Addendum 1

City of Canton, Ohio

Purchasing Department 218 Cleveland Ave. SW, 4th floor Canton, Ohio 44702

36th St NW Storm Sewer & Road Reconstruction Project, GP 1270

Item/Project

Engineering Department

Responsible Department

Monday, April 1, 2019 at 4:00PM Local Time

Bids Due On or Before

Bid Proposal Submitted By:

Company Name

Street Address

City

Contact Person

Phone No.

State

Email Address

Zip

Addition of Information:

Attached below is the 36th Street NW Study as referenced in the General Project Description section of the Request for Qualifications as being posted at <u>http://cantonohio.gov/engineering/?pg=211</u>.

36th Street NW Study

(Frazer Ave. NW to Market Ave. N) City of Canton, Ohio

February 27th, 2019

Prepared by:

Christopher D. Barnes, PE, CPESC, CPSWQ, CPMSM Assistant City Engineer City of Canton Engineering Department 2436 30th St. NE Canton, Ohio 44705 330-489-3381

Purpose of this Study:

The vicinity of 36th Street NW, between Frazer Avenue and Market Avenue, has been plagued by localized flooding for several years. Runoff generally drains from west to east to Logan Avenue, then north on Logan to mid-block between 36th Street and 37th Street where it continues to flow east through properties toward 37th Street and Market Avenue. There is a small existing storm sewer at the intersection of 36th Street and Logan Avenue, but it is severely undersized and insufficient to handle the majority of runoff from the 36th Street watershed. The rest of 36th Street has no storm water drainage infrastructure at all, and as a result, existing pavement is in very poor condition. During heavy rain events, flooding occurs along 36th Street, at Logan Avenue, along Logan Avenue between 36th Street. *See Appendices A and B*.

To alleviate the flooding, the City of Canton plans to construct a storm sewer system along 36th Street to drain runoff to the existing Market Avenue 36-inch diameter storm sewer. Full-depth roadway reconstruction is proposed as well as a reduction in pavement width to improve pavement conditions and reduce runoff. The existing water main will be replaced as well as portions of existing sanitary sewer mains. The general limits of the project will consist of 36th Street NW between Frazer Avenue and Market Avenue along with portions of intersecting streets within these limits extending up to 350 feet. *See Appendix C*.

Although above-ground detention is preferable to underground detention for several reasons, there is no available space within the immediate project vicinity to construct an above-ground detention basin. Therefore, the proposed storm sewer will be oversized to provide underground detention within the project limits. This requires evaluation of the size and length the storm sewer needs to be to manage runoff from the 2-, 5-, 10-, 25-, 50-, and 100-year storm events. In addition, the storm sewer is intended to divert runoff from primarily following the existing drainage path from the low point in Logan Avenue between 36th Street and 37th Street, and instead direct it easterly, "bucking grade" along 36th Street, and discharging it by direct connection to the Market Avenue system. Thus, evaluation of the capacity of the Market Avenue system is essential to determine corresponding allowable discharge rates from the proposed 36th Street system. Ultimately, the proposed 36th Street storm sewer will depend on the desired level of protection to be provided for respective storm events as well as the corresponding construction impacts and costs.

The City of Canton Engineering Department retained the services of the Osborn Engineering Company to assist in this study.

Watersheds:

Two main watersheds were delineated as part of this study:

- Market Avenue watershed: Approximately 33.5 acres drain to the existing storm sewer along the east side of Market Avenue adjacent to 36th Street.
- 36th Street watershed: Approximately 54.8 acres drain to the area that will be discharged by the proposed 36th Street storm sewer to the existing Market Avenue storm sewer.

Currently, runoff from the 36th Street and Market Avenue vicinity eventually discharges to a ravine north of 37th Street on the east side of Market Avenue and ultimately to a tributary of the Middle Branch Nimishillen Creek.

The watersheds were mainly determined from record drawing information and the USGS StreamStats website. While delineating the watershed areas, some assumptions were made that most front yard areas of homes drain out to the streets. Also, some street intersections within proximity to the upper limits of the watershed were field-verified to confirm which direction runoff drains. *See Appendix D*.

Discharge and Storage Analysis:

Peak discharge (flow) rates for the 2- through 100-year storm events for both watersheds were calculated by using the Rational Method. The following values were used:

1. Market Avenue watershed:

Area = 33.45 acres; Runoff Coefficient = 0.3 (single-family residential); Time of Concentration = 30 minutes.

2. 36th Street watershed:

Area = 54.8 acres; Runoff Coefficient = 0.3 (single-family residential); Time of Concentration = 18 minutes.

The minimum Market Avenue "just full" (non-pressurized) storm sewer capacity adjacent to 36th Street is approximately 47.8 cfs and was determined using Manning's Equation. In addition, utilizing as-built top of structure (rim/grate) elevations, pipe sizes, and invert elevations, maximum allowable pressurized flow capacity was estimated in the Market Avenue system to be 49.9 cfs without surcharging out of tops of structures. Comparing this information to peak discharge estimates, there is available capacity in the system to take on additional flows from the 36th Street watershed during the 2- through 100-year storm events.

Since an oversized storm sewer is proposed along 36th Street in order to provide detention storage, the Modified Rational Method was utilized to estimate required storage volumes for the 2- through 100-year storm events. In short, the Modified Rational Method as typically applied is different from the standard Rational Method in that rather than determining maximum peak discharges from the watershed, it instead determines maximum storage volumes required for storm events based on varied storm durations and maximum allowable discharge rates. Thus, for detention purposes, the Modified Rational Method results in trapezoidal "inflow hydrographs" based on longer storm durations but lower peak flows, and a triangular "outflow hydrograph" based on allowable discharge rates. The estimated storage volumes required for detention are the differences in areas *between* the respective inflow and outflow hydrographs for each storm event. In contrast, the standard Rational Method results in triangular hydrographs with shorter storm durations, higher peak flows, and lower storage volumes, but this method was never intended to be used for detention purposes because it underestimates required storage volumes. The additional capacity available in the Market Avenue storm sewer under pressurized conditions was used as the allowable outflows for the 2- through 100-year storm events for the Modified Rational Method analysis. *See Appendix E*.

Table 1 summarizes the estimated discharge rates, capacities, and storage volumes required for the 2- through 100-year storm events.

				Idu	ne T				
		Watersh	eds, Discha	rges, Capa	cities, & St	orage Requi	irements		
		N	Aarket Avenu	e			36th St	reet NW	
	Watershed	Storr	n Sewer (adj	acent to 361	th St.)	Watershed	Undergr	ound Storage	e System
Storm	Rational	"Just Full"	(Manning's)		Allowable re Flow	Rational	Modifie	ed Rational N	/lethod
Event	Method Peak Discharge	Capacity	Available Capacity	Capacity	Available Capacity	Method Peak Discharge	Allowable Discharge Out	Peak Discharge In	Storage Volume
(yr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cf)
2	19.9	48.2	28.2	49.9	30.0	44.8	30.0	38.7	16,476
5	24.6	48.2	23.5	49.9	25.3	54.6	25.3	36.5	36,500
10	28.2	48.2	19.9	49.9	21.7	61.9	21.7	34.6	55,107
25	32.9	48.2	15.3	49.9	17.1	71.2	17.1	29.2	85,106
50	36.3	48.2	11.8	49.9	13.6	78.1	13.6	24.1	115,788
100	39.7	48.2	8.4	49.9	10.2	84.8	10.2	18.8	158,631

Table 1

Proposed Storm Sewer Options:

Alignment of a new storm sewer along 36th Street requires consideration of locations of underground utilities and potential conflicts with those utilities and service laterals. Major underground utilities within the project limits are sanitary sewer, water, and gas. There is an existing 6-inch water main and 4-inch gas main located along the north side of 36th Street, and an existing 8-inch sanitary sewer main located along the center of 36th Street. Since the existing water main is proposed to be replaced as part of this project, the new water main will need to be located under the south side of the street. In order to satisfy Ohio EPA sewer separation requirements and to avoid existing utilities as much as possible, this forces the proposed storm sewer to be located under the north side of the street.

Typical design standards require storm sewer systems to be designed to handle peak discharges from a 10-year storm event under "just-full" (non-pressurized) conditions, while ensuring the hydraulic grade line stays below structure top elevations during the 25-year storm event. The standard Rational Method is typically used to determine peak discharges for storm sewer design.

For evaluation and comparison purposes only, a "typical" storm sewer trunk size was estimated. The flattest slope of 0.48% for the existing sanitary sewer main within the project limits in the vicinity of Logan Avenue was used to also represent the flattest slope of the proposed storm sewer. As a result, this project would require a 48-inch diameter storm sewer to convey the 10-year peak discharge of 61.9 cfs under "just-full" conditions for a typical storm sewer design with no downstream flow restrictions.

However, a "typical" storm sewer design is not applicable for this project. Since in-line detention storage is desired and the Market Avenue system capacity is limited to different rates for different storm events (thus directly impacting the amount of storage volume required), a relatively larger and deep storm sewer is needed.

Osborn Engineering prepared plan and profile sheets along 36th Street between Frazer Avenue and Market Avenue. Existing utilities (gas, water, and sanitary sewer) were plotted in profile view from record information. Due to its relatively large size needed to provide in-line detention and to avoid utility conflicts as much as possible, the top of the storm sewer will need to be below the elevation of the bottom of the sanitary sewer along 36th Street. For analysis purposes and considering the aforementioned Ohio EPA sewer separation requirements and the desire to avoid existing utility conflicts as much as possible, a single-barrel storm sewer was assumed having the same diameter for the entire run of storm sewer main. However, several options with various diameters were evaluated.

Table 2 shows the runoff storage volume required for the 2- through 100-year storm events and the various sizes and corresponding lengths that would be needed to meet those storage requirements.

			Tab	le 2			
	Storm	Event Stor	age Volum	es & Length	s of Pipe N	leeded	
Storm	Storage Volume		Pip	e Diameter (inches) Opti	ons	
Event	Required	36	42	48	60	72	84
(yr)	(cf)	Leng	th of Pipe (f	eet) Needed	to Provide	Required Sto	orage
2	16,476	2,330.9	1,712.5	1,311.1	839.1	582.7	428.1
5	36,500	5,163.7	3,793.7	2,904.6	1,858.9	1,290.9	948.4
10	55,107	7,796.0	5,727.7	4,385.3	2,806.6	1,949.0	1,431.9
25	85,106	12,040.0	8,845.7	6,772.5	4,334.4	3,010.0	2,211.4
50	115,788	16,380.7	12,034.8	9,214.1	5,897.0	4,095.2	3,008.7
100	158,631	22,441.7	16,487.8	12,623.5	8,079.0	5,610.4	4,121.9

Table 3 shows street segments within the project limits, corresponding segment lengths, and maximum storage volumes that can be provided by the various pipe diameter options. The maximum length of storm sewer that can be provided within all segments of the project limits is 4,355 feet. *See Appendix F*.

				Tab	le 3				
		Street	t Lengths &	Storage V	olumes Bas	sed on Pipe	Sizes		
	Street S	egment		p	Pip	e Diameter (inches) Opt	ions	
Changet	From	To	Length	36	42	48	60	72	84
Street	From	То	(ft)		Maximum Po	otential Stor	age Volume	(cf) Availabl	e
36th	Market	Logan	935	6,609	8,996	11,750	18,359	26,437	35,983
36th	Logan	E. Harvard	500	3,534	4,811	6,283	9,817	14,137	19,242
36th	E. Harvard	Harvard	200	1,414	1,924	2,513	3,927	5,655	7,697
36th	Harvard	W. Harvard	150	1,060	1,443	1,885	2,945	4,241	5,773
36th	W. Harvard	Yale	370	2,615	3,560	4,650	7,265	10,462	14,239
36th	Yale	36th (bend)	270	1,909	2,598	3,393	5,301	7,634	10,391
36th	36th (bend)	(south)	200	1,414	1,924	2,513	3,927	5,655	7,697
Logan	36th	(north)	350	2,474	3,367	4,398	6,872	9,896	13,470
Logan	36th	(south)	300	2,121	2,886	3,770	5,890	8,482	11,545
Harvard	36th	(north)	350	2,474	3,367	4,398	6,872	9,896	13,470
E. Harvard	36th	(south)	300	2,121	2,886	3,770	5,890	8,482	11,545
W. Harvard	36th	(south)	260	1,838	2,501	3,267	5,105	7,351	10,006
Yale	36th	(south)	170	1,202	1,636	2,136	3,338	4,807	6,542
		Totals =	4,355	30,784	41,900	54,727	85,510	123,135	167,600
		Storm Event	Storage Volume Required		E	nough Stora	ge Provided	1?	
		(yr)	(cf)						
		2	16,476	Yes	Yes	Yes	Yes	Yes	Yes
		5	36,500	No	Yes	Yes	Yes	Yes	Yes
		10	55,107	No	No	No	Yes	Yes	Yes
		25	85,106	No	No	No	Yes	Yes	Yes
		50	115,788	No	No	No	No	Yes	Yes
		100	158,631	No	No	No	No	No	Yes

Table 3 also shows that when the same size of storm sewer is placed under all street segments within the project limits, minimum required pipe sizes range from 36-inches up to 84-inches to detain runoff for the 2- through 100-year storm events. Thus, as long as the project limits do not increase and only a single-barrel same-size storm sewer is used, providing storage capacity for the 100-yr storm event can only be achieved by utilizing an 84-inch storm sewer (i.e. it would be impossible to install enough single-barrel 60-inch pipe within the project limits to provide storage for a 50-or 100-year storm event; a 60-inch pipe can only provide storage for up to and including the 25-year storm).

Although the proposed storm sewer will need to be deep due to the existing sanitary sewer main along 36th Street, there are a couple of intersecting streets within the project limits that do not have sanitary sewer: Logan Avenue both north and south of 36th Street and Yale Avenue south of 36th Street. As such, the storm sewer can be much shallower within these street segments.

Recommended Storm Sewer Size for Detention:

Upon consideration of the above information and options, 60-inch diameter High-Density Polyethylene (HDPE) storm sewer pipe is recommended for the following reasons:

- Since storm water detention is a goal of this project, temporary storage of storm water in HDPE pipe is strongly preferred over larger diameter pipes such as reinforced concrete pipe (RCP) or corrugated metal pipe (CMP). Underground storage within HDPE pipe is industry-standard; storage within CMP is not considered a viable option.
- 2. HDPE pipe has a longer design life and is less prone to deterioration compared to RCP.
- 3. HDPE costs are typically less expensive than RCP.
- 4. 60-inch is the largest diameter that can currently be obtained in HDPE pipe.
- Utilizing 60-inch HDPE pipe under all street segments provides storage for just above the 25-year storm event and maximizes the project footprint; providing substantial flood control improvement over existing conditions.
- Although protection could be provided for greater storms (50- or 100-yr events) if larger RCP storm sewer is utilized, respective costs would dramatically increase above the cost of 60-inch HDPE.

Another important design consideration for the proposed storm sewer is to ensure that there is enough inlet capacity to allow peak flows from the 25-year storm event to be able to enter into the system. This means that inlet (catch basin) grate capacities will need to be checked and larger grates or additional inlets need to be provided to accomplish this design component. The critical location where runoff drains to is Logan Avenue, so it is especially crucial to ensure sufficient inlet capacity here to allow water to get into the system.

During more extreme storms beyond the 25-year event, temporary surcharging of both the proposed 36th Street storm sewer and the existing Market Avenue storm sewer may occur. Any excess flows exceeding the capacity of the 36th Street storm sewer will continue to follow the existing drainage path from Logan Avenue to the east through properties between 36th Street and 37th Street (however, these flows will be significantly reduced from what is currently experienced). It is important to design a designated "overflow" point, such as a curb cut, along Logan Avenue mid-block between 36th Street and 37th Street to minimize street flooding and promote usage of the existing drainage path. *See Appendix G*. Table 4 summarizes the proposed storm water detention results.

		Summary	of Proposed	Storm Water	Detention		
Storm Event	Existing Maximum Peak Discharge* from 36th St Watershed	Proposed Discharge to Market Ave System	Runoff Storage Volume Required	Runoff Storage Volume Provided	% of Required Runoff Volume Detained	Runoff Volume Not Detained	Approx. <i>Maximum</i> Overflow Discharge* at Logan Ave
(yr)	(cfs)	(cfs)	(cf)	(cf)	(%)	(cf)	(cfs)
2	44.8	17.1	34,658	85,510	100.00%	0	0.0
5	54.6	17.1	51,028	85,510	100.00%	0	0.0
10	61.9	17.1	64,885	85,510	100.00%	0	0.0
25	71.3	17.1	85,106	85,510	100.00%	0	0.0
50	78.1	17.1	102,870	85,510	83.12%	17,360	13.2
100	84.8	17.1	123,135	85,510	69.44%	37,625	25.9

Restrictor Plate Orifices:

In order for the proposed storm sewer to provide effective storage of the 25-year storm event without surcharging at manholes or catch basins, several restrictor plates with smaller diameter orifices will need to be installed at critical manhole locations. In addition to staying below the sanitary sewer main as previously indicated, the top of the run of storm sewer within each section must also be kept below the top of manhole elevation where the section's orifice is located (these considerations can be better visualized as shown on the plan and profile sheets).

The bottom elevation of the orifices must match the invert elevation of their respective manhole's out-letting storm sewer. Sizing of the orifice diameters needs to be based on a combination of two factors:

- Maximum hydraulic head possible within each section without surcharging out of the top of structures. This is the vertical distance from the lowest top of structure elevation within the respective section of storm sewer to the bottom of orifice elevation.
- Allowable discharge at the respective restrictor plate/orifice location based on corresponding percentage of 36th Street watershed draining to the orifice location (e.g. if 50% of the watershed drains to the restrictor plate location, then the orifice needs to be designed to allow no more than 50% of the total allowable flow from the 36th Street watershed).

Table 5 shows six restrictor plates/orifices that would be needed within manhole structures along key locations within the proposed 36th Street storm sewer. The key locations generally coincide with street intersections or where topography indicates the need for one based on potential surcharging out of the tops of structures. *See Appendix H*.

At each proposed location, the corresponding portion of the total 54.8-acre 36th Street drainage area is shown along with its respective percentage of the total area. These percentages were then used to calculate the allowable discharges from each orifice based on the maximum allowable discharge of 17.1 cfs for the entire 36th Street watershed for a 25-year storm event. Using each of the six orifice's allowable discharges and the respective maximum head available within the manhole structures, approximate orifice diameters were calculated using the orifice equation. Thus, at the most downstream end of the storm sewer where the sixth orifice will be located (just prior to connection to the Market Avenue storm sewer), the orifice is sized to pass the maximum allowable 25-year storm discharge of 17.1 cfs under maximum head conditions.

In lieu of restrictor plate orifices, removable stoplogs may be a better option to help facilitate inspection and maintenance of the storm sewer. If utilized, it is essential to design the stoplogs to operate similarly to the orifices in accordance with allowable discharges at respective locations.

			Table 5					
		Detentio	n Design Pa	arameters				
	Target Storm Even	t Detention =	25	year				
	Corresponding Maximum Allowab	le Discharge =	17.1	cfs				
		Restri	ctor Plate (Orifice)				
No.	Location along 36th St.		iting 36th inage Area	Corresp. Allowable Discharge	Maximum Allowable Water Surface Elelvation (Top of Structure)	Approx. Pipe/ Orifice Invert Elev.	Maximum Head	Approx Orifice Diamete
		(acres)	(% of total)	(cfs)	(ft)	(ft)	(ft)	(in)
1	at Yale (Sta. 6+53)	10.85	19.80	3.4	1186.2	1170.0	16.2	5.57
2	at Sta. 8+23	11.65	21.26	3.6	1177.5	1162.9	14.6	5.92
3	at W. Harvard (Sta. 11+03)	23	41.97	7.2	1172.5	1155.7	16.8	8.03
4	at E. Harvard (Sta. 14+03)	32.7	59.67	10.2	1165	1150	15	9.85
5	at Logan (Sta. 18+83)	50.25	91.70	15.7	1156	1144.2	11.8	12.97
6	at Market (Sta. 28+18)	54.8	100.00	17.1	1149.2	1135.7	13.5	13.10

It is important to design the six restrictor plate orifices to be attached to the "downstream" sides of the respective manhole structures for two reasons:

- 1. Maximum head values used to design orifice diameters were based on the lowest top of manhole structures in the sections in which the orifices are located. In all cases except for the orifice at Logan Avenue, the manholes with the lowest top elevations are at the same locations of the proposed restrictor plates. This means that with the restrictor plate attached to the "downstream" side of the manhole, the maximum hydraulic head available is determined from the same manhole (i.e. if the restrictor plate orifices were located on the "upstream" sides of the manholes, then the maximum hydraulic head values would need to be based on the next highest upstream top of structure elevations).
- 2. It is preferable that hydrostatic pressure pushes the restrictor plates against the downstream side of the manholes, not away from the "upstream" sides of the manholes.

