# Hydraulic Structures
# Embankments
# Reservoirs

# Hydraulic Structures in GSSHA

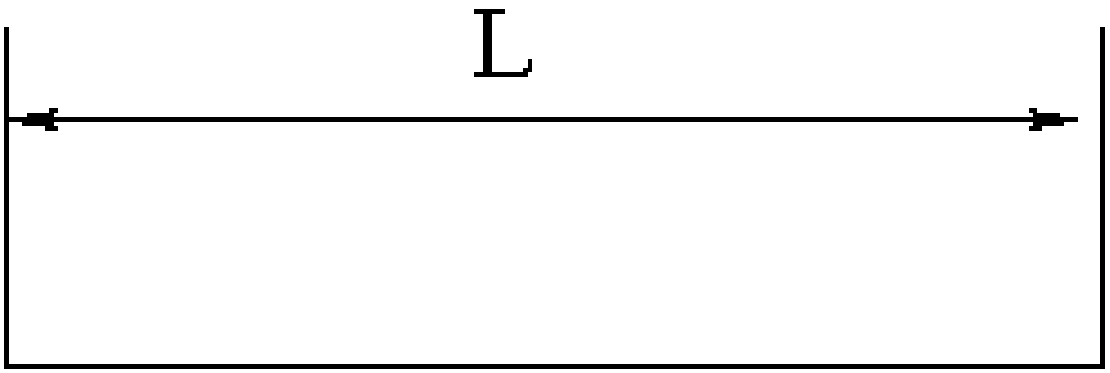
- Can be added to any model with a 1D stream network.
- Structures are special link types.
- Structures function as internal boundary conditions inside the stream network.
- Multiple structures can be combined at a single location.
- Structure types may vary in the stream network and at a single location.

# Structure Types

- Broad crested weirs
  - Horizontal
  - Parabolic
- Culverts
  - Circular
  - Rectangular
- Active control structures
  - Scheduled discharge
- Generic structure rating curve

# Horizontal Weirs

- Common outlets for detention basins.

