

Ionia County Road Department Stormwater Design Requirements

1. Refer to NOAA Point Precipitation Rainfall Estimates for site.
 - a. https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html
 - b. Rainfall estimates change regularly. Please provide a current chart for your specific site.
2. All onsite piping shall be sized to handle the maximum flow rate calculated for a 10 year event using the rational method ($Q_{peak}=C*i*A$)
 - a. Use calculated time of concentration (minimum 10 minutes)
 - b. Minimum self-cleaning pipe slopes per chart shall be met.
3. Detention/Retention facilities should be designed for the 50 year event using NRCS TR-55 Method.
 - a. Infiltration rate of 2 inches per hour over bottom contour can be used for sandy soils
 - i. Greater infiltration rates allowed with testing
 - b. Detention basins shall be designed such that any outflow to county right-of-way will not be greater than the pre-developed condition.
4. Stormwater Design Review submittal requirements
 - a. NOAA Point Precipitation Estimates
 - b. Site Plan with contributing areas delineated.
 - c. Drainage Calculations for pipe and basin sizing
 - d. Soil Infiltration testing results (if applicable)

STORMWATER CALCULATIONS

PIPE SIZING SAMPLE CALCULATIONS

Given

$A_{\text{roof}} := 0.5 \text{ acre}$	measured area of roof
$A_{\text{lawn}} := 0.3 \text{ acre}$	measured area of lawn
$i := 4.88 \frac{\text{in}}{\text{hr}}$	rainfall intensity for calculated time of concentration
$C_{\text{roof}} := 0.95$	runoff coefficient for roof
$C_{\text{lawn}} := 0.30$	runoff coefficient for lawn

Calculations

$$C_{\text{weighted}} := \frac{A_{\text{roof}} \cdot C_{\text{roof}} + A_{\text{lawn}} \cdot C_{\text{lawn}}}{A_{\text{roof}} + A_{\text{lawn}}} = 0.71 \quad \text{weighted (average) runoff coefficient}$$

$$Q_{\text{pipe}} := C_{\text{weighted}} \cdot i \cdot (A_{\text{roof}} + A_{\text{lawn}}) = 2.78 \cdot \frac{\text{ft}^3}{\text{sec}} \quad \text{peak flow in pipe}$$

For pipe system, add upstream peak flow to current pipe peak flow to determine pipe capacity

CONCRETE SEWER SLOPE AND CAPACITY

Manning's N

0.013 for concrete pipe

Size (in)	Minimum Slope	Capacity at Minimum Slope (cf/s)
12	0.48%	2.48
15	0.36%	3.89
18	0.28%	5.57
24	0.17%	9.35
30	0.15%	15.93
36	0.12%	23.17
42	0.12%	34.95
48	0.10%	45.55
54	0.09%	59.15

PLASTIC SEWER SLOPE AND CAPACITY

Manning's N

0.012 for smooth wall HDPE pipe

Size (in)	Minimum Slope	Capacity at Minimum Slope (cf/s)
12	0.48%	2.68
15	0.36%	4.21
18	0.28%	6.04
24	0.17%	10.13
30	0.15%	17.26
36	0.12%	25.10
42	0.12%	37.86
48	0.10%	49.34
54	0.09%	64.08

10 YEAR - 10 MINUTE RAINFALL INTENSITY EXAMPLE



NOAA Atlas 14, Volume 8, Version 2
Location name: Portland, Michigan, USA*
Latitude: 42.8427°, Longitude: -85.0717°
Elevation: 859.74 ft**



