KNOX COUNTY
TENNESSEE

Stormwater Ordinance Revision Seminar

June 27, 2024

140 Dameron Avenue

Knoxville, TN

Seminar Topics

1. Stormwater Quality Standard
2. Manufactured Treatment Devices
3. SCM Treatment Trains
4. Water Quality Buffers
5. Sinkhole Policies
6. Other Changes
7. Closing Remarks

Drivers for Change

- Changes in TDEC's small Municipal Separate Storm Sewer System (MS4) Permit
  - MS4 = System of inlets, pipes, ditches, and outfalls that carry stormwater into local waterways
  - Regulates the discharge of polluted stormwater into local waterways
  - Most recent permit (2022) included significant changes for post-construction stormwater quality designs
- Improved flood protection for developments near sinkholes
- Streamlining design and construction processes

Topic 1:
The Stormwater Quality Standard

Terminology

- **Post-Construction Stormwater Management**
  - Also called “Permanent Stormwater Management”
  - Treatment of pollutants in stormwater from developed properties
  - This is not about Erosion & Sediment Control
- **Total Suspended Solids (TSS)** - Required stormwater treatment parameter
- **Water Quality Volume (WQv)** - Required stormwater treatment volume
- **Best Management Practices (BMPs)**
  - Structural facilities designed, constructed, & maintained to remove pollutants from post-construction stormwater

Overview of Changes

Most changes are **required** by TDEC Rule 04-0400-10 & Knox County's MS4 Permit

What stays the same?

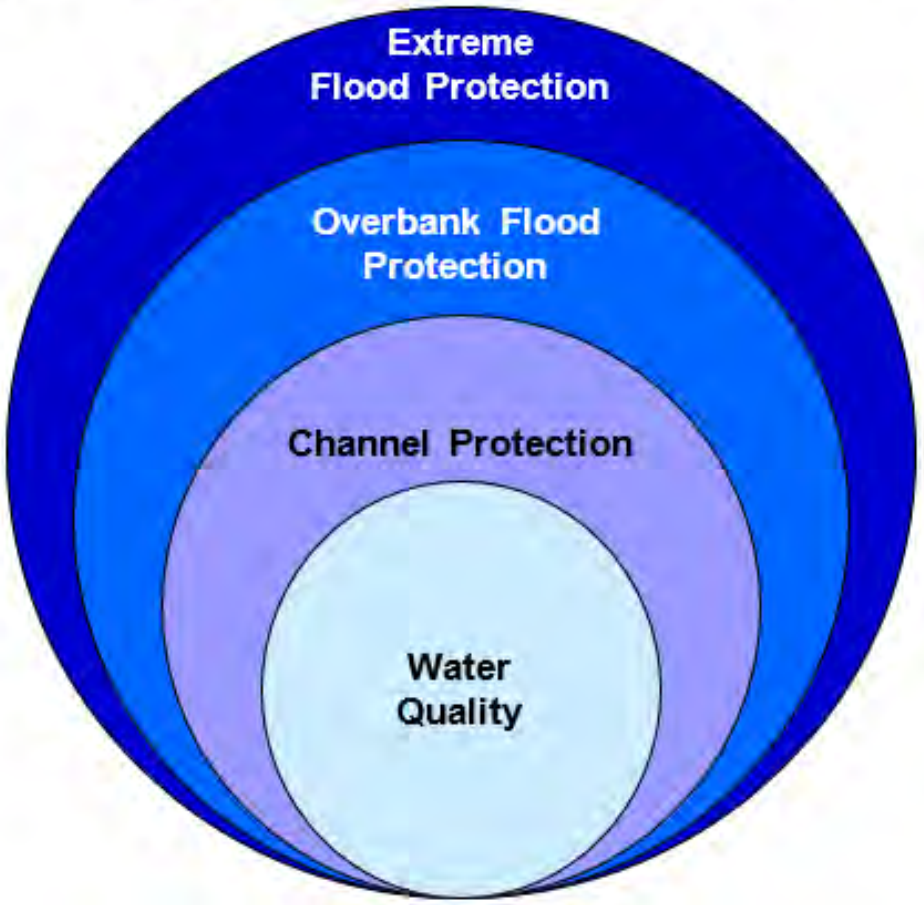
- The Stormwater Quality Standard
  - 80% TSS Removal for the WQv
- Majority of currently accepted structural SCMs will remain
- SCM Design Specifications
  (small changes only)

What will change?

- Rainfall used to determine WQv
- WQv calculation method
- Manufactured Treatment Device policies
- Treatment train policies
- Channel protection (CPv) standard
  (not part of MS4 permit requirements)

Stormwater Design Criteria

Figure 2-1. Design Volume "Nesting" of Stormwater Criteria

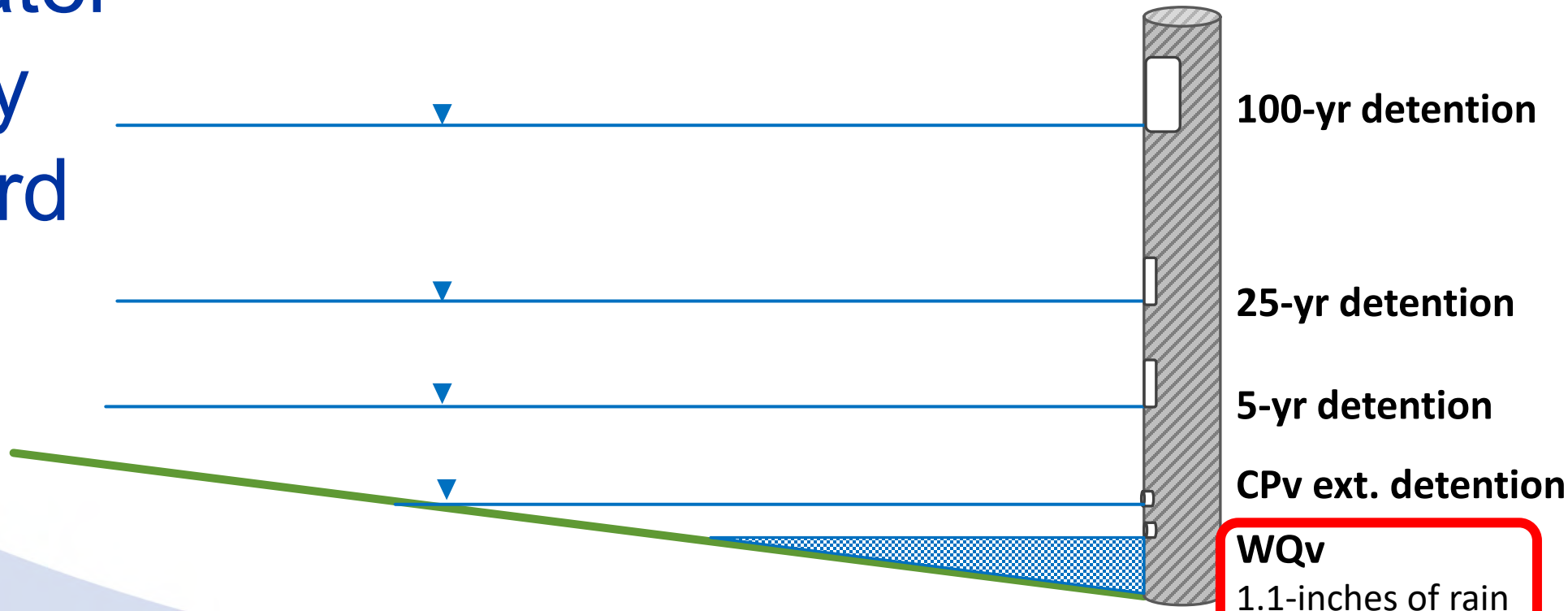


Sizing	
Stormwa (W	d to, at a noval of ume (WQv).
Channel (C	storm period.
Overba Protecti	return post- pment rate.
Extrem Protecti	equency, oment peak

The Current Stormwater Quality Standard

80% TSS Removal of the WQv

- TSS = total suspended solids
- WQv = water quality volume



The WQv amount and calculation method are changing

The new Stormwater Quality Standard is in a SCM Treatment Table

Tier	SCM Treatment Mechanism(s)	Available SCMs	SCM Sizing Requirement for Stormwater Treatment
Tier 1	Infiltration, evap transpira runoff reuse	• Bioretention Area, no underdrain • Infiltration Basin, no underdrain • Wet Enhanced Swale • Cistern • Green Roof • Tier 1 MTDs[1]	v = first 1.0" e 1-yr, 24-hr storm event
Tier 2	Biologi filtrati underdrain	• Bioretention Area, with underdrain Tier 2 MTDs[1]	v = first 1.25" e 1-yr, 24-hr storm event
Tier 3	Sand filtrati	• Wet pond (all types) • Dry extended detention pond • Sand filter (all types) • Stormwater Wetlands • Tier 3 MTDs[1]	WQv = 75% of the runoff volume the 1-year, 24-hour storm
Tier 4	Hydrodynamic separation, baffle box sett flow-thr and treatment trains using MTDs		Maximum runoff rated from the e 1-year, 24-hour storm

80% TSS Removal of the WQTV

80% TSS Removal of the WQTV

80% TSS Removal of the WQTV

80% TSS Removal of the WQTV

Old Method

80% TSS Removal of the WQv

60% TSS Removal

50% TSS Removal

Grass Channel
WQTV (1.1” rain)

Dry ED Pond
WQTV (1.1”
rain)

A SCM treatment train
with both SCMs sized
for a 1.1” rainfall
meets
80% TSS removal

New Method

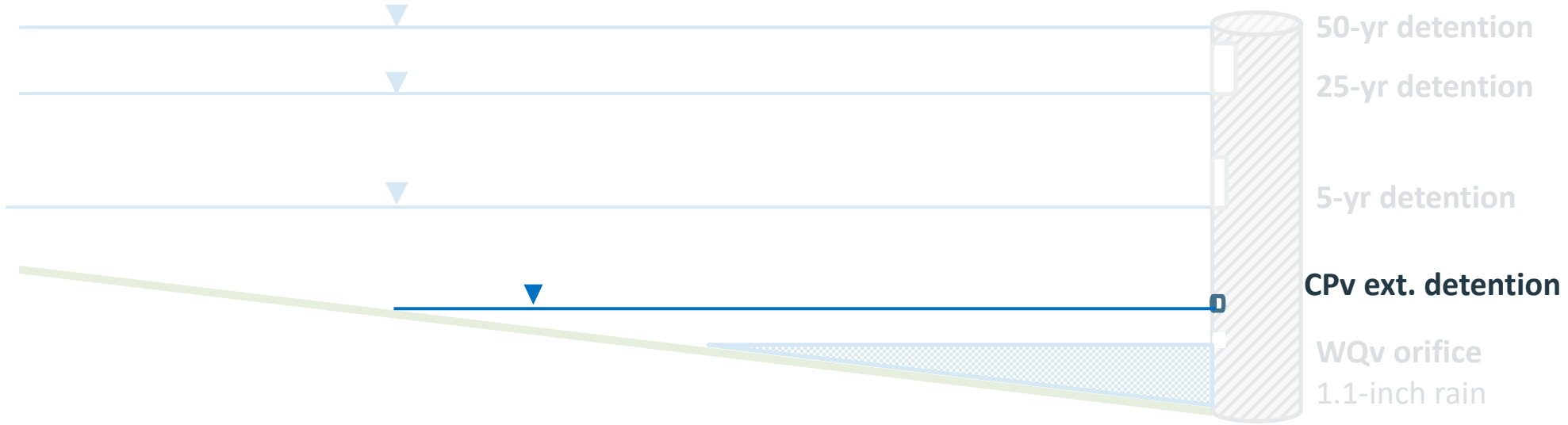
If **bioretention SCM**
WQv → first 1” inch

If **dry extended detention pond SCM**
WQv → 75% of volume
from 1-yr, 24-hr storm