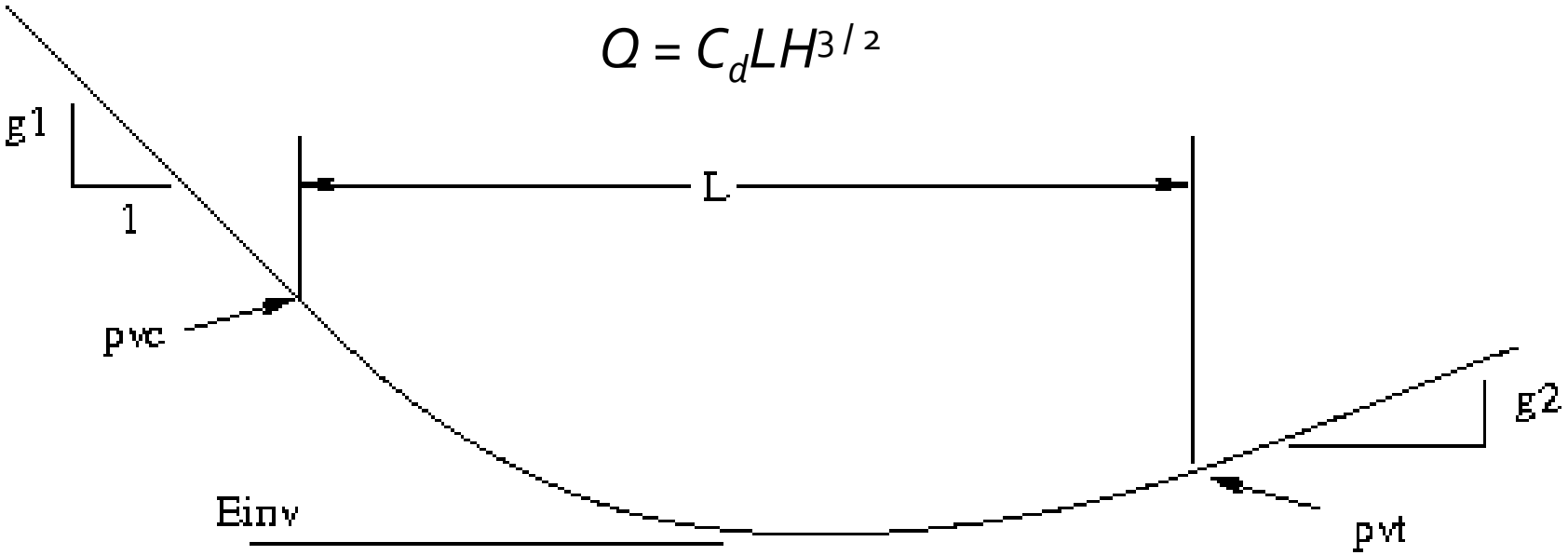



- $Q = C_d L H^{3/2}$

- STRUCTTYPE WEIR
  - CREST_LENGTH
  - CREST_LOW_ELEV
  - DISCHARGE_COEFF_FORWARD
  - DISCHARGE_COEFF_REVERSE

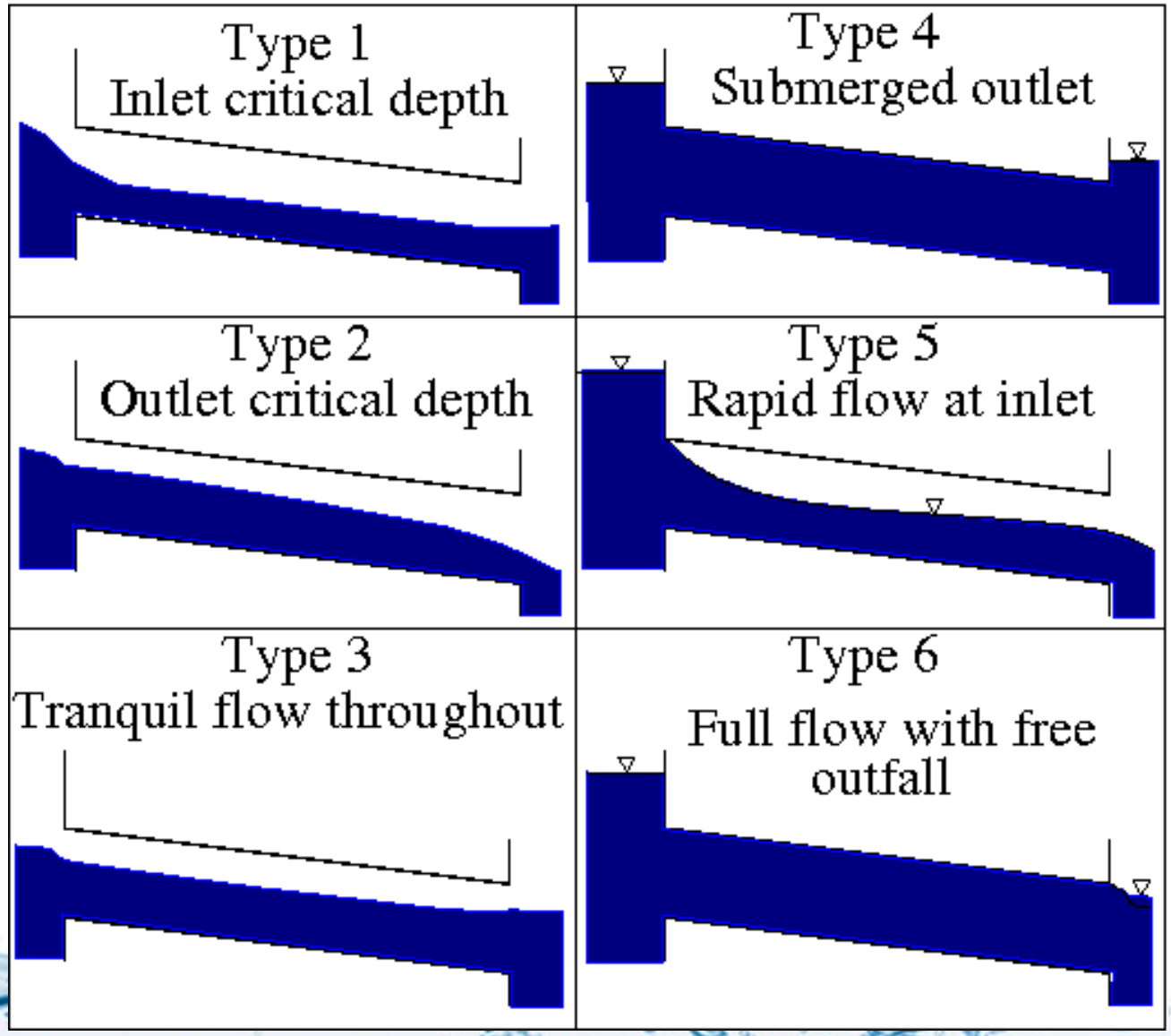
# Sag Curve Weir

$$Q = C_d L H^{3/2}$$




g1= grade of steepest approach (negative) 0–1
pvc= point of vertical curve initiation
L= length of the vertical curve (horizontal dist.) meters
pvt= point of tangency (end of vertical curve)
g2= grade of shallowest approach (positive) 0–1
Einv= Elevation of the invert

# Culvert Flow Types



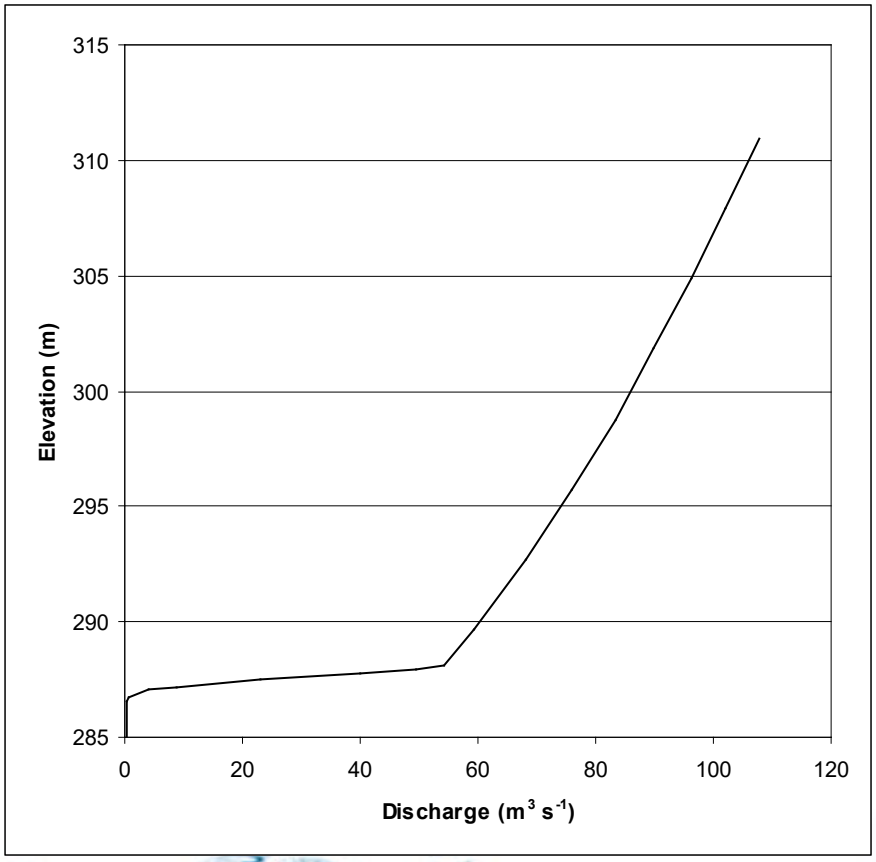
# Scheduled Releases

- Specified discharges as a function of time.
- History matching with known releases.

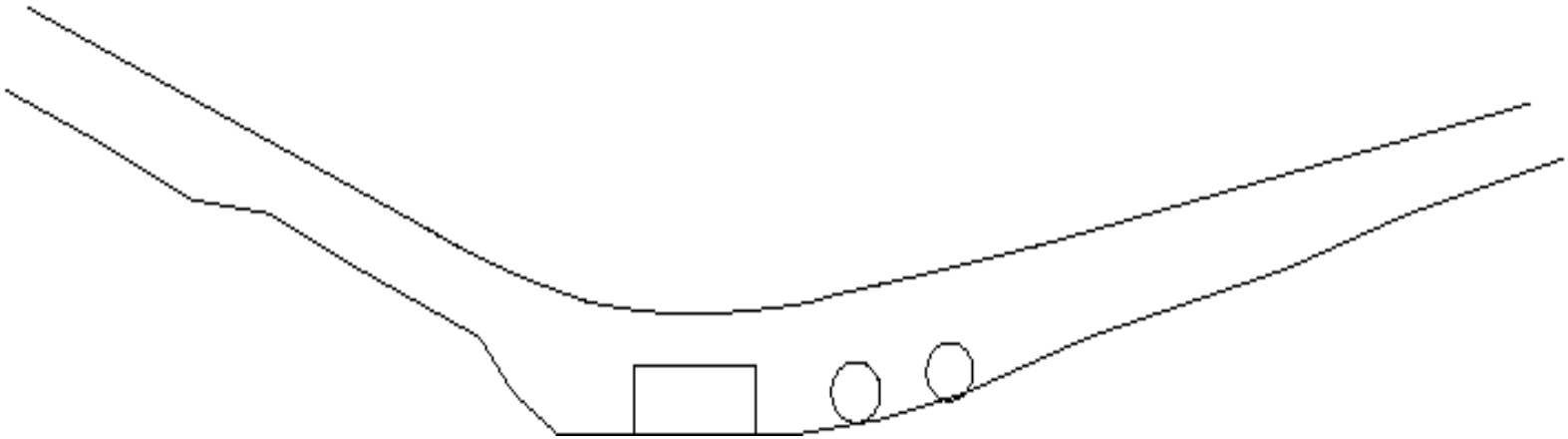
# Rating Curve

- Series of discharge vs. water surface elevation points.
- Simulate any hydraulic structure or flow control device.

| | |
|---|---|
| •286.5 | 0.31 |
| •286.585 | 0.36 |
| •286.737 | 0.714 |
| •287.042 | 4.08 |
| •287.195 | 8.873 |
| •287.50 | 23.05 |
| •287.80 | 40.06 |
| •288.11 | 54.21 |
| •292.683 | 68.027 |
| •298.78 | 83.262 |
| •304.878 | 96.372 |
| •310.975 | 107.70 |



