A New Tool in the Toolbox: Rain on Mesh Analysis

Scott Hubley, P.E., CFM | Luke Andreasen, E.I., CFM
AGENDA

• Rain-on-Mesh Overview
• Lubbock, TX Case Study
• Alvarado, TX Case Study
• Lindsay, OK Case Study
• Questions
Apply precipitation directly to surface to perform 2D hydraulic calculations

AKA:
Direct Precipitation
Direct Rainfall Modeling
Rain on Grid
2D Quick Run
APPLICATONS

- High Level Planning
- Flooding outside the floodplain
- Overland Flow Paths
- Spills between basins
- Inform New Development
- Downstream Impact Analysis
- Initial Project Review
LIMITATIONS

- Garbage In/Garbage Out
- Balance between level of detail and run times
- Hydrologic methods vary
## Software Package Capabilities

<table>
<thead>
<tr>
<th>Feature</th>
<th>HEC-RAS</th>
<th>EPA SWMM</th>
<th>XP-Storm</th>
<th>InfoWorks ICM</th>
<th>ICPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steady</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Dynamic (unsteady)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Open Channel 1D</td>
<td>Excellent</td>
<td>Limited</td>
<td>Limited</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Storm Drains 1D</td>
<td>No</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>2D</td>
<td>Excellent</td>
<td>No</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
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<tr>
<td>License Required</td>
<td>No</td>
<td>No</td>
<td>Yes, but free viewer</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Rain-on-Mesh</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>FEMA Approved</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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</table>
• Spatially varying rainfall accommodated
• Hydrologic losses included
• Storm sewers can be incorporated
• Triangulated mesh to represent surface (terrain-sensitive meshing optional)
XP-STORM

- Rainfall cannot be varied spatially
- Hydrologic losses included
- Storm sewers can be incorporated
- Grid to represent surface
- Rainfall cannot be varied spatially
- Hydrologic losses must be calculated in HEC-HMS
- Apply “Excess Precipitation”
- Cannot model storm drains
- Grid Based, Finite Volume

HEC-RAS 5.0.3
MODEL INPUTS

• 2D Zone Boundary
• 2D Roughness Zone
• 2D Infiltration Zone
• Ground Model TIN
• Rainfall
2D INPUTS

• 2D Zone Boundary / 2D Network Results Polygon
2D Inputs

- 2D Roughness Zone
2D Inputs

- 2D Infiltration Zone
2D Inputs

- Ground Model TIN
- LIDAR, Contours
2D Inputs

- Rainfall
2D MESH GENERATION

• Mesh Generation
RAIN-ON-MESH RESULTS
HEC-RAS COMPARISON

ICM

HEC-RAS
<table>
<thead>
<tr>
<th>Software</th>
<th>Grid Size (ft)</th>
<th>Working Elements</th>
<th>Event</th>
<th>Simulation Time</th>
<th>Max Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICM</td>
<td>~15 – 30</td>
<td>2M</td>
<td>10yr</td>
<td>15.5 hr</td>
<td>6.9</td>
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<tr>
<td>HEC-RAS</td>
<td>50</td>
<td>550K</td>
<td>10yr</td>
<td>20 hr</td>
<td>7.0</td>
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<tr>
<td></td>
<td>250</td>
<td>22K</td>
<td>10yr</td>
<td>11 min</td>
<td>7.2</td>
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<tr>
<td></td>
<td>500</td>
<td>5K</td>
<td>10yr</td>
<td>3 min</td>
<td>7.2</td>
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</table>
Downstream Impact Analysis
RESULTS

Legend
- HV Points
- Flow Line
- Grid Extents
- Node
- Link

Maximum Depth, feet
- < 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Legend
- HV Points
- Flow Line
- Grid Extents
- Node
- Link

Maximum Depth, feet
- < 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00
CASE STUDY: ALVARADO, TX
TWO FREQUENTLY FLOODED PROPERTIES
ALVARADO CASE STUDY
RESULTS

<table>
<thead>
<tr>
<th>Study Area</th>
<th>Study Property</th>
<th>Inlets</th>
</tr>
</thead>
</table>

**Depth**

- 0.1 - 0.5 ft
- 0.5 - 1.0 ft
- 1.0 - 2.0 ft
- 2.0 - 2.5 ft
SOLUTION 2

4' Concrete Flume Lined with 4' Chain Link Fence
SOLUTION 2
CASE STUDY: LINDSAY, OK
CASE STUDY: LINDSAY, OK
Model Input

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IDENTIFICATION AND PRIORITIZATION OF PROBLEM AREAS
QUESTIONS

Scott Hubley, P.E., CFM
817-735-7378
skh@freese.com

Luke Andreasen, E.I., CFM
405-607-7057
Luke.Andreasen@freese.com