Downstream Assessments

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Council of Governments

Agenda

10 min: **Purpose and Conceptual Discussion**

5 min: **Effort required**

25 min: **How to perform and review DS Assessments**

15 min: **Examples**

5 min: **Conclusions**

Q&A

Purpose and Conceptual Discussion

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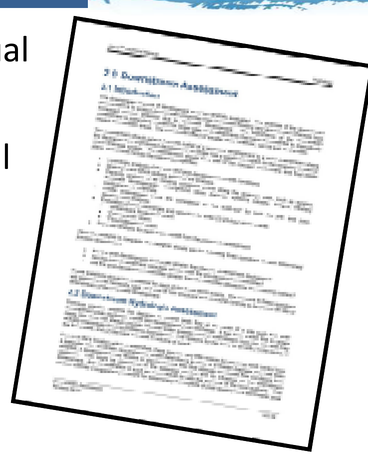
Downstream Assessment in iSWM

- Section 3.3 of 2010 Criteria Manual
- Section 2.0 of Hydrology Technical Manual



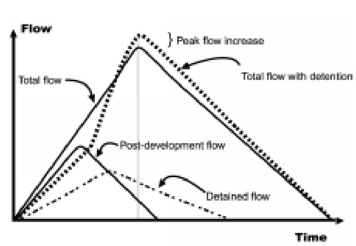


Figure 2.1 Detention Timing Example

iswm.nctcog.org

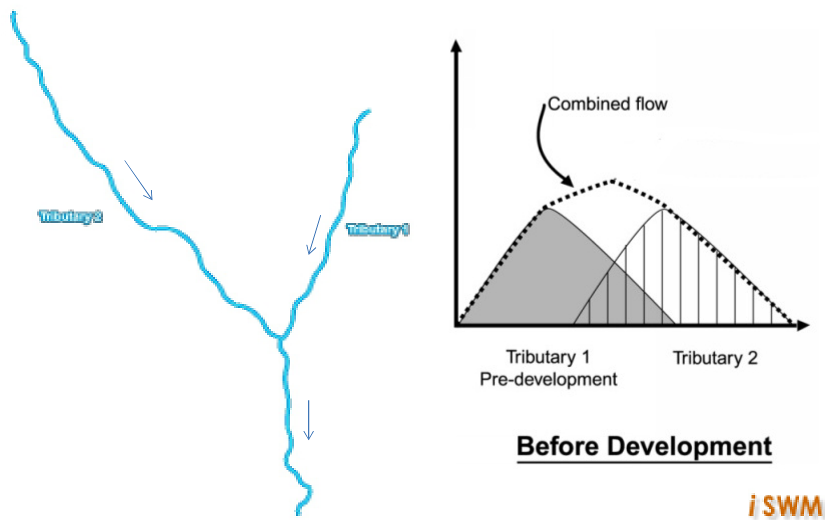
Purpose of a Downstream Assessment

- Protect downstream properties from flood or velocity increases caused by upstream development
- Provide defensible evidence that a proposed development does not impact downstream properties
- **Potentially eliminate the need for detaining increased runoff caused by development**
- Make better informed decisions – win-win for all involved parties

