Managing Local Risk from Future Extreme Flooding in the Chesapeake Bay Watershed

Caveat #1

Perhaps CSN May Not Be Qualified to Opine About Flooding

Caveat # 2
Not much of this helps our tidewater friends

- Today's session primarily focuses on upland stream and riverine flooding
- Does not address impacts of rising waters in tidewater communities, such as:
  - Sea level rise
  - Higher storm surge
  - Blue sky flooding
  - Shoreline retreat, saltwater intrusion, higher water tables and ghost forests
- We hope to do a coastal plain workshop in tidewater VA in Q1 or Q2 of 2022. Anyone else interested?

Caveat No. 3: CSN needs your help in defining local adaptation strategies that work across the watershed

- How to get more precise projections for your community (MARISA tool)
- Quick reference to the August workshop
- Reference to CSN memos
- Focus on what recommendations to send up the CBP food chain in the next few months

Key themes of the session

- How much will extreme storms and design events increase in response to future climate change?
- How are we currently managing our flooding risk in our community?
- What are the most vulnerable assets in our community?
- What tools can help my community develop practical strategies to improve our resilience to future climate change?

Extreme Rainfall in Urban Watersheds: A lot of different risks to be managed

Runs off
impervious surfaces

Enters the
storm drain system

Directed to streams

So what do these numbers mean for my community?

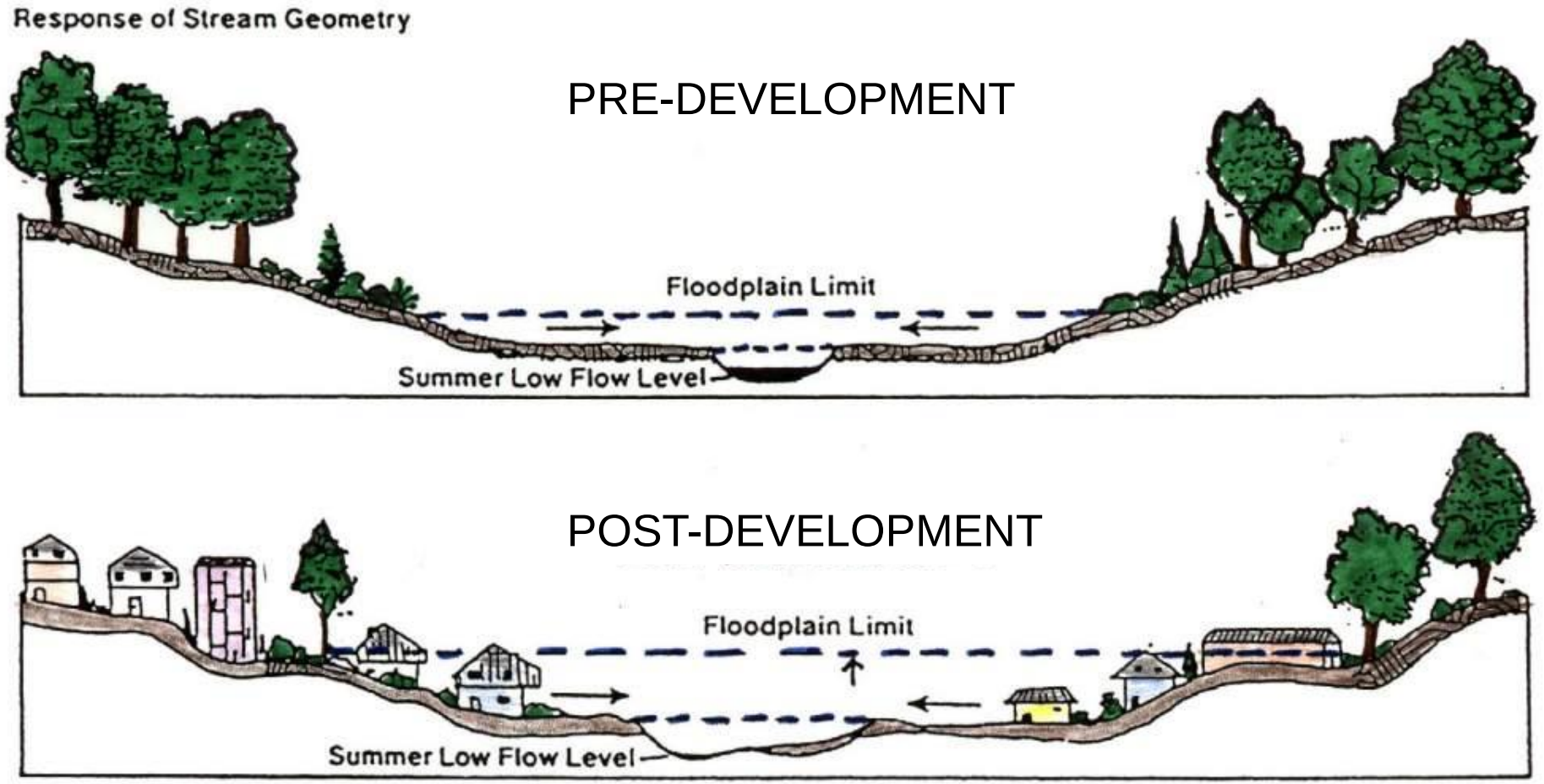
Projected Increase in Future 24 Hour Design Storms Compared to Current Storms			
City	2 Year Storm	10 Year Storm	100 Year Storm
Virginia Beach	+ 13%	+ 8%	+ 13%
Annapolis	+ 14%	+ 17%	+ 9%
Harrisburg	+ 14%	+ 16%	+ 14%
Source: MARISA as included in CSN (2021) **Your local values can be accessed from the tool, along with confidence intervals\ Median Projected Precipitation Depths (In.) for 2050-2100 (RCP 4.5)**			

