November 20, 2020 ***(Revised August 20, 2021 per City of Raleigh Comments)***

To: Tim Beasley, City of Raleigh

From: Mike Sanchez, McAdams

RE: The Point
Sanitary Sewer Capacity Study
AWH-20000

Introduction and Background

This study was performed to determine the sanitary sewer capacity of the existing sanitary sewer outfall that will serve The Point community in the Town of Rolesville. More specifically, this study evaluates whether the existing gravity system can accommodate the sewage generation from the proposed development of approximately 882 lots on The Point project site located along Highway 401 between Jonesville Road to the west and E. Young Street on the east. Approximately 788 lots will be on the south side of Highway 401 (referred to in this study as The Point South) and 94 lots on the north side of Highway 401 (referred to in this study as The Point North). This study also examines the interim condition associated with first phase of development proposed for The Point South and referred to as CD Package #1. This initial phase of development includes 267 single family lots. In coordination with John Sorrell, PE and Tim Beasley, this study evaluates the following two segments of outfall both of which are identified on Exhibit 1:

1. Harris Creek Interceptor (HCI) outfall beginning at MH 54 (as identified on 1992 as-builts prepared by The Wooten Company). This outfall runs along the west side of The Point North and continues along the west side of The Point South down to the termination point, MH 22, identified on Exhibit 1, and
2. Rolesville Sanitary Sewer Outfall (RSSO) beginning at MH 31 (as identified on 2007 as-builts prepared by BNK) near Rolesville High School and west to the connecting manhole, MH 1, along the Harris Creek Interceptor.

Exhibits 2, and 3 provide a more detailed view of the outfall segments evaluated in this study.

Approach

The following approach was used for completing this sanitary sewer capacity analysis:

1. Tributary flow shown in Table 1A is from water meter data obtained from the City of Raleigh for the developed area within the sewage basin north of The Point North and for Rolesville High School..
2. As noted by the City of Raleigh, water meter data was available for all but 43 lots. Therefore, based on the number of lots for which there was water meter data, an average flow per lot was determined for each area and applied to all lots in that area as shown on Table 1A.
3. In Appendix E of the City of Raleigh Public Utilities Handbook, the Sewer Capacity Study Departmental Operating Instructions (effective 12/03/2013) requires that peak flow pass through half full pipe. Table 1B provides the peak flow calculations for each flow entering the system. Where water meter data is used, no peak factor is applied.

4. For calculation of peak flow for The Point, the City of Raleigh sewage generation rate of 250 gpd / lot is used to calculate average daily flow for single-family and townhomes. The City of Raleigh standard operating instructions referenced above also define the peaking factor as 2.5, which was applied to calculate the peak flow for The Point.
5. Table 1B identifies the manholes where the sewage generated by the existing lots, the anticipated sewage from The Point, and the anticipated sewage from future development within the sewer basin were assumed to enter the existing gravity sewer outfall. Table 1C identifies the anticipated sewage from only the lots in CD Package #1. Exhibits 4 and 5 graphically identify the discharge points to the existing outfall for lot segments within The Point.
6. For each pipe evaluated in this study, as-built data (diameter, material, slope, and length) were input into a capacity calculation spreadsheet that uses standard Manning's equations to calculate full and half full capacities. Per the City of Raleigh standard operating instructions referenced above, a Manning's roughness coefficient "*n*" of 0.013 was used for all pipes.
7. In addition, sewage flow rates determined as described above, were also input into the capacity calculation spreadsheet to determine cumulative flow rates and remaining capacities for each existing sewer line that is part of this study.
8. The Kalas Falls development will ultimately have 550 lots. Per information received from CORPUD on 08/19/2021, only Kalas Falls Phases 1 and 2, which will include 239 lots (=129 Ph 1 lots + 110 Ph 2 lots), should be considered "Obligated" for evaluating The Point CD Package #1 sewage capacity. For the purposes of this study, the remainder of the Kalas Falls development will be considered "Obligated" for evaluation of the sewage capacity for the ultimate buildout of The Point.
9. Anticipated flow from the Wheeler Tract is assumed to be part of the future sewage flow for the part of the capacity study that requires consideration of future development of the entire basin.
10. The results of these calculations are provided in the following Tables 9 (NOTE: RSSO = Rolesville Sanitary Sewer Outfall; HCI = Harris Creek Interceptor):
    a. Table 1 – Sewage Generation
    b. Table 2 – RSSO MH 31 to MH 01 Tributary Flow + The Point (CD Package #1 Lots Only)
    c. Table 3 – RSSO MH 31 to MH 01 Tributary Flow + The Point (Full Buildout through RSSO)
    d. Table 4 – HCI MH 54 to MH 22 Tributary + Obligated Flow + The Point (CD Package #1 Lots Only)
    e. Table 5 – HCI MH 54 to MH 22 Tributary + Obligated Flow + The Point (Full Buildout through HCI)
    f. Table 6 – HCI MH 54 to MH 22 Tributary + Obligated Flow + The Point (Full Buildout through HCI) + Future Development within sewer basin with improvements

Summary

This summary evaluates the results under two criteria set by CORPUD. First, for pipes where peak tributary and obligated flow plus the proposed development is predicted to exceed 50% of pipe capacity, a fee-in-lieu is owed by the developer to cover the costs associated with future improvements. Second, for pipes where the peak tributary and obligated flow plus the proposed development is predicted to exceed 65% capacity, the developer must install the necessary improvements to rectify the situation.

As shown in Table 2, with tributary and obligated flow and the anticipated flow for The Point CD Package #1, sewage flow does not exceed 50% capacity in any of the Rolesville Sewer outfall pipes.

As shown in in Table 3, when the remainder of the proposed lots for The Point that will flow through the Rolesville Sanitary Sewer Outfall are included in the analysis, four pipes (MH 07 to MH 06, MH 06 to MH 05, MH 05 to MH 04, and MH 03 to MH 02) are anticipated to flow over 50% capacity but under 65% capacity.

As shown in Table 4, with tributary and obligated flow and the anticipated flow for The Point CD Package #1, eight pipes (MH 42 to MH 41, MH 40 to MH 39, MH 39 to MH 38, MH 38 to MH 37, MH 37 to MH 36, MH 36 to MH 35, MH 35 to MH 34, MH 34 to MH 33) are anticipated to flow over 50% capacity but under 65% capacity. Under that same scenario, 10 pipes (MH 32 to MH 31, MH 31 to MH 30, MH 30 to MH 29, MH 29 to MH 28, MH 28 to MH 27, MH 27 to MH 26, MH 26 to MH 25, MH 25 to MH 24, MH 24 to MH 23, MH23 to MH 22) are anticipated to flow over 65% capacity. Per discussion on August 19, 2021 with Jay Gilleece, with American Engineering, who is the engineer for the Kalas Falls development, American Engineering submitted construction drawings for the improvement of those 10 pipes that are predicted to be over 65% capacity. Those construction drawings are near approval and should be receiving conditional approval soon. The conditions will be based on approval of the 404/401 and acquisition of all necessary easements.

As shown in Table 5, when the remainder of the proposed lots for The Point that will flow through the Harris Creek Interceptor are included in the analysis, one pipe (MH 43 to MH 42) is anticipated to flow over 50% capacity but under 65% capacity. Under that same scenario, 19 pipes (MH 01 to MH 43, MH 42 to MH 41, MH 40 to MH 39, MH 39 to MH 38, MH 38 to MH 37, MH 37 to MH 36, MH 36 to MH 35, MH 35 to MH 34, MH 34 to MH 33, MH 32 to MH 31, MH 31 to MH 30, MH 30 to MH 29, MH 29 to MH 28, MH 28 to MH 27, MH 27 to MH 26, MH 26 to MH 25, MH 25 to MH 24, MH 24 to MH 23, MH23 to MH 22) are anticipated to flow over 65% capacity.

As mentioned above, to determine the ultimate size of improvement needed, the City of Raleigh requires that the entire sewage basin be considered so that those areas that are currently undeveloped or underdeveloped based on the zoning can be developed without requiring future pipe size increases. Exhibit 6 shows the approximate sewer basin. Several areas within this sewage basin are currently undeveloped or underdeveloped. Per the Town of Rolesville Future Land Use Map, a variety of zoning classifications are projected for these areas including medium density residential, business park, and high density residential. For the purposes of this study, future development was projected to be most closely medium density residential. Using a peak flow (gpapd) from Section 7.1.7 of the Public Utilities Handbook Appendix E Sewer Capacity Study Departmental Operating Instructions (effective 12/03/2013) for Residential – 4 zoning, a peak flow of 2,000 gpapd was applied to these areas and the projected sewage flow from these areas were assumed to enter the gravity system considered in this study at the manholes indicated in Table 1B.

