Real Time Flood Mapping Pilot

U.S.Geological Survey, WRD,
Seattle Area Natural Hazards
Project Team

http://wa.water.usgs.gov/urbanhaz/

Status of Flood Mapping

- **Most FIRMs out-of-date**
- **100-year flood misunderstood**
- **Flood forecasts site-specific**
- **No maps associated with forecasts**

Project Goals

- **Pilot a Method to produce and deliver Forecast Flood Maps in near-real-time**
- **Apply state-of-the-art models, data, and software**
- **Develop cooperative relationship with National Weather Service to develop operational tools**

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Description

- NWS flow forecasts fed to hydraulic model
- Model results to GIS
- GIS products to internet map serving software
- Near-real time

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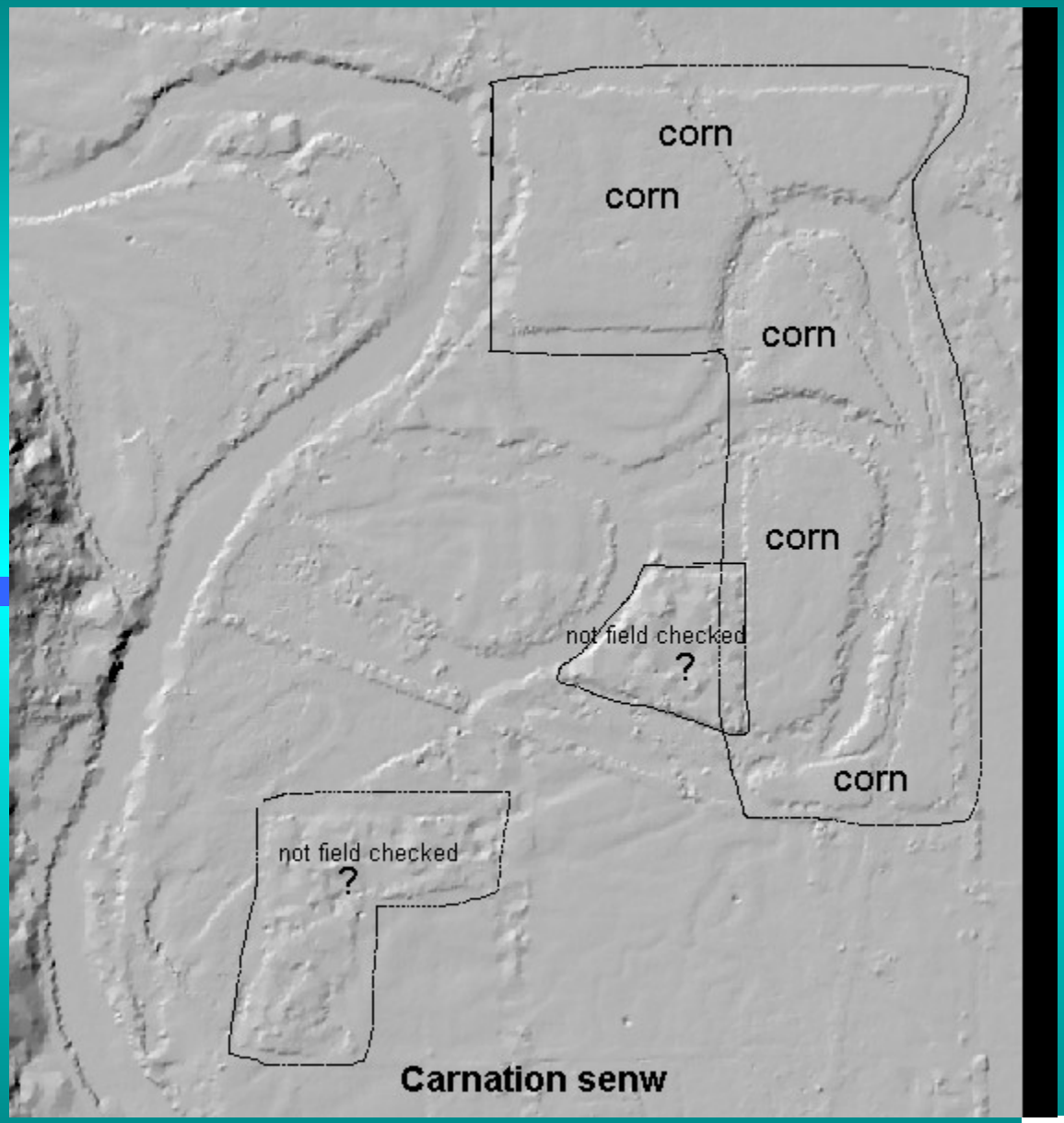
NEW Technology/Data/Models

- New data types: LIDAR very high accuracy digital elevation data
  - +/- 15cm (claimed) vertical accuracy; <$500/mi2; raster, generally dense data
- New hydraulic models: Robust 2-D Finite Difference
  - Accurate, very stable
- New technology: Interactive Internet Map Serving
  - multi-scale, multi-resolution; scalable symbology

