Hydrology and Hydraulics

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Acknowledgements

A special thanks to:

- Chris Dunnaway, City of Springfield
- Kevin Barnes, Greene County Resource Management
- Ryan Stack, Missouri Department of Natural Resources, Dam & Reservoir Safety
- Dr. Charles Patterson
Session Objectives

- What are we trying to accomplish?
- Fundamentals of hydrology and hydraulics.
- Some of the common issues.
- Review some examples and comparisons with specific consideration for the City’s Design Criteria.
Topics for Discussion

💧 Computation of Runoff
Topics for Discussion

💧 Culverts
Topics for Discussion

💧 Detention
Topics for Discussion

💧 Storm sewers
Topics for Discussion

💧 Inlets
Topics for Discussion

💧 Open Channels
Topics for Discussion

💧 Sinkholes
Topics for Discussion

💧 Rules of Thumb
Hydrology

- The study of the occurrence and movement of water (Chow 1959).
- Why are we interested in stormwater?
Hydrologic Analysis and Hydraulic Design

- Estimate runoff:
  - Design of improvements, bridges, lakes, storm sewers, etc.
  - Water quality.
  - Determine flood risk for a location.
  - Determine where to locate improvements.
  - Replicate an observed event.

- Note: We are working with estimates only...
  Models, by definition, are approximations of reality!
A Little Background...

- January 1978 - August 2016, Missouri had 46,073 flood insurance claims totaling over $727 billion (Floodsmart.gov).
- Nationwide flood insurance claims exceeded $53 trillion for the same time period.
- Flash flooding is the leading cause of weather-related deaths in the U.S.- approximately 200 deaths per year (CDC).
- Over 50% of flood-related drownings are vehicle-related.
Stormwater Criteria

- Primary obligation to protect the public.
- Jurisdictions establish minimum design criteria to provide improvements with an acceptable level of risk for the public.
- Keep in mind that an accumulation of minimums will most likely result in a substandard design.
We don’t want to have to appear here!
Missouri Water Law

- Rule of reasonable use.
- “Reasonable” to be determined by courts on a case by case basis.

Three basic tenets:
- Was the alteration to the drainage required to utilize the property?
- Were reasonable efforts made to mitigate the impacts?
- Does the utility of the alteration outweigh the potential harm?
Hydrology is probability based

- What is probability?
- Statistics allows one to make decisions about a population of items, in this case rainfall/runoff events, based upon a representative sample.
- Based on an acceptable level of risk. The Annual Exceedance Probability (AEP) is the likelihood a flowrate will be equaled or exceeded in any given year, $1/\text{Recurrence Interval}$. 
Factor of Safety

- Hydrology is risk based.
- We select AEP’s based on allowable risk.
- Selection of difficult to measure analysis parameters allows one to add an additional factor of safety.
- For example: time of concentration, curve numbers, impervious area.
What is conservative with respect to hydrology?

- Higher peak discharges?
- Higher volume?
- What about situations that involve storage?
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“Must Have” References

- Open Channel Hydraulics, Chow
- Handbook of Hydraulics, Brater & King
- Applied Hydrology, Chow, Maidment, Mays
- NEH-4, National Engineering Handbook, Chapter 4, Hydrology, NRCS
- HDS-5, Hydraulic Design of Highway Culverts, FHWA
- HEC-22, Urban Drainage Design Manual, FHWA
- TR-55, Urban Hydrology for Small Watersheds, NRCS
- HEC-HMS and HEC-RAS Manuals, U.S. Army Corps of Engineers
Suggested Public Domain Software

- Federal Highway Administration:
  - Hydraulic Toolbox
  - HY-8

- U.S. Army Corps of Engineers:
  - HEC-RAS
  - HEC-HMS
  - HEC-1

- U.S. Geological Survey
  - National Stream Statistics