With the future development flows, Table 6 indicates that the one pipe projected to flow over 50% and under 65% in Table 5 and all 19 pipes identified in Table 5 projected to flow over 65%, would need to be upsized to pipe

diameters ranging from 18-inch up to 27-inch in order to accommodate all tributary, obligated, and future development flows within the sewage basin without exceeding 50% capacity. Although the pipes from MH 43 to MH 42 and from MH 33 to MH 32 would be required to be upsized as they are not projected to flow over 65%, they are included in Table 6 as it is anticipated that CORPUD would rather not have larger improved pipe sizes discharging into downstream unimproved pipe sizes. Therefore, a total of 22 pipes are shown in Table 6.

Conclusion

Based on the results of this study described above, the proposed improvements that will be required for both the Rolesville Sanitary Sewer Outfall and the Harris Creek Interceptor for development of The Point are summarized in Table 7 and Table 8, respectively. Those tables include the results based on CD Package #1 and for the full buildout of The Point.

ATTACHMENTS:

Exhibit 1 – The Point Overall Sanitary Sewer
Exhibit 2 – The Point Sanitary Sewer Outfall (1 of 2)
Exhibit 3 – The Point Sanitary Sewer Outfall (2 of 2)
Exhibit 4 – Sewage Discharge Points from The Point South to Existing Outfall
Exhibit 5 – Sewage Discharge Points from The Point North to Existing Outfall
Exhibit 6 – Sanitary Sewer Basin
Table 1 (A&B&C) – Sewage Generation
Table 2 – Sewer Capacity Spreadsheet - RSSO MH 31 to MH 01 Tributary Flow + The Point (CD Package #1 Lots Only)
Table 3 – Sewer Capacity Spreadsheet – RSSO MH 31 to MH 01 Tributary Flow + The Point (Full Buildout through RSSO)
Table 4 – Sewer Capacity Spreadsheet – HCI MH 54 to MH 22 Tributary + Obligated Flow + The Point (CD Package #1 Lots Only)
Table 5 – Sewer Capacity Spreadsheet – HCI MH 54 to MH 22 Tributary + Obligated Flow + The Point (Full Buildout through HCI)
Table 6 – Sewer Capacity Spreadsheet – HCI MH 54 to MH 22 Tributary + Obligated Flow + The Point (Full Buildout through HCI) + Future Development within sewer basin with improvements
Table 7 – Rolesville Sanitary Sewer Outfall Summary of Improvements
Table 8 – Harris Creek Interceptor Summary of Improvements

ROLESVILLE SEWER OUTFALL

HARRIS CREEK INTERCEPTOR

STUDY TERMINATION

EXHIBIT 1 - THE POINT OVERALL SANITARY SEWER

N

0 440 880 1,760 ft

1 inch = 400 feet

EXHIBIT 2 - THE POINT SANITARY SEWER OUTFALL (1 OF 2)

N

0 225 450 900 ft

1 inch = 200 feet

ALL 10-INCH SANITARY SEWER

MH 01
MH 43
0.45%
1.10%
MH 42
0.28%
MH 41
19.71%
MH 40
0.28%
MH 39
0.28%
MH 38
0.28%
MH 37
0.28%
MH 36
0.28%
MH 35
0.28%
MH 34
0.28%
MH 33
4.29%
MH 32
0.28%
MH 31
0.28%
MH 30
0.28%
MH 29
0.28%
MH 28
0.28%
MH 27
0.28%
MH 26
0.28%
MH 25
0.28%
MH 24
0.28%
MH 23
0.28%
MH 22

Lousburg Rd
401
Upchurch Ln
Cousins Ln
Lawn Artist Dr
Harris Creek
Manly Farm Rd

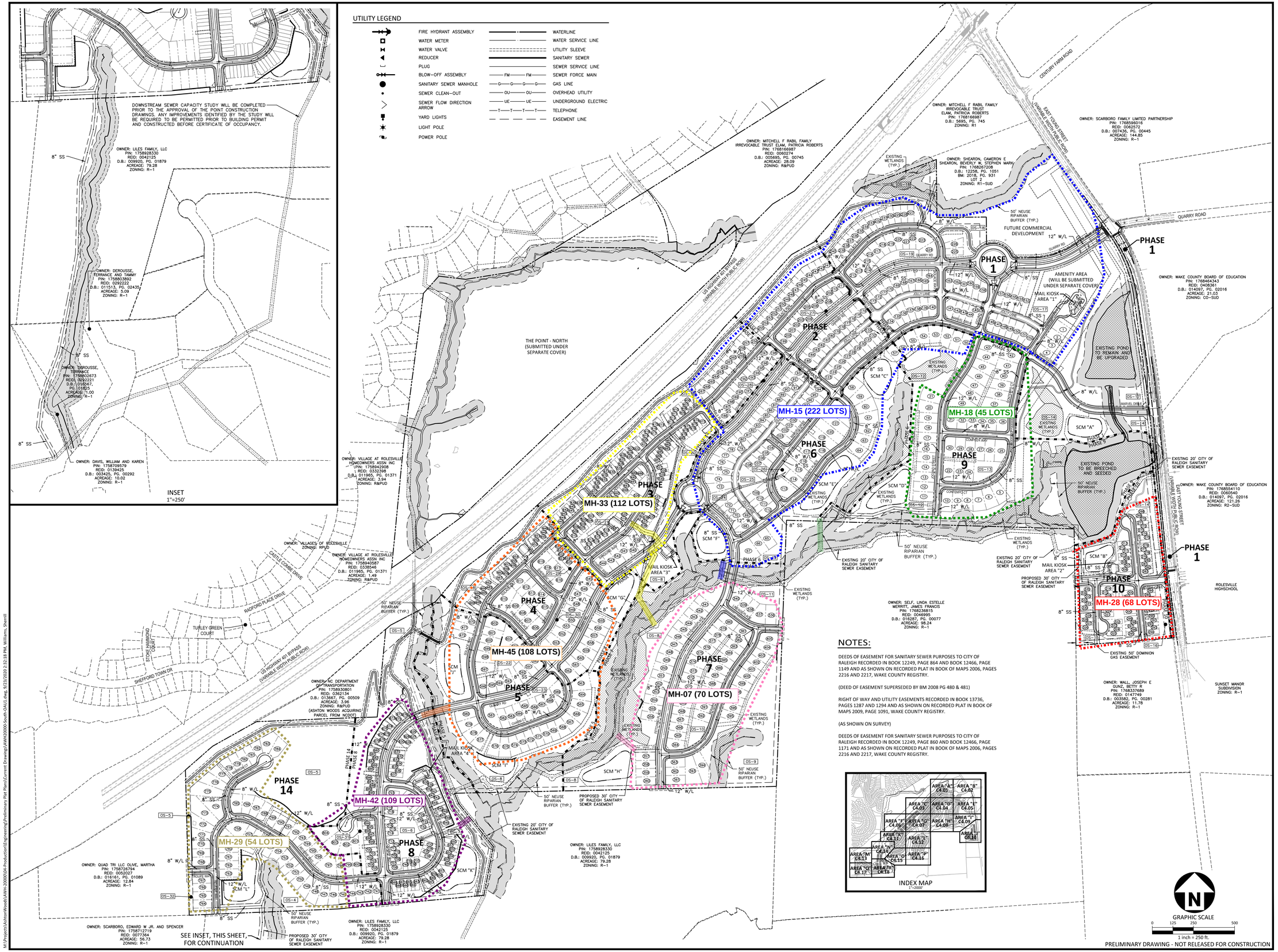
EXHIBIT 3 - THE POINT SANITARY SEWER OUTFALL (2 OF 2)

N

0 225 450 900 ft

1 inch = 200 feet

Disclaimer
iMaps makes every effort to produce and publish the most current and accurate information possible. However, the maps are produced for information purposes, and are **NOT** surveys. No warranties, expressed or implied, are provided for the data therein, its use,or its interpretation.



