Stormwater Calculations

Stor-A-Lot Storage
1725 N. Graham Road
Franklin, Indiana

Submitted:
August 21, 2022

By:

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Table of Contents

Section 1: Stormwater Calculations Summary

Pre-Development Conditions

The project site is located between Graham Road and Commerce Drive approximately 0.33 miles north of Arvin Drive in the City of Franklin, Johnson County, Indiana (see Exhibit 1 – Location and Vicinity Map). The existing site is a ±10.39-acre site consisting of pasture/agricultural field. By graphic plotting, the project site lies within Zone 'X', areas of 0.2% annual chance of flood or areas of 1% annual chance of flood with average depths of less than 1 foot or with drainage areas less than 1 square mile, as shown on the Flood Insurance Rate Map (FIRM) for Johnson County, Indiana, Community Panel No. 18081C0231E, dated January 29, 2021.

Under pre-developed conditions, runoff exits the site at two different outlet points. Runoff from the far western portion of the site drains to the southwest corner of the site that eventually drains to the roadside ditch on the east side of Graham Road and is conveyed south. Runoff from the eastern portion of the site drains to the east of the site that drains into the roadside ditch on the west side of Commerce Drive and is conveyed south. This ditch then conveys runoff through an existing 24" drive culvert and then east through the storm network at the intersection of Arvin Road and Commerce Drive. Ultimately, this runoff is conveyed farther east and south before reaching Hurricane Creek (see Exhibit 2 – Pre-Developed Watershed Map). For the runoff and detention analysis, the enclosed calculations focus entirely on the pre-development basin draining to the east to the existing roadside ditch located on the west side of Commerce Drive as it is anticipated that the entire property will drain east to this ditch in the post-developed conditions.

Post-Development Conditions

This project involves the construction of a ±269,114 sft. Stor-A-Lot Storage complex. All curbs, sidewalk, and parking areas necessary for the development shall be constructed with the storage complex. All stormwater runoff shall be collected via a storm sewer network and directed towards the wet detention pond which will be constructed on the east end of the project site. The proposed wet detention pond will provide stormwater quantity and quality treatment in accordance with Section 6.19 of the City of Franklin Subdivision Control Ordinance (see Exhibit 3 – Post-Developed Watershed Map).

As described in the Pre-Development Conditions above, it is anticipated that the entire property will drain south and east to the existing ditch on the west side of Commerce Drive. Runoff from the site will all drain into the proposed detention pond. The pond will then discharge into the existing ditch located on the west side of Commerce Drive. To achieve water quantity detention standards, the pond and outlet structure will be sized to restrict the peak discharge rate of the 10-year post-developed storm for the site to the peak 2-year pre-developed rate for the east pre-development watershed basin. Additionally, the peak discharge rate of the 100-year post-developed storm for the site will be restricted to the peak 10-year pre-development rate for the east pre-development watershed.

after the peak runoff from a 24-hour storm for water quality treatment. The pond will also be designed to include an emergency overflow spillway that is sufficient enough to convey 1.25 times the peak discharge from the 100-year post-development storm. The wet detention pond will be designed to meet the requirements of Section 6.19, G and H of the City of Franklin Subdivision Control Ordinance.

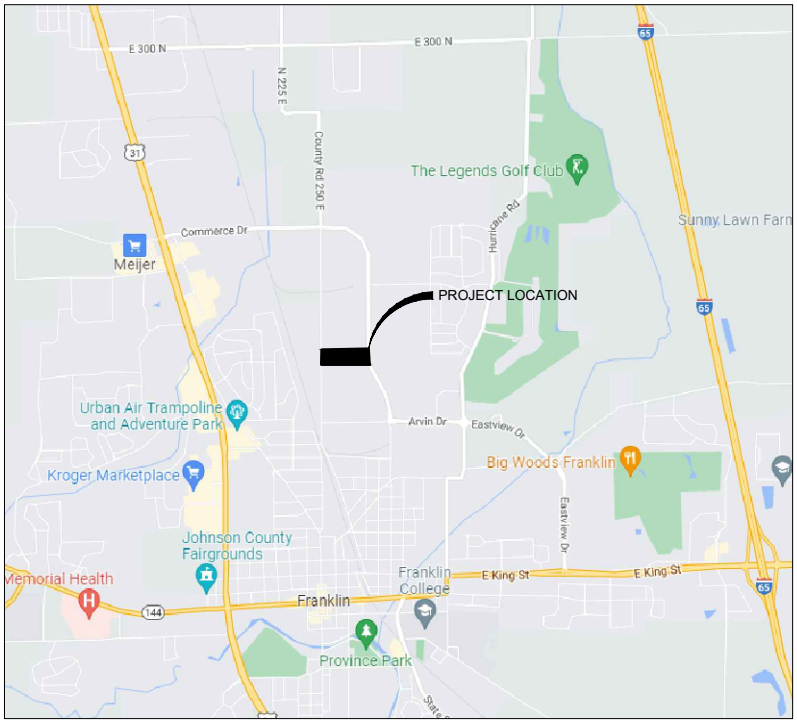
Storm Sewer Design

The proposed storm sewer network is designed to accommodate a 10-year storm event. The Rational Method was used to perform the storm sewer pipe sizing calculations. Structures and grates in the parking lot were designed and placed so that the depth of ponding above the inlet does not exceed 9 inches with the inlet grate 50% plugged.

EXHIBIT 1 - LOCATION AND VICINITY MAPS
STOR-A-LOT STORAGE
GRAHAM ROAD, FRANKLIN, IN

LOCATION MAP

NOT TO SCALE



VICINITY MAP

NOT TO SCALE

NORTH

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Transportation & Development Consultants

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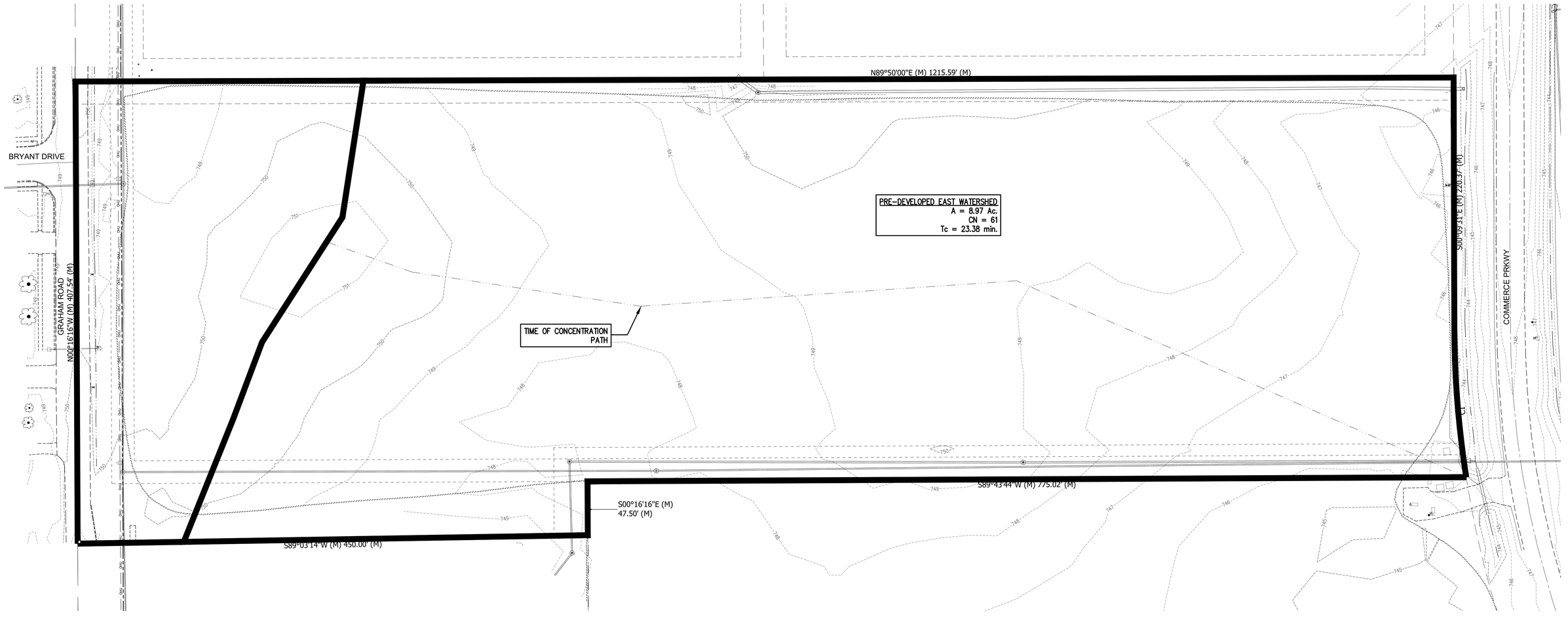
EXHIBIT 2 - PRE-DEVELOPED WATERSHED MAP

