Stormwater Calculations

Johnson County Recycle Center
N. Graham Road
Franklin, Indiana

Submitted:
April 2, 2024

By:

CrossRoad Engineers, PC
115 N. 17th Ave.
Beech Grove, IN 46107
Phone No.: (317) 780-1555
Fax No.: (317) 780-6525
Email: info@crossroadengineers.com

Table of Contents

Section 1: Stormwater Calculations Summary

Pre-Development Conditions

The project site is located in Lot 1 of the Linville Minor Commercial Subdivision. This is on the west side of North Graham Road, north of the intersection with Linville Way in the City of Franklin, Johnson County, Indiana (see Exhibit 1 – Location and Vicinity Map). The existing site is a ±2.94-acre site consisting of pasture/agricultural field. By graphic platting, the project site lies withing Zone 'X', areas of 0.2% annual chance of flood of 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. 18081C0143E, dated January 29, 2021.

Under pre-developed conditions, runoff exits the site at two different outlet points. Runoff from the western half of the site drains to the west to the adjacent field. Runoff from the adjacent field eventually drains to Canary Ditch west of the site. Runoff from the eastern half of the site drains to the southeast corner of the site that is collected in the existing drive culvert. This culvert then conveys runoff south to the existing detention pond on the Animal Shelter property. Ultimately, this runoff is conveyed farther west in storm pipe before reaching Canary Ditch (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 drive culvert on the west side of Graham Road as it is anticipated that the entire property will drain east to this culvert in the post-developed conditions.

Post-Development Conditions

This project involves the construction of a ±10,000 sft. recycling center. All curbs, sidewalks, drives, and parking areas necessary for the development shall be constructed with the recycling center. All stormwater runoff shall be collected via a storm sewer network and directed towards the wet detention pond which will be constructed on the west 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 drive culvert on the west side of Graham Road. Runoff from the majority of the site will all drain into the proposed detention pond. The pond will then discharge into the existing drive culvert located on the west side of Graham Road. 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.

The proposed detention pond will also be designed to detain at least 20% of the runoff from either a 1.25" rainfall depth storm or 0.5" of direct runoff, whichever is greater, for 24 hours

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

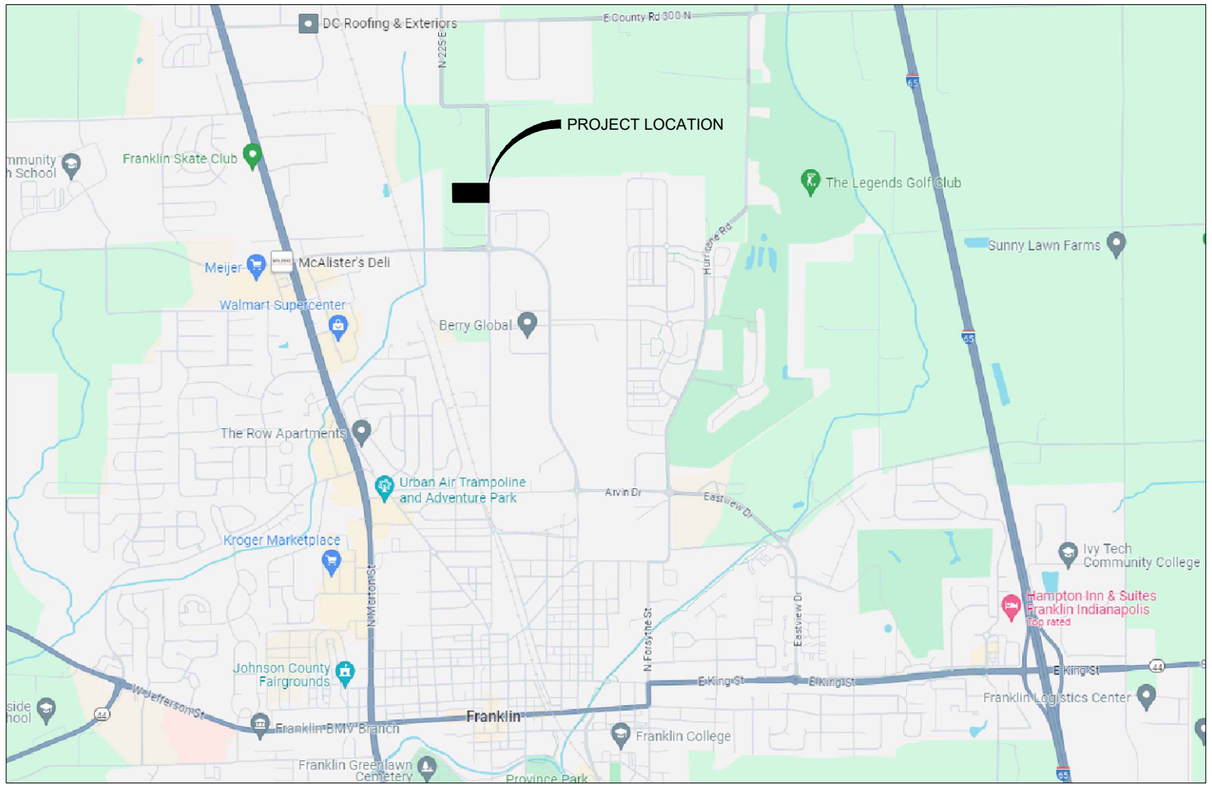
The proposed storm sewer network is designed to accommodate a 10-year storm event. The Rational Method was used to perform the storm sewer pipe sizing calculations. Structures and grates in the paved area were designed and placed so that the depth of ponding above the inlet does not exceed 6 inches with the inlet grate 50% plugged.

EXHIBIT 1 - LOCATION AND VICINITY MAPS

JOHNSON COUNTY RECYCLE CENTER
GRAHAM ROAD, FRANKLIN, IN

LOCATION MAP

NOT TO SCALE



VICINITY MAP

NOT TO SCALE

NORTH

PREPARED BY:

CROSSROAD ENGINEERS, PC

Transportation & Development Consultants

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

APRIL 2, 2024

EXHIBIT 2 - PRE-DEVELOPED WATERSHED MAP

JOHNSON COUNTY RECYCLE CENTER
GRAHAM ROAD, FRANKLIN, IN

NORTH

30 0 30 60

SCALE: 1" = 30'

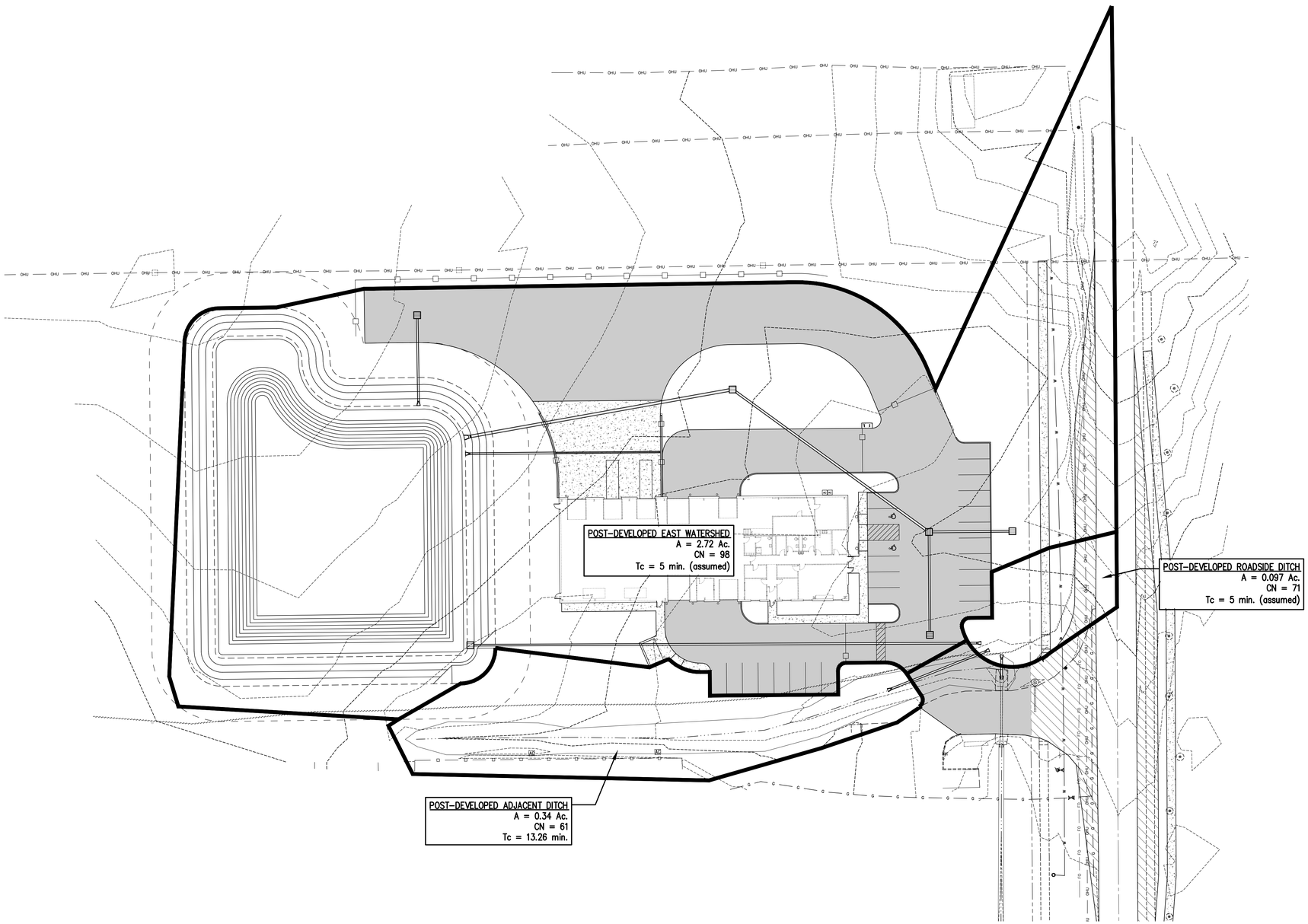
PREPARED BY:

CROSSROAD ENGINEERS, PC
Transportation & Development Consultants
115 N. 17th AVENUE, BEECH GROVE, IN 46107 (317) 780-1555

APRIL 2, 2024

EXHIBIT 3 - POST-DEVELOPED WATERSHED MAP

JOHNSON COUNTY RECYCLE CENTER
GRAHAM ROAD, FRANKLIN, IN



NORTH

30 0 30 60

SCALE: 1" = 30'

PREPARED BY:

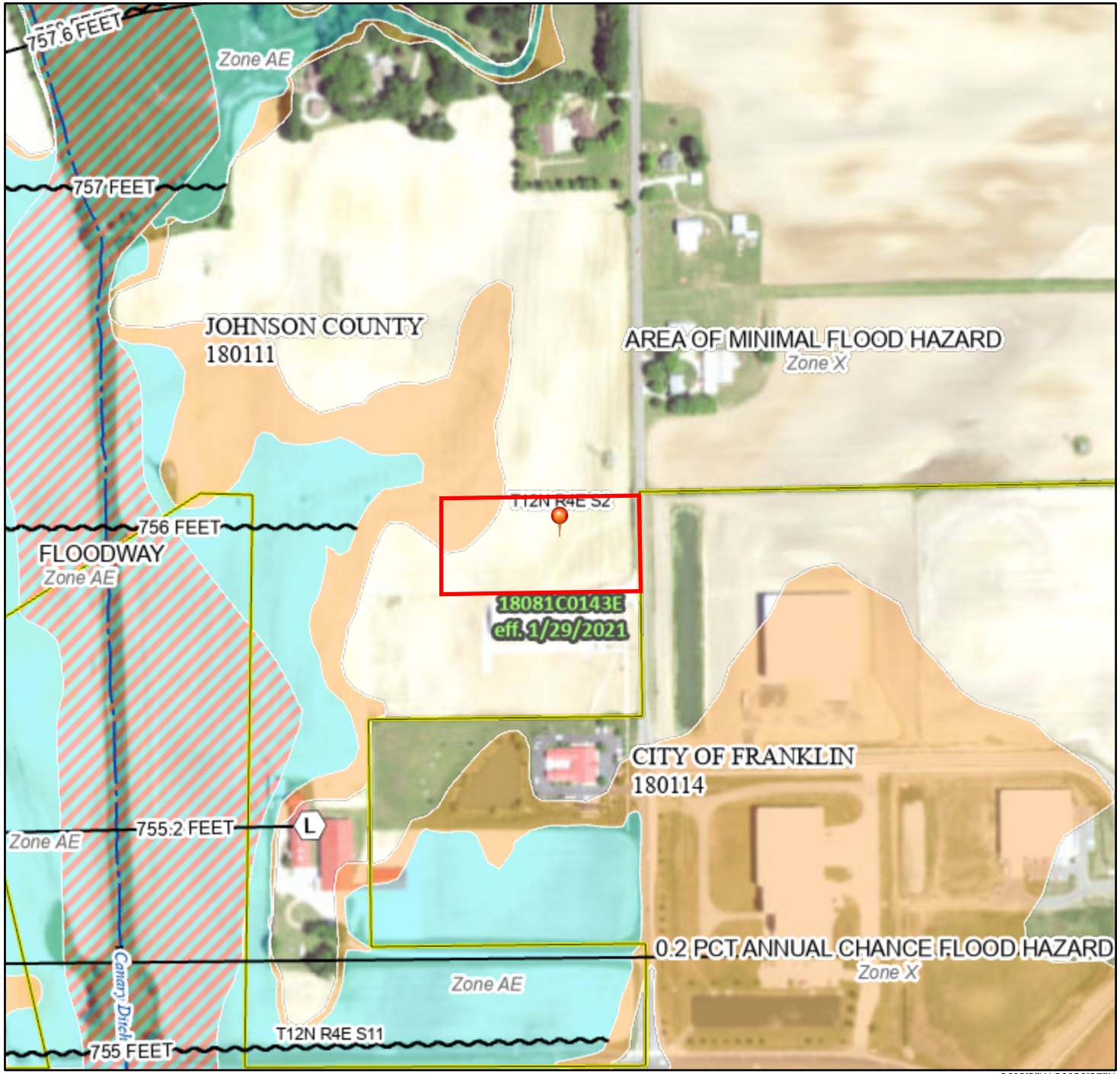
CROSSROAD ENGINEERS, PC
Transportation & Development Consultants
115 N. 17th AVENUE, BEECH GROVE, IN 46107 (317) 780-1555

APRIL 2, 2024

National Flood Hazard Layer FIRMette

FEMA

86°3'41"W 39°30'55"N



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

1:6,000

86°3'3"W 39°30'27"N

Basemap Imagery Source: USGS National Map 2023

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
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- 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 3/26/2024 at 11:37 AM 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.

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	0.1	
Fox complex, FxC2	1.5	
Miami silt loam, MnC2		0.5
Totals	1.6	0.5
Percentages of Hydrologic Groups	**76.19%**	**23.81%**

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*	***76.19%***	***Percentage Used****	***23.81%***			
Pasture/Open Space	61		74		64.10	2.1 ac.	**64**

*See Soil Hydrologic Group Percentage Calculations, Table 1.

Map Scale: 1:981 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 10 20 40 60

Feet
0 45 90 180 270

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 31, Sep 1, 2023

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

Date(s) aerial images were photographed: Jun 15, 2022—Jun 21, 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
Br	Brookston silty clay loam, 0 to 2 percent slopes	0.1	6.3%
FxC2	Fox complex, 6 to 12 percent slopes, eroded	1.5	71.8%
MnC2	Miami silt loam, 6 to 12 percent slopes, eroded	0.5	21.9%
Totals for Area of Interest		**2.1**	**100.0%**

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 accounting for areas that will not be collected by the pond as shown in Exhibit 3, the post-developed watershed basin consists of 2.72 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 east watershed as the allowable release rates will be determined based on the pre-developed east 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	**1.09 cfs**
10	**2.95 cfs**

Basin Allowable Discharge:

Allowable discharge for the critical 10-year post-development storm=
Pre-Development 2-year Peak = 1.09 cfs

Allowable discharge for the critical 100-year post-development storm=
Pre-Development 10-year Peak = 2.95 cfs

Post-Development Conditions

Tables 4-6 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. As shown in Exhibit 3, two smaller areas are excluded from this area that is collected by the detention pond. One area is a portion of the existing roadside ditch that will discharge directly into the existing drive culvert. The second area is part of a ditch that collects off-site runoff from the adjacent property to the south. These two areas have also been accounted for in determining the final allowable release rate. See Appendix 'B' for the post-development hydrographs and peak storm event analysis results.

Table 4
Post-Development Watershed Hydrograph Peak Runoff Rate Summary

Return Period (years)	Storm Duration
	24 Hours
10	**14.50 cfs**
100	**20.99 cfs**

Table 5
Post-Development Roadside Ditch Hydrograph Peak Runoff Rate Summary

Return Period (years)	Storm Duration
	24 Hours
10	**0.21 cfs**
100	**0.42 cfs**

Table 6
Post-Development Adjacent Ditch Hydrograph Peak Runoff Rate Summary

Return Period (years)	Storm Duration
	24 Hours
10	**0.33 cfs**
100	**0.79 cfs**

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 = 10,191.06 ft^3 = 0.234 ac.-ft.

Volume of Runoff from 0.5" Direct Runoff,

V_2 = 2.72 ac. * (0.5"/12) = 0.113 ac.-ft.

Water Quality Volume, WQ_v = 20% * V_1 = 0.2 * 0.234 ac.-ft. = **0.047 ac.-ft. → 2,038 ft^3**

At a time of 24 hours after the peak runoff rate of the inflow hydrograph, the detention pond must have at least 0.047 ac.-ft. or 2,038 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 5.00" 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 7
Water Quality Volume Summary

	Proposed Pond
Time to Peak	13.92 hours
Time of 24 hours Past Peak Runoff	37.92 hours
Storage Volume at Time of 24 hours Past Peak Runoff	2,642 ft^3

Total Storage Volume at Time of 24 hours Past Peak Runoff = **2,642 ft^3 > 2,038 ft^3** (WQ_v)

The storage volume 24 hours after peak runoff is greater than the required water quality volume due to using a water quality orifice of 5.00".

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 = **1.09 cfs**

Allowable discharge for the critical 100-year post-development storm=
Pre-Development 10-year Peak = **2.95 cfs**

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

Post-Development Watershed
Q_{10} = 14.50 cfs
Q_{100} = 20.99 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 5.00" diameter orifice to meet the detention and allowable discharge requirements for the water quality and 10-year critical storm events. One (1) 4" (H) x 18" (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 drive culvert on the west side of Graham Road via a 12" diameter outlet pipe leaving the control structure.