# Compound Structure Example

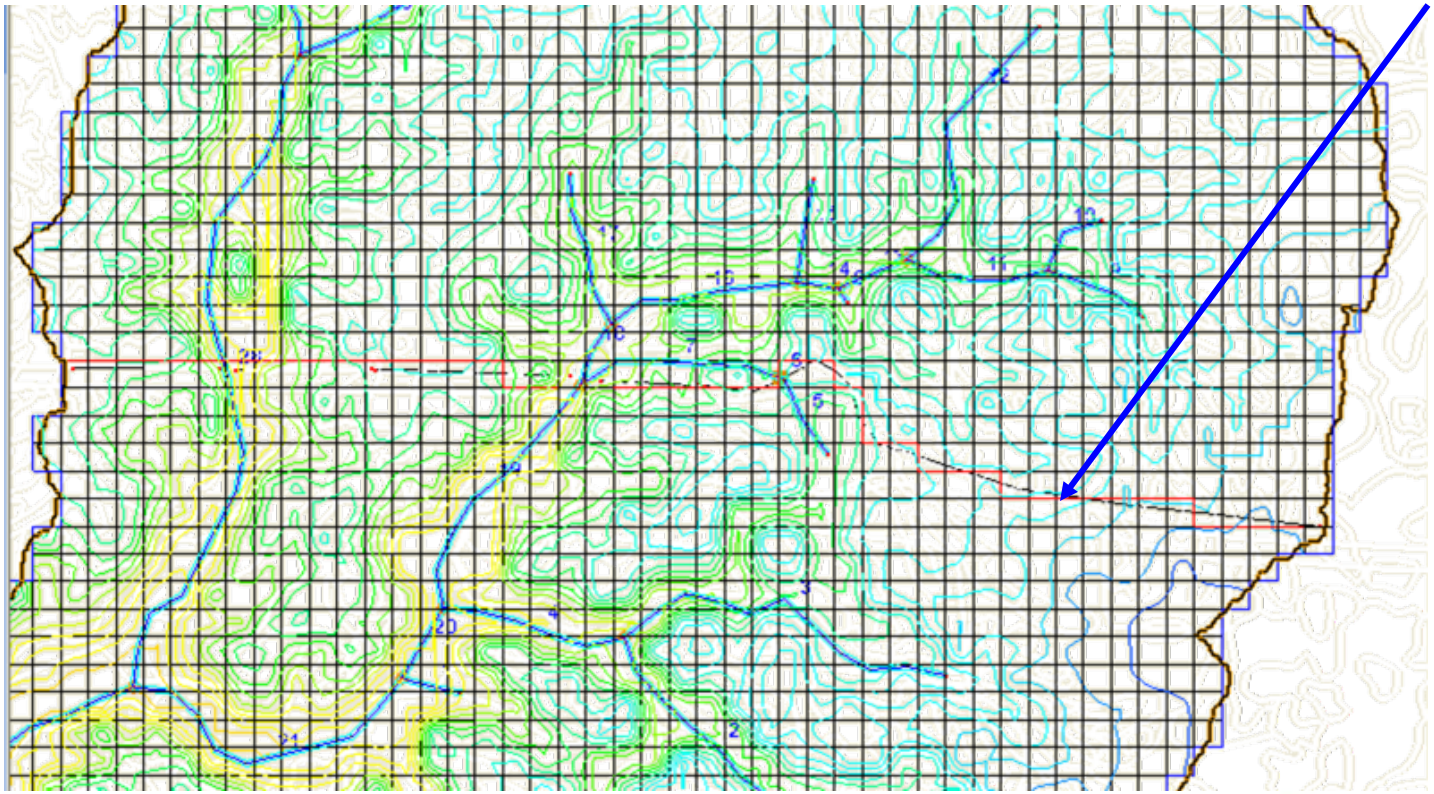


- Hydraulic structure consisting of four elements:
  - sag vertical-curve weir
  - box culvert
  - two circular culverts
- Each structure element allowed to have a different invert elevation.

