cfs	3.61 ft/s	17.3 in.	4.1 ft/s	756.99		752.51	752.00	2.3	

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WEIGHTED RUNOFF COEFFICIENTS

PROJECT NAME: ***BDH FORD DEALERSHIP***
FES PROJECT #: ***2006004***
DATE: ***8/11/2021***

STRUCTURE/BASIN I.D.	TOTAL DRAINAGE AREA	RUNOFF COEFFICIENTS CALCULATIONS			
	(Ac.)	% Grass 0.25	% Gravel/Pvmt 0.85	% Rooftop 0.90	Weighted C
612	0.45 Ac.	16%	84%	0%	Weighted C= 0.75
	19,592 SF	3,192 SF	16,400 SF	SF	
613	0.72 Ac.	17%	83%	0%	Weighted C= 0.75
	31,200 SF	5,330 SF	25,870 SF	SF	
614	0.69 Ac.	15%	85%	0%	Weighted C= 0.76
	30,235 SF	4,635 SF	25,600 SF	SF	
615	0.16 Ac.	0%	100%	0%	Weighted C= 0.85
	7,020 SF	SF	7,020 SF	SF	
622	0.00 Ac.	100%	0%	0%	Weighted C= 0.25
	SF	SF	SF	SF	
623	0.09 Ac.	0%	100%	0%	Weighted C= 0.85
	4,125 SF	SF	4,125 SF	SF	

Fritz Engineering Services, LLC

WEIGHTED RUNOFF COEFFICIENTS

PROJECT NAME: ***BDH FORD DEALERSHIP***
FES PROJECT #: ***2006004***
DATE: ***8/11/2021***

STRUCTURE/BASIN I.D.	TOTAL DRAINAGE AREA	RUNOFF COEFFICIENTS CALCULATIONS			
	(Ac.)	% Grass 0.25	% Gravel/Pvmt 0.85	% Rooftop 0.90	Weighted C
624	0.41 Ac.	0%	12%	88%	Weighted C= 0.90
	17,963 SF	SF	2,120 SF	15,843 SF	
625	0.28 Ac.	0%	17%	83%	Weighted C= 0.89
	12,323 SF	SF	2,100 SF	10,223 SF	
631	0.19 Ac.	22%	78%	0%	Weighted C= 0.72
	8,135 SF	1,750 SF	6,385 SF	SF	
641	0.11 Ac.	0%	100%	0%	Weighted C= 0.85
	4,975 SF	SF	4,975 SF	SF	
DIRECT TO POND	1.87 Ac.	47%	51%	2%	Weighted C= 0.57
	81,420 SF	38,366 SF	41,520 SF	1,534 SF	
DIRECT WEST	0.20 Ac.	100%	0%	0%	Weighted C= 0.25
	8,680 SF	8,680 SF	SF	SF	
DIRECT EAST	0.17 Ac.	100%	0%	0%	Weighted C= 0.25
Overall	5.35 Ac.	30%	58%	12%	Weighted C= 0.68
	233,118 SF	69,403 SF	136,115 SF	27,600 SF	

Fritz Engineering Services, LLC

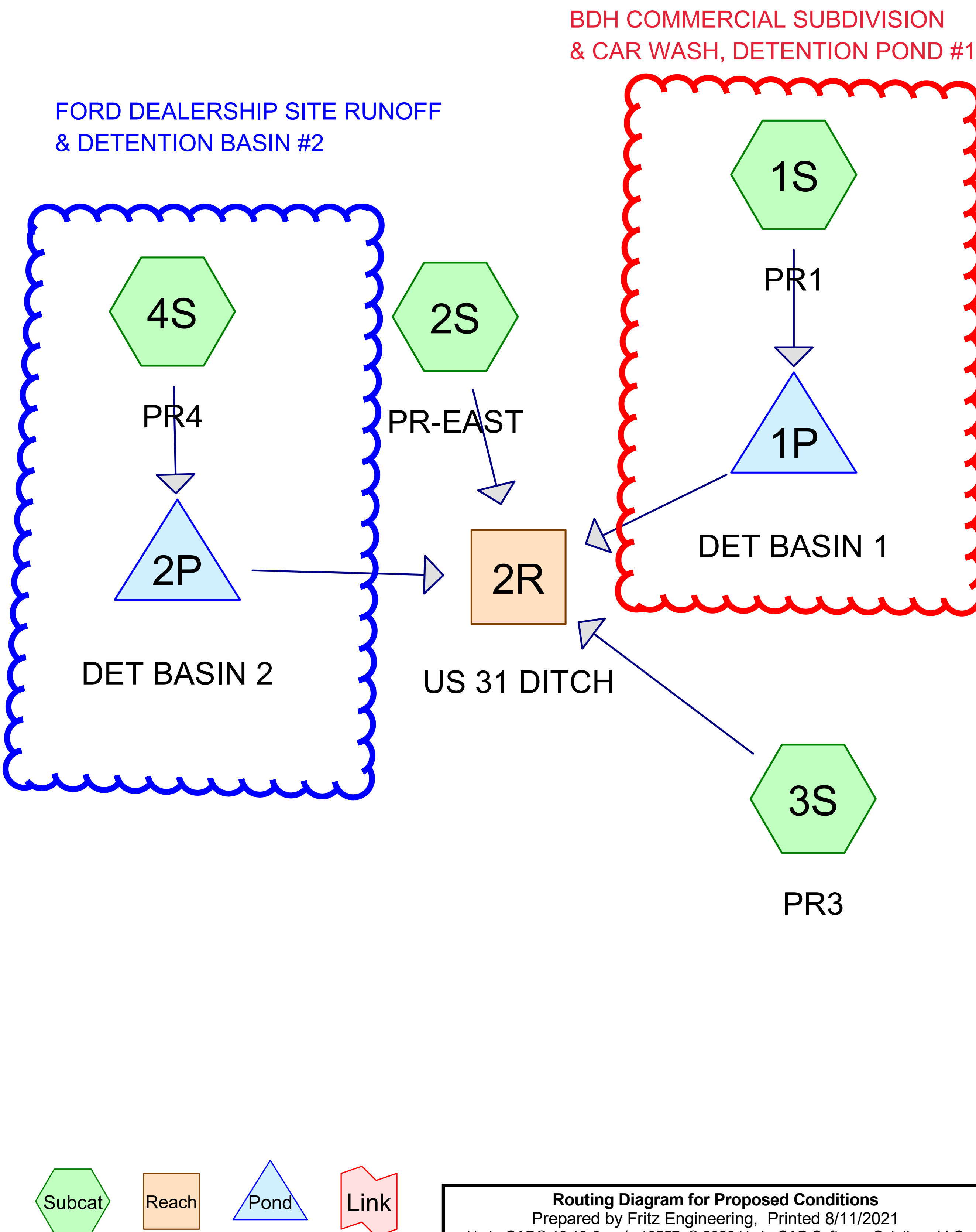
AREA INLET CAPACITY CALCULATIONS

(Sag / Low Point)