Will my floods increase by 15% or more

Why it might not be so bad	Why it may be really bad
• Inadvertent detention • Under-sized pipes and culverts, • Legacy detention ponds • Over-design & free-board (+ 3') • Past floodplain management • Stream buffers Water quality BMPs • Clogged pipes and inlets • Beaver dams • stream channel incision and enlargement	• Our watersheds get harder over time -- IC in the CDA (lot IC + infill IC + soil compaction) • Floodplain insurance boundaries are based on older watershed conditions • "Pluvial" flooding • Aging patchwork of stormwater conveyance, detention and flood control built over the last century fails to provide much real flood protection

While some communities have more resiliency than they think, it may will shift the flooding risk from the bottom to the top of the watershed, where most folks may be unaware of the risk

The Stream and its Floodplain:
The hydrologic boundary vs. the insurance boundary

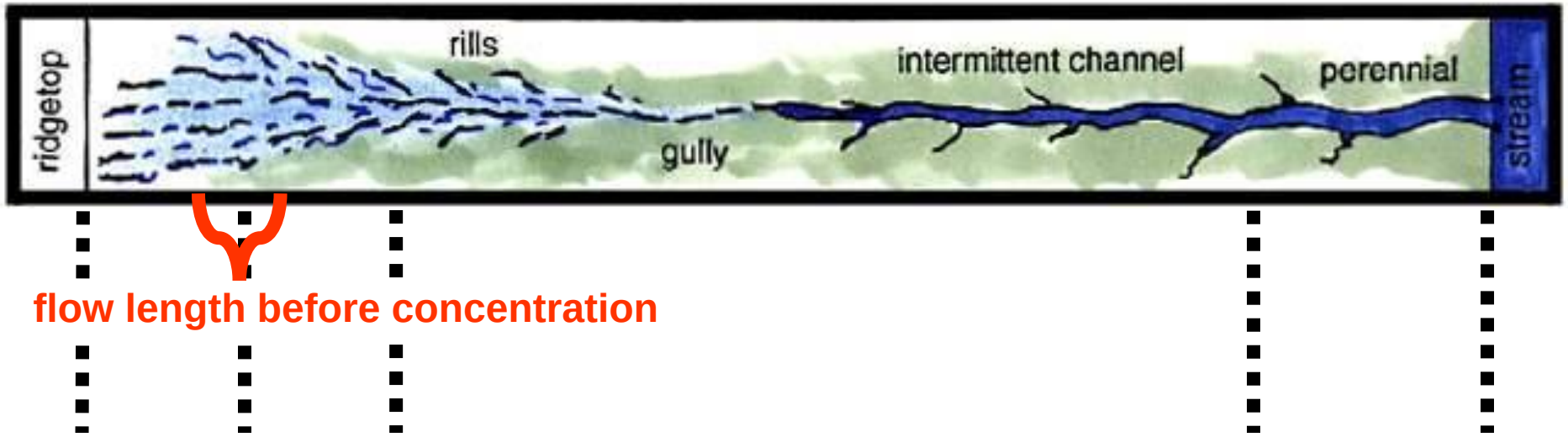


Floodplain boundaries are dynamic in space and time and are only “fixed” by engineering assumptions (i.e., the 100 year Storm Event)

