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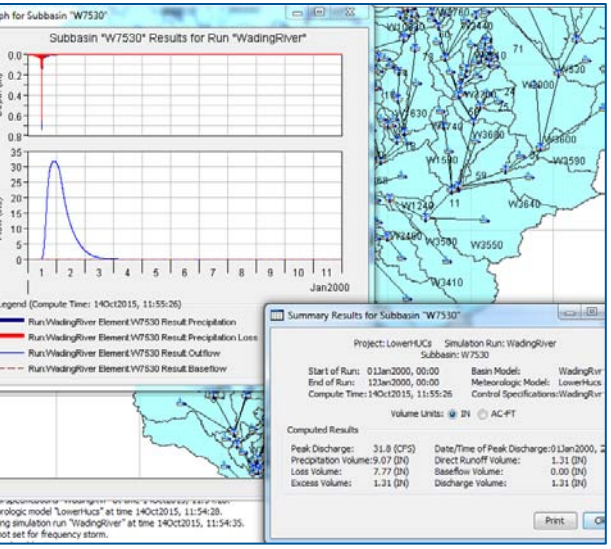

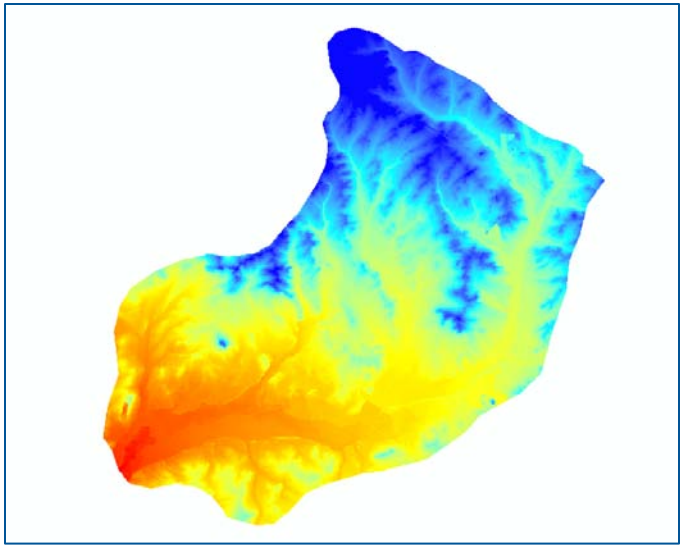

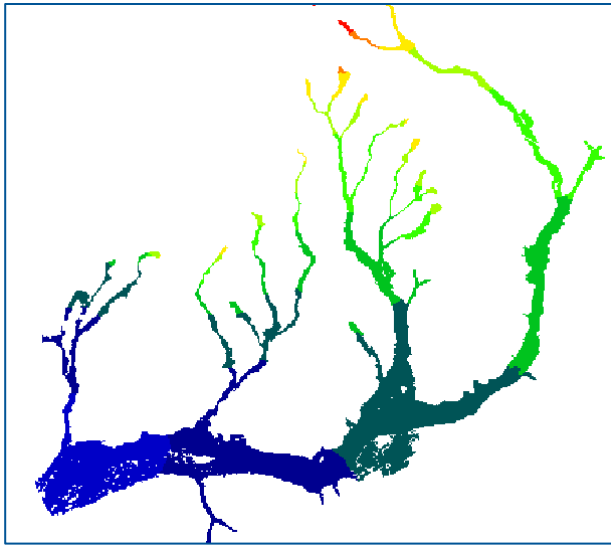

Integrating HEC HMS generated flow hydrographs with FLO-2D

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Focus of this Presentation

- Introduction
- Methodology
- Challenges & Solutions
- Cost Effectiveness
- Conclusion
- Q & A