PROJECT NAME: ***BDH FORD DEALERSHIP***
FES PROJECT #: ***2006004***
DATE: ***8/11/2021***

Enter Appropriate Information for Inlet Grate Capacity

Grate #	Grate Type	Open Area, sf	Perimeter, ft.	Head, ft	Capacity, cfs	50% Clogged Capacity, cfs	Capacity, cfs Weir	Capacity, cfs Transitional	Capacity, cfs Orifice
R-4342	A,C	2.0	6.0	0.50	5.79	2.89	6.81	5.79	7.00
R-3286-8V	V	0.7	4.4	0.50	2.55	1.28	2.55		5.13
R-3010	A,C	1.0	4.6	0.50	3.40	1.70	3.40		5.37
R-3472	A,C	1.3	7.3	0.50	4.43	2.21	4.43		8.52



Routing Diagram for Proposed Conditions
Prepared by Fritz Engineering, Printed 8/11/2021
HydroCAD® 10.10-6a s/n 10557 © 2020 HydroCAD Software Solutions LLC

Events for Pond 2P: DET BASIN 2

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (cubic-feet)
002yr-01hr	4.96	1.67	752.67	7,629
002yr-02hr	3.74	1.60	752.62	6,993
002yr-03hr	2.86	1.48	752.46	5,324
002yr-06hr	2.72	1.59	752.56	6,386
002yr-12hr	1.32	1.21	752.32	3,985
002yr-24hr	1.09	1.06	752.25	3,354
010yr-01hr	9.63	2.39	753.21	15,158
010yr-02hr	7.14	2.38	753.20	14,942
010yr-03hr	5.42	2.17	753.02	12,320
010yr-06hr	3.66	1.91	752.83	9,583
010yr-12hr	2.15	1.76	752.73	8,327
010yr-24hr	1.61	1.54	752.50	5,751
025yr-01hr	12.69	2.74	753.54	20,204
025yr-02hr	9.40	2.76	753.56	20,546
025yr-03hr	7.17	2.57	753.37	17,566
025yr-06hr	4.80	2.27	753.11	13,593
025yr-12hr	2.68	2.11	752.98	11,712
025yr-24hr	1.93	1.76	752.73	8,296
050yr-01hr	15.21	2.99	753.80	24,387
050yr-02hr	11.28	3.04	753.86	25,357
050yr-03hr	8.67	2.87	753.67	22,322
050yr-06hr	5.78	2.55	753.35	17,279
050yr-12hr	3.12	2.37	753.19	14,888
050yr-24hr	2.18	1.97	752.87	10,156
100yr-01hr	17.98	3.23	754.07	28,839
100yr-02hr	13.40	3.33	754.19	30,906
100yr-02hr-back to back	**18.36**	**4.57**	**755.98**	**65,204**
100yr-03hr	10.30	3.17	754.00	27,739
100yr-06hr	6.83	2.82	753.62	21,509
100yr-12hr	3.57	2.63	753.43	18,451
100yr-24hr	2.44	2.16	753.02	12,249

Summary for Pond 2P: DET BASIN 2

Inflow Area = 5.020 ac, 71.71% Impervious, Inflow Depth = 4.87" for 100yr-24hr event
Inflow = 2.44 cfs @ 15.02 hrs, Volume= 2.037 af
Outflow = 2.16 cfs @ 17.52 hrs, Volume= 2.037 af, Atten= 11%, Lag= 150.0 min
Primary = 2.16 cfs @ 17.52 hrs, Volume= 2.037 af
Routed to Reach 2R : US 31 DITCH

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 753.02' @ 17.52 hrs Surf.Area= 14,735 sf Storage= 12,249 cf

Plug-Flow detention time= 71.4 min calculated for 2.035 af (100% of inflow)
Center-of-Mass det. time= 71.6 min (987.4 - 915.8)

Volume	Invert	Avail.Storage	Storage Description
#1	751.50'	65,585 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.50	0	0	0
752.00	6,200	1,550	1,550
753.00	14,700	10,450	12,000
754.00	16,750	15,725	27,725
755.00	18,900	17,825	45,550
756.00	21,170	20,035	65,585

Device	Routing	Invert	Outlet Devices
#1	Primary	751.50'	**10.0" Round Culvert** L= 50.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 751.50' / 751.33' S= 0.0034 '/' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean, Flow Area= 0.55 sf

Primary OutFlow Max=2.16 cfs @ 17.52 hrs HW=753.02' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.16 cfs @ 3.96 fps)