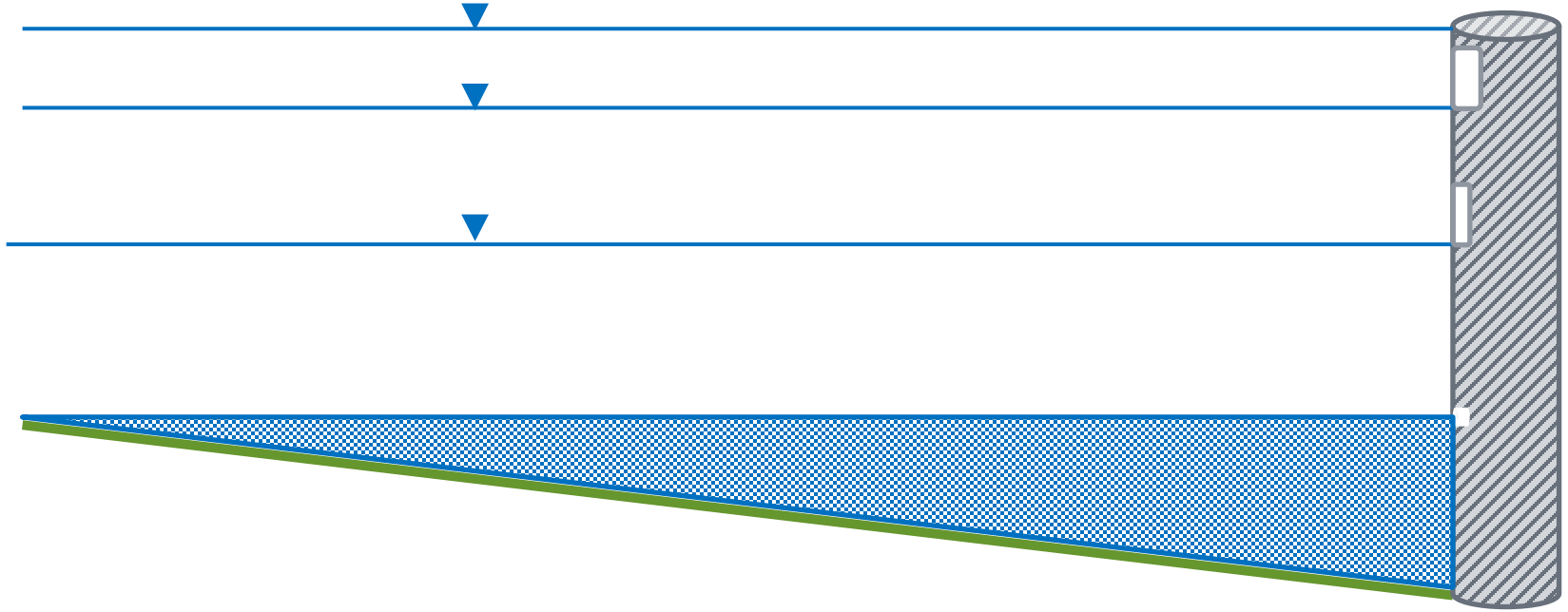
One SCM
sized by treatment type
meets
80% TSS removal

Extended Detention Pond Outlet Profile

Old Method



New Method



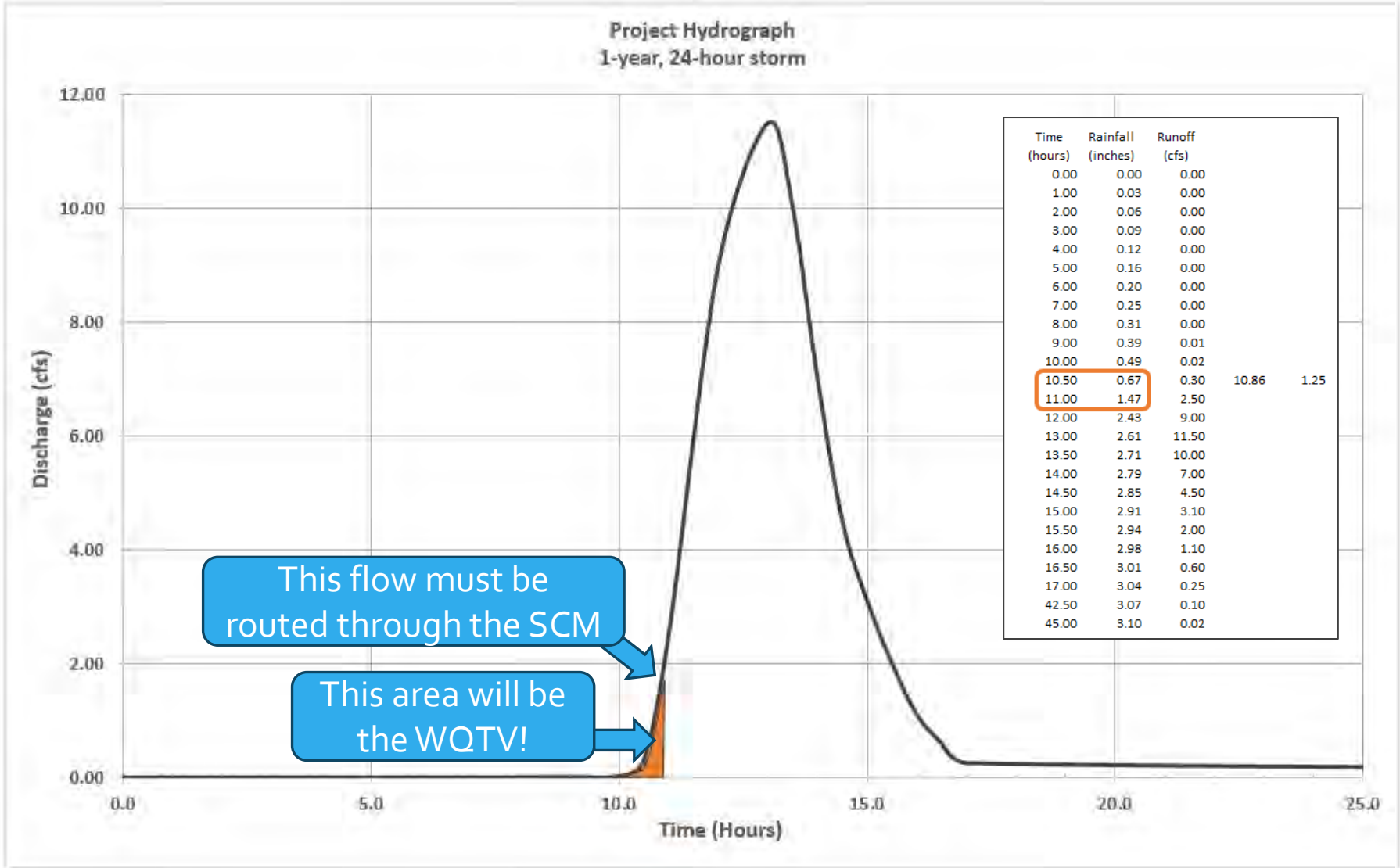
Calculating the WQv

The Runoff Hydrograph Method

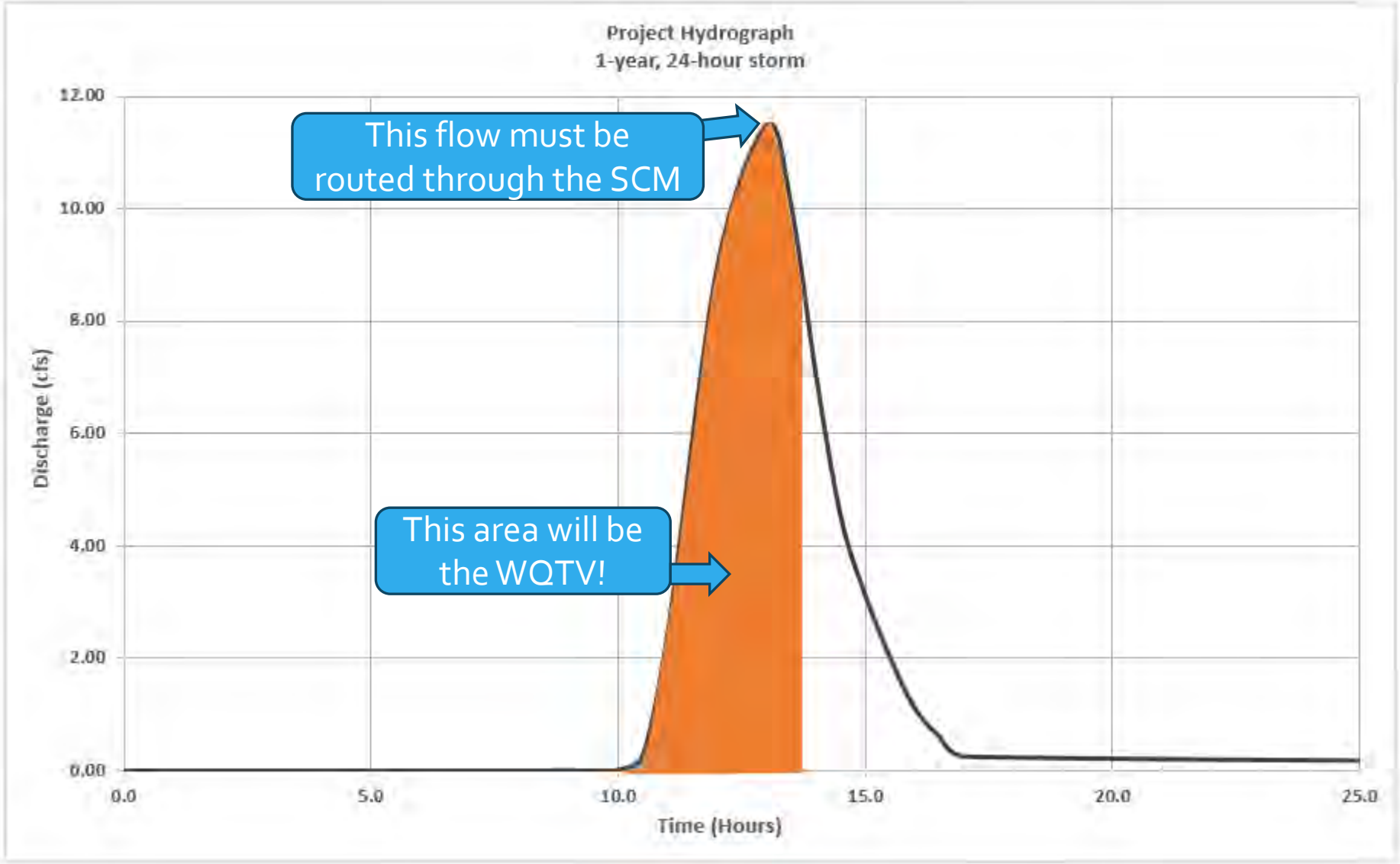
- Generate a runoff hydrograph using NRCS (SCS) methods
  - 1-year, 24-hour design storm
  - Rainfall depth from the SCM Treatment Table (Tiers 1 & 2 only)
  - Use hydrograph to determine runoff volume