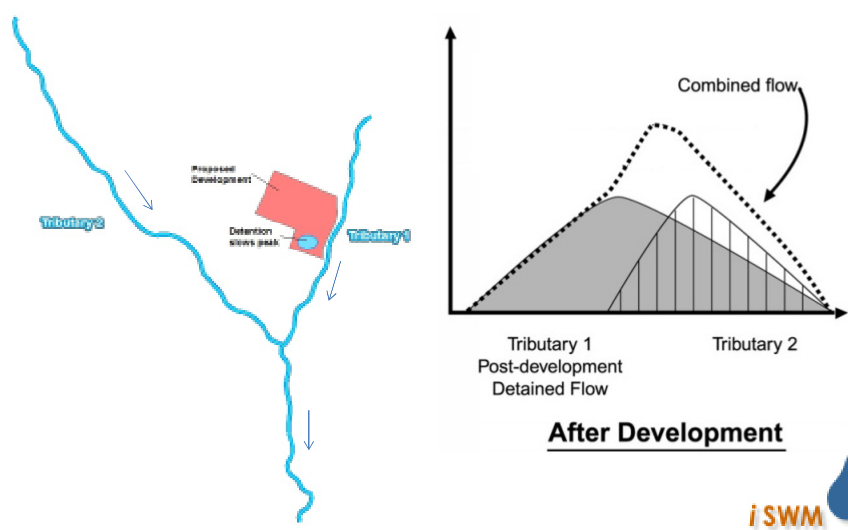
Changes in Detention Philosophy

- Old philosophy
  - Detain on-site flows to the 100-year existing peak flow
- iSWM philosophy
  - Maintain pre-development peak flows throughout the system zone of influence.
  - Maintain non-erosive velocities
  - Detention is not always helpful

Pre-Development Hydrograph

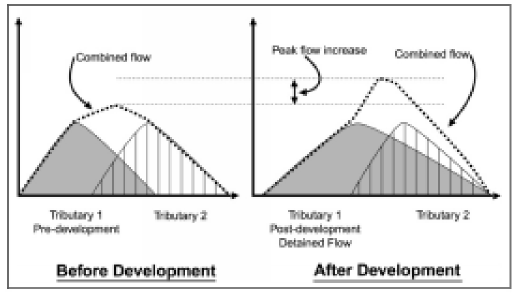


Post-Development Hydrograph



Hydrograph comparison

- By detaining the additional flow on Trib 1, the tributaries peak closer together.
- Detention on Trib 1 actually causes an *increase* in peak at the confluence



Conceptual Discussion

- Changes in philosophy provide more options for design, leading to better decisions
  - No increases downstream, no action required
  - If there are increases, more options provided
    - On-site detention (better design of ponds because timing has been addressed)
    - Downstream improvements
    - Regional detention
    - Easement acquisition

Effort Required to Complete DS Assessment

- On Average, approximately 40 hours of design engineers time plus QC
- Costs typically range from $2,000-$10,000
- Costs are lower if a detailed hydrologic model is available for the receiving stream
- Many variables involved that are site specific.

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How to Perform a Downstream Assessment

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Steps to perform a Downstream Assessment

1. Determine downstream limit of assessment
2. Data Collection
3. Hydrologic Analysis
4. Determine action required

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Determine the downstream limit of assessment

STEP 1

Two methods:

1. *Adequate Outfall:* Location of an acceptable outfall that does not create adverse flooding or erosion conditions downstream
2. *Zone of Influence:* A point downstream where proposed development no longer has significant impact on receiving stream.

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Determine the downstream limit of assessment

STEP 1

- An *adequate outfall* is adoptee defined and can be:
  - *FEMA floodplain*
  - *Existing system designed for ultimate conditions*
  - *Defined natural channel*
  - *Waters of the U.S.*

KEY: An *adequate outfall* does not create adverse flooding or erosion conditions downstream

Determine the downstream limit of assessment

STEP 1

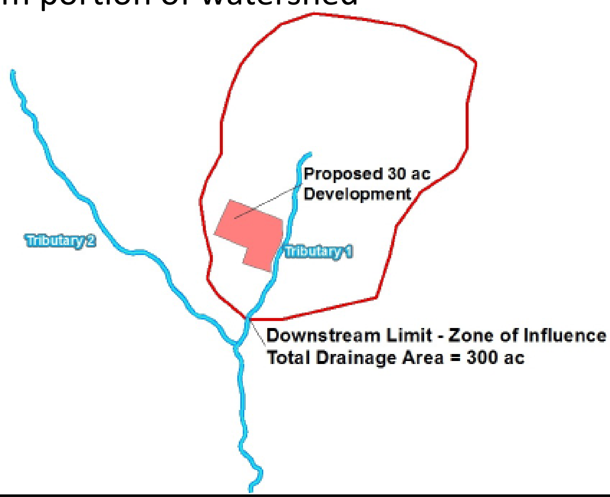
How to find the *Zone of Influence:*

- 10% Rule: Point on the receiving stream where the drainage area controlled by detention comprises only 10% of total drainage area.
- **Important:** 10% rule is an estimate – true extent of analysis determined in Step 3