NOTES:

DEEDS OF EASEMENT FOR SANITARY SEWER PURPOSES TO CITY OF RALEIGH RECORDED IN BOOK 12249, PAGE 864 AND BOOK 12466, PAGE 1149 AND AS SHOWN ON RECORDED PLAT IN BOOK OF MAPS 2006, PAGES 2216 AND 2217, WAKE COUNTY REGISTRY.

(DEED OF EASEMENT SUPERSEDED BY BM 2008 PG 480 & 481)

RIGHT OF WAY AND UTILITY EASEMENTS RECORDED IN BOOK 13736, PAGES 1287 AND 1294 AND AS SHOWN ON RECORDED PLAT IN BOOK OF MAPS 2009, PAGE 1091, WAKE COUNTY REGISTRY.

(AS SHOWN ON SURVEY)

DEEDS OF EASEMENT FOR SANITARY SEWER PURPOSES TO CITY OF RALEIGH RECORDED IN BOOK 12249, PAGE 860 AND BOOK 12466, PAGE 1171 AND AS SHOWN ON RECORDED PLAT IN BOOK OF MAPS 2006, PAGES 2216 AND 2217, WAKE COUNTY REGISTRY.

PRELIMINARY DRAWING - NOT RELEASED FOR CONSTRUCTION

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EXHIBIT 4

SEWAGE DISCHARGE POINTS FROM THE POINT SOUTH TO EXISTING OUTFALL

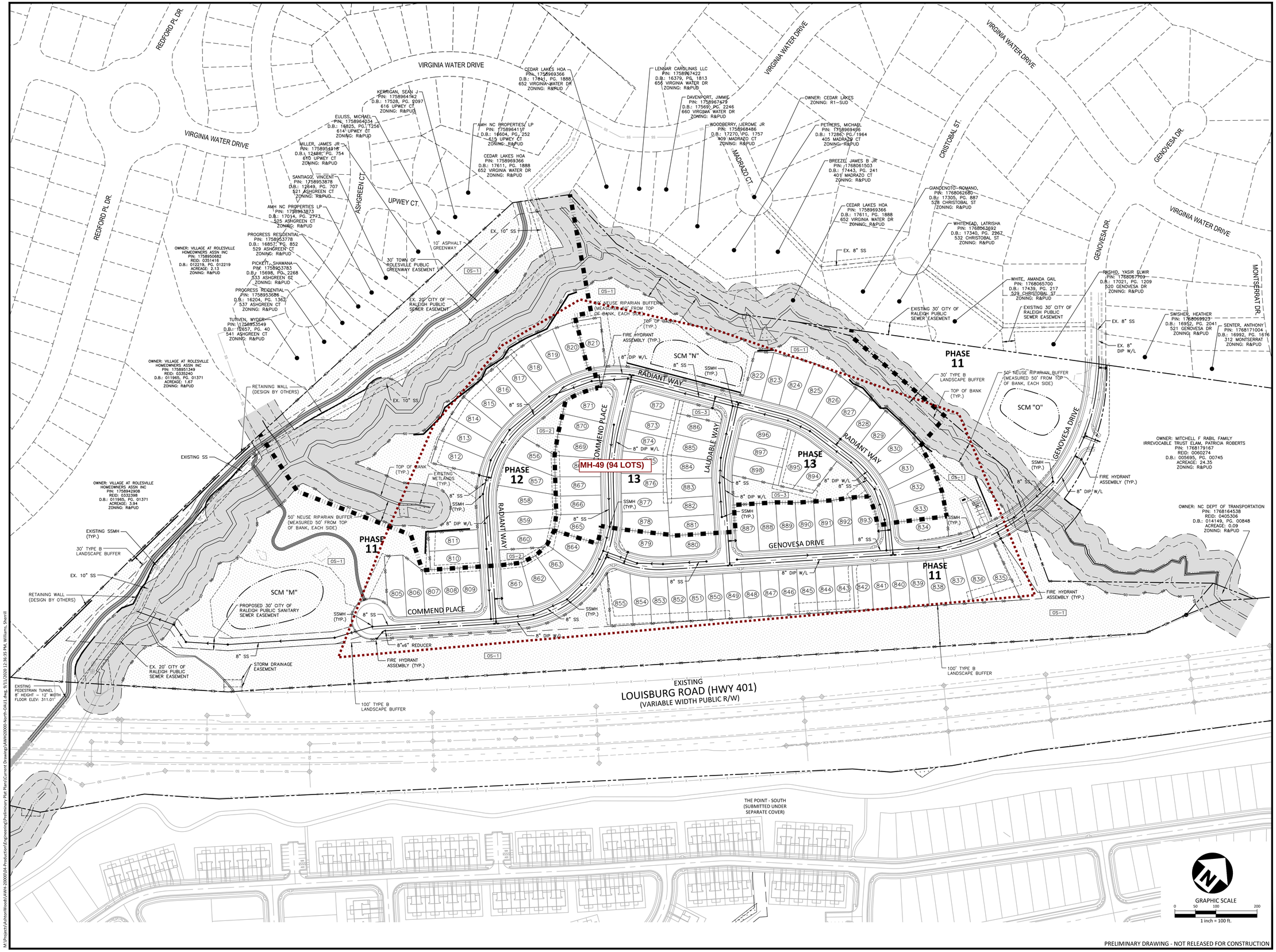

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EXHIBIT 5

SEWAGE DISCHARGE POINTS FROM THE POINT NORTH TO EXISTING OUTFALL

Exhibit 6 - Sewage Basin

N

0 1,050 2,100 4,200 ft

1 inch = 1,000 feet

TABLES 1(A&B&C) - SEWAGE GENERATION

TABLE 1A - CALCULATION OF AVERAGE AND TOTAL FLOW PER LOT BASED ON METERED FLOW

AREA	METERED FLOW (provided by CORPUD)		APPROXIMATE NO. OF METERED LOTS	APPROXIMATE NO. OF UNMETERED LOTS	AVG FLOW PER LOT (based on No. of metered lots)	PEAK FLOW (metered and unmetered)
	gpm	gpd			gpd	gpd
Blue Area (Water Billing Data from Tim Beasley Email 11/16/2020 - see image below)	160.273	230,793	507	43	455.21	250,367
Rolesville High School (Water Billing Data from Tim Beasley Email on 05/07/2020)	4.1	5,904	1	0	5,904	5,904
		-				
					TOTAL PEAK FLOW:	**256,271**