STOR-A-LOT STORAGE
1725 N. GRAHAM ROAD



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AUGUST 11, 2022

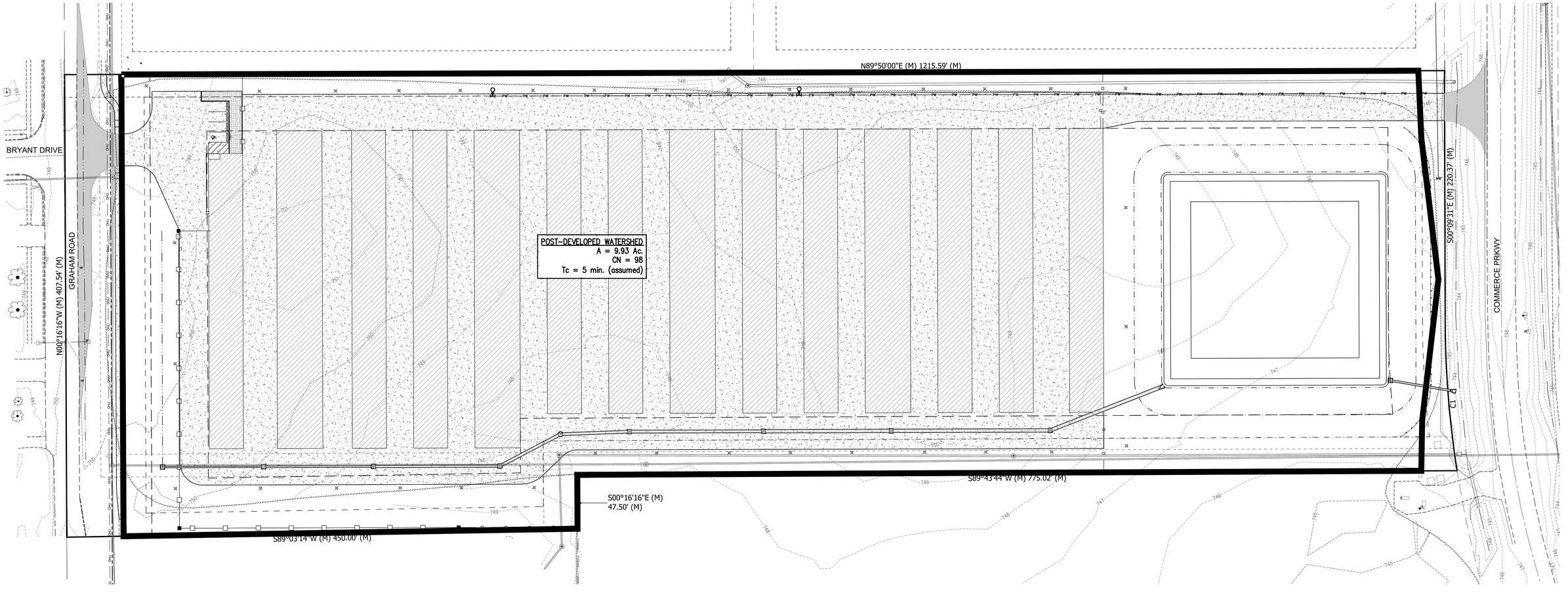
EXHIBIT 3 - POST-DEVELOPED WATERSHED MAP

STOR-A-LOT STORAGE
1725 N. GRAHAM ROAD

NORTH

50 0 50 100

SCALE: 1" = 40'



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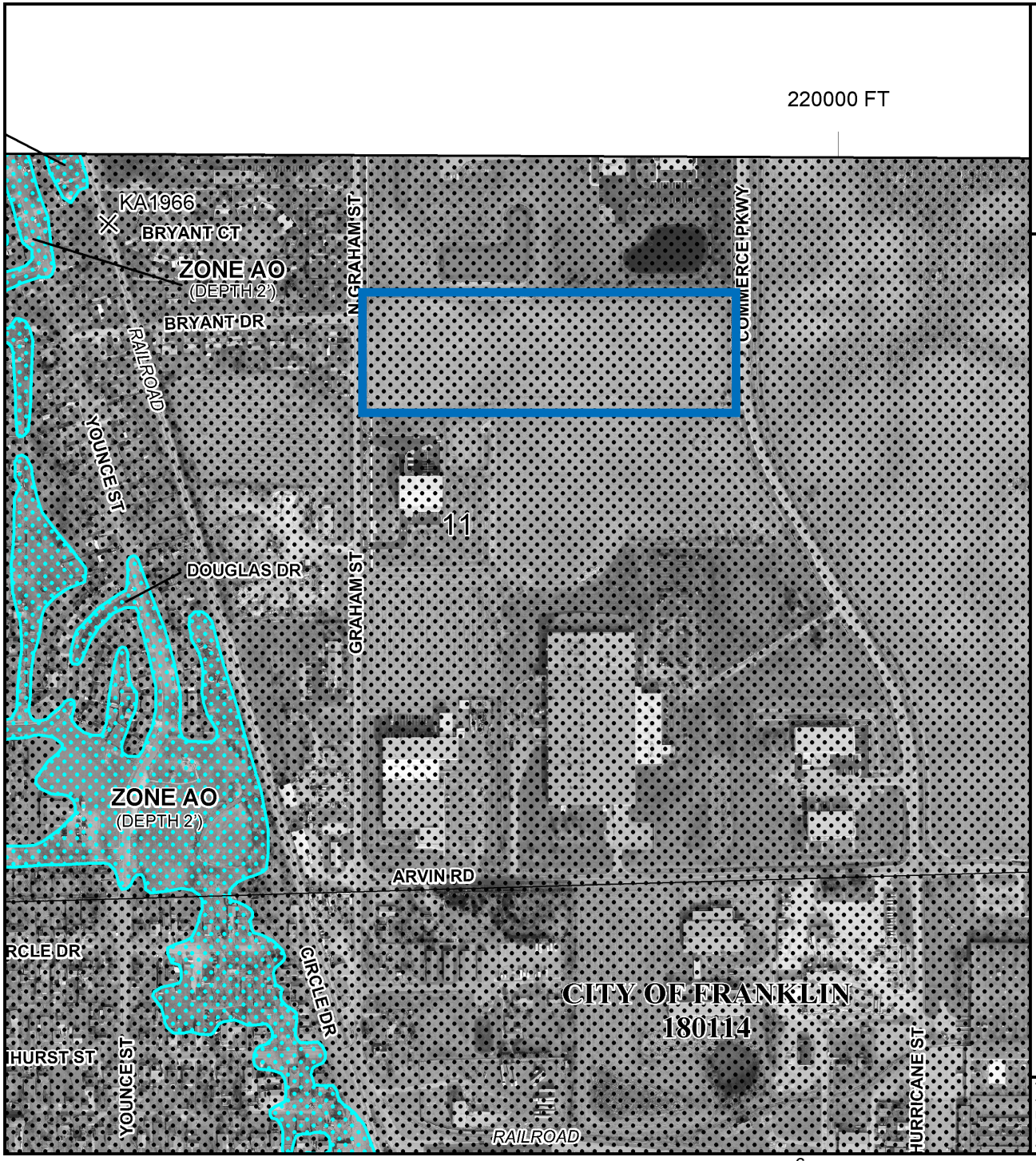
AUGUST 21, 2022



MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 M

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0231E

FIRM

FLOOD INSURANCE RATE MAP

JOHNSON COUNTY, INDIANA AND INCORPORATED AREAS

PANEL 231 OF 352

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FRANKLIN, CITY OF	180114	0231	E
JOHNSON COUNTY	180111	0231	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
18081C0231E

MAP REVISED
JANUARY 29, 2021

Federal Emergency Management Agency

This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at https://msc.fema.gov.

Section 2: Hydrologic Modeling Calculations

All drainage calculations were completed using Autodesk Storm and Sanitary Analysis software. The SCS Curvilinear method utilizing SCS II rainfall distribution was used to calculate the hydrographs. The TR-55 Method was used to calculate times of concentration. Curve numbers were computed based on the applicable cover for fully developed urban areas and the percentage by area of each hydrologic soil type obtained from the USDA Web Soils Survey for the project area. Per Section 6.19.C.6 of the City of Franklin SCO, pre-developed runoff rates shall be based on pasture, meadow, brush or woods ground cover in good hydrologic conditions. As the existing site is predominately cultivated field, the existing ground cover for the entire site will be considered to be pasture cover in good hydrologic condition.

Soil Hydrologic Group Percentage Calculations

Table 1
Soil Hydrologic Group Percentage Calculations

Soil Type	Hydrologic Group – B or B/D (acres)	Hydrologic Group – C or C/D (acres)
Brookston silty clay loam, Br	2.7	
Crosby silt loam, CrA		6.2
Crosby-Miami silt loams, CsB2		1.1
Brookston silty clay loam, YbvA	0.1	
Crosby silt loam, YcIA		0.1
Totals	2.8	7.4
Percentages of Hydrologic Groups	**27.45%**	**72.55%**

Runoff Curve Number Calculations

Pre-Development Conditions

Table 2
Pre-Development Basin Runoff Curve Number Calculations

Land Use Description	Runoff Curve No. For Hydrologic Group – B		Runoff Curve No. For Hydrologic Group – C		Average Runoff Curve Number	Land Use Area	Overall Weighted Curve No.
	Percentage Used*	***27.45%***	***Percentage Used****	***72.55%***			
Pasture/Open Space	61		74		70.43	10.2 ac.	**70**

*See Soil Hydrologic Group Percentage Calculations, Table 1.