Determine the downstream limit of assessment

STEP 1

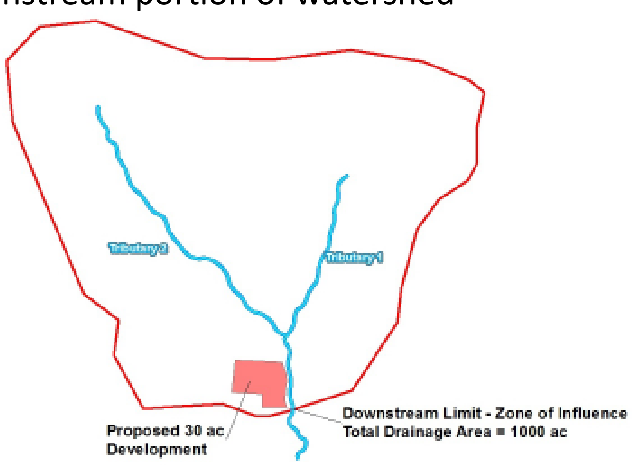
Zone of Influence Example 1 – development in upstream portion of watershed



Determine the downstream limit of assessment

STEP 1

Zone of Influence Example 2 – development in downstream portion of watershed



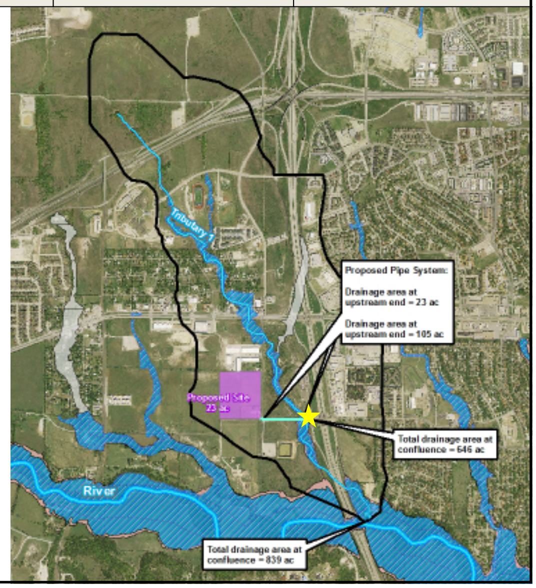
Determine the downstream limit of assessment

STEP 1

Determine the zone of influence

- Proposed site is 23 acres located downstream in watershed
- 10% rule requires to look at a minimum of 230 acres of drainage area

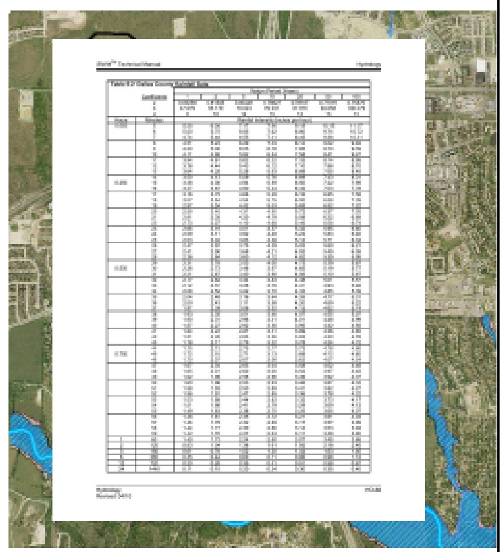
Downstream Assessment required to evaluate impacts to confluence with Stream 1.



Data Collection

STEP 2

- Aerial Photography
- Stream Centerline
- Topographic data
  - Contours or Lidar Data
- Soil Data
- Plans for Existing Infrastructure
- Future Land Use
  - Downstream assessment based on **ULTIMATE** watershed conditions
- FEMA Floodplains (DFIRM)
- Rainfall Data
  - Chapter 5 of Hydrology Technical Manual
- Existing models



Data Collection

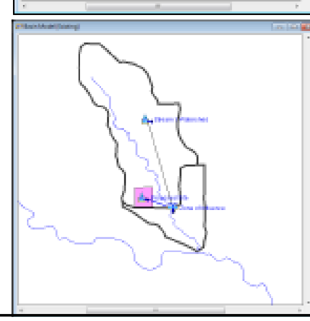
STEP 2

- If downstream system designed for ultimate conditions, no further analysis required
- Develop memorandum stating proof that downstream has capacity for *fully developed* Q and V
- If downstream does not have capacity, continue to Step 3