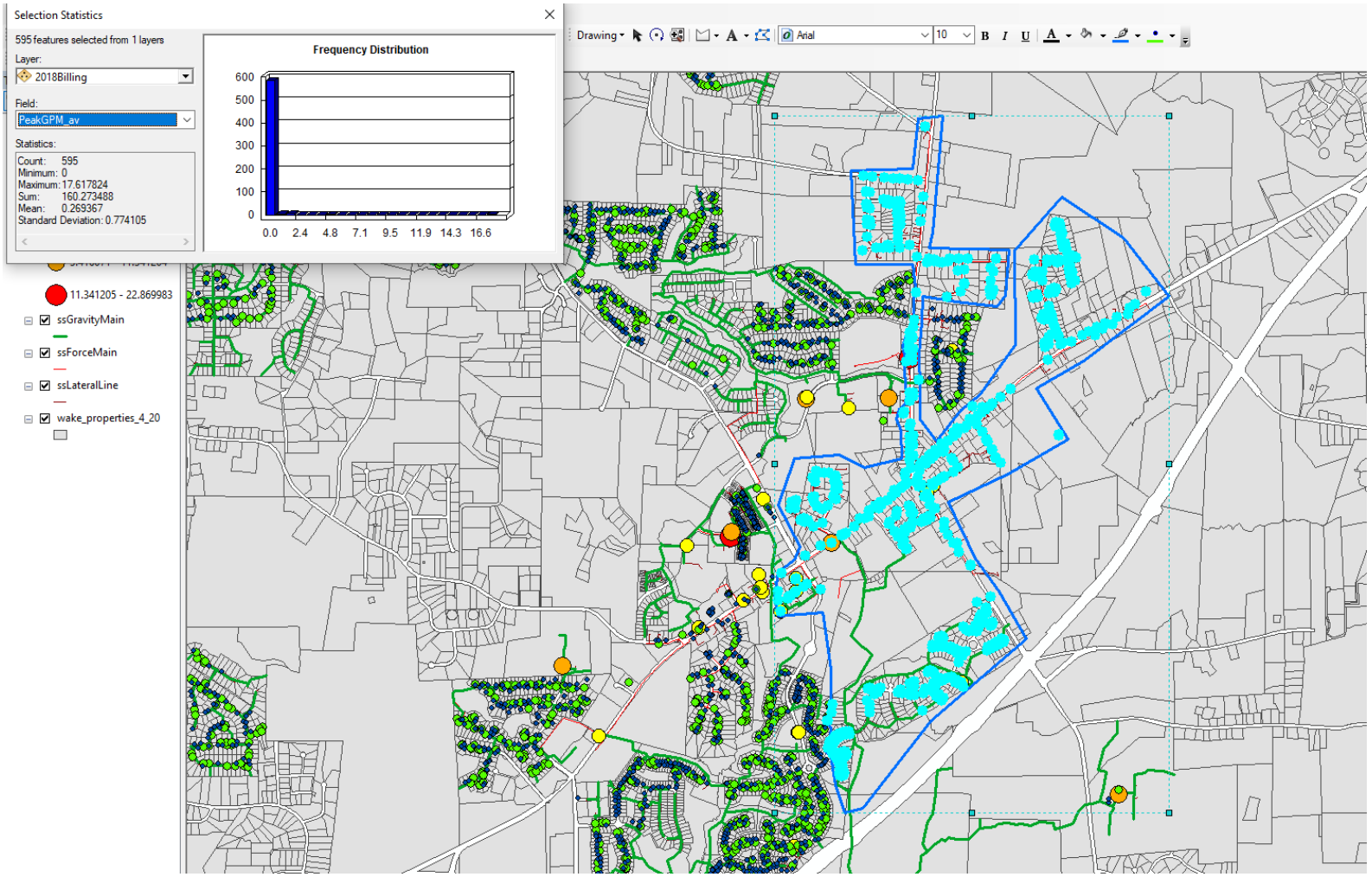


TABLE 1B - SUMMARY OF SEWAGE GENERATION BY AREA

Area	Lots	ADF/Lots	Peak Factor	Total Flow (gpd)
Rolesville High School				
MH 31 (Rolesville SS O/F)				5,904
The Point South				
MH 28 (Rolesville SS O/F)	68	250	2.5	42,500
MH 18 (Rolesville SS O/F)	45	250	2.5	28,125
MH 15 (Rolesville SS O/F)	222	250	2.5	138,750
MH 11 (Rolesville SS O/F)	112	250	2.5	70,000
MH 07 (Rolesville SS O/F)	310	250	2.5	193,750
Ex Dev (see Table A)				
MH 54 (Harris Creek Interceptor)				250,367
The Point North				
MH 49 (Harris Creek Interceptor)	94	250	2.5	58,750
The Point South				
MH 45 (Harris Creek Interceptor)	108	250	2.5	67,500
MH 42 (Harris Creek Interceptor)	109	250	2.5	68,125
MH 29 (Harris Creek Interceptor)	54	250	2.5	33,750
Wheeler Tract (Future)				
MH 32 (Harris Creek Interceptor)	360	250	2.5	225,000
Kalas Falls (Obligated)				
MH 32 (Harris Creek Interceptor)	550	250	2.5	343,750
Future Dev w/in Basin	**Acres**	**Peak (gpad)***		
MH 31 (Rolesville SS O/F)	50	2000		100,000
MH 54 (Harris Creek Interceptor)	530	2000		1,060,000
MH 42 (Harris Creek Interceptor)	850	2000		1,700,000
			TOTAL PEAK FLOW:	**4,386,271**

*Peak per acre flow is from City of Raleigh Public Utilities Handbook Appendix E Sewer Capacity Study Section 7.1.7 for Residential - 4 zoning classification.

TABLE 1C - SUMMARY OF SEWAGE GENERATION WITHIN THE POINT FOR CD PACKAGE #1 ONLY

Area	Lots	ADF/Lots	Peak Factor	Total Flow (gpd)
Rolesville High School				
MH 31 (Rolesville SS O/F)				5,904
The Point South				
MH 28 (Rolesville SS O/F)	0	250	2.5	-
MH 18 (Rolesville SS O/F)	46	250	2.5	28,750
MH 15 (Rolesville SS O/F)	218	250	2.5	136,250
MH 11 (Rolesville SS O/F)	0	250	2.5	-
MH 07 (Rolesville SS O/F)	0	250	2.5	-
Ex Dev (see Table A)				
MH 54 (Harris Creek Interceptor)				250,367
The Point North				
MH 49 (Harris Creek Interceptor)	0	250	2.5	-
The Point South				
MH 45 (Harris Creek Interceptor)	0	250	2.5	-
MH 42 (Harris Creek Interceptor)	0	250	2.5	-
MH 29 (Harris Creek Interceptor)	0	250	2.5	-
Wheeler Tract (Future)				
MH 32 (Harris Creek Interceptor)	0	250	2.5	-
Kalas Falls (Obligated)*				
MH 32 (Harris Creek Interceptor)	239	250	2.5	149,375
Future Dev w/in Basin	**Acres**	**Peak (gpad)**		
MH 31 (Rolesville SS O/F)	0	2000		-
MH 54 (Harris Creek Interceptor)	0	2000		-
MH 42 (Harris Creek Interceptor)	0	2000		-
			TOTAL PEAK FLOW:	**570,646**

*Per information from CORPUD, only Kalas Falls Ph 1 and 2 (239 lots) should be considered "Obligated" for CD Package No. 1 sanitary sewer capacity evaluation.

TABLE 2 - Sewer Capacity Spreadsheet
RSSO MH 31 to MH 01
Tributary Flow + The Point (CD Package #1 Lots Only)