Introduction

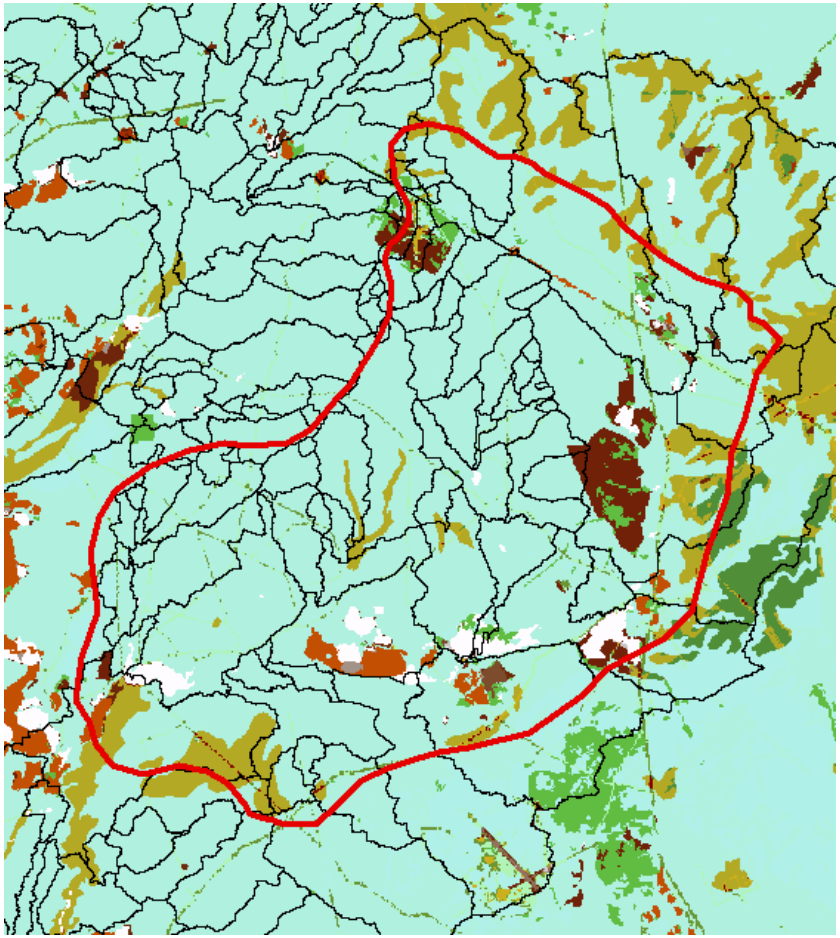
- Study Area – New Jersey
  - 420 Sq. Mi., 320 miles of study scope
  - Northern portion of study area - Moderate to Steep slope
  - Southern portion – Flat terrain
  - 2D model proposed to accommodate wide floodplains
  - 3 HMS models and 20 FLO-2D models
- Selection of Hydrology Method
  - Regression Analysis
    - Constant Hydrograph
  - FLO-2D
    - Rain on Grid approach - Not approved for Hydrology by FEMA yet.

Introduction

- Selection of Hydrology Method
  - Rainfall –Runoff Model
    - Adequately produces stream flow hydrographs that represent the physical characteristics of the watershed
    - Applicable in the areas of significant floodplain storage
    - Used HEC-HMS version 4.0
    - Subbasin flow hydrographs