Example Runoff Hydrograph Method for Tier 1 & 2 SCMs

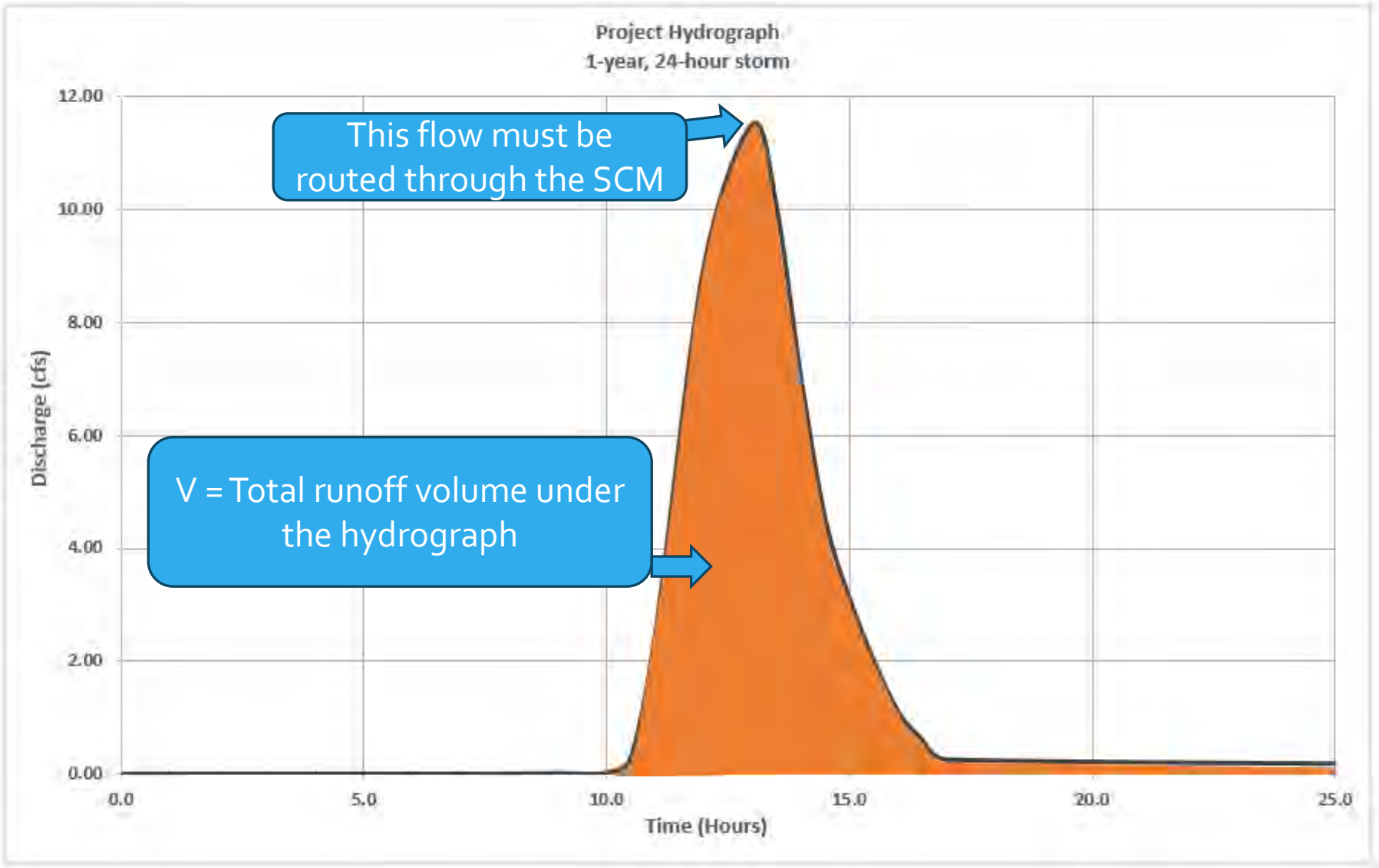
Tier	SCM Treatment	Available SCMs	SCM Sizing Requirement for
Tier 4	flow-through MTDs, and treatment trains using MTDs	• Tier 4 MTDs[1]	entire 1-year, 24-hour storm



When the WQTV passes the hydrograph peak…



WQTV for Tier 3 SCMs



$$WQTV_{Tier3} = 0.75 * V$$

Questions?

Tier	SCM Treatment Mechanism(s)	Available SCMs	SCM Sizing Requirement for Stormwater Treatment
Tier 1	Infiltration, evaporation, transpiration, and/or runoff reuse	• Bioretention Area, no underdrain • Infiltration Basin, no underdrain • Wet Enhanced Swale • Permeable/porous pavements, no underdrain • Cistern • Green Roof • Tier 1 MTDs[1]	WQv = first 1.0" of the 1-yr, 24-hr storm event
Tier 2	Biologically active filtration with an underdrain	• Bioretention Area, with underdrain • Infiltration Basin, with underdrain • Dry Enhanced Swale Tier 2 MTDs[1]	WQv = first 1.25" of the 1-yr, 24-hr storm event
Tier 3	Sand or gravel filtration, settling	• Wet pond (all types) • Dry extended detention pond • Permeable/porous pavements, with underdrain • Sand filter (all types) • Stormwater Wetlands • Tier 3 MTDs[1]	WQv = 75% of the total runoff volume from the 1-year, 24-hour storm
Tier 4	Hydrodynamic separation, baffle box settling, or other flow-through MTDs, and treatment trains using MTDs	• Tier 4 MTDs[1]	Maximum runoff generated from the entire 1-year, 24-hour storm

Topic 2:

Manufactured Treatment Devices (MTDs)

(formerly called Proprietary BMPs)

Manufactured Treatment Devices exist in all 4 SCM Tiers

Tier	SCM Treatment Mechanism(s)	Available SCMs	SCM Sizing Requirement for Stormwater Treatment
Tier 1	Infiltration, evaporation, transpiration, and/or runoff reuse	• Bioretention Area, no underdrain • Infiltration Basin, no underdrain • Wet Enhanced Swale • Permeable/porous pavements, no underdrain • Cistern • Green Roof • Tier 1 MTDs[1]	WQv = first 1.0" of the 1-yr, 24-hr storm event
Tier 2	Biologically active filtration with an underdrain	• Bioretention Area, with underdrain • Infiltration Basin, with underdrain • Dry Enhanced Swale • Tier 2 MTDs[1]	WQv = first 1.25" of the 1-yr, 24-hr storm event
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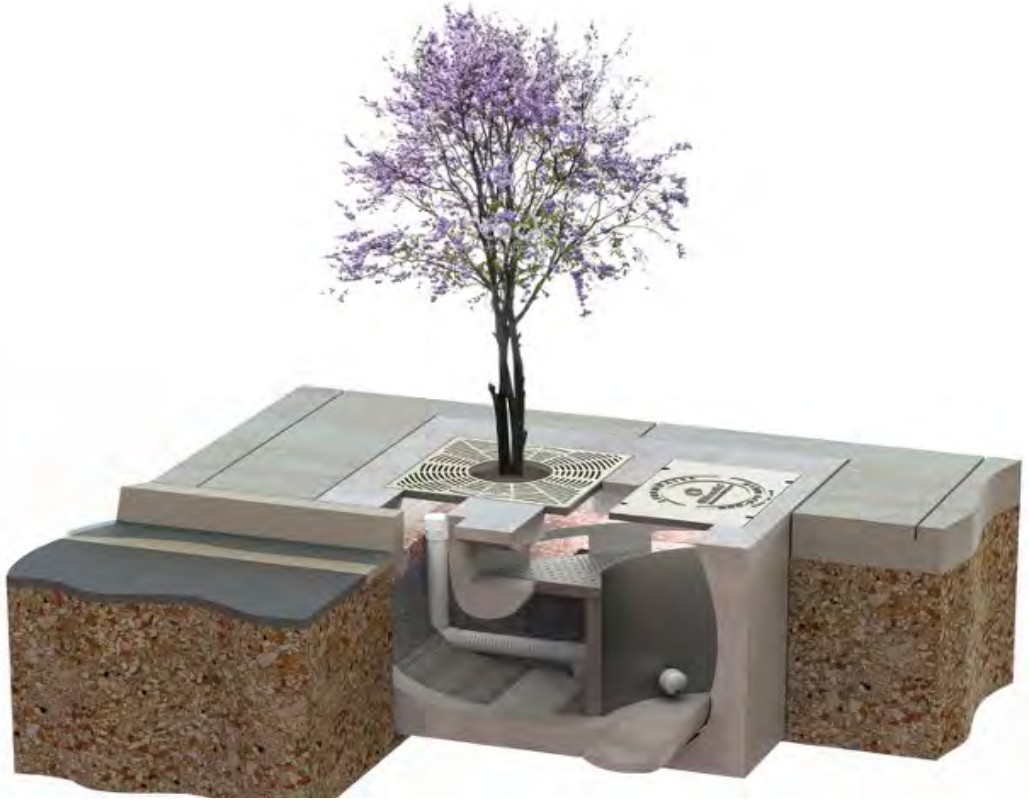
Tier 4	Hydrodynamic separation, baffle box settling, or other flow-through MTDs, and treatment trains using MTDs	• Tier 4 MTDs[1]	Maximum runoff generated from the entire 1-year, 24-hour storm

Tier 1 MTDs

- Infiltration & Evapotranspiration
  - No underdrain!
  - Helps to mimic natural hydrology
- Highest pollutant removal because stormwater volume is decreased
- Feasibility is limited, especially for redevelopments in urban environments
- Requires uncompacted, in-situ soil with good infiltration rates

