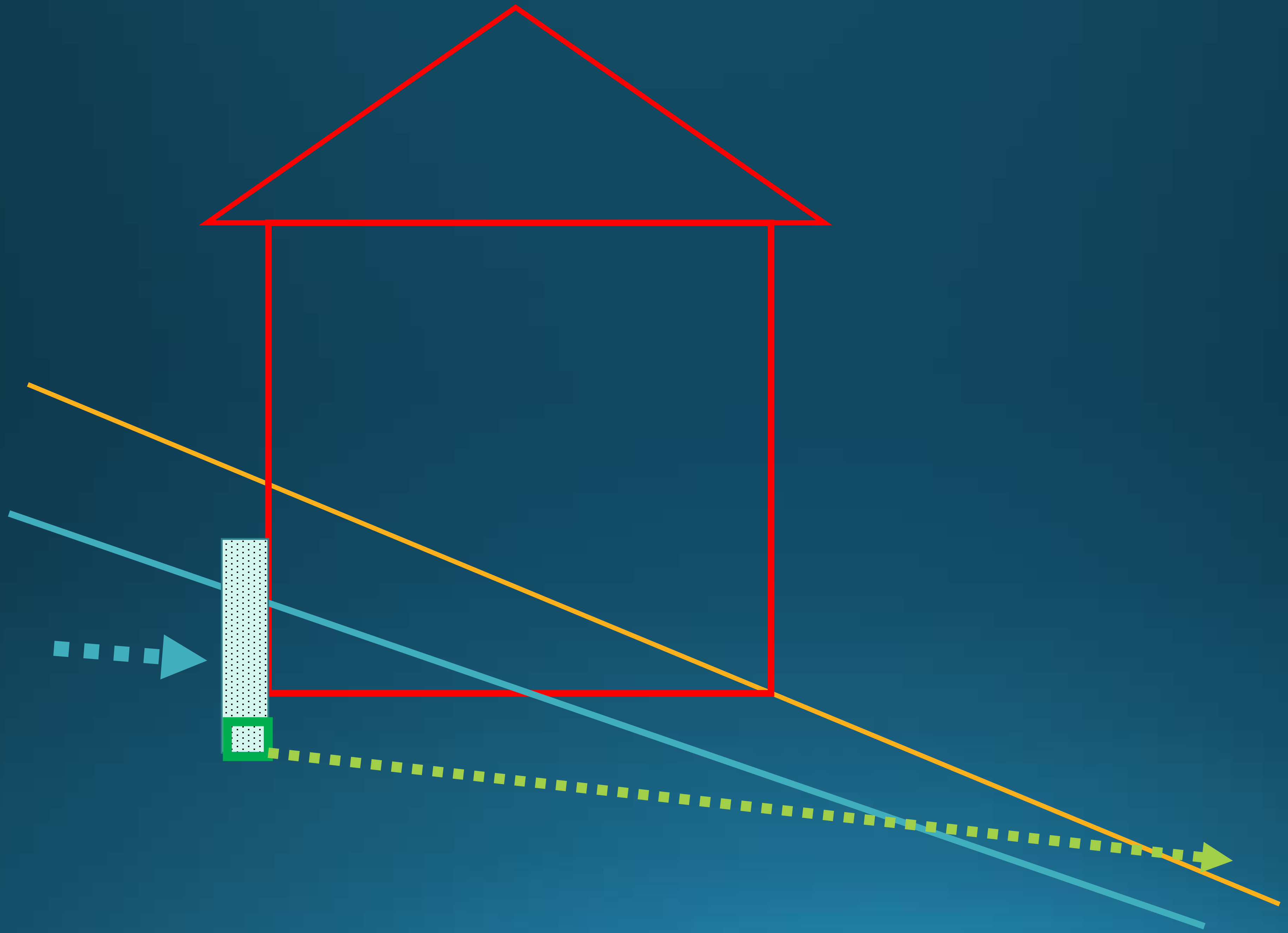
Leif Hauge, Waukesha County LRD

Basement Drainage
Atlas 14
NRCS Soil Class Changes

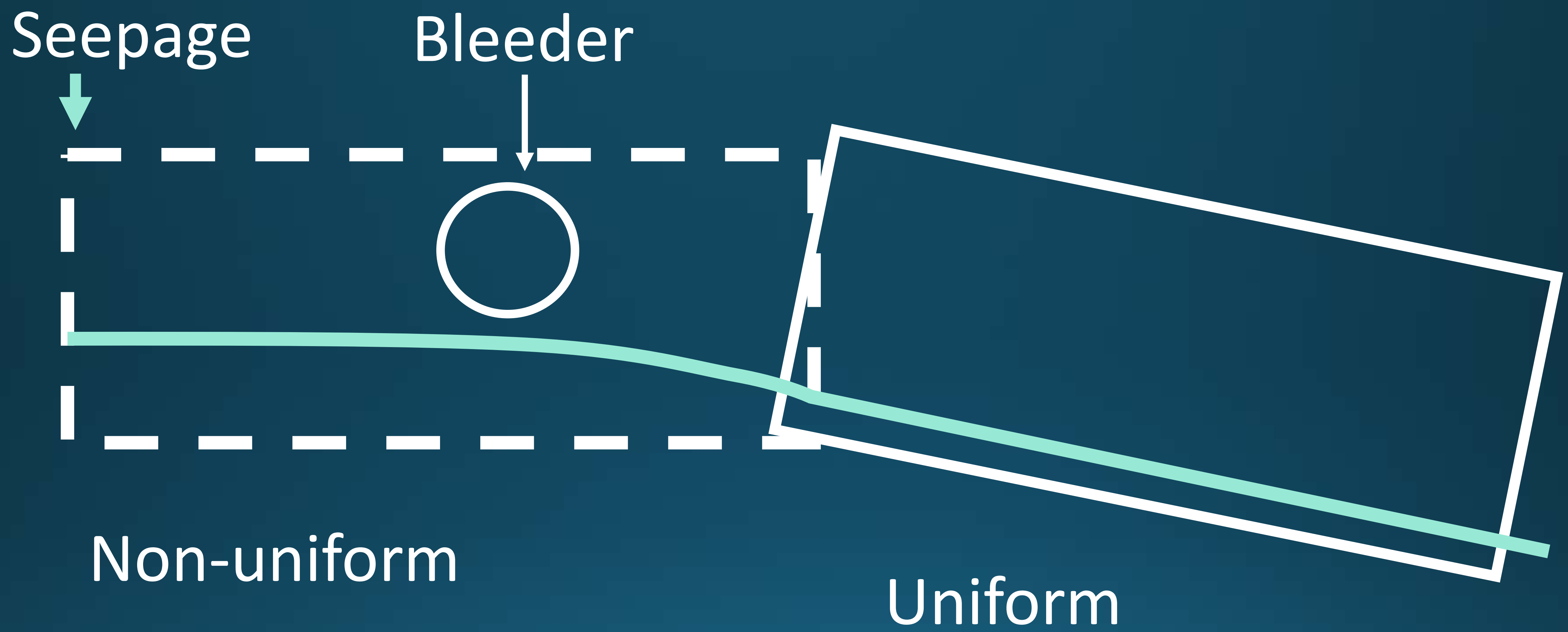
Basement Drainage

- Ordinance requires 1-foot separation from high water table
- Basement may be allowed in high water table if gravity drainage system can be shown to be protective
- Must show that outside seepage stays within exterior drain tile
- LRD calculation tool is used to estimate seepage flow rates and capacity of drain tile
- Tile may be square, round, sloped and flat



The tool uses

- Dupuit-Fourcheimer Approximation of Darcy’s Law to estimate seepage
- Standard Step Method and Newton Raphson Numerical Method (i.e. HEC-RAS technique) to estimate non-uniform gradually-varied flow depth in flat foundation tile
- Manning’s Equation to estimate flow depth in sloped outlet pipe