Storm Water Pollution Prevention:

Any construction activity that will disturb one or more acres of land is subject to regulation under Ohio EPA's National Pollutant Discharge Elimination System (NPDES) Construction Storm Water Permit. This permit requires the implementation of a Storm Water Pollution Prevent Plan (SWPPP) and appropriate best management practices (BMPs) to reduce and control storm water pollution related to construction activities and typically post-construction runoff as well. The proposed 36th Street project will disturb more than one acre and thus will be subject to the permit. However, since there will be no installation of any additional impervious surfaces, but rather a reduction through reduced pavement widths, post-construction pollution prevention BMPs are not required. A SWPPP showing the implementation of BMPs for pollution prevention of runoff only during construction will be required.

Sump Pump Discharges:

There are a few known problematic locations within the project limits where sump pumps discharge frequently out to the street, either over sidewalks or directly to the edge of pavement. These are problematic in that without an existing drainage system for the street, pavement and sidewalks are constantly wet and deteriorate much faster. In the winter, these discharges freeze, thus resulting in hazardous conditions. It is a goal of this project to provide a direct connection of sump pump discharges into the proposed storm sewer at catch basins, as well as to provide an emergency relief at the curb.

Proposed Pavement Reduction:

The existing pavement width along 36th Street is excessively wide, especially west of Logan Avenue. East of Logan, the pavement is approximately 30-feet wide. This is acceptable and is sufficient to allow for parking on both sides of the street within this residential, low-traffic neighborhood. West of Logan Avenue, however, the pavement is wider, averaging around 36 feet. The intersections of East Harvard and West Harvard Boulevards are also extremely wide. Thus, the excess pavement along 36th Street means more storm water runoff which only exacerbates flooding, more pavement to maintain, salt, and plow, and as a result, higher associated operation and maintenance costs.

As part of this project, the City of Canton proposes that 36th Street undertakes a "road diet" and reduces the portions of excessive pavement widths but still maintains the ability to park on both sides of the street. The goal is to use the existing pavement widths east of Logan Avenue as the benchmark and provide the same 30-foot wide pavement width along the remainder of the corridor within the project limits. In rare cases where parked vehicles are immediately across from each other on opposite sides of the street, traveling vehicles may have to "take turns" to proceed. This is no different than what may currently occur east of Logan Avenue, and is appropriate for this neighborhood which has minimal traffic volume.

Roadway Reconstruction:

With the proposed pavement reduction, full-depth roadway reconstruction will also occur. This will result in new roadway base material, new pavement, underdrains, and new curbs for 36th Street between Frazer Avenue and Market Avenue and portions of intersecting streets within the projects limits.

Water Line Replacement:

As part of this project, the City of Canton also plans to replace the existing 6-inch water main under the north side of 36th Street as well as under Harvard Avenue and Logan Avenue between 36th Street and 37th Street. Since the existing water main is located under the north side of 36th Street, the proposed water line will need to be placed under the south side of 36th Street in order to maintain continuous water service to residents during construction. As a result, the proposed storm sewer will need to be located under the north side of the street (thus, the existing water main will need to be removed to install the storm sewer).

Sanitary Sewer Repairs:

The City of Canton Collection Systems Department evaluated the condition of the existing 8-inch sanitary main. It has been determined that there are four sections of sanitary sewer that will need to be replaced along 36th Street as part of the project:

- 1. 30-ft of 8-in sewer from 89-ft to 119-ft east of sanitary manhole #9411
- 2. 12-ft of 8-in sewer from 88-ft to 100-ft east of sanitary manhole #8804
- 3. 44-ft of 8-in sewer from 72-ft to 116-ft east of sanitary manhole #8809
- 4. 25-ft of 8-in sewer from 220-ft to 245-ft east of sanitary manhole #8811

An extra 5-feet on each end of the repair sections should be planned for replacement, for a total of approximately 151-feet of 8-inch sanitary sewer.

In addition, a spray-on polymer liner (e.g. "OBIC Armor"; "Spectrashield"; etc.) is proposed to be used on each sanitary sewer manhole within the project limits to prevent infiltration and corrosion.

Conclusion and Summary:

The City of Canton desires to address the flooding and associated problems along 36th Street NW between Frazer Avenue and Market Avenue and the surrounding vicinity. After consideration of the results of this study, a project is proposed featuring the major components as shown in Table 6.

	Table 6
	Proposed 36 th Street NW Project Summary
Major Component	Description
Project Limits	36 th St between Frazer Ave and Market Ave; portions of Yale Ave, West Harvard Blvd, Harvard Blvd, East Harvard Blvd, and Logan Ave up to 350 feet
Storm Sewer	4,355 feet of 60-inch HDPE pipe trunk line to tie into existing Market Ave storm sewer; Curb inlet catch basins throughout project limits
Storm Water Detention	Utilize 60-inch storm sewer with 6 restrictor plate orifices/stoplogs to provide underground detention for up to and including the 25-year storm event
Storm Water Pollution Prevention	During construction only; No post-construction storm water treatment required
Pavement Width Reduction	Reduce 36 th St pavement width to 30 feet between Frazer Ave and Logan Ave
Roadway Reconstruction	Full depth pavement replacement and new curbs along 36 th Street and portions of intersecting streets within the project limits
Water Line Replacement	36 th St between Frazer Ave and Market Ave; Harvard Ave between 36 th St and 37 th St; Logan Ave between 36 th St and 37 th St
Sanitary Sewer Repairs	Replace approximately 151 feet of 8-inch sewer; line all sanitary manholes
Preliminary Estimated Cost	

See Appendix I for plan and profile sheets showing the proposed storm sewer under 36th Street.

Due to the preliminary estimated cost of \$4,500,000 and projected funding resources, this project is proposed to be constructed in two phases:

- 1. Phase 1 Logan Avenue NW to Market Avenue
- 2. Phase 2 Frazer Avenue NW to Logan Avenue

The general strategy for design, funding, and construction of this project is:

Timeframe	Project Aspect	Description
2019	Design	June - August: Engineering design/plans preparation for OPWC submission for Phase 1
2019	Apply for Funding	September: Apply for OPWC funding for Phase 1
2019-2020	Design	Detailed engineering design (complete Phase 1 & Phase 2)
2020	Apply for Funding	September: Apply for OPWC funding for Phase 2
2020-2021	Construction	September 2020: Earliest construction start for Phase 1
2021-2022	Construction	September 2021: Earliest construction start for Phase 2

Above-Ground Option for Storm Water Detention:

The main objective of a proposed project along 36th Street NW is to alleviate flooding and improve drainage. Improving drainage is accomplished by providing a storm sewer. Alleviating flooding is typically accomplished by providing storm water detention, and the preferred option is to construct an above-ground detention basin. Above-ground detention is preferred over underground detention for the following reasons:

- Relatively less expensive: The majority of costs associated with above ground detention consists of excavation. Excavation costs are almost always less expensive than costs associated with the installation of underground detention facilities.
- Provide storage for greater storm events: Much more storage volume can be provided in an aboveground detention basin compared to underground detention facilities. Thus, greater flood protection during greater storm events can be provided in above-ground versus underground detention.
- Easier to maintain: With above-ground detention, maintenance-related issues can be easily seen and addressed. With underground detention, it is difficult to see and know when maintenance issues arise.

With that being said, the overall recommendation of this study is to provide underground detention by installing a 60-inch diameter storm sewer that will provide flood protection for up to and including the 25-year storm event. This is mainly because there is no room within the project limits to provide above-ground detention without impacting existing houses or streets.

However, if above-ground detention was to be pursued, the closest location that could potentially be utilized without impacting existing houses or streets is the ravine on the east side of Market Avenue north of 37th Street at the outlet of the existing Market Avenue storm sewer. *See Appendix J*. The following critical aspects would also need to be considered:

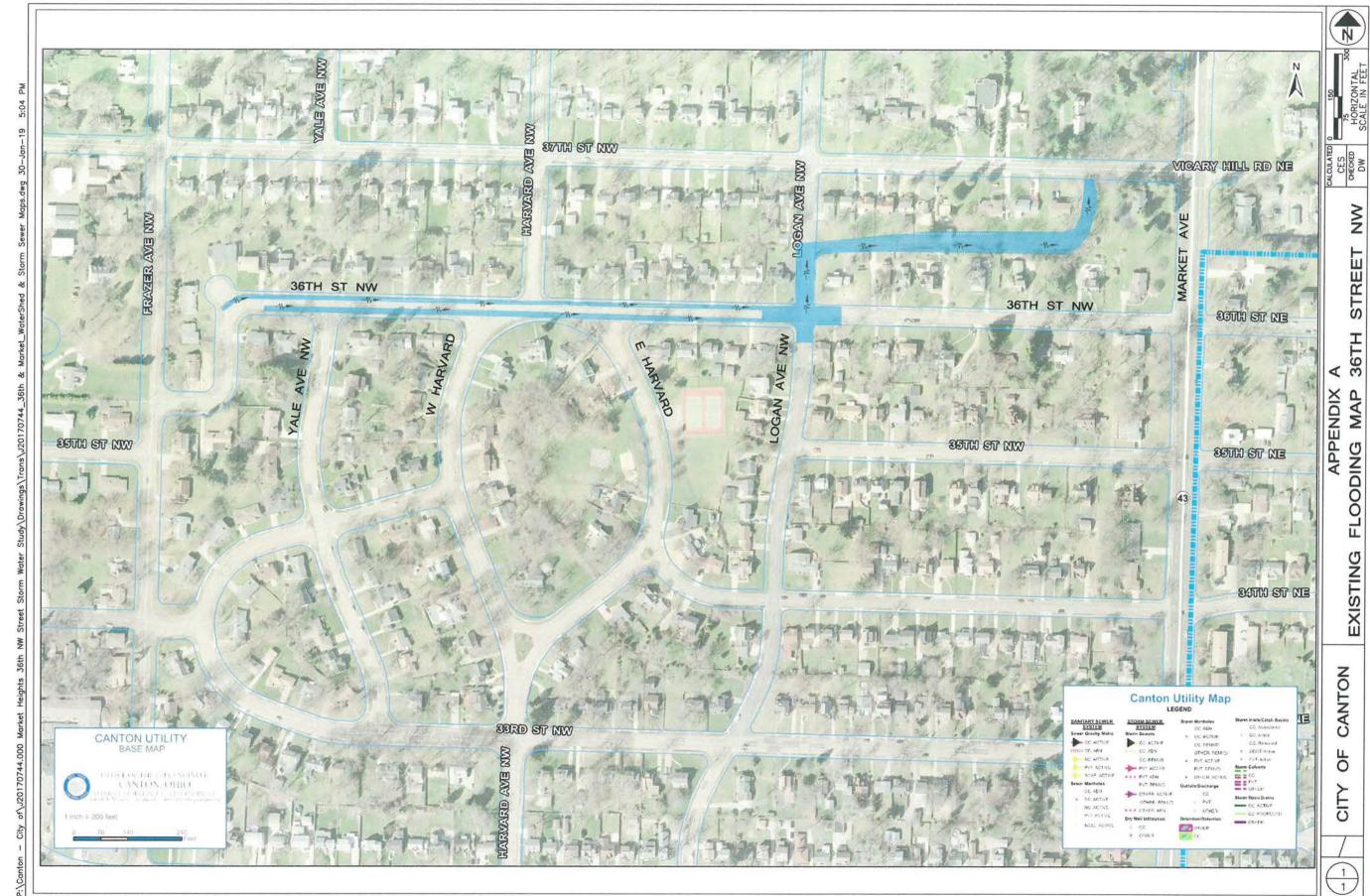
- 1. The project limits would need to be increased.
- 2. The property where the detention basin would be located would need to be acquired.
- The detention basin would need to be designed for the entire contributing drainage area (watershed), which is much larger than just the 36th Street watershed.
- 100-year storm protection would be recommended since this is the standard for above-ground detention.
- A storm sewer large enough to convey the 100-year peak discharge of 84.8 cfs from 36th Street at Logan Avenue would need to be constructed to discharge to the detention basin. This would require at least 2,030 feet of 42-inch diameter storm sewer (to handle the 36th Street watershed only).
- If the discharges from the 36th Street watershed were to be combined with the Market Avenue watershed, approximately 820 feet of the existing Market Avenue storm sewer would need to be replaced (upsized).
- 7. Additional impacts to Market Avenue would occur.
- 8. Additional costs would be incurred.

Due to these additional considerations, above-ground detention is not recommended.

Appendices:

- A. Existing Flooding Map
- B. Market Heights Neighborhood Association Report (courtesy of Marcy Mertes; resident)
- C. Project Limits Map
- D. Watersheds Map
- E. Discharge Analysis
- F. Street Segment Length Map
- G. Recommended 60" Storm Sewer Footprint Map
- H. Restrictor Plate Orifices Location Map
- I. 36th Street NW Typical Section and Plan & Profile Sheets
- J. Potential Location for Above-Ground Detention
- K. Preliminary Cost Estimate

Appendix A. Existing Flooding Map



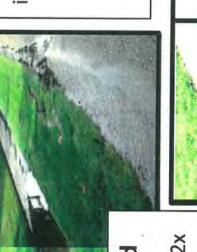
Appendix B. Market Heights Neighborhood Association Report (courtesy of Marcy Mertes; resident)

MARKET HEIGHTS – on a normal day of rain.....



Corner of 36th Street and Harvard

- Road is patched 2-3 times a year (2x in the past month)
 - Water pools until high enough to go over road
- down north side of 36th and pools for After a rain - water continues to run several days
 - High traffic intersection ۰



issues in the streets does not encourage Association is working to prevent flight from the city of Canton. The water Situation has been present for 15+ **Market Height Neighborhood** people to buy homes here. years and getting worse WE NEED YOUR HELP.



MARKET HEIGHTS – on a 10 year rain....

Corner of 36th Street and Logan



MARKET HEIGHTS



Many runners, strollers, walkers, and school buses utilize this corner and can not walk on the sidewalk due to the "pond" that is there for days during and after a rain fall of any amount. This does not encourage people to buy homes in the Canton City neighborhood of Market Heights

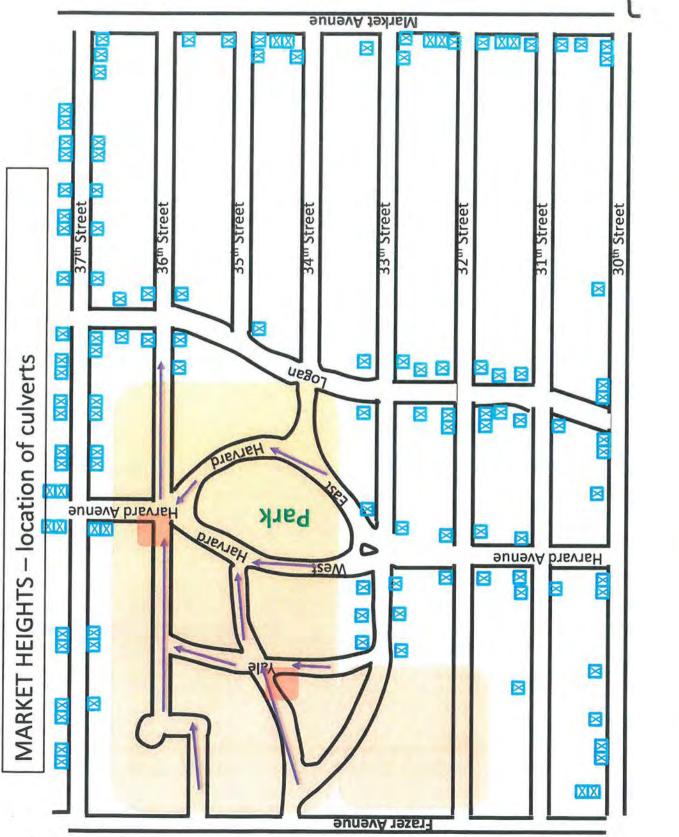
Corner of 36th Street and Harvard

- Road is patched 2-3 times a year (2x in the past month)
- Water pools until high enough to go over road
- After a rain water continues to run down north side of 36th and pools for several days
 - High traffic intersection
 Situation has been present for

15+ years and getting worse







Direction of Pooling of water flow

Affected Area

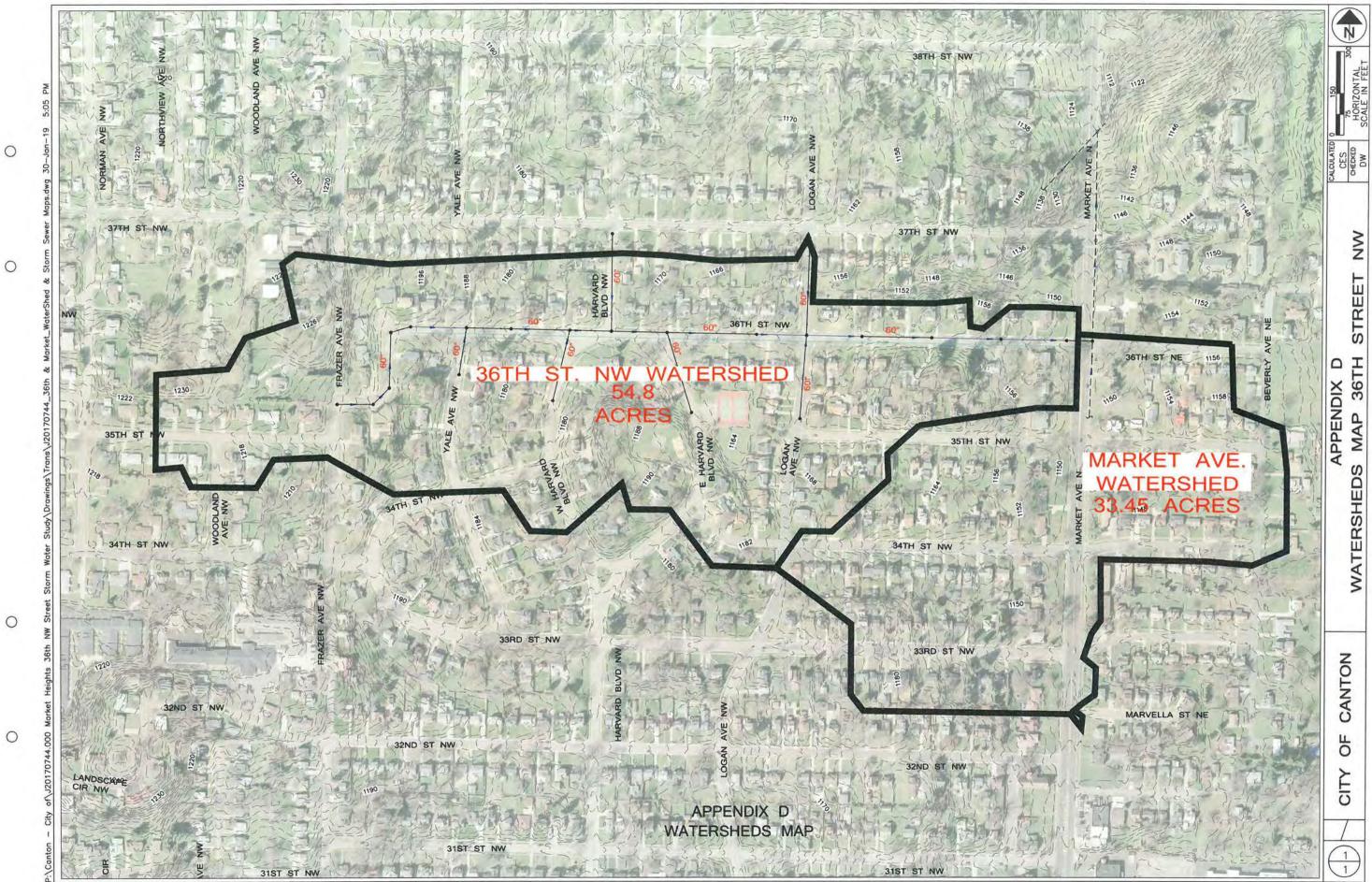
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Culvert

Appendix C. Project Limits Map



Appendix D. Watersheds Map



Appendix E. Discharge Analysis MODIFIED RATIONAL METHOD

Used for Estimating Detention Facility Storage Volumes in Ohio Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1/9/2017