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

Peak 10 Year Post-Development Pond Discharge Rate = **0.54 cfs**
Peak Water Surface Elev. = **758.31** < 758.66 (top of emergency spillway)
Total 10 Year Post-Development Discharge Rate = **1.08 cfs** < 1.09 cfs (allowable)

Peak 100 Year Post-Development Pond Discharge Rate = **1.59 cfs**
Peak Water Surface Elev. = **758.66** < 758.66 (top of emergency spillway)
Total 100 Year Post-Development Discharge Rate = **2.80 cfs** < 2.95 cfs (allowable)

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 = 20.99 cfs
1.25 x Q_{100} Inflow= 26.24 cfs
Length of Weir = 20 ft.
Top of Detention Basin Elevation = 761.25
Spillway Crest Elevation = 758.66
Water Surface Elevation = 759.20
Freeboard = 761.25 – 759.20 = 2.05 ft.

$H = [(1.25*Q100) / (3.3*L)]^{2/3} = [26.24 / (3.3*20)]^{2/3} =$ **0.54'**

The head needed to convey the required flowrate is **0.54'**. The corresponding elevation is **759.20'**, which still allows for **2.05'** of freeboard above the high-water elevation through the emergency spillway.

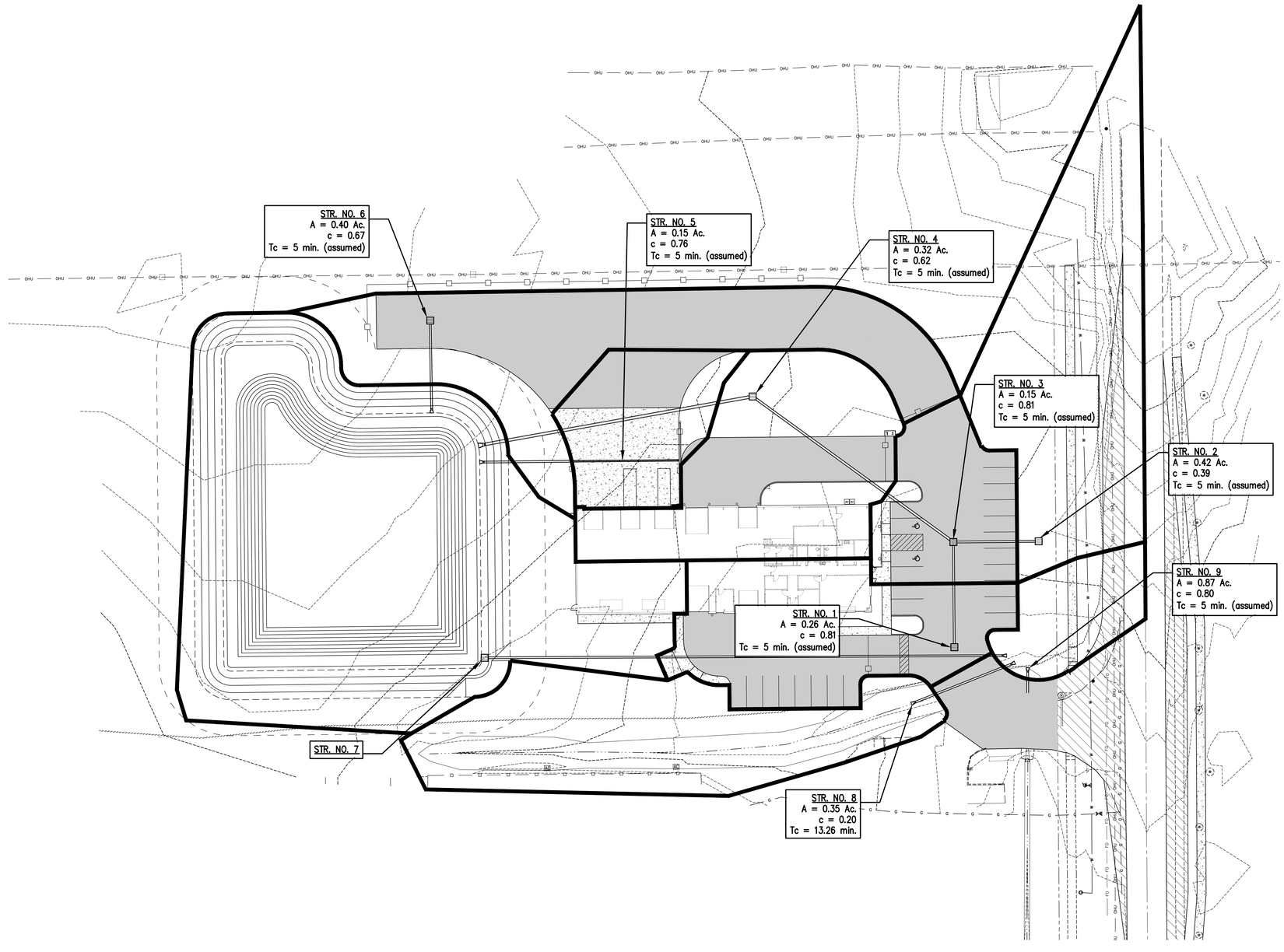
Section 5: Storm Sewer Sizing Calculations

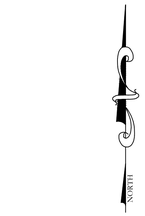
Storm Sewer Sizing Summary

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 in the pavement area. Pipe sizing calculations and the inlet basin map are included within this section.

EXHIBIT 4 - INLET WATERSHED MAP

JOHNSON COUNTY RECYCLE CENTER
GRAHAM ROAD, FRANKLIN, IN





30 0 30 60

SCALE: 1" = 30'

PREPARED BY:

CROSSROAD ENGINEERS, PC
Transportation & Development Consultants
115 N. 17th AVENUE, BEECH GROVE, IN 46107 (317) 780-1555

APRIL 2, 2024

Johnson County Recycle Center
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. 3	59	12	RCP	0.25	0.013	0.06	0.90	0.02	0.20	0.19	0.85	0.26	0.81	5.00	7.21	--	1.55	0.26	0.81	N/A	5.00	7.21	1.55	1.90	2.55	81.53%
Str. 2	Str. 3	48	12	RCP	0.25	0.013	0.00	0.90	0.30	0.20	0.12	0.85	0.42	0.39	5.00	7.21	--	1.19	0.42	0.39	N/A	5.00	7.21	1.19	1.90	2.55	62.69%
Str. 3	Str. 4	138	15	RCP	0.35	0.013	0.00	0.90	0.01	0.20	0.14	0.85	0.15	0.81	5.00	7.21	--	0.89	0.84	0.60	0.39	5.39	7.08	3.56	4.07	3.50	87.57%
Str. 4	Pond	155	18	RCP	0.25	0.013	0.12	0.90	0.12	0.20	0.08	0.85	0.32	0.62	5.00	7.21	--	1.41	1.15	0.61	0.66	6.04	6.87	4.80	5.60	3.34	85.74%
Str. 5	Pond	51	12	RCP	0.29	0.013	0.00	0.90	0.02	0.20	0.13	0.85	0.15	0.76	5.00	7.21	--	0.81	0.15	0.76	N/A	5.00	7.21	0.81	2.01	2.70	40.53%
Str. 6	Pond	52	12	RCP	0.35	0.013	0.00	0.90	0.11	0.20	0.29	0.85	0.40	0.67	5.00	7.21	--	1.92	0.40	0.67	N/A	5.00	7.21	1.92	2.25	3.02	85.29%
Str. 7	OUT	291	12	RCP	0.29	0.013	--	0.90	--	0.20	--	0.85	--	--	--	--	--	--	--	--	--	--	--	1.65	2.09	2.70	78.95%
Str. 8	OUT	62	12	RCP	1.84	0.013	--	0.90	0.35	0.20	--	0.85	0.35	0.20	13.26	4.91	--	0.34	0.35	0.20	N/A	13.26	4.91	0.34	9.57	5.71	3.56%

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 in swales/yard inlets and six (6) inches in paved areas.

Castings located in the drive isles are Neenah R-3405-A. Castings located in grassed areas are Neenah R-4215-C. The perimeter and open area of each inlet grate are as follows:

- R-3405-A → Perimeter = 8 ft. and Open Area = 1.3 $ft.^2$
- 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-3405-A	1.55 cfs	0.50’	2.25 cfs
2	R-4215-C	1.19 cfs	0.50’	5.71 cfs
3	R-3405-A	0.89 cfs	0.50’	2.25 cfs
4	R-4215-C	1.41 cfs	0.50’	5.71 cfs
6	R-3405-A	1.92 cfs	0.50’	2.25 cfs

Sag Inlet Capacity Worksheet **Project:** Jo.Co. Recycle Center **Computed By:** BTV **Date:** 4/2/2024

Inlet Casting Information					
Type	Width (ft)	Length (ft)	P (ft)	A (sq. ft.)	Depression (in)
R-4215-C	2.83	2.83	11.3	3.3	N/A
R-3405-A	1.99	1.99	8.0	1.3	N/A

Inlet Grate Design Parameters		
Type	Max. Spread (ft)	Max. Ponding Depth (ft)
Sag Inlet	N/A	0.50

YARD INLETS

Structure	Casting Type	10-yr Inlet Watershed Flow	50% Wetted Perimeter (ft.)	50% Open Area (sq. ft.)	Max. Allowable Ponding (ft)	Max. Allowable Flow w/50% Clogged (cfs)	10-yr Actual Ponding (Weir Equ)	10-yr Actual Ponding (Orifice Equ)	Check Casting
1	R-3405-A	1.55	4.00	0.65	0.50	2.25	0.26	0.24	ok
2	R-4215-C	1.19	5.65	1.65	0.50	5.71	0.17	0.02	ok
3	R-3405-A	0.89	4.00	0.65	0.50	2.25	0.18	0.08	ok
4	R-4215-C	1.41	5.65	1.65	0.50	5.71	0.19	0.03	ok
6	R-3405-A	1.92	4.00	0.65	0.50	2.25	0.29	0.36	ok