* source: ESRI Maps
 ** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

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PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	3.62 (2.87-4.61)	4.25 (3.36-5.41)	5.32 (4.19-6.78)	6.25 (4.90-7.99)	7.61 (5.77-9.98)	8.71 (6.44-11.5)	9.85 (7.04-13.2)	11.1 (7.57-15.0)	12.7 (8.39-17.6)	14.1 (9.00-19.5)
10-min	2.66 (2.10-3.38)	3.11 (2.46-3.96)	3.89 (3.07-4.96)	4.58 (3.58-5.85)	5.57 (4.23-7.31)	6.37 (4.72-8.41)	7.21 (5.15-9.66)	8.10 (5.55-11.0)	9.32 (6.14-12.9)	10.3 (6.59-14.3)
15-min	2.16 (1.71-2.75)	2.53 (2.00-3.22)	3.17 (2.49-4.04)	3.72 (2.91-4.76)	4.53 (3.44-5.94)	5.18 (3.84-6.84)	5.86 (4.19-7.85)	6.58 (4.51-8.96)	7.58 (4.99-10.5)	8.37 (5.36-11.6)
30-min	1.57 (1.24-2.00)	1.84 (1.45-2.34)	2.30 (1.81-2.93)	2.71 (2.12-3.46)	3.29 (2.50-4.32)	3.77 (2.79-4.98)	4.27 (3.05-5.71)	4.79 (3.28-6.52)	5.52 (3.64-7.64)	6.10 (3.90-8.48)
60-min	1.02 (0.802-1.29)	1.20 (0.943-1.52)	1.51 (1.18-1.92)	1.78 (1.39-2.27)	2.17 (1.65-2.86)	2.50 (1.85-3.30)	2.84 (2.03-3.80)	3.20 (2.19-4.35)	3.70 (2.43-5.11)	4.09 (2.62-5.69)
2-hr	0.622 (0.498-0.780)	0.735 (0.588-0.922)	0.930 (0.740-1.17)	1.10 (0.872-1.39)	1.35 (1.04-1.75)	1.56 (1.17-2.03)	1.77 (1.28-2.35)	2.00 (1.39-2.69)	2.32 (1.55-3.17)	2.57 (1.67-3.54)
3-hr	0.457 (0.369-0.569)	0.540 (0.435-0.673)	0.685 (0.549-0.854)	0.813 (0.649-1.02)	1.00 (0.778-1.29)	1.16 (0.875-1.50)	1.32 (0.964-1.74)	1.49 (1.05-2.00)	1.74 (1.17-2.37)	1.93 (1.26-2.65)
6-hr	0.271 (0.221-0.332)	0.317 (0.258-0.389)	0.398 (0.324-0.490)	0.472 (0.382-0.582)	0.582 (0.459-0.744)	0.674 (0.518-0.866)	0.772 (0.573-1.01)	0.878 (0.625-1.17)	1.03 (0.703-1.39)	1.15 (0.762-1.56)
12-hr	0.159 (0.131-0.192)	0.182 (0.151-0.221)	0.225 (0.185-0.273)	0.265 (0.217-0.322)	0.325 (0.261-0.411)	0.376 (0.294-0.479)	0.432 (0.325-0.558)	0.492 (0.356-0.648)	0.579 (0.402-0.775)	0.649 (0.437-0.871)
24-hr	0.092 (0.077-0.110)	0.105 (0.088-0.126)	0.129 (0.108-0.155)	0.151 (0.126-0.182)	0.185 (0.150-0.231)	0.214 (0.169-0.268)	0.244 (0.187-0.312)	0.278 (0.204-0.361)	0.326 (0.230-0.432)	0.365 (0.249-0.485)
2-day	0.052 (0.044-0.062)	0.060 (0.051-0.071)	0.075 (0.063-0.088)	0.087 (0.073-0.103)	0.106 (0.087-0.130)	0.122 (0.098-0.151)	0.139 (0.107-0.174)	0.157 (0.116-0.201)	0.182 (0.130-0.238)	0.202 (0.140-0.266)
3-day	0.038 (0.033-0.045)	0.044 (0.038-0.051)	0.053 (0.046-0.063)	0.062 (0.053-0.073)	0.075 (0.062-0.091)	0.086 (0.069-0.105)	0.097 (0.076-0.122)	0.110 (0.082-0.140)	0.127 (0.092-0.165)	0.141 (0.099-0.185)
4-day	0.031 (0.027-0.036)	0.035 (0.030-0.041)	0.042 (0.036-0.049)	0.049 (0.042-0.057)	0.059 (0.049-0.071)	0.067 (0.054-0.082)	0.076 (0.059-0.094)	0.085 (0.064-0.108)	0.098 (0.071-0.127)	0.109 (0.077-0.142)
7-day	0.021 (0.018-0.024)	0.023 (0.020-0.027)	0.028 (0.024-0.032)	0.032 (0.027-0.037)	0.038 (0.032-0.045)	0.042 (0.035-0.051)	0.048 (0.038-0.059)	0.053 (0.041-0.067)	0.061 (0.045-0.078)	0.067 (0.048-0.087)
10-day	0.017 (0.015-0.019)	0.019 (0.016-0.021)	0.022 (0.019-0.025)	0.025 (0.022-0.028)	0.029 (0.025-0.034)	0.033 (0.027-0.039)	0.036 (0.029-0.044)	0.040 (0.031-0.050)	0.046 (0.034-0.059)	0.050 (0.036-0.065)
20-day	0.011 (0.010-0.013)	0.013 (0.011-0.014)	0.015 (0.013-0.016)	0.016 (0.014-0.018)	0.019 (0.016-0.022)	0.021 (0.017-0.024)	0.023 (0.018-0.027)	0.025 (0.019-0.031)	0.028 (0.021-0.035)	0.030 (0.022-0.038)
30-day	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.012 (0.011-0.013)	0.013 (0.012-0.015)	0.015 (0.013-0.017)	0.016 (0.014-0.019)	0.018 (0.015-0.021)	0.019 (0.015-0.023)	0.021 (0.016-0.026)	0.023 (0.017-0.028)
45-day	0.008 (0.007-0.008)	0.008 (0.008-0.009)	0.010 (0.009-0.011)	0.011 (0.010-0.012)	0.012 (0.010-0.014)	0.013 (0.011-0.015)	0.014 (0.012-0.016)	0.015 (0.012-0.018)	0.016 (0.012-0.020)	0.017 (0.013-0.021)
60-day	0.007 (0.006-0.007)	0.007 (0.007-0.008)	0.008 (0.008-0.009)	0.009 (0.008-0.010)	0.010 (0.009-0.012)	0.011 (0.010-0.013)	0.012 (0.010-0.014)	0.013 (0.010-0.015)	0.013 (0.010-0.016)	0.014 (0.010-0.018)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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50 YEAR - 24 HOUR RAINFALL DEPTH EXAMPLE