November 20, 2020
Revised: April 21, 2021

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*													Estimated Flows		
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	Flow /Full Pipe Flow Rate (%)	Flow Depth (inches)
MH 31 TO MH 30	8	DIP	0.520	0.00520	239		0.013	0.67	0.33	0	0	0.013	0.0052	0.35	2.09	0.17	0.87	564,677	282,338	196	5,904	1.00	0.40
MH 30 TO MH 29	8	DIP	0.530	0.00530	209		0.013	0.67	0.33	0	0	0.013	0.0053	0.35	2.09	0.17	0.88	570,080	233,733	162	5,904	1.00	0.40
MH 29 TO MH 28	8	DIP	2.660	0.02660	244		0.013	0.67	0.33	0	0	0.013	0.0266	0.35	2.09	0.17	1.98	1,277,141	523,628	364	5,904	0.50	0.40
MH 28 TO MH 27	8	PVC	2.960	0.02960	110		0.013	0.67	0.33	0	0	0.013	0.0296	0.35	2.09	0.17	2.08	1,347,237	552,367	384	5,904	0.40	0.40
MH 27 TO MH 26	8	PVC	0.550	0.00550	126		0.013	0.67	0.33	0	0	0.013	0.0055	0.35	2.09	0.17	0.90	580,737	290,368	202	5,904	1.00	0.40
MH 26 TO MH 25	8	PVC	1.840	0.01840	272		0.013	0.67	0.33	0	0	0.013	0.0184	0.35	2.09	0.17	1.64	1,062,202	531,101	369	5,904	0.06	0.40
MH 25 TO MH 24	8	PVC	2.220	0.02220	171		0.013	0.67	0.33	0	0	0.013	0.0222	0.35	2.09	0.17	1.81	1,166,741	583,371	405	5,904	0.05	0.40
MH 24 TO MH 23	8	PVC	0.500	0.00500	187		0.013	0.67	0.33	0	0	0.013	0.0050	0.35	2.09	0.17	0.86	553,711	276,855	192	5,904	1.10	0.40
MH 23 TO MH 22	8	PVC	0.510	0.00510	96		0.013	0.67	0.33	0	0	0.013	0.0051	0.35	2.09	0.17	0.87	559,221	229,280	159	5,904	1.10	0.40
MH 22 TO MH 21	8	PVC	0.530	0.00530	155		0.013	0.67	0.33	0	0	0.013	0.0053	0.35	2.09	0.17	0.88	570,080	233,733	162	5,904	1.00	0.40
MH 21 TO MH 20	8	PVC	1.760	0.01760	182		0.013	0.67	0.33	0	0	0.013	0.0176	0.35	2.09	0.17	1.61	1,038,854	425,930	296	5,904	0.60	0.40
MH 20 TO MH 19	8	PVC	0.580	0.00580	80		0.013	0.67	0.33	0	0	0.013	0.0058	0.35	2.09	0.17	0.92	596,365	244,510	170	5,904	1.00	0.40
MH 19 TO MH 18	8	PVC	0.920	0.00920	300		0.013	0.67	0.33	0	0	0.013	0.0092	0.35	2.09	0.17	1.16	751,090	307,947	214	5,904	0.80	0.40
MH 18 TO MH 17	10	PVC	0.510	0.00510	295		0.013	0.83	0.42	0	0	0.013	0.0051	0.55	2.62	0.21	1.57	1,013,935	415,713	289	34,654	3.40	1.20
MH 17 TO MH 16	10	PVC	1.640	0.01640	213		0.013	0.83	0.42	0	0	0.013	0.0164	0.55	2.62	0.21	2.81	1,818,221	745,471	518	34,654	1.90	1.00
MH 16 TO MH 15	10	PVC	0.510	0.00510	175		0.013	0.83	0.42	0	0	0.013	0.0051	0.55	2.62	0.21	1.57	1,013,935	415,713	289	34,654	3.40	1.20
MH 15 TO MH 14	10	PVC	0.520	0.00520	87		0.013	0.83	0.42	0	0	0.013	0.0052	0.55	2.62	0.21	1.58	1,023,827	419,769	292	170,904	16.70	3.25
MH 14 TO MH 13	10	PVC	0.500	0.00500	69		0.013	0.83	0.42	0	0	0.013	0.0050	0.55	2.62	0.21	1.55	1,003,945	411,617	286	170,904	17.00	3.25
MH 13 TO MH 12	10	PVC	0.710	0.00710	227		0.013	0.83	0.42	0	0	0.013	0.0071	0.55	2.62	0.21	1.85	1,196,338	490,499	341	170,904	14.30	3.00
MH 12 TO MH 11	10	PVC	1.140	0.01140	136		0.013	0.83	0.42	0	0	0.013	0.0114	0.55	2.62	0.21	2.35	1,515,923	621,529	432	170,904	11.30	2.50
MH 11 TO MH 10	10	PVC	0.300	0.00300	141		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	170,904	22.00	3.67
MH 10 TO MH 09	10	PVC	0.300	0.00300	252		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	170,904	22.00	3.67
MH 09 TO MH 08	10	PVC	0.300	0.00300	133		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	170,904	22.00	3.67
MH 08 TO MH 07	10	PVC	0.440	0.00440	234		0.013	0.83	0.42	0	0	0.013	0.0044	0.55	2.62	0.21	1.46	941,784	386,131	268	170,904	18.10	3.33
MH 07 TO MH 06	10	DIP	0.300	0.00300	205		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	170,904	22.00	3.67
MH 06 TO MH 05	10	PVC	0.390	0.00390	280		0.013	0.83	0.42	0	0	0.013	0.0039	0.55	2.62	0.21	1.37	886,660	363,531	252	170,904	19.30	3.42
MH 05 TO MH 04	10	DIP	0.300	0.00300	175		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	170,904	22.00	3.67
MH 04 TO MH 03A	10	PVC	9.550	0.09550	192		0.013	0.83	0.42	0	0	0.013	0.0955	0.55	2.62	0.21	6.79	4,387,595	1,798,914	1,249	170,904	3.90	1.40
MH 03A TO MH 03	10	PVC	1.130	0.01130	87		0.013	0.83	0.42	0	0	0.013	0.0113	0.55	2.62	0.21	2.34	1,509,260	618,797	430	170,904	11.30	2.50
MH 03 TO MH 02	10	PVC	0.310	0.00310	71		0.013	0.83	0.42	0	0	0.013	0.0031	0.55	2.62	0.21	1.22	790,507	324,108	225	170,904	21.60	3.67
MH 02 TO MH 01	10	DIP	2.130	0.02130	193		0.013	0.83	0.42	0	0	0.013	0.0213	0.55	2.62	0.21	3.21	2,072,119	849,569	590	170,904	8.20	2.13

Equations used for calculations:

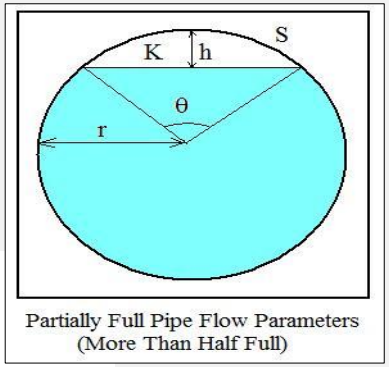
$r = D/2$

$h = 2r - y$

$$\theta = 2\arccos\left(\frac{r - h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r * \theta$$



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe ($ft.^2$)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)

TABLE 3 - Sewer Capacity Spreadsheet
RSSO MH 31 to MH 01
Tributary Flow + The Point (Full Buildout through RSSO)

November 20, 2020
Revised: April 21, 2021

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*													Estimated Flows		
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	(Flow) / (Full Pipe Flow Rate)	Flow Depth (inches)
MH 31 TO MH 30	8	DIP	0.520	0.00520	239		0.013	0.67	0.33	0	0	0.013	0.0052	0.35	2.09	0.17	0.87	564,677	282,338	196	5,904	1.00	0.40
MH 30 TO MH 29	8	DIP	0.530	0.00530	209		0.013	0.67	0.33	0	0	0.013	0.0053	0.35	2.09	0.17	0.88	570,080	233,733	162	5,904	1.00	0.40
MH 29 TO MH 28	8	DIP	2.660	0.02660	244		0.013	0.67	0.33	0	0	0.013	0.0266	0.35	2.09	0.17	1.98	1,277,141	523,628	364	5,904	0.50	0.40
MH 28 TO MH 27	8	PVC	2.960	0.02960	110		0.013	0.67	0.33	0	0	0.013	0.0296	0.35	2.09	0.17	2.08	1,347,237	552,367	384	48,404	3.60	1.12
MH 27 TO MH 26	8	PVC	0.550	0.00550	126		0.013	0.67	0.33	0	0	0.013	0.0055	0.35	2.09	0.17	0.90	580,737	290,368	202	48,404	8.30	1.70
MH 26 TO MH 25	8	PVC	1.840	0.01840	272		0.013	0.67	0.33	0	0	0.013	0.0184	0.35	2.09	0.17	1.64	1,062,202	531,101	369	48,404	4.60	1.28
MH 25 TO MH 24	8	PVC	2.220	0.02220	171		0.013	0.67	0.33	0	0	0.013	0.0222	0.35	2.09	0.17	1.81	1,166,741	583,371	405	48,404	4.10	1.12
MH 24 TO MH 23	8	PVC	0.500	0.00500	187		0.013	0.67	0.33	0	0	0.013	0.0050	0.35	2.09	0.17	0.86	553,711	276,855	192	48,404	8.70	1.80
MH 23 TO MH 22	8	PVC	0.510	0.00510	96		0.013	0.67	0.33	0	0	0.013	0.0051	0.35	2.09	0.17	0.87	559,221	229,280	159	48,404	8.70	1.80
MH 22 TO MH 21	8	PVC	0.530	0.00530	155		0.013	0.67	0.33	0	0	0.013	0.0053	0.35	2.09	0.17	0.88	570,080	233,733	162	48,404	8.50	1.80
MH 21 TO MH 20	8	PVC	1.760	0.01760	182		0.013	0.67	0.33	0	0	0.013	0.0176	0.35	2.09	0.17	1.61	1,038,854	425,930	296	48,404	4.70	1.28
MH 20 TO MH 19	8	PVC	0.580	0.00580	80		0.013	0.67	0.33	0	0	0.013	0.0058	0.35	2.09	0.17	0.92	596,365	244,510	170	48,404	8.10	1.70
MH 19 TO MH 18	8	PVC	0.920	0.00920	300		0.013	0.67	0.33	0	0	0.013	0.0092	0.35	2.09	0.17	1.16	751,090	307,947	214	48,404	6.40	1.44
MH 18 TO MH 17	10	PVC	0.510	0.00510	295		0.013	0.83	0.42	0	0	0.013	0.0051	0.55	2.62	0.21	1.57	1,013,935	415,713	289	76,529	7.50	2.13
MH 17 TO MH 16	10	PVC	1.640	0.01640	213		0.013	0.83	0.42	0	0	0.013	0.0164	0.55	2.62	0.21	2.81	1,818,221	745,471	518	76,529	4.20	1.40
MH 16 TO MH 15	10	PVC	0.510	0.00510	175		0.013	0.83	0.42	0	0	0.013	0.0051	0.55	2.62	0.21	1.57	1,013,935	415,713	289	76,529	7.50	2.13
MH 15 TO MH 14	10	PVC	0.520	0.00520	87		0.013	0.83	0.42	0	0	0.013	0.0052	0.55	2.62	0.21	1.58	1,023,827	419,769	292	215,279	21.00	3.58
MH 14 TO MH 13	10	PVC	0.500	0.00500	69		0.013	0.83	0.42	0	0	0.013	0.0050	0.55	2.62	0.21	1.55	1,003,945	411,617	286	215,279	21.40	3.58
MH 13 TO MH 12	10	PVC	0.710	0.00710	227		0.013	0.83	0.42	0	0	0.013	0.0071	0.55	2.62	0.21	1.85	1,196,338	490,499	341	215,279	18.00	3.33
MH 12 TO MH 11	10	PVC	1.140	0.01140	136		0.013	0.83	0.42	0	0	0.013	0.0114	0.55	2.62	0.21	2.35	1,515,923	621,529	432	215,279	14.20	3.00
MH 11 TO MH 10	10	PVC	0.300	0.00300	141		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	285,279	36.70	4.73
MH 10 TO MH 09	10	PVC	0.300	0.00300	252		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	285,279	36.70	4.73
MH 09 TO MH 08	10	PVC	0.300	0.00300	133		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	285,279	36.70	4.73
MH 08 TO MH 07	10	PVC	0.440	0.00440	234		0.013	0.83	0.42	0	0	0.013	0.0044	0.55	2.62	0.21	1.46	941,784	386,131	268	285,279	30.30	4.27
MH 07 TO MH 06	10	DIP	0.300	0.00300	205		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	479,029	61.60	6.38
MH 06 TO MH 05	10	PVC	0.390	0.00390	280		0.013	0.83	0.42	0	0	0.013	0.0039	0.55	2.62	0.21	1.37	886,660	363,531	252	479,029	54.00	5.87
MH 05 TO MH 04	10	DIP	0.300	0.00300	175		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	479,029	61.60	6.38
MH 04 TO MH 03A	10	PVC	9.550	0.09550	192		0.013	0.83	0.42	0	0	0.013	0.0955	0.55	2.62	0.21	6.79	4,387,595	1,798,914	1,249	479,029	10.90	2.50
MH 03A TO MH 03	10	PVC	1.130	0.01130	87		0.013	0.83	0.42	0	0	0.013	0.0113	0.55	2.62	0.21	2.34	1,509,260	618,797	430	479,029	31.70	4.40
MH 03 TO MH 02	10	PVC	0.310	0.00310	71		0.013	0.83	0.42	0	0	0.013	0.0031	0.55	2.62	0.21	1.22	790,507	324,108	225	479,029	60.60	6.31
MH 02 TO MH 01	10	DIP	2.130	0.02130	193		0.013	0.83	0.42	0	0	0.013	0.0213	0.55	2.62	0.21	3.21	2,072,119	849,569	590	479,029	23.10	3.75