Appendix A: Pre-Development Runoff Data

SUB-BASIN INPUT SUMMARY TABLE								
SN	Element ID	Description	Area (acres)	Drainage Node ID	Weighted Curve Number	Time of Concentration (days hh:mm:ss)	Rain Gage ID	Peak Rate Factor
1	Post-Dev Basin		2.72	West Pond	98.00	0 00:05:00		484
2	Post-Dev Roadside Ditch		0.10	Drive Culvert	70.81	0 00:05:00		484
3	Post-Dev Adjacent Ditch		0.35	Drive Culvert	61.00	0 00:13:16		484
4	Pre-Dev East Basin		2.11	Ex Culvert	64.00	0 00:06:37		484

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Johnson County Recycle Center

Designer: BTV **Date:** 2-Apr-24

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	41.72	ft.		12.00	ft.		0.00	ft.
4.	Two-yr 24-hr Rainfall, (P2)	2.92	in.		2.92	in.		2.92	in.
5.	Land Slope, (s)	0.0710	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])	0.057	hr	+	0.004	hr	+	0.000	hr

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	unpaved			paved			unpaved	
8.	Flow Length, (L)	339.40	ft.		100.00	ft.			ft.
9.	Watercourse Slope, (s)	0.0230	ft./ft.		0.0230	ft./ft.		0.0102	ft./ft.
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	2.447	ft./s		2.447	ft./s		1.630	ft./s
11.	Travel Time, (Tt) (Tt = L/3600V)	0.039	hr	+	0.011	hr	+	0.000	hr

Watershed or Subarea Tc or Tt =

0.110 hr

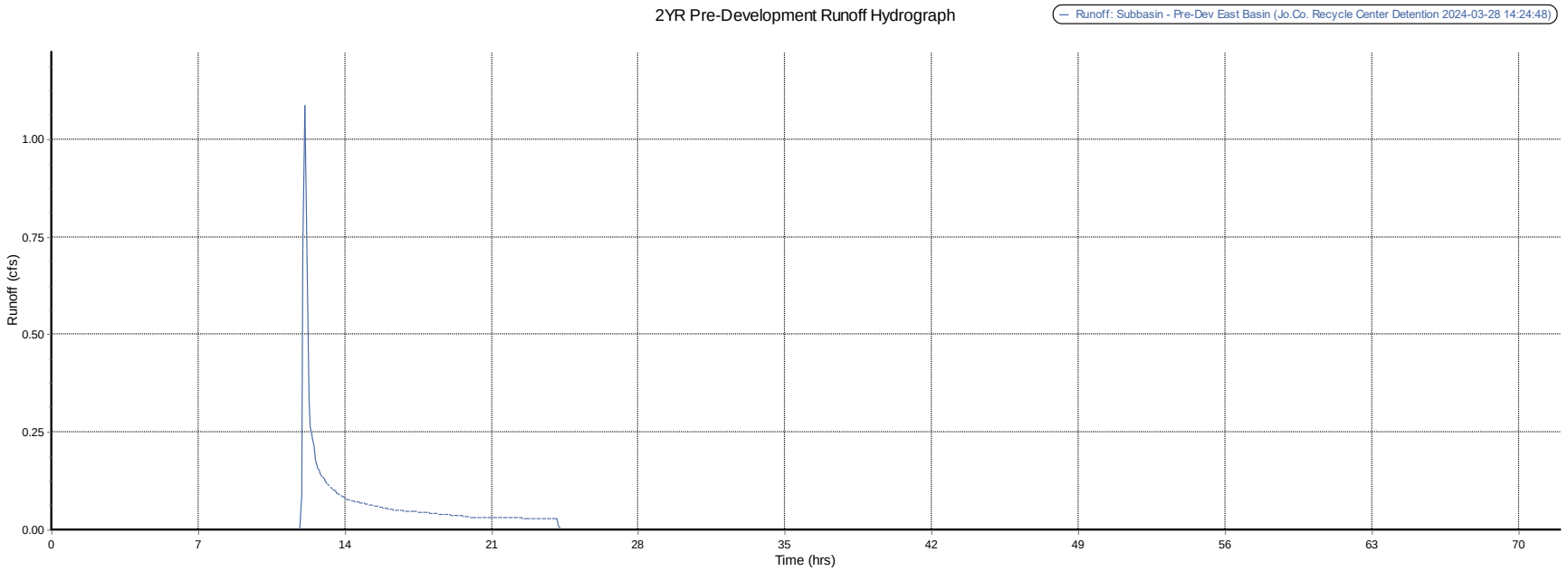
or

6.62 min

Channel Flow

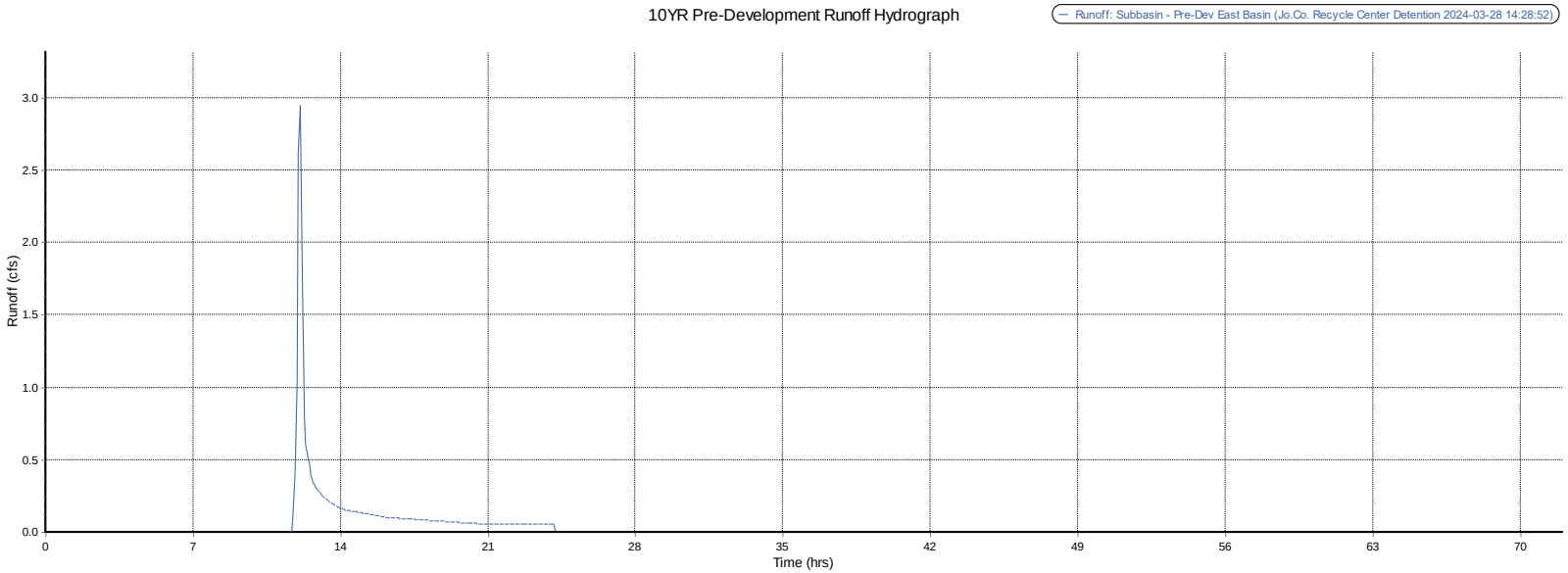
12.	Cross Sectional Flow Area, (a)	0.32	ft.^2		7.07	ft.^2		20.20	ft.^2
13.	Wetted Perimeter, Pw	1.68	ft.		4.71	ft.		18.20	ft.
14.	Hydraulic Radius, (r) (r = a/Pw)	0.189	ft.		1.501	ft.		1.110	ft.
15.	Channel Slope, (s)	0.0038	ft./ft.		0.0120	ft./ft.		0.0050	ft./ft.
16.	Manning's Roughness Coeff., (n)	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-Dev East Basin
Maximum Runoff (cfs)	**1.09**
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.01
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)	3288.66
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

10yr Pre-Development Basin Runoff Hydrograph and Results



Element ID	Pre-Dev East Basin
Maximum Runoff (cfs)	**2.95**
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.03
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)	7779.29
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

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

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Johnson County Recycle Center

Designer: BTV **Date:** 2-Apr-24

Str. No.: Str. 8/Adjacent Ditch

Sheet Flow

1.	Surface Description	pavement			pavement			grass	
2.	Manning's Roughness Coeff., (n)	0.011			0.011			0.170	
3.	Flow Length, (L) **total L<= 300 ft	0.00	ft.		0.00	ft.		78.34	ft.
4.	Two-yr 24-hr Rainfall, (P2)	2.92	in.		2.92	in.		2.92	in.
5.	Land Slope, (s)	0.0050	ft./ft.		0.0050	ft./ft.		0.0320	ft./ft.
6.	Travel Time, (Tt) (Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])	0.000	hr	+	0.000	hr	+	0.129	hr