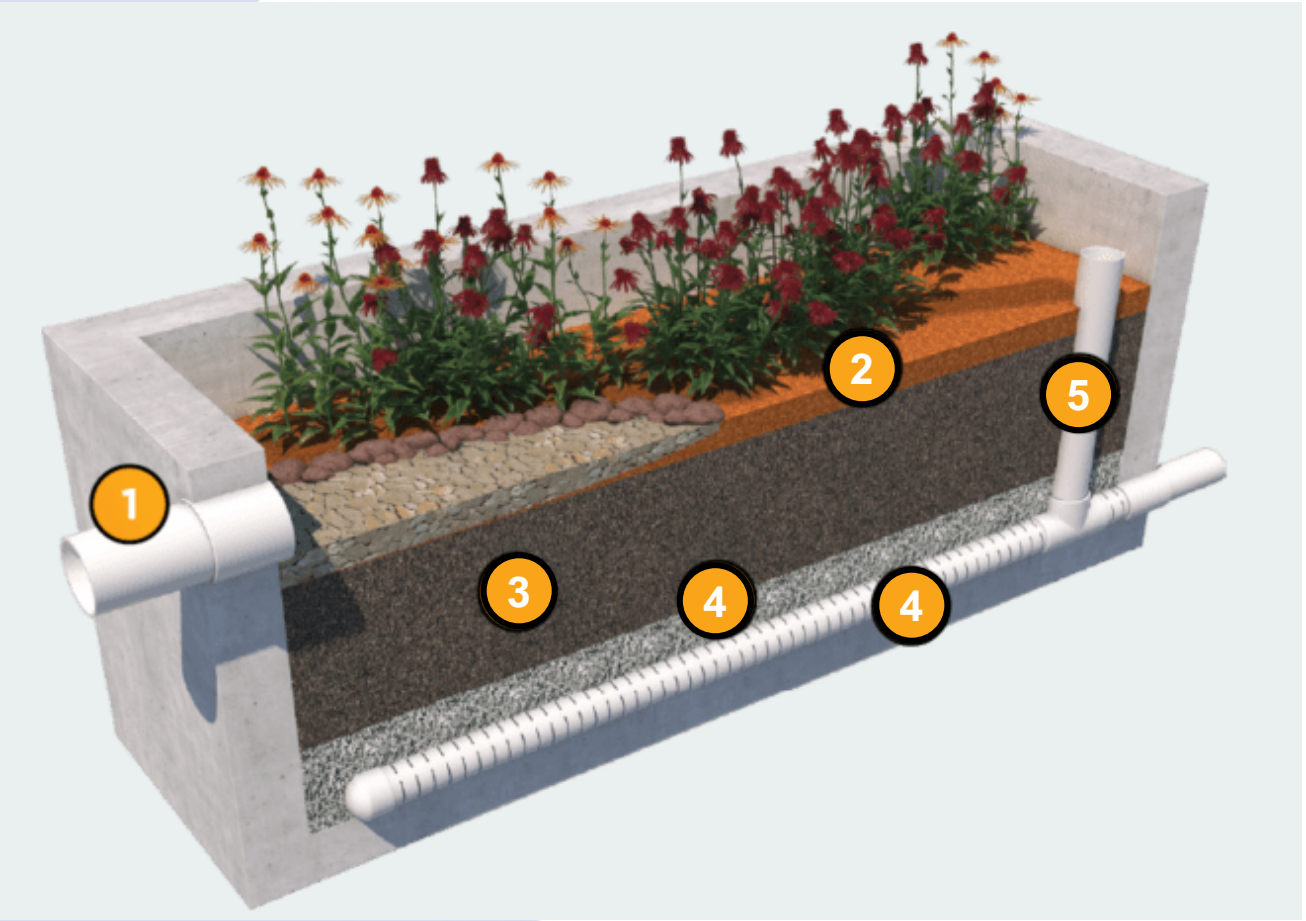
Tier 2 MTDs



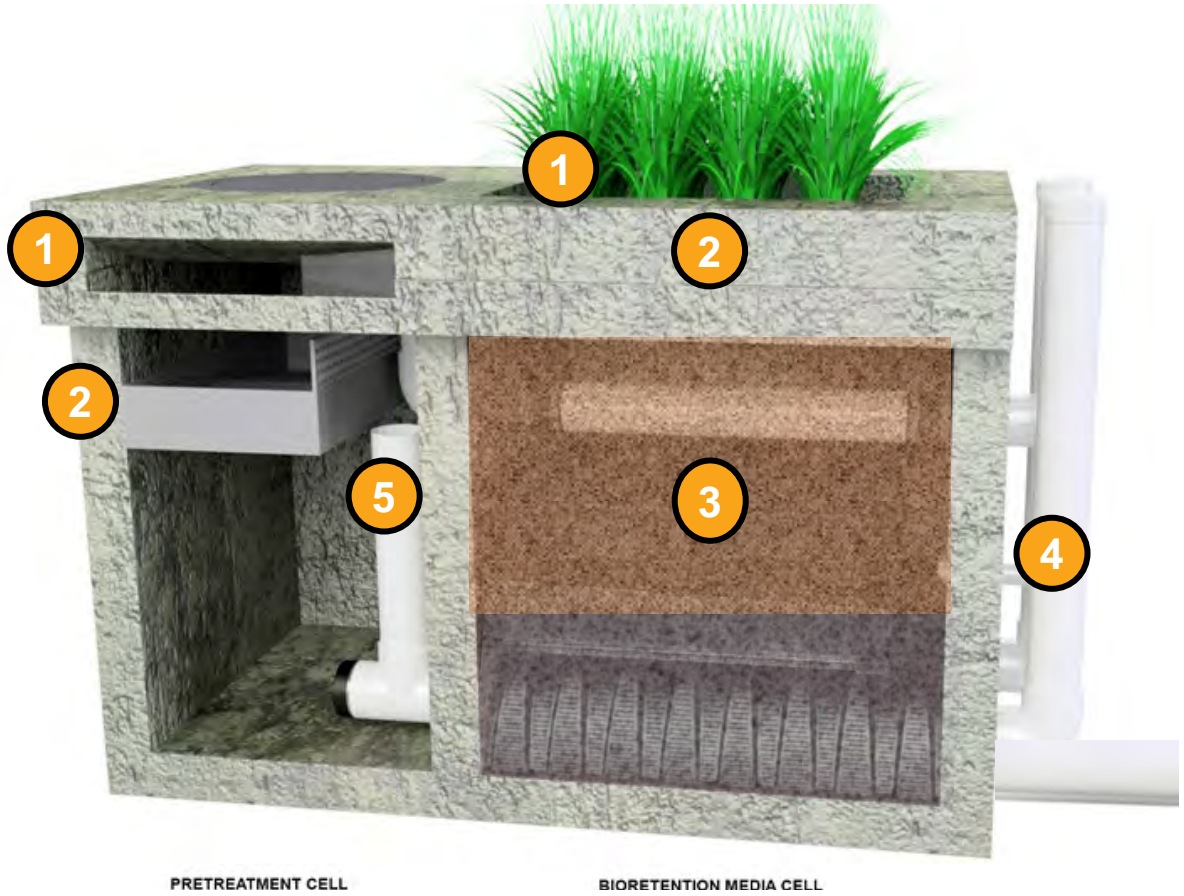
BioPod™ Tree by Oldcastle Infrastructure

- Biologically-active filtration
  - Plant uptake
  - Engineered media sorption
  - Anoxic denitrification
- Bioretention with an underdrain & at least 12-inches of internal water storage

Tier 2 MTDs



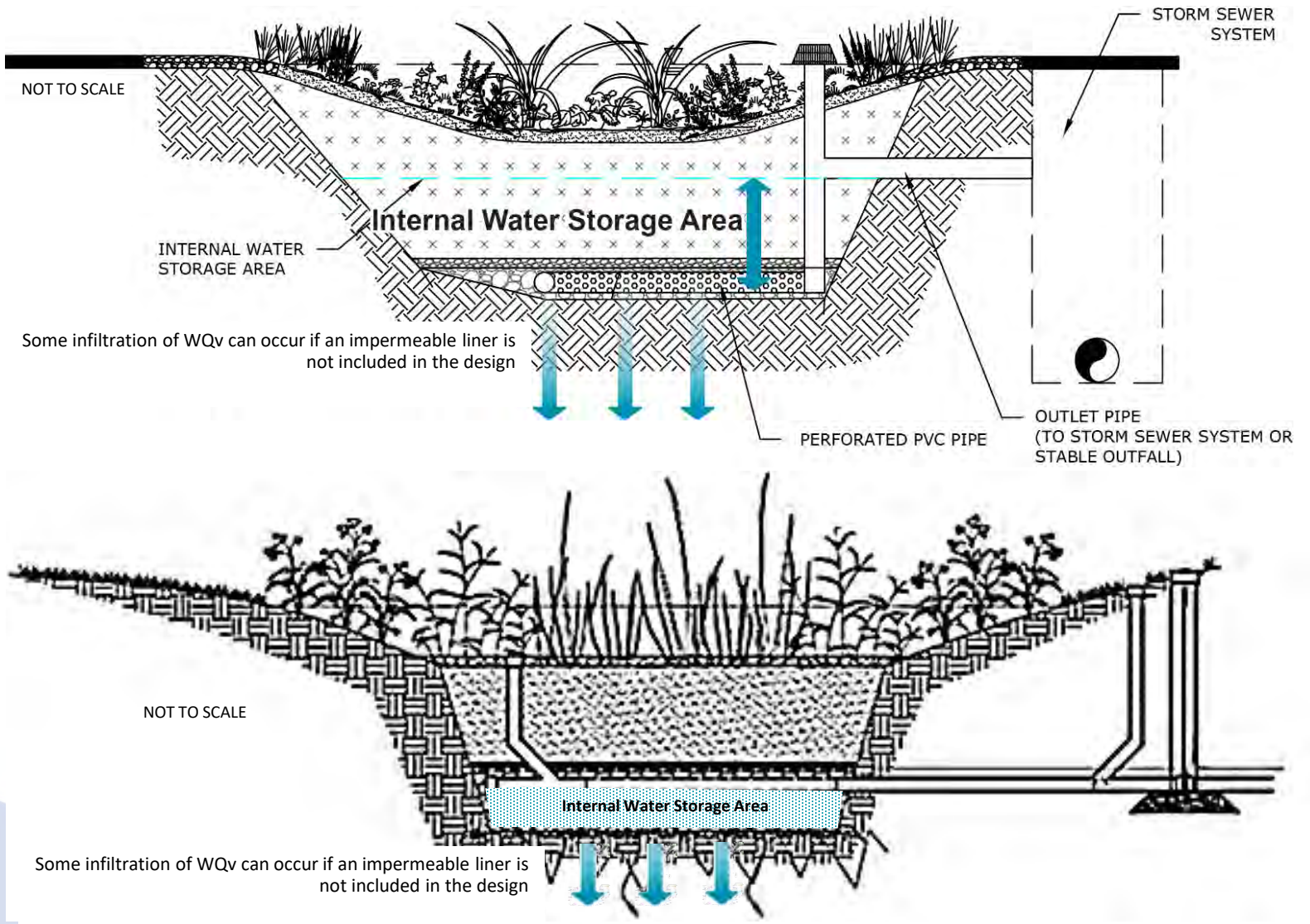
Jensen Precast Biofiltration System



ADS EcoPure™ BioFilter

Note: Graphics do not show Internal Water Storage

Designing Internal Water Storage



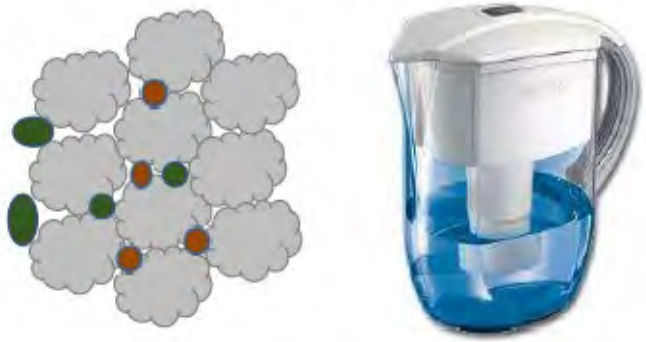
Graphic adapted from the Minnesota Stormwater Manual

Tier 3 MTDs

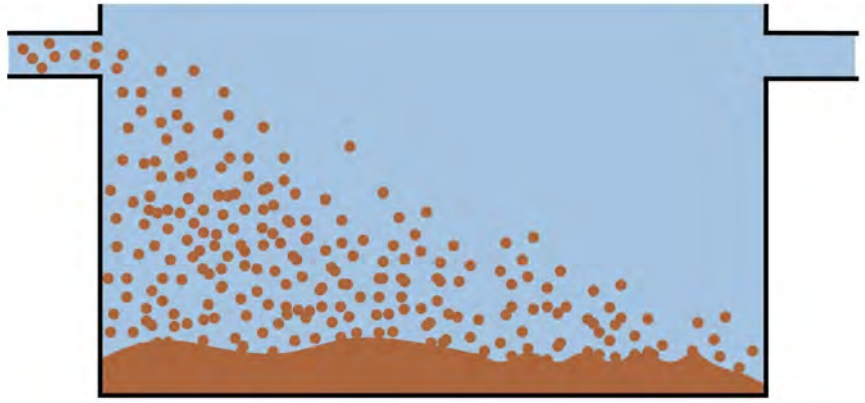
Physical removal of pollutants in at least one of 3 ways…

Surface/Membrane Filtration

Depth/Bed Filtration



Particulate Settling



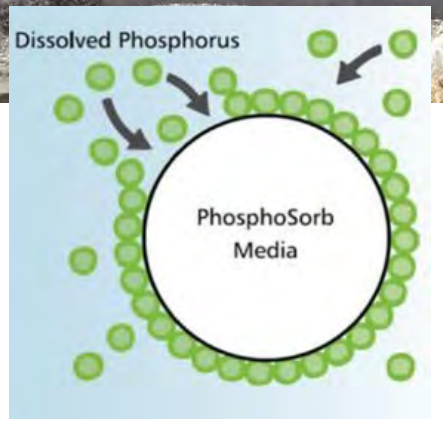
Some slide concepts provided by Jacob Dorman, Contech Engineered Solutions LLC

Tier 3 MTDs

Stormwater360
Jellyfish®

Underground Detention Systems

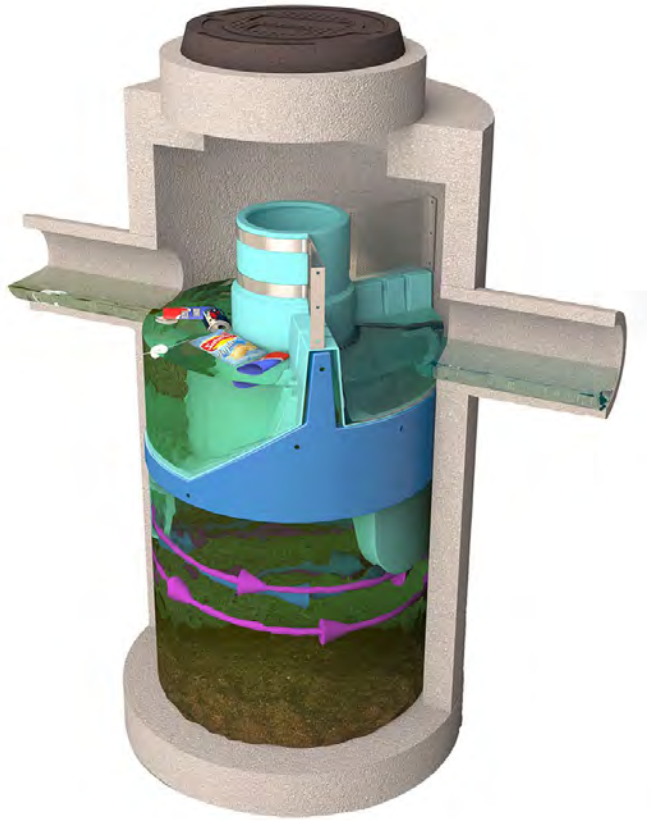
Contech StormFilter®



Slide concepts provided by Jacob Dorman, Contech Engineered Solutions LLC

Tier 4 MTDs

- Swirling, baffles, flow controls, etc.