Seepage
Bleeder
Non-uniform
Uniform

Model input and output

- User provides seepage face geometry, hydraulic conductivity, footing and outlet drain tile geometry
- Bleeders connecting inside and outside drain tile are assumed to be 2 inches above bottom of outside drain tile
- Model states whether water in outside drain tile stays below bleeders or not

Water Surface Calculator for Horizontal Formadrain Outletting to Round, Sloped Drain Tile

Inputs by User					Outputs				
Seepage Face Height	2	ft			Seepage Rate	40.00	gal/day, or	0.00006	cfs
Seepage Face Length	100	ft			Flow depth in Drain Tile	<0.005	ft, or	<0.06	inches
Seepage Face Hydraulic Conductivity	10.0000	gal/day/ft^2, see below			Max depth in Formadrain*	<0.021	ft, or	<0.25	inches
Ground or Water Table Slope at seep face	0.02	ft/ft, or	2	percent					
Drain Tile Diameter (4" or 6") *	4	inches, or	0.333	ft					
Elevation difference btwn tile and FAD at joint	0	inches							
Drain Tile Slope	0.05	ft/ft, or	5	percent	Comment:				
Manning's number for Drain Tile	0.01	dimensionless, 0.010 for PVC			Formadrain overflows to interior drainage system with bleeder elevation at two inches				
Formadrain Length	80	ft							