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	paved			unpaved			unpaved	
8.	Flow Length, (L)		ft.		175.46	ft.			ft.
9.	Watercourse Slope, (s)	0.0050	ft./ft.		0.0084	ft./ft.		0.0050	ft./ft.
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	1.437	ft./s		1.479	ft./s		1.141	ft./s
11.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr	+	0.033	hr	+	0.000	hr

Watershed or Subarea Tc or Tt =

0.221 hr

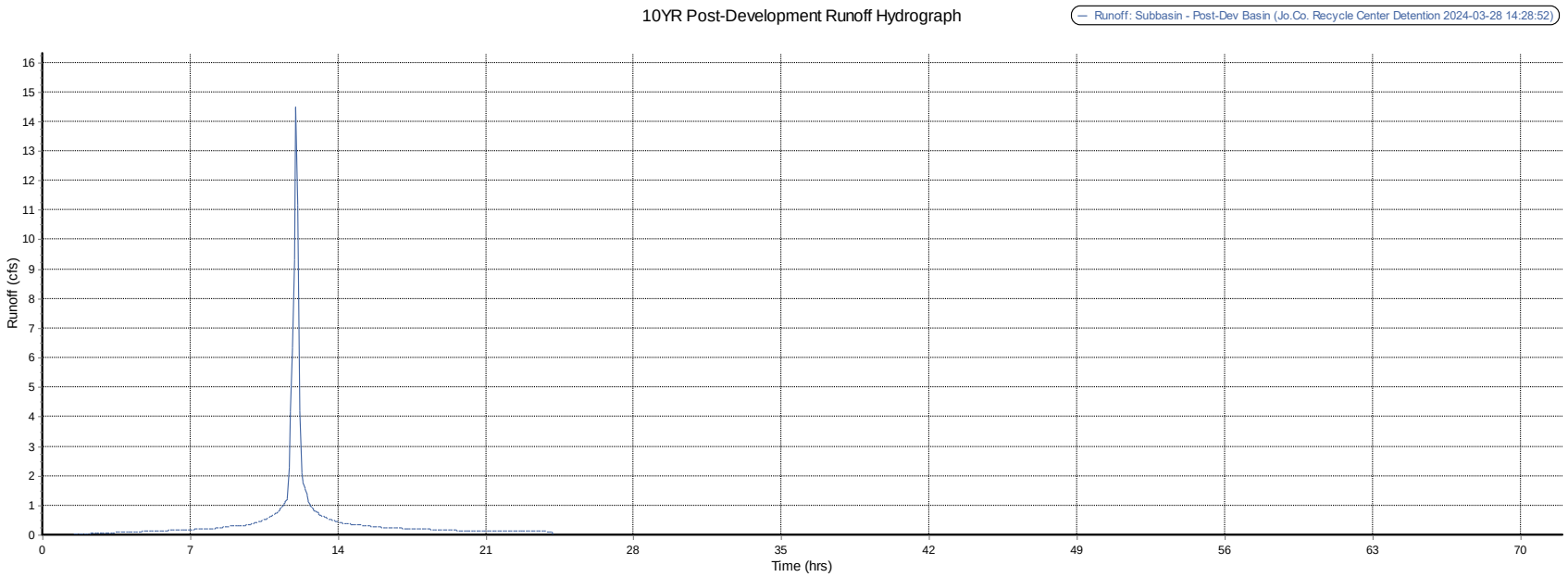
or

13.26 min

Channel Flow

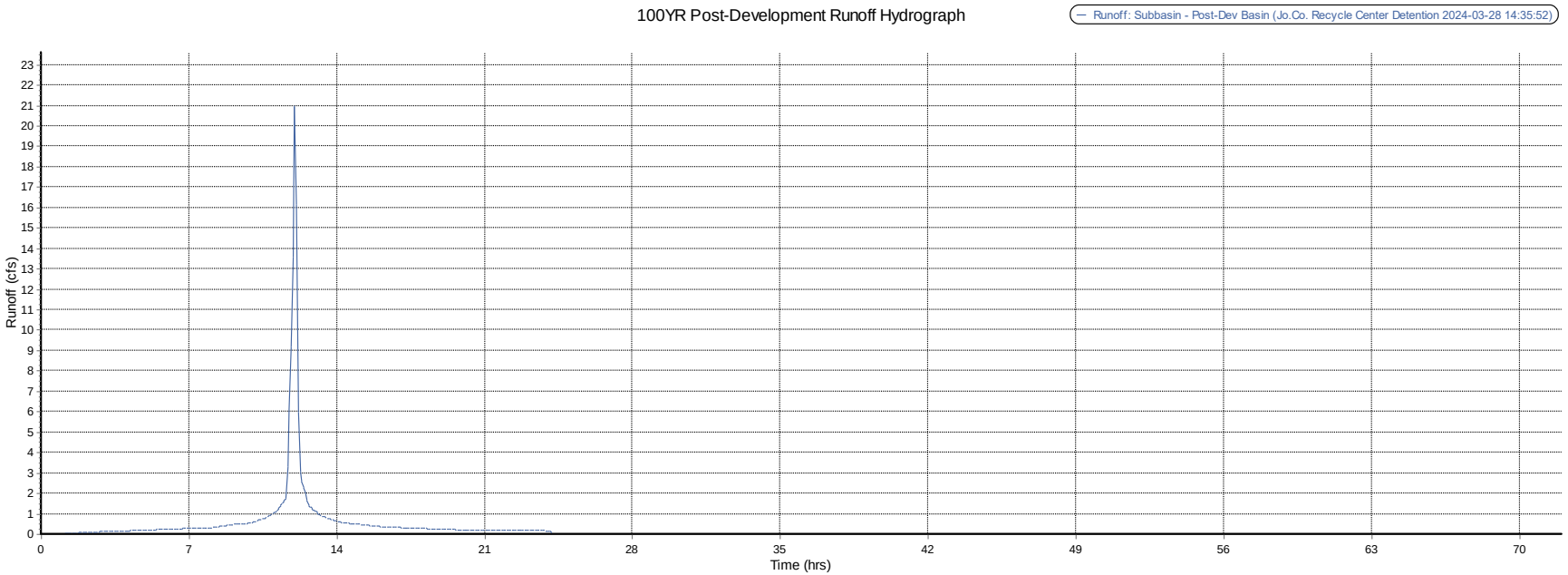
12.	Cross Sectional Flow Area, (a)	0.32	ft.^2		7.07	ft.^2		20.20	ft.^2
13.	Wetted Perimeter, Pw	1.68	ft.		4.71	ft.		18.20	ft.
14.	Hydraulic Radius, (r) (r = a/Pw)	0.189	ft.		1.501	ft.		1.110	ft.
15.	Channel Slope, (s)	0.0072	ft./ft.		0.0072	ft./ft.		0.0050	ft./ft.
16.	Manning's Roughness Coeff., (n)	0.170			0.170			0.060	
17.	Velocity, (V) (V = [1.49*r^0.67*s^0.5]/n)	0.243	ft./s		0.976	ft./s		1.883	ft./s
18.	Flow Length, (L)		ft.		208.00	ft.		0.00	ft.
19.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr	+	0.059	hr	+	0.000	hr

10yr Post-Development Basin Runoff Hydrograph and Results



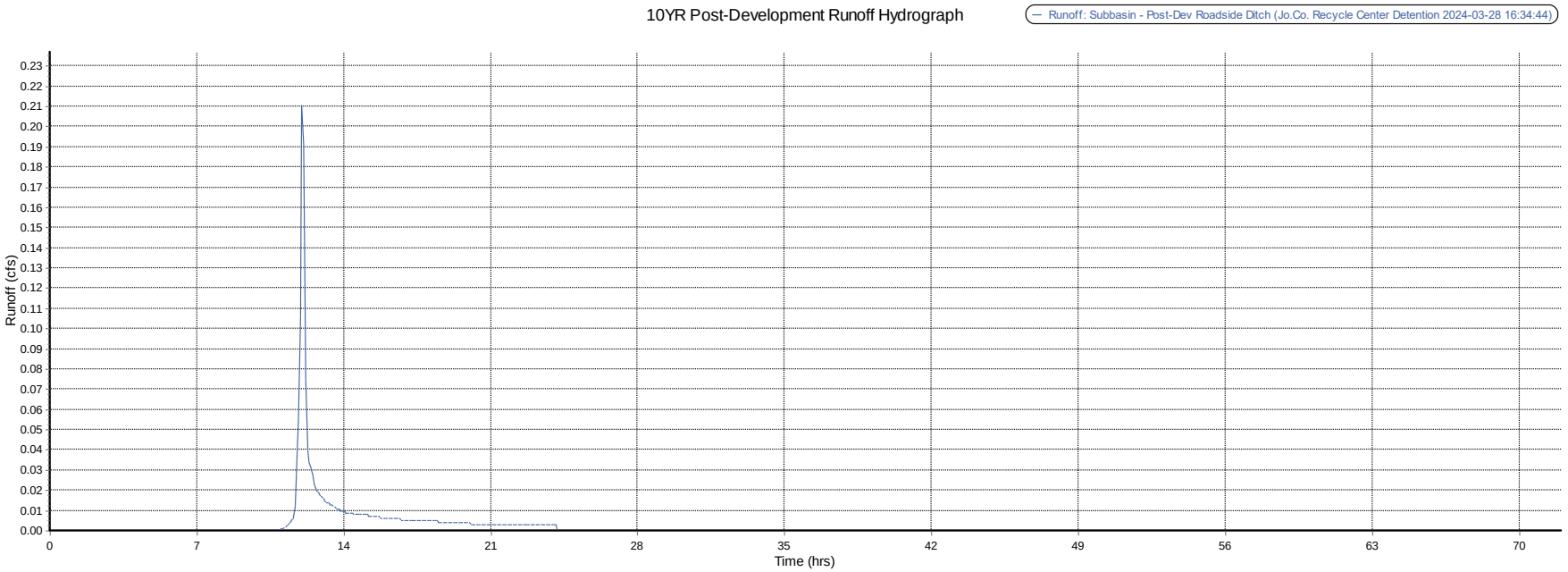
Element ID	Post-Dev Basin
Maximum Runoff (cfs)	**14.50**
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.15
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Runoff (ft^3)	37907.55
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