As a conservative measure, it was assumed that the entire site in pre-developed conditions was a Type B HSG and a curve number of 61 was used to determine the pre-development runoff calculations for the 2-year and 10-year scenarios.

Post-Development Conditions

As a conservative measure, it was assumed that the entire site in post-developed conditions was impervious and a curve number of 98 was used to determine the post-development runoff calculations for the 10-year and 100-year scenarios and detention design. After right-of-way dedication to the City of Franklin, the post-developed watershed basin consists of 9.93 acres with an assumed Time of Concentration of 5.00 minutes and an assumed CN of 98.

Hydrologic Modeling Runoff Summary

Pre-Development Conditions

The City of Franklin Subdivision Control Ordinance requires a detention design that outlets stormwater at the following rates:

Post-Development:		Pre-Development:
Post 10-yr Q	≤	Pre 2-yr Q
Post 100-yr Q	≤	Pre 10-yr Q

The City of Franklin requires that the 10-year and 100-year post-development rain events shall be limited to the pre-developed 2-year and 10-year rain events, respectively. The City of Franklin Subdivision Control Ordinance requires that the storm events are calculated at durations of 1, 2, 3, 6, 12 and 24 hours to identify the critical storm events which are to be used for the respective limiting pre-development rates; however, only the 24 hour storm was calculated, as it is customary that the peak runoff is generated during the 24 hour event using the SCS II rainfall distribution. Table 3 summarizes the peak runoff rates (cfs) resulting from the hydrologic modeling of the Pre-Development Watershed Basin which is representative of the contributing watershed area in the existing condition. Runoff rates were only calculated for the pre-developed north watershed as the allowable release rates will be determined based on the pre-developed north watershed only. See Appendix 'A' for the pre-development hydrograph and peak storm event analysis results.

Table 3
Pre-Development Watershed Hydrograph Peak Runoff Rate Summary

Return Period (years)	Storm Duration
	24 Hours
2	**1.74 cfs**
10	**6.45 cfs**

Basin Allowable Discharge:

Allowable discharge for the critical 10-year post-development storm=
Pre-Development 2-year Peak = 1.74 cfs

Allowable discharge for the critical 100-year post-development storm=
Pre-Development 10-year Peak = 6.45 cfs

Post-Development Conditions

Table 4 summarizes the peak runoff rates (cfs) resulting from the hydrologic modeling of the Post-Development Watershed Basin which is representative of the contributing watershed area in the proposed condition. See Appendix 'B' for the post-development hydrographs and peak storm event analysis results.

Table 4
Post-Development Combined Watershed Hydrograph Peak Runoff Rate Summary

Return Period (years)	Storm Duration
	24 Hours
10	**52.95 cfs**
100	**76.63 cfs**

Map Scale: 1:2,050 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 50 100 200 300

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 29, Sep 8, 2021

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

Date(s) aerial images were photographed: Oct 22, 2020—Nov 12, 2020

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Br	Brookston silty clay loam, 0 to 2 percent slopes	2.7	26.2%
CrA	Crosby silt loam, fine-loamy subsoil, 0 to 2 percent slopes	6.2	60.6%
CsB2	Crosby-Miami silt loams, 2 to 4 percent slopes, eroded	1.1	11.0%
YbvA	Brookston silty clay loam-Urban land complex, 0 to 2 percent slopes	0.1	0.8%
YclA	Crosby silt loam, fine-loamy subsoil-Urban land complex, 0 to 2 percent slopes	0.1	1.4%
Totals for Area of Interest		**10.2**	**100.0%**

Section 3: Water Quality Calculations

The City of Franklin Subdivision Control Ordinance requires all paved areas to be routed through a water quality detention system. The water quality detention system shall be designed to detain, for over 24 hours after peak runoff, at least 20% of the volume of runoff from either a 1 ¼" rainfall depth storm or 0.5" of direct runoff, whichever is greater. The minimum water quality outlet shall be 2" in diameter. See Appendix B for the water quality hydrograph results, additional water quality data and routed water quality hydrograph.

Water Quality Volume

Volume of Runoff from 1 ¼" Rainfall Depth Storm, V_1 = 37,225 ft^3 = 0.855 ac.-ft.

Volume of Runoff from 0.5" Direct Runoff,

V_2 = 9.93 ac. * (0.5"/12) = 0.414 ac.-ft.

Water Quality Volume, WQ_v = 20% * V_1 = 0.2 * 0.855 ac.-ft. = **0.171 ac.-ft. → 7,449 ft^3**

At a time of 24 hours after the peak runoff rate of the inflow hydrograph, the detention pond must have at least 0.171 ac.-ft. or 7,449 ft^3 remaining in the basin.

Routed Water Quality Storm Hydrograph

The 1 ¼" storm event is routed through the proposed detention pond with a 5.0" diameter circular water quality orifice. The Routed 1.25" Storm Event Hydrograph (see following page) is used to verify the water quality volume, WQ_v, is remaining after 24 hours after peak runoff.

Table 5
Water Quality Volume Summary

	Proposed Pond
Time to Peak	14.58 hours
Time of 24 hours Past Peak Runoff	38.58 hours
Storage Volume at Time of 24 hours Past Peak Runoff	9,431 ft^3

Total Storage Volume at Time of 24 hours Past Peak Runoff = **9,431 ft^3 > 7,449 ft^3** (WQ_v)

The storage volume 24 hours after peak runoff is greater than the required water quality volume due to using the minimum size water quality orifice of 5.0".

The water quality orifice is discussed further in Section 4: Detention Calculations.

Section 4: Detention Calculations

Per ordinance, stormwater detention is addressed by restricting the release rate of runoff as previously described in Section 2: Hydrologic Modeling Calculations. The following information is provided as verification that the proposed wet detention ponds and outlet structure are capable of detaining and restricting the release rate of runoff from the post-development site.

Allowable Discharge Rate (see Section 2: Hydrologic Modeling Calculations, Hydrologic Modeling Runoff Summary)

Allowable discharge for the critical 10-year post-development storm=
Pre-Development 2-year Peak = **1.74 cfs**

Allowable discharge for the critical 100-year post-development storm=
Pre-Development 10-year Peak = **6.45 cfs**

Post-Development Peak Flowrate (see Section 2: Hydrologic Modeling Calculations, Hydrologic Modeling Runoff Summary)

Post-Development Watershed
Q_{10} = 52.95 cfs
Q_{100} = 76.63 cfs

Outlet Structure Summary (see Appendix C: Post-Development Runoff & Routed Storm Data)

The proposed outlet structure shall utilize a Modified Inlet Type "E" with one (1) circular 5.0" diameter orifice to meet the detention and allowable discharge requirements for the water quality and 10-year critical storm events. One (1) 12" (H) x 24" (W) rectangular orifice shall be utilized to meet the detention and allowable discharge requirements for 100-year critical storm events. Discharge will be conveyed to the existing roadside ditch on the west side of Commerce Drive via an 18" diameter outlet pipe leaving the control structure.

Routed Storm Hydrographs (see Appendix C: Post-Development Runoff & Routed Storm Data)

Peak 10 Year Post-Development Discharge Rate = **0.95 cfs** < 1.74 cfs (allowable)
Peak Water Surface Elev. = **746.19** < 746.82 (top of emergency spillway)

Peak 100 Year Post-Development Discharge Rate = **4.45 cfs** < 6.45 cfs (allowable)
Peak Water Surface Elev. = **746.82** < 746.82 (top of emergency spillway)

All post-development storms are discharged at a flowrate less than their respective allowable discharge rates. All post-development storms produce a peak water surface elevation below the maximum detention pond elevation.

Emergency Scenario

An emergency spillway will be constructed on the north side of the detention pond. The emergency spillway was designed to convey 1.25 x Q_{100} where Q_{100} equals the peak 100-year inflow to the basin from the entire contributing watershed. The Q_{100} inflow used to design the pond's emergency spillway is equal to the total inflow from the post-developed watershed. The spillway will discharge into the existing roadside ditch on the west side of Commerce Drive. Below are calculations for the emergency spillway:

Q_{100} Inflow = 76.63 cfs
1.25 x Q_{100} Inflow= 95.80 cfs
Length of Weir = 35 ft.
Top of Detention Basin Elevation = 749.75
Spillway Crest Elevation = 746.82
Water Surface Elevation = 747.70
Freeboard = 749.75 – 747.70 = 2.05 ft.

$H = [(1.25*Q100) / (3.3*L)]^{2/3} = [130.84 / (3.3*35)]^{2/3} =$ **0.883'**

The head needed to convey the required flowrate is **0.883'**. The corresponding elevation is **747.70'**, which still allows for **2.05'** of freeboard above the high-water elevation through the emergency spillway.

Section 5: Storm Sewer Sizing Calculations

Storm Sewer Sizing Summary

The Rational Method was used to size the pipes to convey the peak runoff from the 10-year storm. The Time of Concentration was assumed to be 5 minutes for all proposed structures. Pipe sizing calculations and the inlet basin map are included within this section.

