VANDERBURGH COUNTY TECHNICAL MEMORANDUM #1 EFFECTIVE DATE JANUARY 1, 2018

The attached information is for the purpose of supplying supplemental information to the approved Vanderburgh County Drainage Code. The included information is for the purpose of supplying consultants with necessary technical information no longer included in the code or additional technical information not previously included within the code. This Memorandum is referenced in the Vanderburgh County Drainage Code as Approved on November 14, 2017. The Memorandum was approved by the Vanderburgh County Drainage Board on December 5, 2017 and shall be considered to be in effect beginning January 1, 2018 until such time as the memorandum is updated.

The Technical Memorandum consists of the following:

- C VALUES
- RAINFALL INTENSITIES
- CRITERIA GOVERNING HIGHWAY 41/POND FLAT IMPACTED AREA
- VANDERBURGH COUNTY REGISTERED NEIGHBORHOOD ASSOCIATIONS
- UNDETAINED DRAINAGE AREAS
- SOLAR FARMS
- BENCH MARKS-APPROVED DATUM
- HYDRAULIC PROGRAMS
- REVIEW FEES
- HUFF CURVES
- NPDES GENERAL PERMIT
- LEGAL DRAINS

C VALUES

The table lists acceptable C coefficients for Undeveloped and Developed Runoffs. These values are to be used exclusively. Additional values outside these values may be utilized only when appropriate values are not included in the table, the source of the values is documented and the utilized values match the assumed storms and other assumptions.

RUNOFF COEFFICIENTS		
		C
Surface Type-Woodland, Turfed Meadows, Rough Pasture, Fallow Brush		
	Slope less than 2%	0.12
	Slope 2% to 5%	0.24
	Slope 5% to 10%	0.36
	Over 10%	0.48
Surface Type-Cultivated Fields.		
	Slope less than 2%	0.20
	Slope 2% to 5%	0.35
	Slope 5% to 10%	0.50
	Over 10%	0.65
Surface Type-Pavement, Rooftop, Other Impervious Surfaces:		
	Slope less than 2%	0.92
	Slope 2% to 5%	0.94
	Slope 5% to 10%	0.96
	Over 10%	0.98
Surface Type-Lawns with Turf.		
	Slope less than 2%	0.15
	Slope 2% to 5%	0.25
	Slope 5% to 10%	0.40
	Over 10%	0.55
Gravel Roadway and Parking		
	Gravel Roadway and Parking-10 Year Storm and less	0.50
	Gravel Roadway and Parking-25 Year Storm	0.60
	Gravel Roadway and Parking-50 & 100 Year Storm	0.65
Other		
	All Water Surfaces, Basins, Ponds and Lakes	1.00

It should be noted that while other sources may be preferred to be utilized by the design engineer such as *ASCE Design and Construction of Sanitary and Storm Sewers (ASCE)*, the values listed in the table in the ASCE are for storms of 5 and 10 year frequencies and therefore are not valid for use on the design of stormwater storage facilities without adjusting the factors. Therefore, prior to using any values from the ASCE book or any other design manual, the designer should contact the Vanderburgh County Surveyor about the use of any alternative values.

RAINFALL INTENSITIES

The table below shows calculated rainfall intensities to be utilized when the Rational Formula is used to calculate runoff quantities. The table is based upon formulas and constants that included in the LTAP STORMWATER DRAINAGE MANUAL, dated December 2015. For the 60 minute time period on the table the values are averages of the numbers calculated utilizing both sets of constants.

RAINFALL INTENSITY CALCULATIONS

$$i = \frac{cT_r^{\alpha}}{(t+d)^{\beta}}$$

For Evansville	C	A	d	B
0.083 hour to 1 hour	1.9533	0.1747	0.522	1.6408
1 hour to 36 hours	1.3411	0.2166	0.3	0.8154