100yr Post-Development Basin Runoff Hydrograph and Results



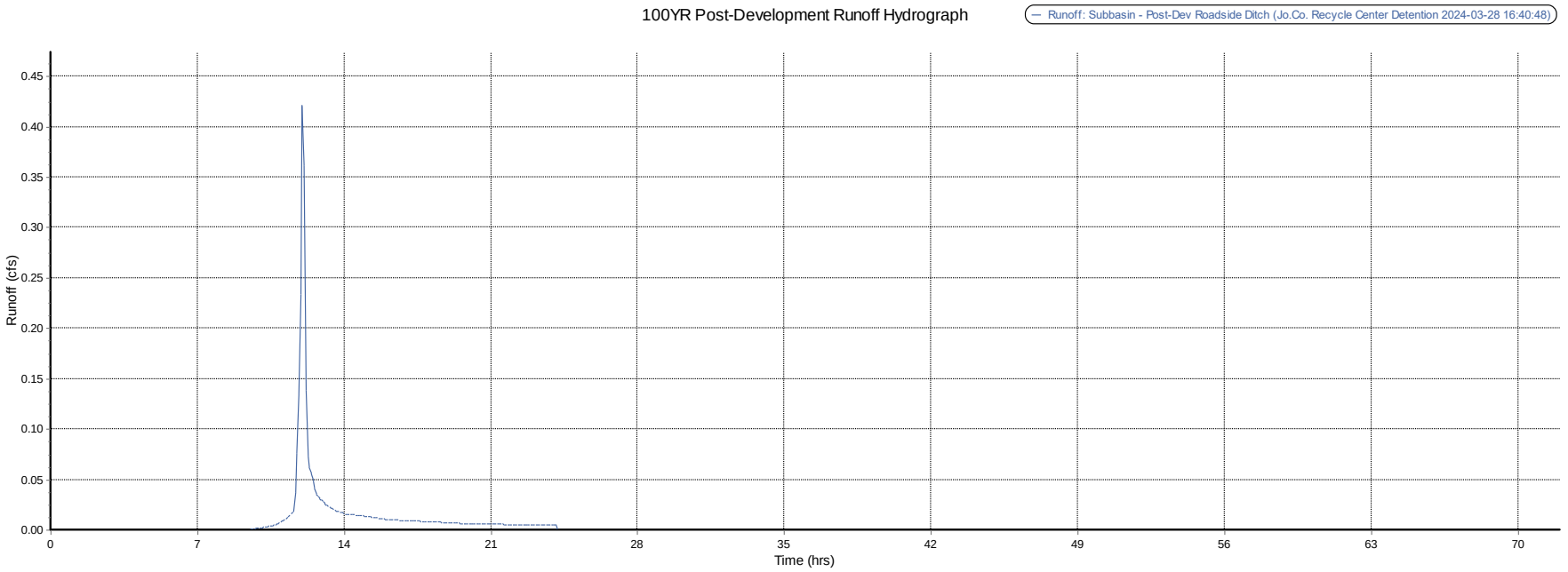
Element ID	Post-Dev Basin
Maximum Runoff (cfs)	**20.99**
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.21
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Runoff (ft^3)	55635.83
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

10yr Post-Development Roadside Ditch Runoff Hydrograph and Results



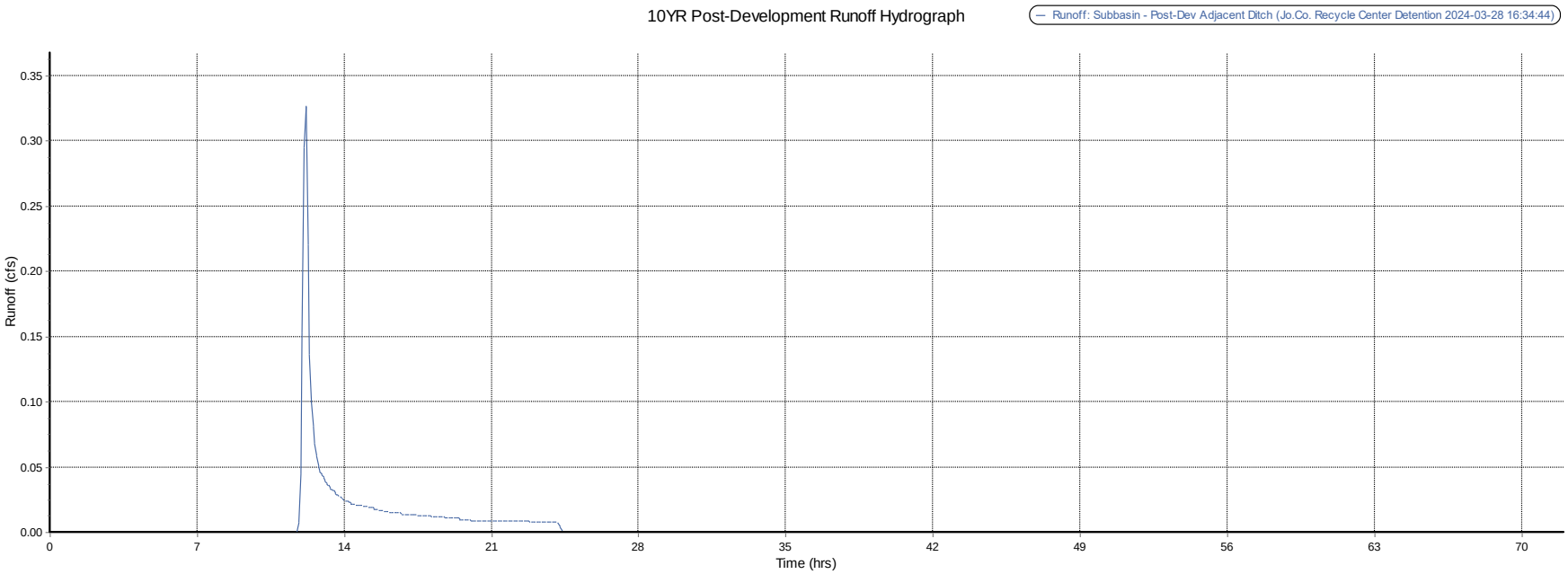
Element ID	Post-Dev Roadside Ditch
Maximum Runoff (cfs)	**0.21**
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.00
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Runoff (ft^3)	495.33
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

100yr Post-Development Roadside Ditch Runoff Hydrograph and Results



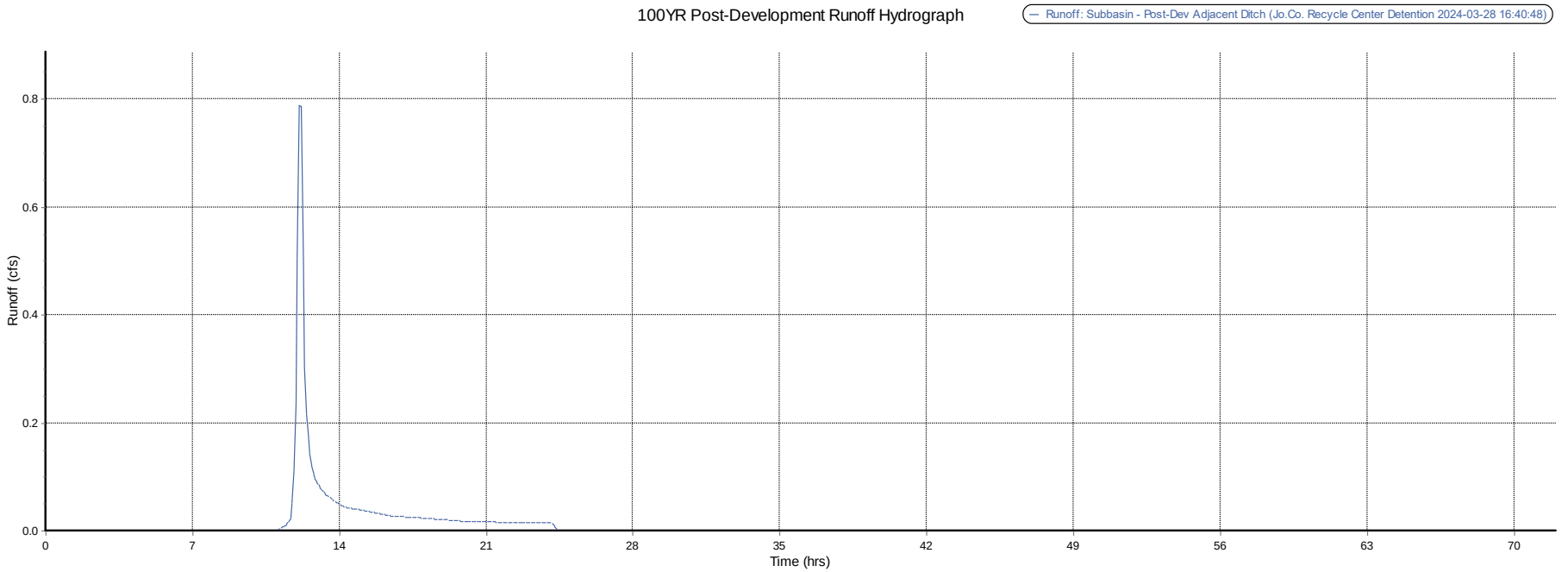
Element ID	Post-Dev Roadside Ditch
Maximum Runoff (cfs)	**0.42**
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.00
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Runoff (ft^3)	966.81
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