USGS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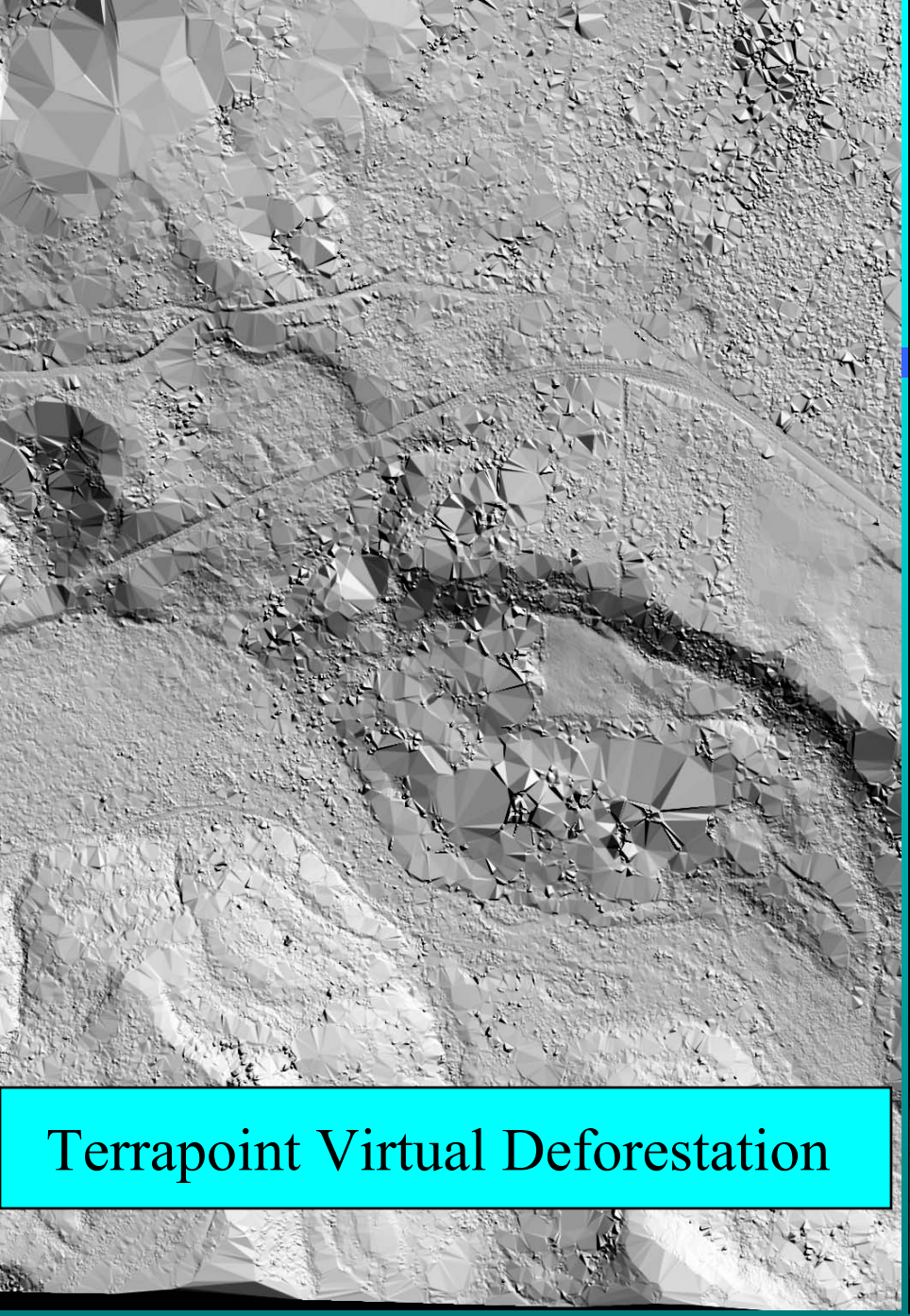
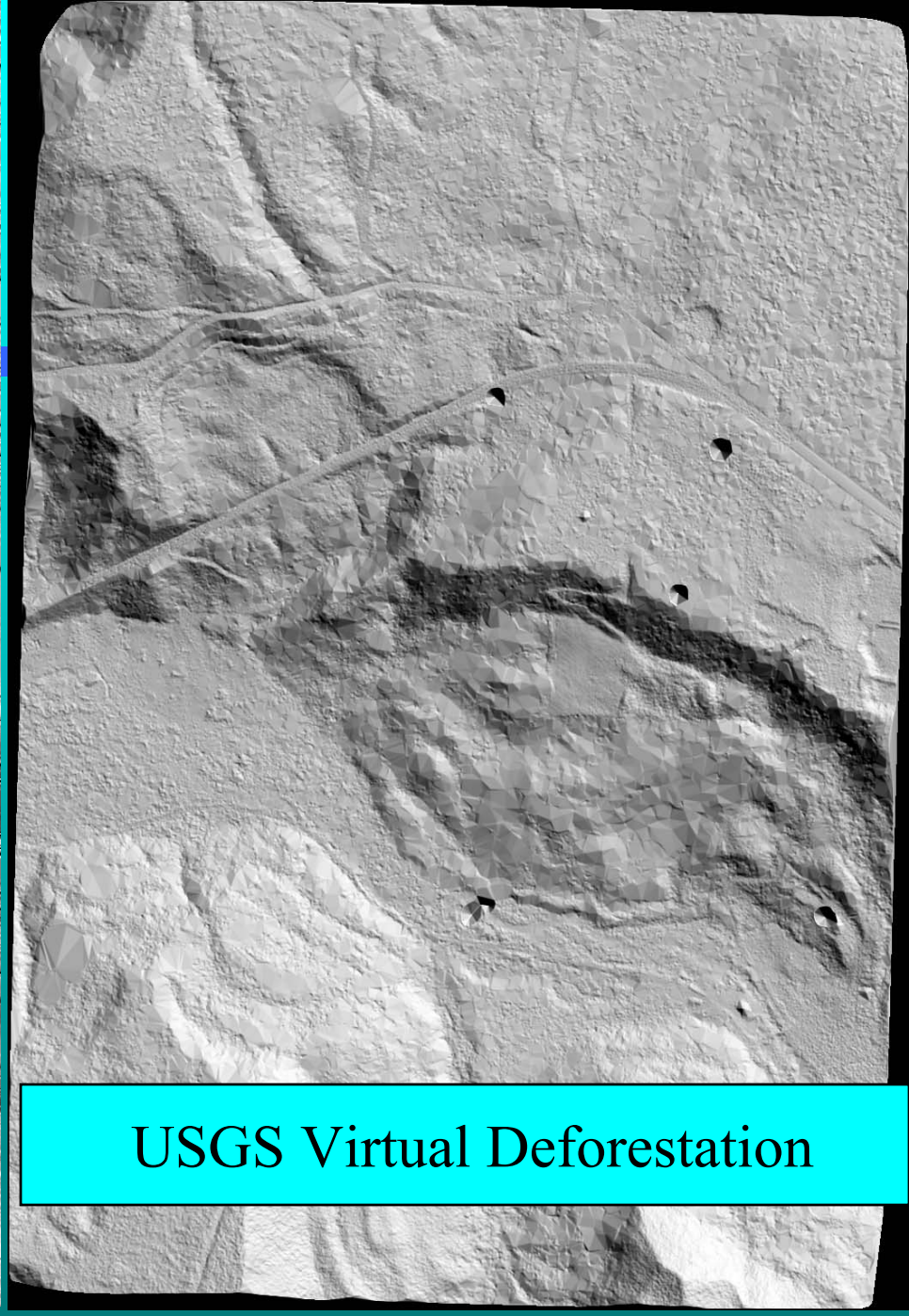