		RECURRANCE INTERVAL (YEARS)					
		2	5	10	25	50	100
Time (min)	Time (hrs.)						
5	0.08	5.02	5.90	6.66	7.81	8.82	9.95
10	0.17	4.07	4.77	5.39	6.32	7.13	8.05
15	0.25	3.37	3.96	4.47	5.24	5.92	6.68
30	0.50	2.13	2.50	2.82	3.31	3.73	4.21
45	0.75	1.49	1.74	1.97	2.31	2.61	2.94
60	1.00	1.18	1.42	1.62	1.95	2.23	2.56
120	2.00	0.79	0.96	1.12	1.37	1.59	1.84
180	3.00	0.59	0.72	0.83	1.02	1.18	1.37
240	4.00	0.47	0.58	0.67	0.82	0.95	1.11
300	5.00	0.40	0.49	0.57	0.69	0.80	0.93
360	6.00	0.35	0.42	0.49	0.60	0.70	0.81
420	7.00	0.31	0.38	0.44	0.53	0.62	0.72
480	8.00	0.28	0.34	0.39	0.48	0.56	0.65
540	9.00	0.25	0.31	0.36	0.44	0.51	0.59
600	10.00	0.23	0.28	0.33	0.40	0.47	0.54
660	11.00	0.22	0.26	0.31	0.37	0.43	0.50
720	12.00	0.20	0.25	0.29	0.35	0.40	0.47
780	13.00	0.19	0.23	0.27	0.33	0.38	0.44
840	14.00	0.18	0.22	0.25	0.31	0.36	0.42
900	15.00	0.17	0.21	0.24	0.29	0.34	0.39
960	16.00	0.16	0.20	0.23	0.28	0.32	0.37
1020	17.00	0.15	0.19	0.22	0.26	0.31	0.36
1080	18.00	0.15	0.18	0.21	0.25	0.29	0.34
1140	19.00	0.14	0.17	0.20	0.24	0.28	0.33
1200	20.00	0.13	0.16	0.19	0.23	0.27	0.31
1260	21.00	0.13	0.16	0.18	0.22	0.26	0.30
1320	22.00	0.12	0.15	0.18	0.21	0.25	0.29
1380	23.00	0.12	0.15	0.17	0.21	0.24	0.28
1440	24.00	0.12	0.14	0.16	0.20	0.23	0.27

When utilizing unit hydrographs, a Type II Storm Distribution should be utilized. Rainfall for various storms is to be based upon NOAA Atlas 14. A summary of data for Vanderburgh County from NOAA is listed below:

	Average Recurrence Interval (years)						
Duration	1	2	5	10	25	50	100
2 Hour	1.46	1.77	2.22	2.57	3.06	3.45	3.86
6 Hour	1.91	2.31	2.88	3.35	4.01	4.55	5.13
12 Hour	2.27	2.73	3.39	3.93	4.69	5.3	5.95
24 Hour	2.71	3.26	4.06	4.71	5.62	6.36	7.14

*P_2 for Time of Concentration

When solving for T_t utilizing the formula $T_t = \frac{0.007(nl)^{0.8}}{P_2^{0.5} s^{0.4}}$ for use 3.3.

CRITERIA GOVERNING HIGHWAY 41/POND FLAT IMPACTED AREA

A Resolution Regarding Runoff Rates from Projects within the Impacted US 41 North/Pond Flat Drainage Area was approved by the Vanderburgh County Drainage Board on February 28, 2017. A complete copy of the Resolution is available upon request. However, in summary the Resolution addresses the following criteria for the Highway 41/Pond Flat Impacted Area

> Effective with the passing of this Resolution all Projects as defined in the Drainage Code and falling within impacted area of North US Highway 41 and draining into the Pond Flat System of Regulated Drains shall be designed that the post development controlled release rate of the stormwater shall not exceed a two year return period storm from the same land area prior to its development and per Section 13.04.015 shall therefore store the excess storm water generated during a one hundred year storm.
>
> That the proposed revised release rate as defined in this Resolution shall not apply to any existing developed projects where such projects propose additional developments within their site boundaries as those boundaries existed at the time of the original drainage plan approval. For those types of projects, the originally approved runoff rates and storms shall apply.
>
> That this Resolution can be reviewed on a site by site basis and where determined due to undo hardships, lack of available area for the required basin size or other cases that fall under the Drainage Board's discretionary powers that a project may

release at a rate not to exceed a five (5) year return period storm or a ten (10) year return period storm from the same land area prior to its development.

VANDERBURGH COUNTY REGISTERED NEIGHBORHOOD ASSOCIATIONS

The listing below is of all Registered Neighborhood Associations as of the effective date of this memorandum. Information regarding additional associations, post the effective date of this memorandum, may be obtained from the County Commissioners Office or by contacting kcomer@vanderburghgov.org or emiller@vanderburghgov.org.