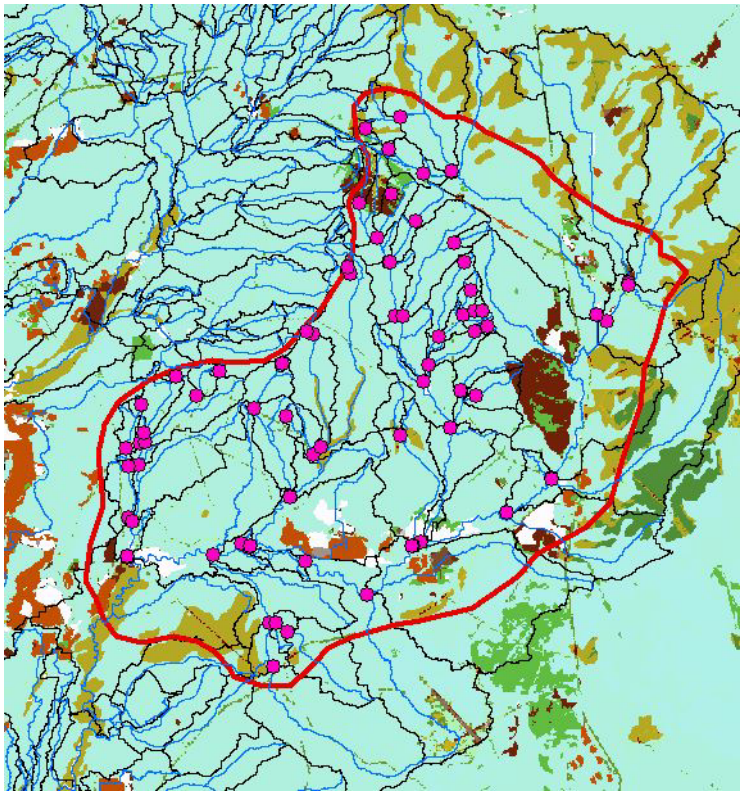
Methodology

- Hydrology
  - Watershed Delineation
    - Streams with moderate to steep slopes – USGS 10m DEM
    - Flat Streams – 2 m LiDAR
  - Precipitation
    - Frequency Storm method – NOAA Atlas 14
  - Infiltration/Loss Method
    - Curve Number from SSURGO and 2011 NLCD dataset
  - Lag Time
    - Watershed Lag method



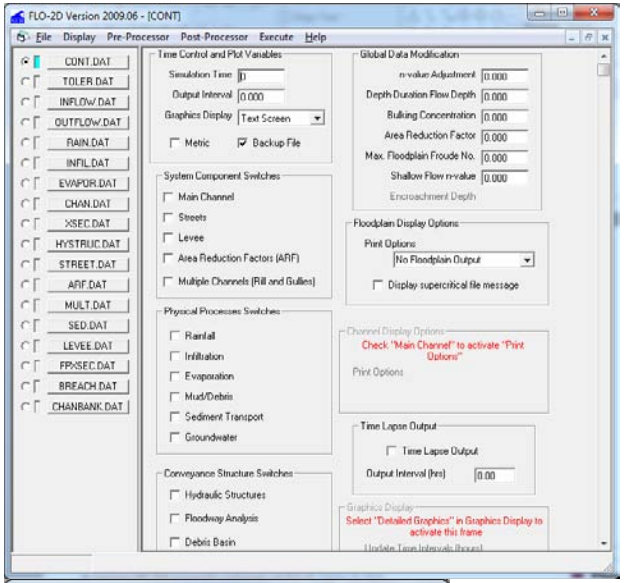
Methodology

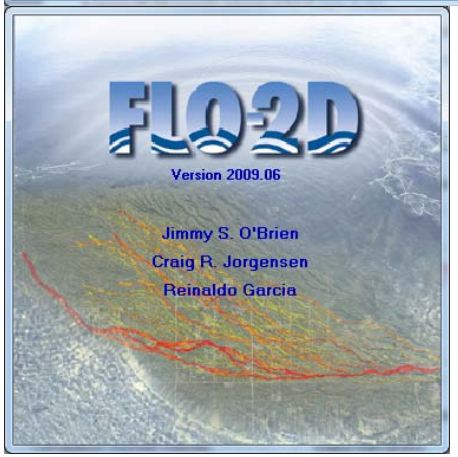
- Hydrology
  - Channel Routing
    - Attained through FLO-2D
  - Comparison
    - Regression Equation Discharges – Headwater Basins
  - Discharges
    - Hydrographs for each sub basin generated



Methodology

- Hydraulics
  - FLO-2D
    - Volume conservation flood routing model
    - Routes rainfall-runoff and flood hydrographs over unconfined flow surfaces or in channels
    - Governing equations are the continuity equation and the equation of motion
    - Moves blocks of volume around on the grid system in eight directions