BDH FORD DEALERSHIP - DETENTION BASIN EMERGENCY SPILLWAY

Trapezoidal Weir

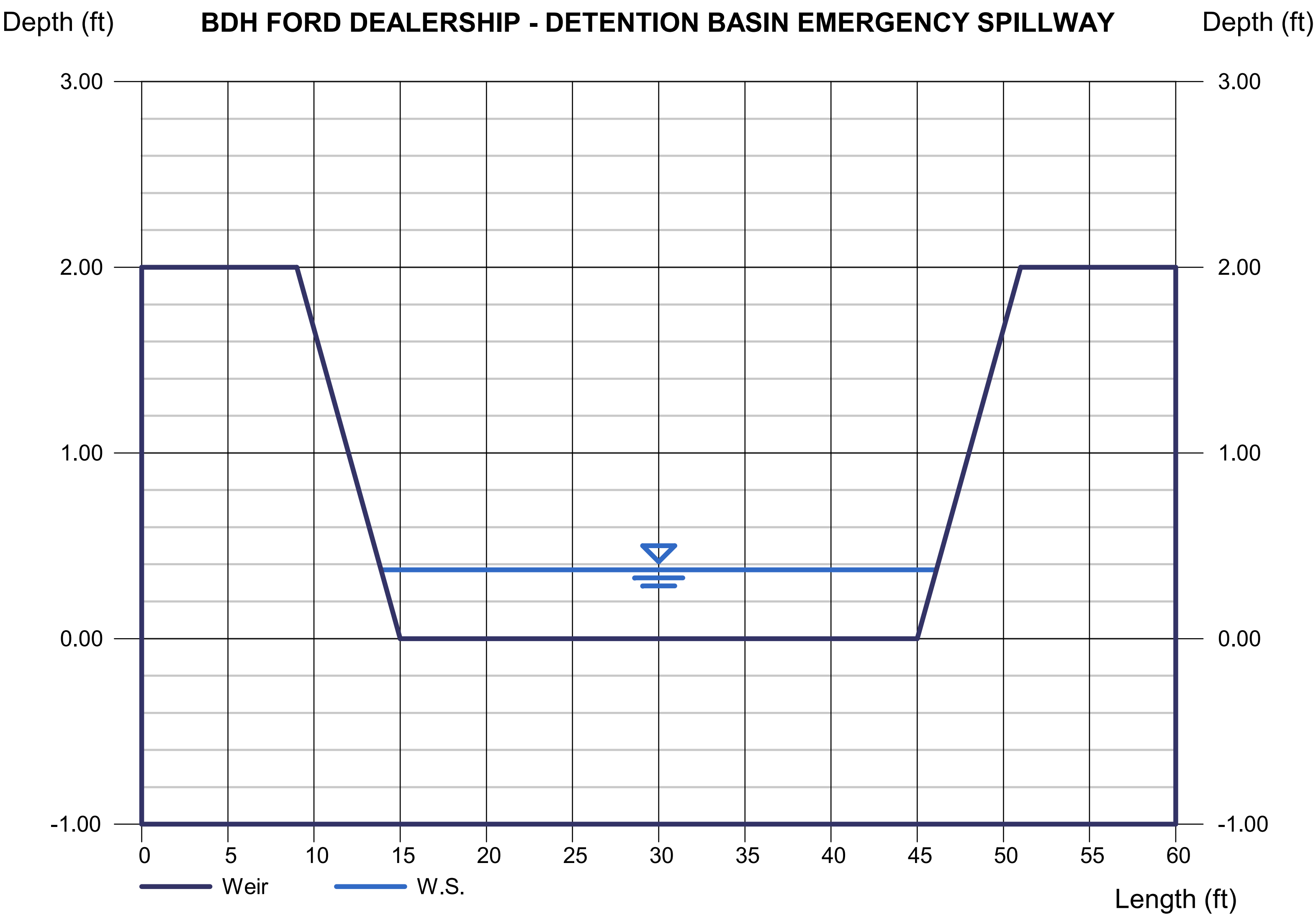
Crest	= Sharp
Bottom Length (ft)	= 30.00
Total Depth (ft)	= 2.00
Side Slope (z:1)	= 3.00

Calculations

Weir Coeff. Cw	= 3.30
Compute by:	Known Q
Known Q (cfs)	= 22.48

Highlighted

Depth (ft)	= 0.37
Q (cfs)	= 22.48
Area (sqft)	= 11.51
Velocity (ft/s)	= 1.95
Top Width (ft)	= 32.22