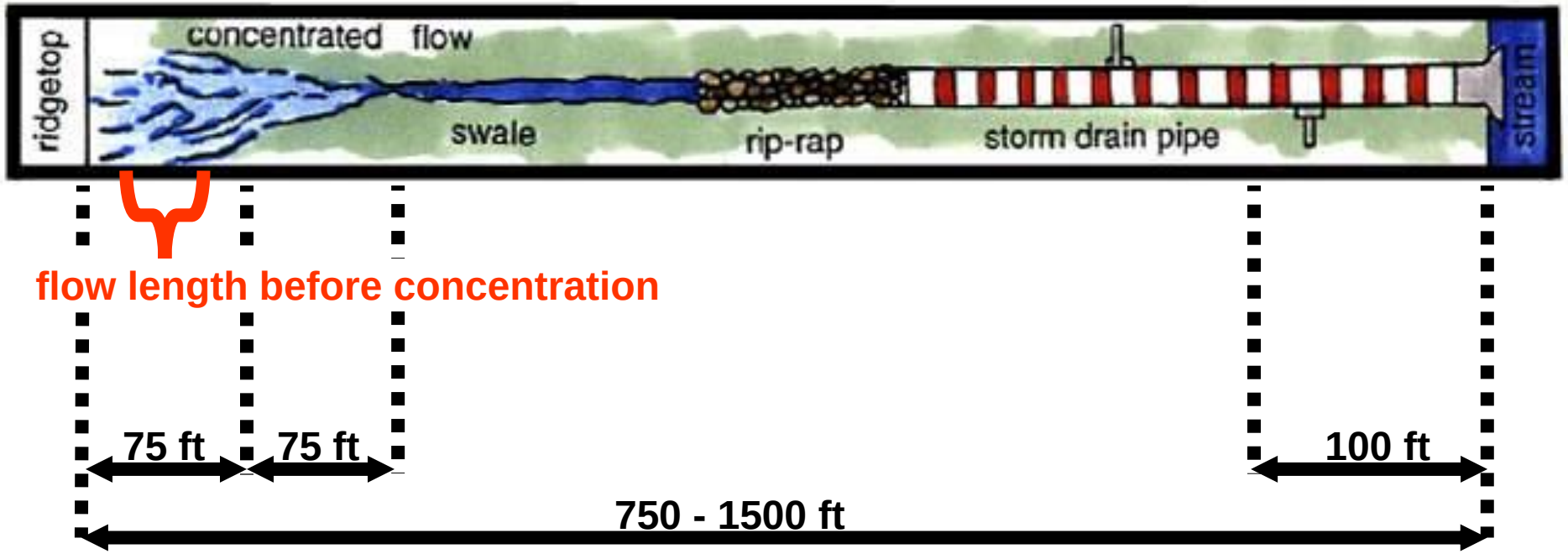
Local and FEMA Floodplain Boundaries

Type	FEMA Floodplains	Local Floodplain Regs
Triggered By:	Local Flood Mapping	Land Development/Zoning
Purpose	Flood Insurance Boundaries	Prevent Flooding Problems and Establish Buffers
Coverage	Excludes Headwaters	Include Headwaters
Defined By	Regression Equations	H & H Modeling
Use idf curves?	No	Yes
Flexibility	No, must follow national rules	Yes, based on local ordinance but may piggyback on FEMA maps (+ 2 + 3)
Updates?	Most maps are several decades old, and new studies take about a decade	Boundaries are defined by studies when development is proposed
Other Notes	Determines flood insurance rates	Often includes on-site stormwater detention requirements for flood control