Equations used for calculations:

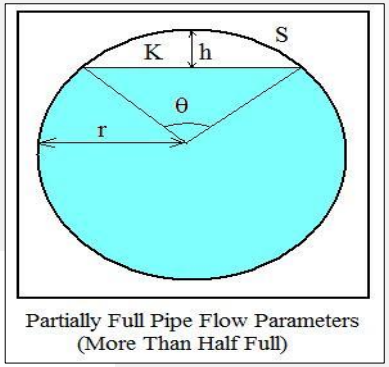
$r = D/2$

$h = 2r - y$

$$\theta = 2\arccos\left(\frac{r - h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r * \theta$$



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe ($ft.^2$)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)

TABLE 4 - Sewer Capacity Spreadsheet
HCI MH 54 to MH 22
Tributary + Obligated Flow + The Point (CD Package #1 Lots Only)

November 20, 2020
Revised: August 20, 2021

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*												Estimated Flows		
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	Flow / Full Pipe Flow Rate (%)	Flow Depth (inches)
MH 54 TO MH 53	10	DIP	1.070	0.01070	147		0.013	0.83	0.42	0	0	0.013	0.0107	0.55	2.62	0.21	2.27	1,468,645	734,322	510	250,367	17.00	3.25
MH 53 TO MH 52	10	PVC	0.280	0.00280	298		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30	4.47
MH 52 TO MH 51	10	PVC	0.270	0.00270	410		0.013	0.83	0.42	0	0	0.013	0.0027	0.55	2.62	0.21	1.14	737,746	368,873	256	250,367	33.90	4.53
MH 51 TO MH 50	10	PVC	0.840	0.00840	376		0.013	0.83	0.42	0	0	0.013	0.0084	0.55	2.62	0.21	2.01	1,301,261	533,517	370	250,367	19.20	3.42
MH 50 TO MH 49	10	PVC	8.800	0.08800	114		0.013	0.83	0.42	0	0	0.013	0.0880	0.55	2.62	0.21	6.52	4,211,785	1,726,832	1,199	250,367	5.90	1.80
MH 49 to MH 48	10	DIP	0.280	0.00280	160		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30	4.47
MH 48 to MH 47	10	PVC	0.280	0.00280	396		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30	4.47
MH 47 TO MH 46	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30	4.47
MH 46 TO MH 45	10	PVC	0.280	0.00280	292		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	250,367	33.30	4.47
MH 45 TO MH 44	10	PVC	1.960	0.01960	292		0.013	0.83	0.42	0	0	0.013	0.0196	0.55	2.62	0.21	3.08	1,987,709	814,961	566	250,367	12.60	2.75
MH 44 TO MH 01	10	PVC	0.464	0.00464	209		0.013	0.83	0.42	0	0	0.013	0.0046	0.55	2.62	0.21	1.50	967,571	396,704	275	250,367	25.90	4.00
MH 01 TO MH 43	10	PVC	0.452	0.00452	82		0.013	0.83	0.42	0	0	0.013	0.0045	0.55	2.62	0.21	1.48	954,181	391,214	272	421,271	44.20	5.20
MH 43 TO MH 42	10	PVC	1.100	0.01100	388		0.013	0.83	0.42	0	0	0.013	0.0110	0.55	2.62	0.21	2.30	1,489,091	610,527	424	421,271	28.30	4.13
MH 42 TO MH 41	10	PVC	0.280	0.00280	295		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	421,271	56.10	6.00
MH 41 TO MH 40	10	DIP	19.710	0.19710	118		0.013	0.83	0.42	0	0	0.013	0.1971	0.55	2.62	0.21	9.75	6,303,302	2,584,354	1,795	421,271	6.70	2.00
MH 40 TO MH 39	10	PVC	0.280	0.00280	184		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	421,271	56.10	6.00
MH 39 TO MH 38	10	PVC	0.280	0.00280	351		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	421,271	56.10	6.00
MH 38 TO MH 37	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	421,271	56.10	6.00
MH 37 TO MH 36	10	PVC	0.280	0.00280	366		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	421,271	56.10	6.00
MH 36 TO MH 35	10	PVC	0.280	0.00280	132		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	421,271	56.10	6.00
MH 35 TO MH 34	10	PVC	0.280	0.00280	155		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	421,271	56.10	6.00
MH 34 TO MH 33	10	PVC	0.280	0.00280	359		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	421,271	56.10	6.00
MH 33 TO MH 32	10	DIP	4.290	0.04290	153		0.013	0.83	0.42	0	0	0.013	0.0429	0.55	2.62	0.21	4.55	2,940,719	1,205,695	837	421,271	14.30	3.00
MH 32 TO MH 31	10	PVC	0.280	0.00280	280		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27
MH 31 TO MH 30	10	PVC	0.280	0.00280	221		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27
MH 30 TO MH 29	10	PVC	0.280	0.00280	416		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27
MH 29 TO MH 28	10	PVC	0.280	0.00280	328		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27
MH 28 TO MH 27	10	PVC	0.280	0.00280	240		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27
MH 27 TO MH 26	10	PVC	0.280	0.00280	399		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27
MH 26 TO MH 25	10	PVC	0.280	0.00280	419		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27
MH 25 TO MH 24	10	PVC	0.280	0.00280	369		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27
MH24 TO MH 23	10	PVC	0.280	0.00280	396		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27
MH 23 TO MH 22	10	PVC	0.280	0.00280	391		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	570,646	76.00	7.27