APPENDIX F – SUPPORT DOCUMENTATION

NOAA Atlas 14, Volume 2, Version 3
Location name: Franklin, Indiana, USA*
Latitude: 39.4845°, Longitude: -86.058°
Elevation: 739.2 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**4.48** (3.98-5.06)	**5.33** (4.74-6.01)	**6.38** (5.66-7.20)	**7.21** (6.38-8.14)	**8.30** (7.30-9.37)	**9.16** (7.99-10.4)	**9.98** (8.63-11.3)	**10.9** (9.30-12.4)	**12.0** (10.1-13.8)	**12.9** (10.7-14.9)
10-min	**3.47** (3.10-3.93)	**4.16** (3.70-4.69)	**4.96** (4.40-5.60)	**5.57** (4.93-6.28)	**6.35** (5.58-7.16)	**6.94** (6.05-7.85)	**7.52** (6.50-8.52)	**8.11** (6.94-9.23)	**8.84** (7.44-10.1)	**9.39** (7.79-10.8)
15-min	**2.84** (2.53-3.21)	**3.39** (3.02-3.83)	**4.06** (3.61-4.58)	**4.57** (4.04-5.15)	**5.23** (4.60-5.90)	**5.73** (5.00-6.47)	**6.23** (5.38-7.06)	**6.72** (5.76-7.65)	**7.36** (6.19-8.43)	**7.82** (6.49-9.03)
30-min	**1.88** (1.68-2.12)	**2.27** (2.02-2.56)	**2.78** (2.47-3.14)	**3.17** (2.81-3.57)	**3.69** (3.25-4.17)	**4.09** (3.57-4.63)	**4.50** (3.89-5.10)	**4.91** (4.20-5.58)	**5.45** (4.59-6.24)	**5.86** (4.86-6.77)
60-min	**1.15** (1.02-1.30)	**1.39** (1.24-1.57)	**1.74** (1.55-1.97)	**2.02** (1.79-2.27)	**2.40** (2.11-2.70)	**2.70** (2.35-3.05)	**3.01** (2.60-3.41)	**3.33** (2.85-3.79)	**3.77** (3.17-4.32)	**4.12** (3.42-4.75)
2-hr	**0.670** (0.598-0.760)	**0.812** (0.722-0.921)	**1.02** (0.907-1.16)	**1.19** (1.05-1.34)	**1.42** (1.25-1.61)	**1.62** (1.41-1.83)	**1.82** (1.57-2.06)	**2.04** (1.73-2.31)	**2.34** (1.95-2.67)	**2.59** (2.12-2.97)
3-hr	**0.473** (0.423-0.538)	**0.573** (0.510-0.650)	**0.722** (0.642-0.820)	**0.843** (0.746-0.954)	**1.01** (0.888-1.15)	**1.16** (1.00-1.31)	**1.31** (1.12-1.49)	**1.47** (1.24-1.67)	**1.70** (1.40-1.95)	**1.89** (1.53-2.18)
6-hr	**0.284** (0.252-0.325)	**0.343** (0.305-0.393)	**0.433** (0.384-0.494)	**0.507** (0.447-0.577)	**0.613** (0.534-0.696)	**0.702** (0.606-0.796)	**0.797** (0.679-0.905)	**0.899** (0.753-1.02)	**1.05** (0.857-1.20)	**1.17** (0.937-1.35)
12-hr	**0.169** (0.151-0.191)	**0.203** (0.182-0.230)	**0.253** (0.226-0.286)	**0.293** (0.261-0.331)	**0.350** (0.308-0.393)	**0.397** (0.347-0.446)	**0.446** (0.385-0.501)	**0.498** (0.423-0.561)	**0.571** (0.476-0.648)	**0.630** (0.517-0.720)
24-hr	**0.101** (0.094-0.111)	**0.122** (0.112-0.133)	**0.149** (0.137-0.163)	**0.171** (0.157-0.186)	**0.200** (0.183-0.218)	**0.223** (0.203-0.243)	**0.246** (0.223-0.269)	**0.270** (0.243-0.295)	**0.302** (0.270-0.331)	**0.328** (0.291-0.365)
2-day	**0.059** (0.055-0.064)	**0.071** (0.066-0.077)	**0.087** (0.080-0.094)	**0.099** (0.091-0.107)	**0.115** (0.106-0.125)	**0.128** (0.117-0.139)	**0.141** (0.128-0.153)	**0.154** (0.139-0.168)	**0.172** (0.154-0.188)	**0.186** (0.165-0.203)
3-day	**0.043** (0.040-0.046)	**0.051** (0.047-0.055)	**0.062** (0.057-0.066)	**0.070** (0.065-0.075)	**0.081** (0.075-0.087)	**0.090** (0.083-0.097)	**0.099** (0.091-0.107)	**0.108** (0.099-0.116)	**0.120** (0.109-0.130)	**0.130** (0.117-0.140)
4-day	**0.034** (0.032-0.036)	**0.041** (0.038-0.043)	**0.049** (0.046-0.052)	**0.056** (0.052-0.059)	**0.064** (0.060-0.069)	**0.071** (0.066-0.076)	**0.078** (0.072-0.083)	**0.085** (0.079-0.091)	**0.094** (0.087-0.101)	**0.102** (0.093-0.109)
7-day	**0.023** (0.022-0.025)	**0.027** (0.026-0.029)	**0.033** (0.031-0.035)	**0.037** (0.035-0.040)	**0.043** (0.040-0.046)	**0.048** (0.044-0.051)	**0.053** (0.049-0.056)	**0.057** (0.053-0.061)	**0.064** (0.058-0.068)	**0.069** (0.063-0.074)
10-day	**0.018** (0.017-0.020)	**0.022** (0.021-0.023)	**0.026** (0.025-0.028)	**0.030** (0.028-0.032)	**0.034** (0.032-0.036)	**0.038** (0.035-0.040)	**0.041** (0.038-0.044)	**0.045** (0.042-0.048)	**0.050** (0.046-0.053)	**0.054** (0.049-0.058)
20-day	**0.013** (0.012-0.013)	**0.015** (0.014-0.016)	**0.018** (0.017-0.019)	**0.020** (0.019-0.021)	**0.022** (0.021-0.024)	**0.025** (0.023-0.026)	**0.027** (0.025-0.028)	**0.029** (0.027-0.031)	**0.032** (0.029-0.033)	**0.034** (0.031-0.036)
30-day	**0.010** (0.010-0.011)	**0.012** (0.012-0.013)	**0.014** (0.013-0.015)	**0.016** (0.015-0.017)	**0.018** (0.017-0.019)	**0.019** (0.018-0.020)	**0.021** (0.019-0.022)	**0.022** (0.021-0.024)	**0.024** (0.022-0.026)	**0.026** (0.024-0.027)
45-day	**0.009** (0.008-0.009)	**0.010** (0.010-0.011)	**0.012** (0.011-0.013)	**0.013** (0.012-0.014)	**0.015** (0.014-0.015)	**0.016** (0.015-0.017)	**0.017** (0.016-0.018)	**0.018** (0.017-0.019)	**0.019** (0.018-0.020)	**0.020** (0.019-0.022)
60-day	**0.008** (0.007-0.008)	**0.009** (0.009-0.010)	**0.011** (0.010-0.011)	**0.012** (0.011-0.012)	**0.013** (0.012-0.014)	**0.014** (0.013-0.015)	**0.015** (0.014-0.016)	**0.016** (0.015-0.017)	**0.017** (0.016-0.018)	**0.018** (0.017-0.019)

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

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

Please refer to NOAA Atlas 14 document for more information.