predevelopment, pervious flow path



post-development, impervious flow path

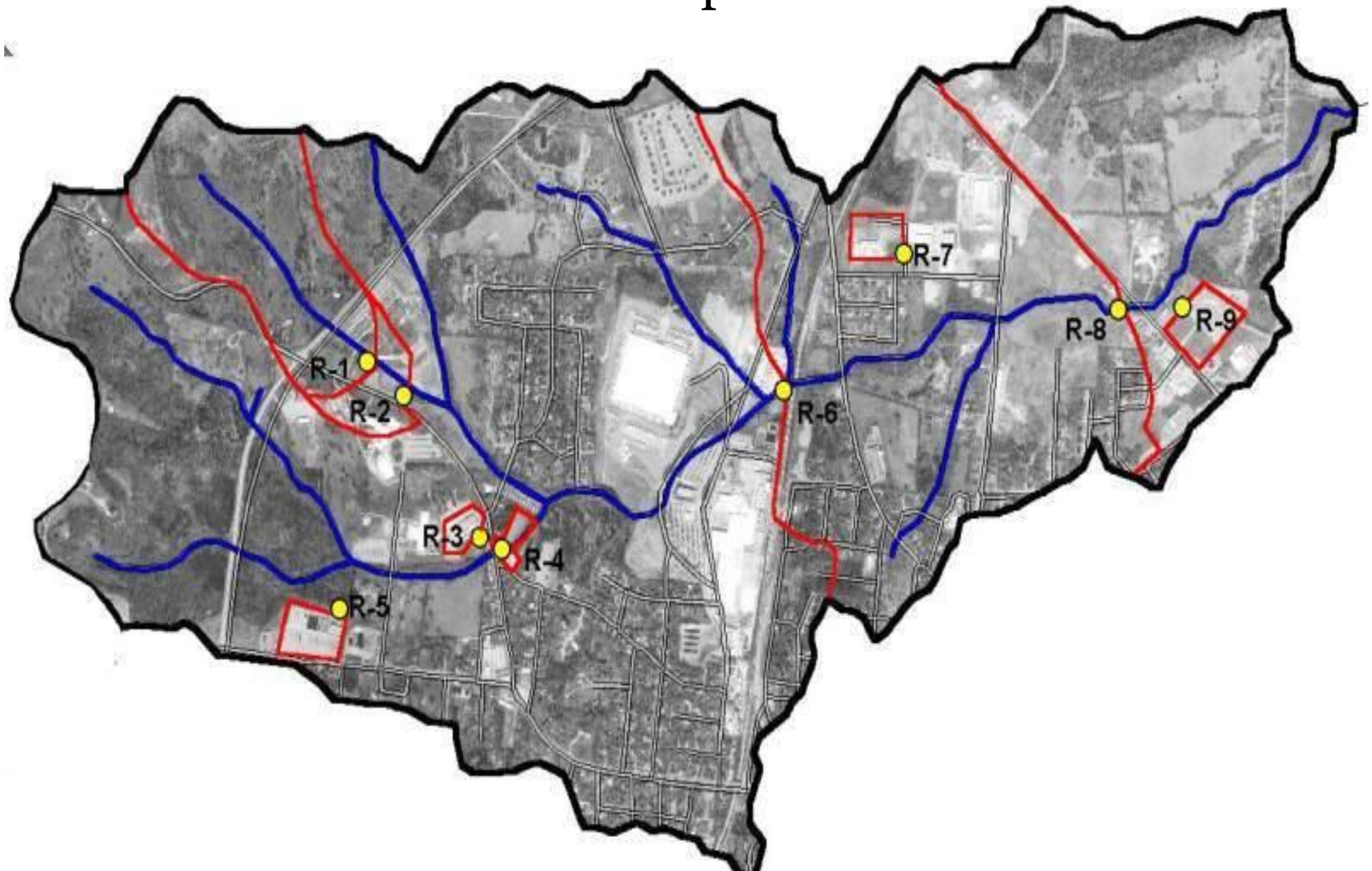


Flow in Stormwater Pipes

Pipe Diameter (in)	Max Discharge (cfs)	Max Velocity (ft/sec)	Drainage Area (est. acres)
6	1	4	0.1 to 1
12	3	6	1 to 2
24	25	10	2 to 5
36	90	12	5 to 25
48	150	14	25 to 100
60	300	18	100 to 200

For pipes flowing full with 1% slope

Which areas are in the FEMA Floodplain?



Needed: Lawyers & Money

- Floodplain insurance boundaries create a lot of real estate winners and losers
- Public and private floodplain insurance rates are rising fast:
  - Developers and re-developers push to build projects in our near-floodplain boundaries
  - Local operations are often located on or near cheap floodplain lands
- Managing more extreme storms can be extremely costly (culverts/detention)
- Much of the private pond infrastructure is owned by zombie HOAs who lack the chops and dollars to get the job done
- Most communities have some publicly owned ponds, that have a million-dollar price tag for required make-overs

New Tools for Local Watershed Planning

- 6 rapid studies tailored for small and large communities
- Panel of experts to define the methods for each community resiliency study
- Studies assess community-wide risk and more detailed investigations for individual sites

Rapid Community Vulnerability Analysis

Quick planning checkup to identify your most vulnerable:

- Neighborhoods
- Infrastructure
- Facilities
- Ponds
- BMPs
- Habitats

MVN: Most Vulnerable Neighborhoods

- 40% of U.S. urban flood damage occurs outside of FEMA boundaries
- What kind of floodplain boundaries (FEMA or otherwise) exist in my community?
- Which neighborhoods are most at risk from flooding in my community (small watershed studies; proximity to water, age of development, upstream IC, past problems, stormwater detention, etc, etc)?
- Of the neighborhoods at risk, what are their demographic and economic characteristics, and how do we prioritize equity and diversity in our risk management decisions?
- When MVN's are outside of FEMA insurance boundaries, what outreach can we do to notify residents about risks, and getting home flood insurance riders?

MVI: Most Vulnerable Infrastructure

- Water and sewer lines in the stream corridor
- Local roads, bridges and culverts
- Flood damage takes a long time and a lot of money to repair
- Roadway outfalls and road way embankments as stormwater detention ponds (Shepp retrofit)
- Other important municipal or utility infrastructure
- Rapid GIS watershed analysis to identify where MVI exists in your community and how to protect/relocate it

