FLO-2D Pro Model Verification & Approval Project

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Engineering Division
Agenda

- Model applications
- Why?
- What was tested and how
- Examples
- Approval
- FLO-2D Web Viewer Tool

Tom praying all the test models work this time!
# Maricopa County Statistics

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area</td>
<td>9,222</td>
<td>sq miles</td>
</tr>
<tr>
<td>Larger than</td>
<td>23</td>
<td>states</td>
</tr>
<tr>
<td>Incorporated area</td>
<td>1,828</td>
<td>sq miles</td>
</tr>
<tr>
<td>Population (2010)</td>
<td>3.82</td>
<td>million</td>
</tr>
<tr>
<td>Most populous</td>
<td>4th</td>
<td>in USA</td>
</tr>
<tr>
<td><strong>Delineated FEMA Floodplains</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td>750</td>
<td>sq miles</td>
</tr>
<tr>
<td>Stream Miles</td>
<td>&gt;4,100</td>
<td>miles</td>
</tr>
<tr>
<td><strong>Jurisdictional Dams Operated by FCDMC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>22</td>
<td>ea</td>
</tr>
<tr>
<td>Total Length</td>
<td>64</td>
<td>miles</td>
</tr>
<tr>
<td>Area Benefited</td>
<td>700</td>
<td>sq miles</td>
</tr>
</tbody>
</table>
What We Do

- Flood hazard identification
- Floodplain management for unincorporated county and 14 of 25 municipalities
- Watershed planning
- CIP, Structures and O&M
Model Applications

- Area Drainage Master Studies and Plans
- Floodplain delineation studies
- Emergency Action Plans
- Integrated hydrology & hydraulics
Model Applications

- Studies completed and in progress map.
- Areas

Legend

Name
- Maricopa County
- Status of 2D Model Studies
  - Status
    - Completed
    - In Progress
  - Name
    - Avondale ADMS
    - Awatukee Foothills ADMS
    - Broadway-Rural ADMP
    - Gila Bend ADMS

ADMS/ADMP Studies Based on 2D Modeling

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Total Area Completed</td>
<td>729</td>
<td></td>
</tr>
<tr>
<td>Total Area In Progress</td>
<td>239</td>
<td></td>
</tr>
<tr>
<td>Total Area</td>
<td>968</td>
<td></td>
</tr>
<tr>
<td>Total Area of Maricopa County</td>
<td>9,222</td>
<td></td>
</tr>
</tbody>
</table>
Time to Peak
PMF Breach of East Dam

Legend

- HEC-RAS Breach of East Dam Evacuation Area (2001)
- HEC-RAS Breach of North Dam Evacuation Area (2001)

TP
- 3.92 - 4.50
- 4.51 - 5.00
- 5.01 - 5.50
- 5.51 - 6.00
- 6.01 - 8.00
- 8.01 - 10.00
- 10.01 - 14.00
- 14.01 - 18.00
- 18.01 - 22.00
- 22.01 - 27.00

Guadalupe FRS Impoundment Area
Guadalupe_FRS_Watershed

12/2009 Aerial Photograph
Why this study?

- Professional responsibility
- Technical documentation for FCDMC acceptance of FLO-2D Pro
- Request for FEMA’s approval for local agency use of FLO-2D Pro
- Integrated 2D hydrology & hydraulics
Report Outline

- Technical Suitability
- Unique Capabilities
- Verification
- Reporting Capabilities
- Approval & Stipulations
- Use Recommendations
- References
What components were tested?

- Rainfall Losses
- Hydraulic Calculations
- Flow Obstructions (ARFs & WRFs)
- Levees (including failure)
- Hydraulic Structures
- Multiple Channels
- Storm Drains

• Sanity!
What was not tested?

- Streets
- Evaporation
- Erosion Breach (using BREACH.DAT)
- Sediment Transport
- Mud Flow
How were the components tested?