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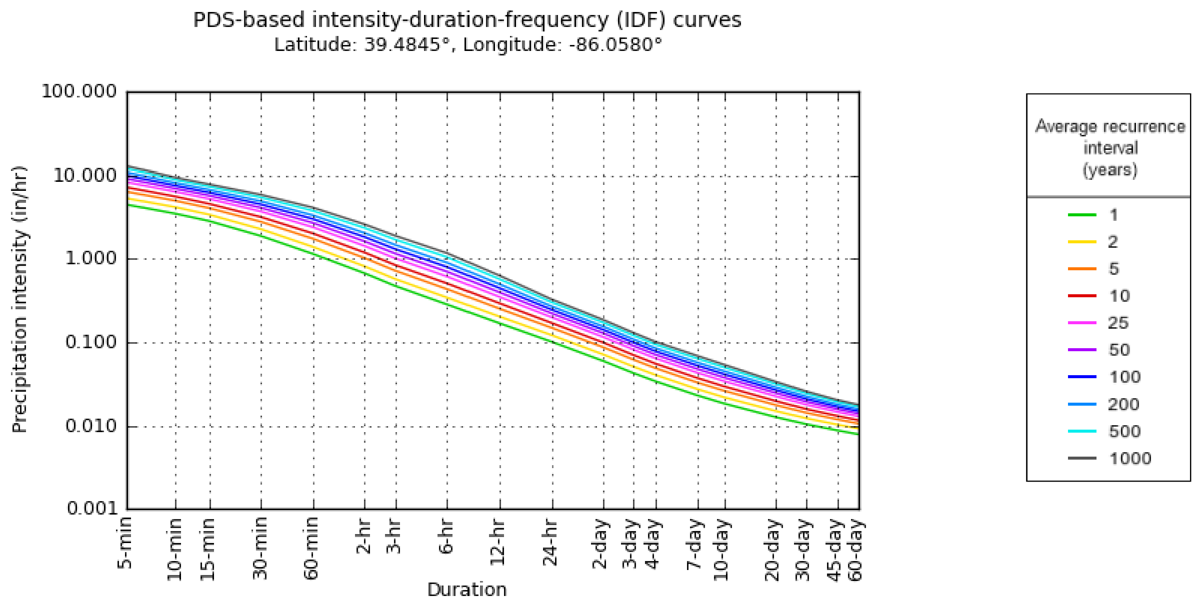
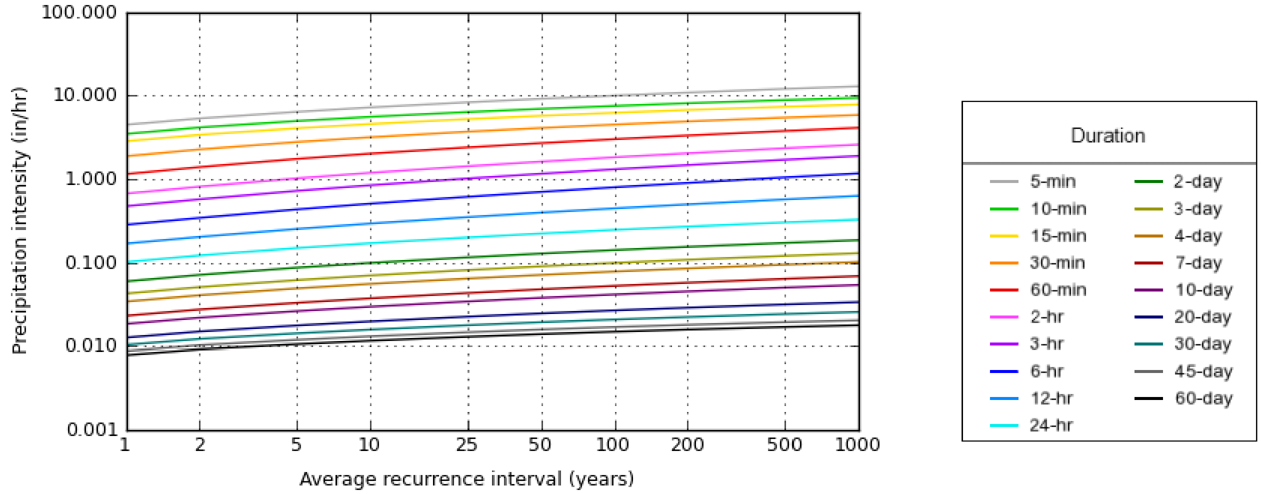
PF graphical





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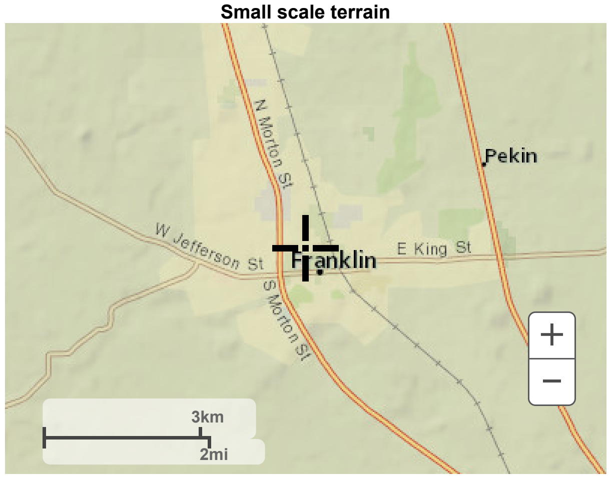
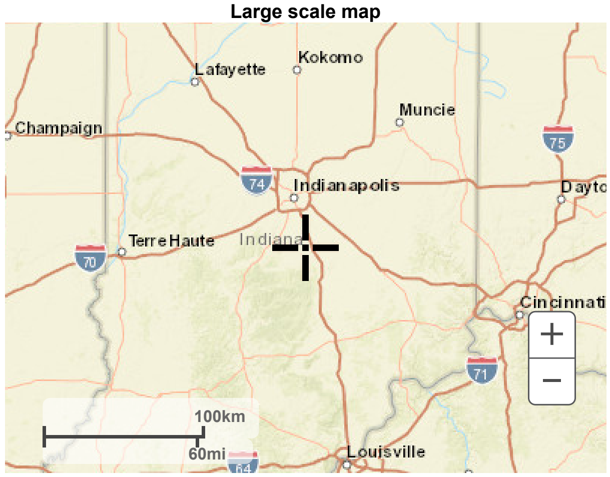
Maps & aerials

Small scale terrain

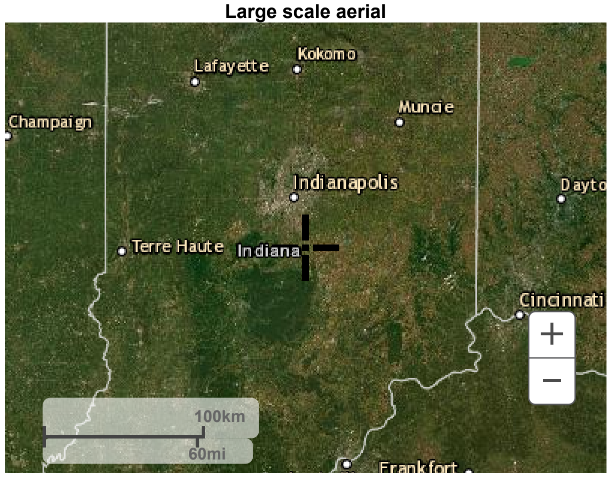


Large scale terrain

Large scale map



Large scale aerial



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[National Oceanic and Atmospheric Administration]
[National Weather Service]
[National Water Center]
1325 East West Highway
Silver Spring, MD 20910
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storm-sewer system. The results from an electronic or manual method should be provided in an accepted tabular method as shown in Figure 203-4 I.