Hydro International First Defense

Hydro International Hydro DryScreen™

MTD Policies

Tier	SCM Treatment Method	Description	Sizing Criteria	Other Design Criteria & Policies
Tier 1	Infiltration, with or without evaporation or transpiration	MTDs that uses a bio-filtration media and infiltrates stormwater into the subsoil. *(Does not include prefabricated underground detention structures)*	Peak rate of discharge for P = 1.0 inch	– Must meet infiltration feasibility rules to be approved *(designers must complete the Tier 1 SCM Feasibility form, see Appendix XYZ)* – Cannot have an underdrain – NJDEP certified TSS Removal rate cannot be less than 80% unless used in a treatment train
Tier 2	Biologically active filtration with an underdrain	MTDs configured above or below ground that uses a bio-filtration media and has an underdrain	Peak rate of discharge for P = 1.25 inches	– The MTD must provide a minimum of 12-inches of internal water storage – Must have an underdrain – If the MTD allows infiltration into surrounding soils, it must meet infiltration feasibility rules to be approved *(designers must complete the Tier 1 SCM Feasibility form, see Appendix XYZ)* – NJDEP certified TSS Removal rate cannot be less than 80% unless used in a treatment train
Tier 3	Filtration via physical and chemical processes (i.e., not-bio-filtration)	MTDs that remove pollutants using removable/replaceable filter/medial cartridges, inserts, or screens	Maximum runoff generated from the 1-year, 24-hour design storm	– Use is limited to only those situations where all other SCMs are not feasible – NJDEP certified TSS Removal rate cannot be less than 80% unless used in a treatment train or for pretreatment purposes
Tier 4	Hydrodynamic separation, baffle box settling, or other flow-through MTDs and treatment trains using MTDs	Vortex and gravity separators, MTDs used as pretreatment devices upstream of other SCMs, etc.	Maximum runoff generated from the 1-year, 24-hour design storm	– May be used for SCM pretreatment – NJDEP certified TSS Removal rate cannot be less than 80% unless used in a treatment train or for pretreatment purposes

Questions?

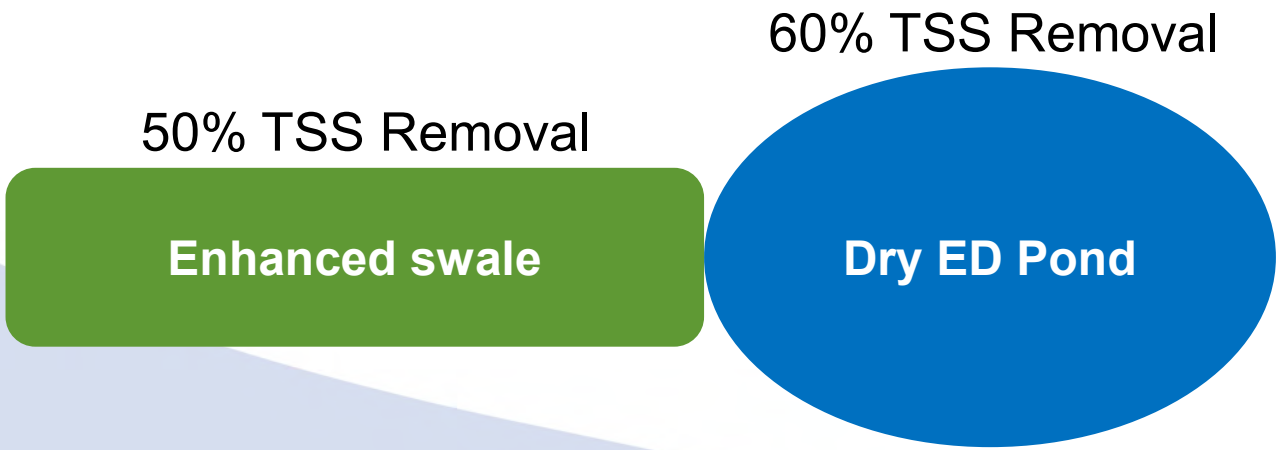
Topic 3:

SCM Treatment Trains

Treatment Trains

- A treatment train is two or more SCMs designed in series
  - Useful when a single SCM does not have the capacity to treat the entire WQv
- When MTDs are not included:
  - Combined treatment must be 80% TSS Removal
  - The downstream SCM must be sized based on its Tier
  - Subtract the volume managed by the upstream SCM from the required WQv for the downstream SCM

$$Tv_{ds} = WQv_{ds} - Tv_{us}$$



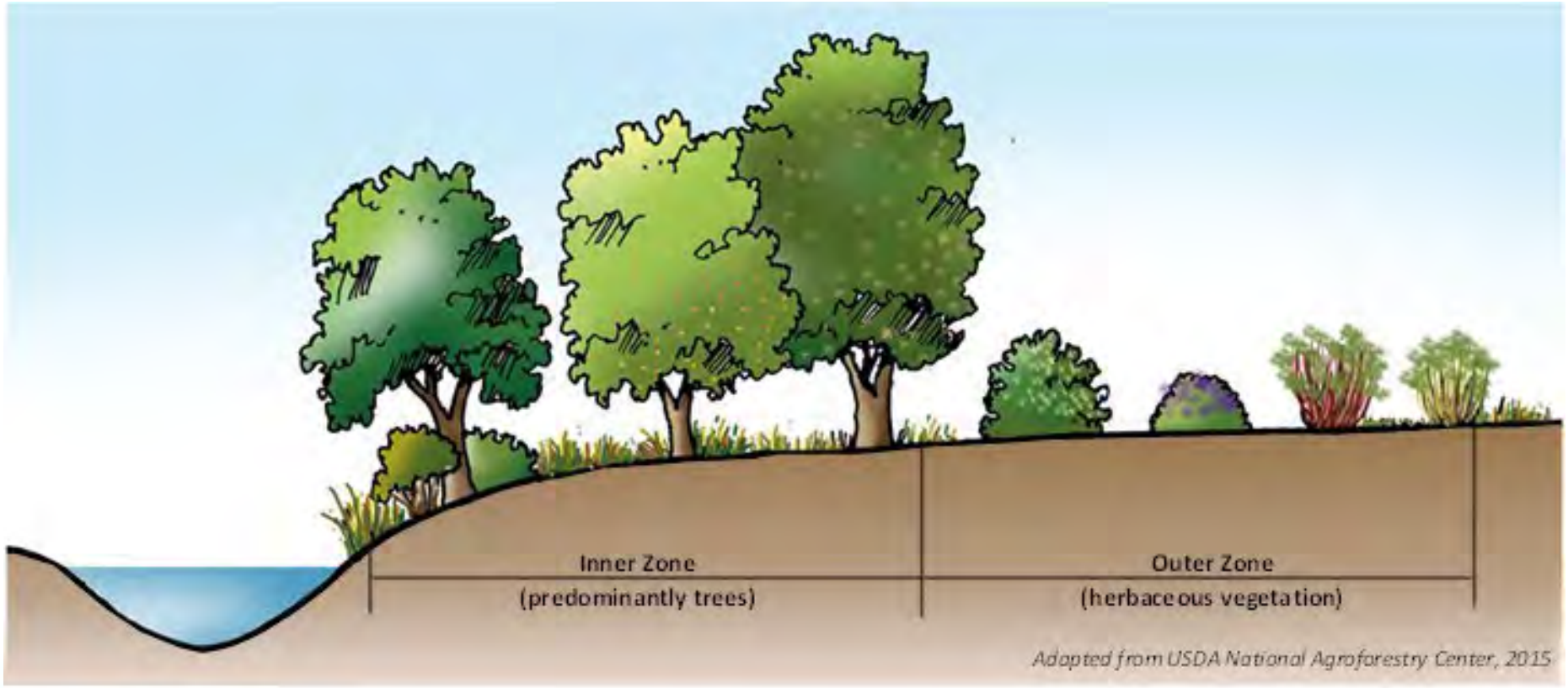
This treatment train is sized for the Dry ED Pond's Tier (75% of the runoff from the 1-yr, 24-hr storm)

Treatment Trains

- A treatment train is two or more SCMs designed in series
  - Useful when a single SCM does not have the capacity to treat the entire WQv
- When MTDs are not included:
  - Combined treatment must be 80% TSS Removal
  - The downstream SCM must be sized based on its Tier
  - Subtract the volume managed by the upstream SCM from the required WQv for the downstream SCM
- When MTDs are included:
  - The MTD **must** be the upstream SCM in the train
  - Two MTDs cannot be placed in the same treatment train

Questions?

Topic 4: **Water Quality Buffers**



Overview

Main requirements align with TDEC Rule 04-0400-10 & Knox County's MS4 Permit

What stays the same?

- Required for streams, wetlands, lakes, and ponds
- Width measured from top of bank
- Buffer averaging & related rules
- Sheet flow required for overland discharges to buffer
- Restrictions on use and activities in the buffer

What will change?

- No "community waters" designation
- Width increase for most Knox Co streams
- Revised rules for:
  - buffer vegetation
  - allowed entry/uses

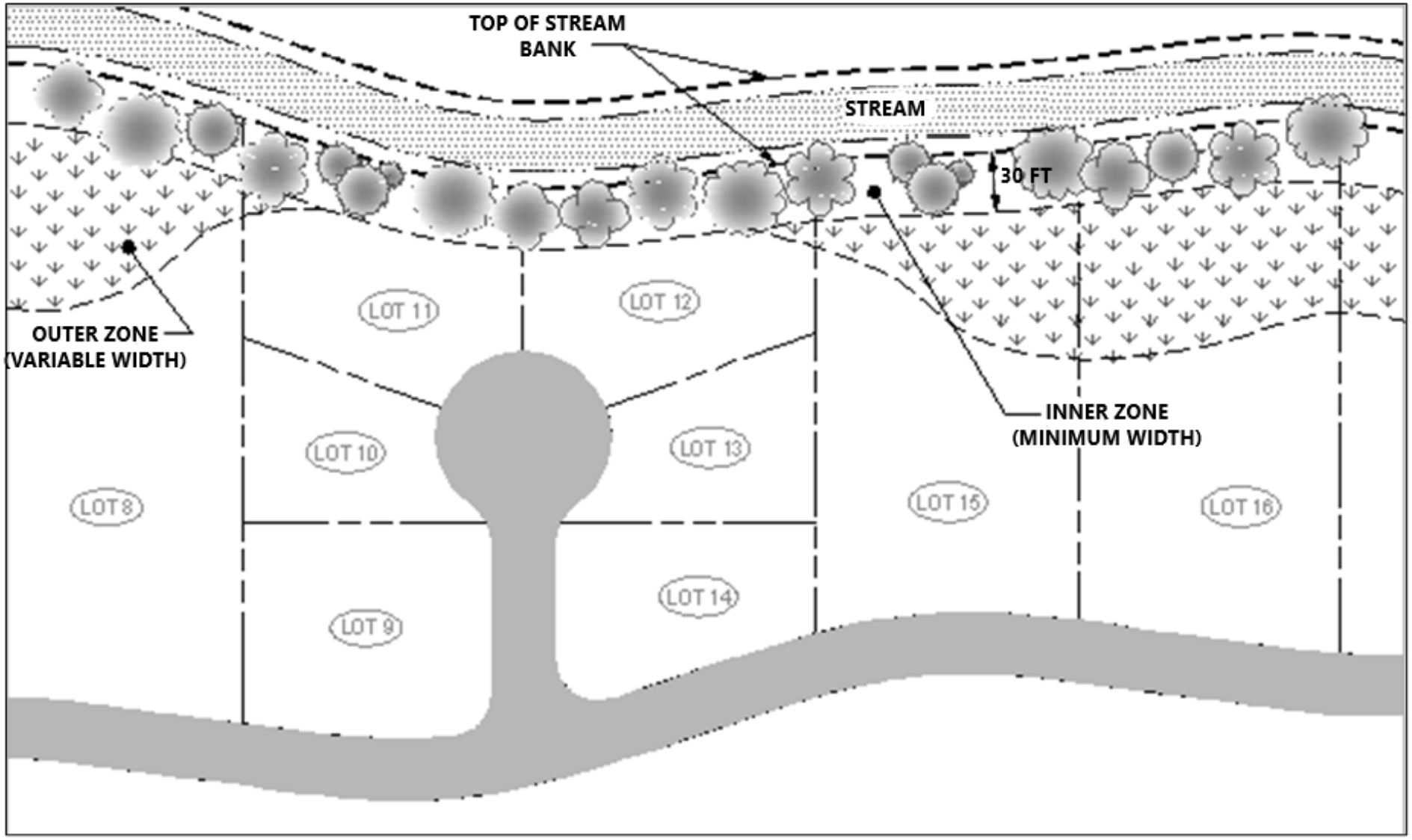
Buffer Widths

- Applied to streams, wetlands, ponds, lakes (widths no longer differ)
- Purpose: additional water quality protection, streambank/shoreline stabilization and canopy protection (shading)