Terrapoint Virtual Deforestation


USGS Virtual Deforestation

NEW Technology/Data/Models

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Project Model: TrimR2D

- **Developer: Vincenzo Casulli, Univ. Of Trento**
- **Solves: shallow-water equations**
- **Method: semi-implicit, semi-lagrangian, finite difference**
- **Survey-wide license acquired for newest version, UnTrim**

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Some Numerical Properties

- **Unstable terms (gravity wave in momentum, transport in continuity) treated implicitly for stability**
- **Staggered grid allows for semi-implicit, semi-explicit solution formulation**
- **Solved by preconditioned conjugate gradient method**
- **Properly accounts for positive and zero depths**

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Model Validation

- Uniform Flow (Manning's equation)
- Extreme conditions (Dam Break)
- Real transient conditions (Chattahoochee River)

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Uniform Flow

$$Q = \frac{1}{n} A R^{2/3} S^{1/2}$$

- **Rectangular flume**
- **4m width x 1000m long**
- **Channel slope is 0.005**
- **Model is 6 by 1001 cells**

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Laboratory Dam Break
(U.S. Army Corps of Engineers)

- 1.219m wide rectangular flume
- Dam is 45.72m from outflow boundary
- Flume slope is 0.005
- Dam is explosively removed
- Time period of 240 seconds

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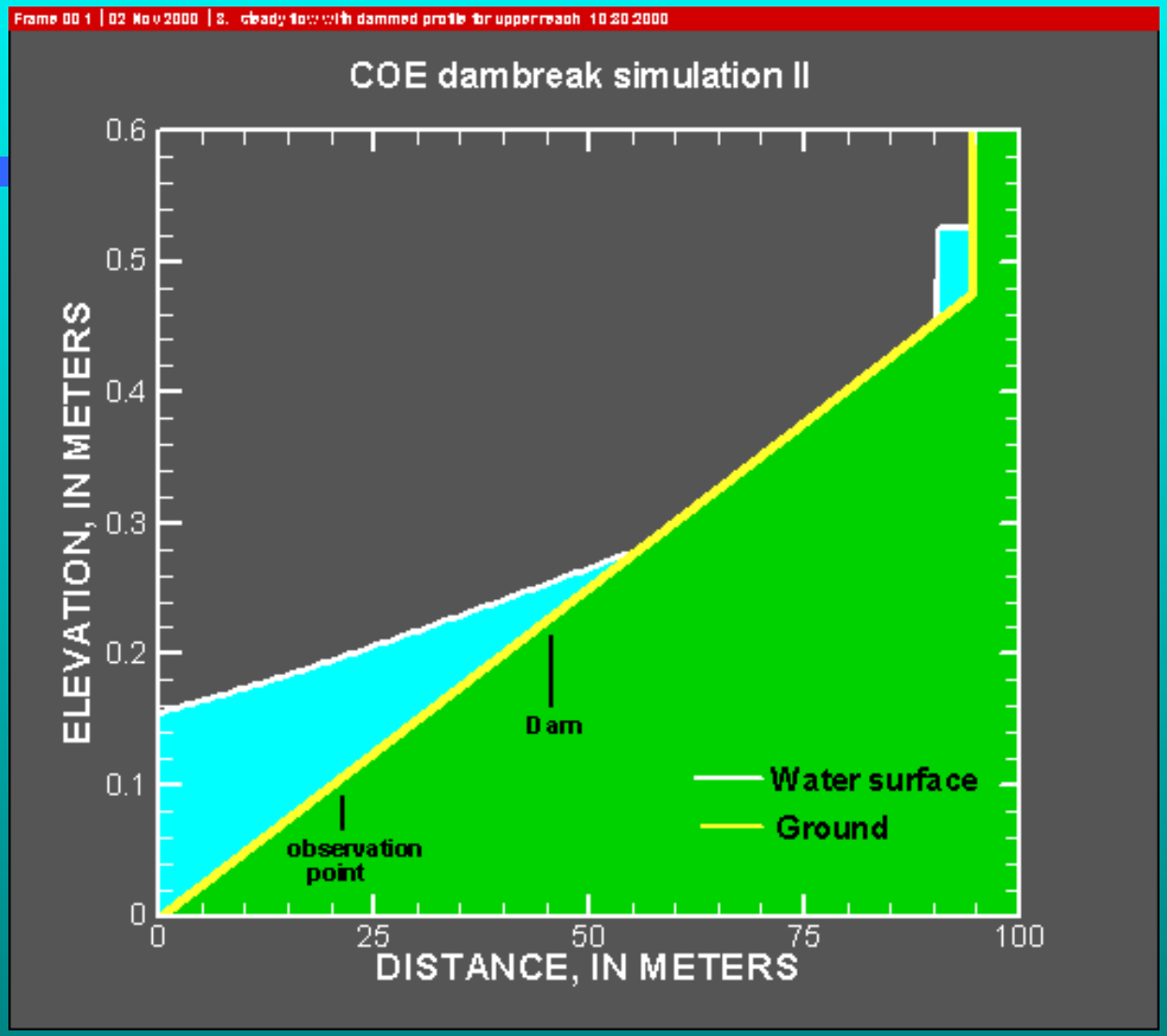
Dam Break Animation



Chattahoochee River
(U.S. Geological Survey)

- Reach is from Littles Ferry Bridge to GA Highway 141 (15 kilometers)
- Time period is March 22-23, 1976 (2250 minutes)
- Two peaks occur, broad and sharp