203-4.05(03) Hydraulic Grade Line Check

The final storm-sewer design should be checked to determine its adequacy by analysis using a 2% annual EP through the entire system of the hydraulic gradient. The gradient line should not exceed the elevation of an opening into the system. A tabular summary or plotted profile should be provided in the hydraulics-report submittal.

203-4.05(04) Plan and Profile

Road plans for a storm-drain project should be submitted so that the appropriate inlet and storm drain pipe locations can be identified. The plan view should be simplified to show the pipe type, slope, and size; structure identifier, road grade, and other information necessary to evaluate the storm-drain system. The plans structure numbers should match the computer and tabular results in the report submittal. All discrepancies should be addressed prior to report submittal.

203-4.05(05) Additional Information

Other information that the designer deems necessary toward validation of the design should be provided in the hydraulics report. Non-traditional methodology requires the approval of the Office of Hydraulics manager.

203-5.0 STORMWATER MANAGEMENT AND DETENTION

203-5.01 Introduction

The traditional design of a storm-drainage system has been to collect and convey storm runoff as rapidly as possible to a suitable location where it can be discharged. However, the impact of such a traditional storm-drainage design has not always been favorable. Rapidly conveying stormwater can cause environmental impacts to karst topography and wetlands downstream, overwhelm limited outlet capacities, and flood downstream properties, especially where the amount of impervious area is increased as part of a roadway project. To reduce these impacts, various forms of stormwater management have been developed, for an open-system or closed-system facility, as described below.

203-5.02 General Policy

203-5.02(01) Reasons for Storage

Controlling the quantity of stormwater release using a storage facility can provide the potential benefits as follows:

1. prevention or reduction of peak runoff rate increase;
2. mitigation of downstream drainage-capacity problems;
3. reduction or elimination of the need for downstream outfall improvements; and
4. protection of environmentally-sensitive areas, such as karst topography.

203-5.02(02) Downstream Conditions

Storage can be developed in a depressed area in a parking lot, road embankment, freeway interchange, or a small lake, pond, or depression. The utility of a storage facility depends on the amount of storage, its location within the system, and its operational characteristics. An analysis of such a storage facility should consist of comparing the design flow at a point or points downstream of the proposed storage site, with or without storage. Other flows in excess of the design flow that can be expected to pass through the storage facility may be required in the analysis, i.e., 1% annual EP flood. The design criteria for a storage facility should include the following:

1. release rate;
2. storage volume;
3. grading and depth requirements;
4. outlet works; and
5. location.

At a minimum, a storage facility should be designed to detain the 1% annual EP, post-development peak runoff rate, and release it at the 10% annual EP, pre-developed peak runoff rate. An emergency overflow capable of accommodating the 1% annual EP post-development discharge may be required.

203-5.02(03) Local Jurisdictional Requirements

A local jurisdiction can be more restrictive than INDOT drainage requirements. INDOT requirements need not be in accordance with local jurisdictional rules and regulations. However, the local design parameters should be followed as much as practical.

203-5.03 Design Considerations

A pump station may be required to outlet from an infiltration/detention facility. The use of a pump station to outlet a facility is not desirable. If a pump station is being considered, the Office of Hydraulics should be contacted for approval.

Dam safety should be considered for a berm or embankment created as part of a detention facility. An embankment should not be subject to IDNR regulation and inspection requirements. Per the Indiana Code, IDNR has jurisdiction over all structures, except where the embankment is lower than 20 ft, the contributing drainage area is less than 1 sq mi, or the storage volume behind the structure is less than 100 ac-ft. For more information, see *Indiana Code* 14-27-7.5: Regulation of Dams.

203-5.03(01) Detention Pond

A detention pond is designed to reduce the peak discharge and detain runoff only for a specific duration. A detention basin should have a positive outlet that empties all runoff between storms. The excavation of a detention pond can extend below the water table or outlet level where the bottom is sealed due to sedimentation. This is a detention pond or wet-bottom detention basin. The detention pond also has a positive outlet and releases all temporary storage.

A dry-bottom detention facility should be used. A detention basin will require additional right of way. The basin will require a certain amount of space, and it should be outside the clear-zone for safety purposes. The pond location and outlet should be considered, especially for flood routing. The overflow location should avoid impacting nearby property and the roadway.

203-5.03(02) Retention Pond

A retention pond retains runoff for an indefinite time and has no positive outlet. Runoff is removed only by means of infiltration through a permeable bottom or by means of evaporation. A retention pond or lake is an example of a retention facility. A retention pond is designed to drain into the groundwater table.

Soil characteristics are the primary concern in designing a retention pond. A geotechnical report should be obtained from the Office of Geotechnical Services, county surveyor's office, etc, to determine the infiltration capacity of the substratum.

A retention pond will require additional right of way. It should be located outside the clear-zone for safety purposes.

203-5.03(03) Roadside Ditch Detention

A roadside ditch detention system takes advantage of the additional capacity of the roadside and median ditches created by the clear-zone requirements. A roadside ditch detains runoff from the roadway and discharges it at a restricted rate to a positive outlet.

A roadside ditch is the least expensive open-detention system, since it does not require additional right of way or significant additional maintenance. Since the ditch is within the right of way, safety considerations and roadway serviceability should be evaluated.

203-5.03(04) Underground Storage

Underground detention is best suited to an urbanized area where right of way and available land are constrained. It is desirable for where an underground storage structure is to be located outside the pavement limits. Coordination with local utilities is required. Conflicts should be minimized. Clearances should be observed between stormwater and other systems such as drinking water and sanitary sewers. In considering underground detention, the native soil should be determined to ensure constructability. All inline detention should have a positive grade to minimize sedimentation. Access should be provided for cleaning of the underground facility. The grade should be set to avoid the need for a pump station if possible.

The types of underground detention include underground storage, inline detention, parallel storage systems, oversize storm-sewer system, and infiltration trench. Underground storage can be built as one single unit with one inlet and one outlet, under a large area such as a parking lot. It can also be built as a pipe network or conduit system with multiple inlets and only one outlet, under a large area such as a parking lot. Inline detention replaces part of a storm-sewer system with a larger structure near the outlet to detain water within the system. A parallel storage system runs parallel to the existing storm-sewer system to provide additional storage. An oversize storm-sewer system increases the pipe sizes as needed in parts of the storm sewer to add storage to the entire system. An infiltration trench functions like a roadway underdrain, but it can be used only in sandy soil, where the infiltration rate is high.