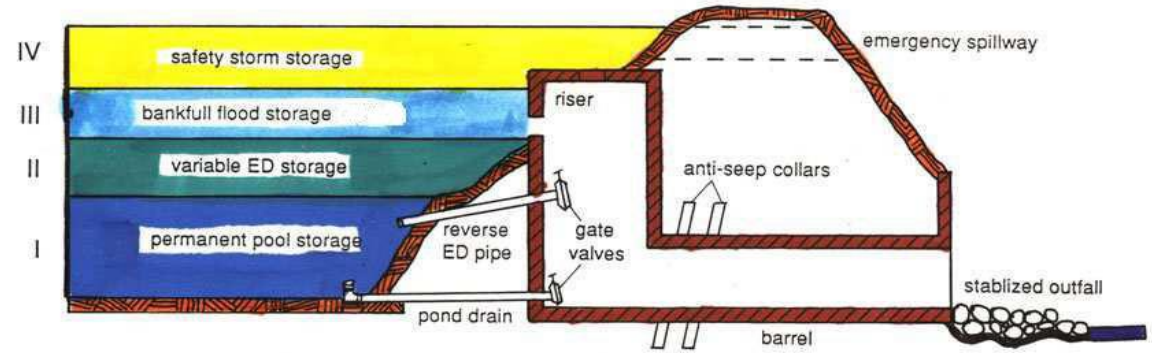
MVF: Most Vulnerable Facilities

- ID the municipal facilities at greatest risk in the stream corridor/shoreline
- Inventory of facilities subject to flooding
  - Public works yards
  - Waste-water treatment plants
  - Pumping stations
- Site-based investigations to reduce flooding and other risks to individual MVF's

MVP: Most Vulnerable Ponds

- Publicly-owned ponds vs. privately-maintained ponds vs. odd balls (e.g., farm ponds/PL-566/reservoirs)
- Older legacy ponds are near end of design life, especially due to poor construction materials and past maintenance history
- Key risk criteria
  - Dam Safety Hazard Class (640/20)
  - Era Constructed
  - Contributing Drainage Area
  - Change in CDA Since Construction (i.e. % IC)
  - Maintenance history (any inspections in last 5 years)
- Zombie HOAs lack $$$ and technical chops to do makeovers of legacy ponds
- Put together your dirty dozen list of legacy ponds

STANDARD POND SYSTEM DESIGN
CROSS-SECTION VIEW



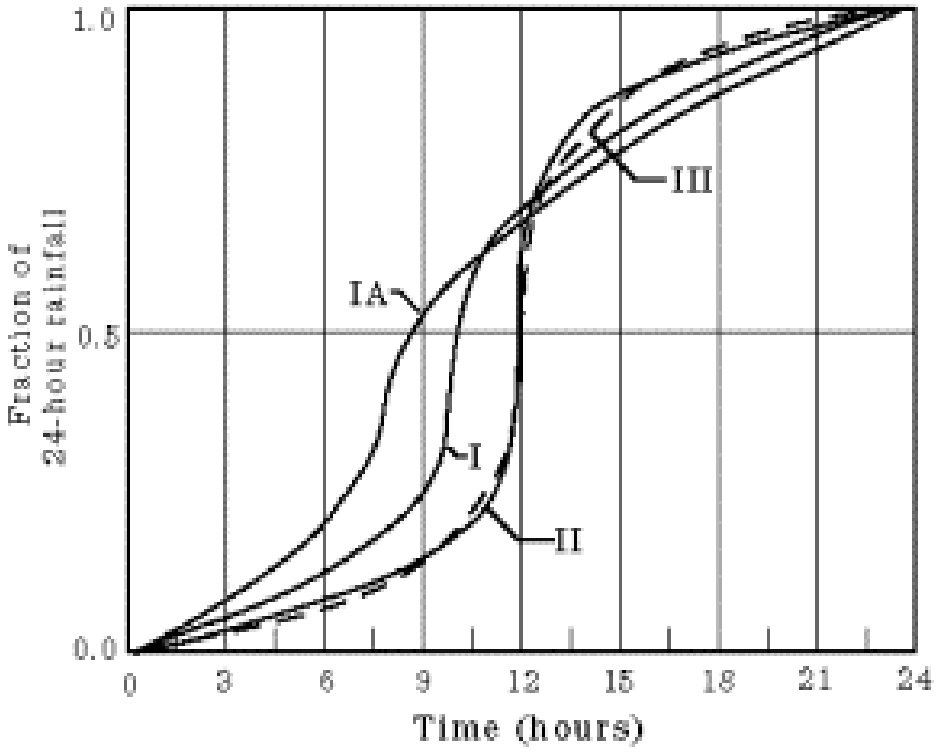
Source: Schueler, T. R. 1992. Design of Stormwater Wetland Systems. MWCOG