yellow = enter site-specific data

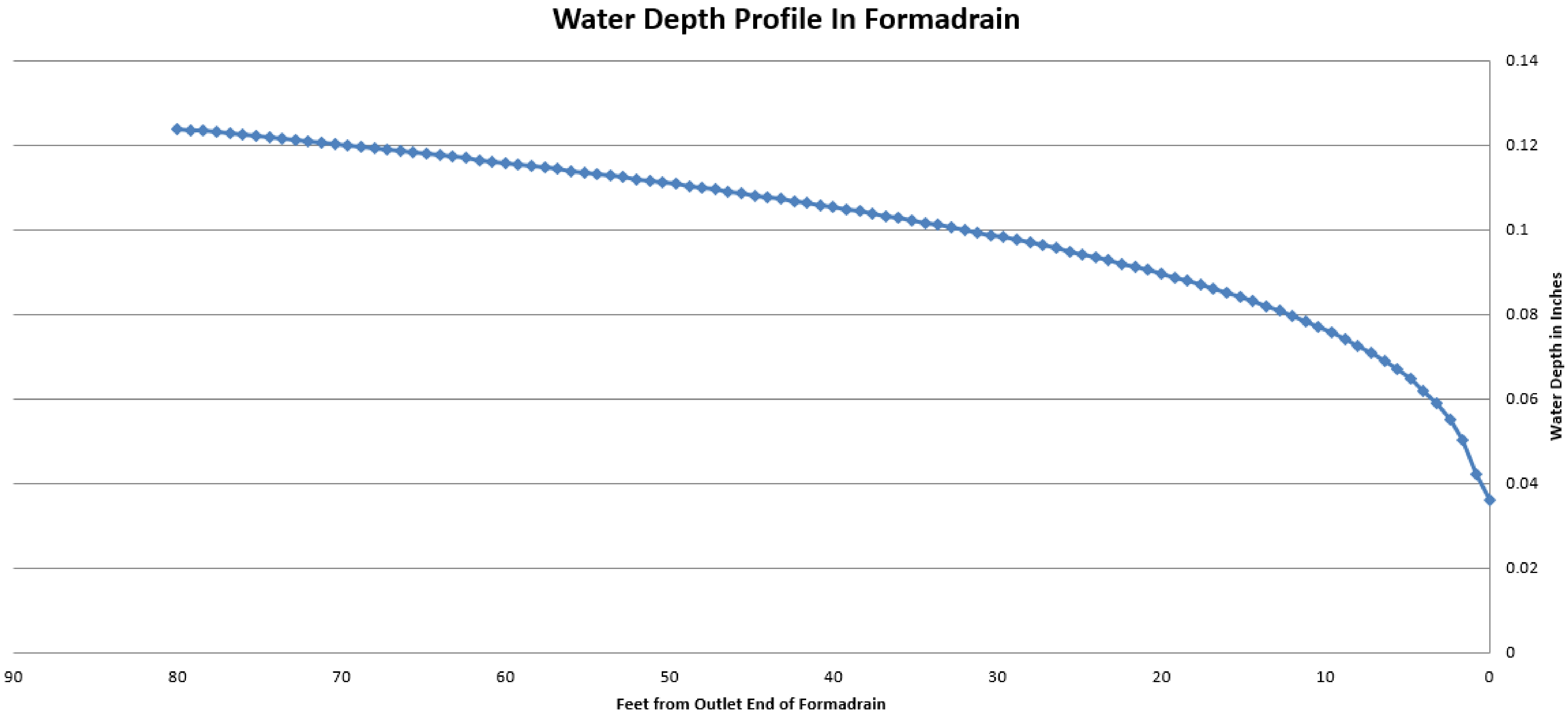
green = outputs

* For seepage rates > 8,100 gal/day, exceeds capacity of Formadrain with bleeders at two inches from bottom

Suggested hydraulic conductivities	
Soil	K (gal/day/ft^2)
Clay, silty clay	0.01
Silt loam, silty clay loam, loam, clay loam, sandy clay loam	10
Sandy loam	100
Gravelly loam, loamy sand	1,000
Sand, fine sand	10,000
Sand and gravel	100,000
Very gravelly sand	1,000,000
Sources: Freeze and Cherry, 1979, p. 29	

Notes and Assumptions

- *Seepage rate estimated using Dupuit-Forchheimer Approximation of Darcy's Law*
- *No shortcutting by surface runoff directly to drainage system*
- *Flow in sloped, round drain tile is uniform*
- *Manning's equation used to determine flow depth and velocity in drain tile*
- *Flow in horizontal FAD is non-uniform and gradually varied*
- *Flow in FAD estimated using Standard Step Method and Newton Raphson Numerical Method*
- *FAD geometry assumed to be 2-inch wide rectangular channel with no bends or top. Bleeders connect inside and outside FAD at 2 inches from bottom of FAD with standard FAD fittings.*
- *No parallel flow in stone around FAD.*



Water Depth Profile In Formadrain
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Water Depth in Inches
90
80
70
60
50
40
30
20
10
0
Feet from Outlet End of Formadrain

Effects Of Switch To NOAA Atlas 14 On Peak Flow Rates

- Higher-intensity rainfall distribution
- Greater depth for 100-year event
- Minor depth changes for some smaller events

Hydrology, Hydraulics, Cli ×

www.nrcs.usda.gov/wps/portal/nrcs/detail/wi/technical/engineering/?cid=nrcs142p2_025417

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Hydrology, Hydraulics, Climate and Wetland Resources

Notice – The following spreadsheets, computer programs and supporting documenta typical hydrologic or hydraulic calculations or wetland hydrologic evaluations. The eng understand the assumptions and calculations contained in these tools and is responsi Some of the spreadsheets contain macros.

Many additional engineering spreadsheets are available in the Wisconsin Engineering

Hydrology

NRCS Wisconsin Hydrology Resources:

MSE3_and_MSE4_NRCS_Distributions_WinTR20_Data (2).xlsx [Protected View] - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW DEVELOPER DYMO Label

PROTECTED VIEW Be careful—files from the Internet can contain viruses. Unless you need to edit, it's safer to stay in Protected View. Enable Editing