SITEIN	SITE INPUT INFORMATION	MATION
Site Name & Location:	Market Ave	Site Name & Location: Market Ave watershed draining to vicinity of 36th St
Date:		11/5/2018
Input By:		CDB
Ohio Rainfall Area (Intensity Zone):	A	(Select A,B,C, or D)
Note: The Rainfall Intensity Area value c	an be foun	Note: The Rainfall Intensity Area value can be found from Figure 1101-3 in Ohio Department
Of Transportation's Location & D	esign Mani	Of Transportation's Location & Design Manual - Volume II - Drainage Design.
Note: Canton is in Area "A".	rea "A".	
Pre-Dev	Pre-Developed Conditions	nditions
Time of Concentration, T _c =	30	minutes (range 10 to 200)
Drainage Area, A =	33.450	acres (should not exceed 30)
Composite Runoff Coefficient, C =	0.3	(range 0.00 to 1.00)
Post-Dev	Post-Developed Conditions	Inditions
Time of Concentration, T _e =	30	minutes (range 10 to 200)
Drainage Area, A =	33.450	acres (should not exceed 30)
Composite Runoff Coefficient, C =	0.3	(range 0.00 to 1.00)

YSTEM	stream system (i.e. ditch, storm sewer, stream, etc.) that the site will discharge to:	HGL slope (without exceeding rim elevations along Market Ave just north of 33rd St) results in a "pressurized" capacity of approx. 49.9) of downstream system = 49.9 [cfs (assuming "open channel flow" conditions)	convey without flooding? 100 year storm runoff (MUST consider runoff from entire contributing drainage area)	1 data
REAM S	orm sewe	g rim elev		49.9	100	Surveyed
20000000000000000000000000000000000000	Description of existing downstream system (i.e. ditch, sto	Area discharges into existing 36" storm sewer along E side of Market Ave. The HGL slope (without exceeding	cfs.	Minimum capacity ("chokepoint") of downstream system =	Approx. which storm event can the downstream system adequately convey without flooding?	Is the above "chokepoint" capacity based on approximated or surveyed data? Surveyed data

torm	Area	a (Intensity Zor	ne) A	Mrea (Intensity 2	cone) B	Area	(Intensity Zon	le) C	Area	(Intensity Zo	as/B
Event	1	Peak Flow	Volume		Peak Flow	Volume		Peak Flow	Volume		Poak Flow	Victoria
(Year)	(in/hr)	(cfs)	(cf)	(in/hr)	(cfs)	(cf)	(in/hr)	(cfs)	(cf)	(112/FWT)	(cls)	(cf)
2	1.99	19.92	35,856	205	20,70	37.255	222	22.32	40.169	20.0	1100	AN DEG
5	2.46	24.64	44,350	2.53	25.43	45.779	2.70	27.05	45.601	02.0	37.05	12 882
10	2.81	28.24	50,832	2.81	20.16	52,480	3,06	30.75	55 359	5	31.46	50,272
25	3.27	32.85	59,133	3,37	1000	60,867	3,85	35.50	54 113F	3.60	35.37	65.470
50	3.62	36.31	65,350	3.68	36,82	66.470	100 27	38.94	70,090	2.02	201 30	EVE CL
100	3.96	39.72	71,492	-20B	40.98	73.764	114	at 50	75.404	TR P	13.56	10000

Note: Volumes for pre- and post-developed peak flows are based on "3 Point Triangular Hydrographs" derived from application of standard Rational Method

Storm	Area	Intensity Z	one) A	Area	Intensity 2	one) B	Area	(Intensity Zor	one) C	Area	(Intensity Zni	10/11
Event	1	Peak Flow	Volume		Peak Flow	Volume		Peak Flow	Volume		Peak Flow	Volume
(Year)	(in/hr)	(cfs)	(cf)	(jra/lar)	(cfs)	(Cf)	(in/hr)	(cfs)	(cf)	(in/hr)	(cfs)	(10)
2	1.99	19.92	35,856	2,16	20.70	37,235	2.23	20.35	30.180	166	24.47	40 020
5	2.46	24.64	44.350	2,523	57 50	45.779	2 70	27.05	48.981	102	1111	100.000
10	100	10 00	0000	in sol	100 40	A DECEMBER OF THE PARTY OF THE	1 1 1	1000	100104	11-5	61.143	100101
	107	47.07	20'03K	1272	a/-r2)	006-102	202	34.75	35,250	8/13	31.46	58.672
25	3.27	32.85	59,133	3.37	33,83	80,887	1.55	35.58	64.035	5.62	36.57	65 470
50	3.62	36.31	65,350	3,65	36,93	G6.470	3.88	33.94	70,090	4.02	40.30	72 543
100	3.96	39.72	71,492	1.05	40.95	73,764	4.18	41.90	75,424	4.37	13.86	78,956

MRM_CDB_01092017_MARKET AVE WATERSHED.xlsx

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MODIFIED RATIONAL METHOD Used for Estimating Detention Facility Storage Volumes in Ohio

Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1/9/2017

	ŝ	36th St NW vicinity of Logan Ave 11/21/2018
Site Name & Location:		11/21/2018
Date:		
Input By:		CDB
Ohio Rainfall Area (Intensity Zone):	A	(Select A,B,C, or D)
Note: The Rainfall Intensity Area value ca	in be foun	Note: The Rainfall Intensity Area value can be found from Figure 1101-3 in Ohio Department
Of Transportation's Location & Design Manual - Volume II - Drainage Design.	sign Man	Jal - Volume II - Drainage Design.
Note: Canton is in Area "A",	ea "A",	
andra and a state and a state and a state of the state of	Pre-Developed Conditions	nditions
Time of Concentration, T _c =	18	minutes (range 10 to 200)
Drainage Area, A =	54.800	acres (should not exceed 30)
Composite Runoff Coefficient, C =	0.3	(range 0.00 to 1.00)
Post-Dev	eloped C	Post-Developed Conditions
Time of Concentration, T _c =	18	minutes (range 10 to 200)
Drainage Area, A =	54.800	acres (should not exceed 30)
Composite Runoff Coefficient, C =	0.3	(range 0.00 to 1.00)

STEM	ownstream system (i.e. ditch, storm sewer, stream, etc.) that the site will discharge to:	m course of Morket Aust	III SEWEI AL AVE.	cfs	2 year storm runoff (MUST consider runoff from entire contributing drainage area)	data
REAM SYS	orm sewer,	ind 36" ctor	ine on fill	49.9	2	Surveyed
EXISTING DOWNSTREAM SYSTEM	Description of existing downstream system (i.e. ditch, sto	Area is nonneed to discharte into aviation 20 million and the discharted to an		apacit	Approx. which storm event can the downstream system adequately convey without flooding?	Is the above "chokepoint" capacity based on approximated or surveyed data? Surveyed data

Storm	Area	Area (Intensity Zor	ne) A	Area	(Intensity Zai	ne) B	Area	(Intensity Zone	ne) C	Area	(Intensity Zor	Tal D
Event	1	Peak Flow	Volume	1	Peak Flow	Volume	1	Peak Flow	Volume	-	Peak Flow	Volume
(Year)	(in/hr)	(cfs)	(cf)	(m/m)	(cls)	(cf)	(in/hr)	(cfs)	(c1)	l'im/hell	(cfs)	(c))
2	2.72	44.76	48,337	2,83	A5.50	50.224	3.04	16.6#	53,985	3.40.	50.90	55.067
5	3.32	54.56	58.921	Ext	56.33	60 834	3.64	50 26	10000	i i i	20.05	00000
10						10000	100	in the second se	100 10	ERY C	DEVEN	720 +0
DL	3.11	61.93	66,880	12:00	63.56	68,967	4.09	67.22	72.620	6. 5	58.02	74,434
25	4.34	71.27	76,971	1 /20	73.34	79,211	4.68	76.91	83.064	2,70	28.82	85,126
50	4.75	78.13	84,382	4.86	79.83	86,325	5,03	83.62	90.312	1910	86.56	787 25
100	5.16	84.81	91.592	al a	27.24	3104B		B0.01	07.345	11 40		ADA HEA

Note: Volumes for pre- and post-developed peak flows are based on "3 Point Triangular Hydrographs" derived from application of standard Rational Method

			PO	POST-DEVELO	PED PEAK FL	OWS (BASE	D ON RATE	ONAL METHO	(Q)			
Storm	Area	Intensity 2	Cone) A	Area	(Intensity Zor	1e) B	Area	(Intensity Zor	Te) C	Area	Untensity Zni	160 D
Event	1	Peak Flow	Volume	- F	Peak Flow	Volume	4	Peak Flow	Volume	+	Posk Flow	Valuato
(Year)	(in/hr)	(cfs)	(cf)	(authe)	(cfs)	(cf)	(in/hr)	(cfs)	(cf)	(in/int)	(cfs)	(cf)
2	2.72	44.76	48,337	2,853	46.50	50.224	3.04	49.87	33,465	2.10	Sh an	55.067
2	3.32	54.56	58.921	10,415	56.33	60.834	3 64	80.00	64.620	1.2.2	50.96	PARTS -
10	3.77	61 93	66 880	2.84	日本語は	32 047	0.00	27.54	and of	in all the	20100	700/10
25	4.34	71.27	76.971	a d6	78.82	100000		76.04	1 A (0) (0)	04.2	10 00	01 - 10
50	4.75	78.13	84.382	.86	10.93	86.325	2.00	63.82	90.31	Dis I	20.3C	031,60
100	5.16	84.81	91,592	5.3	87.24	84,248	5.48	10.06	97.218	5.70	23.67	101.164

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MODIFIED RATIONAL METHOD

Used for Estimating Detention Facility Storage Volumes in Ohio Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S

Version 1/9/2017

	Area	Area	Area	AFRE
Storm	(Intensity	Untensity	(Intensity	(Interesty)
Event	Zone) A	Zone) B.	Zone) C	Zone) D
	Volume	Volume	Volume	Valume
(Year)	(cf)	(ct)	(c1)	(0)
2	0	0	. 0	p
2	0	c	0	0
10	0	ē	12	0
25	0	÷0.	ci	()
50	0	c	D	D
100	0	0	0	d

misapplied and result in severely underestimated storage volumes when compared to volumes determined from application of the Modified Rational Method. Note: The above chart is provided to show how the standard Rational Method can be

Storm Event	Pre- Developed Peak Flow from Site	Down- stream System "Choke- point" Capacity	Proportional Flow from Site Allowed in Downstream System	Recom- mended Allowable Detention Facility Outflow*	Selected Detention Facility Outflow	Max. Post- Developed Peak Flow to Detention Facility	Maximum % Reduction in Post-Dev. Peak Flow
(Year)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(%)
2	44.76	49.90	44.76	44.76	30.00	44.76	32.97
5	54.56	49.90	44.76	44.76	25.30	54.56	53.63
10	61.93	49.90	44.76	44.76	21.70	61.93	64.96
25	71.27	49.90	44.76	44.76	17.10	71.27	76.01
50	78.13	49.90	44.76	44.76	13.60	78.13	82.59
100	84.81	49.90	44.76	44.76	10.20	84.81	87.97

		Area (Intensity Zone) A	ity Zone) A			Area (Intens	ity Zonel B			Area (Intens	Intensity Zone) C			Area (Intens	nlensily Zone) D	
Storm Event	Volume	Critical Duration	Resulting Intensity	Resulting Peak Inflow	Volume	Sritical Duration	Rasulting. Intensity	Resulting Peak Inflow	Volume	Critical Duration	Resulting	Resulting Peak Inflow	Volume		10 2	Resulting Peak Inflov
(Year)	(cf)	(min)	(in/hr)	(cfs)	(2)	(mim)	(in/hr).	(cis)	(cf)	(mim)	(in/hr)	(cfs)	(c!)	(mim)	(in/hr)	(Cfs)
2	16,476	23	2.353	38.68	18,562	24	2.381	39.14	22,947	26	2.439	-30.05	24.293	38	087 C	30.91
2	36,500	35	2.222	36.54	35.954	220	2 294	37.71	44,025	100	7,350	AR. P.O.	44 028	1.0	1 280	10 mil
10	55,107	47	2.101	34.55	58 150	EF.	2136	14-52	63 656	69	2,185	35.07	56.474	i i	and c	36.35
25	85,106	76	1.779	29.24	88.247	52	1.038	30.21	162.46	12	1 935	51.87	250 26	182	1 012	20 A R
50	115,788	119	1.463	24.05	117,194	318	1.475	PZ V2	122,231	105	1.654	27 19	129,851	Ell	1.66.1	27.14
100	158,631	200	1.142	18.78	156.375	122	1 237	20.34	159,578	183	1 225	20.15	169,424	84	1.274	20.95
	Maxim	Maximum Volume =	158,631	cubic feet	Maximu	in Valanie -	158.372	- cubic feel	Maximus	= Shume =	159,576	Cubic Feel	Maximut	m Volumud =	ACA BRA	numer fact

Caution! A critical duration of 200 minutes exists for selected intensity area (zone). Further evaluation is advised since spreadsheet does not evaluate durations longer than 200 minutes. Storage routing calculations MUST be performed to ensure estimated detention volume is adequate! Tailwater must be taken into consideration when routing!

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RAINFALL INTENSITY EQUATION

i=a/(t+b)^c

Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1/9/2017

1010100		Area	Intensity Zo	one) A		
1999,0488	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
a=[46.184	56.985	64.167	66.528	65.702	64.489
b=	9.000	10.250	11.000	11.000	10.750	10.500
c=	0.859	0.851	0.842	0.811	0.782	0.754

12000003		Area (Intensity Zo	one) B		antes Carles
	2 vr	5 yr	10 yr	25 yr	50 yr	100 yı
a =[47.987	60.684	73.126	75.841	65.621	85.047
b =	9,000	10.500	12.000	12.000	10.000	13.250
c =	0.859	0.858	0.863	0.833	0.781	0.806

		Area	Intensity Zo	one) C		1111111111
eleteret const	2 VF	5 vr	10 yr	25 yr	50 yr	100 yr
a = [56,299	67.933	84.550	95.736	96.783	80.436
b =	10.000	11.000	13.000	14.000	14.000	11.500
c=	0.876	0.869	0.882	0.871	0.850	0.794

0001000264-5		Area	Intensity Zo	one) D		
	2 vr	5 vr	10 yr	25 yr	50 yr	100 yr
a=[57,448	67.933	79.192	87.886	95.169	91.982
b=	10.000	11.000	12.000	12.750	13.500	13.000
c =	0.876	0.869	0.864	0.849	0.839	0.810

Note: The above values are taken from Ohio Department Of Transportation's Location and Design Manual - Volume II - Drainage Design. The user must ensure the above values are consistent with values from the current edition of the manual and revise them as necessary.

RATIONAL METHOD PEAK FLOW HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A" Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWO, CMS4S

Pre-Develo	ped Co	aditions			blavad-1504	ped Cont	litions	
Time of Concentration, T _e		18	minutes	Time of (Time of Concentration, T _c		18	minutes
Drainage Area, A =		54.8	acres		Drainage Area, A =		54.8	acres
Composite Dunoff Coefficient C =	,	0.3		Composite Run	Composite Runoff Coefficient, C =		0.3	

Composite Runoff Coefficient, C =

(cfs)

Q coordinate

(mlm)

Pre-Developed Peak Flow Hydrograph

Points & Values

10-Year Storm Event

		Time coordinate	x1	×2	x3		Time coordinate	¥,	x2	x3	un in		60.00	60 CC	00.06	40.00	(4) D	30.00	20.00	to the		0.00 10.00 5.0		Present and
		(cfs)	0.00	54,56	0.00		(cfs)	00'0	54.56	0.00												35.00 40.00	drograph	58,920.91 58,920.91
o-rear Storin Event	Pre-Developed Peak Flow Hydrograph Dotets & Values	Q coordinate	Y1	y2	y3	Post-Developed Peak Flow Hydrograph Points & Values	Q coordinate	y1	y2	y3	5-Year		18,00, 54,56	/	/	/	/	/	/			20.00 25.00 30.00 Time (min)	raph Post-Dev Peak Q Hydrograph	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =
VIC IPAL-C	Pre-Developed Peak Flow P Points & Values	(min)	0.00	18.00	36.00	ost-Developed Pea	(min)	0.00	18.00	36.00	5-Y			/	/	/	/	/				10.00 15.00	Pre-Dev Pesk O Hydrograph	Jeveloped Peak Q I
		Time coordinate	xt	x2	x3		Time coordinate	x1	x2	x3		00'00	to to	- Contract	40.00	1 10-	(eto) (8 8	2	20100	0001	/	0.00 5.00	1	Pre-I
	1	(cfs)	0.00	44.76	0.00		(cfs)	0.00	44.76	0.00												35.00 40.00	hograph	48,336.55 48,336.55
rm Event	r Flow Hydrograph	Coordinate	ł	y2	y3	loped Peak Flow Hydrograph	Values O coordinate	vi	y2	y3	ar		18.00, 44.76	/	/	/	/	/	/			20.00 25.00 30.00	ane (mm) aph Post-Dav Peak Q Hydrograph	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =
2-Year Storm Event	Pre-Developed Peak Flow Hydrograph	Points & Values	0.00	18.00	36.00	Post-Developed Pea	Points & Values	0.00	18.00	36.00	2-Year		-	/	1	/	/	/				10,00 15.00	nme 	Pre-Developed Peak Q Hydrograph Area (cf) = ost-Developed Peak Q Hydrograph Area (cf) =
		Time coordinate		22	x3			I Ime coordinate	x2	×3		20.00	45.00 -	40.00	35.00	30.00	(efs) 25.00	20.00	15.00	10.00	5:00	0.00 0.00 0.00 0.00	I	Pre-

10.00 Y 18.00 y2 36.00 y2 Post-Developed Pask Flow Hydrograph Points & Values (min) Q coordinate 10.00 y1 10.00 y2	10.00 Y2 61 18.00 y2 61 Post-Developed Peak Flow Hydrograph 0.0 0 Points & Values Points & Values 0 0 10.00 y1 0 0 0 110-Year 10-Year 0 0 0 0 13.00 y2 61 0 <th></th> <th></th> <th></th> <th>000</th>				000
18.00 y2 36.00 y3 Post-Developed Peak Flow Hydrograph Post-Developed Peak Flow Hydrograph Image: Construct the stress of th	18.00 y2 36.00 y3 Post-Developed Peak Flow Hydrograph Points & Values (min) Q coordinate 0.00 y1 18.00 y2 36.00 y1 0.00 y1 18.00 y2 36.00 y3 36.00 y2 56.00 y3 10-Year 1 10-Year 1 <t< td=""><td>x1</td><td>00'0</td><td>K.</td><td>0.00</td></t<>	x1	00'0	K.	0.00
x3 36.00 y3 Econdinate (min) Q coordinate x1 9.00 y1 x2 36.00 y2 x3 36.00 y2 x00 10-Year 1 x00 10.00 et ta 10	36.00 y3 0. Post-Developed Peak Flow Hydrograph Points & Values 0.0 Points & Values 0.00 y1 0.0 10.00 y2 61 0.0 18.00 y2 61 0.0 36.00 y2 61 0.0 10-Year 1 0.00 93 0.0 10-Year 1 1.0 0.0 0.0 10-Year 1 1.0 90 0.0 0.0 10-Year 1.0 93 0.0 0.0 0.0 0.0 10-Year 1.0 90 90	×2	18.00	y2	61.93
Post-Developed Peak Flow Hydrograph Points & Values (min) Q coordinate 0.00 y1 18.00 y2 36.00 y3 10-Year	Post-Developed Peak Flow Hydrograph Points & Values Romoting Q coordinate (c) 0.00 y1 0.0 18.00 y2 61 36.00 y3 0.0 10-Year 10-Year 0	x3	36.00	y3	0.00
Post-Developed Peak Flow Hydrograph Points & Values (min) 0.00 y1 18.00 y2 36.00 y2 10-Year	Post Developed Peak Flow Hydrograph Points & Values Points & Values V1 C 0.00 V1 0.0 0 18.00 V2 61 0 36.00 Y2 61 0 36.00 Y2 61 0 10-Year 1 1 0 0 10 1 1 0 0 10 1 1 1 0 10 1 1 1 0 10 1 1 1 1 10 1 1 1 1 10 1 1 1 1				
(min) Q coordinate 0.00 y1 18.00 y2 36.00 y3	(min) Q coordinate (c 0.00 y1 0 0 18.00 y2 61 0 36.00 y3 0 0 10-Year 10-Year 0 0 36.00 y3 0 0 0 10-Year 10 0 0 10-Year 10 0 0 0 10 10 10 10 0 0 10 10 10 10 0 0 0 10 10 10 10 10 0 0 0 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10		Post-Developed Point	Peak Flow Hydrograph is & Values	
0.00 y1 18.00 y2 36.00 y2 10-Year	0.00 y1 0.10 18.00 y2 61 36.00 y3 0 10-Year 10 61 10-Year 10 0 10-Year 10 0 10 35.00 y3 0 0 0 32 0 0 10 1 10 10 10 10 1 10 10 10 10 10 1 10 10 10 10 10 10 1 10 10 10 10 10 10 10 1 10 10 10 10 10 10 10 1 10	e coordinate	(min)	Q coordinate	(cfs)
10. y2 36.00 y3 10.Year	x2 13.00 y2 61 x3 36.00 y3 00 0 50.0	×1	0.00	71	0.00
x3 36.00 y3 2000 40.00 2000 2000 10-Year 10-Year	x3 36.00 y3 0 700 10-Year 10-Year 0 6000 40.00 10-Year 10 9000 40.00 1000 1000 1000 9000 000 1000 1000 1000 1000 9000 000 15.00 20.00 25.00 20.00 25.00 9000 0.00 15.00 20.00 25.00 20.00 26.00 9000 2000 15.00 20.00 25.00 20.00 26.00 9000 500 15.00 20.00 25.00 20.00 26.00 9000 500 15.00 20.00 25.00 20.00 26.00 9000 500 25.00 20.00 25.00 20.00 26.01 9000 500 15.00 26.01 90.00 26.01 26.01	x2	18.00	y2	61.93
10-Ye 20:00 40:00 20:00 20:00 10:00 20	10-Year 10.00	x3	36.00	y3	0,00
7000 5000 40.00 20.00 20.00	7000 40.00 40.00 20.		÷	0-Year	
60.00 50.00 20.00 20.00 10.00	6000 5000 2000 000 000 000 000 000	20,07			-
	90.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 15.00 25.00 10.00 15.00 25.00 25.00 10.00 15.00 25.00 25.00 15.00 25.00 15	60.00		A 18.00.01.03	
	40.00 20.00 20.00 0.0	50.00		/	
	30.00 20.00 0.00		/	/	
2000	Pre-Developed Peak Q Hydrograph Area (c) = 66.		/	/	
1000	Pre-Developed Peak Q Hydrograph Area (cf) = 66,	20,00	/		
	Contraction Contracti	10.00			/
		Ľ	- Prs-Dev Pesk O Hys	+	Hydrograph
+		Pre	-Developed Peak	Q Hydrograph Area (cf) =	
Hydrogra		Post	t-Developed Peak	Q Hydrograph Area (cf) =	