Waterbody Characterization	Minimum Width (feet)	Minimum Average Width (feet)
Waters with available parameters for siltation and habitat alteration or unassessed waters.	15	30
Waters with unavailable parameters for siltation and habitat alteration or Exceptional Tennessee Waters	30	60

- Width averaging allowed in the outer zone

Buffer Width Averaging



Buffer Widths & Prohibitions

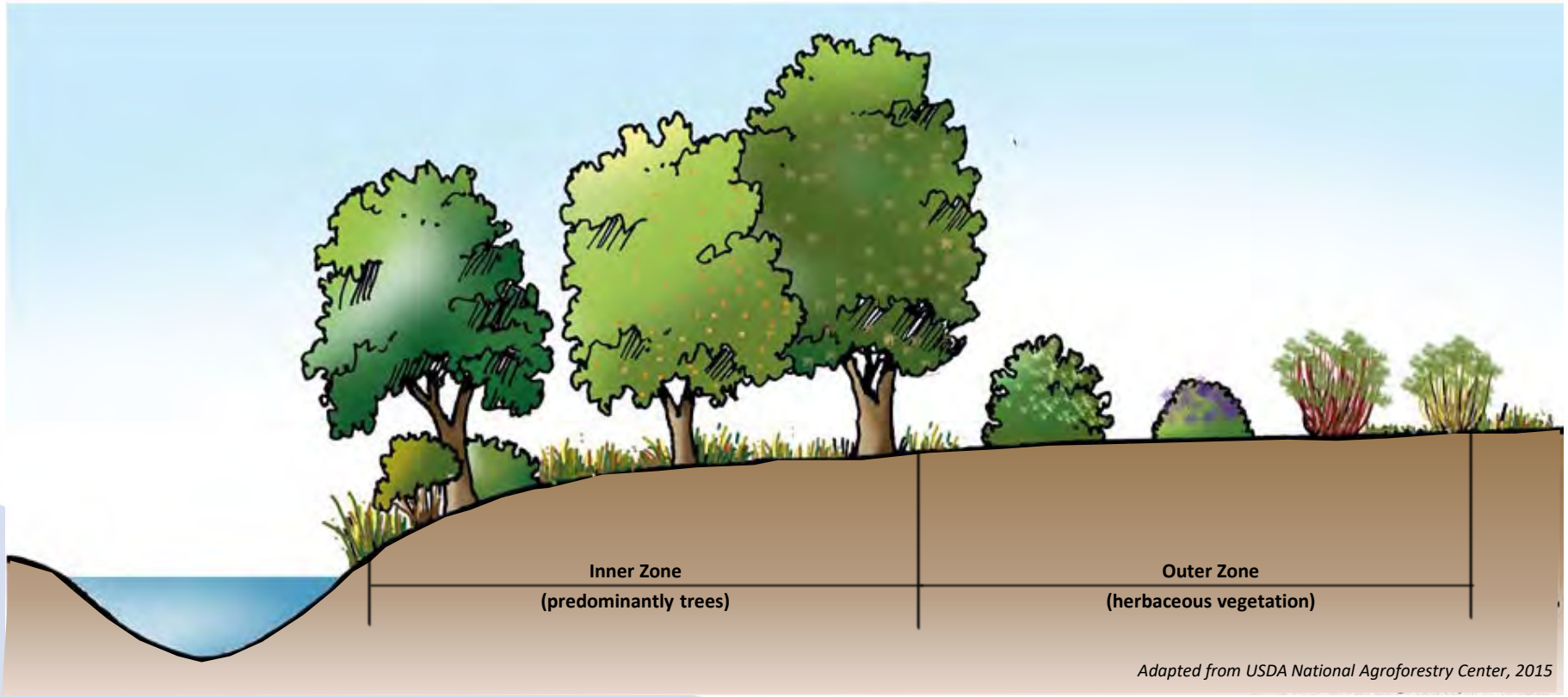
Waterbody Characterization	Minimum Width (feet)	Minimum Average Width (feet)
Waters with available parameters for siltation and habitat alteration or unassessed waters.	15	30
Waters with unavailable parameters for siltation and habitat alteration or Exceptional Tennessee Waters	30	60

- Necessary impervious surfaces only
- Total width must be increased by the width of impervious trails in the buffer

- Prohibitions:
  - Concentrated animal lots, kennels, etc.
  - Vehicle/equipment parking, repair, storage, use
  - Materials storage and transfer
  - Waste dumping, handling and storage
  - Other potential polluting activities

Buffer Vegetation

- 70% coverage with permanent, perennial, dense vegetation
- Inner zone: Predominantly trees
- Outer zone: grass, shrubs, and/or trees



Questions?

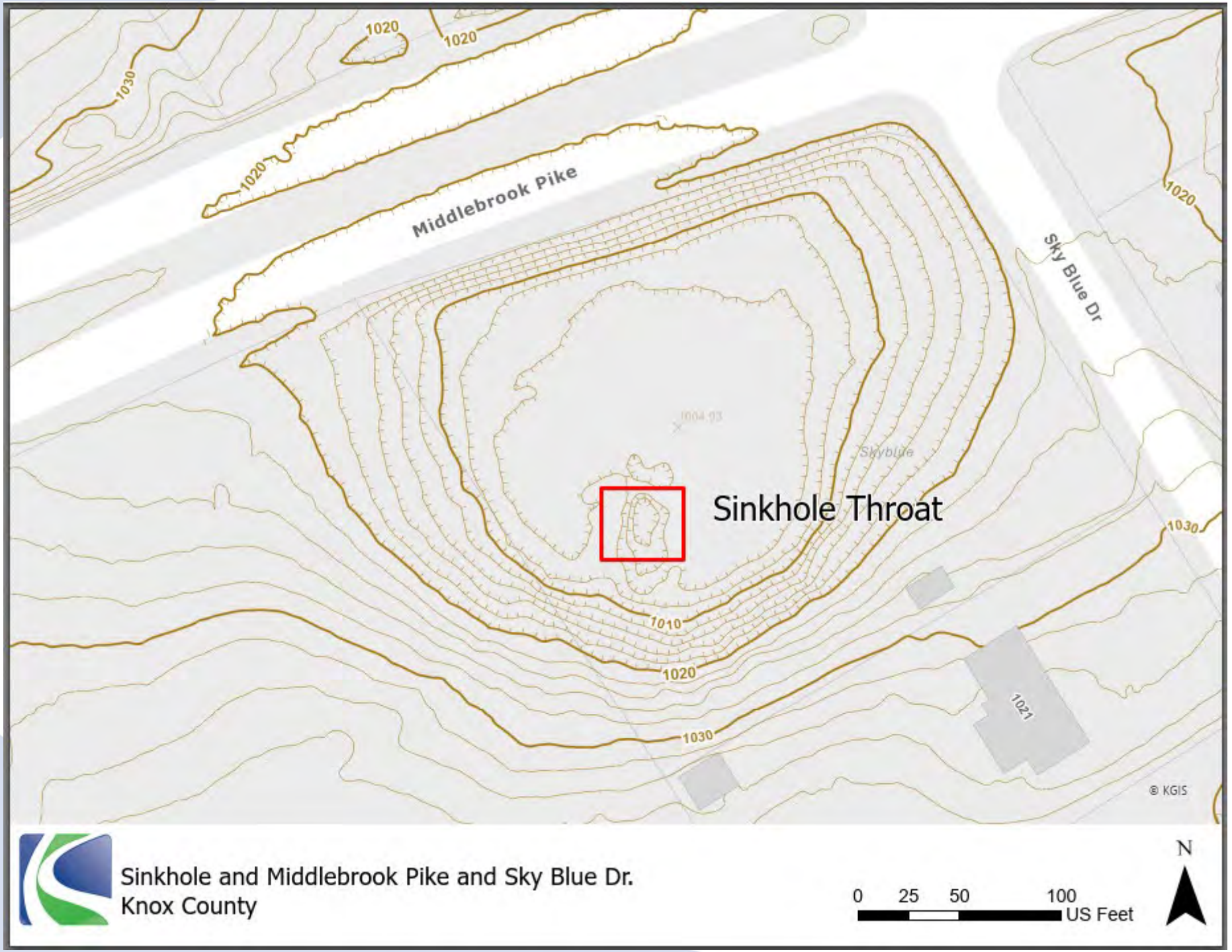
Topic 5: **Sinkhole Policies**

Why change sinkhole policies?

- Continued increases in sinkhole formation caused by concentrated stormwater
- Continued increases in flooding caused by flooded sinkholes
- Need improved protection for existing and future developments

What is a sinkhole in Knox County?

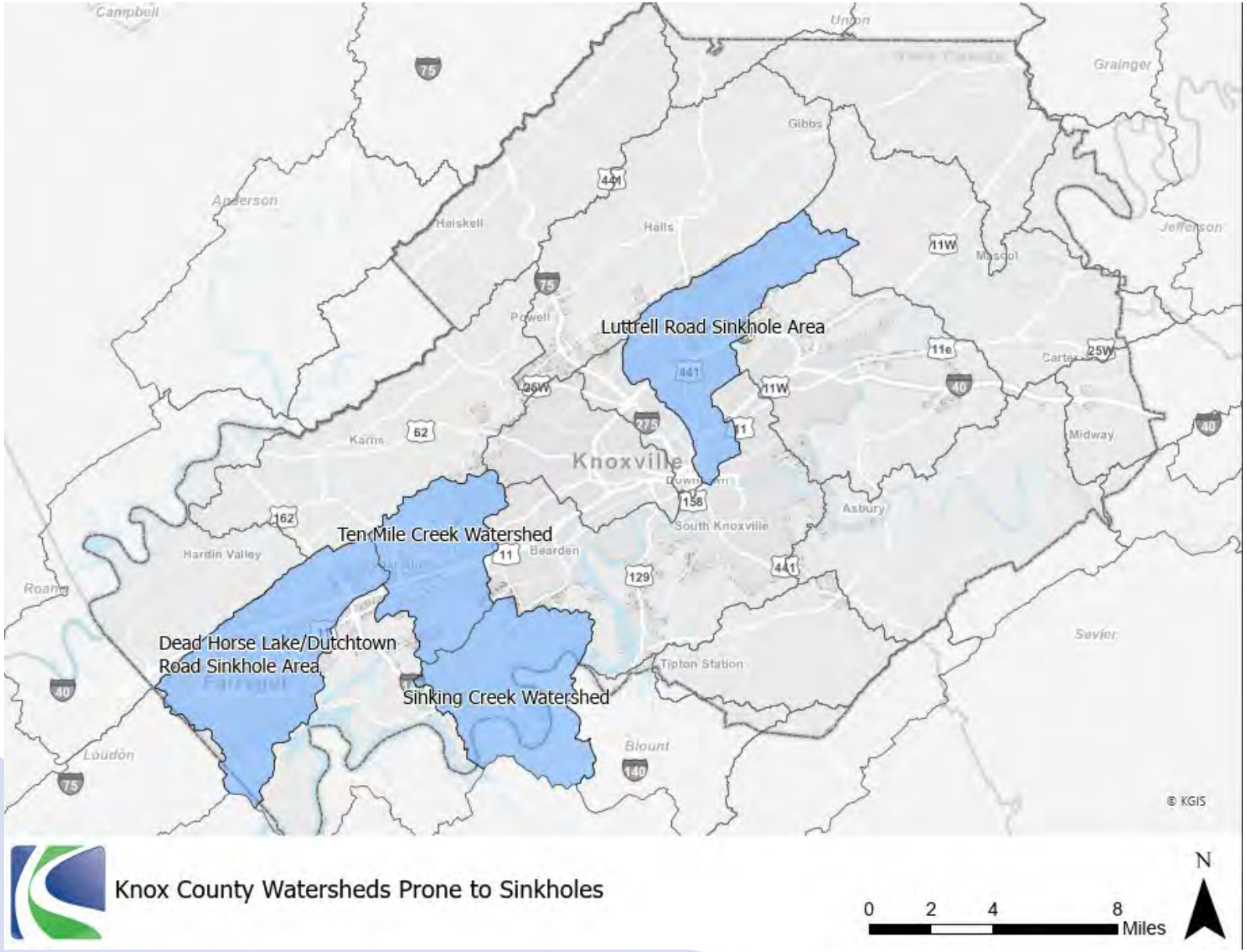
- Sinkhole vs. manmade depression
- Closed, hachured contours on a KGIS map are sinkholes unless definitively determined otherwise