Hydrologic Analysis

STEP 3

- Hydrologic Analysis involves two components:
  - Watershed hydrology
  - Site hydrology
- If hydrologic model is available for the watershed, engineer must modify to accommodate specific basin conditions for proposed site

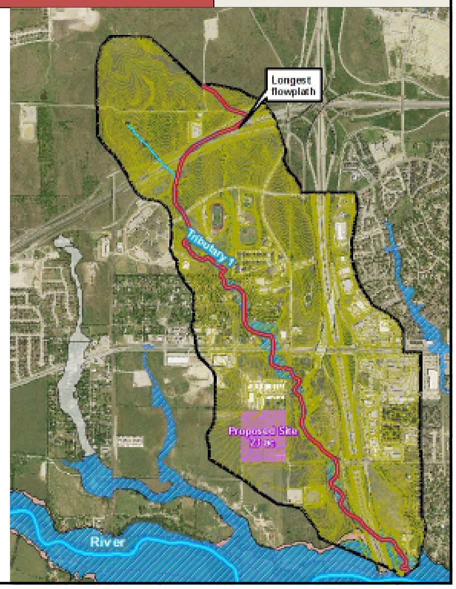


Hydrologic Analysis

STEP 3

If no model available,

- Calculate fully developed basin data for **watershed**:
  - Curve numbers – *Table 1.9 of Hydrology Technical Manual*
    - **Future** Land Use
    - Soil
    - Drainage Areas
  - Time of concentration- *Section 1.3.6 of Hydrology Technical Manual*
    - Topography, land use



Hydrologic Analysis

STEP 3

- Calculate basin data for **proposed development**:
  - Time of Concentration
  - Curve Number
  - Outfall characteristics

- **Most important component of DS assessment is an accurate representation of change in hydrology from existing to proposed conditions**

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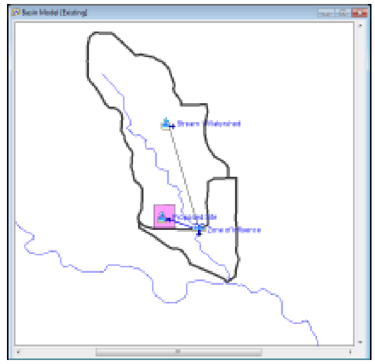
Hydrologic Analysis

STEP 3

EXISTING CONDITIONS MODEL:

Develop a simple hydrologic model (HEC-HMS) to represent existing conditions

- Begin model with meteorologic data and control specifications
- Create a simple model using basins, junctions, and reaches
- Enter fully developed data for watershed
- Enter existing conditions data for proposed site



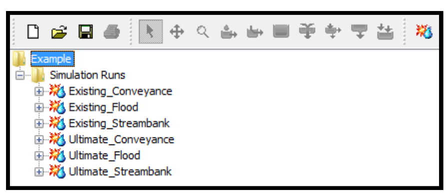
Hydrologic Analysis

STEP 3

ULTIMATE CONDITIONS MODEL:

Create copy of existing basin model

- Revise basin data for proposed site to reflect ultimate conditions
- Create simulation runs for both existing and proposed in all storm events
- Run all simulations and compare results



iSWM Storms Events:

- Streambank Protection
- Conveyance
- Flood Mitigation

Hydrologic Analysis

STEP 3

- Summary of hydrologic analysis
  - Calculate basin parameters for watershed (ultimate) and proposed site (existing and ultimate)
  - Create existing hydrologic model using:
    - Fully developed watershed
    - Existing conditions on proposed site
  - Create ultimate hydrologic model using:
    - Fully developed watershed
    - Ultimate conditions of proposed site
  - Compare results from existing to proposed

Hydrologic Analysis

STEP 3

- Compare pre/post development Q and V at downstream extent of model:
  - If:

    Post-Dev. Q > Pre-Dev. Q

    or

    Post-Dev. V > Allowable V (Table 3.2 of hydraulics technical manual)

  - Assessment must be extended further downstream to a point where no influence seen

Determine Action Required

STEP 4

Two Outcomes:

1) No increases in Q or V
   - No required action

2) Increases in Q or V
   - Must choose 1 of 3 options to mitigate impacts for *Streambank Protection* and *Flood Control*

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Determine Action Required

STEP 4

If increases found downstream, 3 options available:

1. *Document that downstream conveyance is adequate to convey post-development flows and/or velocities*
2. *Reduce WSEL and/or velocity using channel or conveyance improvements*
3. *Design on-site structural controls to maintain pre-development flows*

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Determine Action Required

STEP 4

Coordination Meeting:

- Engineer submits a memorandum to City explaining the results of assessment
- Developers/engineers meet with City to discuss results
- Preliminary site plan meeting (or sooner)
- Detention needs have significant effects on site planning. "Sooner the better"

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Downstream Assessment Examples

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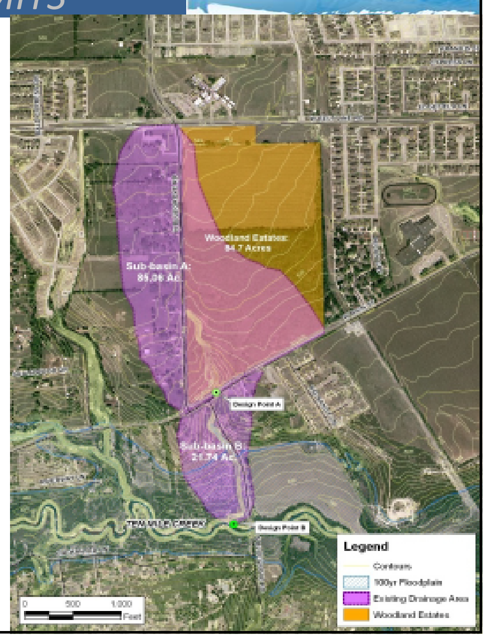
EXAMPLE A: WOODLAND ESTATES

- LARGE DEVELOPMENT
- REDIRECTING RUNOFF
- HISTORICAL FLOODING
- HYDROLOGIC MODEL AVAILABLE

Example A – Woodland Estates

STEP 1: DOWNSTREAM LIMITS

- 85 Acre site, naturally divided to East and West outfall locations
- 150 acre proposed drainage area to limit of assessment
- Design point A – Culvert at West Main Street (128 acres)
- Design point B – Ten Mile Creek confluence (28,310 acres)



Example A – Woodland Estates

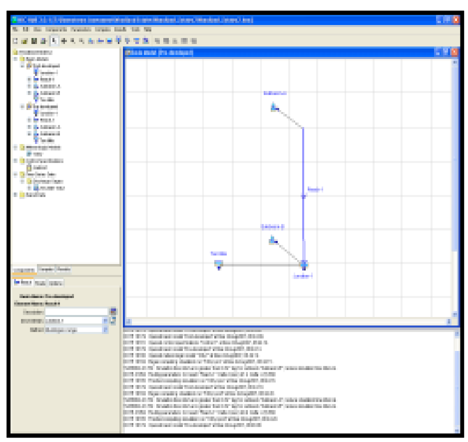
STEP 2: DATA COLLECTION

- Historical flooding reported from subdivision to the east and overtopping of W. Main Street to the west
- Based on historical flooding, developer proposed to direct all site flow to West Main St. culvert

Example A – Woodland Estates

STEP 3: HYDROLOGIC ANALYSIS

- Two sub-basins delineated
- Unit hydrograph model for existing and proposed created in HEC-HMS
- Hydrologic model of Ten Mile Creek at the point of confluence was obtained from Storm Water Master Plan



Example A – Woodland Estates

STEP 4: DETERMINE ACTION REQUIRED

- Discuss results of modeling

Hydrologic Element	Pre-Developed Drainage Area (mi2)	100yr Pre-Development Peak Discharge (cfs)	Post-Developed Drainage Area (mi2)	100yr Post-Development Peak Discharge (cfs)	Increase in Area (acres)	Increase in Discharge (cfs)
Sub-basin-A: Design Pt. A	0.1329	382.81	0.1997	695.15	42.8	312.34
Reach-1	0.1329	380.90	0.1997	693.91	42.8	313.01
Subbasin-B	0.0339	104.34	0.0339	104.34	0.0	0.00
Ten Mile	44.0000	36499.48	44.0000	36499.48	0.0	0.00
Junction-1: Design Pt. B	44.1668	36550.01	44.2336	36588.91	42.8	38.90