203-5.03(05) Outlet Conditions

An outlet work can take the form of combinations of a drop inlet, pipe, weir, or orifice. An outlet work selected for a storage facility includes a principal spillway or an emergency overflow. It should be able to accomplish the design functions of the facility.

A slotted-riser pipe should not be used due to clogging problems. A curb opening can be used for parking-lot storage. The principal spillway is intended to convey the design storm without allowing flow to enter an emergency outlet.

An emergency spillway is an outlet provided to allow excess water to exit the pond once the design storm is exceeded. Usually in the shape of a weir, the emergency outlet should be located so that the excess stormwater flows to an adequate outlet and does not damage nearby property. An emergency spillway should be included in a storage-facility design if possible. However, a viable emergency spillway location may not exist.

203-5.03(06) Maintenance

To ensure acceptable performance and function, a storage facility that requires extensive maintenance is discouraged. The maintenance problems that are typical of a detention facility are as follows:

1. weed growth;
2. grass and vegetation maintenance;
3. bank deterioration;
4. standing water or soggy surface;
5. mosquito control;
6. blockage of outlet structures;
7. litter accumulation; or
8. maintenance of fences and perimeter plantings.

The design should focus on the elimination or reduction of maintenance requirements by addressing the potential for problems as follows:

1. Both weed growth and grass maintenance can be addressed by constructing side slopes that can be maintained using available power-driven equipment, such as a tractor mower.
2. Bank deterioration can be controlled with protective lining or by limiting bank slopes.
3. Standing water or soggy surfaces can be eliminated by means of sloping the basin bottom toward the outlet, or by means of constructing a low-flow pilot channel across the basin bottom, from the inlet to the outlet.

4. Once the problems listed above are addressed, mosquito control will not be a major problem.
5. An outlet structure should be selected to minimize the possibility of blockage. A pipe of diameter of less than 6 in. tends to block easily and should be avoided.
6. The facility should be located for easy access where the maintenance associated with litter and damage to fences or perimeter plantings can be conducted regularly.

Routine maintenance activities include an annual inspection, preferably during wet weather, and mowing, as required.

203-5.03(07) Safety Issues

Ponding of water for a significant period of time, at a relatively shallow depth, can introduce an additional risk factor for property damage, personal injury, or loss of life. Safety considerations include reducing the chance of drowning by fencing the basin, reducing the maximum depth, or including ledges or mild slopes to prevent a person from falling in and to facilitate his or her escape from the basin. A storage facility in a location that is easily accessible to the public should be provided with fencing adequate to prevent entry onto the site by unauthorized persons. A storage facility located adjacent to a roadway should be provided with an adequate clear zone to minimize the accidental entry of an errant vehicle.

Protective treatment is required to prevent entry to a facility that poses a hazard to all persons. Fences and signs are required for a detention or retention pond with a locked gate to allow for maintenance access.

Where a storage facility is located near a roadway, the road should be provided with an adequate clear zone. The maximum operating-pool depth is limited to 5 ft unless otherwise approved by the Office of Hydraulics.

203-5.04 Design Procedure

A storage facility will require an inflow rate and an outflow rate to determine the necessary storage volume.

The amount of water flowing into the storage facility should be determined. This inflow rate is the post-developed 1% annual EP. However, an additional smaller inflow rate should be considered, if a stricter local ordinance is being followed. The outflow rate should then be determined. The outflow rate is the pre-developed 10% annual EP. However, additional smaller outflow rate should be considered, if a stricter local ordinance is being followed.

The required storage volume should be calculated, based on the inflow and outflow rates, and storm duration. If the watershed draining into a storage facility is greater than 2 ac, the design should be based on reservoir-routing methods which develop hydrographs for both inflow and outflow. WinTR-20 and HEC-HMS are available public-domain hydrographic programs. A basin regulating less than 2 ac can be analyzed using the Rational Method to create a triangular hydrograph.

203-5.04(01) Detention Pond

For a detention pond, a minimum freeboard of 1 ft above the 1% annual EP storm highwater elevation should be provided. Other considerations in setting the depth include flood-elevation requirements, public safety, land availability, land value, present and future land use, water-table fluctuations, soil characteristics, maintenance requirements, and required freeboard.

The primary outlet should be designed to drain the entire detention volume within 72 h. A restrictor plate should not be used. See the INDOT *Standard Drawings*.

An emergency overflow structure should also be added. The emergency overflow structure should be placed in a location that will accept the extra flow. This may or may not outlet to the design outfall. Usually, the emergency overflow structure takes the shape of a weir.

The area above the detention pond's normal high-water elevation should be sloped towards the pond. The bottom area of the pond should be graded toward the outlet to prevent standing water conditions. A low-flow or pilot channel constructed across the facility bottom from the inlet to the outlet should be used to convey low flow. See HEC-22, Chapter 8 for example problems and more information.

203-5.04(02) Retention Pond

The inflow rate is calculated using the Rational Method, regardless of the size of the drainage area. Since the pond is retaining all of the runoff from the 1% annual EP, the outflow rate is almost negligible, because infiltration and evaporation are the only available mechanisms for drainage. To determine the infiltration rate, soil borings should be obtained to ensure accurate calculations.

A retention pond also requires an emergency spillway. The emergency spillway should overflow to an acceptable outlet. The pond should be sized to allow for 1 ft of freeboard below the emergency spillway. If an acceptable emergency overflow outlet is not available, the pond should be sized for 1.5 times the total volume required, plus 1 ft of freeboard.

The construction of a storage facility can require excavation or placement of an earthen embankment to obtain sufficient storage volume. The embankment should be of less than 6.5 ft height. A vegetated embankment should not be steeper than 3H:1V. A riprap-protected embankment should not be steeper than 2H:1V. An excavated storage facility should not have an operating design-pool depth of greater than 5 ft unless approved by the Office of Hydraulics.

203-5.04(03) Roadside Ditch Detention

A detention pond detains water from the entire drainage area. A roadside ditch detains water only from additional pavement being added during construction. However, the methodology for determining that volume remains the same. To detain the water in a roadside ditch, a berm should be built upstream of the stream receiving the flow from the ditch. The outlet structure diameter should not be smaller than 6 in. to prevent clogging. The berm should be constructed with an overflow weir for a storm event that exceeds the design storm. For more information on emergency overflow design, see HEC-22, Chapter 8. The capacity of the outfall may not allow for a normal 1% annual EP inflow and 10% annual EP outflow situation. The release rate should be considered, since the roadside ditch can be outletting upstream of existing structures.