Equations used for calculations:

$r = D/2$

$h = 2r - y$

$$\theta = 2\arccos\left(\frac{r - h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

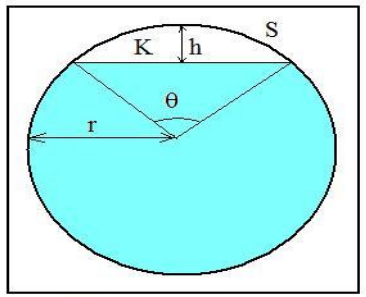
Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe (ft^2)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)



Partially Full Pipe Flow Parameters
(More Than Half Full)

TABLE 5 - Sewer Capacity Spreadsheet
HCI MH 54 to MH 22
Tributary + Obligated Flow + The Point (Full Buildout through HCI)

November 20, 2020
Revised: April 21, 2021

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*												Estimated Flows		
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	Flow / Full Pipe Flow Rate (%)	Flow Depth (inches)
MH 54 TO MH 53	10	DIP	1.070	0.01070	147		0.013	0.83	0.42	0	0	0.013	0.0107	0.55	2.62	0.21	2.27	1,468,645	734,322	510	250,367	17.00	3.25
MH 53 TO MH 52	10	PVC	0.280	0.00280	298		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30	4.47
MH 52 TO MH 51	10	PVC	0.270	0.00270	410		0.013	0.83	0.42	0	0	0.013	0.0027	0.55	2.62	0.21	1.14	737,746	368,873	256	250,367	33.90	4.53
MH 51 TO MH 50	10	PVC	0.840	0.00840	376		0.013	0.83	0.42	0	0	0.013	0.0084	0.55	2.62	0.21	2.01	1,301,261	533,517	370	250,367	19.20	3.42
MH 50 TO MH 49	10	PVC	8.800	0.08800	114		0.013	0.83	0.42	0	0	0.013	0.0880	0.55	2.62	0.21	6.52	4,211,785	1,726,832	1,199	250,367	5.90	1.80
MH 49 to MH 48	10	DIP	0.280	0.00280	160		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	309,117	41.10	5.00
MH 48 to MH 47	10	PVC	0.280	0.00280	396		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	309,117	41.10	5.00
MH 47 TO MH 46	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	309,117	41.10	5.00
MH 46 TO MH 45	10	PVC	0.280	0.00280	292		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	309,117	41.10	5.00
MH 45 TO MH 44	10	PVC	1.960	0.01960	292		0.013	0.83	0.42	0	0	0.013	0.0196	0.55	2.62	0.21	3.08	1,987,709	814,961	566	376,617	18.90	3.42
MH 44 TO MH 01	10	PVC	0.464	0.00464	209		0.013	0.83	0.42	0	0	0.013	0.0046	0.55	2.62	0.21	1.50	967,571	396,704	275	376,617	38.90	4.87
MH 01 TO MH 43	10	PVC	0.452	0.00452	82		0.013	0.83	0.42	0	0	0.013	0.0045	0.55	2.62	0.21	1.48	954,181	391,214	272	855,646	89.70	8.25
MH 43 TO MH 42	10	PVC	1.100	0.01100	388		0.013	0.83	0.42	0	0	0.013	0.0110	0.55	2.62	0.21	2.30	1,489,091	610,527	424	855,646	57.50	6.13
MH 42 TO MH 41	10	PVC	0.280	0.00280	295		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	923,771	123.00	#N/A
MH 41 TO MH 40	10	DIP	19.710	0.19710	118		0.013	0.83	0.42	0	0	0.013	0.1971	0.55	2.62	0.21	9.75	6,303,302	2,584,354	1,795	923,771	14.70	3.08
MH 40 TO MH 39	10	PVC	0.280	0.00280	184		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	923,771	123.00	#N/A
MH 39 TO MH 38	10	PVC	0.280	0.00280	351		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	923,771	123.00	#N/A
MH 38 TO MH 37	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	923,771	123.00	#N/A
MH 37 TO MH 36	10	PVC	0.280	0.00280	366		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	923,771	123.00	#N/A
MH 36 TO MH 35	10	PVC	0.280	0.00280	132		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	923,771	123.00	#N/A
MH 35 TO MH 34	10	PVC	0.280	0.00280	155		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	923,771	123.00	#N/A
MH 34 TO MH 33	10	PVC	0.280	0.00280	359		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	923,771	123.00	#N/A
MH 33 TO MH 32	10	DIP	4.290	0.04290	153		0.013	0.83	0.42	0	0	0.013	0.0429	0.55	2.62	0.21	4.55	2,940,719	1,205,695	837	923,771	31.40	4.33
MH 32 TO MH 31	10	PVC	0.280	0.00280	280		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,267,521	168.70	#N/A
MH 31 TO MH 30	10	PVC	0.280	0.00280	221		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,267,521	168.70	#N/A
MH 30 TO MH 29	10	PVC	0.280	0.00280	416		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,267,521	168.70	#N/A
MH 29 TO MH 28	10	PVC	0.280	0.00280	328		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,301,271	173.20	#N/A
MH 28 TO MH 27	10	PVC	0.280	0.00280	240		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,301,271	173.20	#N/A
MH 27 TO MH 26	10	PVC	0.280	0.00280	399		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,301,271	173.20	#N/A
MH 26 TO MH 25	10	PVC	0.280	0.00280	419		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,301,271	173.20	#N/A
MH 25 TO MH 24	10	PVC	0.280	0.00280	369		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,301,271	173.20	#N/A
MH24 TO MH 23	10	PVC	0.280	0.00280	396		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,301,271	173.20	#N/A
MH 23 TO MH 22	10	PVC	0.280	0.00280	391		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	1,301,271	173.20	#N/A

Equations used for calculations:

$r = D/2$

$h = 2r - y$

$$\theta = 2\arccos\left(\frac{r - h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

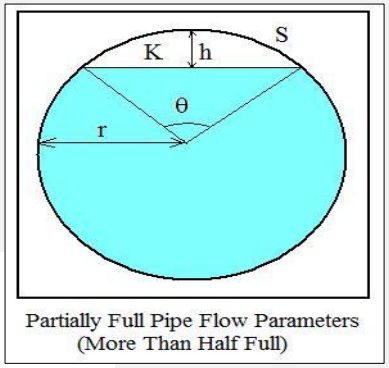
Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe (ft^2)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)



Partially Full Pipe Flow Parameters
(More Than Half Full)

TABLE 6 - Sewer Capacity Spreadsheet
HCI MH 54 to MH 22
Tributary + Obligated Flow + The Point (Full Buildout through HCI) + Future Development w/in Sewer Basin w/ Improvements