NOAA Atlas 14, Volume 8, Version 2
Location name: Portland, Michigan, USA*
Latitude: 42.8427°, Longitude: -85.0717°
Elevation: 859.74 ft**
* source: ESRI Maps
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POINT PRECIPITATION FREQUENCY ESTIMATES

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PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.302 (0.239-0.384)	0.354 (0.280-0.451)	0.443 (0.349-0.565)	0.521 (0.408-0.666)	0.634 (0.481-0.832)	0.726 (0.537-0.958)	0.821 (0.587-1.10)	0.922 (0.631-1.25)	1.06 (0.699-1.47)	1.17 (0.750-1.63)
10-min	0.443 (0.350-0.563)	0.519 (0.410-0.660)	0.649 (0.511-0.827)	0.763 (0.597-0.975)	0.928 (0.705-1.22)	1.06 (0.786-1.40)	1.20 (0.859-1.61)	1.35 (0.925-1.84)	1.55 (1.02-2.15)	1.72 (1.10-2.39)
15-min	0.540 (0.427-0.687)	0.633 (0.499-0.805)	0.792 (0.623-1.01)	0.931 (0.728-1.19)	1.13 (0.859-1.49)	1.30 (0.959-1.71)	1.47 (1.05-1.96)	1.65 (1.13-2.24)	1.90 (1.25-2.62)	2.09 (1.34-2.91)
30-min	0.786 (0.621-1.00)	0.921 (0.727-1.17)	1.15 (0.906-1.47)	1.35 (1.06-1.73)	1.65 (1.25-2.16)	1.89 (1.40-2.49)	2.13 (1.53-2.86)	2.40 (1.64-3.26)	2.76 (1.82-3.82)	3.05 (1.95-4.24)
60-min	1.02 (0.802-1.29)	1.20 (0.943-1.52)	1.51 (1.18-1.92)	1.78 (1.39-2.27)	2.17 (1.65-2.86)	2.50 (1.85-3.30)	2.84 (2.03-3.80)	3.20 (2.19-4.35)	3.70 (2.43-5.11)	4.09 (2.62-5.69)
2-hr	1.25 (0.996-1.56)	1.47 (1.18-1.85)	1.86 (1.48-2.34)	2.20 (1.74-2.77)	2.70 (2.08-3.51)	3.11 (2.34-4.06)	3.54 (2.57-4.69)	4.00 (2.78-5.39)	4.63 (3.09-6.35)	5.14 (3.33-7.08)
3-hr	1.37 (1.11-1.71)	1.62 (1.31-2.02)	2.06 (1.65-2.57)	2.44 (1.95-3.05)	3.01 (2.34-3.88)	3.47 (2.63-4.51)	3.96 (2.90-5.22)	4.49 (3.14-6.01)	5.22 (3.52-7.11)	5.80 (3.80-7.94)
6-hr	1.62 (1.32-1.99)	1.90 (1.55-2.33)	2.38 (1.94-2.94)	2.83 (2.29-3.49)	3.49 (2.75-4.46)	4.04 (3.10-5.19)	4.62 (3.43-6.04)	5.26 (3.74-6.98)	6.15 (4.21-8.31)	6.87 (4.56-9.32)