D18

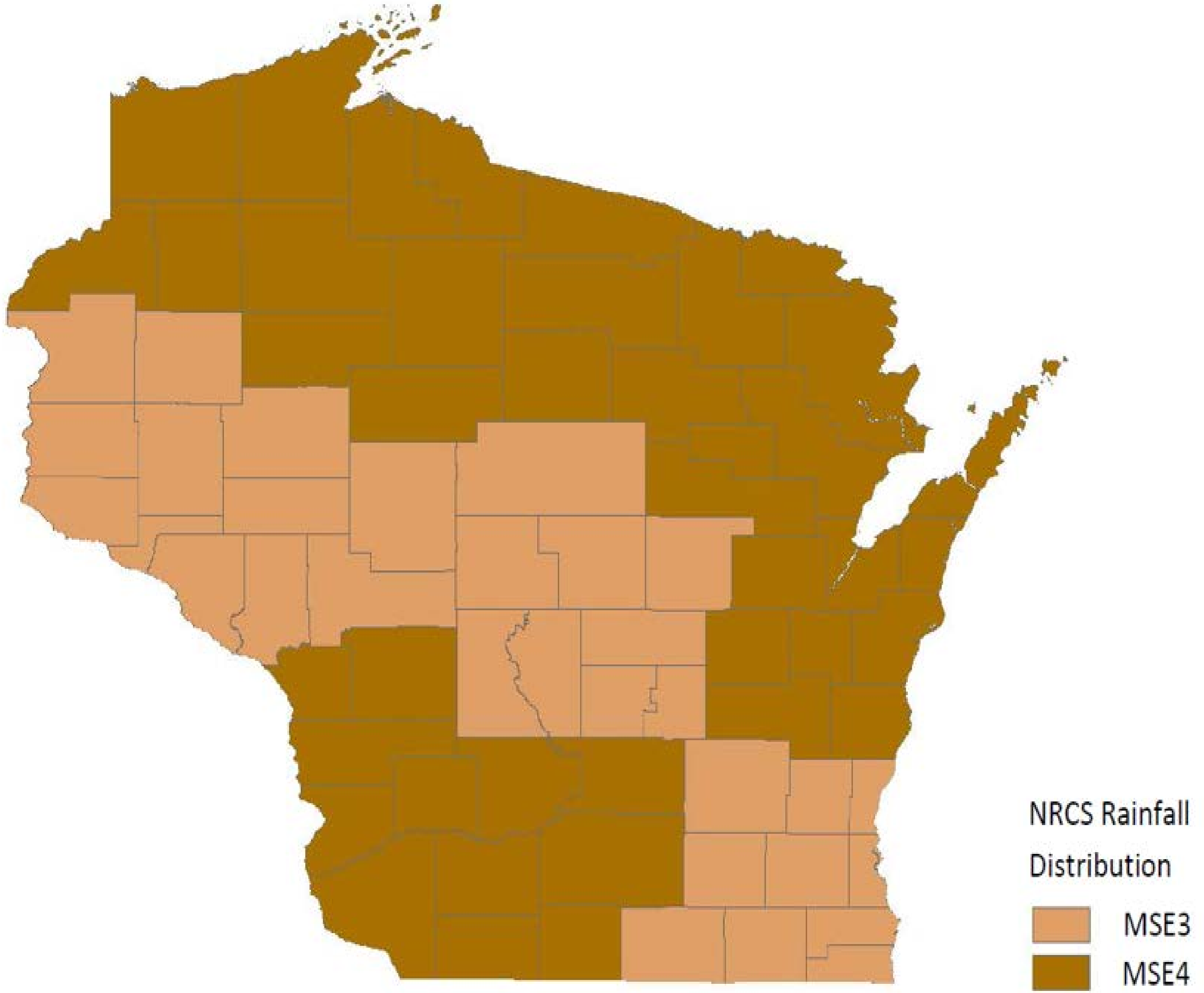
Final NRCS MSE3 and MSE4 Rainfall Distributions (smoothed)

These distributions were developed by the NRCS National Water Quality and Quantity Technology Development Team (WQQT) using precipitation data from **NOAA Atlas 14, Precipitation Frequency Atlas of the US, Volumes 7** (Southeastern US) **and 8** (Midwestern US).