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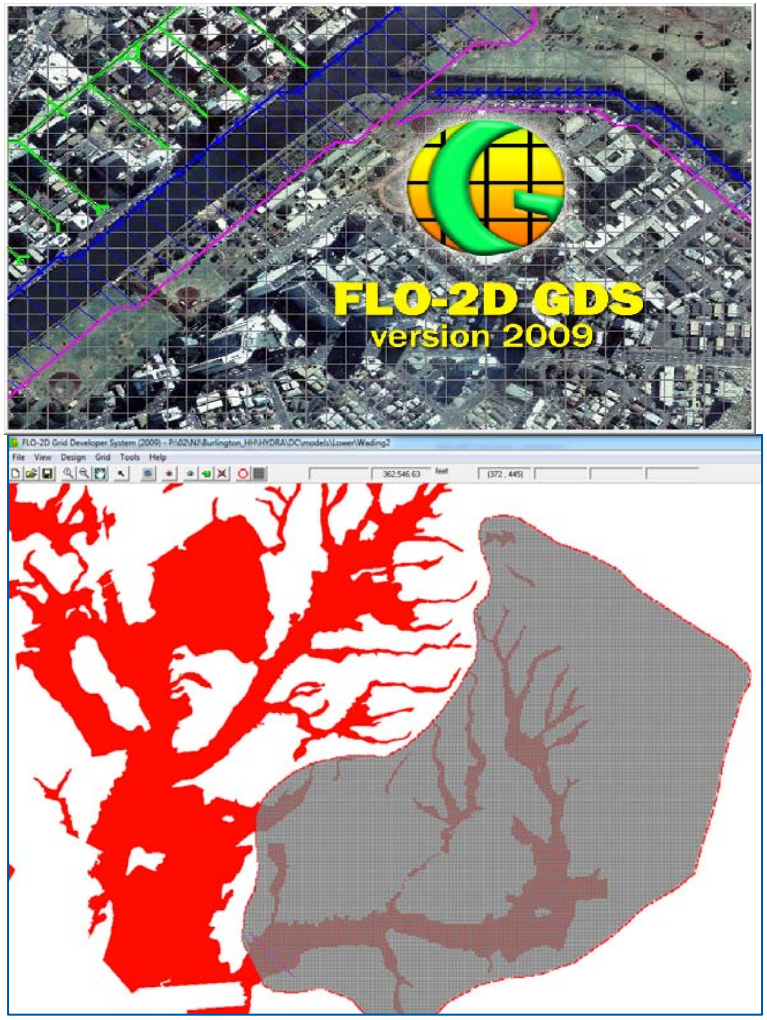
Methodology

- Hydraulics
  - FLO-2D
    - Grid Developer System (GDS)
      - Pre-processor program – Overlays the grid system on the DTM points, interpolates and assign elevations to the grid elements
      - Roughness, Inflow & Outflow nodes, Area and width reduction factors.
      - Prepares the basic input files for the FLO-2D model
      - Grid Element Size of 50 feet – 100 feet



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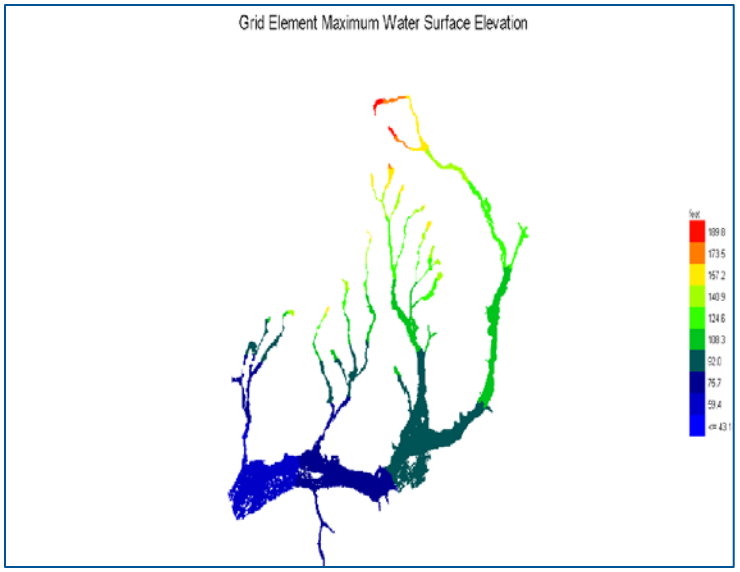
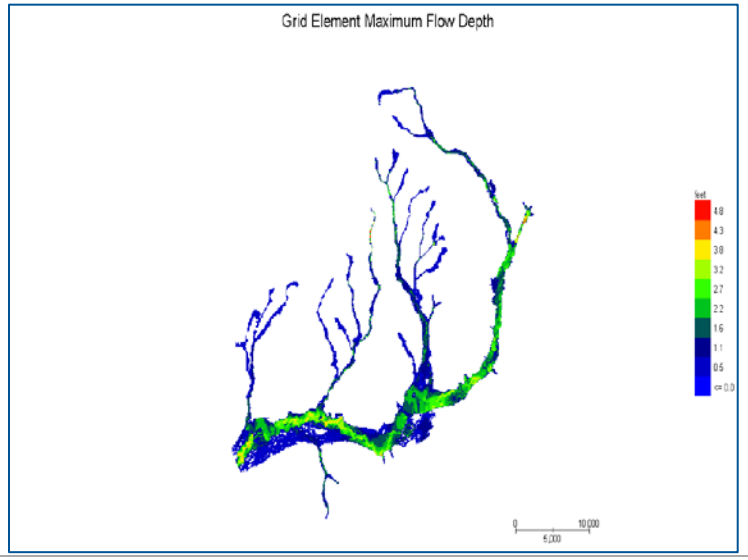
Methodology