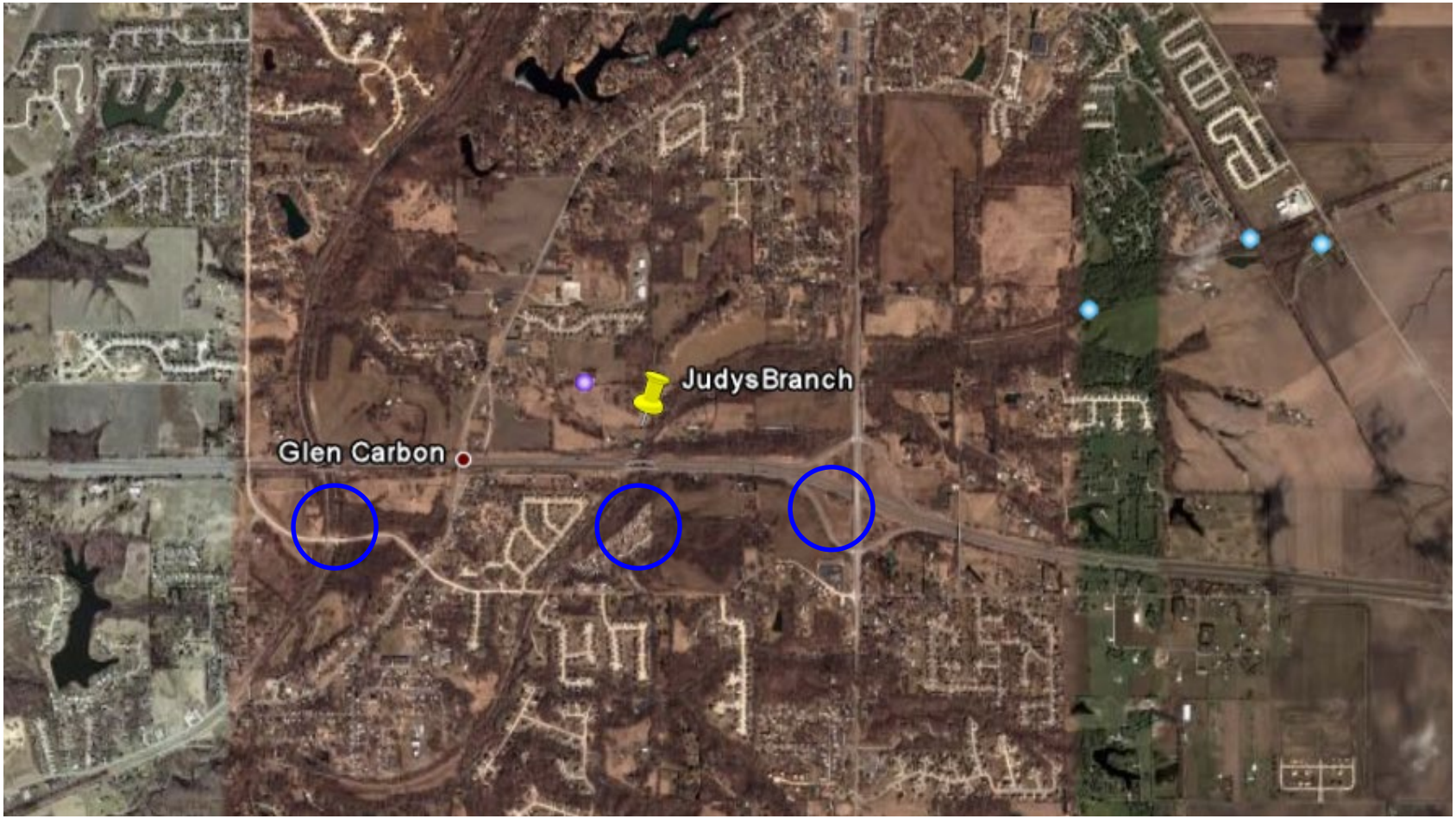
# Embankment Conceptualization

# GSSHA Embankment

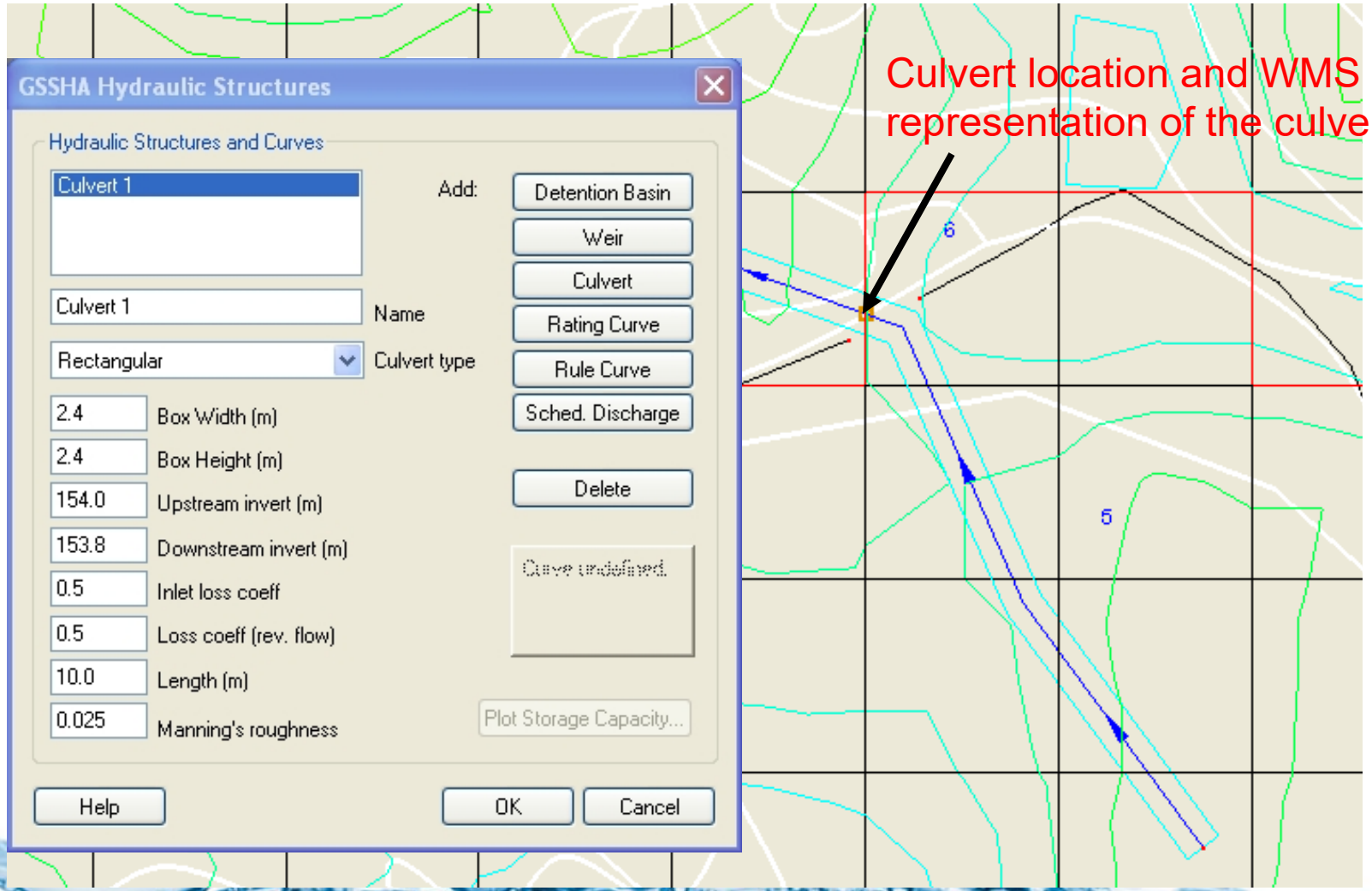
Red line representing embankment in WMS



# Culvert Locations

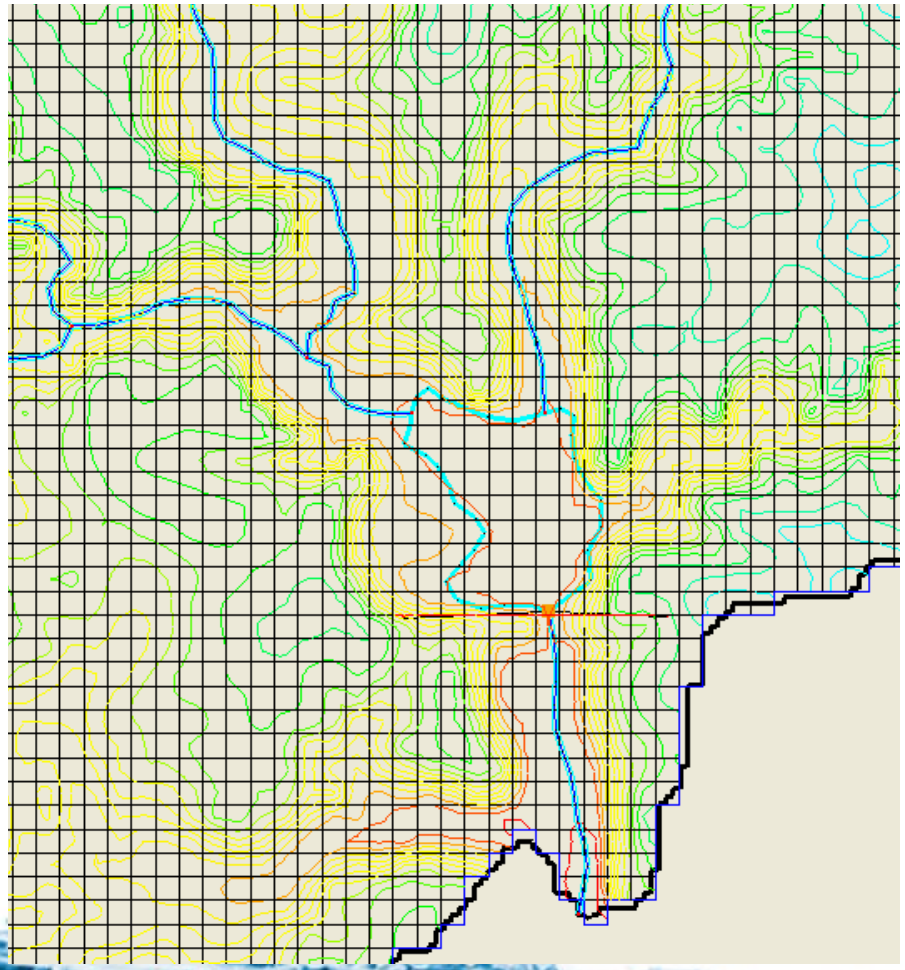


# Culvert Conceptualization



# Lakes/Reservoirs/ Detention Basins

- Lakes/reservoirs and detention basins are dynamic features that exist both in the stream network and on the overland flow plane.



# Reservoir Fluxes

- Rainfall
- Overland flow
- Stream flow
- ET
- Outlet discharge
- Seepage/groundwater recharge

# Interaction with Overland

- Reservoirs occupy overland flow cells.
- Water flows from the overland cells to the reservoirs and from the reservoirs to the overland cells.
- As reservoirs expand they overtake overland cells.
- As reservoirs recede they release overland cells.

# Overland Cells Within a Reservoir

No cell processes occur while overland cells are occupied

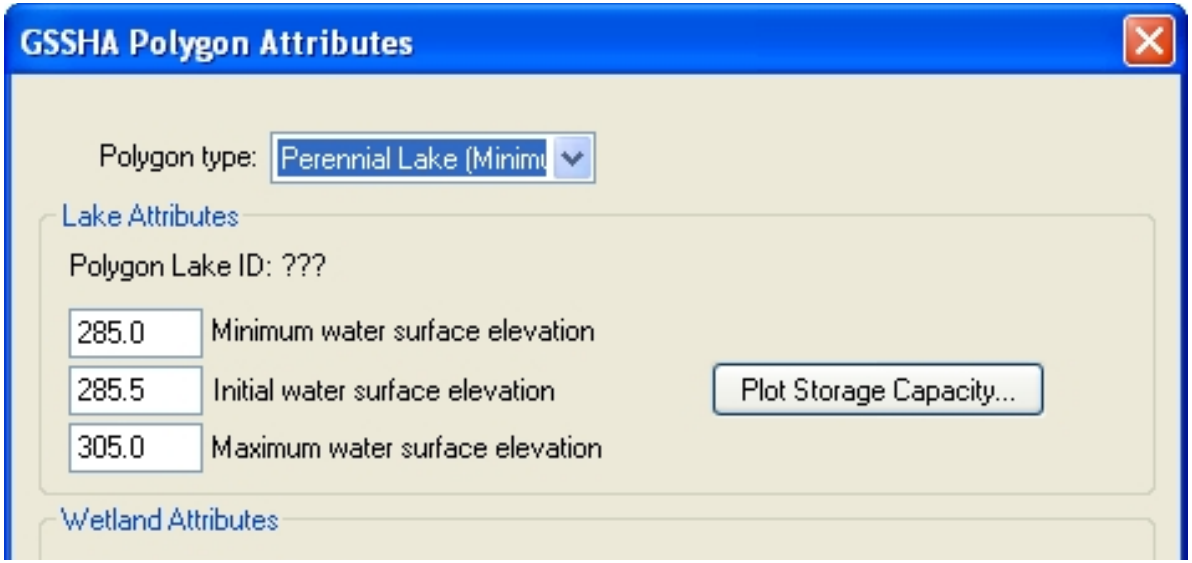
- Cell to cell flow
- Infiltration
- Soil ET

# Reservoir Stream Interaction

- A reservoir is a boundary condition in stream network.
- Flow from streams to reservoirs and from reservoirs to streams
- Reservoirs overtake stream cells when the overland flow cells containing them are taken.
- Reservoir releases stream cells as overland cells are released.