11/21/2018

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RATIONAL METHOD PEAK FLOW HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A" Spreadsheet created by Christopher D. Bames, PE, CPESC, CPSWQ, CMS4S

Versi	on 1/9/2017	
Pre-Developed Conditions	Post-Developed Conditions	
ie of Concentration, T _o = 18 minutes	Time of Concentration, T _c = 18	minutes

Time of Concentration, T _o	18	minutes	Time of Concentration, T _c =	18	minutes
Drainage Area, A	54.8	acres	Drainage Area, A =	54.8	acres
omnosite Runoff Coefficient C	0.3		Composite Runoff Coefficient, C =	0.3	

0.00 84.81

0.00

(cfs)

84.81

0.00

00'0 (cfs)

The second second second second	Pre-Developed Peak Flow Hydrograph Points & Values	Q coordinate	14	y2	y3	Post-Developed Peak Flow Hydrograph	Points & Values	Q coordinate	ł	y2	y3	100-Year	10.00, 84.81 2000 25.00 30.00 2000 25.00 30.00 2000 25.00 30.00	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) = Difference Between Hydrograph Areas (cf) =
Contraction of the second s	Pre-Developed Pe Points	(min)	0.00	18.00	36.00	Post-Developed P	Points	(min)	00.00	18.00	36.00	100	0 0 10 00 15 00 2 11ma	Developed Peak Q Developed Peak Q fference Between I
		Time coordinate	x1	x2	x3			Time coordinate	*	¥2	×3		0000 00000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000	Pre-
		lefel	0.00	78.13	0.00	T		(cfs)	0.00	78.13	0.00		35 00 45,000	84,381.91 84,381.91
	c Flow Hydrograph Values	O coordinate	y	y2	y3	k Flow Hvdrograph	Values	Q coordinate	4	y2	y3	ear	16.00. 78.13 20.00 26.00 30.00 36.00 28.00 26.00 30.00 36.00 28.00 26.00 20.00 26.00	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =
	Pre-Developed Peak Flow Hydrograph	(min)	0.00	18.00	36.00	Post-Developed Peak Flow Hvdrograph	Points & Values	(min)	0.00	18.00	36.00	50-Year	10.00 15.00 Pre Dev Paak O Hydro	Developed Peak Q H Developed Peak Q H
		The summary	x1	×2	x3			Time coordinate	x1	×2	×3		80 80 80 80 80 80 80 80 80 80	Pre-
	1		0.00	71.27	0.00			(cfs)	0.00	71.27	0.00		000 95 00 000 100 000 000 000 000 000 000 000	76,970.67 76,970.67
	(Flow Hydrograph	Values	Q COORDINATE	v2	y3	the state of the state and state of the	K Flow Hydrograph	Q coordinate	14	y2	y3	ear	11 200, 71 27 2000 25.00 30.00 35.00 Time (min) - Post O Hydropren	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =
	Pre-Developed Peak Flow Hydrograph	POINTS & VAIUES	(min)	18.00	36.00		Post-Developed Peak Flow Hydrograph	(min) Q C	0.00	18.00	36.00	25-Year	16.00 15.00 - Pie-Dev Peak O Hydrog	re-Developed Peak Q Hydrograph Area (cf) st-Developed Peak Q Hydrograph Area (cf)
			Time coordinate	cx	2			Time coordinate	xt	22	x3		(ma) 0 (ma) 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Pre-

11/21/2018

30.00-0.00 40.00

35.00

91,592.14 91,592.14

Post-Dev Peak Q Hydrograph

0.00

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MODIFIED RATIONAL METHOD HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A" Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1932017

Time of Concentration, Te	18	minutes	Time of Concentration, T _c	•	18	minutes
Drainage Area, A =	54.8	acres	Drainage Area, A =		54.8	acres
Comments Dunoff Coofficient C	0.3		Composite Runoff Coefficient, C		0.3	

Time coordinate x1		2-Year Storm Even							a state of the sta	The second se	
Time coordinate x1	Estimated Out	Estimated Outflow Hydrograph			Estimated Out	Estimated Outflow Hydrograph Dointe & Values			Estimated Out Points	Estimated Outflow Hydrograph Points & Values	
x1 x1	(min)	Points & Values D coordinate	(cfs)	Time coordinate	(mim)	Q coordinate	(cfs)	Time coordinate	(min)	Q coordinate	(cfa)
1	0.00	ł	0.00	x1	0.00	71	0.00	x	0.00	71	00.0
X	27.04	22	30.00	x2	40.54	y2	25.30	x2	53.69	72	21.70
×3	59.31	y3	0.00	x3	101.09	y3	0.00	x3	149.65	y3	0.00
	Modified Infie	Modified Inflow Hydrograph			Modified Infic	Modified Inflow Hydrograph			Modified Infi	Modified Inflow Hydrograph	
	Pointa	Pointa & Values			Points	Points & Values			Points	Points & Values	
Time coordinate	(min)	Q coordinate	(cfs)	Time coordinate	(min)	Q coordinate	(cfs)	Time coordinate	(mim)	Q coordinate	(cfs)
¥	0.00	*	0.00	x	0.00	14	00.00	¥1	00.0	۲	00'0
x2	18.00	y2	38.68	x2	18.00	y2	36.54	×2	18.00	y2	34.55
x3	23.00	¥3	38.68	x3	35.00	y3	36.54	Q 1	47.00	er a	34.55
X4	41.00	yd	0.00	X4	00.00	- X4	000		2000		
	2-1	2-Year			5-1	5-Year			10.	10-Year	
45:00			Ī	40.00				40.00			
- 00 04	-+++ 00, 238 881 38 68	38.66		35.00	18.00, 36 6435 00, 36 54	2		35.00	-18:00-34:55 47,00, 34,55	(56	
35.00 -	2			30.00	-			30.00			
30.00	X	27.04, 30.00		100 M	A 40 54	40 54 25 30		26.00	_		
25.00	1	/			4			(4	63.63	53,69, 21,70	
30.00	/	/		a (a)	/	/		0 50 B	1	1	
1500		/		15,00	/	/		00.51	/	/	
/ mm		/		10:00		/		10.00	/	/	
11		/		5.00		/		2005		/	/
2005								and me			1
0.00 10.00 10.00	20.00 30	30.00 40.00 50.00 Three (min)	60.00 70.00	0.00 20 20 20	20.00 40.00	60.00 80.00 Time (min)	100,00 120,00	0.00 20.00	40.00 60.00	80.00 100.00 120.00 Time (min)	140.00 160.00
	Entineted Outflow Hydrograph	tograph Medified Inflow Hydrograph	hograph	1	Essmated Cutliow Hydrograph	righting	their agree of the			Rograph Modified Inflow Hyttrograph	Hydrograph
Area un Area under	ider Modified Ir r Estimated Out	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) =	53,376.32 53,376.32	Arei Area ur	a under Modified In nder Eatimated Out	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) =	76,727.36 76,727.36 36 500 36	An Area (Area Under Mod. Ir	ea under Modified II under Estimated Ou nflow Hvd. & above	Area under Modified Inflow Hydrograph (cf) = Area under Ettimated Outflow Hydrograph (cf) = Area under Mod Inflow Hyd. (c6) =	97,421.83 97,421.83 55.106.83
Area under Mod. Innow		Area under mod. Innow ryd. a above tst. Outnow ryd. (u) - Critical Duration (min) =	23.00		0	Critical Duration (min) =	35.00			Critical Duration (min) =	
		eterne Renter Francis (SDE) -	86.1		Storm D	Storm Duration Factor (SDF) =	1.94		Storm	Storm Duration Factor (SDF) =	2.61

11/21/2018

MRM_CDB_01092017_36TH ST WATERSHED.xlsx

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MODIFIED RATIONAL METHOD HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A" Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 192007

Pre-Daveloned Co	aditiona.			of Charlieland	
Time of Concentration, T _c =	18	minutes	Time of Concentration, T _c =	18	minutes
Drainage Area, A =	54.8	acres	Drainage Area, A	s4.8	acres
Composite Runoff Coefficient, C =	0.3		Composite Runoff Coefficient, C =	0.3	

0.00

0.00

(cfs)

18.78

00.0

(cfs)

00.0

100-Year Storm Event	Estimated Outflow Hydrograph	Points & Values	y1	y2	y3	Modified Inflow Hydrograph	Points & Values	Q coordinate	71	y2	y3	y4	Year						/	/	/	400.00 500.00 600.00 70 Time (min)	raph Modified Inflow Hydrogra	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Mod. Inflow Hyd. (cg) = Critical Duration (min) = Critical Duration (min) =
100-Year S	Estimated Out	(min)	0.00	208.22	736.40	Modified Infic	Points	(min)	00'0	18.00	200.00	218.00	100-Year	9 200.00, 18.78				208.22, 10 20				200.00 300.00		under Modified Infi ler Estimated Outfi w Hyd. & above Es Cri tove entitori duratio
		Time coordinate	×	x2	K3			Time coordinate	¥	x2	×3	X4		20.00	19.00	14.00	12.00	040) D 2 8 8	008	400		0.00 1 0.00 100.00	ł	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Critical Duration (min) = Califord Above utilical duration is at maximum 's unit
		(cfa)	00.0	13.60	0.00			(cfs)	00.0	24.05	24.05	0.00								_	/	400.00 450.00	trograph	171,683,54 171,683,54 115,787,54 119,00
rm Event	w Hydrograph	Q coordinate	14	y2	y3	Hydrograph	Values	Q coordinate	r,	y2	by B	yd	ar						/	/		0.00 250.00 300.00 350.00 Time (min)	h Modified Inflow Hydrograph	dified Inflow Hydrograph (cf) = ated Outflow Hydrograph (cf) = above Est. Outflow Hyd. (cf) = Critical Duration (min) =
50-Year Storm Event	Estimated Outflow Hydrograph	(min)	0.00	126.82	420.79	Modified Inflow Hydrograph	Points & Values	(mim)	0.00	18.00	119.00	137.00	50-Year		119.00, 24.05		_	A 128.82 13.60	/		_	100.00 150.00 200.00 250.00 Time (min)	Estimated Outflow Hydrograph	Area under Modified Inflow Hydrograph (cf) = Area under Eatimated Outflow Hydrograph (cf) = Rod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Critical Duration (min) =
		Time coordinate	1*	x2	x3			Time coordinate	¥	x2	x3	×4		30.00	25.00 -18.00,24.05	20,00		0 (chi	10,00	2000	-	0.00 50.00	+	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) =
		(cfia)	0.00	17.10	0.00			(cfs)	0.00	29.24	29.24	0.00						-				250.00 300.00	ugraph	133,327.89 133,327.89 85,105.89 76.00
rm Event	w Hydrograph Values	Q coordinate	y1	y2	y3	Hydrograph	Values	Q coordinate	٢	y2	y3	y4	ar						/	/	/	200 00	th	dfifed inflow Hydrograph (cl) = ated Outflow Hydrograph (cl) = above Eat. Outflow Hyd. (cl) = Critical Duration (cont.) = Storm Duration Econo. (chic) =
25-Year Storm Event	Estimated Outflow Hydrograph Points & Vature	(min)	0.00	83.47	259.90	Modified Inflow Hydrograph	Points & Values	(min)	0.00	18.00	76,00	94.00	25-Year		18.00, 29.24 1 75 00, 29.24		_	01.71.710 83.47.17.10				100.00	- Estimated Cuttow Hydrograph	Area under Modified Inflow Hydrograph (cf) = Area under Eatimated Outflow Hydrograph (cf) = flod, Inflow Hyd. & above Est. Outflow Hyd. (cf) = Critical Duration (min) = Critical Duration (min) =
		Time coordinate	¥	x2	x3			Time coordinate	¥	x2	K3	x4		35.00	20.00	25.00	20.00 -	10 (cft 15 80	0001	200		0.00 50.00	Ŧ	Area under Modified Inflow Hydrograph (cf) = Area under Eatimited Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Critical Duration (min) = Storm Duration Econo. (SRC) =

MRM_CDB_01092017_36TH ST WATERSHED.xlsx

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800.00

700,007

diffed triflow Hydrograph

225,339.13 158,631.13 225,339.13

200.00

11.11

(maile

Used for Estimating Detention Facility Storage Volumes in Ohio MODIFIED RATIONAL METHOD

Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1/9/2017

Sito Name & Location	36	36th St and Market Ave watershed 11/21/2018
		11/21/2018
Date:		
Input By:		CDB
Ohio Rainfall Area (Intensity Zone):	A	(Select A.B.C. or D)
Vote: The Rainfall Intensity Area value ca	in be found	Note: The Rainfall Intensity Area value can be found from Figure 1101-3 in Ohio Department
Of Transportation's Location & Design Manual - Volume II - Drainage Design	sign Manu	ual - Volume II - Drainage Design.
Pre-Dev	Pre-Developed Conditions	nditions
Time of Concentration, T _c =	30	minutes (range 10 to 200)
Drainage Area, A =	88.250	acres (should not exceed 30)
Composite Runoff Coefficient, C =	0.3	(range 0.00 to 1.00)
Post could be a construction of the set Dev	Post-Developed Conditions	inditions
Time of Concentration, T _c =	30	minutes (range 10 to 200)
Drainage Area, A =	88.250	acres (should not exceed 30)
Comnosite Runoff Coefficient C =	0.3	(range 0.00 to 1.00)

Description of existing downstream system (i.e. ditch, storm sewer, stream, etc.) that the site will discharge to: Both watersheds will discharge into existing 36" storm sewer at Market Ave which has a maximum pressurized flow capacity of 49.9 cfs prior to surcharging out of top the top of the MH at Market Ave just north of cfs year storm runoff (MUST consider runoff from entire contributing drainage area) EXISTING DOWNSTREAM SYSTEM
 Maximum capacity of downstream system =
 49.9
 cfs

 Approx. which storm event can the downstream system adequately convey without flooding?
 2
 year

 Is the above "chokepoint" capacity based on approximated or surveyed data?
 Surveyed
 data
 33rd St.

Storm	Area	(Intensity Zor	Te) A	Area	(Intensity Zot	one) B	Area	(Intensity Zon	1e/ C	Area	Intertsity Zor	0 (9)
Event	1	Peak Flow	Volume		Peak Flow	Volume	-	Peak Flow	Values	-	ď	Volumo
(Year)	(in/hr)	(cfs)	(cf)	(in/hr)	(cls)	(cf) .	(in/hr)	(Efs)	(c?)	(In/hc)	(cfs)	100
2	1.99	52.55	94,597	200	54,65	98,290	223	58.85	105.975	78.6	80.08	108 138
2	2.46	65.00	117,007	2,53	87.10	120.77.8	35	71.35	128.434	020	201.145	108.474
10	2.81	74.50	134,108	102	76.92	138,457	3.06	31.12	146.050	ELC.	82.90	140 921
25	3.27	86.67	156,007	137	89.24	160,637	3.55	93.86	168 842	5.82	95.76	172.716
50	3.62	95.78	172,412	1.66	97,42	15.365	3.88	102.73	184 915	2.02	106 23	181 387
100	3.96	104.79	188.614	1,008	- DK-12	1 OA ROO	3.18	110.65	C 44	20. 2	12.210	000 000

POST-DEVELOPED PEAK FLOWS (BASED ON RATIONAL METHOD) Area (Intensity Zone) A

Note: Volumes for pre- and post-developed peak flows are based on "3 Point Triangular Hydrographs" derived from application of standard Rational Method

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28,43A 72 728 101,387

71,35

64

1135 21.14 93.8E 110.55

221/02 136,457

54.61 87.40 78.92 89.24 97.42

2.05 2.01 2.05 3.37 3.37 3.38 3.38

(cf) 94,597 117,007 134,108 156,007 172,412 172,412 188,614

(cfs) 52.55 65.00 74.50 86.67 95.78 95.78

2.46 2.81 3.27 3.62 3.96

25 50 100 10 N 40

2000

Volume

Flow

Peak Flow

Volume

Peak Flow

(in/hr)

Event Year) Storm

1.99

888,3883

95.96 105.33

168,842 28,434

124,975

10273

(75,365

808,48

108.15

193

Used for Estimating Detention Facility Storage Volumes in Ohio MODIFIED RATIONAL METHOD

Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1/9/2017 Maximum % Reduction in

Peak Flow to Developed Max. Post-

Selected Detention Facility

mended Allowable Detention

stream System "Choke-

Developed Peak Flow

Storm Event

Pre-

DETENTION CRITERIA

Recom-

Proportional Site Allowed Downstream

-uwoq

Flow from

Detention

Outflow (cfs)

Facility Outflow*

s

(cfs)

System (cfs)

Capacity (cfs)

(cfs)

(Year)

point"

from Site

Facility (cfs)

Peak Flow Post-Dev.

(%)

Storm (Intensity Event (Intensity Zone) A (Intensity Zone) B (Intensity Zone) B (Intensity Zone) D Year) Volume Volu		Area	Area	Area	Area
Zone) A Zone) B Zone) C Volume Volume Volume (cd) (cf) (cf) 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Storm	(Intensity	(Intensity	(Intensity	(Intensity
Volume Volume Volume V (cf) (cf) (cf) (cf) 0 (cf) (cf) (cf)	Event	Zone) A	Zone) B	Zone) C-	Zome\ D
		Volume	Volume	Velume	Valume
200000 22 22 22 22 20 0 0 0 0 0 0 0 0 0	(Year)	(cf)	(0)	(c)	(14)
20000 2210 20000 20000	2	0	12	0	ç
20 0 25 0 50 0 50 0 50 0	20	0	-TD-	¢.	.0
25 0 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	10	0	R	0	D
50 0 0 0	25	0	R	0	0
	50	0	L.	0	0

Storage routing calculations MUST be performed to ensure estimated detention volume is adequate! Tailwater must be taken into consideration when routing!

cubic feet

113,637

Maximum Volume =

100

Event Storm

(Year)

50 22 25

RAINFALL INTENSITY EQUATION

i=a/(t+b)^c

Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1/9/2017

RAINFALL INTENSITY EQUATION CONSTANTS FOR OHIO								
Area (Intensity Zone) A								
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr		
a = [46.184	56.985	64.167	66.528	65.702	64.489		
b =	9.000	10.250	11.000	11.000	10.750	10.500		
c =	0.859	0.851	0.842	0.811	0.782	0.754		

Area (Intensity Zone) B							
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	
a =[47.987	60.684	73.126	75.841	65.621	85.047	
b =	9.000	10.500	12.000	12.000	10.000	13.250	
c =	0.859	0.858	0.863	0.833	0.781	0.806	

Area (Intensity Zone) C							
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	
a = [56.299	67.933	84.550	95.736	96.783	80.436	
b =	10.000	11.000	13.000	14.000	14.000	11.500	
c =	0.876	0.869	0.882	0.871	0.850	0.794	

Area (Intensity Zone) D							
-	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	
a =	57.448	67.933	79.192	87.886	95.169	91.982	
b =	10.000	11.000	12.000	12.750	13.500	13.000	
c=	0.876	0.869	0.864	0.849	0.839	0.810	

Note: The above values are taken from Ohio Department Of Transportation's Location and Design Manual - Volume II - Drainage Design. The user must ensure the above values are consistent with values from the current edition of the manual and revise them as necessary.

Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S RATIONAL METHOD PEAK FLOW HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A"

minutes acres 88.25 30 Post-Developed Con Time of Concentration, T_o = Drainage Area, A = Version 1/9/2017 minutes acres 88.25 30 0.3 ante o Pre-Developed Condit Time of Concentration, T_e = Drainage Area, A = Composite Runoff Coefficient, C

0.3

Composite Runoff Coefficient, C

74.50

0.00

0.00

(cfs)

10-Year Storm Event	Pre-Developed Peak Flow Hydrograph	Points & Values		5	y3		rust-Developed Peak Flow Hydrograph Points & Values	Q coordinate	44	y2	1		30.00, 74,50	/	/	2	/		.00 40.00 50.00 Time (min)	M Post-Dev Peak Q Hydro	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =
10-Year S	Pre-Developed Pea	Points	000	30.00	60.00		Points /	(min)	0.00	30.00	10-Year		<	~	/				20.00 30	- Pre-Dav Pank O Hydrograph	eveloped Peak Q Hy eveloped Peak Q Hy
		Time coordinate	1	×2	x3			Time coordinate	×	2 5	2	00 00	8 8 8 9	80.00	(ata) 55.00 40.00	30.00	20.00	10:00	0.00 0.00 0.00	+	Pre-D Post-D
		(cfs)	0.00	65.00	0.00			(cfs)	0.00	65.00	000								00.00 70.00 00.00	fograph	117,007.38 117,007.38
rm Event	k Flow Hydrograph	Q coordinate	14	y2	y3	b Elmu Hudeneseeh	Values	Q coordinate	71	¥2 64			30.06, 65.00		/	/	/		100 40.00 50.00 Time (min)	Post-Dev Peak Q Hydrograph	re-Developed Peak Q Hydrograph Area (cf) = st-Developed Peak Q Hydrograph Area (cf) =
S-Year Storm Event	Pre-Developed Peak Flow Hydrograph	(min)	0.00	30.00	60.00	Doct-Developed Death Flow Workson	Points & Values	(min)	0.00	30.00	5-Year		<	1	/				20.00	Pro-Dav Pask Q Hydrograph	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =
		Time coordinate	¥	x2	x3			Time coordinate	xI	X 72		70.00	80 88	50.00	(eha) (6, 8	808	20.00	- 00'01	0.00 0.00 10.00	t	Pre-D Post-D
		(cfs)	0.00	52.55	0.00			(cfs)	0.00	52.55 0.00									60.00 70.00	rograph	94,596.60 94,596.60
m Event	Flow Hydrograph Values	Q coordinate	y1	y2	y3	c Flow Hvdrooraph	Values	Q coordinate	y1	y2 y3			30.00. 52.55	/	/	/	/		00 40.00 50.00 Time (min)	Post-Dev Peak Q Hydrograph	rograph Area (cf) = rograph Area (cf) =
2-Year Storm Event	Pre-Developed Peak Flow Hydrograph Points & Values	(min)	0.00	30,00	60.00	Post-Developed Peak Flow Hvdrograph	Points & Values	(min)	0.00	30.00	2-Year		ē	/	/	/			20.00 30	- Pre-Dev Peak Q Hydrograph	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =
		Time coordinate	×1	x2	x3			Time coordinate	x	X2 X2		00'00	- 00'09	40.00	(sia) 0	20.00	/	0000	0.00 - 0.00 - 0.00 - 0.00	Ľ	Pre-D Post-D

00:00:0:00 74.50 (cfs) 0.00 0.00 Peak Q Hydrograph 00'00 00.00

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Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S RATIONAL METHOD PEAK FLOW HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A"

minutes acres 88.25 0.3 30 Post-Developed Conditions Time of Concentration, T_e = Drainage Area, A = Composite Runoff Coefficient, C = Version 1/9/2017 minutes acres 88.25 30 0.3 Pre-Developed Conditions Drainage Area, A = Time of Concentration, T_o = . Composite Runoff Coefficient, C

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torm Event	Pre-Developed Peak Flow Hydrograph	Points & Values	Q coordinate	y1	y2	y3	Post-Daveloned Deak Flow Hudenorsh	Values	Q coordinate	41	¥2	y3	'ear		1000	30.00, 104.70	/	/	/	/	/	/		00 40.00 50.00 Time (min)	h Post-Dev Peek Q Hy	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =
100-Yéár Storm Event	Pre-Developed Pea	Points 6	(min)	00.0	30.00	60.00	Post-Davaloned Des	Points & Values	(min)	0.00	30.00	60.00	100-Year			<	1	1	/	/				20.00		eveloped Peak Q Hy eveloped Peak Q Hy
			Time coordinate	xt	x2	x3			Time coordinate	×1	x2	x3		120,00	6	100.00 -		80.00	(s)		40.00	1	20.00	0.00 0.00 10.00	t	Pre-D Post-D
			(cfs)	0.00	95.78	0.00			(cfs)	0.00	95.78	0.00												00:00-00:00 00:00 70:00	rograph	172,411.91 172,411.91
orm Event	(Flow Hydrograph	Values	Q coordinate	*	y2.	y3	k Flow Hydrograph	Values	Q coordinate	y1	y2	y3	ar			30.00, 95.78		/	1	/	/	/		00 40.00 50.00 Time (min)	- Post-Dev Peak O Hydrograph	re-Developed Peak Q. Hydrograph Area (cf) = st-Developed Peak Q. Hydrograph Area (cf) = Difference Between Lutercorrech Access (cf) =
50-Year Storm Event	Pre-Developed Peak Flow Hydrograph	Points & Values	(min)	0.00	30.00	60.00	Post-Developed Peak Flow Hydrograph	Points & Values	(min)	00.0	30,00	60.00	50-Year					1	/	/				20.00 30	Pre-Dev Peak, C Hydrograph	Pre-Developed Peak Q. Hydrograph Area (cf) = Post-Developed Peak Q. Hydrograph Area (cf) = Difference Bottomon Undersonal Actor (cf) =
			Time coordinate	X	x2	£x			Time coordinate	x	x2	x3		120.00		100.00		80.00	619) 6100	ø	40.00			0.00 0.00 0.00	+	Pre-D Post-D
			(cfs)	0.00	86.67	0.00	Ι		(cfs)	0.00	86.67	0.00												60.00 70.00	ograph	156,007.41 156,007.41 0.00
The property in the second sec	Flow Hydrograph	santes	Q coordinate	LK.	2	y3	Flow Hydrograph	/alues	Q coordinate	łł	y2	y3	ar		30.00, 86.67		/	/	/	/	/	/	/	0.00 40.00 50.00 Time (min)	Past-Dev Pesk Q Hydrograph	rograph Area (cf) = cograph Area (cf) = ograph Areas (cf) =
COLLEGE ONDER THE PARTY	Pre-Developed Peak Flow Hydrograph	LOINS & VAIUES	(min)	0.00	30.00	60.00	Post-Developed Peak Flow Hydrograph	Points & Values	(min)	0.00	30.00	60.00	25-Year		00	<	1	/	/	/				20.00	- Pre-Dev Peak Q Hydrograph	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) = Difference Between Hydrograph Areas (cf) =
			Time coordinate	X	X2	x3			Time coordinate	×1	x2	x3		100.001	00.00	80.00	70.00	60.00	(#12) 50.00	40.00	30.00	20.00	10.00	0.00 0.00 0.00	ŧ	Pre-De Post-De Diffe

60.00 70.00 188,613.61 188,613.61 st-Dav Pask Q Mydrograph Area (cf) = reas (cf) = Area (cf) = 50.00

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0.00

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MODIFIED RATIONAL METHOD HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A" Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 198/2017

Pre-Develope	ed Conditions		Past-Dev	eloped Co	nditions	
Time of Concentration, T _e =	- 30	minutes	Time of Concentration, T		30	minutes
Drainage Area, A	88.25	acres	Drainage Area, A	= ¥	88.25	acres
Composite Runoff Coefficient, C =	= 0.3		Composite Runoff Coefficient.		0.3	

	Entimated Outflow Hydrograph Points & Values	Time coordinate (min) 0 co	0,00	x2 28.61	x3 56.44	Modified Inflow Hydrograph	Points & Va	rdinate (min)	20 000	22.00	52,00	2-Year	700 900 900 900 900 100 100 100 1
100	ograph	O coordinate	r,	v 2	y3	graph		Q coordinate	5	y3	yd		90.00.64.01 81,49.00 81,49.00 90 90 90 90 90 90 90 90 90
		(cfa)	0.00	49.90	0.00			(cfs)	0.00	64.01	0.00		00000000000000000000000000000000000000
		Time coordinate	x1	×2	¥3			Time coordinate	IX S	2 2	X4		70.00 90.00 90.00 0.0
	Estimated Ou Points	Inter 1	000	36.46	77.19	Modified Infi	Points	(min)	00:00	30.00	59.00	5	2000 30 00 40 00 200 30 00 40 00 7me (r 7me (r real under Modified Inflow Inflow Hyd. & above Est. O Critical
	Estimated Outflow Hydrograph Points & Values		u coordinate	5	y3	Modified Inflow Hydrograph	Points & Values	Q coordinate	z	72	y4	5-Year	200 600 900 900 900 900 900 900 9
		1.41	0.00		0,00			(cfs)	0.00	66.41	0.00		6000 0000 115,554.86 115,554.86 23.00
			Lime coordinate		1 2			Time coordinate	¥	cx S	4x		600 700 700 700 700 700 700 700
	Estimated Out	Louns	(min)	2007	93.88	Modified Infic	Points	(min)	0.00	30.00	64.00		20 00 all of the second of the
A THE THINK WITH THE TANK	Estimated Outflow Hydrograph	Fornts & Values	Q coordinate	*	yz y3	Modified Inflow Hydrograph	Points & Values	Q coordinate	71	y2	y4	10-Year	Area under Estimated Outflow Hydrograph (cf) = 144 Area under Estimated Outflow Hydrograph (cf) = 144 Critical Duration (min) = 2
			(cfs)	0.00	0.00			(cfs)	00.0	68.89	68.89		0 10000 140,531,26 140,531,26 140,531,26 34,00

MODIFIED RATIONAL METHOD HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A" Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWO, CMS4S Version 19/2017

Pre-Develop	of Conditi	ions			Post-Develo	iped Cot	nditionis	
Time of Concentration, T _e		30	minutes	Time of Concent	tration, T _e		30	minutes
Drainage Area, A =		88.25	acres	Drainag	inage Area, A.		88.25	acres
mposite Runoff Coefficient, C		0.3		Composite Runoff Coa	filcient. C	i,	6.0	

			(cfs)	0.00	49.90	0.00			Infal	000	69.74	69.74	0.00		-									/	0 150,50 180,50		drograph	246,870.01 246,870.01 113,637.01 59.00	
100-Year Storm Event	Estimated Outflow Hydrograph	Points & Values	Q coordinate	14	y2	y3	a the state of the state of the	Values	O coordinate	11	72	EX	ya	ear					87 53, 49 90		/	/	/		09-00, 0.00 100.00 120.00 140.00	2	ph	nflow Hydrograph (cf) = utflow Hydrograph (cf) = Eat. Outflow Hyd. (cf) = Crtitcal Duration (min) =	
100-Year S	Estimated Outfi	Points &	(mim)	0.00	67.53	164.91	Modified Indian United	Pointe & Values	(min)	0.00	30.00	59.00	89.00	100-Year		AT ON ON THE TO DO NO TH		-	A 87 53	1	/	/			40.00 60.00 80.00	Ę	Entrusted Cutiline Hydrograph	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Mod. Inflow Hyd. & above Est. Outflow (hyd.) = Critical Duration (min) =	
			lime coordinate	x	×2	¥3			Time coordinate	x	x2	x3	X4		80.00	70.00		800	50.00	(#)0 89	30.00		20.00	1000	0.00 0.00 20.00	1	+	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) =	
			0.00		49.90	0.00			(cfa)	0.00	70.09	70.09	0.00												00 001 00 001	Control of the second se	(up) any	210,282.25 210,282.25 90,522.25 50.00	
orm Event	w Hydrograph	Values	and the second s		Å	y3	Hvdrograph	Values	Q coordinate	71	y2	y3	y4	ar	ł				00.60		/	/	/		80.00 100.00 120.00	1	Magazied Infam Hydrograph	inflow Hydrograph (cf) = utflow Hydrograph (cf) = i Est. Outflow Hyd. (cf) = Critical Duration (min) =	Circuit Control Control
50-Year Storm Event	Eatimated Outflow Hydrograph	Points & Values	000	20.01	10.00	140.47	Modified Inflow Hydrograph	Points & Values	(min)	00.0	30.00	50.00	80.00	50-Year		00.00, 70, 080, 00, 70, 09	-	/	28.64, 49.82	1	/				40.00 60.00 8	Time	With Point & working beimung -	Area under Modified Inflow Hydrograph (cf) = Area under Eatimated Outfilow Hydrograph (cf) = Area under Eatimated Outfilow Hyd. (cf) = Kod. Inflow Hyd. & above Est. Outfilow Hyd. (cf) = Critical Duration (min) =	Storm Dires
		Time coordinate	x1	5	* 5	22			Time coordinate	xI	x2	Ex.	x4		80.00	70.00	809		50.00	(aja)	30.00	20 mm	/	1000	0.00 0.00 20.00	1		Area under Modified Inflow Hydrograph (cf) = Area under Eatimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Area under Mod. Inflow Hyd. & Critical Duration (min) =	
		(cfs)	0:00	49.90	000	200			(cfs)	00.0	70.38	70,38	0.00		T			-							120.00 140.00	Arritori		177,359.01 177,359.01 69,575.01 42.00	1.40
orm Event	ow Hydrograph Values	Q coordinate	z	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	5	~	v Hydrograph	Values	Q coordinate	ł	y2	y3	y4	ar					05.6		/	/	/		00 80,00 100,00 1 Time (min)	A Modified Inflow Hydrograph		Inflow Hydrograph (cf) = utflow Hydrograph (cf) = . Eat. Outflow Hyd. (cf) = . Critical Duration (min) =	Storm Duration Factor (SDF) =
25-Year Storm Event	Estimated Outflow Hydrograph Points & Values	(min)	0.00	50.73	118.48		Modified Inflow Hydrograph	Points & Values	(min)	0.00	30.00	42.00	12.00	25-Year		90.01, CESED, 70.36	~		N 64 124 05	1	/				40.00 60	Estmahed Outlow Hydrograph		Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area Unflow Hyd. (cg) = Mod. Inflow Hyd. (a) = Critical Duration (min) =	Storm Dural
		Time coordinate	x1	x2	×3				Time coordinate	¥	x2	2 1	X4		90.00	70.00	60.00		20.00	(sis) 0 (cis)	30.00	20.00	1.000	_	0.00 20.00	H		Area under Rociffed Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) =	

MRM_CDB_01092017_COMBINED 36TH AND MARKET WATERSHEDS.xIsx

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11/21/2018

MODIFIED RATIONAL METHOD

Used for Estimating Detention Facility Storage Volumes in Ohio Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1/9/2017

Site Name & Location:	36th St N A A	Site Name & Location: 36th St NW vicinity of Logan Ave (recommended detention criteria) Date: Date: Date: 11/21/2018 Input By: CDB Ohio Rainfall Area (Intensity Zone): A Note: The Rainfall Intensity Area value can be found from Figure 1101-3 in Ohio Department Of Transportation's Location & Design Manual - Volume II - Drainage Design. Note: Toton is in Area "A".
	A A be foun	11/21/2018 CDB (Select A,B,C, or D) d from Figure 1101-3 in Ohio Department ual - Volume II - Drainage Design.
Date:	A an be foun	CDB (Select A,B,C, or D) d from Figure 1101-3 in Ohio Department ual - Volume II - Drainage Design.
Input By:	A an be foun	(Select A,B,C, or D) d from Figure 1101-3 in Ohio Department ual - Volume II - Drainage Design.
Ohio Rainfall Area (Intensity Zone):	an be foun	d from Figure 1101-3 in Ohio Department ual - Volume II - Drainage Design.
Note: The Rainfall Intensity Area value c		ual - Volume II - Drainage Design.
Of Transportation's Location & D	esign Man	
Note: Canton is in Area "A".	rea "A".	
Pre-Dev	Pre-Developed Conditions	Inditions
Time of Concentration, T _c =	18	minutes (range 10 to 200)
Drainage Area, A =	54.800	acres (should not exceed 30)
Composite Runoff Coefficient, C =	0.3	(range 0.00 to 1.00)
Post-Dev	reloped C	Post-Developed Conditions
Time of Concentration, Te=	18	minutes (range 10 to 200)
Drainage Area, A =	54,800	54,800 acres (should not exceed 30)
Composite Runoff Coefficient. C =	0.3	(range 0.00 to 1.00)

EXISTING DOWNSTREAM SYSTEM	stream system (i.e. ditch, storm sewer, stream, etc.) that the site will discharge to:	During the 25-year storm, it is estimated that the Market Avenue system has 17.1 cfs of available capacity (under pressurized flow).	/ of downstream system = 17.1 cfs	convey without flooding? 25 year storm runoff (MUST consider runoff from entire contributing drainage area)	eyed data? Surveyed data
	Description of existing downstream system (Area is proposed to discharge into existing 36" storm sewer at Market Ave. During the 25-ye	Maximum capacity of downstream	Approx. which storm event can the downstream system adequately convey without	Is the above "chokepoint" capacity based on approximated or surveyed data? Surveyed data

storm	Area	Intensity Zo	ne) A	Area	(Intensity Zone)	16) B	Area ((Intensity Zor	ne) C	Area	(Intensitu 76	nel D
Event		Peak Flow	Volume	- F	Peak Flow	Volume	1	Peak Flow	Volume	-1	Paale Flow	Volumo
(Year)	(in/hr)	(cfs)	(cl)	(in/hr)	(cfs)	(cf)	(indiat)	(cfs)	(cf)	Viribit	(cfs)	(LCF)
2	2.72	44.76	48.337	2,83	48.50	50.224	AD E	40.97	63,065	U= 0	120 00	120 12
5	3.32	54.56	58.921	3,45	58.33	80,834	3.84	50.86	54 853	Vio	50.05	unning va
10	377	61 93	66 880	-00	20 20	FOR OS	3 66	24.12	Non on	No.	10,00	200/10
2		20.10	000'00	2012	ENO COL	100'00	1917	42 113	12020	121 12	28:90	1979 E
25	4.34	71.27	76,971	9	73.34	1.2.64	199	76.31	83/064	21.73	78.82	85 12R
50	4.75	78.13	84,382	4.86	79.93	86.325	5.09	23.67	20.312	5.02	85 56	OR ASA
100	5.16	84.81	91,592	10.07	87.24	94.248	5,48	10.06	07 216	5.70	13.50	ADD INTE

Note: Volumes for pre- and post-developed peak flows are based on "3 Point Triangular Hydrographs" derived from application of standard Rational Method

Storm	Area	Area (Intensity Zoi	one) A	Area	(Intensity Zou	ne) B.	Area	(Intensity Zor	le) C	COLU	(Intensity Znr	Int D
Event	1	Peak Flow	Volume		Peak Flow	Valume-	-	Peak Flow	Valuana	14	Daple Flow	Malerino
(Year)	(in/hr)	(cfs)	(cf)	{in/hr}	(cfs)	(cl)	(in/in)	(cfs)	(CE)	(in/hr)	(cfs)	(Fill)
2	2.72	44.76	48.337	2,80	46.50	50.224	204	10.97	AT GRE	240	SPIDD	120 35
								1 States		2.4	Tool of the second	(DM)CD
0	3.32	54.56	58,921	× 7 77	56.33	10 C 34	3.84	59.8E	64,657	3.64	50.86	622,653
10	3.77	61.93	66.880	3 25	63 35	69,067	4.00	87.32	009.64	101	20.07	10.474
	101		10000		T as a set			A A A	1000		50:05	10,903
07	4.54	17.11	10,9/1	S.MD	135,36	19,211	4.68	76.91	33,064	12.1	78.82	85.126
50	4.75	78.13	84,382	4,20	29.03	26.225	5.09	53.62	00,317	5.27	SU CE	03 494
100	5.16	84.81	91,592	5.3	87.24	347.42	5:49	0.01	101 245	6.70	102.87	

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MRM_CDB_01092017_36TH ST WATERSHED_RECOMMENDED.xlsx

MODIFIED RATIONAL METHOD Used for Estimating Detention Facility Storage Volumes in Ohio Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1/9/2017

Maximum % Reduction in Post-Dev. Peak Flow

Max. Post-Developed Peak Flow to Detention Facility

Selected Detention Facility Outflow

Pre-Developed Peak Flow from Site

Storm Event

DETENTION CRITERIA Proportional Recom-Flow from mended Site Allowed Allowable in Detention Downstream Facility System Outflow* (cfs) (cfs) 54.56 17.10 54.56 17.10 54.56 17.10 71.27 17.10 71.27 17.10

Down-stream System Choke-point" Capacity 17.10 17.10 17.10 17.10 17.10

(cfs) 44.76 54.56 61.93 71.27 78.13 84.81

(Year) 2 50 50 100

mended Allowable Detention Facility Outflow* 17.10 17.10 17.10 17.10 17.10 17.10

(%) 61.79 68.66 72.39 72.39 78.11 79.84

(cfs) 44,76 54,56 61,93 71.27 78,13 78,13 84,81

(cfs) 17.10 17.10 17.10 17.10 17.10 17.10

	Area	Area -	Area	Bank
Storm	(Intensity	(intensity.	(Intensity	(Intensity)
Event	Zone) A	Zonn) B	Zone) C	Zone) D
	Volume	Volume	Volume	Volume
(Year)	(cf)	(ci)	(cl)	(cf)
2	0	0	10	0
5	0	0	9.0	
10	0	10	0	
25	0	0	0	0
50	0		0	b
100	0		0.	