- Hydraulics
  - FLO2D
    - MAPPER
      - Primary program for displaying results
      - Creates Ground Elevation, & Water Surface Elevation and Flood Depth maps
      - Creates an approximate Area of Inundation layer
      - Floodplain Delineation based on detailed topo data – ArcGIS methods work best





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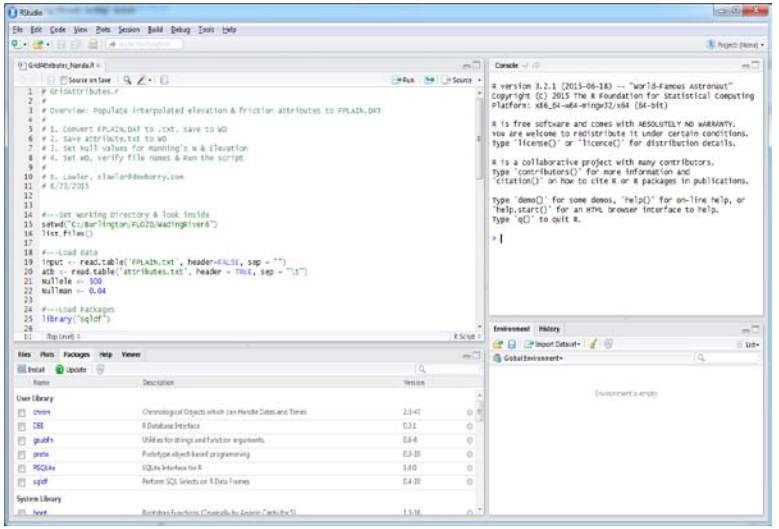
Challenges & Solutions

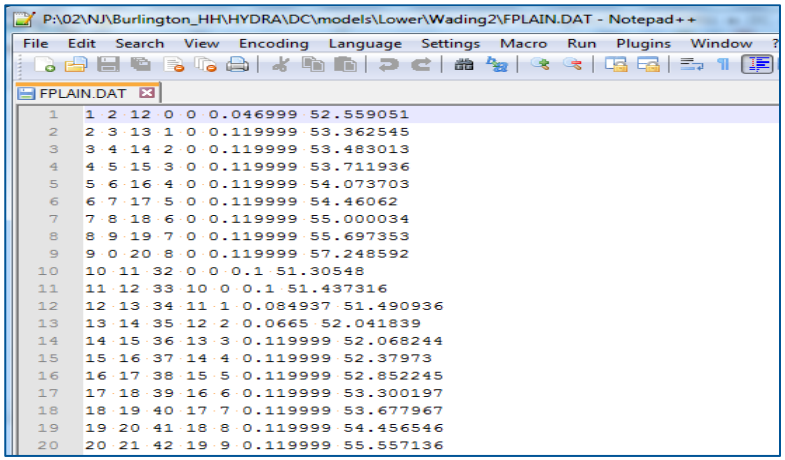
1) Challenge

Grid Developer System – Long Loading times due to detailed topo data and roughness data



Solution

- Used the 100 feet grid from GDS in ArcGIS – Extracted elevation and manning's n values using Zonal Statistics
- Used 'R' (a programming language) scripts to write the elevation & manning's n values into FPLAIN.DAT file, an input file for FLO-2D