1020
1020
1030
1020
Middlebrook Pike
Sky Blue Dr
1020
1004.93
Skyblue
Sinkhole Throat
1030
1010
1020
1021
1030
© KGIS
Sinkhole and Middlebrook Pike and Sky Blue Dr.
Knox County
0 25 50 100
US Feet
N

What is a sinkhole in Knox County?

- Sinkhole vs. manmade depression
- Closed, hachured contours on a KGIS map are sinkholes unless definitively determined otherwise
- Two ways to prove a manmade depression
  - Onsite inspection or knowledge and written confirmation **by County staff**
  - Geotechnical study that shows:
    - no soluble, carbonate bedrock at development location, and
    - No karst formations within ½ mile of development location

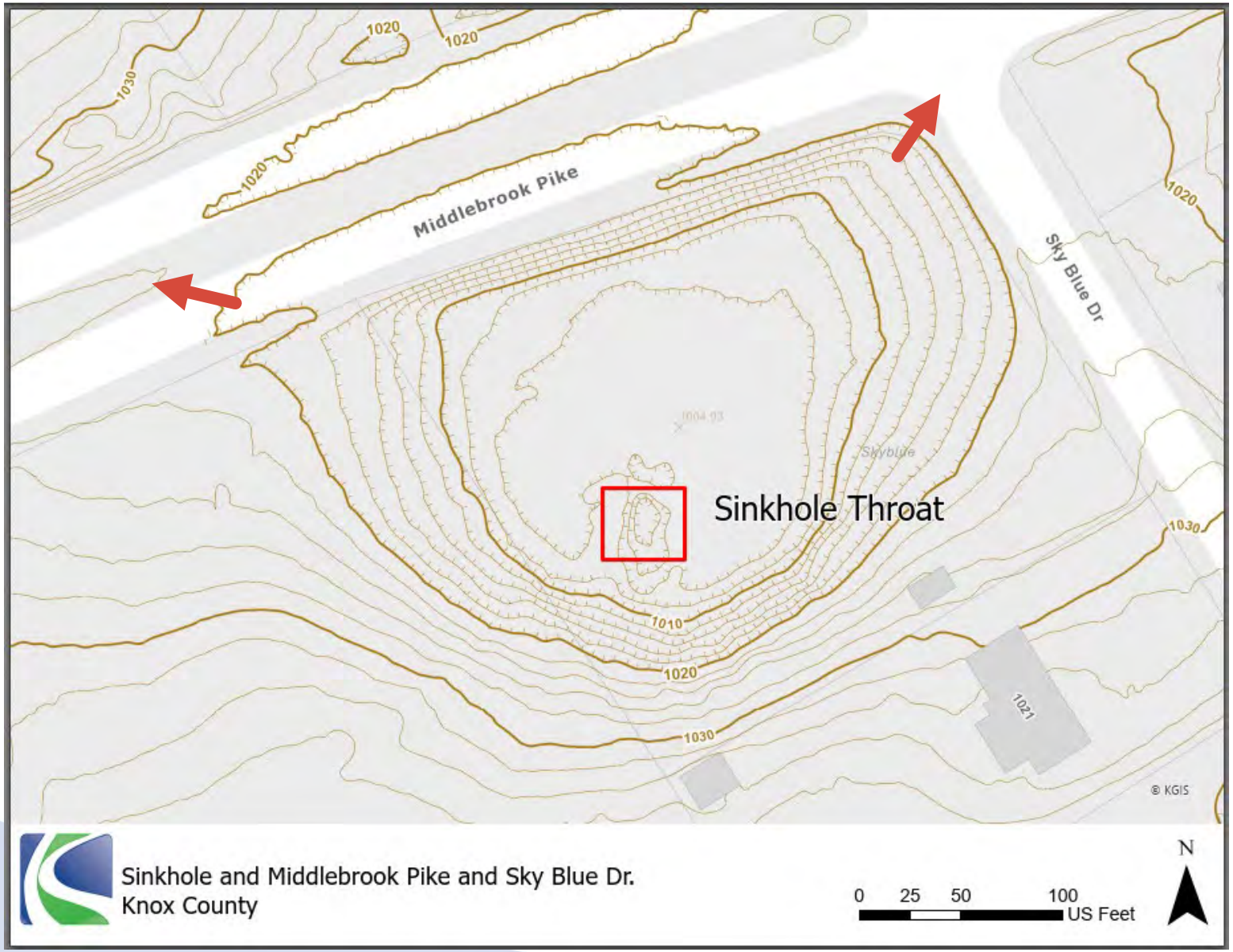
Knox County's Sinkhole Areas



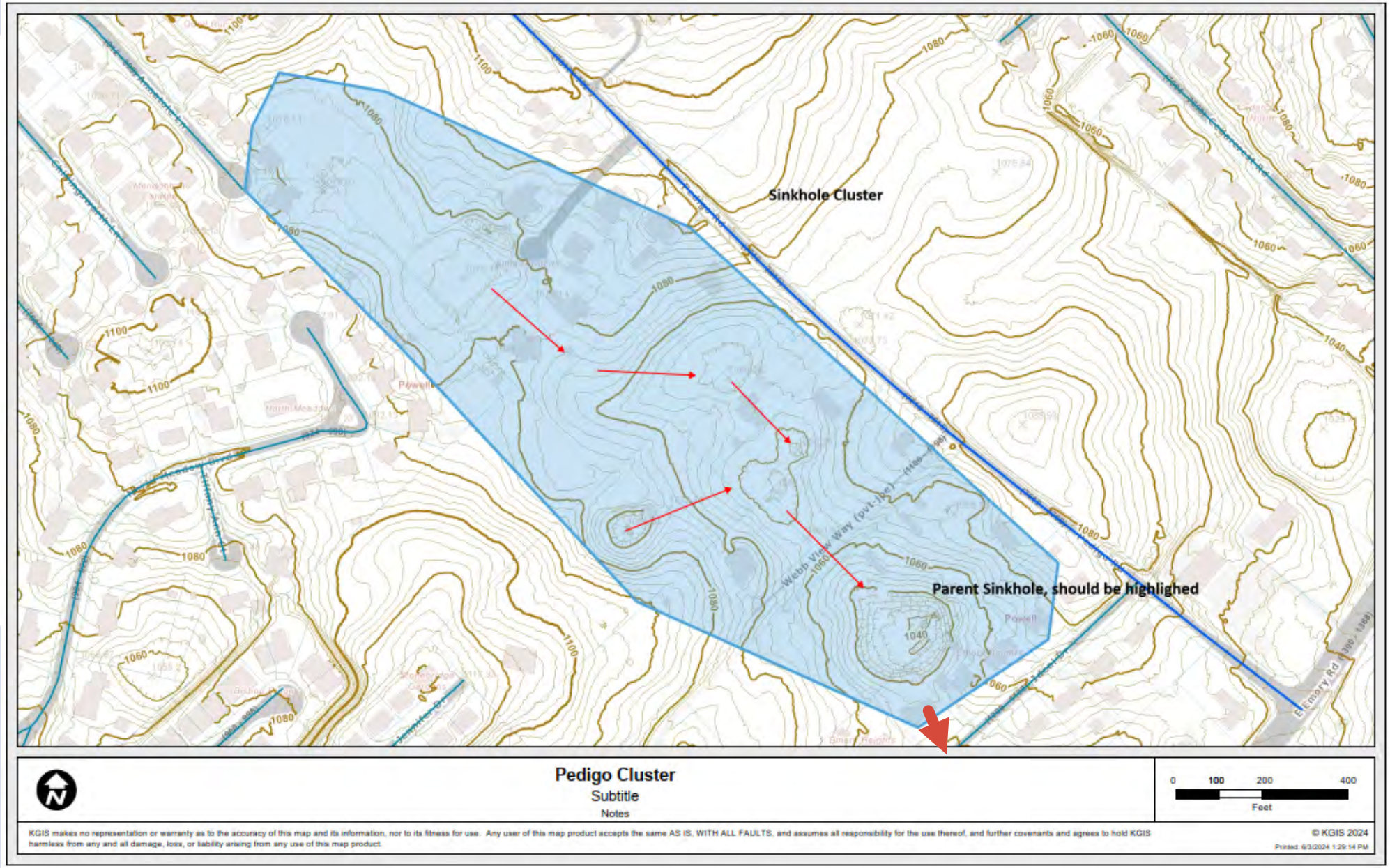
Sinkhole Protections

- No excavating, filling, or obstructing without prior County approval
  - Geotechnical and other studies may be required
- Encouragement to limit impervious surfaces and use Better Site Design to reduce stormwater runoff
- MFE ≥ 1 foot above **sinkhole overflow elevation**