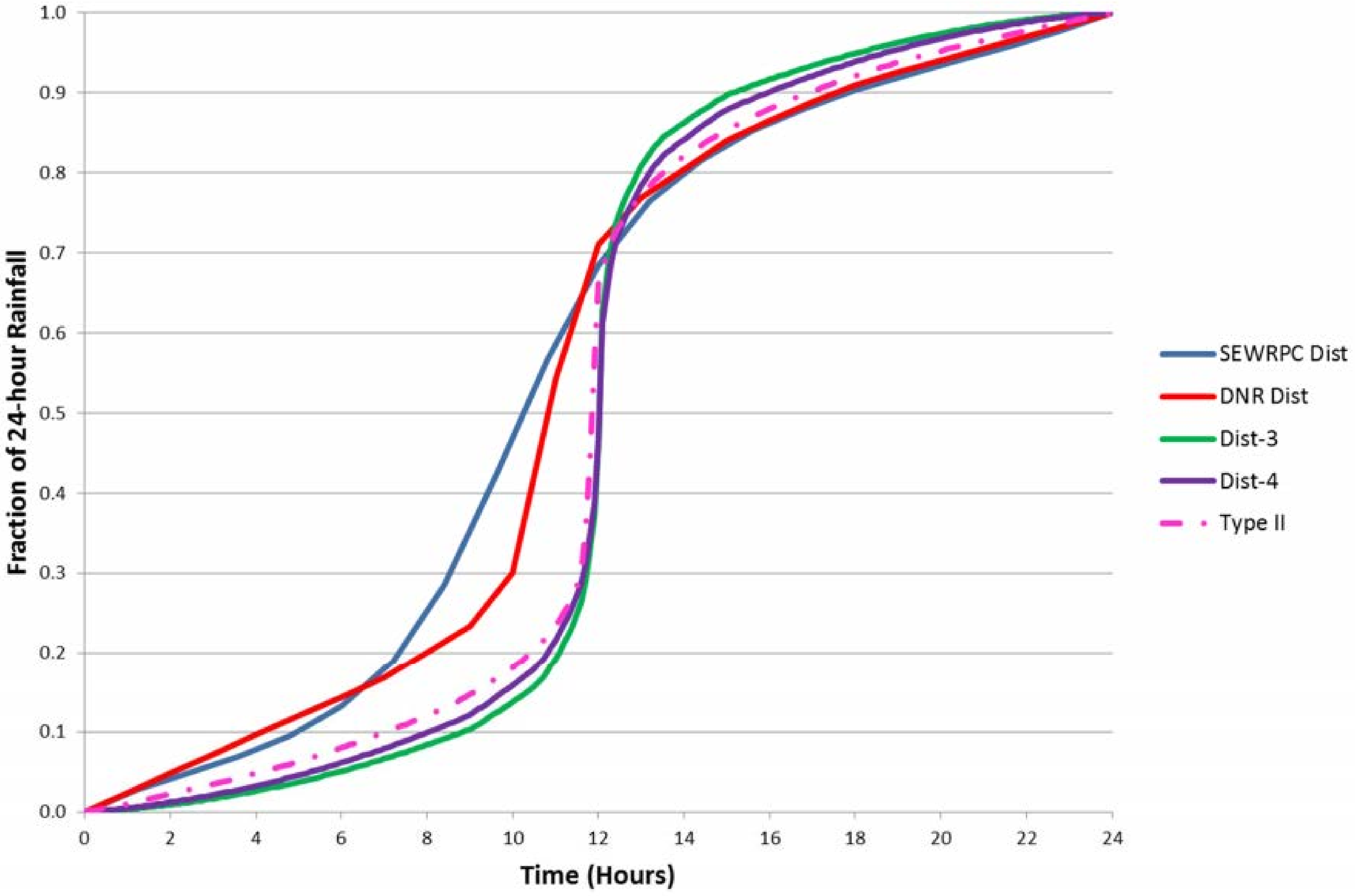
The following NRCS MSE3 and MSE4 distribution data, and the "Distribution Plots" given on the next tab, are to be used for **24-hour duration** storm dis
They represent the accumulated rainfall during the 24-hour storm duration on a **non-dimensional basis** for the MSE3 and MSE4 distributions. The ma
accumulated rainfall in the plot is 1.0, which represents the total (100%) of the 24-hour storm rainfall. These rainfall distributions are represented in Win
in tabular format at a time interval of 0.1 hour. NOTE that these distributions are intended to be used for **design purposes**. They are not intended to
the distribution of rainfall within a typical Wisconsin storm.