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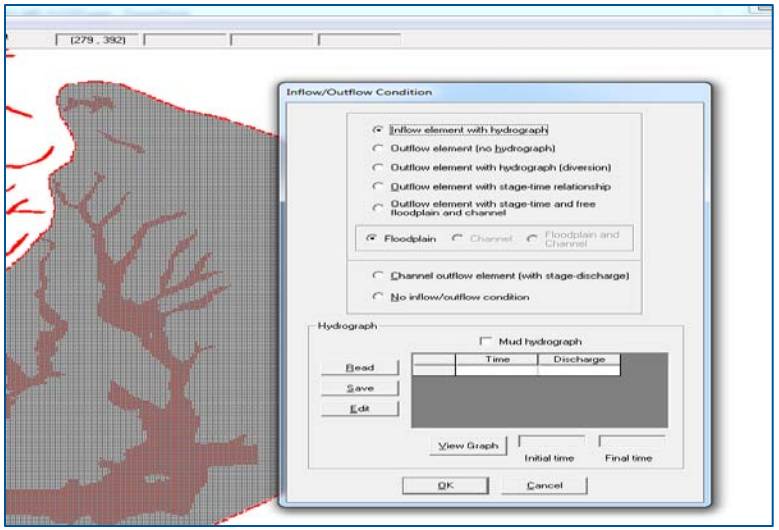
Challenges & Solutions

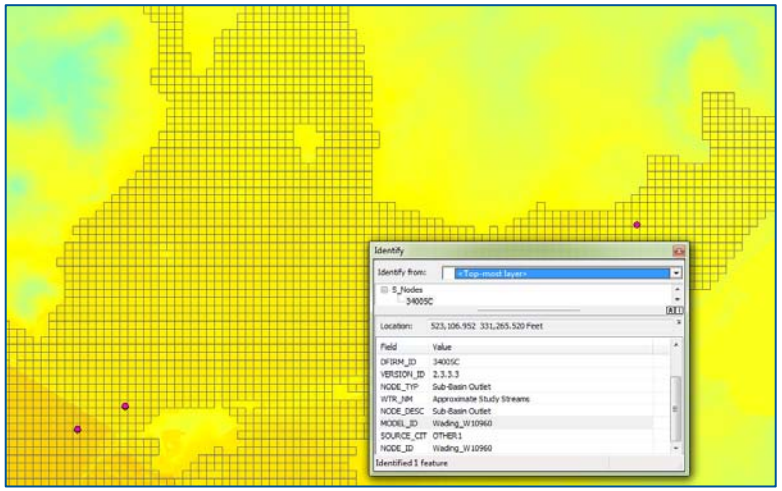
2) Challenge

Inflow nodes – Laborious process to get the outflow hydrograph from HEC-HMS and input into the GDS – more than 600 flow change locations



Solution

- Used HEC-DSSVue to export all the hydrographs into a spreadsheet.
- Linked the flow change points spatial file and grid spatial file
- Used 'R' scripts to extract specific hydrographs for each point and write them into INFLOW.DAT file



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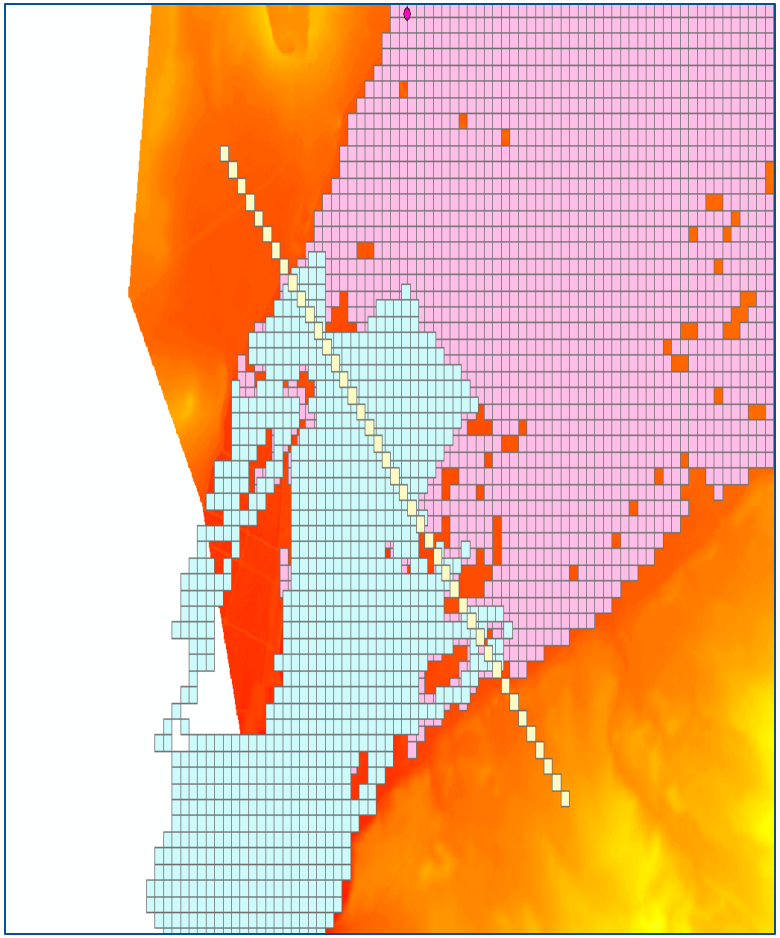
Challenges & Solutions