Note: The above chart is provided to show how the standard Rational Method can be misapplied and result in severely underestimated storage volumes when compared to volumes determined from application of the *Modified* Rational Method.

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		Area (Intensit	sity Zone) A			Area (Intens	ity Zone) B.			Area (Intensi	ity Zone) C			Area Unionality	Clury Thread D	
Storm Event	Volume	Critical Duration	Resulting Intensity	Resulting Peak Inflow	Volumi	Collical Duration	Resulting	Resulting Peak Inflow	Volume	Critical Duration	Resulting Intensity	Resulting Peak Inflow	Volume	불성	1 1 2	Resulting Peak Inflow
Year)	(cf)	(min)	(in/hr)	(cfs)	(cf)	(min)	{inthr}	(cís)	(cl)	(mim)	(inthr)	(cfs)	(cf)	(min)	(inline)	(cis)
2	34,658	38	1.691	27.80	37.145	36	1.726		42.432	25	1.787	201.05	12020	2.9	52.6.5	10 Miles
10	51.028	69	1767	20 05	F-4 600	205	1.708	20.60	Ed 767	1.8	1.000	alle and	10000	1		101105
-				00.04	Soninn	1	1000		38/606	36	1,000	30.20	292,62	122	1,855	30.50
10	64,885	29	1.794	29.49	67.282	50	1.847	30.36	73.747	12	1,500	20.02	YA 495	110	1 200	Sec. 16
25	85,106	26	1.779	29.24	-VBC 24V-	10	1.6.32	10.02	20.701	7.4	1000	100.00	10000	100	1000	07-10
50	102.870	93	1.742	28.64	102.307	03	1 755	10 S	140.450	0.0	1000	10112	HCR. IA	10	1 310	24-12
100	122 125	446	1 607	62.20	100.000	-01	1000	and and	2012/01/	10	100	01 10	110,000	n	172FL	31 05
2	140,100		1	61.13	100,001	104	1.626	30,05	127,461	106	1,823	30.02	136,793	109	1.675	30.88
	Maximum	m Volume =	123,135	cubic feet	Maximum	m Volume =	124 031	111010 Each	Maximus	Maximum Volume =	124.462	South Street	Manchenter	Maidmanne Malateria	100	

consideration when routing! must be taken into volume is adequate! Tailwater tion dete De ed to perform Storage routing calculations MUST be

Page 2 of 2

MRM_CDB_01092017_36TH ST WATERSHED_RECOMMENDED.xlsx

11/21/2018

RAINFALL INTENSITY EQUATION

i=a/(t+b)^c

Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1/9/2017

		Area	Intensity Zo	one) A		
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
a =	46.184	56.985	64.167	66.528	65.702	64.489
b =	9.000	10.250	11.000	11.000	10.750	10.500
c =	0.859	0.851	0.842	0.811	0.782	0.754

3397 B.B.G		Area	Intensity Zo	one) B		
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
a =	47.987	60.684	73.126	75.841	65.621	85.047
b =	9.000	10.500	12.000	12.000	10.000	13.250
c =	0.859	0.858	0.863	0.833	0.781	0.806

n na serie		Area	Intensity Zo	one) C		
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
a = [56.299	67.933	84.550	95.736	96.783	80.436
b =	10.000	11.000	13.000	14.000	14.000	11.500
c =	0.876	0.869	0.882	0.871	0.850	0.794

		Area	Intensity Zo	one) D		el e e e e e e e e e e e e e e e e e e
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
a =	57.448	67.933	79,192	87.886	95.169	91.982
b =	10.000	11.000	12.000	12.750	13.500	13.000
c =	0.876	0.869	0.864	0.849	0.839	0.810

Note: The above values are taken from Ohio Department Of Transportation's Location and Design Manual - Volume II - Drainage Design. The user must ensure the above values are consistent with values from the current edition of the manual and revise them as necessary.

Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S RATIONAL METHOD PEAK FLOW HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A"

Pre-Developed C	onditions		0-160-	veloped Col	duohini	
Time of Concentration, T _c =	18	minutes	Time of Concentration, 1	T _c =	18	minutes
Drainage Area, A =	54.8	acres	Drainage Area,	= ¥	54.8	acres
Composite Runoff Coefficient. C =	0.3		Composite Runoff Coefficient	# 0	0.3	

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0.00

(cfs)

61.93 (cfs)

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Pre-Developed Pea	Pre-Developed Peak Flow Hydrograph			Pre-Developed P	Pre-Developed Peak Flow Hydrograph			Pre-Developed Pea	Pre-Developed Peak Flow Hydrograph	
Points	Points & Values			Points	Points & Values			Points &	Points & Values	
Time coordinate (min)	Q coordinate	(cfs)	Time coordinate	(min)	Q coordinate	(cfs)	Time coordinate	(min)	Q coordinate	(cfs)
x1 0.00 x2 18.00	2.9	0.00	X X	0.00	7	0.00	x1 x2	0.00	y1 v2	0.00
-	y3	0.00	S S	36.00	y3	00.0	x3	36.00	ex.	0.00
Post-Developed Pe	Post-Developed Peak Flow Hydrograph Points & Values			Post-Developed P	Post-Developed Peak Flow Hydrograph Points & Values			Post-Developed Pe	Post-Developed Peak Flow Hydrograph Points & Values	
Time coordinate (min)	Q coordinate	(cfs)	Time coordinate	(min)	Q coordinate	(cfs)	Time coordinate	(min)	Q coordinate	(cfs)
	14	0.00	xı	0.00	71	0,00	×	0.00	r,	0.00
x2 18.00 x3 36.00	y2 v3	44.76 0,00	x3 X3	18.00 36.00	y2 y3	54.56 0.00	x2 x3	18.00 36.00	y2 y3	61.90
	2-Year				5-Year				10-Year	
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45.00	18.00.44.78				A 18.00, 54.58		NO ON		18.00. 61.93	
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35,00	/		40.00	/	/		50.00	/	/	
30.00	/			/	/		40.00	/	/	
25.00	/		(ଲ୍ଲବ) (ରୁଷ୍ପ ପ୍ର	/	/		(sto) (/	1	
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15.00	/		20.00	-	/		20,00	/	/	
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5.00		/	/			/	0000			/
0.00 0 0.00 0.00 10,00 15,00	20.00 25.00 30.00 Time (min)	35.00 40.00	0.00 6 0.00 0.00	0 10.00 15.00	20.00 25.00 30.00 Time (min)	35.00 40.00	0.00 0.00 5.00	10.00 15.00	20.00 25.00 30.00 Time (min)	35,00
Pre-Dev Peek O Hydrograph	raph Post-Dev Peak Q Hydrograph	frograph	1	Pra-Dav Peak O Hydrograph	graph	fydrograph	1		aph	ydrograph
Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =	Hydrograph Area (cf) = Hydrograph Area (cf) =	48,336.55 48,336.55	Pre	re-Developed Peak Q Hydrograph Area (cf) ≂ st-Developed Peak Q Hydrograph Area (cf) =	Pre-Developed Peak Q Hydrograph Area (cf) ≕ Post-Developed Peak Q Hydrograph Area (cf) ≕	58,920.91 58,920.91	Pre-	Developed Peak Q H Developed Peak Q H	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrograph Area (cf) =	66,880

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66,880.30 66,880.30

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MRM_CDB_01092017_36TH ST WATERSHED_RECOMMENDED.xlsx

RATIONAL METHOD PEAK FLOW HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A" Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S

Version 1/9/2017

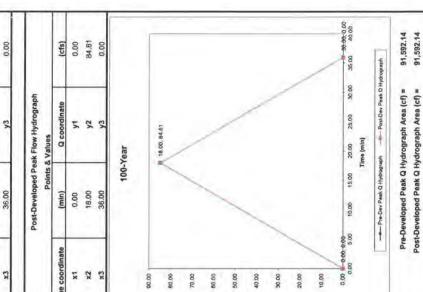
itration, T _e	48	minutes		TIM	e of Cor	centration,	T. =		18	minutes
ainage Area, A	54.8	acres			Dra	Drainage Area, A	-	J	54.8	acres
Runoff Coefficient, C	0.3		0	omposite	Runoff	Composite Runoff Coefficient, (" U	l	0.3	

0.00

(cfs)

Time coordinate (r x1 0 x2 11 x3 31	Dolnte B	Inder Rom for war i was i madaiasan at i		
	L'UIUN O	Points & Values		
	(min)	Q coordinate	(cfs)	Time coor
	0.00	y1	0.00	1×1
	18.00	y2	71.27	x2
	36.00	y3	0.00	x3
Post-De	eveloped Peak Flow I Points & Values	Post-Developed Peak Flow Hydrograph Points & Values		
Time coordinate (r	(min)	Q coordinate	(cfs)	Time coor
x1 0	0.00	y1	0.00	1x
x2 18	18,00	y2	71.27	X
x3 36	36.00	y3	0.00	K3
	25-Year	ear		
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0000	/	/	_	W 02
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ww		/		80.00
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0.00 0.00 0.00 10.00	15.00	20,00 25.00 30.00	35.00 40.00	00 d
	T	Time (min)		
Pre-Dev	Pre-Dev Peak Q Hydrograph	ph Post-Dev Peak Q Hydrograph	frograph	
Pre-Develope	ed Peak Q Hy	Pre-Developed Peak Q Hydrograph Area (cf) ==	76,970.67	
Post-Develope	ed Peak Q Hy	Post-Developed Peak Q Hydrograph Area (cf) =	76,970.67	

Flow Hydrograph	Values	Q coordinate	¥2	y3	k Flow Hydrograph	Values	Q coordinate	14	y2	y3	ear	18.00, 84.81	/	2	/	1	/			20.00 25.00 30.00 Time (min)	h Past-Dev Paek C Hy	Pre-Developed Peak Q Hydrograph Area (cf) = Post-Developed Peak Q Hydrooraph Area (cf) =
Pre-Developed Peak Flow Hydrograph	Points & Values	(min) 0.00	18.00	36.00	Post-Developed Peak Flow Hydrograph	Points & Values	(min)	0.00	18.00	36.00	100-Year	<	~	/	/	/				10.00 15.00 Tin	Pre-Dev Peak Q Hydrograph	eveloped Peak Q Hy
		Time coordinate x1	×2	x3			Time coordinate	xt	x2	x3		00'08	70.00	60.00	. 200.00 (*)	Q (c)	. 00.06	20.00	00'01	0.00 0.00 5.00	1	Pre-D
		(cfs) 0.00	78.13	0.00			(cfs)	0.00	78.13	0.00									/	35.00 40.00	drograph	84,381.91 84 381 91
Pre-Developed Peak Flow Hydrograph	Points & Values	Q coordinate	y2	y3	Post-Developed Peak Flow Hydrograph	Points & Values	Q coordinate	y1	y2	y3	ear	18.00, 78.13	/	/	/	/	/			20.00 25.00 30.00 Time (min)	ph Post-Dev Peak Q Hydrograph	Pre-Developed Peak Q Hydrograph Area (cf) = Poet-Developed Peak Q Hydrograph Area (cf) =
Pre-Developed Pea	Points 8	(min) 0.00	18.00	36.00	Post-Developed Per	Points 8	(min)	0.00	18.00	36.00	50-Year		/	/	/	/	/			10.00 15.00	Pre-Dev Feak Q Hydrograph	Jeveloped Peak Q Hy Jeveloped Peak Q Hy
	F	me coordinate x1				ľ	me coordinate											1	-	0.00 5.00	1	Pre-C



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MODIFIED RATIONAL METHOD HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A" Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S

Pre-Developed Con	ditions		Post-Devic	Idped Co	nditions	
Time of Concentration, T _e =	18	minutes	Time of Concentration, T _o		18	minutes
Drainage Area, A =	54.8	acres	Drainage Area, A		54.8	acres
Composite Runoff Coefficient. C =	0.3		Composite Runoff Coefficient, C		0.3	

		Time o	Time of Concentration, Te	= 18	minutes	Time	Time of Concentration, Te =	intration, T _o = 18	minutes		
		Composite Rt	Drainage Area, A : Composite Runoff Coefficient, C ·	= 54.8 = 0.3	acres	Composite R	Drainage Area, A = Composite Runoff Coefficient, C =	= 54.8 = 0.3	acres		
	2. Vane S	Arvant Storten Econot	Sector sector		S-Year S	S-Year Storm Event	100000000000000000000000000000000000000		10-Year S	10-Year Storm Event	
	Estimated Out	Estimated Outflow Hydrograph			Estimated Out	Estimated Outflow Hydrograph			Eatimated Out Points	Estimated Outflow Hydrograph	
Time scordingle	(min)	O coordinate	Infel	Tima coordinata	(min)	O coordinate	(cfs)	Time coordinate	(min)	O coordinate	(cfa)
x1	0.00	y1	0.00	at at	00'0	y1	0.00	1×	0.00	y1	000
x2	44.93	yz	01.11	x2	56.40	y2	17.10	¥2	66.56	y2	17.10
×3	123.56	y3	0.00	x3	166.47	y3	0:00	x3	203.48	y3	0.00
	Modified Infi	Modified Inflow Hydrograph			Modified Infi	Modified Inflow Hydrograph			Modified Infi	Modified Inflow Hydrograph	
	Points	Points & Values	141		Points	Points & Values	141	Without an additional of	Points	Points & Values	
1 ime coordinate	(uiu)	d coordinates	(crs)		(mm)	of coordinates	0.00		(mm)	N COOLUINGIE	000
E CA	18.00	5.5	27.80	2	18.00	22	29.05	22	18.00	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	29.49
1 5	38.00	5	27.80	1 9	00.69	1 5	29.05	1 9	23.00	ev	29.49
x x	56.00	A4	0.00	x4	67.00	y4	0.00	x4	77.00	ya	0.00
	2-1	2-Year				5-Year			10-	10-Year	
20.05	16.00.278038.00, 27.80			35.00				35.00			
25.00	-				9 -18 -00, 28 -09 -40 -00, 29 -05			-	10-00,29 48 59 00, 29 49		
20.00	-			22.88	-			22:00			
(eta) D 55 8	44.82, 17.10	12.10		(ete) 2 20 5 8 8 8 8 8 8 8	01.71.04-09	7.40		20 00 12 00 10 00 10 10 10 00 10 10 10 10 10 10 10 10 10 10 10 10 1	00 21 10 00 C		
1000	1	/		10.00	1	/		10.00		/	
200	_	/		2005		/	1	805		/	
0.00 - 0.00 - 20.00	40.00 Entimated Outflow F	66.90-0.00 90.00 90.00 100.00 120.00 Time (min) Vyritegraph Modified Infow Hytegraph	120 00 140 00	0.00 20.00	40.00 60.00	94.96, 959 80.00 100.00 120.00 140.00 189.0 Three (min) Artograph Modified Inflow Hydrograph	00 160.00 180.00	000 000	50.00 100.00 50.00 100.00	150.00 mán) Mediñad Inito	200.00 200.00 kiter
Area Area un Area under Mod. Inf	a under Modified In rder Estimated Out iow Hyd. & above E	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Critical Duration (min) =	63,386.41 63,386.41 34,658.41 38.00	Ar Area Area under Mod. I	rea under Modified in under Estimated Out Inflow Hyd. & above E Ci	Area undar Modified Inflow Hydrograph (cf) = Area undar Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Eat. Outflow Hyd. (cf) = Area under Mod. Inflow Hyd. & Cfilical Duration (min) =	85,398.83 85,398.83 51,027.83 49,00	Area under Mod	Area under Modified In a under Eatimated Out . Inflow Hyd. & above E	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Area under Mod. Inflow Hyd. & Critical Duration (min) =	104,386 104,385 64,885 59.0
	C moto	eterne Counting County (COE) -	2.02				-				

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104,386.48 104,386.48 64,885,48

59.00

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Page 1 of 2

MODIFIED RATIONAL METHOD HYDROGRAPHS for Ohio Rainfall Intensity Area (Zone) "A" Spreadsheet created by Christopher D. Barnes, PE, CPESC, CPSWQ, CMS4S Version 1992017

Time of Concentration, T _c =	nditions	minutes	Time of Concentration, T _c =	d Conditions	minutes
Drainage Area, A =	54.8	acres	Drainage Area, A =	54,8	acres
Composite Runoff Coefficient. C =	0.3		Composite Runoff Cosfilcient, C =	0.3	

		(cfs)	00.0	0.00		fortal	0.00	27.73	27.73	0:00		/	300.00 350.00 400.00)= 191,363.53)= 191,363.53)= 123,134.53)= 115,00
100-Year Storm Event	Estimated Outflow Hydrograph Points & Values	Q coordinate	7	y2 y3	Modified Inflow Hydrograph	Points & Values	41	y2	EX	ya	100-Year	R PL	0 250.00 Mn)	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Area under Mod. Inflow Hyd. & above
100-Year	Estimated Out Points	(min)	0.00	373.03	ful pellibom	(min)	0.00	18.00	115.00	133.00	1001	21-20 - 115 00 - 21 - 73 - 121-80, 171-10	100.00 Fetmated Or	a under Modified In nder Eatimated Out flow Hyd. & above C C
		Time coordinate	tx	X 2		Time coordinate	x	x2	x3	X4		25.00, 27.75 25.00 10.00 5.00 5.00	0,00 000 000	Are Area u Area under Mod. In
		(cfs)	00.0	00.0		ficted	0.00	28.64	28.64	0.00			00 00 000 000 000 000 000 000 000 000	159,812.93 159,812.93 102,869.93 93,00
orm Event	w Hydrograph Values	Q coordinate	71	54 64	v Hydrograph	Values D coordinate	ł	y2	y3	y4	aar		000 200.00 250.00 300.00 Time (min) Spiren	Area under Modified Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Critical Duration (min) =
50-Year Storm Event	Estimated Outflow Hydrograph Points & Values	(min)	0.00	311.53	Modified Inflow Hydrograph	Points & Values	0.00	18.00	93.00	111.00	50-Year	100 28 64	100.00 111.00. 150.00 150.	under Modified Infic der Estimated Outfi ow Hyd. & above Es Crit
		Time coordinate	xt	x3 x3		Time condicate	1×	x2	x3	X4		30 00 25 00 15 00 5 00 5 00 5 00 5 00 5 00 5 00	000 000	Area Area ur Area under Mod. Inf
		(cfs)	0:00	0.00		(stel	0.00	29.24	29.24	0.00			256.00 256.906.00 256.00 200.00	133,327,89 133,327,89 85,105,89 76.00
orm Event	w Hydrograph Values	Q coordinate	7	y2 v3	r Hydrograph	Values	v1	y2	y3	y4	3år		00 200 60 Min) 200 60	Area under Modifiad Inflow Hydrograph (cf) = Area under Estimated Outflow Hydrograph (cf) = Area under Mod. Inflow Hyd. & above Est. Outflow Hyd. (cf) = Area under Mod. Inflow Hyd. & Critical Duration (min) =
25-Year Storm Event	Estimated Outflow Hydrograph Pointe & Values	(min)	0.00	83.47 259.90	Modified Inflow Hydrograph	Points & Values	0.00	18,00	76,00	94.00	25-Year	10 17 1 10 00 10 10 10 10 10 10 10 10 10 10 1	00 00 00 1500 00 1500 00 150 0	under Modified Infit der Eatimated Outfik iow Hyd. & above Est
		Time coordinate	x	x2 x3		Time of stationate	x1	x2	K3	X4		5 00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0.00	Area un Area un Area under Mod. Infl

