A Plan for the Future Based on an Coupled Modeling Approach

City of El Cajon’s Master Drainage Plan

Eric Fontenot, PE
Overview

- The City of El Cajon
- The Master Drainage Plan
- Modeling Approach
- Existing Conditions Model
- Model Results *(Preliminary)*
- Lessons to Share *(Refinements)*
- Benefits of Approach
- Next Steps
The City of El Cajon
Located in San Diego County, CA
The City of El Cajon

- Nestled in a valley surrounded by mountains
- City Area – 14.43 Square Miles
- Population (2011) – 100,116

- Climate Information
  - Semi-Arid
  - Warmest month - August 88.1 °F
  - Coldest month - December 40.3 °F
  - Wettest month - March (2.66 in)
  - Average precipitation - 11.96 inches
Master Drainage Plan

Objectives

1. Upgrade inventory to GIS
2. Model complex drainage system:
   • Underground pipe network
   • Open channel conveyance
   • Streets used to convey flow
3. Identify capacity constraints

Phased Planning Approach

1. Existing Conditions Model
2. Future Conditions Model (2050)
3. Capital Improvement Project Identification
All models are wrong.... Some models are useful.

- Statistician George Box

The key is to understand:

• limitations of the computer system(s)
• the actual performance of the natural system
Model Types

One-dimensional (1D)
- Variables change in one defined direction, horizontally (i.e. – distance, along the channel)
- Best suited for closed pipe networks, in-channel flows and when floodplain flows are minor.

Two-dimensional (2D)
- Variables are computed horizontally in both the X,Y direction
- More accurate representations of:
  - Flow distribution
  - Velocity distribution
  - Water Surface Elevation
  - Backwater
  - Velocity magnitude
  - Velocity direction
  - Flow depth
  - Shear stress
Modeling Approach

MIKE FLOOD

• Originally planned as traditional 1D analysis
• Realized surface conveyance and storage weren’t captured
• Abandoned 1D in favor of coupled approach
• 2D model captures surface storage in more detail

Important process in areas with little elevation relief as...
Modeling Approach

MIKE FLOOD

- Hydrologic and Hydraulic models linked
  - Sub-basins linked to Nodes/Grid Cells
  - Runoff hydrograph “pour point” location
- 1D and 2D modeling data “coupled”
  - Flow exchanged at 1D nodes
  - Transfer to 2D ground surface
  - Transfer to downstream node back into system
Modeling Approach

• Data Collection & Data Entry
  • MIKE software accepts inventory information in multiple formats
  • Import from asset geodatabase
  • Asset data “hydro-corrected”

• QA/QC checks performed for 1D, 2D, Coupled elements
Modeling Approach

Modeling Approach

Modeling Approach

Modeling Approach
Modeling Approach

• Hydrology Model
  • SD County Hydrology
  • Basin Delineation
  • Catchment Parameter Assignment
    • Landuse
    • Rainfall Distribution
    • Basin Lag Time Calculation
Modeling Approach

- **Hydraulics Model**
  - 1-D Model Development
    - Open channels + closed conduits
    - Inlet capacity representation
  - 2-D model Development
    - Terrain Development
  - Coupling of 1-D and 2-D models
    - Identify connections
      - 1D nodes
      - 2D grid cells
Existing Conditions Model
Model Results
(10-Year Preliminary)

Q vs. Qmanning
Model Results
(100-Year Preliminary)

Q vs. Qmanning
Lessons to Share

- Elevation Datum
- Review system to assist Grid Resolution decisions
- Review 2D terrain in the vicinity of inlets/catchments
- Model result review against:
  - High-water marks
  - Gage information
  - Local knowledge of system
- Use Engineering Theory and Calculations…
  Don’t forget your common sense.
Benefits

• **GIS data file management**
  - Centralizes current inventory, modeling, planning and capital improvement project information.
  - Allows visualization of the system components and results to assist decision makers

• **More realistic drainage system modeling**
  - Model coupling of 1D & 2D surfaces better describe the storm water system’s behavior
  - Allows overland flow and storage
  - System facilities can be more adequately sized to provide required level of service
Benefits

• Assists “root cause” capacity analysis
  • Allows review of both pipe capacity and inlet efficiency
  • Is the water getting into the system?
  • Is the system properly sized?

• **Emergency Response Planning**
  • Review of ponding areas can identify evacuation areas
  • Identification of road closure areas if necessary
  • Model could act as basis of real-time weather forecasting

• **Flood Mapping Update**
  • May be submitted for FIRM update
Next Steps

• Finalize existing conditions modeling
• Run future conditions modeling
• Identify system deficiencies
  • Generate alternatives
  • Cost estimates
• Environmental Impact Statements
• Finalize Master Plan
QUESTIONS?