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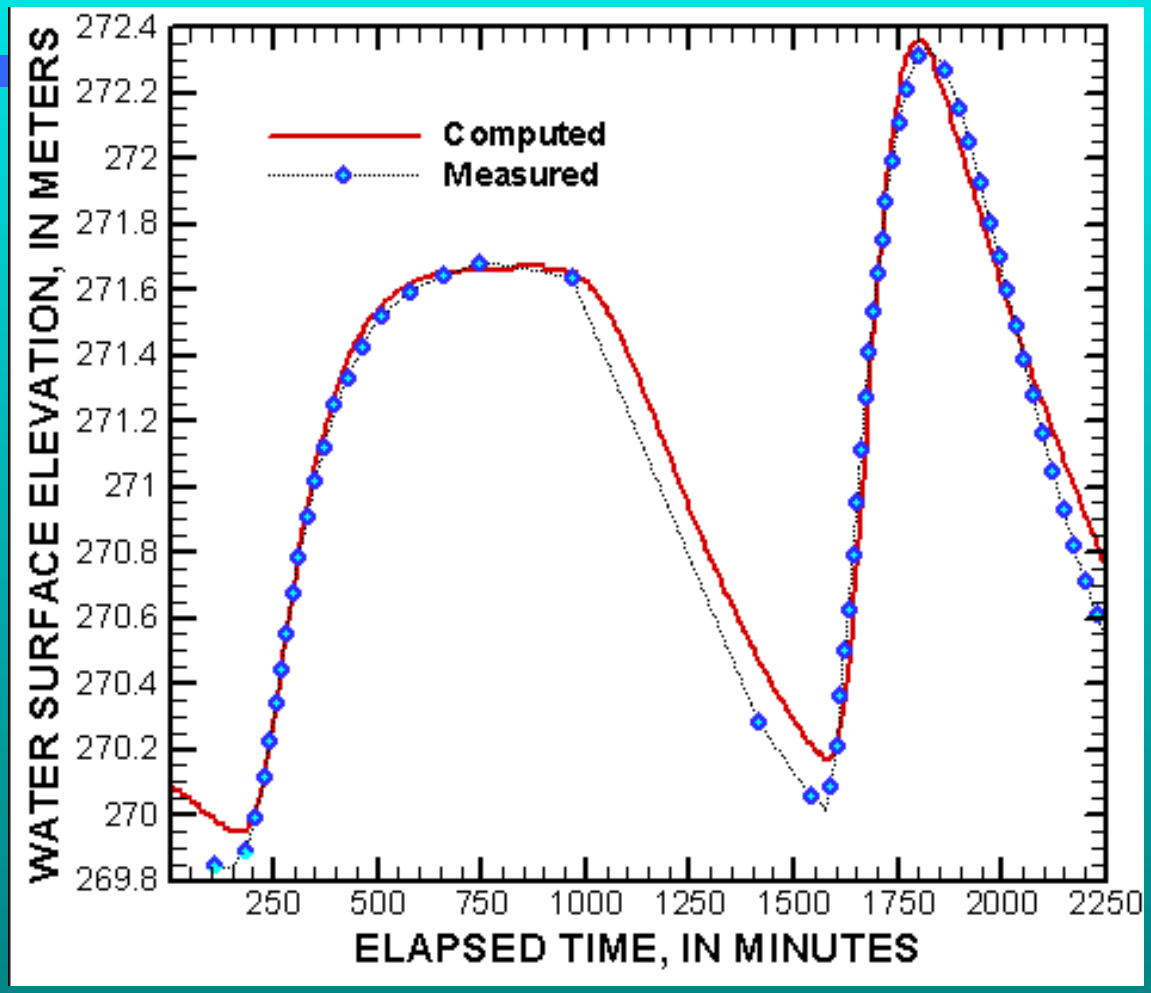
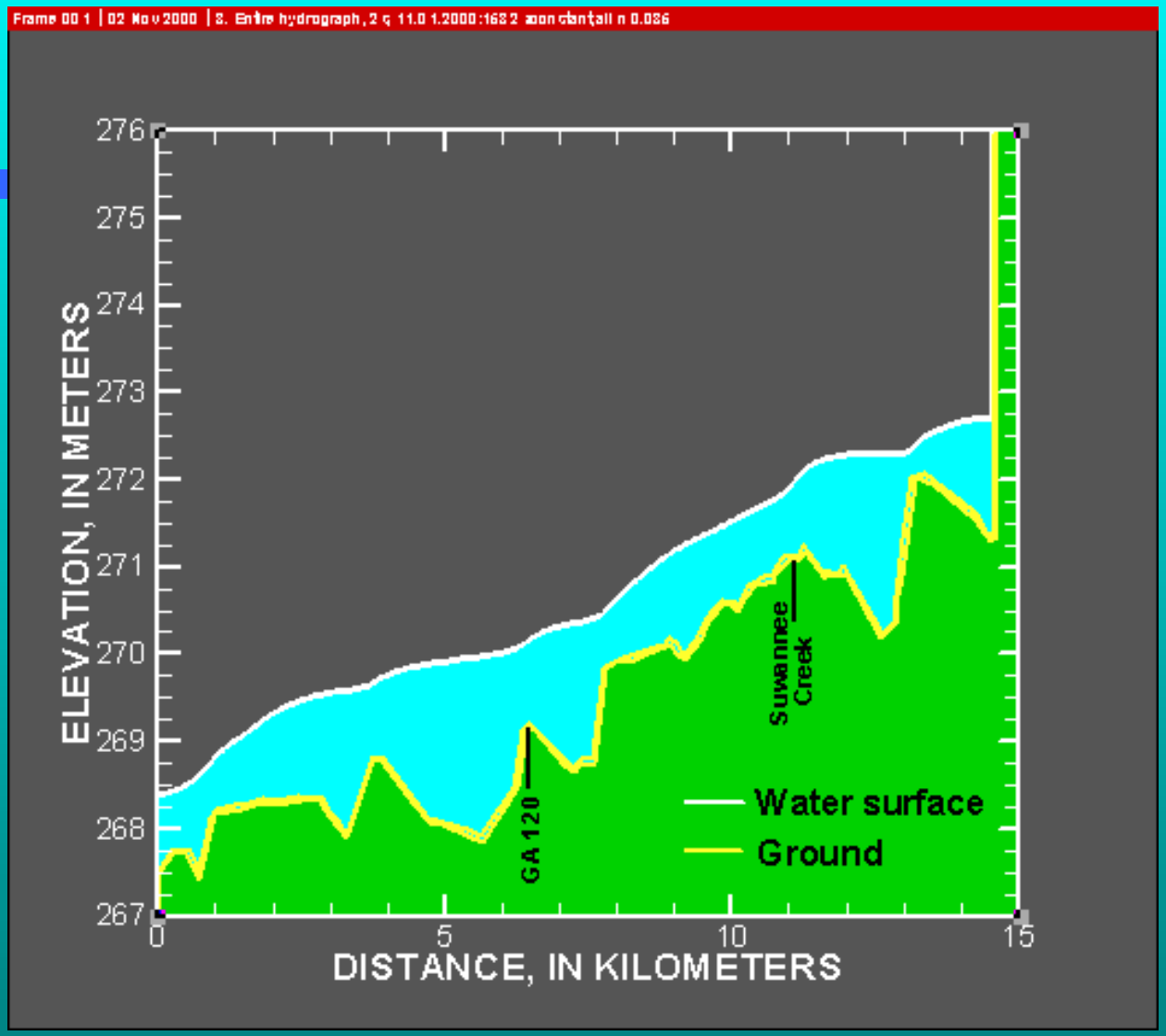
Hydrograph at GA Highway 120