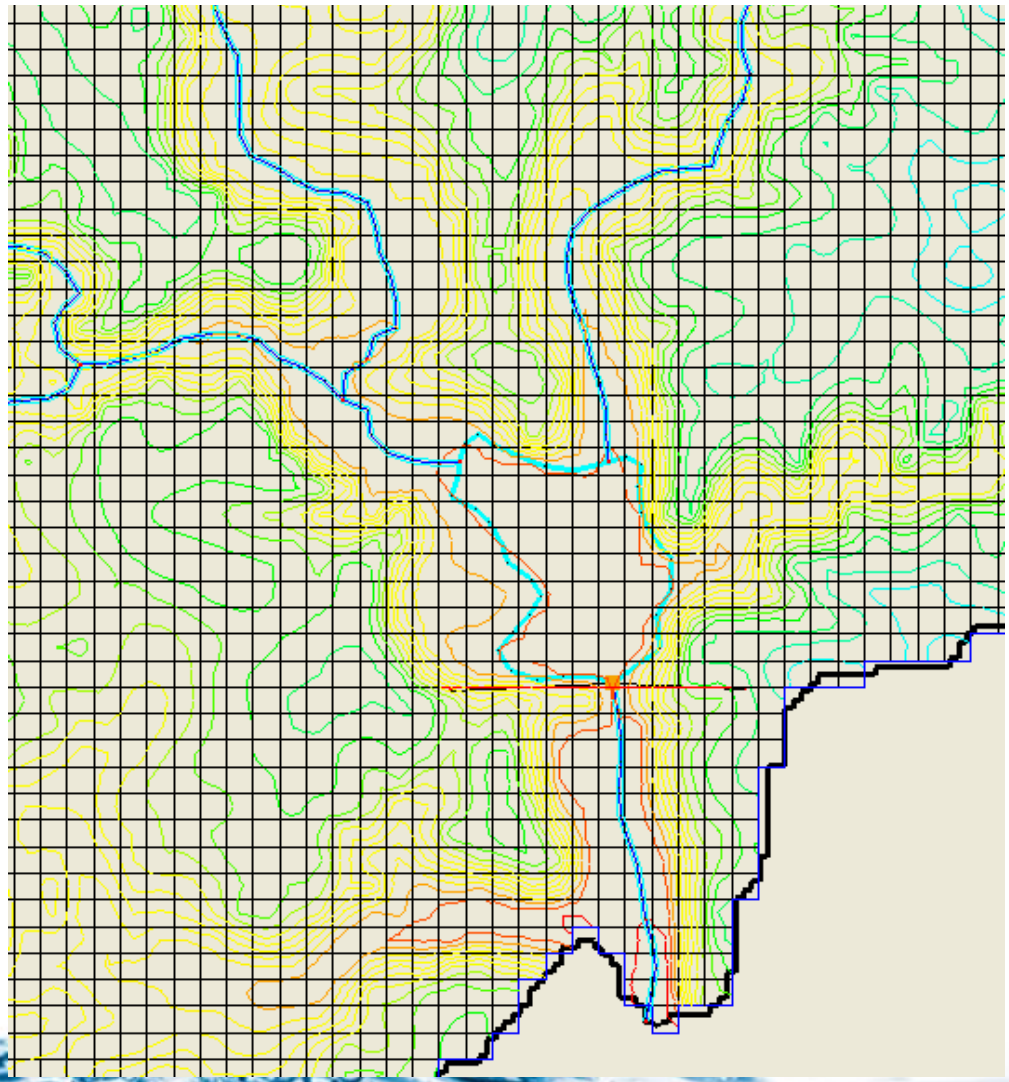
# Creating Reservoirs

- Defined in stream network with polygon
- Embankment that represents the dam
- Specify outlet hydraulic structure
- Specify minimum, maximum and initial water level