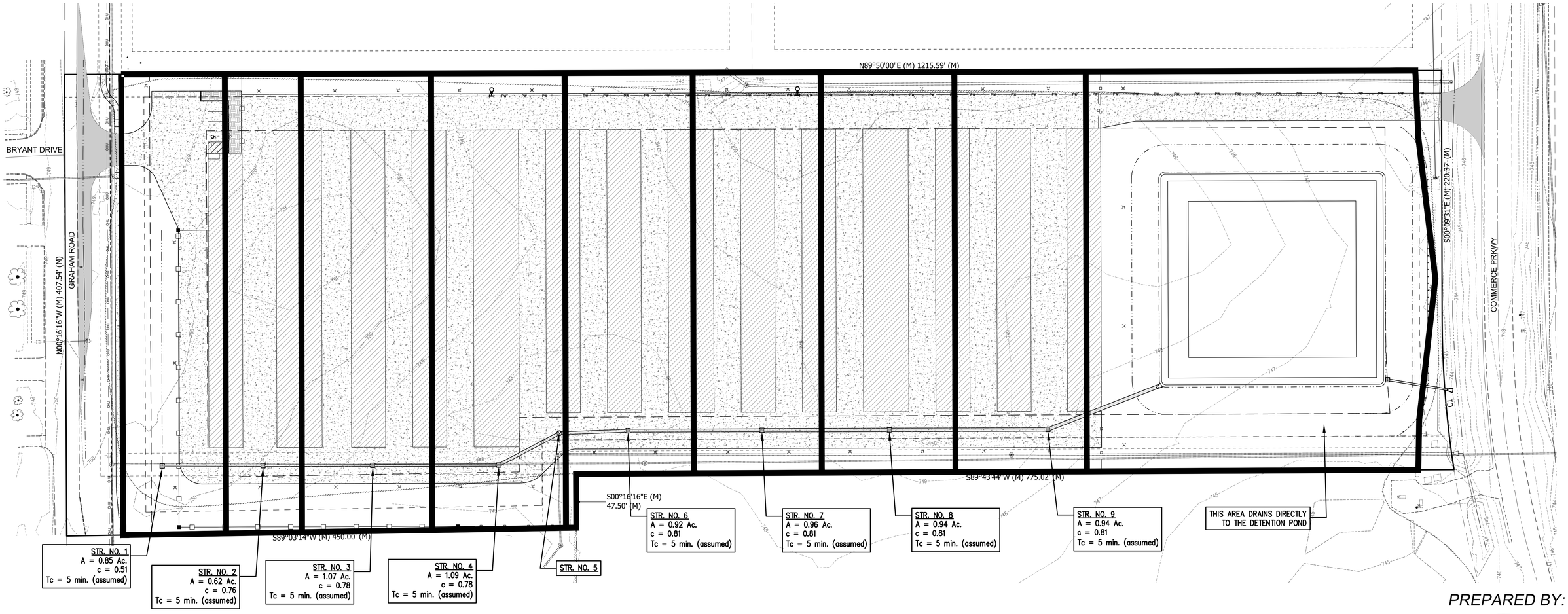
EXHIBIT 4 - INLET WATERSHED MAP

STOR-A-LOT STORAGE
1725 N. GRAHAM ROAD

NORTH

50 0 50 100

SCALE: 1" = 40'



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115 N. 17th AVENUE, BEECH GROVE, IN 46107 (317) 780-1555

AUGUST 21, 2022

Stor-A-Lot Franklin
Pipe and Inlet Sizing Calculations

Structure	Pipe Data						Inlet Watershed Data											Contributing Watershed Data						Pipe Analysis		
	Downstream Structure	Length (ft)	Pipe Diameter (in)	Pipe Material	Invert Slope (%)	Mannings Number n	Catchment Area (ac) Roof	Runoff Coefficient C Roof	Catchment Area (ac) Grass	Runoff Coefficient C Grass	Catchment Area (ac) Impervious	Runoff Coefficient C Impervious	Total Area A (ac)	Composite Coefficient C	Tc (min)	Rainfall Intensity (i) in/hr	Manual Input Flow Q (cfs)	Q=CiA (cfs)	Total Area A (ac)	Runoff Coefficient C	Time in Upstream Pipe (min)	Total Time of Concentration Tc (min)	Intensity I (in/hr)	Total Pipe Flow (cfs)	Pipe Capacity Qmax (cfs)	Pipe Velocity (ft/s)	% of Full Flow Capacity
Str. 1	Str. 2	89	15.00	RCP	0.40	0.013	0.09	0.90	0.45	0.20	0.31	0.85	0.85	0.51	5.00	7.21	--	3.12	0.85	0.51	N/A	5.00	7.21	3.12	4.35	3.74	71.71%
Str. 2	Str. 3	97	18.00	RCP	0.40	0.013	0.22	0.90	0.10	0.20	0.30	0.85	0.62	0.76	5.40	7.08	--	3.34	1.47	0.62	0.40	5.40	7.08	6.41	7.08	4.22	90.52%
Str. 3	Str. 4	111	24.00	RCP	0.40	0.013	0.42	0.90	0.14	0.20	0.51	0.85	1.07	0.78	5.78	6.95	--	5.80	2.54	0.69	0.38	5.78	6.95	12.10	15.25	5.12	79.33%
Str. 4	Str. 5	65	30.00	RCP	0.40	0.013	0.44	0.90	0.15	0.20	0.50	0.85	1.09	0.78	6.14	6.83	--	5.80	3.62	0.71	0.36	6.14	6.83	17.69	27.65	5.94	63.98%
Str. 5	Str. 6	61	30.00	RCP	0.40	0.013	--	--	--	--	--	--	--	--	6.32	6.68	--	--	3.62	0.71	0.18	6.32	6.68	17.29	27.65	5.94	62.55%
Str. 6	Str. 7	118	30.00	RCP	0.40	0.013	0.37	0.90	0.09	0.20	0.46	0.85	0.92	0.81	6.49	6.61	--	4.91	4.55	0.73	0.17	6.49	6.61	22.03	27.65	5.94	79.68%
Str. 7	Str. 8	112	36.00	RCP	0.40	0.013	0.40	0.90	0.09	0.20	0.47	0.85	0.96	0.81	6.83	6.52	--	5.05	5.50	0.75	0.33	6.83	6.52	26.78	44.97	6.71	59.54%
Str. 8	Str. 9	140	36.00	RCP	0.40	0.013	0.34	0.90	0.09	0.20	0.51	0.85	0.94	0.81	7.10	6.41	--	4.86	6.44	0.76	0.28	7.10	6.41	31.16	44.97	6.71	69.30%
Str. 9	Pond	115	36.00	RCP	0.40	0.013	0.34	0.90	0.09	0.20	0.51	0.85	0.94	0.81	7.45	6.41	--	4.86	7.38	0.76	0.35	7.45	6.41	36.02	44.97	6.71	80.10%

Section 6: Storm Inlet/Grate Calculations

Storm Inlet Summary

Storm inlets were placed throughout the site to ensure that sag inlets will be adequate to pass the design 10-year flow with 50% of the sag inlet clogged with the maximum depth of water not exceeding nine (9) inches.

Castings located in the drive isles are Neenah R-1878-B7G. Castings located in grassed areas are Neenah R-4215-C. The perimeter and open area of each inlet grate are as follows:

- R-1878-B7G → Perimeter = 10.5 ft. and Open Area = 3.3 $ft.^2$
- R-4215-C → Perimeter = 11.3 ft. and Open Area = 3.3 $ft.^2$

To simulate a clogged inlet, the dimensions are reduced by 50%. For depths less than 0.3 feet, the inlet grate acts as a weir and maximum capacity of the grate, assuming 50% clogged and ponding depths equal to the maximum allowable, can be calculated as follows:

$Q = 3.3P(h)^{1.5}$

Where P = perimeter of the grate, ft.
h = head above the casting, ft.
Q = Capacity, cfs

For depths greater than 0.4 feet, the inlet grate acts as an orifice and the maximum capacity of the grate, assuming 50% clogged and ponding depths equal to the maximum allowable, can be calculated as follows:

$Q = 0.6A(2gh)^{0.5}$

Where A = free open area of grate in, ft^2
g = 32.2 ft/sec^2
h = head above casting, ft.

The following table indicates the maximum inlet capacity assuming a 50% clogged condition with ponding depths up to the maximum allowable. Please refer to Exhibit 4 – Inlet Basin Watershed Map for additional information.