Sinkhole Overflow Elevation – **Single Sinkhole**

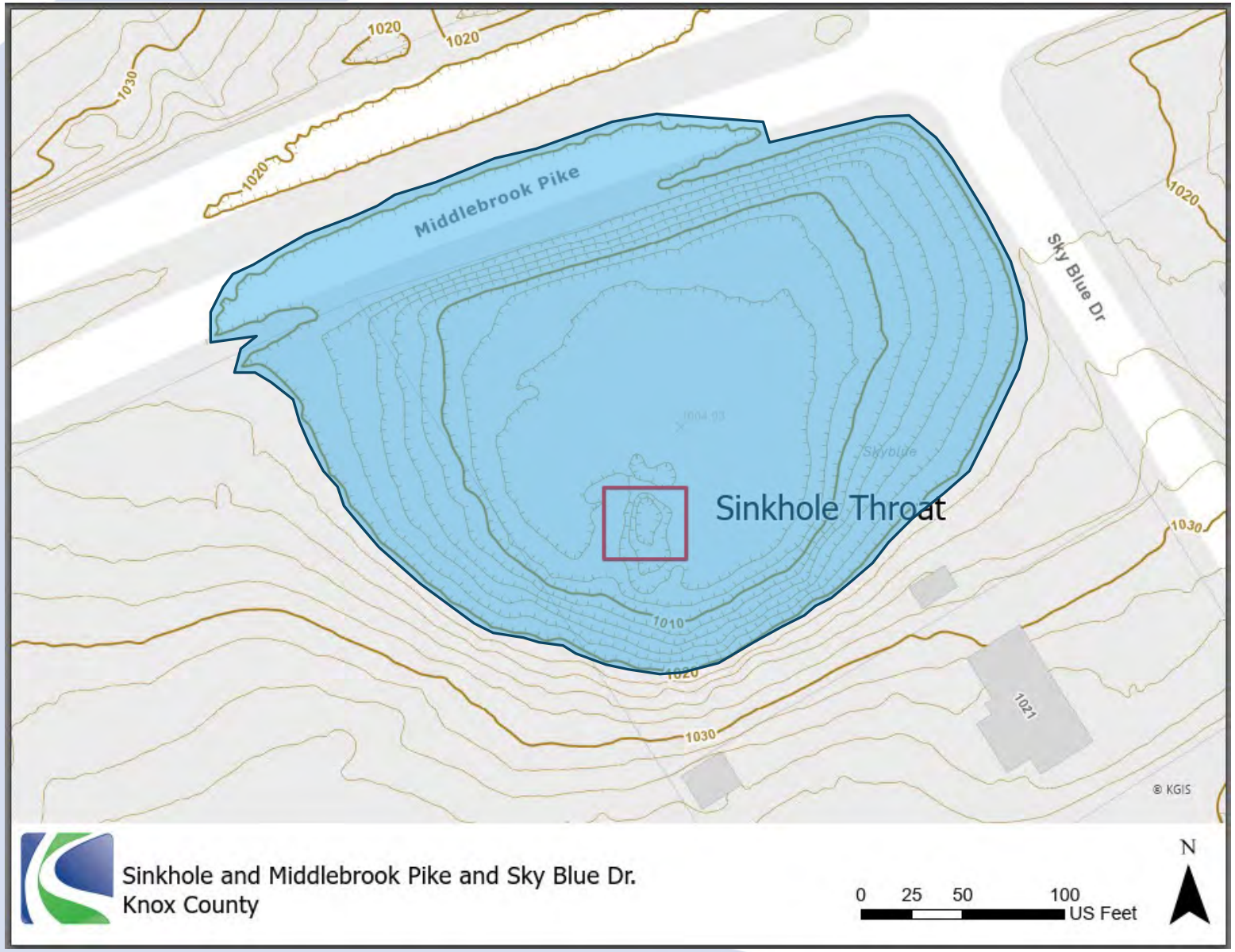


Sinkhole Overflow Elevation – **Sinkhole Cluster**



Sinkhole Protections

- No excavating, filling, or obstructing without prior County approval
  - Geotechnical and other studies may be required
- Encouragement to limit impervious surfaces and use Better Site Design to reduce stormwater runoff
- MFE ≥ 1 foot above **sinkhole overflow elevation**
- No explosives within 50 ft building set back from uppermost contour
- No dumping or discharges into sinkholes other than stormwater
- Closed depressions and drainage easements must be platted



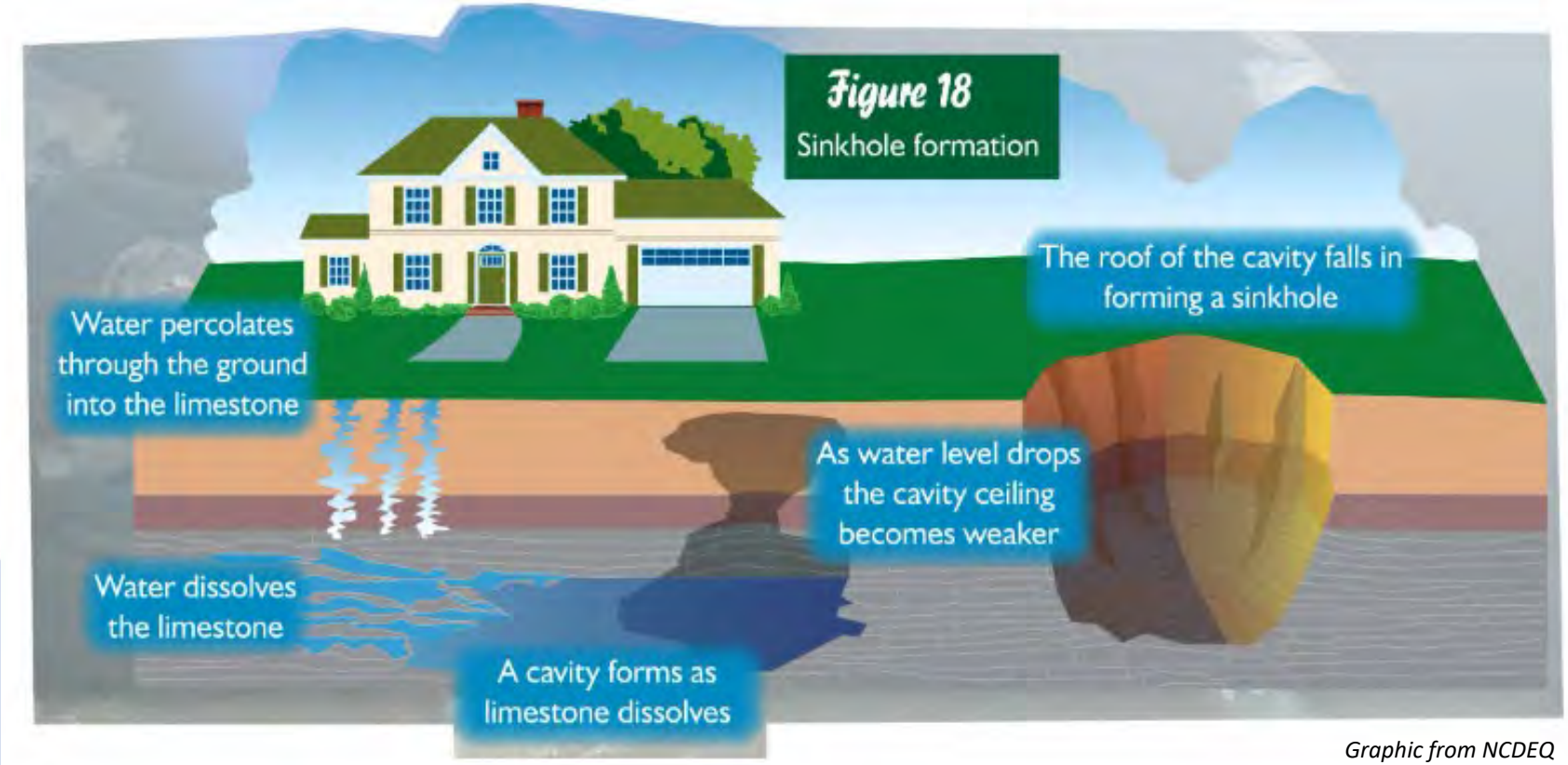
Sinkhole Easements

- 5 ft outside uppermost closed contour and encompassing entire sinkhole
- Easement shown on the plat
- No land disturbing activities in the easement
- Protect from erosion and sediment discharges to preserve storage capacity and protect the throat

Requirements for Developments that Drain to Sinkholes

Knox Co. Stormwater Manual, Vol. 2, Chap. 8

- No Tier 1 and 2 SCMs, so no infiltration!



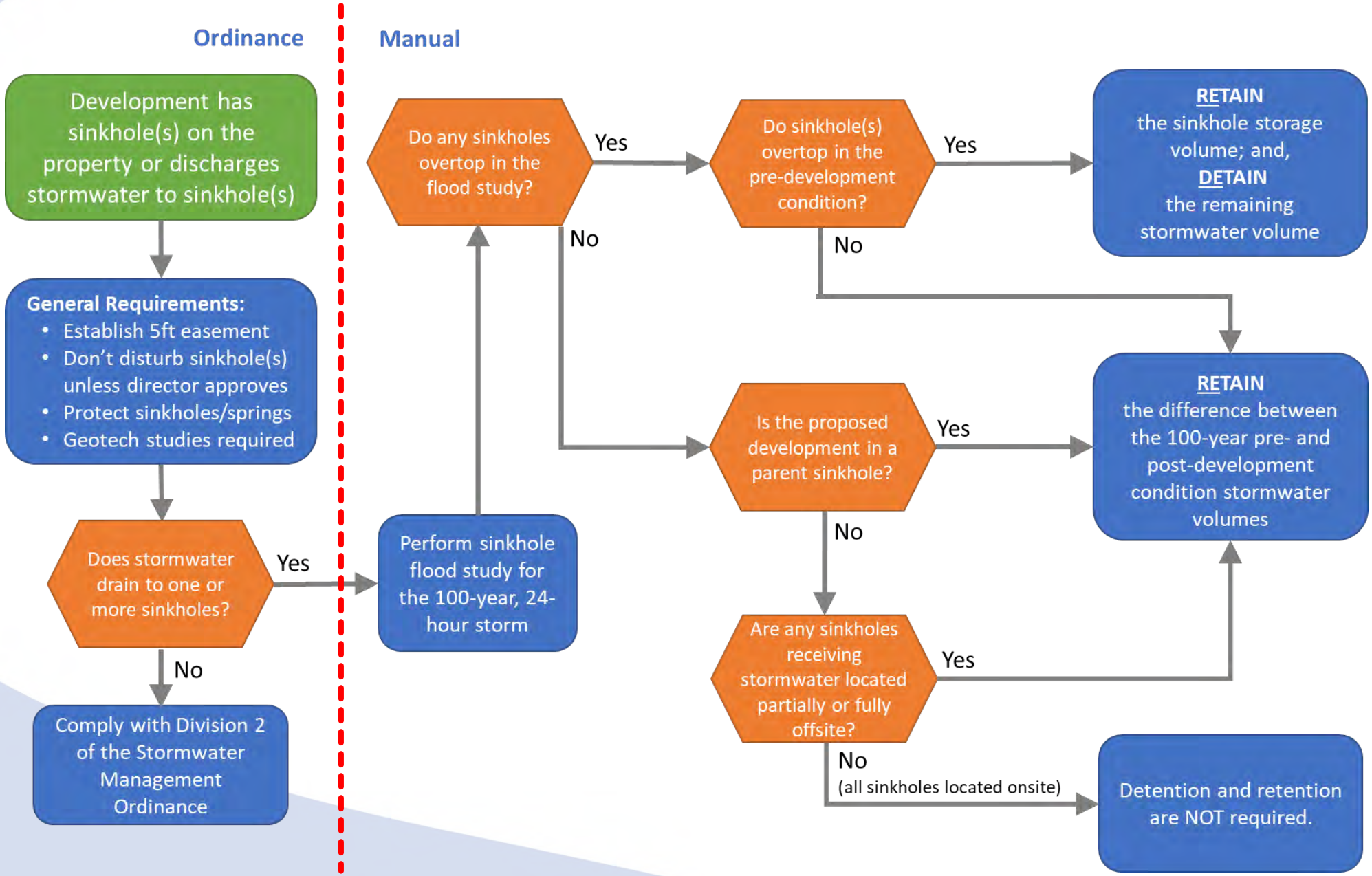
Graphic from NCDEQ

Requirements for Developments that Drain to Sinkholes

Knox Co. Stormwater Manual, Vol. 2, Chap. 8

- No Tier 1 and 2 SCMs, so no infiltration!
- If stormwater will drain to a sinkhole, perform a sinkhole "flood study"
  - If development is in a sinkhole cluster, all "parent" and "child" sinkholes must be included
  - 100-year, 24-hour storm event, Type II rainfall distribution
  - Assume closed sinkhole throat(s)
  - Curve number:
    - New development: use NRCS methods
    - Redevelopments: CN = 60
  - Compare sinkhole capacity and runoff volume, with consideration of sinkhole overtopping in sinkhole clusters *(discharge over highest closed contour)*
  - Consider flood elevations and roadway/structure elevations

Developments that Drain to Sinkholes



Questions?

Topic 6:

Other Ordinance or Manual Changes

Other Changes

- Stormwater Manual Changes
  - Updated design guidance on infiltration practices (ex. Bioretention, infiltration trenches, etc.)
  - Channel Protection Volume changed from 1yr event to 75% of 1yr event (equal to WQV storm event)
- Updated policy standards for Rainfall IDF data –Changing to NOAA Atlas 14 for quantity and quality calculations vs the what is currently in Table 3-4 & Table 3-5.
- Impervious Areas between 10,000sqft -20,000sqft, detention and water quality maybe waived. A stormwater management plan will still be required to assess downstream infrastructure impacts. Example small 5 lot subdivision.
- As-builts required to be submitted with 90 days after post construction conversion.
- Minor changes to FEMA Floodplain Section 26-196 a. & 26-197 to 50 lots or 5 acres for base flood elevation and floodway study

Questions?

Next Steps