Go to the "Distributions by County" Tab to determine the applicable NRCS Storm Distribution (MSE3 or MSE4) to use for each Wis

	WinTR-20 RF Dist MSE3 smoothed		**WinTR-20 RF Dist MSE4 smoothed**
Time - hours	**Fraction of 24-Hr Precip**	**Time - hours**	**Fraction of 24-Hr Precip**
0	0	0	0
0.1	0.000267	0.1	0.000395
0.2	0.000555	0.2	0.000812
0.3	0.000861	0.3	0.00125


NRCS Rainfall
Distribution
MSE3
MSE4

Comparison of Storm Distributions



Waukesha County Atlas 14 rainfall depths in inches

	1 year	2 year	10 year	100 year
TP-40	2.3	2.7	4.0	5.6
Atlas 14	2.4	2.7	3.81	6.18
% change	+4	0	-5	+9

- The Atlas 14 100-year rainfall depths range from 5.22 inches in Marinette to 7.78 inches east of Platteville.

Comparison of runoff in cfs from a hypothetical 1 acre site between the new and old rain depths and distributions.

- RCN 70, single watershed
- Tc: 2% slope, 500 feet, 17.3 min.

	1 year	2 year	10 year	100 year
TP 40	0.30	0.52	1.4	2.7
Atlas 14	0.36	0.55	1.4	3.5
% change	+20	+6	0	+31

Comparison of runoff in cfs from a hypothetical 2 acre site between the new and old rain depths and distributions.

- Two 1-acre subwatersheds, both RCN 70,
- Tc: 17.3 min., 30 min.

	1 year	2 year	10 year	100 year
TP 40	0.41	0.74	2.1	4.1
Atlas 14	0.52	0.77	1.9	5.1
% change	+27	+4	-10	+24

Comparison of runoff in cfs from a hypothetical 2 acre site between the new and old rain depths and distributions.

- Two 1-acre subwatersheds, both RCN 70,
- Tc: 12 min., 40 min.   (wider spacing)

	1 year	2 year	10 year	100 year
TP 40	0.37	0.66	1.9	3.6
Atlas 14	0.46	0.68	1.7	4.6
% change	+24	+3	-10	+27

Modeled Runoff In cfs From County Highway Reconstruction Project With 138-Acre Total Watershed (Mostly Flow-Through)

	1 year	2 year	10 year	100 year
TP 40	65	84	153	245
Atlas 14	68	82	142	290
% change	+5	-2	-7	+18

- 9 subwatersheds, Tc range 13 – 71 minutes, mostly storm sewer

Possible Conclusions – Atlas 14

- Need 20-30% more storage for 100-year event
- For communities requiring reduction of 100-post to 10-pre, much harder to comply
- Having complex site with multiple subwatersheds with broad range of Tc may reduce change in peak flow
- Slightly larger storm sewers
- Increased setbacks for internally-drained areas

Soil Reclassification by NRCS

B to C

- FmB Fox sandy loam
- MoB Mayville silt loam

B to D

- HmB Hochheim loam

C to B/D

- LmB Lamartine silt loam

Effect on Peak Flow Requirement

- Hypothetical site:
  - Cornfield to office,
  - 4 acres,
  - 70% impervious,
  - Hochheim soil,
  - 2% slopes.
- Pre-development RCN was 69, now will be 83. Tc = 41 min.
- Post-development RCN was 87, now will be 92. Tc = 13 min (grass ditches).

Peak Flows From Hypothetical Site (cfs)

Condition	1-Year	2-Year	10-Year	100-Year
Pre-developed, B soils	0.66	1.1	2.9	7.8
Post-developed, B soils	5.5	7.1	12	22
Pre-developed, D soils	2.4	3.3	5.9	12
Post-developed, D soils	7.2	8.9	14	23