Structure No.	Casting Type	Inlet Basin Watershed Runoff	Max. Allowable Ponding Depth	Max. Grate Capacity @ 50% Clogged
1	R-4215-C	3.12 cfs	0.75’	6.88 cfs
2	R-1878-B7G	3.34 cfs	0.75’	6.88 cfs
3	R-1878-B7G	5.80 cfs	0.75’	6.88 cfs
4	R-1878-B7G	5.80 cfs	0.75’	6.88 cfs
6	R-1878-B7G	4.91 cfs	0.75’	6.88 cfs
7	R-1878-B7G	5.05 cfs	0.75’	6.88 cfs
8	R-1878-B7G	4.86 cfs	0.75’	6.88 cfs
9	R-1878-B7G	4.86 cfs	0.75’	6.88 cfs

Appendix A: Pre-Development Runoff Data

SUB-BASIN INPUT SUMMARY						
SN	**Element ID**	**Description**	**Area (acres)**	**Drainage Node ID**	**Weighted Curve Number**	**Time of Concentration (days hh:mm:ss)**
1	Post-Developed Basin		9.93	East Pond	98.00	0 00:05:00
2	Pre-Developed East Basin		8.97	Out-01	61.00	0 00:23:23

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Stor-A-Lot Storage Franklin

Designer: BTV **Date:** 5-Aug-22

Str. No.: Pre-Developed East Basin

Sheet Flow

1.	**Surface Description**	**grass**			**pavement**			**grass**	
2.	**Manning's Roughness Coeff., (n)**	0.170			0.011			0.170	
3.	**Flow Length, (L) **total L<= 300 ft**	79.00	ft.		0.00	ft.		0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.92	in.		2.92	in.		2.92	in.
5.	**Land Slope, (s)**	0.0116	ft./ft.		0.0200	ft./ft.		0.0090	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.195	hr	+	0.000	hr	+	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description (paved or unpaved)**	**unpaved**			**unpaved**			**unpaved**	
8.	**Flow Length, (L)**	231.00	ft.		306.00	ft.		423.00	ft.
9.	**Watercourse Slope, (s)**	0.0112	ft./ft.		0.0038	ft./ft.		0.0102	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.708	ft./s		0.995	ft./s		1.630	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.038	hr	+	0.085	hr	+	0.072	hr

Watershed or Subarea Tc or Tt =

0.390 hr

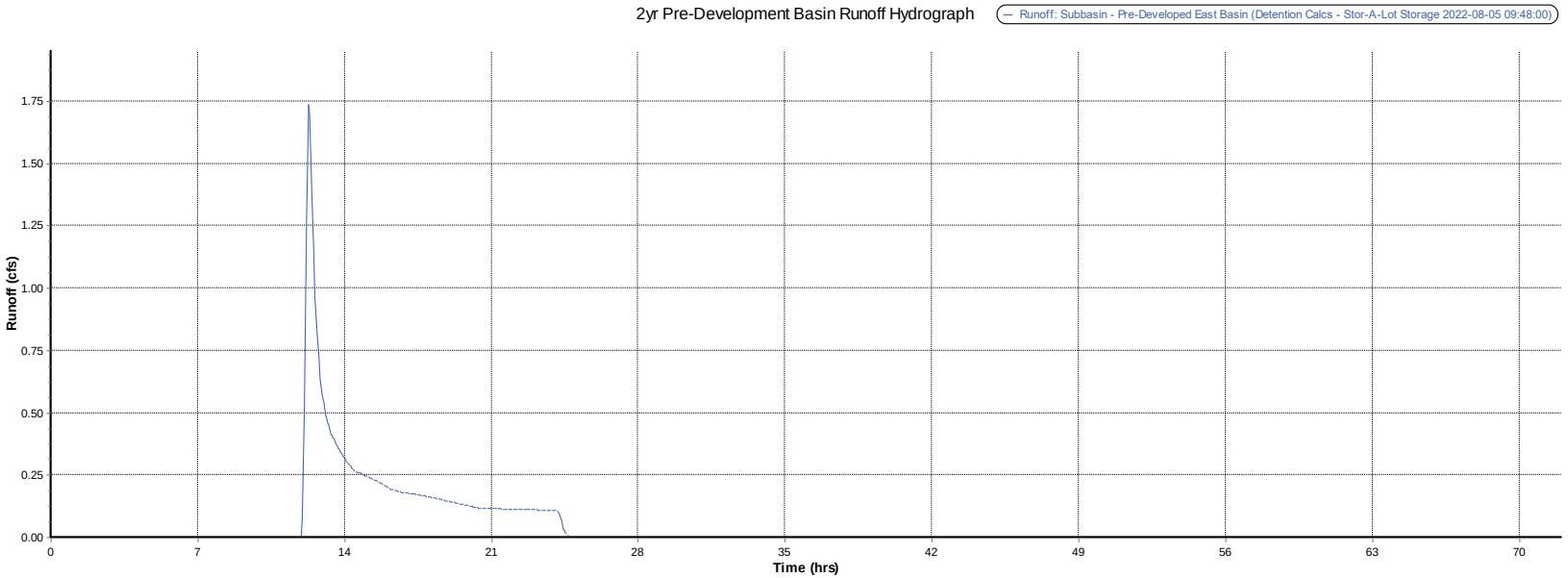
or

23.38 min

Channel Flow

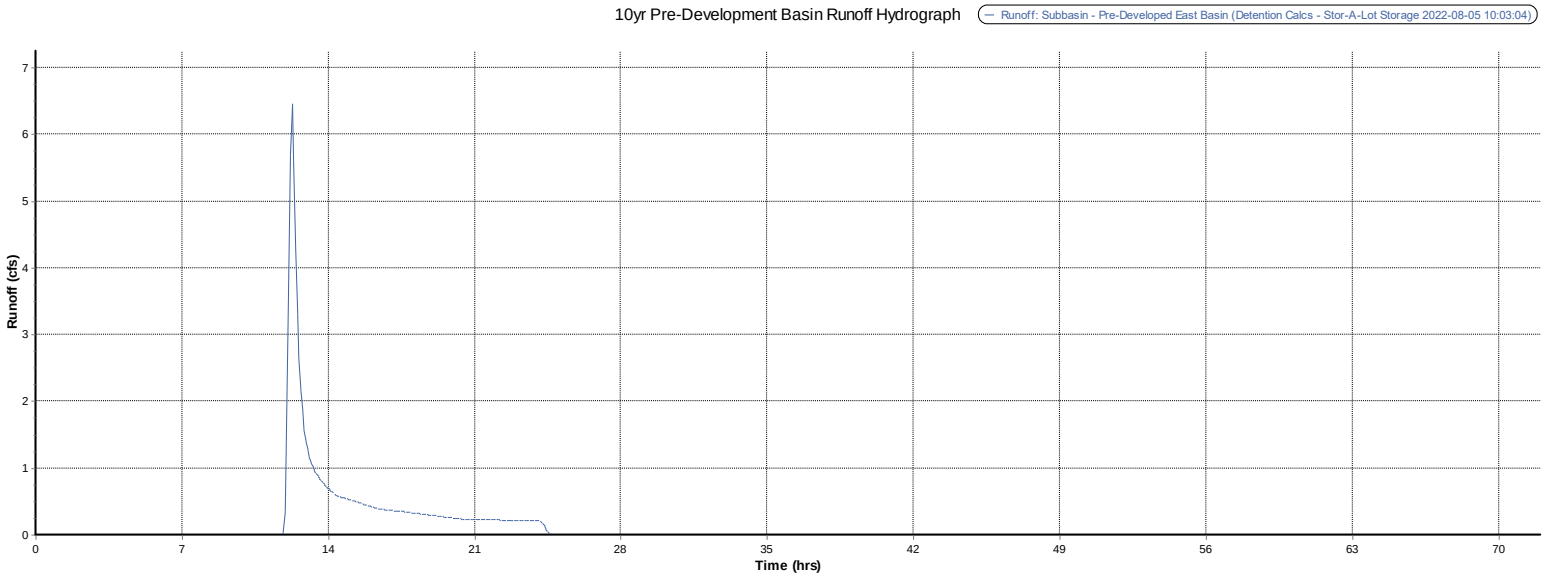
12.	**Cross Sectional Flow Area, (a)**	0.32	ft.^2		7.07	ft.^2		20.20	ft.^2
13.	**Wetted Perimeter, Pw**	1.68	ft.		4.71	ft.		18.20	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	0.189	ft.		1.501	ft.		1.110	ft.
15.	**Channel Slope, (s)**	0.0038	ft./ft.		0.0120	ft./ft.		0.0050	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.170			0.170			0.060	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	0.177	ft./s		1.260	ft./s		1.883	ft./s
18.	**Flow Length, (L)**	0.00	ft.		0.00	ft.		0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr	+	0.000	hr	+	0.000	hr

2yr Pre-Development Basin Runoff Hydrograph and Results



Element ID	Pre-Developed East Basin
Maximum Runoff (cfs)	1.74
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.04
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Runoff (ft^3)	10924.67
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