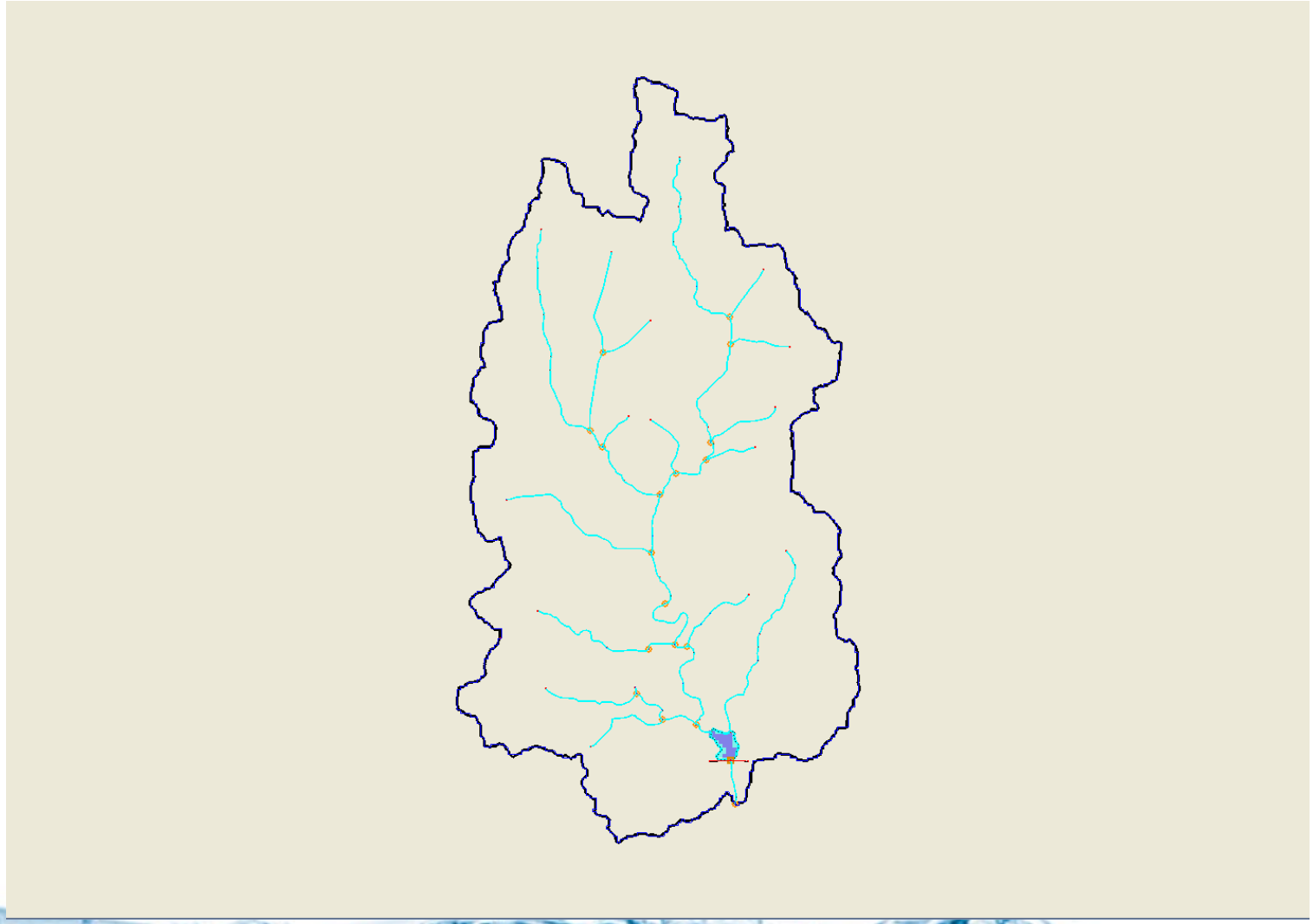


# Stage/Area/Volume Relationship

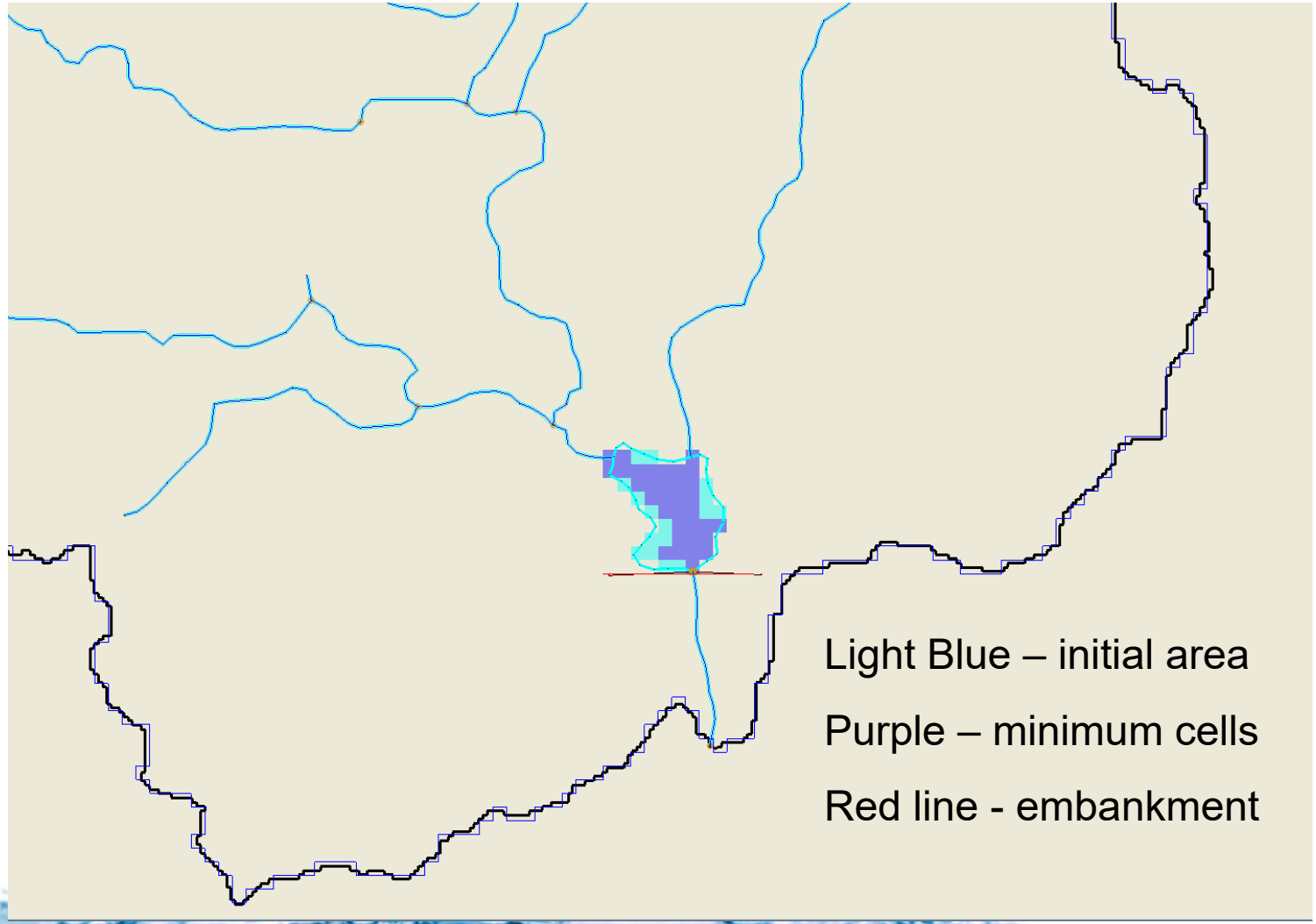
- Stage/Area/Volume relationship is calculated directly from the grid elevations.
- WMS shows plots of relationships.



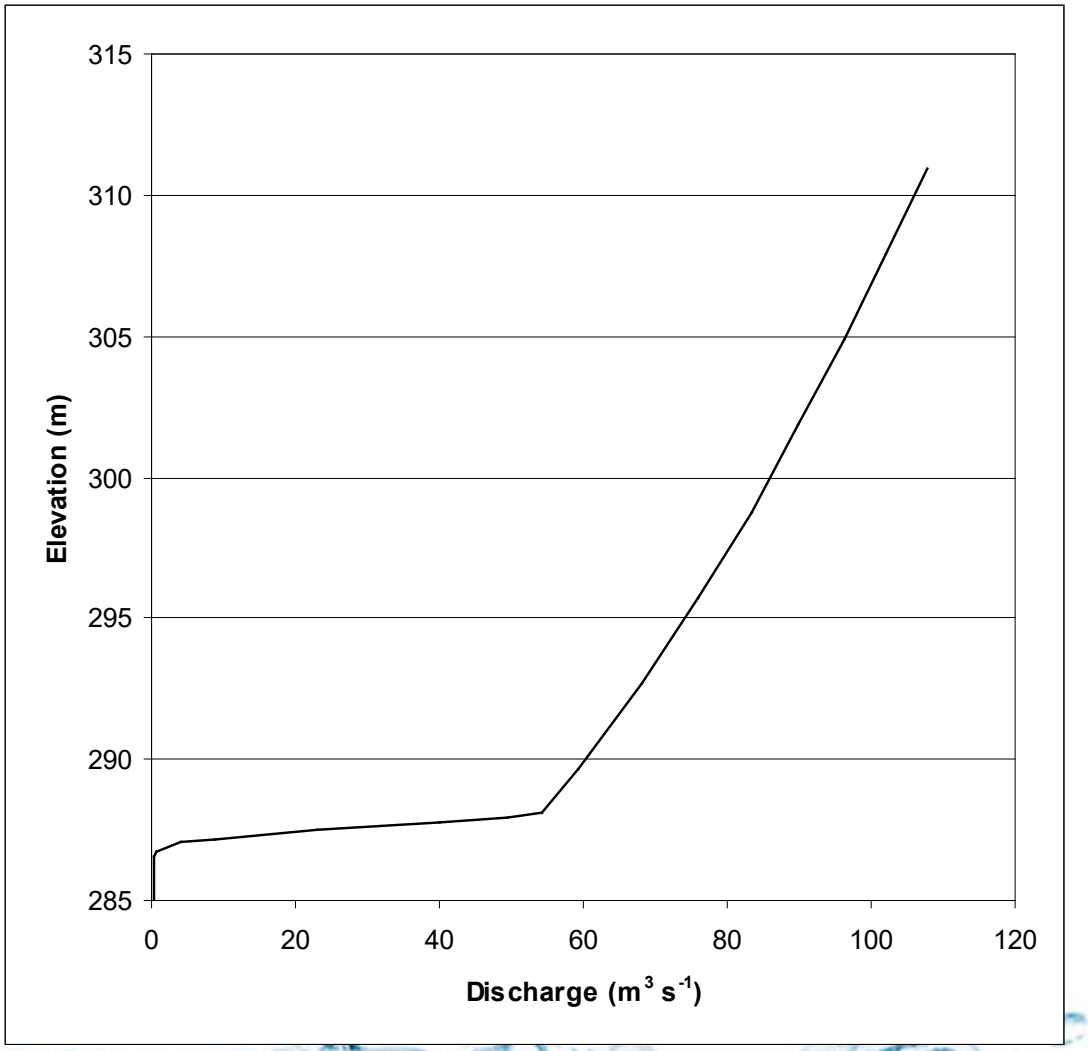
# Eau Galle Reservoir Watershed with Stream Network