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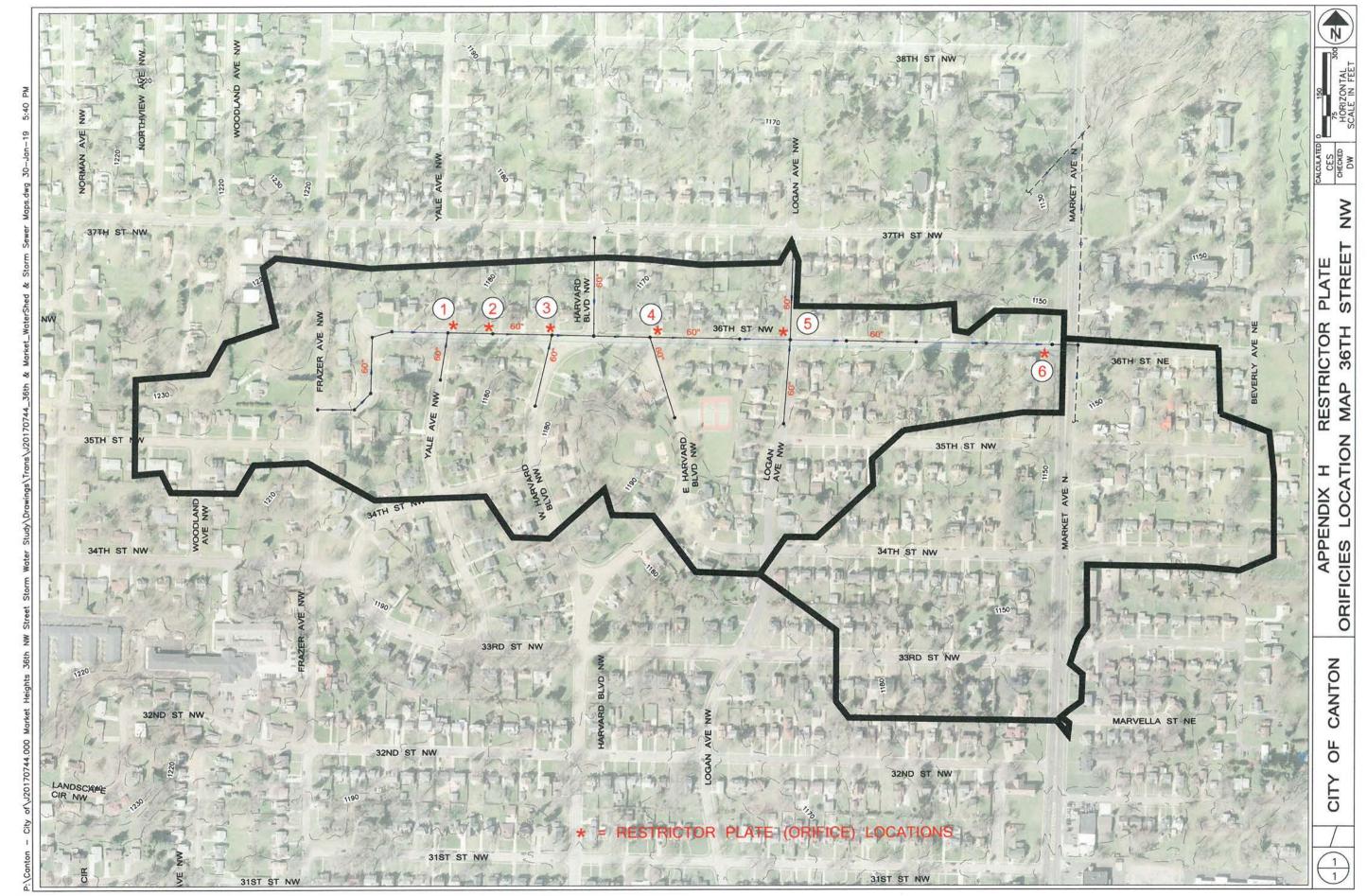
Appendix F. Street Segment Length Map



Appendix G. Recommended 60" Storm Sewer Footprint Map



Appendix H. Restrictor Plate Orifices Location Map



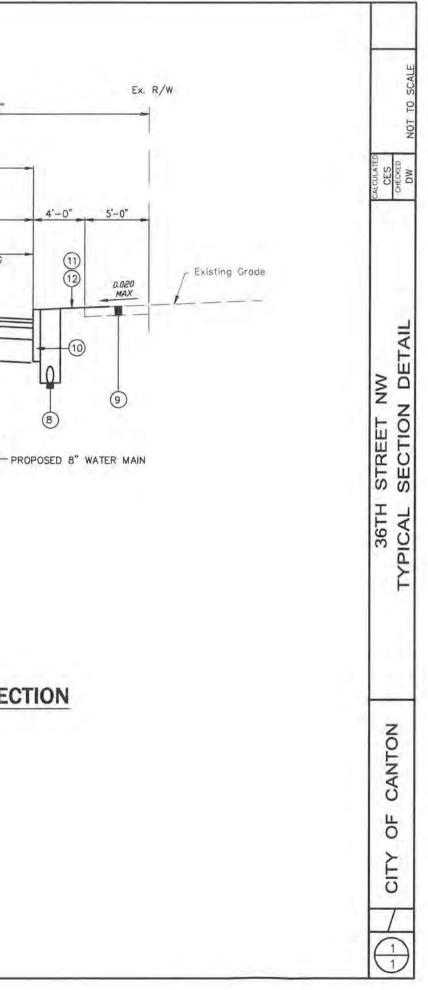
Appendix I. 36th Street NW Typical Section and Plan & Profile Sheets

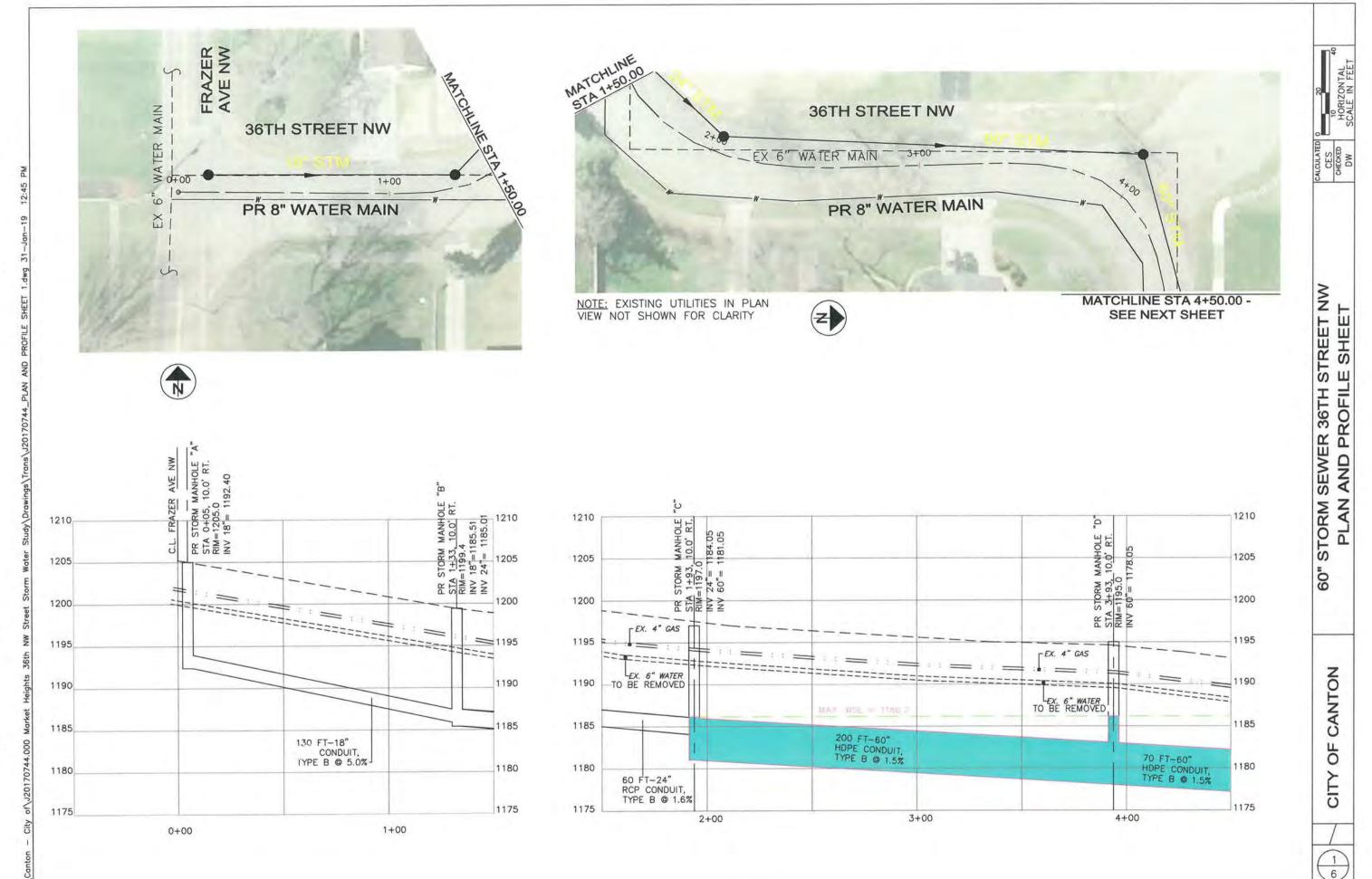
CONSTRUCTION Ex. R/W 25'-0" 25'-0" 30'-0" 4'-0" 5'-0" 15'-0" 15'-0" 11'-0" WESTBOUND LANE 11'-0" 8'-0" (11) PARKING WESTBOUND LANE PROPOSED LEGEND LANE Existing Grade (12) 1) ITEM 204 - SUBGRADE COMPACTION 0.020 MAX 0.020 0.020 2 ITEM 301 - 4" ASPHALT CONCRETE BASE 11 3 ITEM 304 - 6" AGGREGATE BASE 10 (4) ITEM 407 - TACK COAT FOR INTERMEDIATE COURSE AV V (5) 0 ITEM 407 - TACK COAT, 702.13 0.-10, 00 (5) 3 6 ITEM 441 - 1-1/2." ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE 2, (448), PG 64-22 (4) (9) 6 EX 6" WATER 8 ITEM 441 - 1-1/2." ASPHALT CONCRETE SURFACE COURSE, TYPE 1, (448), PG 64-22 (7)EX 8" SAN REMOVE EXISTING 6" WATER MAIN 8 ITEM 605 - 6" SHALLOW PIPE UNDERDRAIN WITH FILTER FABRIC 9 ITEM 608 - CONCRETE WALK, AS PER PLAN 10 ITEM 609 - CURB, TYPE 6 (11) ITEM 653 - 4" TOPSOIL FURNISHED AND PLACED (12) ITEM 659 - SEEDING AND MULCHING, CLASS 1 10'-0" 11'-0" 5'-0" & STORM € ROAD PROPOSED STORM SEWER **36th STREET NW - PROPOSED TYPICAL SECTION** (LOOKING EAST)

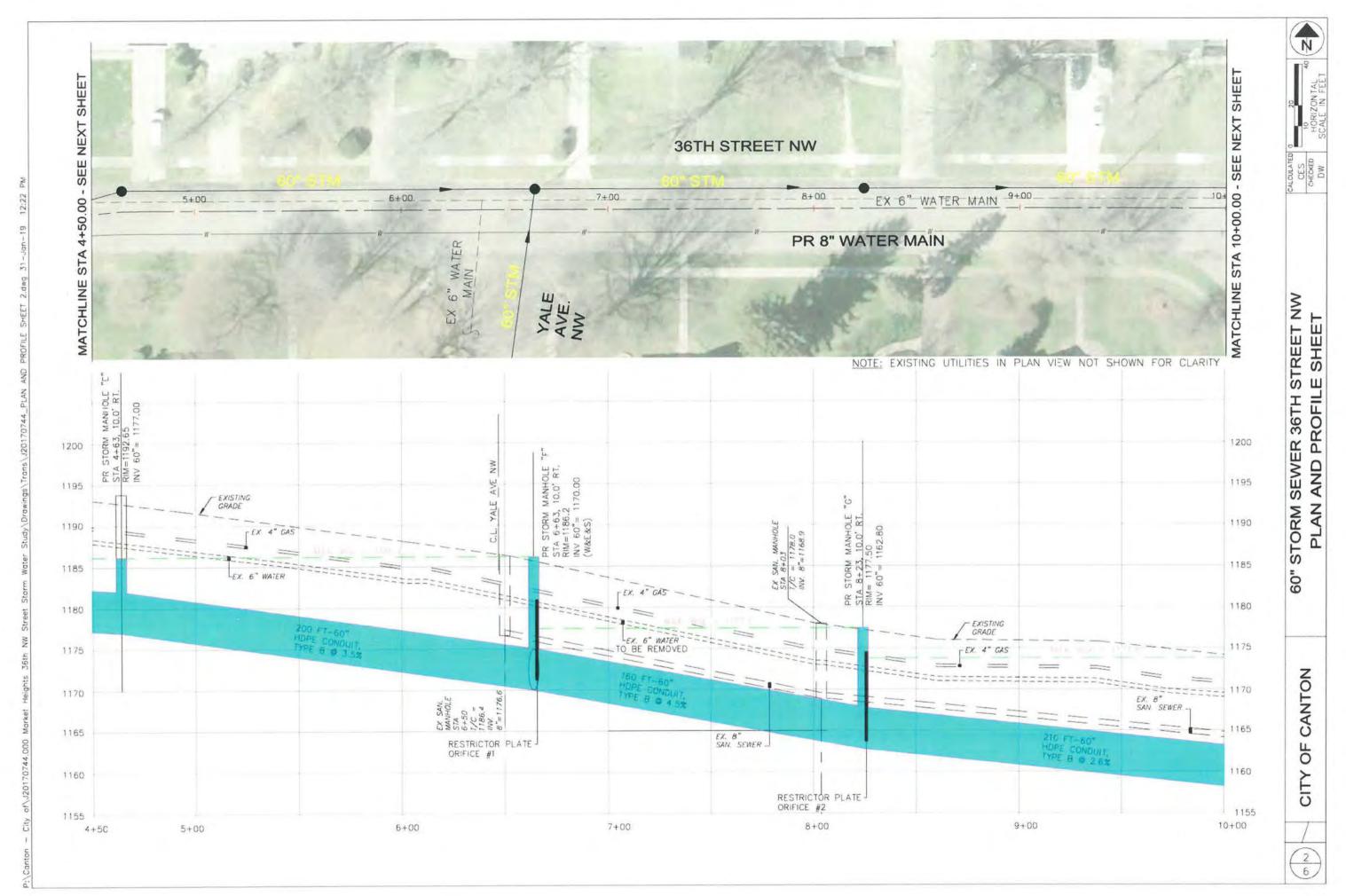
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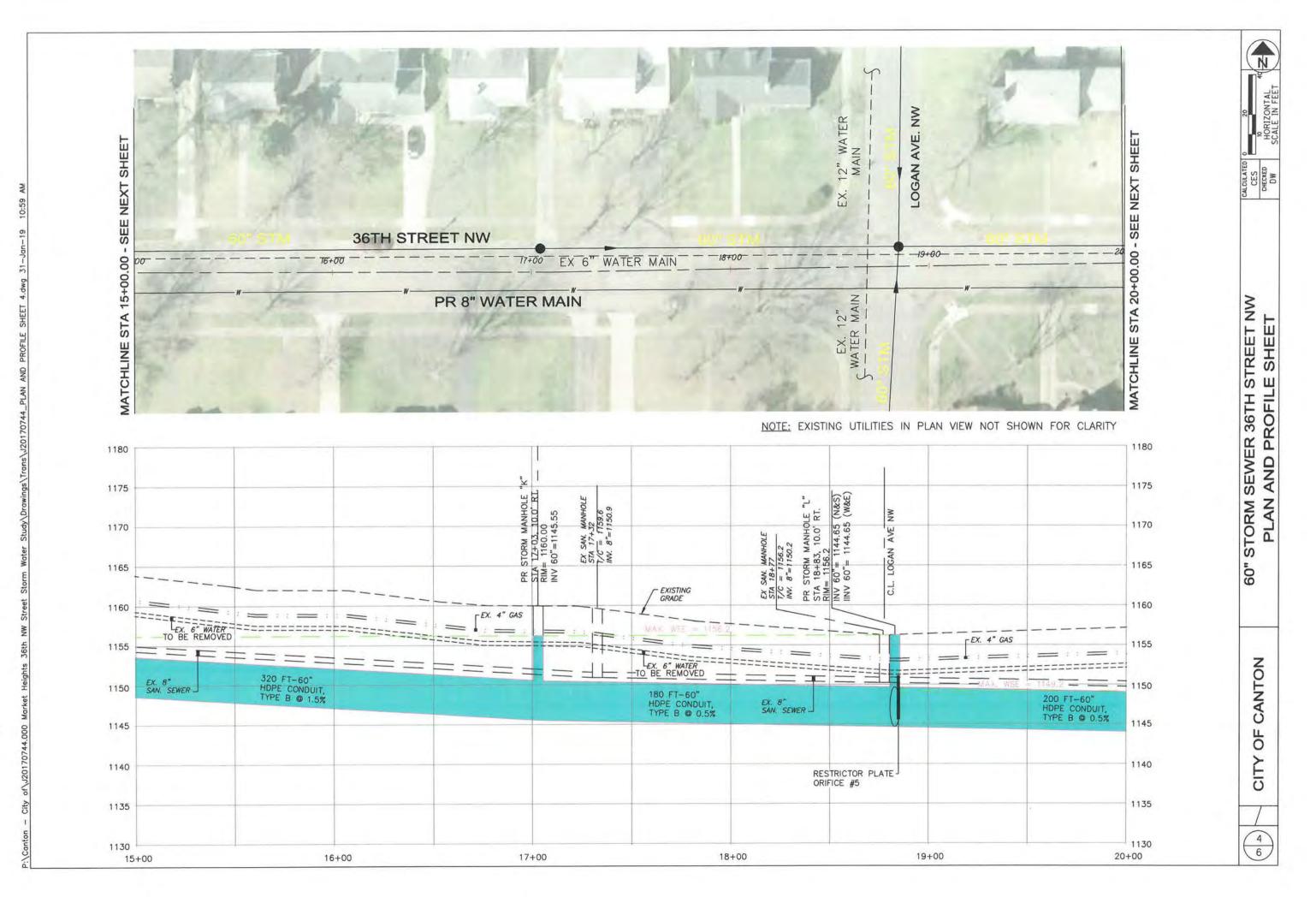
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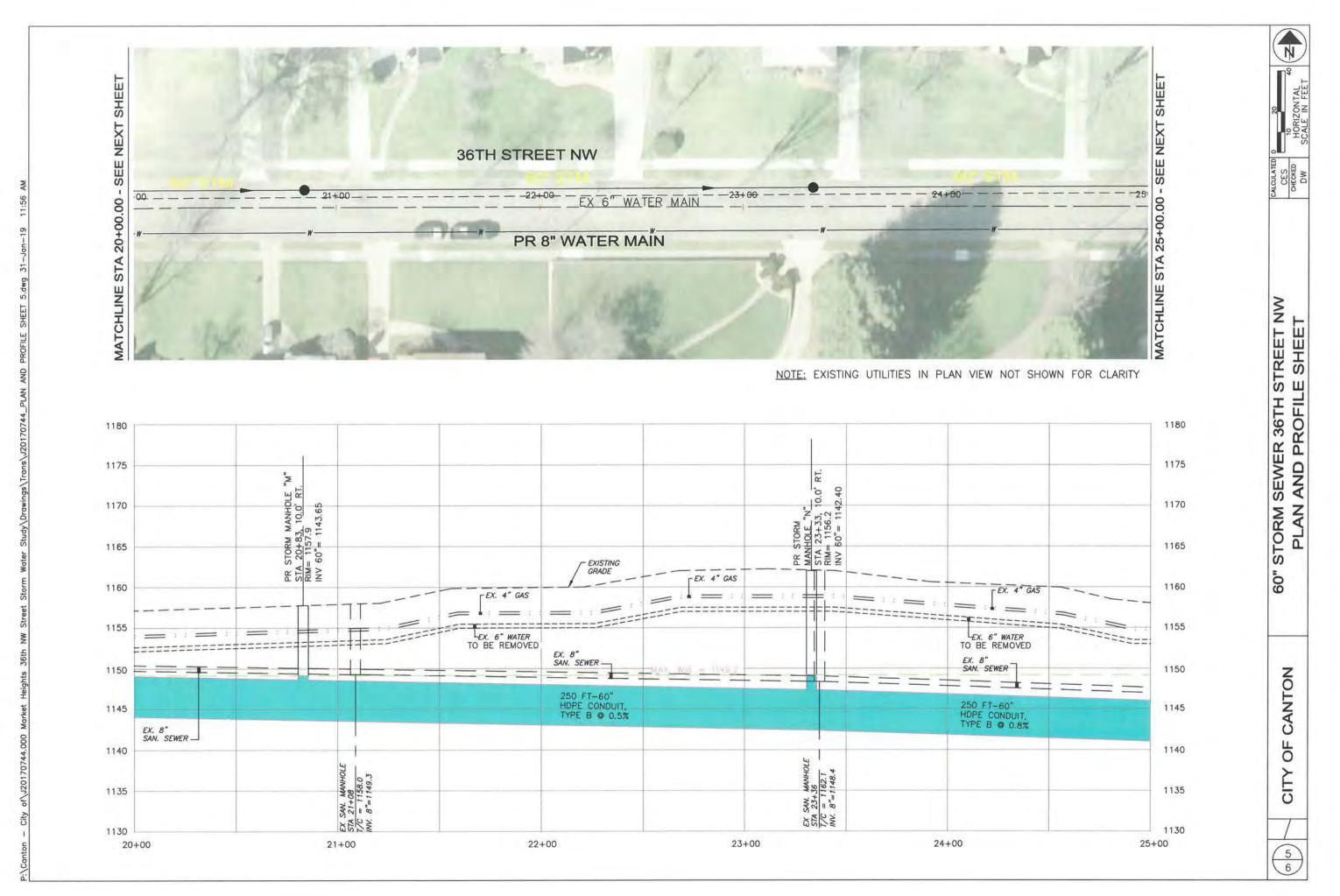
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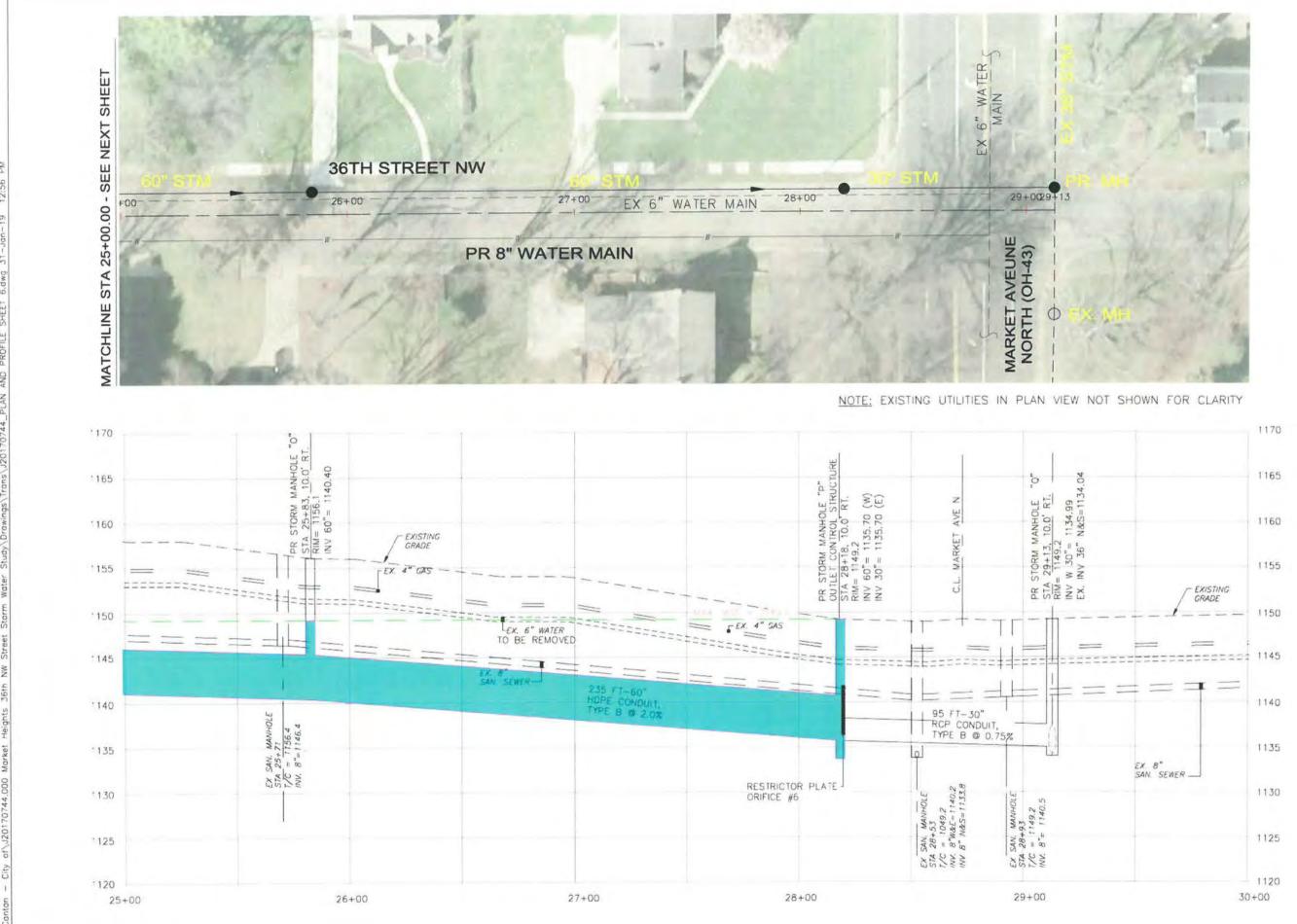