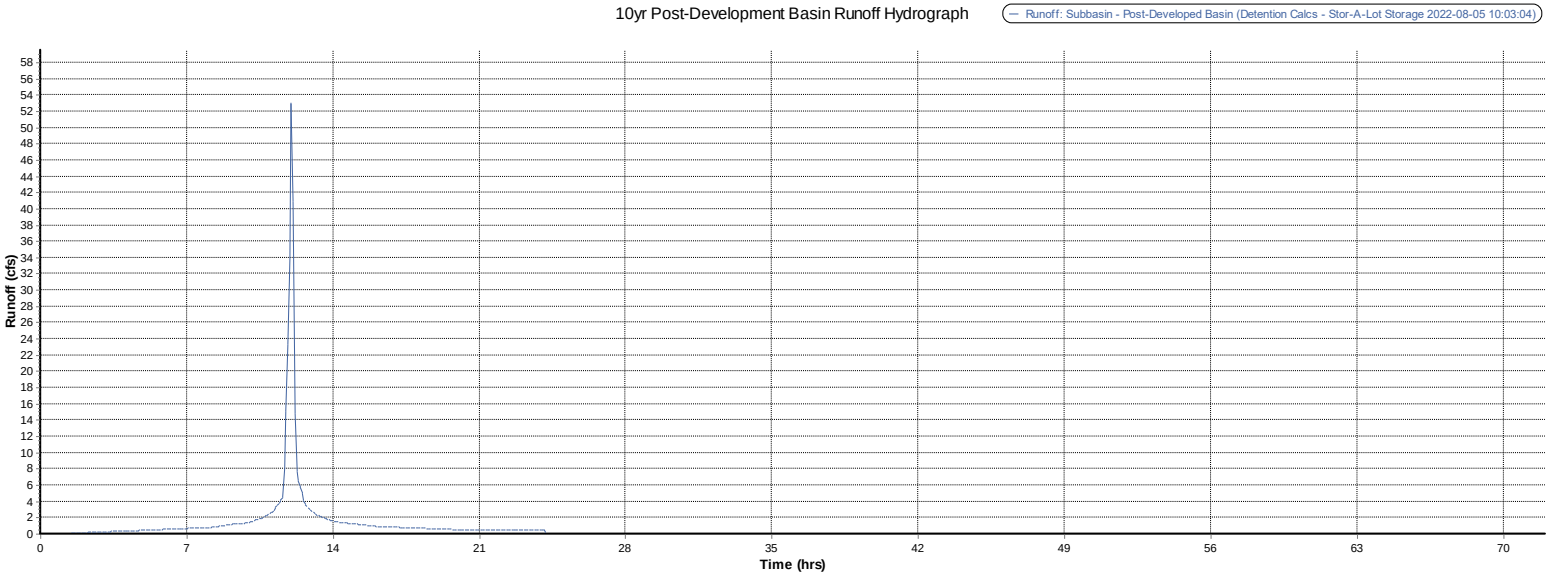
10yr Pre-Development Basin Runoff Hydrograph and Results



Element ID	Pre-Developed East Basin
Maximum Runoff (cfs)	6.45
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.11
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Runoff (ft^3)	27808.29
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

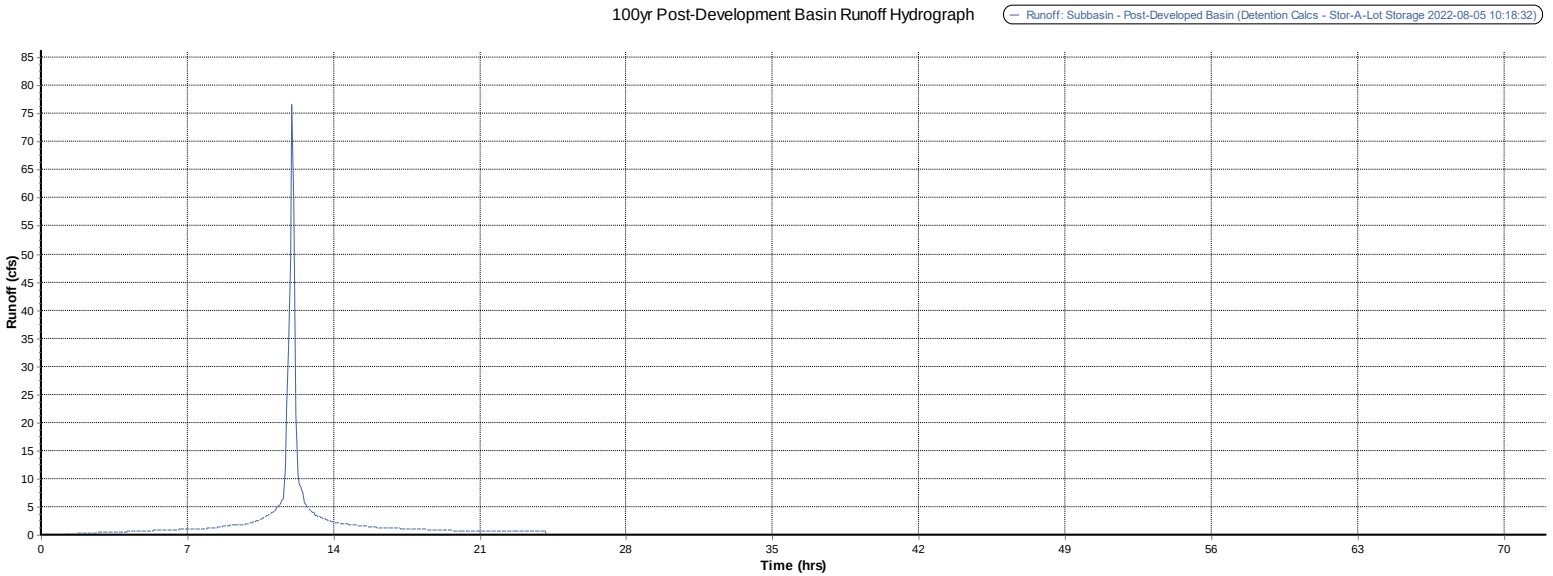
Appendix B: Post-Development Runoff and Water Quality Calculations Data

10yr Post-Development Basin Runoff Hydrograph and Results



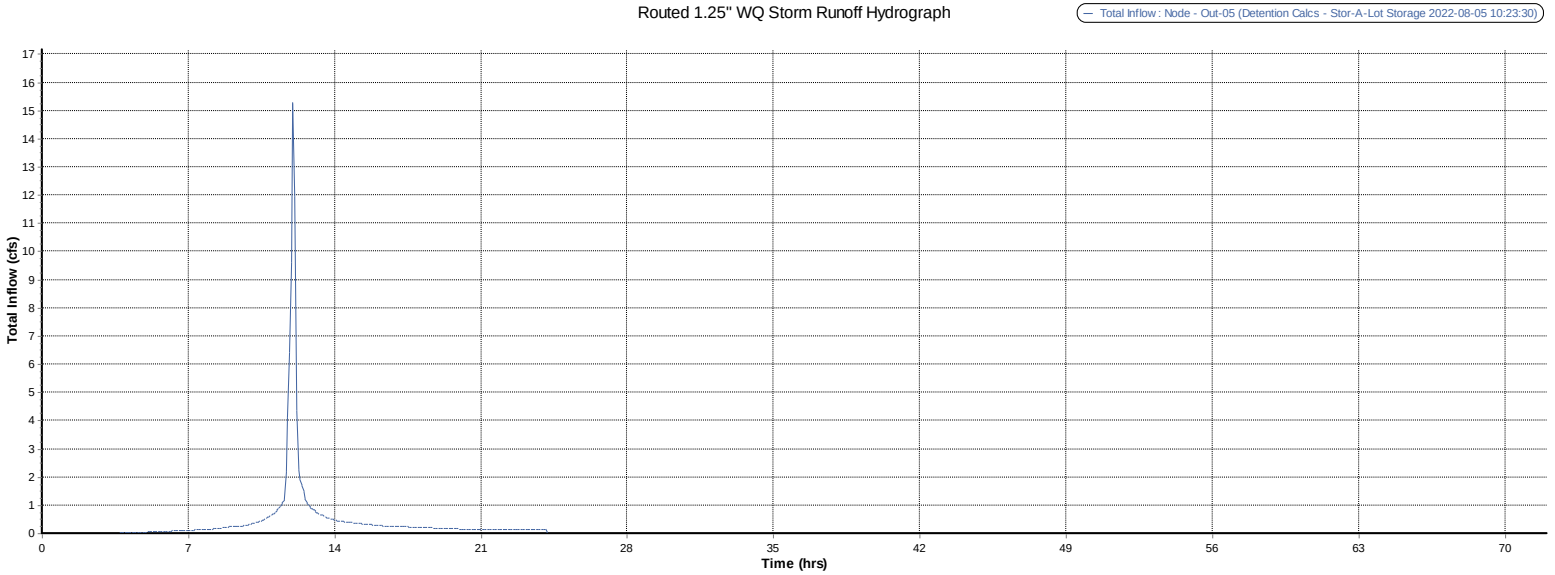
Element ID	Post-Developed Basin
Maximum Runoff (cfs)	52.95
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.53
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Runoff (ft^3)	138369.07
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