10yr Post-Development Adjacent Ditch Runoff Hydrograph and Results



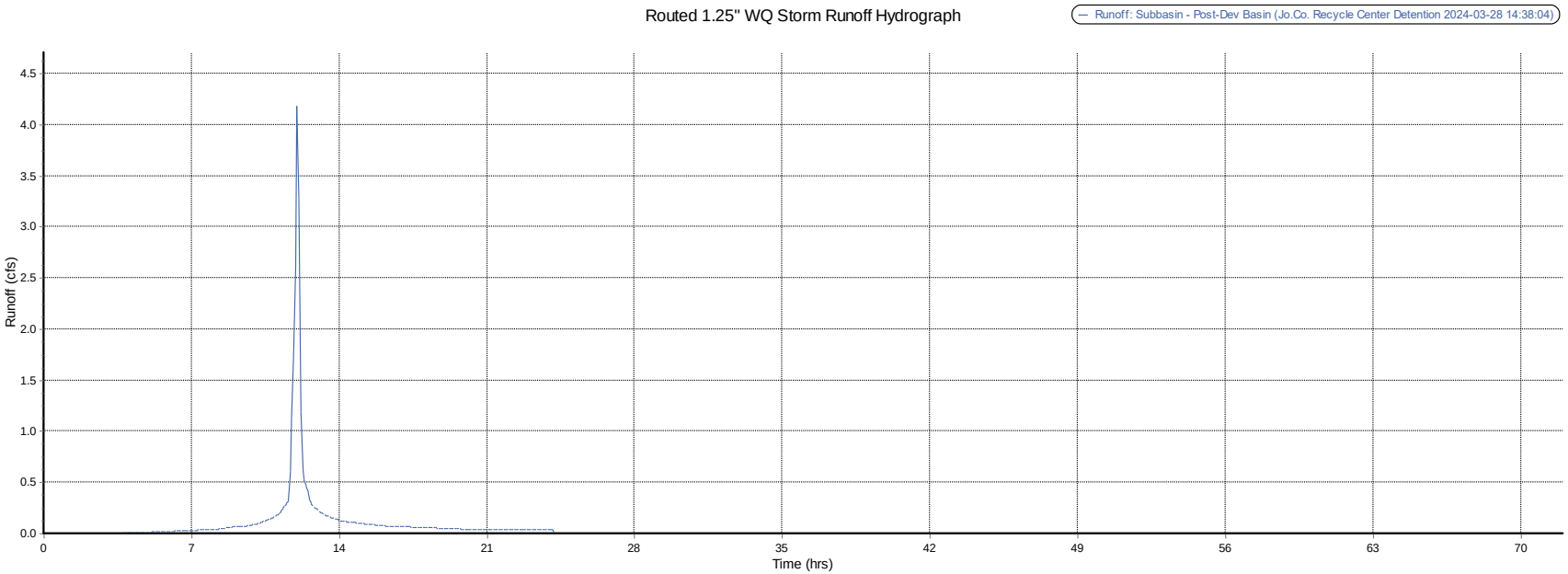
Element ID	Post-Dev Adjacent Ditch
Maximum Runoff (cfs)	**0.33**
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.00
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Runoff (ft^3)	1070.12
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

100yr Post-Development Adjacent Ditch Runoff Hydrograph and Results



Element ID	Post-Dev Adjacent Ditch
Maximum Runoff (cfs)	**0.79**
Minimum Runoff (cfs)	0.00
Event Mean Runoff (cfs)	0.01
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)	2417.23
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

Routed 1.25” WQ Storm Runoff Hydrograph and Results



Element ID	Post-Dev Basin
Maximum Runoff (cfs)	4.18
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)	**10191.06**
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

Routed 1.25” WQ Storm Pond Volume Hydrograph and Results

Volume at Time to Peak + 24 hrs = 2,642 cu. Ft.

Time to Peak = 13.92 hrs

Time to Peak + 24 hrs = 37.92 hrs

Element ID	West Pond
Maximum Volume (ft³)	6923.94
Minimum Volume (ft³)	0.00
Event Mean Volume (ft³)	2593.77
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

Johnson County Recycle Center						
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.)
757.25	22,477.77	N/A	N/A	0	N/A	0
758.25	25,004.05	1	23,740.91	23,740.91	23,729.70	23,729.70
759.25	27,523.95	1	26,264.00	50,004.91	26,253.92	49,983.62
760.25	30,109.11	1	28,816.53	78,821.44	28,806.86	78,790.49
761.25	33,186.07	1	31,647.59	110,469.03	31,635.12	110,425.60

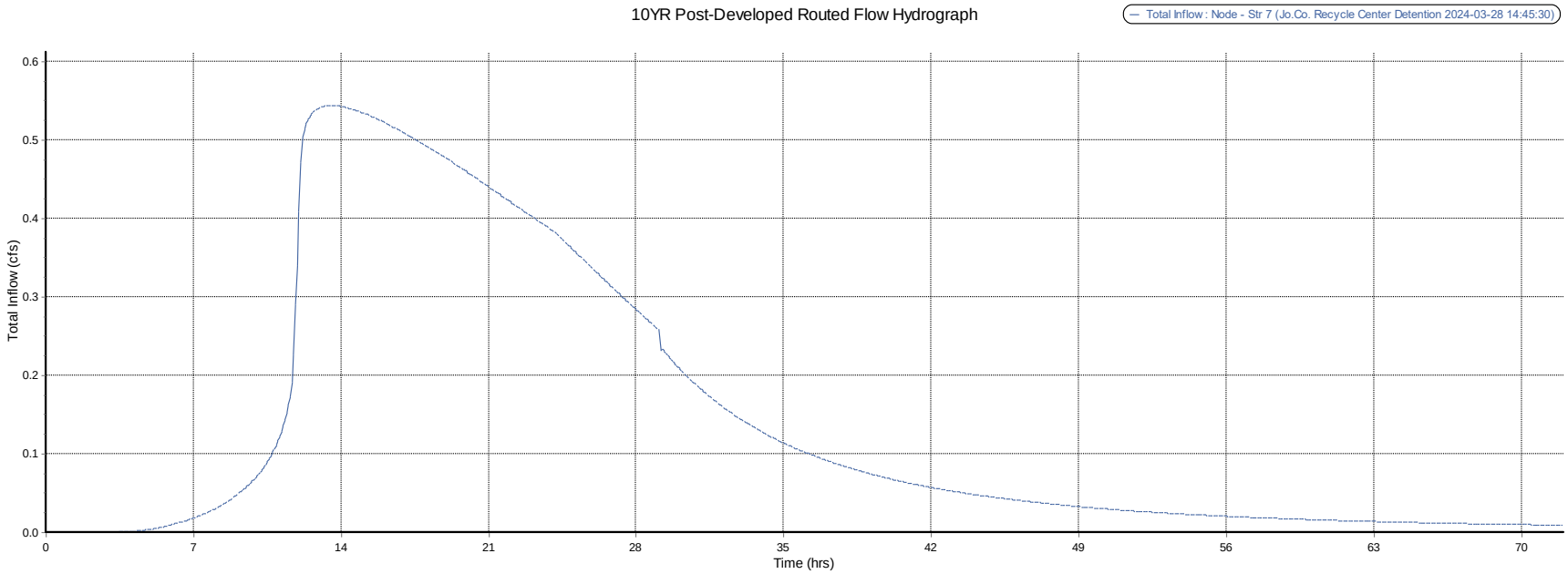
STORAGE NODE INPUT SUMMARY TABLE											
SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (ft)	Max (Rim) Elevation (ft)	Max (Rim) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Ponded Area (ft^2)	Evaporation Loss
1	West Pond	9618.07	4594.80		757.25	761.25	4.00	757.25	0.00	0.00	0.00

PIPE INPUT SUMMARY TABLE																			
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		Str 7	Drive Culvert	291.00	757.25	0.00	756.45	0.05	0.80	0.2800	CIRCULAR	12.000	0.00	0.0130	0.5000	0.5000	0.0000	0.00	NO

ORIFICE INPUT SUMMARY TABLE															
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		West Pond	Str 7	757.25	757.25	SIDE	RECT_CLOSED	NO		0.33	1.50	758.31	1.06	0.6260
2	10YR		West Pond	Str 7	757.25	757.25	SIDE	CIRCULAR	NO	5.00			757.25	0.00	0.6140