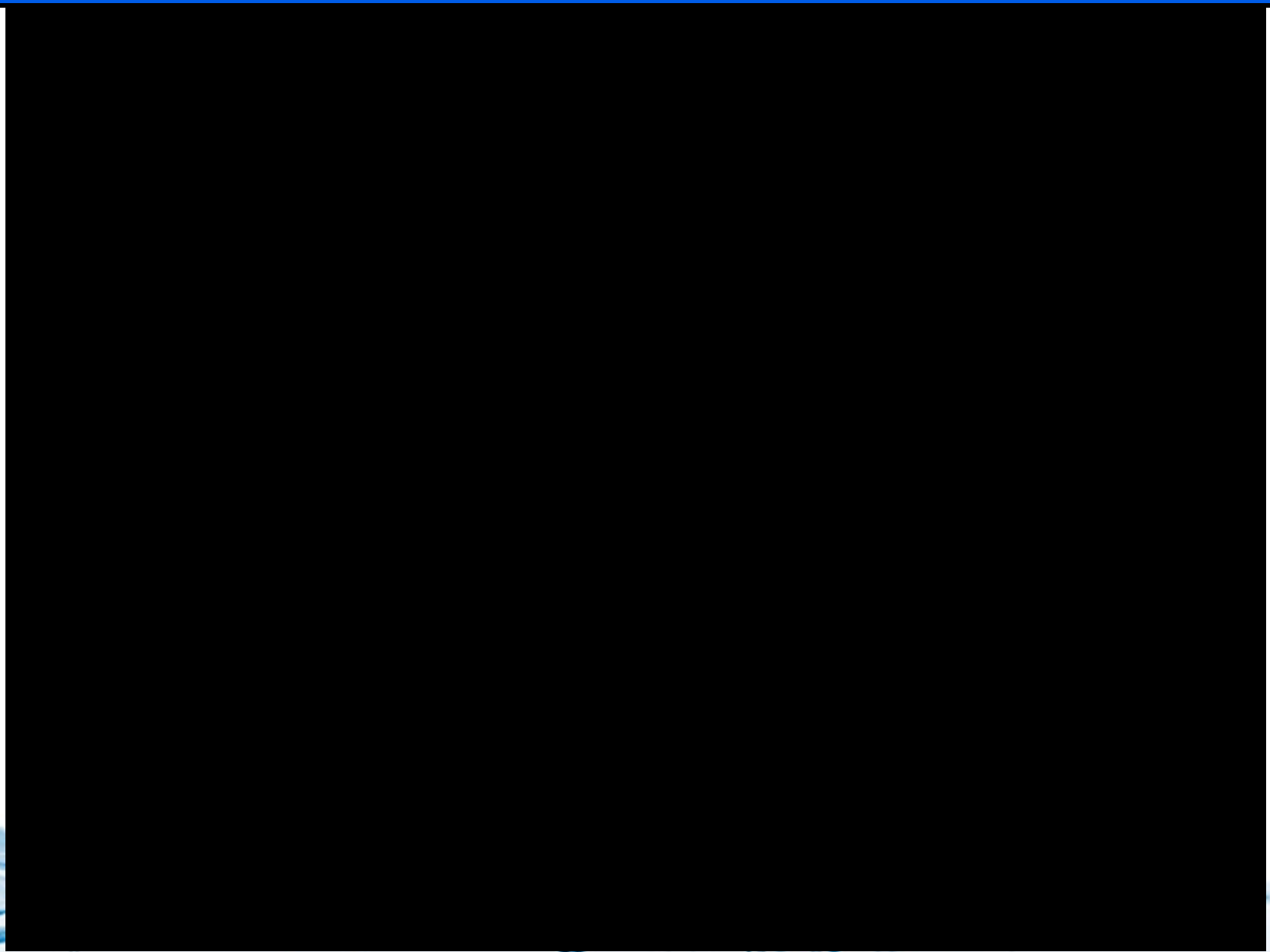
# Eau Galle Reservoir



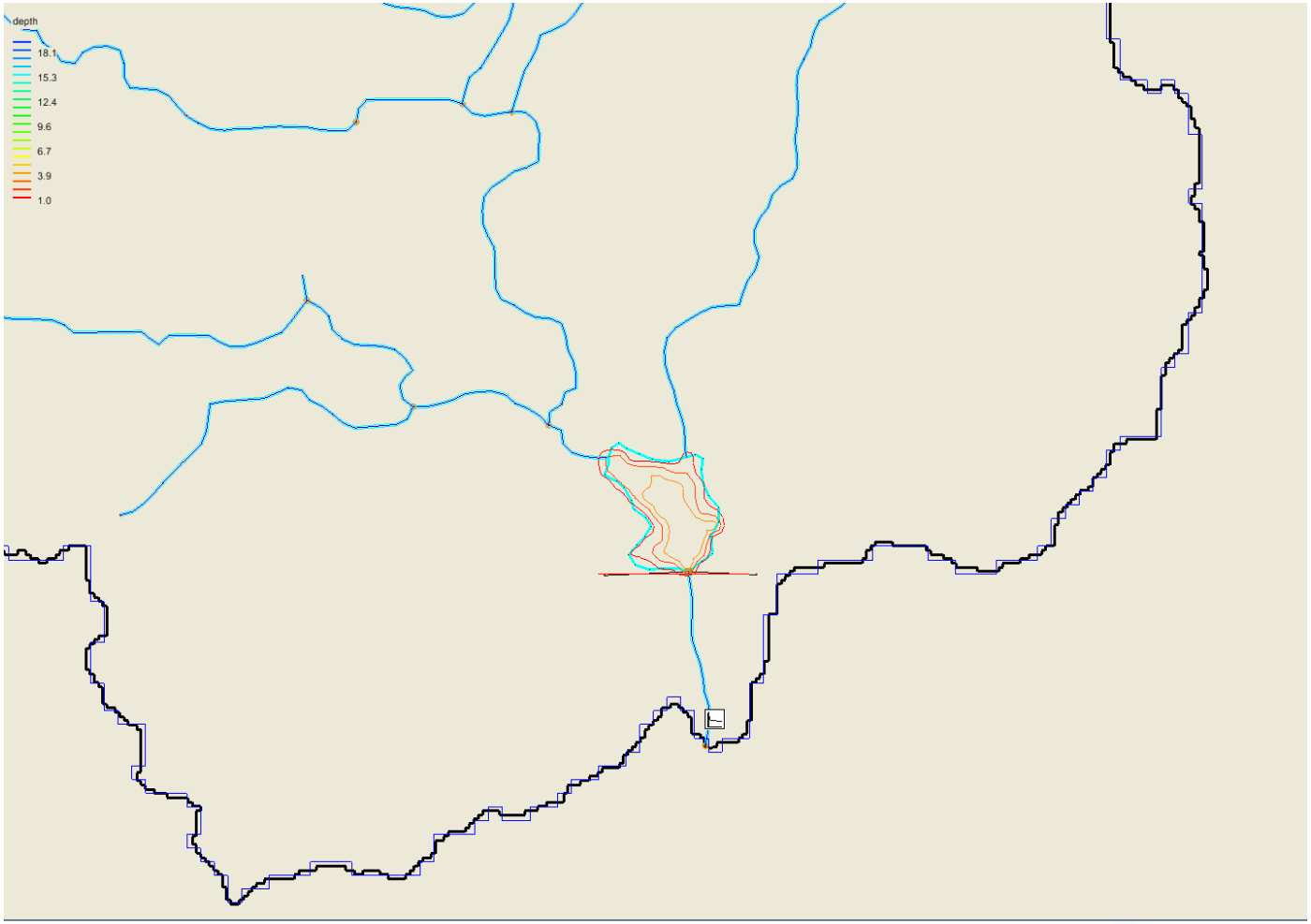
# Eau Galle Reservoir Outlet Works



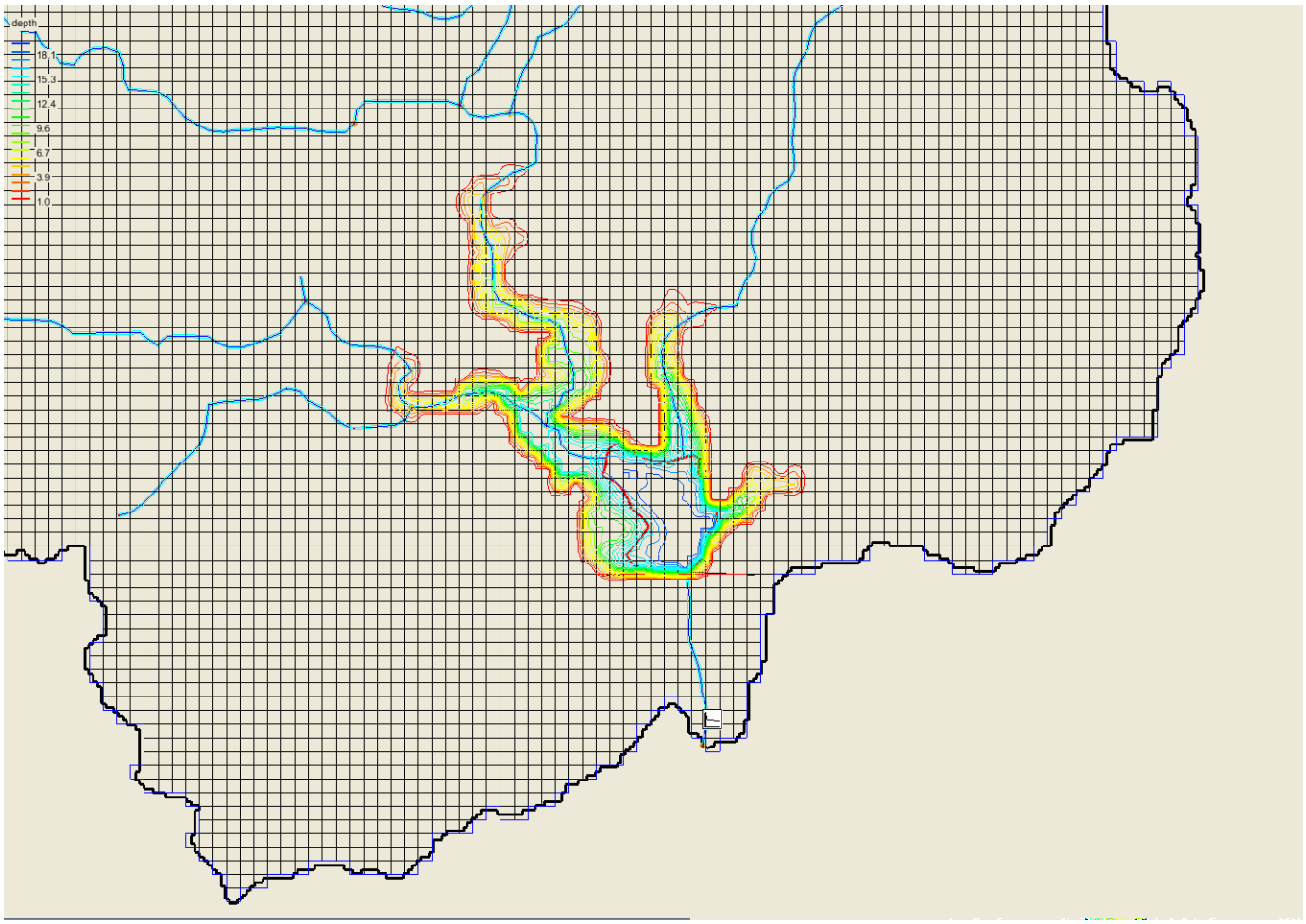
