Hydrologic Modeling System (HEC-HMS)

New Features For Urban Hydrology

Introduction

- New and expanded capabilities for reservoirs
  - Large dams spanning a stream
  - Interior protection pump stations
- Flood frequency studies
  - Watersheds with large area
  - Watersheds with many sub-areas
- Continuous simulation in areas with high percentages of impervious area, but heterogenously distributed

Storage Indication Routing

- Also know as modified Puls routing
- Single composite curve
  - Storage versus outflow
  - Elevation versus storage versus outflow
  - Elevation versus area versus outflow
- Curve is developed by user to include outlets, spillways, other structures
- Negatives
  - Difficult to modify physical properties
  - Curve is static
  - No tailwater affects

Mass Conservation Routing

- **Assumption: if the reservoir pool is level, there is one and only one pool elevation for any given configuration of pumps, gates, and other control structures**
- **Mass conservation in the reservoir pool is a sufficient condition for determining the pool elevation**

$$\frac{dS(wse)}{dt} - I(t) + \sum_{n} O(wse,t) = 0$$

- **Solve the equation using Brent's root finding method**

Tailwater Submergence

- No tailwater
- Tailwater stage calculated from total reservoir outflow and a rating curve
- User-specified time-series of tailwater stage elevations
- Tailwater stage calculated from total reservoir outflow plus outflow from adjacent elements, and a rating curve

Existing and New Routing

- Existing routing
  - 0 or 1 ogee or broad-crested spillway
  - 0 or 1 level or non-level overflow
  - 0 or 1 pressure flow orifice outlet
  - Optional dam break
- New routing
  - 0 to 10 ogee or weir spillways
  - 0 to 10 level or non-level overflows
  - 0 to 10 orifice or culvert outlets
  - 0 to 10 head-discharge pumps
  - Optional overtop or piping dam break

Culvert Outlet

- Inlet and outlet control
  - User selection of control method
  - Automatic selection of inlet or outlet solution using highest energy head
  - Outlet solution discarded if discharge energy is insufficient compared to tailwater stage
- Variety of cross section shapes
  - Box, circular, semi-circular, elliptical, arch, high-profile arch, low-profile arch, pipe arch, con-span
- FHWA chart and scale numbers

Head-Discharge Pump

- Head versus discharge curve describes operational characteristics of the pump
- Separate "on" and "off" reservoir pool elevations for pump operation
- Two sources of head
  - Fixed equipment losses from intake, piping system friction, expansion
  - Difference between reservoir pool elevation and discharge elevation

Flood Frequency Studies

- Develop frequency curves at multiple locations-of-interest in a watershed
- Use a family of frequency-based precipitation storms to develop the complete frequency curve
- Multiple curves at each location due to varying future scenarios
- Significant amount of manual work required to properly compute flows for each exceedance probability

Depth-Area Analysis Tool

- Configure a normal simulation run with a meteorologic model that uses the frequency storm method
- Select locations where frequency results are required
- Program automatically generates precipitation storm with correct area for each location
- Each storm is applied and results are cataloged so correct flows are computed for each location

Deficit-Constant Loss Method

- Simplified one-layer soil model for continuous simulation
- Combined tension and gravity storage in soil
- Fixed percolation rate out of soil, but only when soil storage is full
- Evapo-transpiration extractions from soil, but only during time steps with no precipitation
- Percentage impervious area

Loss Method Extension

- Urban watersheds are typically very heterogeneous in soil properties and impervious area
- Create a grid cell version of the deficit constant method
  - Grid of soil storage initial condition
  - Grids of soil storage depth, percolation, and impervious area parameter values
  - Grids of precipitation and evapo-transpiration boundary conditions
- Each grid cell evolves independently of its neighboring cells, calculating percolation and surface excess

Parameter Development

- Build a GIS tool to manage soil property and surface land use databases
- Analyze data and conduct numerical experiments to estimate soil properties and impervious area percentages for land uses familiar to development planners
- Use tool to select proposed development sites and specify new land use type
- Tool creates new parameter grids for use in the program
- Program performs simulation with new parameter grids, compares results from different planning scenarios

More Info and Download

www.hec.usace.army.mil