Chattahooche River Animation



Model Validation Summary

- Friction effects handled appropriately
- Doesn’t crash easily
- Wets and dries cells easily
- Compares well with measured data for real rivers
- DEM data should work well for grids

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Snoqualmie River Calibration

- 28 kilometer reach; steep upstream
- Four boundary condition sites
  - 3 inflow hydrograph boundary conditions
  - 1 outflow stage boundary condition
- Calibrated/Verified with 10-year RI floods
  - Calibration; single peak
  - Verification; multiple peaks
- USACOE HWM data for 5 sites

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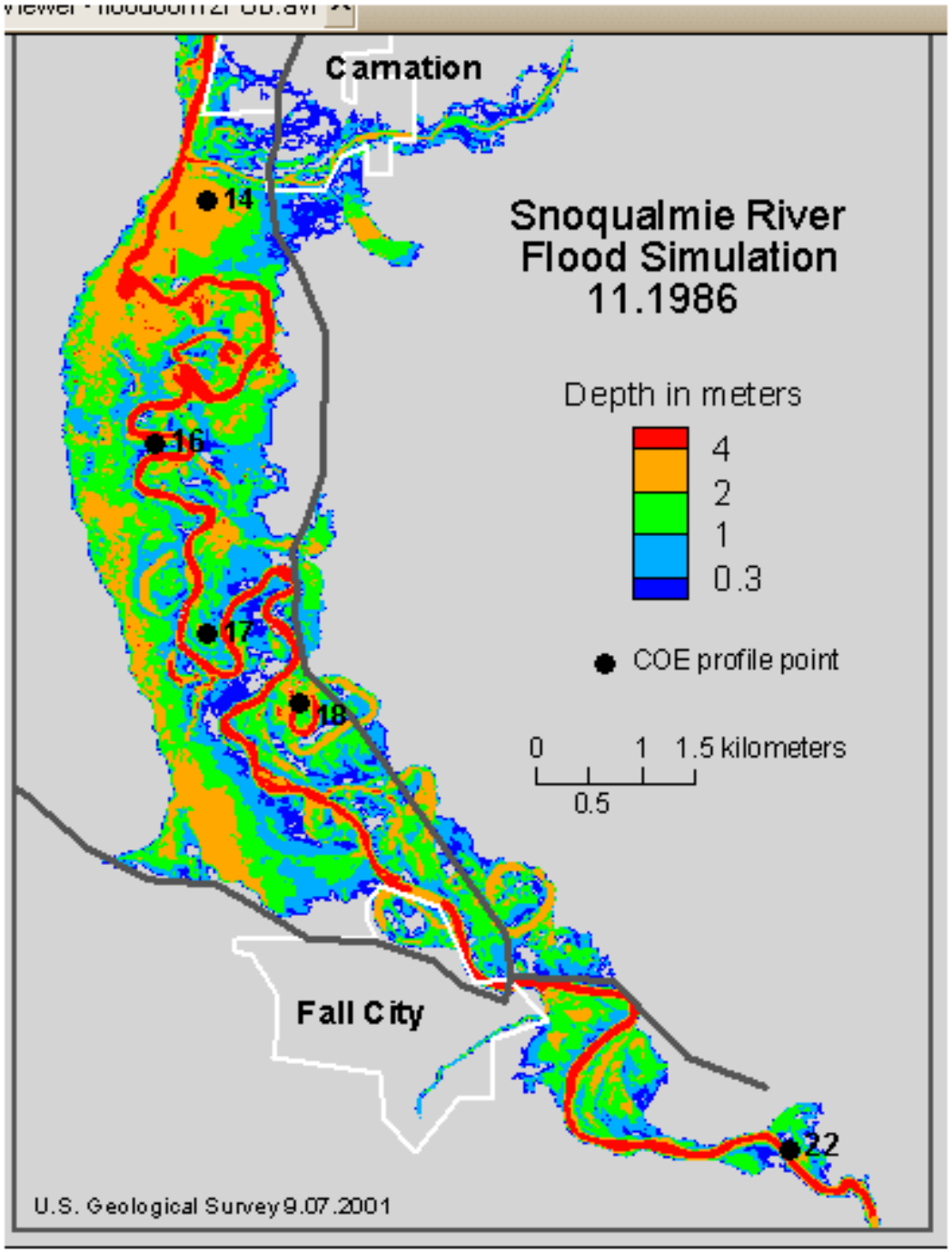
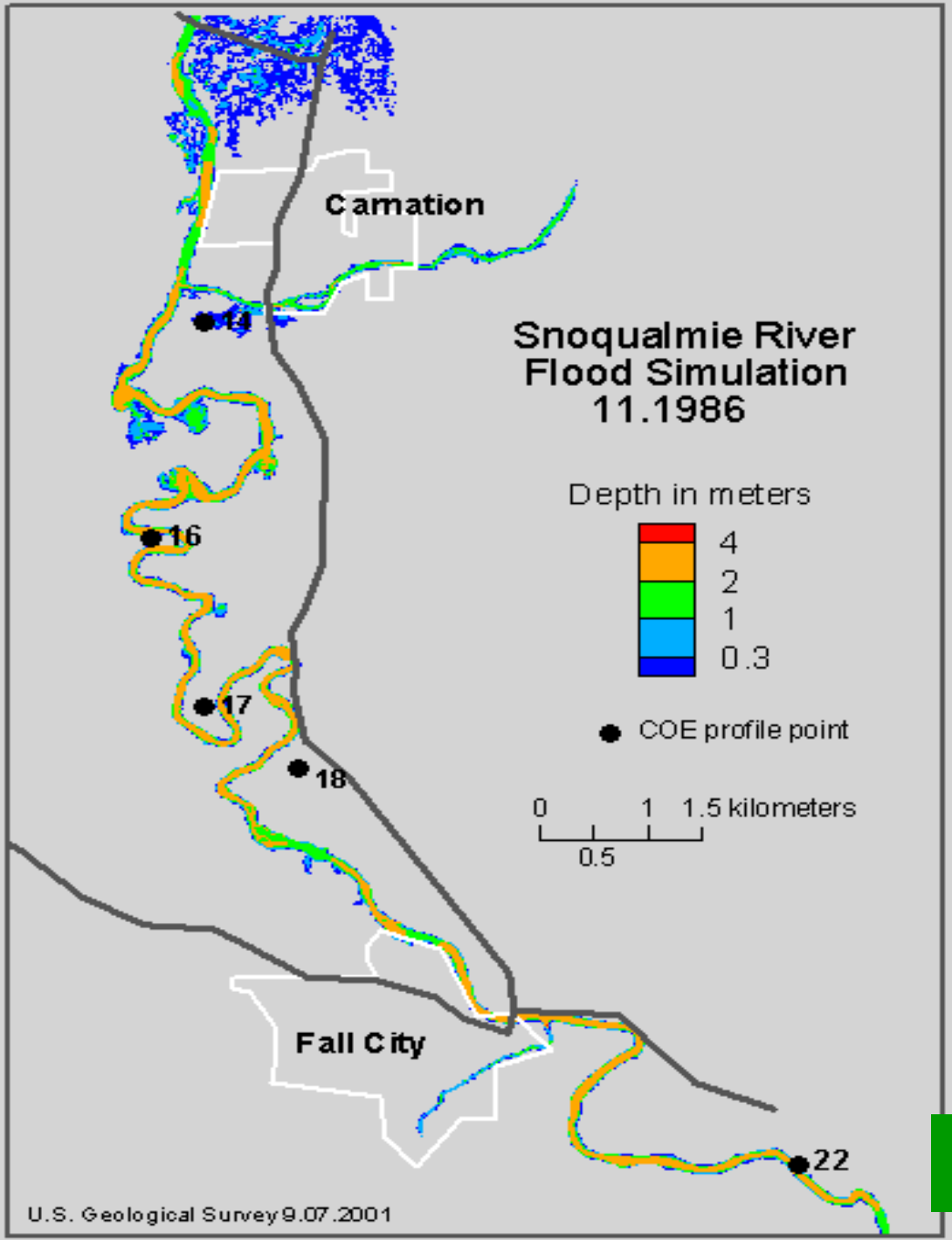