# Reservoir Animation



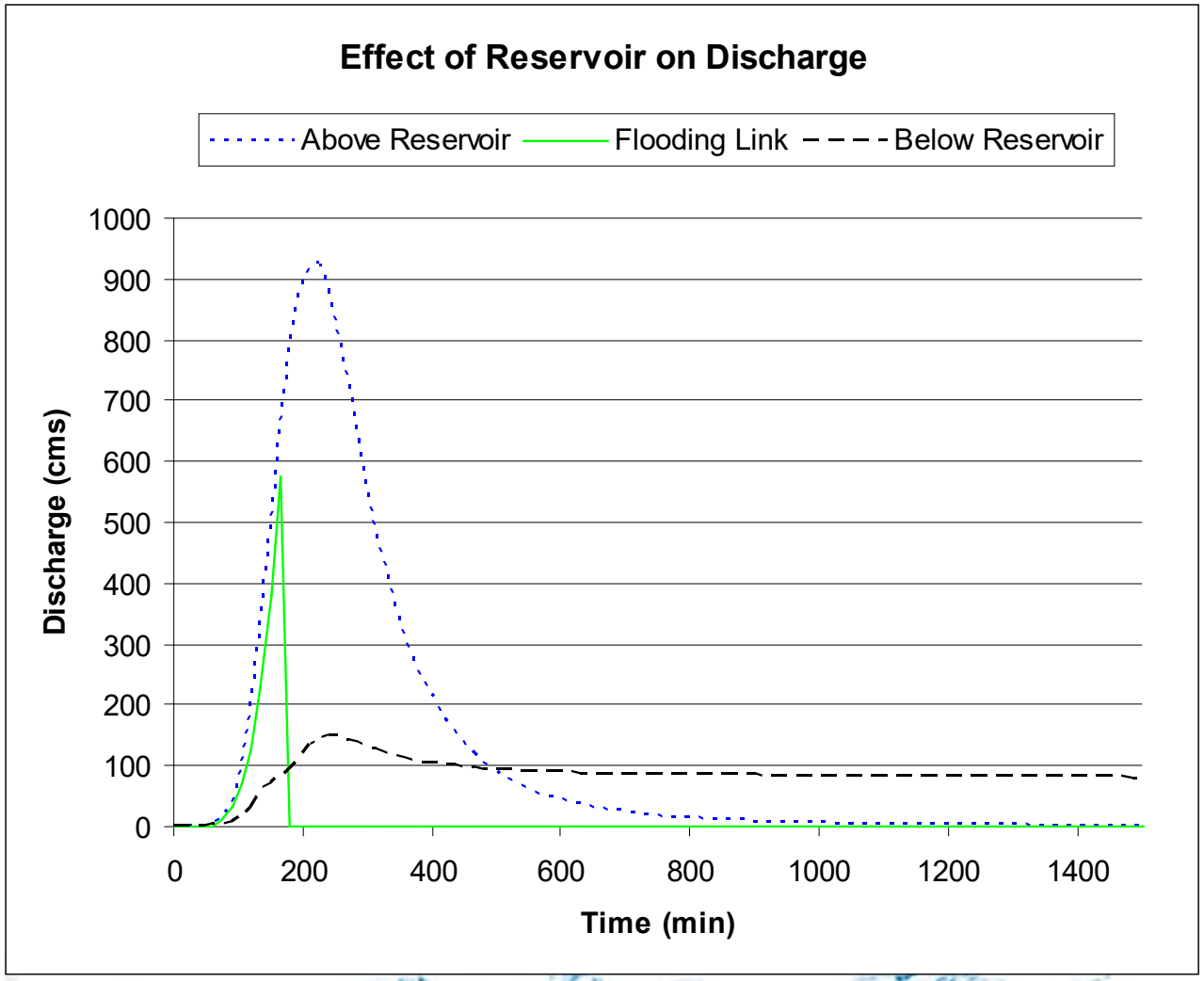
# Eau Galle Reservoir Initial Condition



# Eau Galle Reservoir Maximum Flood



# Stream Discharge Associated with Reservoir



# Reservoir Level and Volume