DETERMINED SOLUTION:

- **On-site detention required**
- **Potential joint City/Developer improvements to tributary upstream of Ten Mile Creek.**

EXAMPLE B:
DRILLING PAD SITE

- SMALL DEVELOPMENT
- NO HYDROLOGIC MODEL AVAILABLE

Example B – DRILLING PAD SITE
STEP 1-2: DOWNSTREAM LIMITS

- 2.1 acre site – discharges directly into an oxbow of the West Fork Trinity River
- Entire watershed is 545 acres
- Site is less than 10% of watershed, therefore;
- Point of interest is where site outfalls to the oxbow

Example B – DRILLING PAD SITE
STEP 3: HYDROLOGIC ANALYSIS

- Unit hydrograph model created in HEC-HMS to represent existing and proposed conditions.

Basin	Existing Tc	Existing CN	Developed T_c	Developed CN
5C	5.51	69	1.05	85
5D	5.58	69	1.21	85

Example B – DRILLING PAD SITE
STEP 4: DETERMINE ACTION REQUIRED

- Results of modeling
  - Site discharges decreased by 1.0 cfs after impervious site additions
  - Existing flow at oxbow discharge = 3,195.7 cfs
  - Proposed flow at oxbow discharge = 3,194.7 cfs

DETERMINED SOLUTION: No Detention Required

EXAMPLE C: MIXED USE DEVELOPMENT

- SMALL DEVELOPMENT
- TWO DISCHARGE LOCATIONS
- NO HYDROLOGIC MODEL AVAILABLE

Example C – Mixed Use Development

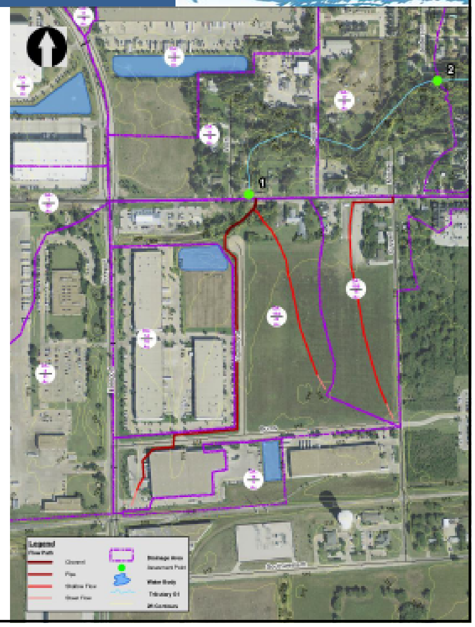
STEPS 1-2: DOWNSTREAM LIMITS AND DATA COLLECTION

Downstream Limits

- Development within 780 acre watershed that discharges into Trib G-1
- Site is less than 10% of watershed
- Extent of study at discharge point(s) of the system

Data Collection

- Gathered data for entire watershed
- Determined that site has two discharge locations



Example C – Mixed Use Development

STEP 3: HYDROLOGIC ANALYSIS

- Unit hydrograph model for existing and ultimate site conditions created in HEC-HMS

	Existing Tc (min)	Developed Tc (min)	Existing CN	Developed CN
15A	28.99	14.42	87	90
15B	34.81	10.49	84	89

Example C – Mixed Use Development
STEP 4: DETERMINE ACTION REQUIRED

- Results of modeling
  - Discharge at Design Point 1 decrease by 49 cfs
    - Existing Flow = 1,913 cfs
    - Proposed Flow = 1,864 cfs
  - Discharge at Design Point 2 decrease by 48 cfs
    - Existing flow = 2,927 cfs
    - Proposed flow = 2,879 cfs

DETERMINED SOLUTION: No Detention Required

Conclusions

- Four steps to perform assessment:
  - Determine the downstream limit of assessment
  - Data Collection
  - Hydrologic Analysis
  - Determine action required
- Detention is *not always* required!

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QUESTIONS?

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