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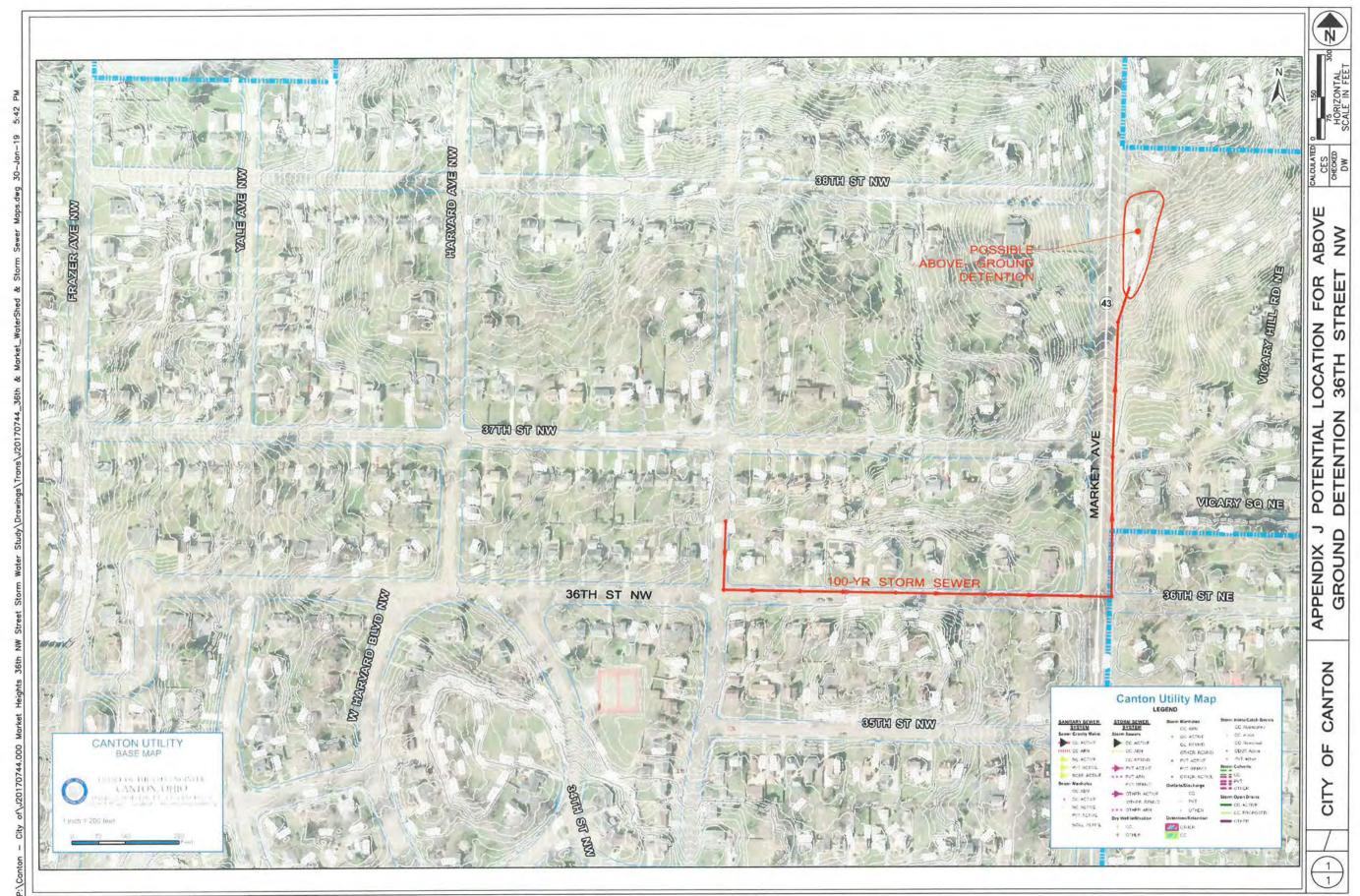
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Appendix J. Potential Location for Above-Ground Detention



Appendix K. Preliminary Cost Estimate

I Reconstruction Project	Probable Construction Costs
36th St NW Storm Sewer Road	Engineer's Opinion of Preliminary P

TAL		116,060.40	47,062.50	31,375.00	10,000.00	20,289.15	9,492.00	26,292.84	1,779.00	141,187.50	16,000.00	5,500.00	425,038.39		7,665.00	3,978.00	10,000.00	6,000.00	27,643.00		4,233.00	2,076.78	50,200.00	854.00	36,540.00	12,153.70	7,896.00	12,923.80	1,959,750.00	75,000.00
ITEM TOTAL		49	5				-	69	*	*	*	*					-	49			5			-	-		5	5		-
ESTIMATED DOLLARS I CTS		\$ 8.24	\$ 1.50	\$ 5.00	\$ 12.50	\$ 1.71	\$ 12.00	\$ 33.24	\$ 1.50	\$ 4.50	\$ 1,000.00	\$ 500.00			\$ 35.00	\$ 2.00	10,000.00	6,000,00			14.11	346.13	8.00	8.54	73.08	93.49	131.60	136.04	450.00	2,500.00
DOLLARSI																	59	63			69	69	69	67	65	69	69	69	44	69
DOLLARSI																														
QUANTITY		14,085	31,375	6,275	800	11,865	191	791	1,186	31,375	16	11	ROADWAY :		219	1,989	٠	۲	EROSION CONTROL :		300	ø	6,275	100	500	130	60	95	4,355	30
LIND		SQ. YD.	SQ. FT.	FOOT	SQ. YD.	sa, yb.	cu. YD.	cu. YD.	SQ. YD.	SQ. FT.	CORNER	EACH	SECTION TOTAL ROADWAY		cu. Yb.	sq. yb.	LUMP	LUMP			FOOT	EACH	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	EACH
ON ITEM DESCRIPTION	ROADWAY	0 PAVEMENT REMOVED	0 WALK REMOVED, AS PER PLAN	0 CURB AND GUTTER REMOVED, AS PER PLAN	0 REMOVAL MISC.: DRIVEWAY APRON	0 SUBGRADE COMPACTION	0 EXCAVATION OF SUBGRADE	0 GRANULAR MATERIAL, TYPE B	0 GEOTEXTILE FABRIC, 712.09 TYPE D	1 4" CONCRETE WALK, AS PER PLAN	CURB RAMP. AS PER PLAN	1 MONUMENT ASSEMBLY, AS PER PLAN		EROSION CONTROL	1 TOPSOIL FURNISHED AND PLACED	1 SEEDING AND MULCHING, AS PER PLAN	1 EROSION CONTROL, AS PER PLAN	1 STORM WATER POLLUTION PREVENTION PLAN	SECTION TOTAL	DRAINAGE	PIPE REMOVED, 24* AND UNDER	2 CATCH BASIN OR INLET REMOVED	6" SHALLOW PIPE UNDERDRAINS WITH FILTER FABRIC	6* CONDUIT, TYPE E	1 12" CONDUIT, TYPE B, 706.02	18" CONDUIT, TYPE B, 706.02	24" CONDUIT, TYPE B, 706.02	30° CONDUIT, TYPE B, 706.02	60" HDPE CONDUIT, TYPE B, 706.02	CURB CATCH BASIN
EXTENSION		23000	30000	32500	98100	10000	13000	30010	50000	13001		38501			10001	10001	30001	30001			35100	58300	11100	01400	04400	07400	10400	13400		98101
ITEM NUMBER		202	202	202	202	204	204	204	204	608	SPECIAL	623			653	659	832	832			202	202	605	611	611	611	611	611	611	611
REF NO.		-	2	0	4	Q	9	7	8	6	10	H			12	13	14	15			16	11	18	19	20	21	22	23	24	25

n Sewer Road Reconstruction Project	Preliminary Probable Construction Costs	
36th St NW Storm Sew	Engineer's Opinion of Prelimi	

611	99574	MANHOLE	EACH	17	\$	3,500.00	\$	59,500.00
611	99574	MANHOLE (OUTLET CONTROL STRUCTURE W / WEIR WALL)	EACH	9	69	4,500.00	*	27,000.00
611	99820		POUNDS	500	69	1.00	*	500.00
611	00666	DRAINAGE STRUCTURE, MISC: ADJUSTING STREET CASTINGS TO GRADE (SEWER), AS PER PLAN	EACH	13	69	400.00	67	5,200.00
		SECT	SECTION TOTAL DRAINAGE	DRAINAGE :				2,253,827.28
		WATER LINE						
		REMOVAL EXISTING 6" DIP WATER MAIN (MARKET TO FRAZER)	FOOT	2,950	69	20.00	\$	59,000.00
		REMOVAL EXISTING HYDRANT ASSEMBLY	EACH	3	s	500.00	-	1,500.00
		8" DIP WATER MAIN WITH PREMIUM BACKFILL	FOOT	2,925	69	90.00		263,250.00
		6" FIRE HYDRANTS ASSEMBLY INCLUDING TEE & BRANCH	EACH	10	8	5,500.00		55,000.00
		TAPPING SLEEVES AND VALVES (MARKET AVE & FRAZER)	EACH	2	69	5,000.00	*	10,000.00
		GATE VALVES	EACH	10	S	1,500.00		15,000.00
		WATER MAIN CROSS FITTINGS (LOGAN AVE)	EACH	1	8	1,200.00	**	1,200.00
	-	WATER MAIN TEE FITTINGS	EACH	5	69	1,200.00	-	6,000.00
		WATER MAIN BENDS & THRUST BLOCKS	EACH	10	69	600.00	**	6,000.00
		1 INCH HOUSE SERVICE CONNECTION (LONG)	EACH	30	69	1,750.00	**	52,500.00
		1 INCH HOUSE SERVICE CONNECTION (SHORT)	EACH	24	\$	1,500.00	-	36,000.00
		TESTING AND CHLORINATION	TUMP	+	69	-1-	**	•
		3% INFLATION	LUMP	F	\$	15,163.50	*	15,163.50
		SECTION	SECTION TOTAL WATERLINE	NATERLINE :				505,450.00
		SANITARY						
611	01800	8" CONDUIT, TYPE B	FOOT	151	60	67.51	49	10,194.01
. 1		RELINING OF EXISTING SANITARY SEWER MANHOLE (SPECTRASHIELD)	EACH	15	63	2,000.00	\$	30,000.00
		SECT	SECTION TOTAL SANIATRY	SANIATRY :			-	40,194.01
81.1		PAVEMENT						
301	46000	4" ASPHALT CONCRETE BASE, PG 64-22	CU. YD.	1,305	69	110.00	- 19	143,550.00
304	20000	AGGREGATE BASE	CU. YD.	1,977	69	50.00	~	98,850.00
407	10000	TACK COAT FOR INTERMEDIATE COURSE	GAL.	1,186	69	2.00	\$	2,372.00
407	14000	TACK COAT, 702.13	GAL.	1,186	69	2,00		2,372.00
441	50301	1-1/2" ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE 2 (448), PG 64-22,	cu. YD.	577	49	160.00	\$	92,320.00
441	50100	1-1/2" ASPHALT CONCRETE SURFACE COURSE, TYPE 1, PG 64-22	CU.YD.	412	6	170.00	*	70 040 00

405,766.75	5		10% CONTINGENCY	10% CO	10% CONTINGENCY		
4,057,667.52	\$	_	GRAND SUB TOTAL :	GRAND S			
149,000.00	5		ILLANEOUS	SECTION TOTAL MISCELLANEOUS	SECTIO		
3,000.00	\$1,500.00 \$	\$1,5(2	EACH	PROJECT SIGN		SPECIAL
1,000.00	\$1,000.00 \$	\$1.0	1	LUMP	PRE CONSTRUCTION VIDEO TAPING OF RIGHT OF WAY		SPECIAL
110,000.00	\$ 00.00	\$110,000.00	÷	LUMP	MOBILIZATION	10000	624
35,000.00	\$ 00.00	\$35,000.00	1	LUMP	CONSTRUCTION LAYOUT STAKES AND SURVEYING, AS PER PLAN	10000	623
•	\$1,500.00 \$	\$1,5	0	MONTHS	FIELD OFFICE, TYPE B	16010	619
	-				MISCELLANEOUS		
58,316.00	s		DE TRAFFIC	AINTENANCE	SECTION TOTAL MAINTENANCE OF TRAFFIC		
6,300.00	700.00 \$	\$ 70	9	TON	CALCIUM CHLORIDE	20000	616
1,800.00	50.00 \$	s S	36	M GAL	WATER	10000	616
216.00	3.00 \$	69	72	FOOT	WORK ZONE STOP LINE, CLASS 1, 642 PAINT	26200	614
20,000.00	200.00 \$	\$ 20	100	CU. YD.	ASPHALT CONCRETE FOR MAINTAINING TRAFFIC	13000	614
	45.00 \$	\$	0	HOUR	LAW ENFORCEMENT OFFICER	11110	614
3,000.00	75.00 \$	\$	40	HOUR	LAW ENFORECMENT OFFICER WITH PATROL CAR	11110	614
25,000.00	\$ 00.00	\$ 25,000.00	1	LUMP	MAINTAINING TRAFFIC, AS PER PLAN	11000	614
2,000.00	20.00 \$	59	100	CU. YD.	TRAFFIC COMPACTED SURFACE, TYPE A OR B	12000	410
					MAINTENANCE OF TRAFFIC		
3,819.84	*		CONTROL :	SECTION TOTAL TRAFFIC CONTROL	section		
1,670.40	2.61 \$	67	640	FOOT	CROSSWALK LINE	00900	644
424.08	5.89 \$	69	72	FOOT	STOP LINE	00500	644
110.32	13.79 \$	69	8	EACH	REMOVAL OF GROUND MOUNTED POST SUPPORT AND DISPOSAL	86002	630
147.36	18.42 \$	69	8	EACH	REMOVAL OF GROUND MOUNTED SIGN AND STORAGE	85000	630
612.00	15.30 \$	69	40	SQ. FT.	SIGN, FLAT SHEET	80100	630
855.68	7.64 \$	69	112	FOOT	GROUND MOUNTED SUPPORT, N	02100	630
594,379.00	~		AVEMENT :	SECTION TOTAL PAVEMENT	TRAFFIC CONTROL		
156,875.00	25.00 \$	69	6,275	FOOT	CURB, TYPE 6	26000	609
28,000.00	35.00 \$	\$	800	SQ. YD.	6" NON-REINFORCED CONCRETE PAVEMENT, CLASS QC1 (FOR DRIVES),	12011	452