- Calibration (11/86)
  - 10yr RI
  - + 0.7 m at station 22
  - -0.5 m at station 14
- Validation (12/75)
  - 10yr RI
  - + 0.7 m at station 22
  - -0.2 m at station 14


Carnation
Snoqualmie River
Flood Simulation
11.1986
Depth in meters
4
2
1
0.3
COE profile point
0
1
1.5 kilometers
0.5
14
16
17
18
22
Fall City
U.S. Geological Survey 9.07.2001

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Flood Hazards

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- Mapping NWS Flood Forecasts
- Updating Existing Flood Maps Efficiently

Publications and Products
- About Floods
- Ground-Water Flooding
- Updating Flood Maps

Seattle Area Natural Hazards Home Page

Water Resources of Washington State

Other Flood Projects

More Info

Contact Us

The Water Resources Program of the U.S. Geological Survey in Tacoma, Washington, is studying flood hazards in the Seattle area, as part of a 5-year project designed to broaden the scientific understanding of natural hazards in Snohomish, King, Pierce, Thurston, and Kitsap Counties.

Major efforts included:

- **Developing new methods for mapping flood hazard areas;**
- **Piloting real-time mapping of forecast floods for delivery on the Internet;**
- **Identifying the causes and locations of ground-water flooding;**
- **Studying and mapping channel migration hazards.**

Riverine flooding from heavy rainfall and snowmelt is common in the Seattle area. The Seattle area also is affected by localized groundwater flooding and geologically young river channels that are actively eroding and moving. These processes create additional, previously little-known hazards to structures located in the flood plains.

For more information on the natural hazards of the Seattle area, visit the Seattle Area Natural Hazards web page. In addition, the following publications present information on natural hazards of the Seattle area.

U.S. Geological Survey Programs in Washington: U.S. Geological Survey Fact Sheet FS-049-99.

Learning to Live with Geologic and Hydrologic Hazards: U.S. Geological Survey Water-Resources Investigations Report 99-4182. The Fact Sheet is in PDF format. **(PDF:4 pages/347 KB).** Text only accessible version **(PDF:4 pages/195KB)**

Document: Done

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USGS – Flood Hazards – Mapping NWS Flood Forecasts – Snoqualmie River Flood Map Server - Microsoft Internet Explorer

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USGS science for a changing world

Flood Hazards Home Page
Flood Mapping Research
Mapping NWS Flood Forecasts
Updating Existing Flood Maps Efficiently

Snoqualmie River Flood Map Server

AutoDesk Tools

- Use the magnifying glass icons to zoom in (+), out (-), or to a specific scale (->)
- Use the little hand to pan.
- Turn 'layers' on or off by clicking the check boxes.

The current stage at the Snoqualmie River downstream of the Falls is **12.33** as of **Nov 19 10:54**

Click here to see a graph of stage and discharge downstream of Snoqualmie Falls

Click here to see a graph of stage and discharge near Carnation and click here to see hydrologic forecasts from NOAA's Northwest River Forecast Center

The START TIME for this Model Simulation is 0100 PDT, November 23, 1986 --a flood used for model calibration.

Zoom into your area of interest and select the flood information to view (note: you may have to "deselect" the previous information to avoid clutter).