3) Challenge

Handoff Points – To reduce computation times, study area was divided into multiple models – Outflow hydrograph of U/S becomes inflow hydrograph of D/S model



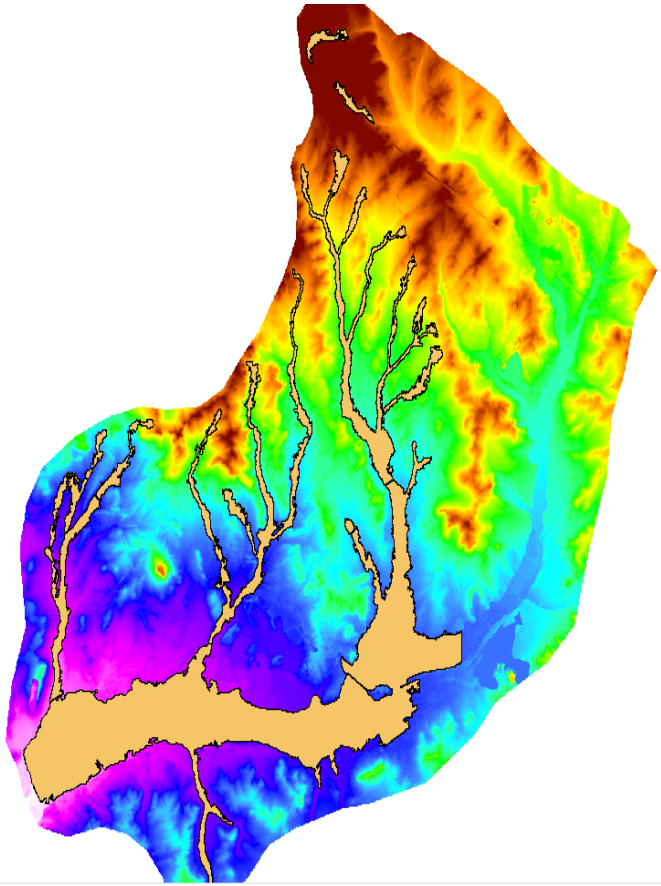
Solution

- FPXSEC.DAT identifies grid cells where the user wants flow computations
- Read the CROSSQ.OUT (output files) from the U/S model run – Identify grid cells that are intersecting from D/S model
- Used 'R' scripts to extract specific hydrographs for each grid cell and write them into INFLOW.DAT file for the D/S model