12-hr	1.91 (1.58-2.31)	2.19 (1.82-2.66)	2.71 (2.23-3.29)	3.19 (2.61-3.88)	3.92 (3.14-4.96)	4.54 (3.54-5.77)	5.20 (3.92-6.73)	5.93 (4.29-7.80)	6.97 (4.84-9.34)	7.82 (5.27-10.5)
24-hr	2.21 (1.85-2.64)	2.53 (2.12-3.02)	3.10 (2.59-3.71)	3.63 (3.02-4.36)	4.44 (3.61-5.54)	5.12 (4.05-6.43)	5.86 (4.48-7.49)	6.67 (4.89-8.67)	7.82 (5.51-10.4)	8.75 (5.98-11.6)
2-day	2.51 (2.14-2.96)	2.90 (2.46-3.41)	3.58 (3.03-4.22)	4.19 (3.52-4.96)	5.10 (4.18-6.25)	5.85 (4.68-7.23)	6.65 (5.15-8.37)	7.52 (5.58-9.65)	8.73 (6.24-11.4)	9.71 (6.74-12.8)
3-day	2.77 (2.37-3.23)	3.16 (2.70-3.69)	3.85 (3.28-4.51)	4.47 (3.79-5.25)	5.40 (4.47-6.58)	6.18 (4.99-7.58)	7.00 (5.47-8.75)	7.89 (5.92-10.1)	9.15 (6.60-11.9)	10.2 (7.12-13.3)
4-day	2.99 (2.58-3.47)	3.38 (2.91-3.92)	4.07 (3.49-4.73)	4.69 (4.01-5.48)	5.63 (4.69-6.82)	6.42 (5.21-7.83)	7.26 (5.70-9.02)	8.16 (6.16-10.4)	9.45 (6.86-12.2)	10.5 (7.39-13.7)
7-day	3.53 (3.08-4.05)	3.94 (3.43-4.53)	4.68 (4.06-5.38)	5.33 (4.60-6.16)	6.32 (5.32-7.55)	7.13 (5.86-8.60)	8.00 (6.36-9.84)	8.94 (6.82-11.2)	10.3 (7.54-13.2)	11.3 (8.08-14.6)
10-day	4.01 (3.52-4.56)	4.46 (3.91-5.08)	5.25 (4.59-6.00)	5.95 (5.18-6.82)	6.99 (5.92-8.27)	7.84 (6.48-9.37)	8.73 (6.99-10.7)	9.69 (7.45-12.1)	11.0 (8.16-14.1)	12.1 (8.71-15.6)
20-day	5.41 (4.82-6.07)	6.00 (5.34-6.74)	6.99 (6.20-7.86)	7.83 (6.91-8.84)	9.03 (7.73-10.5)	9.97 (8.35-11.7)	10.9 (8.87-13.1)	12.0 (9.31-14.7)	13.3 (10.0-16.7)	14.4 (10.5-18.3)
30-day	6.64 (5.96-7.38)	7.35 (6.59-8.17)	8.50 (7.60-9.48)	9.46 (8.41-10.6)	10.8 (9.28-12.4)	11.8 (9.94-13.7)	12.8 (10.5-15.2)	13.8 (10.9-16.8)	15.2 (11.5-18.9)	16.2 (12.0-20.5)
45-day	8.26 (7.48-9.10)	9.11 (8.24-10.0)	10.5 (9.44-11.6)	11.6 (10.4-12.8)	13.0 (11.3-14.7)	14.1 (12.0-16.2)	15.1 (12.4-17.8)	16.2 (12.8-19.4)	17.5 (13.3-21.5)	18.4 (13.7-23.1)
60-day	9.68 (8.81-10.6)	10.7 (9.70-11.7)	12.2 (11.1-13.4)	13.4 (12.1-14.8)	14.9 (13.0-16.8)	16.1 (13.7-18.3)	17.1 (14.1-19.9)	18.1 (14.4-21.6)	19.3 (14.8-23.7)	20.1 (15.1-25.2)

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