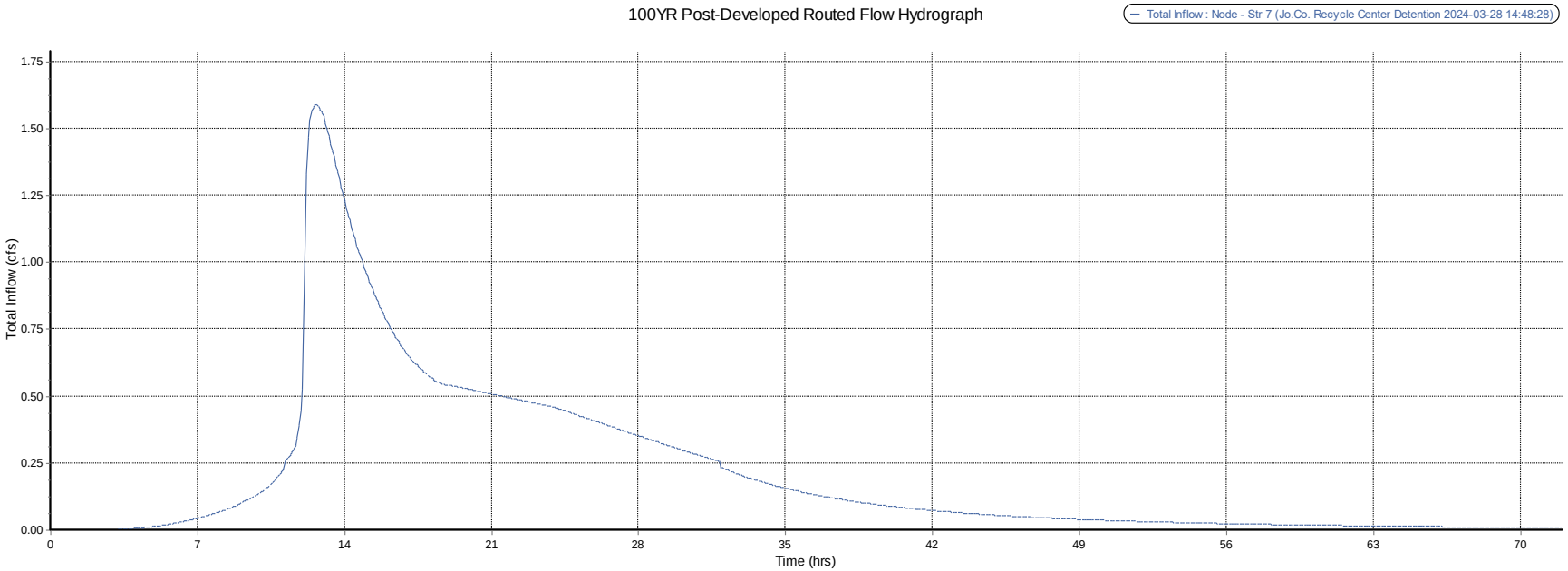
JUNCTION INPUT SUMMARY TABLE													
SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (inches)
1	Str 7	11446.40	4581.05		757.25	761.00	3.75	757.25	0.00	761.00	0.00	0.00	0.00

10yr Post-Developed Routed Flow Hydrograph and Results



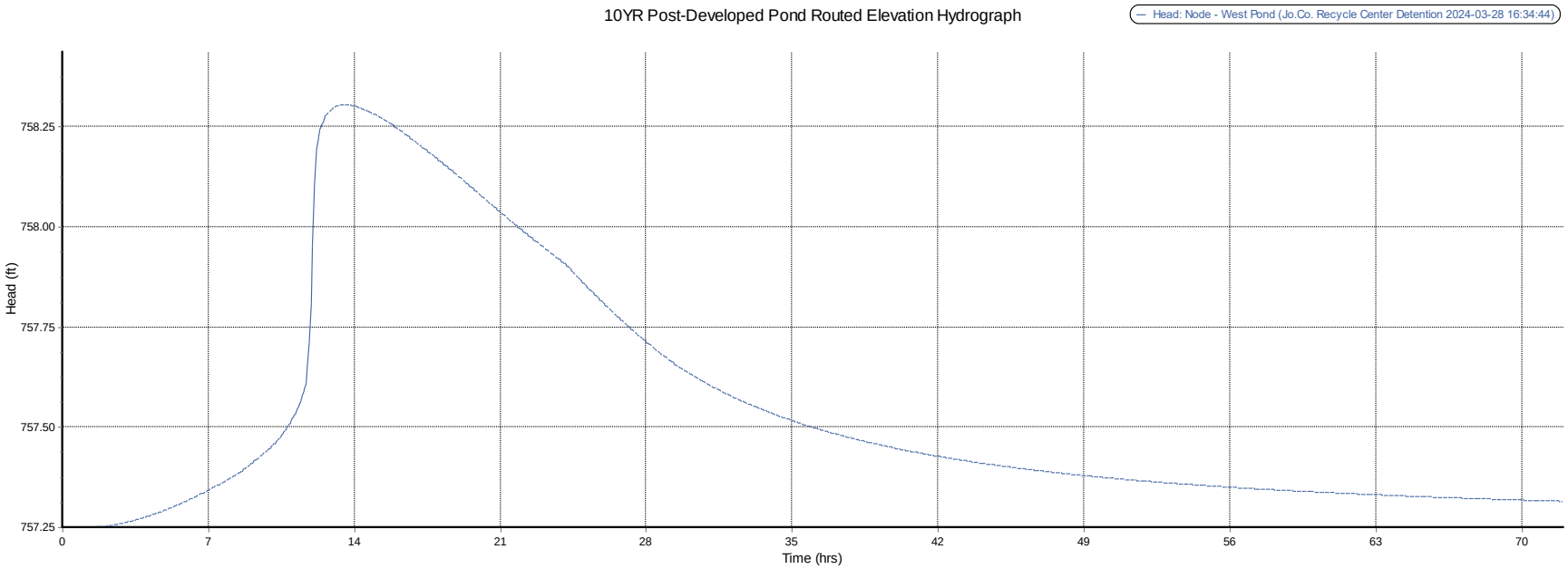
Element ID	Str 7
Maximum Total Inflow (cfs)	**0.54**
Minimum Total Inflow (cfs)	0.00
Event Mean Total Inflow (cfs)	0.14
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft³)	N/A
Volume of Deficit (ft³)	N/A
Total Inflow Volume (ft³)	36421.33
Detention Storage (ft³)	N/A
Exceedance	0
Deficit	0

100yr Post-Developed Routed Flow Hydrograph and Results



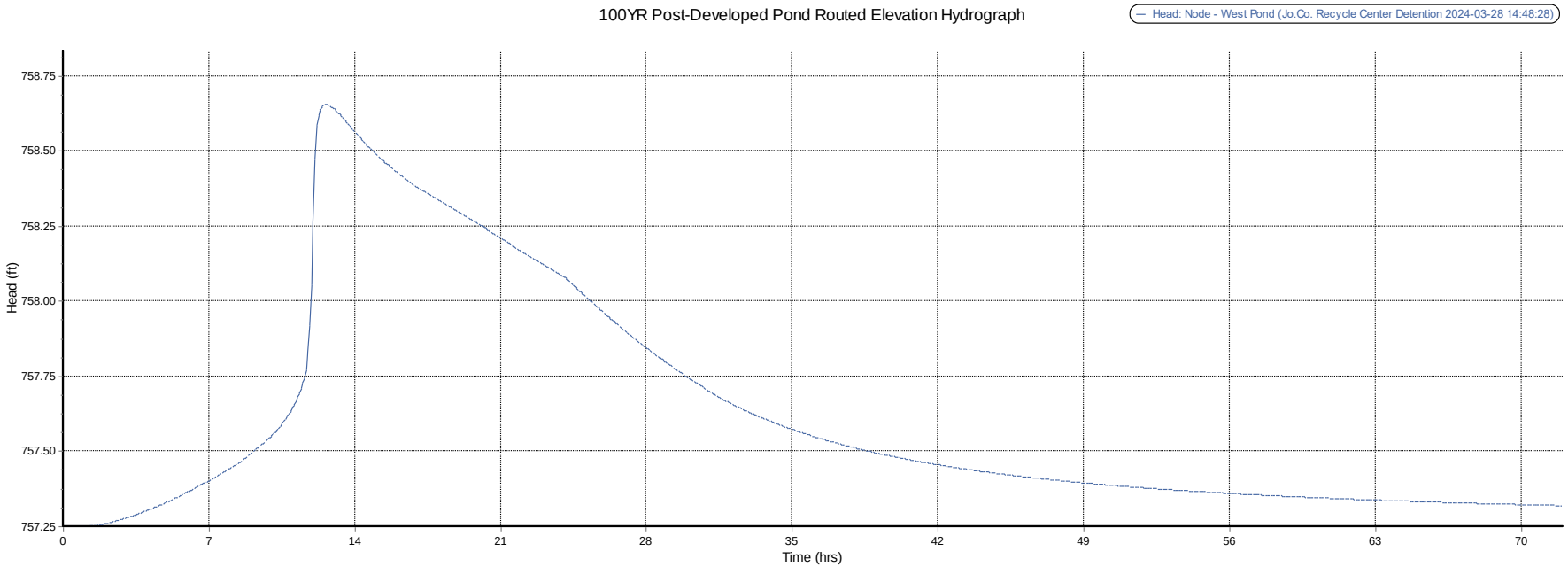
Element ID	Str 7
Maximum Total Inflow (cfs)	**1.59**
Minimum Total Inflow (cfs)	0.00
Event Mean Total Inflow (cfs)	0.21
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft^3)	N/A
Volume of Deficit (ft^3)	N/A
Total Inflow Volume (ft^3)	54060.86
Detention Storage (ft^3)	N/A
Exceedance	0
Deficit	0

10yr Post-Developed Pond Routed Elevation Hydrograph and Results



Element ID	West Pond
Maximum Head (ft)	**758.31**
Minimum Head (ft)	757.25
Event Mean Head (ft)	758.42
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	West Pond
Maximum Head (ft)	**758.66**
Minimum Head (ft)	757.25
Event Mean Head (ft)	758.49
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