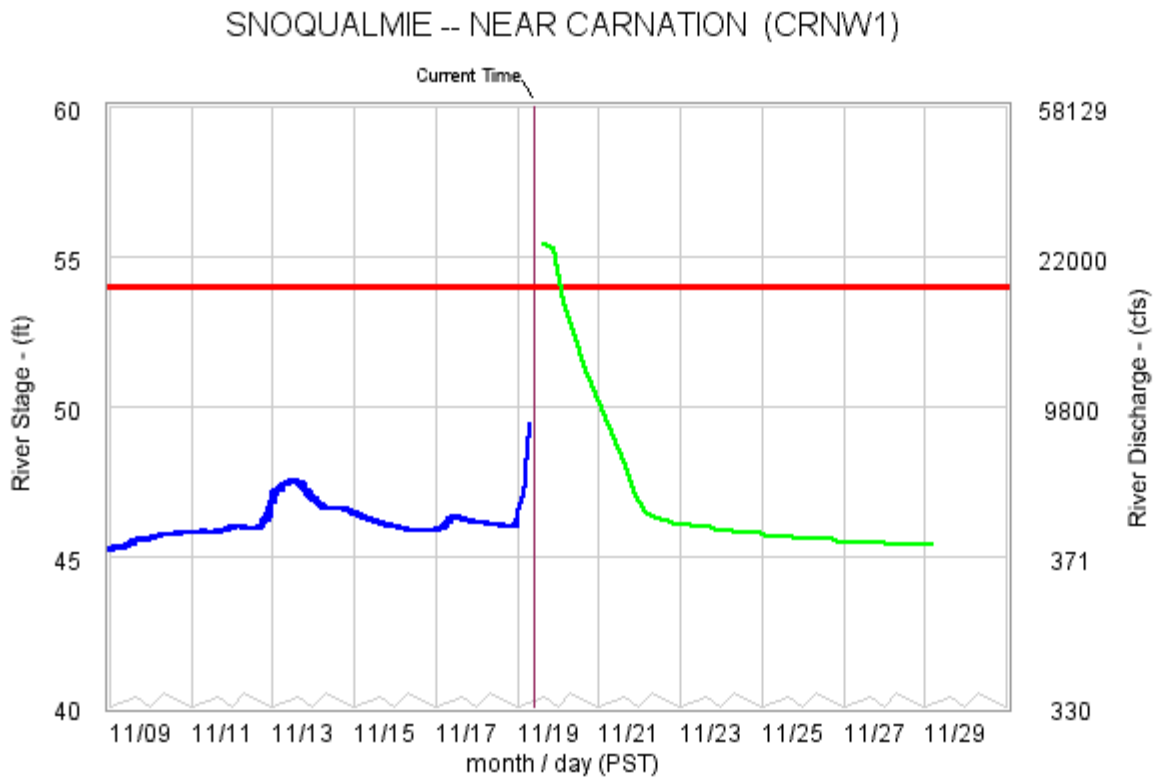
autodesk

SNOQUALMIE--NEAR CARNATION (CRNW1)

County: KING State: WA
Elevation: 60 (feet) Latitude: 47 39' 58" Longitude: 121 55' 27"
Flood Stage: 54.00 (feet)

River Information Plots

The following data is preliminary and subject to change



Latest: 49.39 ft 8434 cfs (44% of flood flow) [11/19 07:00]

Created: Tue Nov 19 10:13:15 PST 2002

Autodesk MapGuide Author - [Map1 - G:\hazards\mwf\snoq.mwf]

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- Snoqualmie basin
- Pilot project area, model boundary
- Primary roads
- Secondary roads
- Surface water gages
- Snoqualmie River
- Topographic quads 16m
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Design View

0 feature(s) selected | 1 : 342,131 | 36.1 x 32.5 (mi)

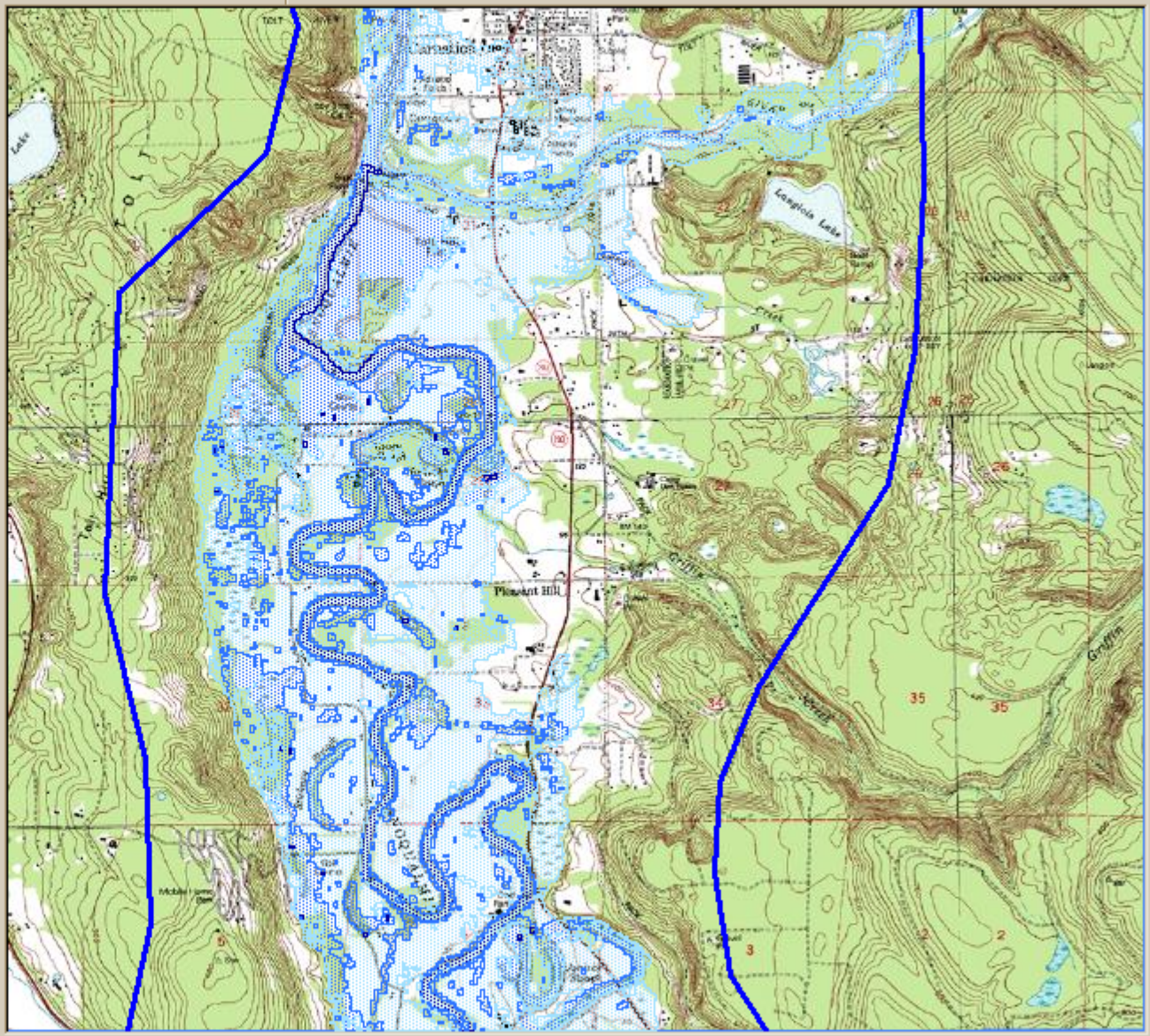
142470 bytes transferred

Autodesk MapGuide Author - [Map1 - G:\hazards\mwf\snoq.mwf]