MVB: Most Vulnerable BMPs (non-pond)

- Reduce small drainage and homeowner erosion complaints (# 1 in DPW)
- More resilient design criteria for rooftop disconnection, sheet flow to buffer and other soft LID practices
- Updated “plumbing” criteria to manage inflows and overflows to on-line LID practices
- More stringent design criteria to boost performance and maintain longevity of practices
- Updated modeling guidance to handle extreme storms, provide a downstream “flow-way” and enable disconnection

What is the best design storm for cloud-burst events?

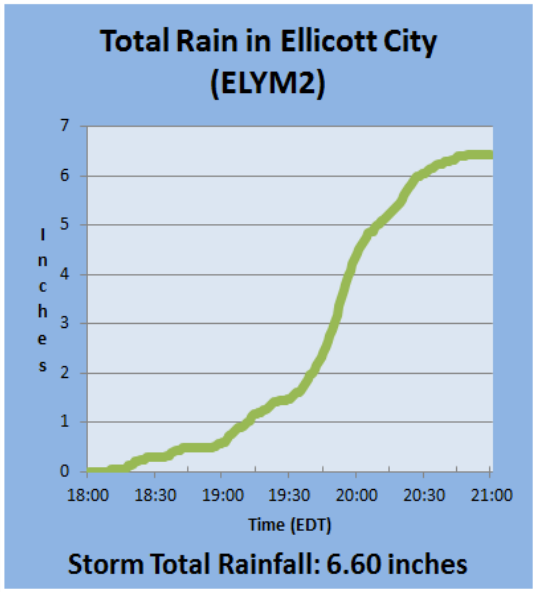
Riverine Event: NRCS Type 2, 24 hour Storm Distribution



Pluvial Event: 1 to 3 hour micro-burst event Overwhelms stormwater conveyance system

Historic Rainfall in Ellicott City, Maryland – July 30, 2016

Duration	Max Rainfall in Duration	Time of Occurrence
1 minute	0.20”	7:52pm-7:53pm
5 minutes	0.80”	7:50pm-7:55pm
10 minutes	1.44”	7:50pm-8:00pm
15 minutes	2.04”	7:46pm-8:01pm
20 minutes	2.44”	7:44pm-8:04pm
30 minutes	3.20”	7:36pm-8:06pm
60 minutes	4.56”	7:30pm-8:30pm
90 minutes	5.48”	7:00pm-8:30pm
2 hours	5.96”	6:50pm-8:50pm



Information obtained from the Ellicott City (ELYM2) rain gauge.
This gauge reports in 0.04” increments.

Review of local codes, ordinance and stormwater regulations to reduce the vulnerability of future new and redevelopment projects in our community