Challenges & Solutions

4) Challenge

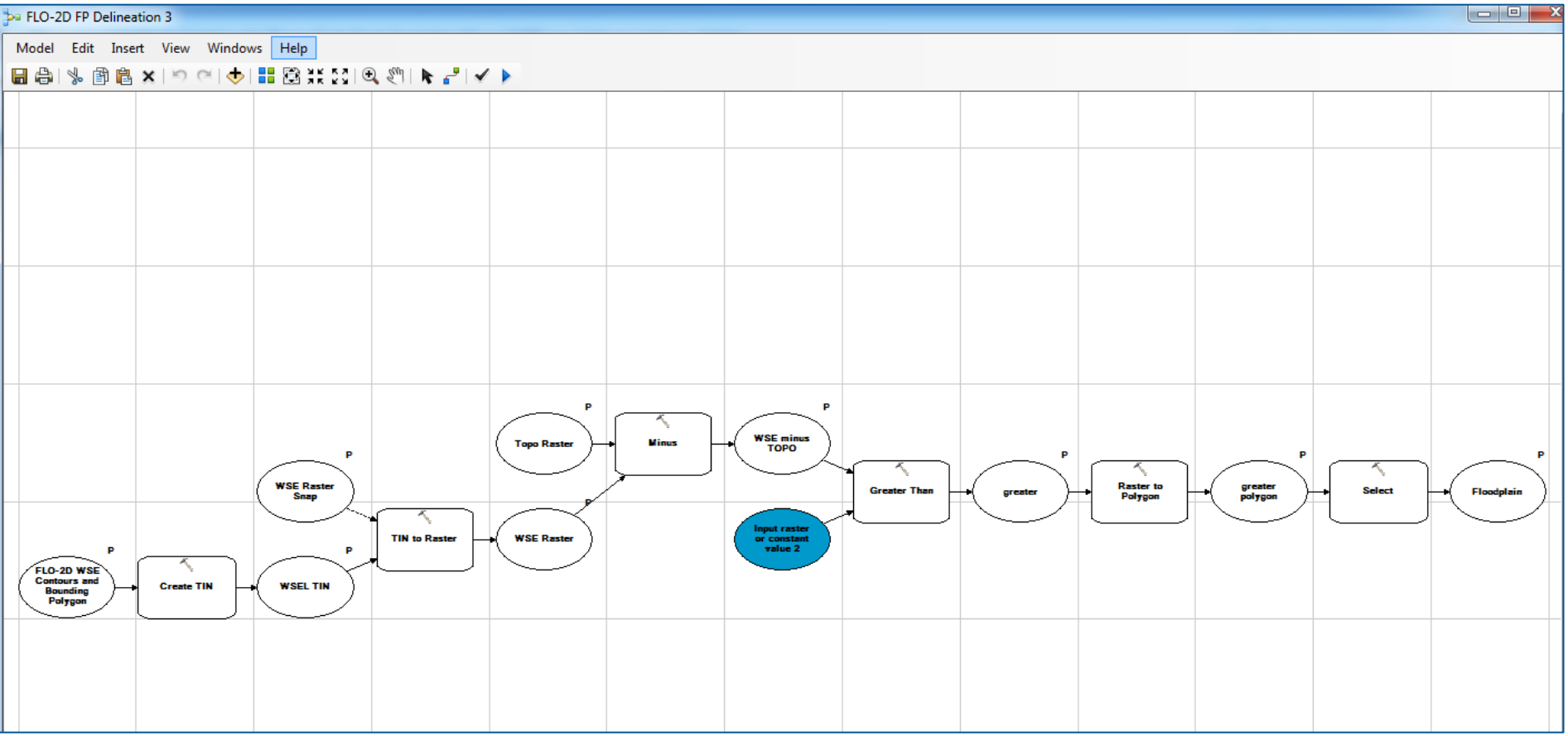
Floodplain Mapping – Extremely time consuming in FLO-2D to delineate floodplain based on high resolution LiDAR data. Example: 5 feet LiDAR based raster



Solution

- Used ArcGIS to develop the work flow to delineate floodplains.
- Flood Depth at each grid cell is used
- Model builder is to used to reduce any redundancies

Challenges & Solutions



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Cost Effectiveness

- Cost/Time matched the 1-D HECRAS approach.
- Cost includes learning time, overcoming challenges (script development)
- Next application of this method (HEC-HMS/FLO-D) – 75% of the 1-D HECRAS approach.

Conclusion

- Integrating HEC-HMS results into FLO-2D is a challenging process, if FLO-2D's GUI (2009 version) is solely used
- Process Improvements such as R scripts to reduce computation times do help.
- Rain-on-Grid approach i.e., generating the flood hydrograph at a specific location by modeling the rainfall-runoff in FLO-2D might be an approach that needs consideration
- With HEC-RAS 2D on the horizon, it needs to be seen how cost effective FLO-2D can still be.

Questions?