100yr Post-Development Basin Runoff Hydrograph and Results



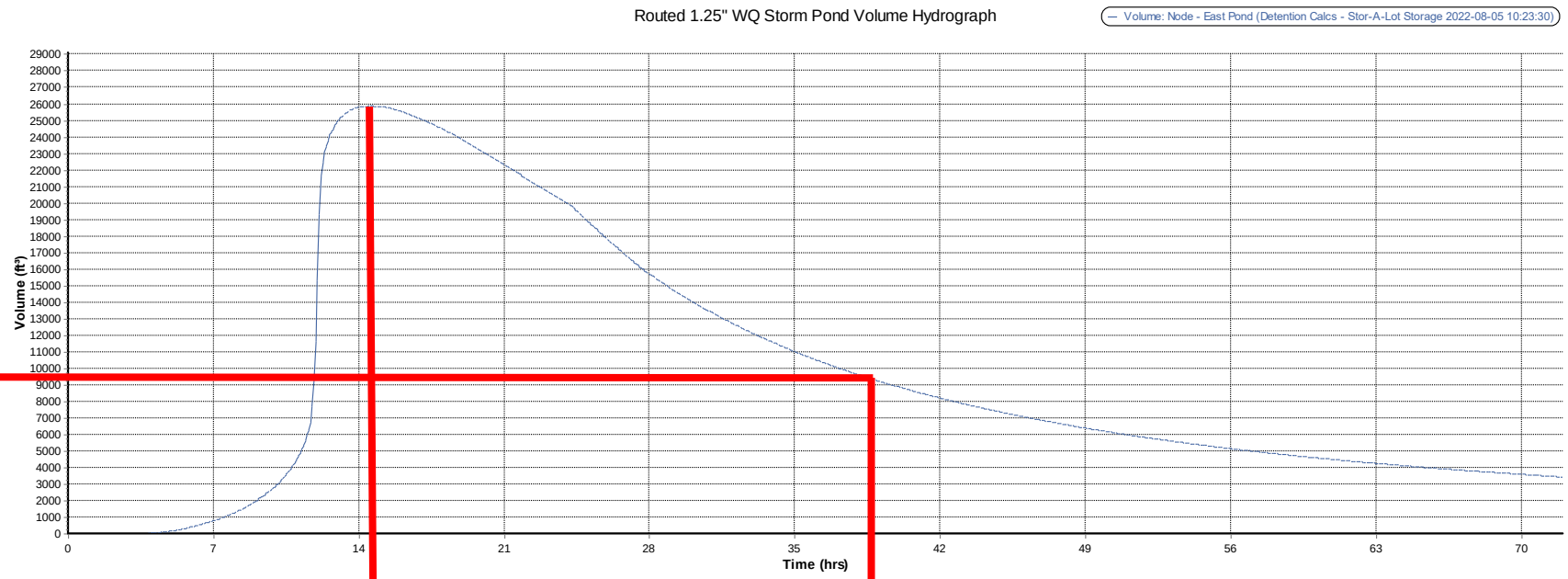
Element ID	Post-Developed Basin
Maximum Runoff (cfs)	76.63
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.78
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Runoff (ft^3)	203046.01
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

Routed 1.25” WQ Storm Runoff Hydrograph and Results



Element ID	Out-05
Maximum Total Inflow (cfs)	15.27
Minimum Total Inflow (cfs)	0.00
Event Mean Total Inflow (cfs)	0.14
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft³)	N/A
Volume of Deficit (ft³)	N/A
Total Inflow Volume (ft³)	37224.25
Detention Storage (ft³)	N/A
Exceedance	0
Deficit	0

Routed 1.25” WQ Storm Pond Volume Hydrograph and Results



Volume at Time to Peak + 24 hrs = 9,431 cu. Ft.

Time to Peak = 14.58 hrs

Time to Peak + 24 hrs = 38.58 hrs

Element ID	East Pond
Maximum Volume (ft³)	25878.64
Minimum Volume (ft³)	0.00
Event Mean Volume (ft³)	9588.63
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Exceedance	0
Deficit	0

Appendix C: Proposed Pond Data

Stor-A-Lot Storage						
Stage Storage Proposed Pond						
Contour Elevation	Contour Area (sq. ft.)	Depth (ft.)	Incremental Volume Avg. End (cu. Ft.)	Cumulative Volume Avg. End (cu. Ft.)	Incremental Volume Conic (cu. Ft.)	Cumulative Volume Conic (cu. Ft.)
743.75	37,969.10	N/A	N/A	0	N/A	0
744.75	41,098.16	1	39,533.63	39,533.63	39,523.30	39,523.30
745.75	44,327.75	1	42,712.96	82,246.58	42,702.78	82,226.08
746.75	74,657.88	1	45,992.81	128,239.40	45,982.76	128,208.85
747.75	51,088.53	1	49,373.20	177,612.60	49,363.27	177,572.11
748.75	54,619.72	1	52,854.12	230,466.73	52,844.29	230,416.41
749.75	58,251.43	1	56,435.58	286,902.30	56,425.83	286,842.24

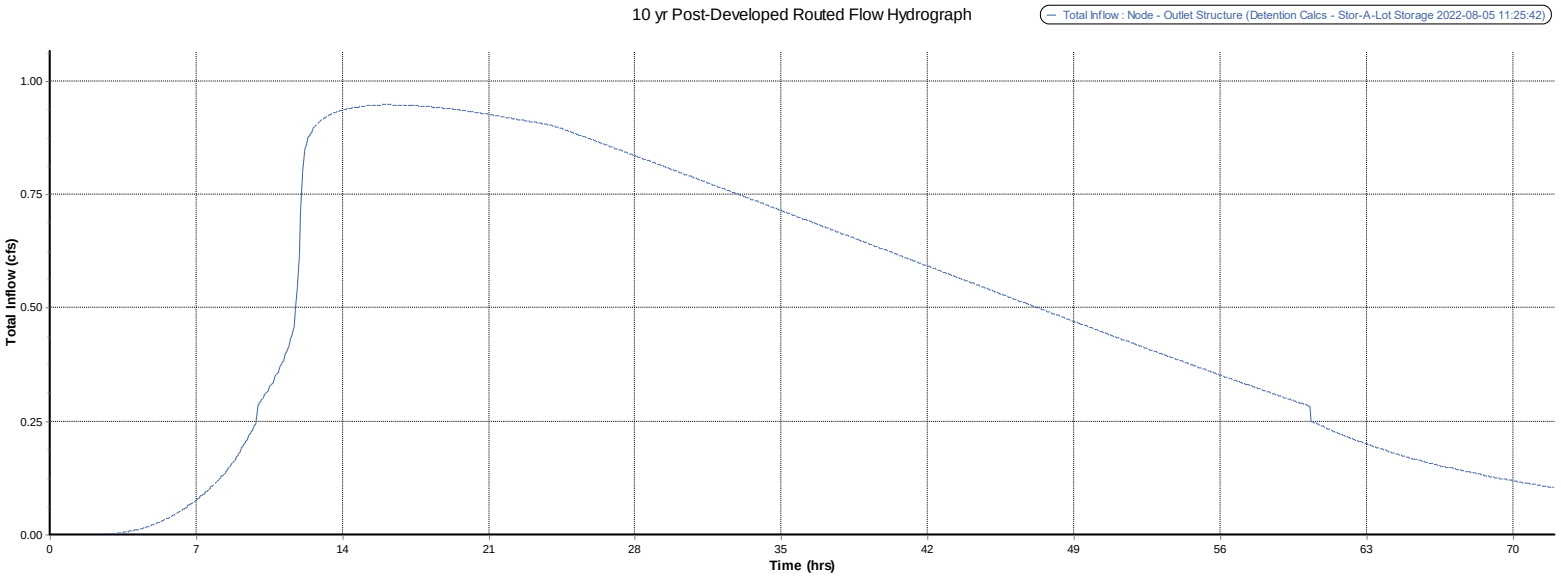
Storage Node Summary											
SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (ft)	Max (Rim) Elevation (ft)	Max (Rim) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Ponded Area ($ft^{2)}$	Evaporation Loss
1	East Pond	3267.19	4263.64		743.75	749.75	6.00	743.75	0.00	0.00	0.00

LINK INPUT SUMMARY																				
SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (inches)	Pipe Width (inches)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Outlet Pipe		Outlet Strucutre	Ex. Ditch	61.00	743.75	0.00	743.50	0.00	0.25	0.4100	CIRCULAR	18.000	18.00	0.0130	0.5000	0.5000	0.0000	0.00	NO

ORIFICE INPUT SUMMARY															
SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	From (Inlet) Node Invert Elevation (ft)	To (Outlet) Node Invert Elevation (ft)	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (inches)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Invert Offset (ft)	Orifice Coefficient
1	100yr		East Pond	Outlet Strucutre	743.75	743.75	SIDE	RECT_CLOSED	NO		1.00	2.00	746.19	2.44	0.6260
2	WQ & 10yr		East Pond	Outlet Strucutre	743.75	743.75	SIDE	CIRCULAR	NO	5.00			743.75	0.00	0.6140