Association Name	Boundaries
Indian Woods/Windsong	Greencastle, Crossfield, Foxfield, Foxcross
Westside Improvement	Map
Oak Hill	Map
Blue Grass	Map
Villas of Deerfield	Map

UNDETAINED DRAINAGE AREAS

1. A Proposed Developed Area designated to leave undetained must be less than 10% of the total project area

2. The Proposed Developed Area designated to leave undetained must be equal to or less than the undisturbed area currently leaving the area in the same location

3. The following methodology must be utilized and met

a) utilizing c values listed in this Technical Memorandum compute the weighted c (c_u) of the undeveloped area currently flowing to the area proposed to leave undetained.

b) utilizing c values listed in this Technical Memorandum compute the weighted c (c_d) of the Proposed Developed Area to be left undetained

c) If the equation

$$\text{Proposed Developed Area} \times c_d < \text{Undeveloped Area} \times c_u$$

is met and the Proposed Developed Area meets the criteria of #1 and #2 above, than the proposed developed area does require retention/detention and the drainage from Proposed Developed Area can leave the project undetained.

SOLAR FARMS

Solar farms, consist of areas of solar panels installed in fields, grass areas, previous farm ground areas, etc. are not by definition exempt from the Vanderburgh County Drainage Code. While it is realized that in some cases solar panels may be installed at a combined height and angle so that the rainfall will fall into the areas that were previously impervious so that the net effect is that no additional runoff will be incurred. However, in other cases, panels may be installed, close to the ground, nearly horizontal to the ground so that the runoff from these panels will run to the grass or rock strips between the panels, and then when these areas are saturated will then increase the runoff from the previous undisturbed areas. This would be similar to shelter house built over bare ground. The water would run off of the roof and then once the surrounding area is saturated the water would run off even though the ground underneath the shelter may be dry.

There has not been significant research in the effects of runoff from solar farms. In the abstract from a study "Hydrologic Response of Solar Farms" the American Society of Civil Engineers states the following.

:...Using sensitivity analyses, modeling showed that the solar panels themselves did not have a significant effect on the runoff volumes, peaks, or times to peak. However, if the ground cover under the panels is gravel or bare ground, owing to design decisions or lack of maintenance, the peak discharge may increase significantly with storm-water management needed."

Therefore, rather than assume that a solar farm add no effect or has a large effect of storm water runoff, the engineer shall supply information the following information if the desire is to not provide for detention/retention of runoff from a solar farm.

- Overall size of area in which panels are to be installed
- Height of panels
- Angle of panels
- Approximate area under panels which will not receive rainfall
- Open spacing between panels
- Proposed ground cover between panels and under panels
- General statement based upon the information provided, why the panels will not be increasing the impervious area by 10,000 ft^2

Based upon the above information, a determination will then be made as to whether a drainage plan and/or detention is required.

BENCH MARKS-APPROVED DATUM

Bench Mark datum will utilize the North American Vertical Datum of 1988.

HYDRAULIC PROGRAMS

The following programs are acceptable for Hydraulic Programs that can be utilized for submittal of drainage calculations

- Commercially available hydraulic programs that utilize methodology of Soil Conservation Service TR-20, TR-55, HydroCAD
- Programs developed by the Army Corp of Engineers (HEC-1, HEC HMS, HEC-RAS and HEC-GEO)
- AutoCAD Civil 3D
- US Department of Transportation Programs **HY-8** Culvert Hydraulic Analysis Program
- SEDCAD

REVIEW FEES

This Technical Memorandum has no review fees to be charged for the review of any Drainage Plan. Review fees to be applied, if any, would be contained in future Technical Memorandum and apply to projects that would be submitted after the approval date of any future Technical Memorandum.

HUFF CURVES

Huff Curves will no longer be published as part of the Vanderburgh County Drainage Code. Huff Curve Information is provided in the Indiana LTAP Stormwater Drainage Manual and any values required should be utilized from the tables included in this manual.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) GENERAL PERMIT

At the time of the effective date of this Technical Memorandum, an anticipated change in the Rule 5 for Indiana may include the move to an NPDES General Permit. That permit may require certain changes in the design of the retention/detention ponds for when those ponds are utilized during the construction phase. When the permit becomes in effect, changes that will affect basin design will be addressed in this section.

LEGAL DRAINS

The Vanderburgh County Drainage Code has been changed to allow the use of legal drains within certain sections of subdivisions. The system to establish legal drains is contained in Indiana Code 36-9-27. Additional forms to assist developers may be created to assist developers in establishing these drains. Those forms when developed will be listed in this section of the Technical Memorandum.

VANDERBURGH COUNTY DRAINAGE BOARD

Cheryl A.W. Musgrave, President

Ben Shoulders, Vice President

Bruce Ungethiem, Member

December 5th, 2017

Date