November 20, 2020

Revised: April 21, 2021

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*											
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth
MH 01 TO MH 43	18	PVC	0.452	0.00452	82		0.013	1.50	0.75	0	0	0.013	0.0045	1.77	4.71	0.38	7.08	4,574,645	1,875,604	1,303
MH 43 TO MH 42	18	PVC	1.100	0.01100	388		0.013	1.50	0.75	0	0	0.013	0.0110	1.77	4.71	0.38	11.05	7,139,172	2,927,061	2,033
MH 42 TO MH 41	24	PVC	0.280	0.00280	295		0.013	2.00	1.00	0	0	0.013	0.0028	3.14	6.28	0.50	12.00	7,757,119	3,180,419	2,209
MH 41 TO MH 40	24	DIP	19.710	0.19710	118		0.013	2.00	1.00	0	0	0.013	0.1971	3.14	6.28	0.50	100.70	65,082,582	26,683,859	18,530
MH 40 TO MH 39	24	PVC	0.280	0.00280	184		0.013	2.00	1.00	0	0	0.013	0.0028	3.14	6.28	0.50	12.00	7,757,119	3,180,419	2,209
MH 39 TO MH 38	24	PVC	0.280	0.00280	351		0.013	2.00	1.00	0	0	0.013	0.0028	3.14	6.28	0.50	12.00	7,757,119	3,180,419	2,209
MH 38 TO MH 37	24	PVC	0.280	0.00280	385		0.013	2.00	1.00	0	0	0.013	0.0028	3.14	6.28	0.50	12.00	7,757,119	3,180,419	2,209
MH 37 TO MH 36	24	PVC	0.280	0.00280	366		0.013	2.00	1.00	0	0	0.013	0.0028	3.14	6.28	0.50	12.00	7,757,119	3,180,419	2,209
MH 36 TO MH 35	24	PVC	0.280	0.00280	132		0.013	2.00	1.00	0	0	0.013	0.0028	3.14	6.28	0.50	12.00	7,757,119	3,180,419	2,209
MH 35 TO MH 34	24	PVC	0.280	0.00280	155		0.013	2.00	1.00	0	0	0.013	0.0028	3.14	6.28	0.50	12.00	7,757,119	3,180,419	2,209
MH 34 TO MH 33	24	PVC	0.280	0.00280	359		0.013	2.00	1.00	0	0	0.013	0.0028	3.14	6.28	0.50	12.00	7,757,119	3,180,419	2,209
MH 33 TO MH 32	24	DIP	4.290	0.04290	153		0.013	2.00	1.00	0	0	0.013	0.0429	3.14	6.28	0.50	46.98	30,363,380	12,448,986	8,645
MH 32 TO MH 31	27	PVC	0.280	0.00280	280		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024
MH 31 TO MH 30	27	PVC	0.280	0.00280	221		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024
MH 30 TO MH 29	27	PVC	0.280	0.00280	416		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024
MH 29 TO MH 28	27	PVC	0.280	0.00280	328		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024
MH 28 TO MH 27	27	PVC	0.280	0.00280	240		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024
MH 27 TO MH 26	27	PVC	0.280	0.00280	399		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024
MH 26 TO MH 25	27	PVC	0.280	0.00280	419		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024
MH 25 TO MH 24	27	PVC	0.280	0.00280	369		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024
MH24 TO MH 23	27	PVC	0.280	0.00280	396		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024
MH 23 TO MH 22	27	PVC	0.280	0.00280	391		0.013	2.25	1.13	0	0	0.013	0.0028	3.98	7.07	0.56	16.43	10,619,577	4,354,026	3,024

Equations used for calculations:

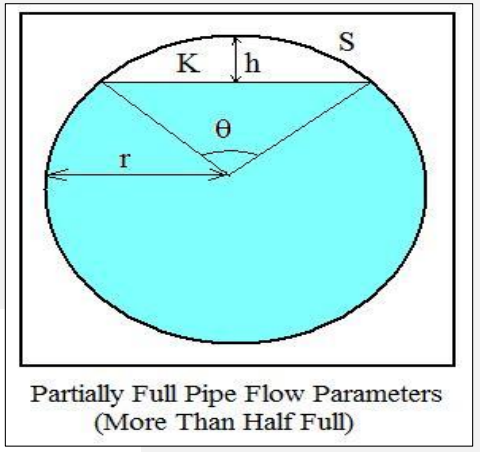
$r = D/2$

$h = 2r - y$

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe ($ft.^2$)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)

TABLE 7 - Rolesville Sanitary Sewer Outfall Summary of Proposed Improvements

April 21, 2021

PIPE	EXISTING SIZE	PROPOSED IMPROVEMENTS	
		CD PACKAGE #1	FULL BUILDOUT
ROLESVILLE SANITARY SEWER OUTFALL (MH 31 TO MH 01)			
MH 31 TO MH 30	8 -INCH	NONE	NONE
MH 30 TO MH 29	8 -INCH	NONE	NONE
MH 29 TO MH 28	8 -INCH	NONE	NONE
MH 28 TO MH 27	8 -INCH	NONE	NONE
MH 27 TO MH 26	8 -INCH	NONE	NONE
MH 26 TO MH 25	8 -INCH	NONE	NONE
MH 25 TO MH 24	8 -INCH	NONE	NONE
MH 24 TO MH 23	8 -INCH	NONE	NONE
MH 23 TO MH 22	8 -INCH	NONE	NONE
MH 22 TO MH 21	8 -INCH	NONE	NONE
MH 21 TO MH 20	8 -INCH	NONE	NONE
MH 20 TO MH 19	8 -INCH	NONE	NONE
MH 19 TO MH 18	8 -INCH	NONE	NONE
MH 18 TO MH 17	10-INCH	NONE	NONE
MH 17 TO MH 16	10-INCH	NONE	NONE
MH 16 TO MH 15	10-INCH	NONE	NONE
MH 15 TO MH 14	10-INCH	NONE	NONE
MH 14 TO MH 13	10-INCH	NONE	NONE
MH 13 TO MH 12	10-INCH	NONE	NONE
MH 12 TO MH 11	10-INCH	NONE	NONE
MH 11 TO MH 10	10-INCH	NONE	NONE
MH 10 TO MH 09	10-INCH	NONE	NONE
MH 09 TO MH 08	10-INCH	NONE	NONE
MH 08 TO MH 07	10-INCH	NONE	NONE
MH 07 TO MH 06	10-INCH	NONE	FEE IN LIEU
MH 06 TO MH 05	10-INCH	NONE	FEE IN LIEU
MH 05 TO MH 04	10-INCH	NONE	FEE IN LIEU
MH 04 TO MH 03A	10-INCH	NONE	NONE
MH 03A TO MH 03	10-INCH	NONE	NONE
MH 03 TO MH 02	10-INCH	NONE	FEE IN LIEU
MH 02 TO MH 01	10-INCH	NONE	FEE IN LIEU

TABLE 8 - HARRIS CREEK INTERCEPTOR
Summary of Proposed Improvements

April 21, 2021

PIPE	EXISTING SIZE	PROPOSED IMPROVEMENTS		
		CD PACKAGE #1	FULL BUILDOUT	
HARRIS CREEK INTERCEPTOR (MH 54 TO MH 22)				
MH 54 TO MH 53	10-INCH	NONE	NONE	
MH 53 TO MH 52	10-INCH	NONE	NONE	
MH 52 TO MH 51	10-INCH	NONE	NONE	
MH 51 TO MH 50	10-INCH	NONE	NONE	
MH 50 TO MH 49	10-INCH	NONE	NONE	
MH 49 to MH 48	10-INCH	NONE	NONE	
MH 48 to MH 47	10-INCH	NONE	NONE	
MH 47 TO MH 46	10-INCH	NONE	NONE	
MH 46 TO MH 45	10-INCH	NONE	NONE	
MH 45 TO MH 44	10-INCH	NONE	NONE	
MH 44 TO MH 01	10-INCH	NONE	NONE	
MH 01 TO MH 43	10-INCH	NONE	18-INCH	
MH 43 TO MH 42	10-INCH	NONE	18-INCH	**NOTE 1**
MH 42 TO MH 41	10-INCH	FEE IN LIEU	24-INCH	
MH 41 TO MH 40	10-INCH	NONE	24-INCH	**NOTE 2**
MH 40 TO MH 39	10-INCH	FEE IN LIEU	24-INCH	
MH 39 TO MH 38	10-INCH	FEE IN LIEU	24-INCH	
MH 38 TO MH 37	10-INCH	FEE IN LIEU	24-INCH	
MH 37 TO MH 36	10-INCH	FEE IN LIEU	24-INCH	
MH 36 TO MH 35	10-INCH	FEE IN LIEU	24-INCH	
MH 35 TO MH 34	10-INCH	FEE IN LIEU	24-INCH	
MH 34 TO MH 33	10-INCH	FEE IN LIEU	24-INCH	
MH 33 TO MH 32	10-INCH	NONE	24-INCH	**NOTE 3**
MH 32 TO MH 31	10-INCH	15-INCH	27-INCH	
MH 31 TO MH 30	10-INCH	15-INCH	27-INCH	
MH 30 TO MH 29	10-INCH	15-INCH	27-INCH	
MH 29 TO MH 28	10-INCH	15-INCH	27-INCH	
MH 28 TO MH 27	10-INCH	15-INCH	27-INCH	
MH 27 TO MH 26	10-INCH	15-INCH	27-INCH	
MH 26 TO MH 25	10-INCH	15-INCH	27-INCH	
MH 25 TO MH 24	10-INCH	15-INCH	27-INCH	
MH 24 TO MH 23	10-INCH	15-INCH	27-INCH	
MH 23 TO MH 22	10-INCH	15-INCH	27-INCH	

NOTE 1 - Projected flow with existing pipe at 57% capacity but proposed improvement to prevent larger pipe discharging into smaller pipe

NOTE 2 - Projected flow with existing pipe at 14.7% capacity but proposed improvement to prevent larger pipe discharging into smaller pipe