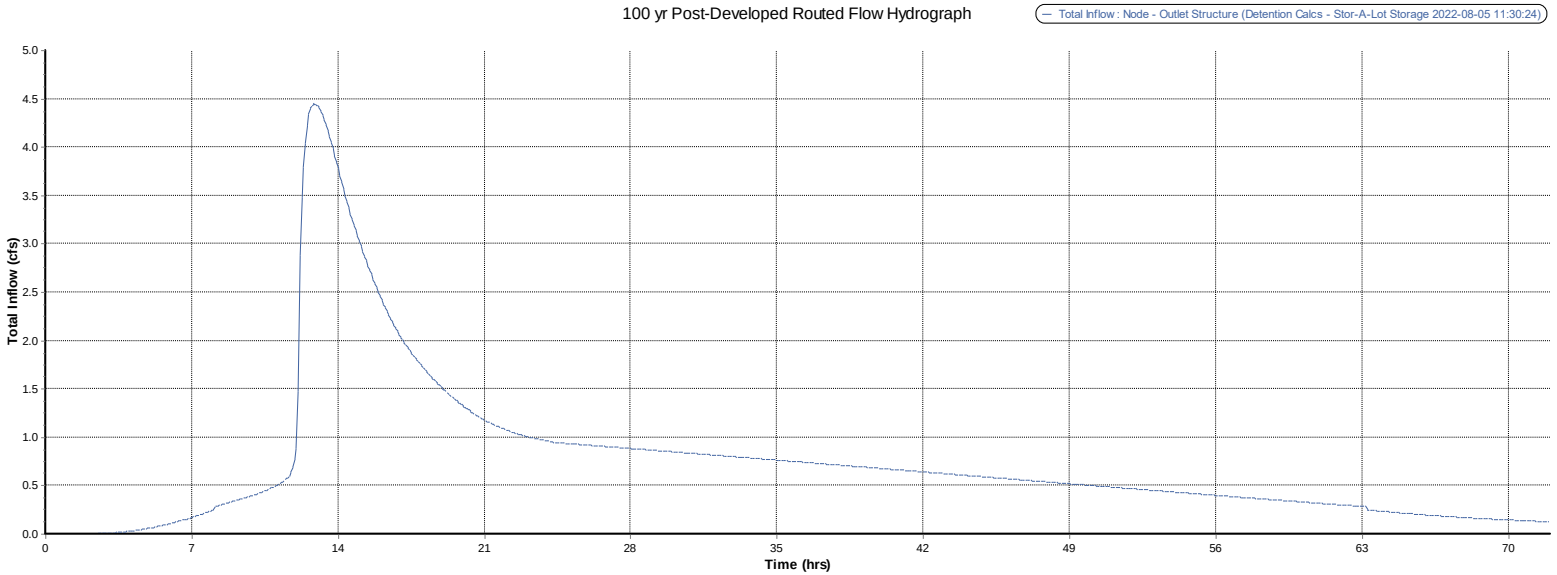
Junction Input Summary													
SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (inches)
1	Outlet Structure	4869.32	4240.97		743.75	747.75	4.00	0.00	743.75	747.75	0.00	0.00	0.00

10yr Post-Developed Routed Flow Hydrograph and Results



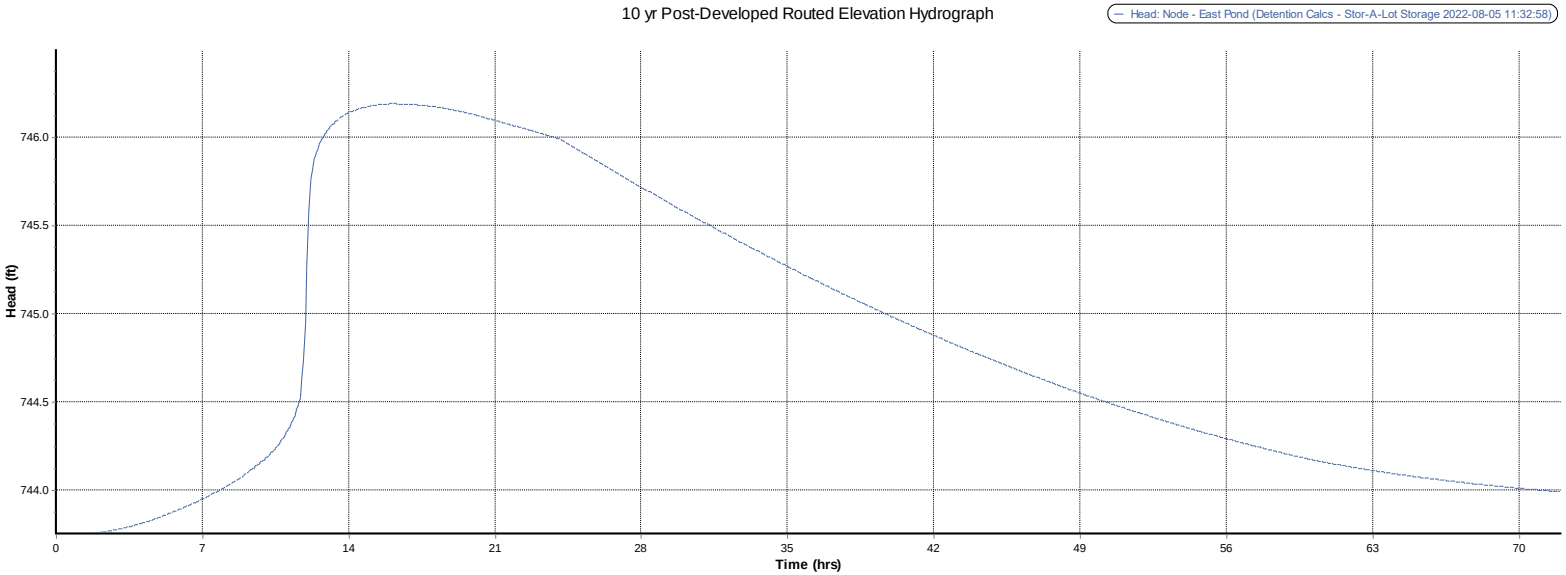
Element ID	Outlet Structure
Maximum Total Inflow (cfs)	**0.95**
Minimum Total Inflow (cfs)	0.00
Event Mean Total Inflow (cfs)	0.50
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Inflow Volume (ft^3)	129226.26
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

100yr Post-Developed Routed Flow Hydrograph and Results



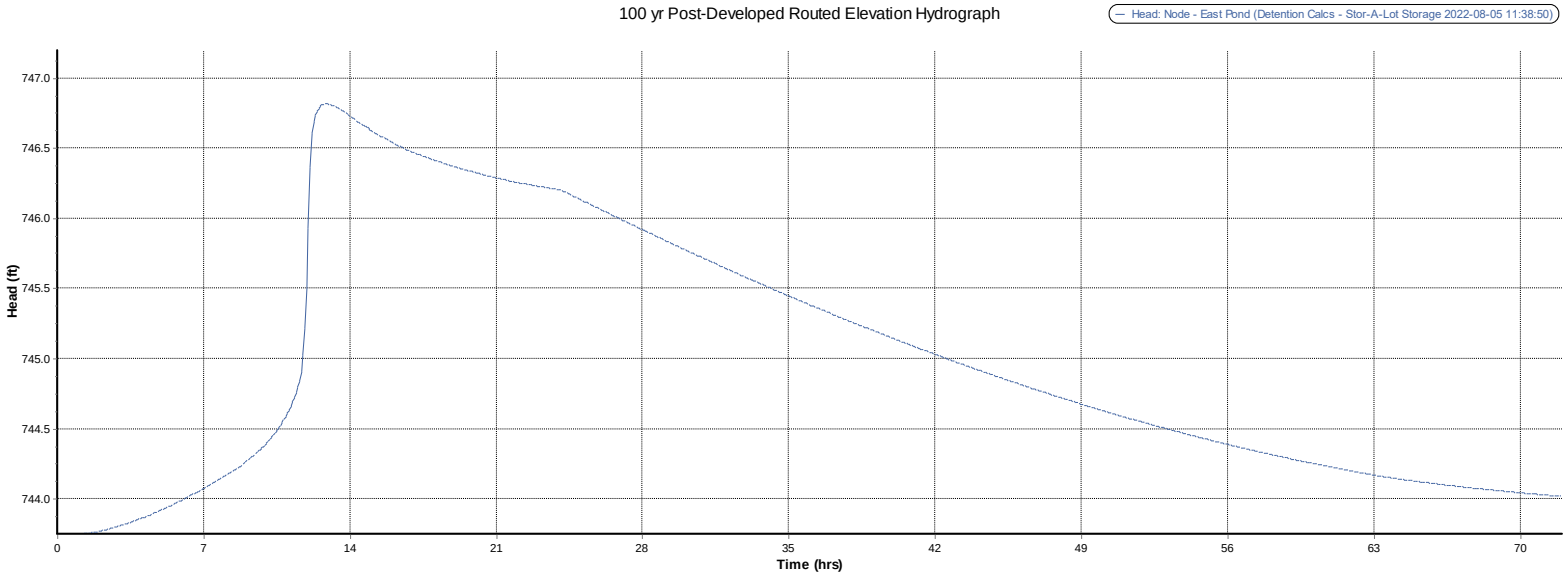
Element ID	Outlet Structure
Maximum Total Inflow (cfs)	**4.45**
Minimum Total Inflow (cfs)	0.00
Event Mean Total Inflow (cfs)	0.74
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Inflow Volume (ft^3)	192691.17
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

10yr Post-Developed Pond Routed Elevation Hydrograph and Results



Element ID	East Pond
Maximum Head (ft)	**746.19**
Minimum Head (ft)	743.75
Event Mean Head (ft)	745.69
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Exceedance	0
Deficit	0

100yr Post-Developed Pond Routed Elevation Hydrograph and Results



Element ID	East Pond
Maximum Head (ft)	**746.82**
Minimum Head (ft)	743.75
Event Mean Head (ft)	745.86
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Exceedance	0
Deficit	0