- Comparison to HEC-1, HEC-HMS, HEC-RAS, HY-8, SWMM, StormCAD
- Comparison with independent calculations
- Simulation of actual storm events
- Review of program source code
The Numbers

- Over 250 FLO-2D Models
- 11 HEC-1 and 1 HEC-HMS Models
- Over 50 HEC-RAS Plans
- 17 Hydraulic Structure Scenarios
- 43 SWMM Storm Drain Scenarios

Staff surfing the data wave
Testing Overview

- Rainfall Losses
- Hydraulic Calculations
- Flow Obstructions
- Hydraulic Structures
- SWMM Storm Drains
- Real Storms
Rainfall Losses
Using Green & Ampt

- FLO-2D was compared with HEC-1, HEC-HMS and G&A Program
- For all 11 soil texture classes:
  - Rainfall and transmission loss
  - Limiting infiltration depth
  - With/without head term
  - Deep ponded conditions
- Runoff from buildings
Compared to HEC-RAS

5 scenarios developed

- Floodplain grids
- 1D prismatic channel
- 1D channel to downstream floodplain
- Upstream floodplain to 1D channel
- 1D natural channel
Flow Obstructions

- Simulated using ARF, WRF and combinations
- 6 scenarios developed
- Checked against hand calculations
Hydraulic Structures

- Compared to Unsteady HEC-RAS
- 17 scenarios developed, 170 models
  - Circular and rectangular
  - Modeled outlet, inlet & inlet/outlet
  - Rating table & general culvert equations
  - Courant: 0.1, 0.2, 0.3, 0.4 & 0.6
- Also used for hydraulic testing
Scenario 10

- General Eqns
- 1D Channel to 1D Channel
- Inlet/Outlet Control
SWMM Storm Drain

- Compared to hand calculations
- 43 scenarios tested
- 5 types of inlets tested
- Pressure vs non-pressure pipes
- Modeled shallow to high ponding depths at the inlets

It's for when your FLO-2D SWMM model hydrographs oscillate like crazy. You can bang your head all you want!

"It's the latest innovation in office safety."
Scenario 2

- Inlet Type 1 – Curb Opening Inlet, Inlet at Grade
- Orifice flow into inlet
Real Storms
Real Storms

- **Rainbow Wash at SR85**
  - August 7-8, 2008
  - January 18-23, 2010
  - July 29, 2010
  - August 21, 2012

- **Seven Springs Wash at Seven Springs Rd.**
  - July 29-30, 2006
    - July 14, 2008
    - 100-yr, 24-hr Design Storm
Real Storms

- Guadalupe FRS
  - July 13, 2008

- Hohokam ADMS Study Area
  - July 13, 2008
  - July 31, 2010
July 29-30, 2006

3 inches in 3 hours

Rainfall was not uniform over most of the watershed.

Majority of the rain along the middle of the watershed in a northwest to southeast band.
Approval & Stipulations

- Model results exceed requirements
- FLO-2D 2009.06
  - Approved for hydrology
- FLO-2D Pro
  - Build 12.10.02 through 15.07.12
    - Hydrology, hydraulics, rating table based hydraulic structures
  - Build 15.10.13 and newer
    - Add general culvert equations for hydraulic structures
    - Add storm drain component
Application
Recommendations

- Procedures for modeling rainfall losses
- Use of grids for simulating prismatic 1D channels
- Calibration techniques
- Storm drains
Submitted to FEMA Region IX on 6/1/2016

Report available:

• Search for: “FLO-2D Verification”

- Provide our clients with access to FLO-2D model input data and results

- General Public
  - Not password protected
  - Maximum WSEL, discharge and direction
Staff, Municipalities, Consultants

- Password protected, Available on Request
- All important input and output data
- Feature hydrographs
- Hydrographs and profiles by line
- GIS data, graphics, and tabular data export
FLO-2D Web Tool

Flo2D Projects
- Active
  - Holohokam
  - Pinnacle Peak South
  - Pinnacle Peak West
  - San Tan West

In Progress

Maricopa County

Enter password

Submit
FLO-2D Web Tool
Questions