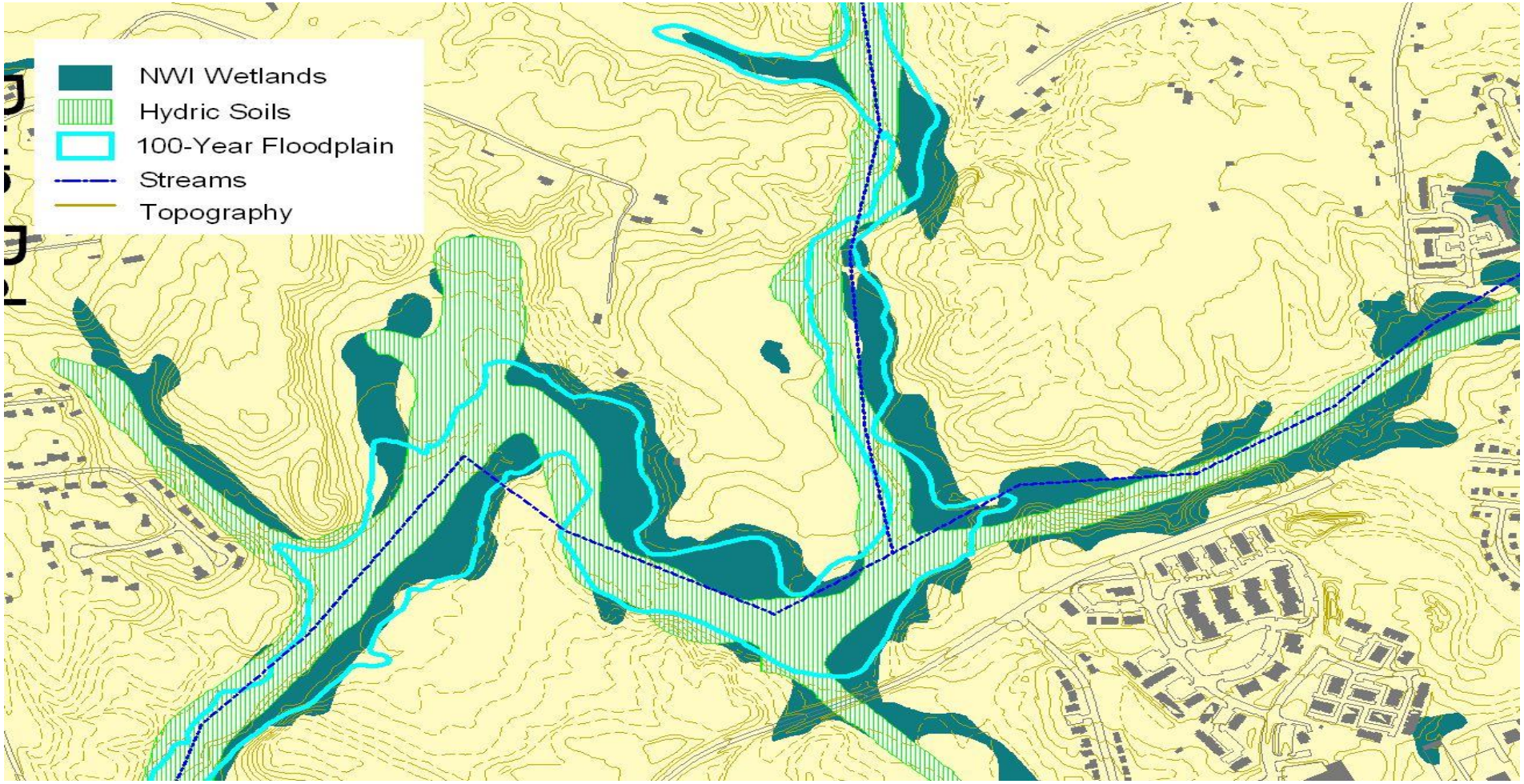
- What local stormwater modeling and design criteria are needed to improve the resiliency of local development projects going forward?
- How far back should we shift buffer, floodplain and shoreline boundaries to prevent future problems?
- How should we manage the stream corridor to retain floodwaters and provide ecological services

MVH: Most Vulnerable Habitats

Field and GIS investigations to identify the critical MVHs in your community’

- Urban stream quality (benthic habitat, channel incision, floodplain disconnection, riparian degradation, invasive plants)
- Stream, floodplain and shoreline restoration assets *
- Greenways, trails and parks
- Natural conservation areas adjacent to the stream corridor and waterfront (streams, riparian buffers, non-tidal wetlands, conservation areas)
- Cold and cool-water watersheds
- Degraded tidal wetlands and ghost forests

Streams, wetlands, floodplains, hydric soils and forests are adapted to surface and groundwater conditions



Changes in water conditions in the stream corridor has a major influence on future vegetation and ecological services

Facilitated Discussion

- Are there any other community vulnerabilities to assess?
- Which ones should be the highest priority for local managers?
- What is the best way to get consensus on rapid and low cost assessment tools?