203-5.04(04) Oversized Storm Sewer and Inline Detention

An oversized storm sewer system upsizes the pipes near the outlet of the system to provide extra capacity. An oversized storm-sewer system uses larger round or deformed pipes to provide the extra capacity, while inline detention uses vaults or boxes to provide the extra capacity.

An oversized storm sewer or inline detention should be designed in accordance with Section 203-4.0 for inlet spacing, water-spread calculations, trunk-line placement, and outlet tailwater conditions. However, detention-routing calculations should be performed to ensure that a sufficient amount of water is being detained. Gravity flow should be maintained for the 10% annual EP. The 2% annual EP hydraulic-grade line should remain below the structure top casting elevation. If local detention requirements require the 1% annual EP to be detained, another hydraulic-grade-line check should be made, to ensure that the hydraulic-grade line remains below the structure top casting elevation at the 1% annual EP. Since the velocity through the oversized section is likely to be lower than the suggested minimum velocity, sedimentation is a potential problem. Manholes should be oversized and placed more frequently through the oversized section, to assist maintenance personnel in removing sediment from the storm-sewer system.

Since inline detention is usually present near the outlet of the storm-sewer system, an emergency overflow structure should be placed in the underground storage vault. This consists of a pipe placed in the upper corner of the storage vault. A pipe of diameter of at least 6 in. should be used to prevent the emergency overflow structure from clogging.

203-5.04(05) Infiltration Trench

An infiltration trench is similar to a retention pond, except it is long and narrow and may work within the right-of-way. An infiltration trench is lined with geotextiles and backfilled with aggregate. The Rational Method should be used to calculate the inflow rate. The outflow rate will then be determined based on the infiltration capacity of the soil. Only highly pervious soils should be considered. The length of the system will depend on the volume required, given the inflow and outflow rates. Only the volume of the pipe should be considered for storage. The volume of the voids available in the backfilled trench should be ignored, to provide a factor of safety. Larger pipes should be used, to allow for maintenance. An infiltration trench should be constructed in accordance with Section 203-4.0. For additional information, see HEC-22, Chapter 8 or Chapter 10.

203-5.05 Pump Station

A pump station requires electricity as well as regular maintenance for proper function. It requires accessibility, monitoring, has limited capacity, and can be expensive. During a large storm event, it can be prone to flooding and failure. For these reasons, use of a pump station is discouraged by INDOT. However, because of topography or geometrics, it may become necessary. If so, the Office of Hydraulics should be contacted and the design guidelines for a pump station shown in HEC-24 should be followed.

203-5.06 Documentation

The information is required for a storage-facility submittal is as follows:

1. project background, including existing and proposed structure;
2. summary of hydraulics design and assumptions, including design criteria;
3. USGS topographic map, or county 2 ft contour lines, and aerial map of the project site to determine the drainage area for the storage design;
4. Hydrology, depending on methods used, IDNR discharge letter if required, coordinated discharges, FIS information, gaged sites or TR-55 and hydrograph methodologies. See Section 203-2.0;

5. computation of the inflow hydrograph;
6. computation of the outflow hydrograph or the restricted outflow according to the pertinent ordinance;
7. summary performance table for the storage system used to determine the maximum storage volume and the maximum water surface elevation, and to verify the release rate relative to the INDOT, city or town, or county regulation. See Figure 203-5A;
8. computation of the outflow-rating curve, or stage-storage-discharge relationship;
9. plan sheet showing the geometric shape of the detention including the maximum water surface elevation inside the pond, the freeboard, and the emergency spillway if applicable; and
10. an appendix including the calculation and computer-program input and output data used to determine the data shown on the summary-performance table.

203-6.0 CHANNEL OR DITCH

203-6.01 Introduction

An open channel is a natural or constructed conveyance for water in which the water surface is exposed to the atmosphere and the gravity-force component in the direction of motion is the driving force.

The types of open channels related to a transportation facility are stream channel, or artificial channel or ditch.

The principles of open-channel-flow hydraulics are applicable to each drainage facility including a culvert or a storm drain.

A stream channel has the properties as follows:

1. a natural channel with its size and shape determined by means of natural forces;
2. compound in cross section with a main channel for conveying low flow and a floodplain to transport flood flow, and
3. shaped geomorphologically due to the long-term history of sediment load and water discharge which it experiences.

Each Indiana Station Contains Four Quartiles

% Storm Time	Indianapolis				Evansville				Fort Wayne				South Bend			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	20.00	6.50	5.26	6.67	22.82	6.28	5.13	6.92	20.00	6.67	6.00	7.14	20.00	7.50	7.00	8.26
20	40.80	18.13	11.55	14.25	44.69	17.33	11.11	14.04	41.11	17.14	12.23	14.23	40.00	18.57	13.33	16.35
30	54.95	35.85	17.06	20.00	57.11	33.33	16.67	20.51	54.83	34.17	18.86	20.00	51.67	34.00	20.00	22.73
40	62.50	52.94	24.24	26.09	65.33	53.09	25.44	27.06	62.00	52.18	26.15	25.71	60.89	51.43	27.50	28.50
50	68.75	67.86	37.78	33.33	71.43	69.57	37.93	34.21	68.42	66.67	38.46	33.33	67.35	66.67	39.13	34.04
60	76.67	76.52	58.33	40.00	78.15	78.57	57.39	40.91	75.00	76.36	57.23	38.00	75.00	75.17	58.46	40.20
70	83.05	83.81	78.03	50.00	84.66	85.60	77.44	50.79	81.62	84.29	76.11	48.50	80.83	82.32	75.98	50.00
80	89.70	90.67	88.68	68.57	90.00	91.72	88.54	69.70	87.50	90.00	87.69	68.24	86.67	88.89	86.79	67.50
90	95.00	95.89	95.29	88.37	95.36	96.50	95.88	89.36	93.75	95.56	95.08	87.88	92.89	94.78	94.17	87.50
100	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: Quartile II is recommended for use.

HUFF DISTRIBUTION OF DESIGN RAINFALL
(50% Probability Curve Ordinates)

Figure 29-10A