File Edit Navigate Bookmarks Select View Window Help

- Snoqualmie basin
- Pilot project area, model boundary
- Surface water gages
- flood depth (calibration flood displayed when th
  - .1 - 2 feet deep
  - 2 - 5 feet deep
  - greater than 5 feet deep
- Aerial Photo 4m
- Topographic quads 8m

Design View



0 feature(s) selected | 1 : 44,370 | 4.68 x 4.21 (mi)

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- Snoqualmie basin
- Pilot project area, model boundary
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- flood depth (calibration flood displayed when th
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  - 2 - 5 feet deep
  - greater than 5 feet deep
- Aerial Photo 4m
- Topographic quads 8m

Design View

Snoqualmie basin : | 0 feature(s) selected | 1 : 24,413 | 2.57 x 2.32 (mi)

14938 bytes transferred

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- Snoqualmie basin
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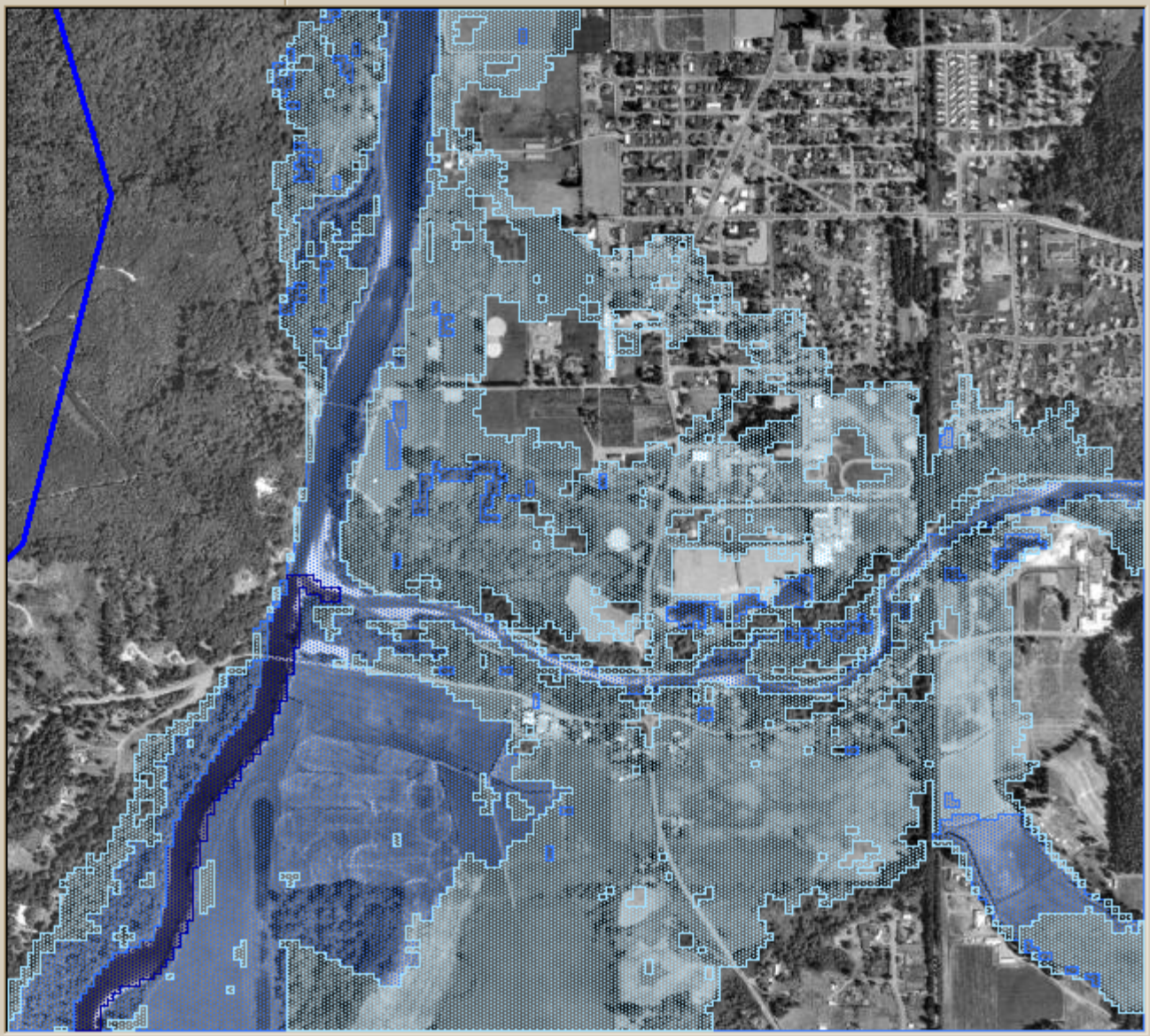
- Surface water gages
- flood depth (calibration flood displayed when th
  - .1 - 2 feet deep
  - 2 - 5 feet deep
  - greater than 5 feet deep
- Topographic quads 4m (optional)
- Aerial Photo 2m

Design View



Snoqualmie basin : | 0 feature(s) selected | 1 : 16,097 | 1.70 x 1.53 (mi)

7055 bytes transferred

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- Snoqualmie basin
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  - .1 - 2 feet deep
  - 2 - 5 feet deep
  - greater than 5 feet deep
- Topographic quads 2m
- Aerial Photo

Design View

Snoqualmie basin : | 0 feature(s) selected | 1 : 5,886 | 3,275 x 2,948 (ft)

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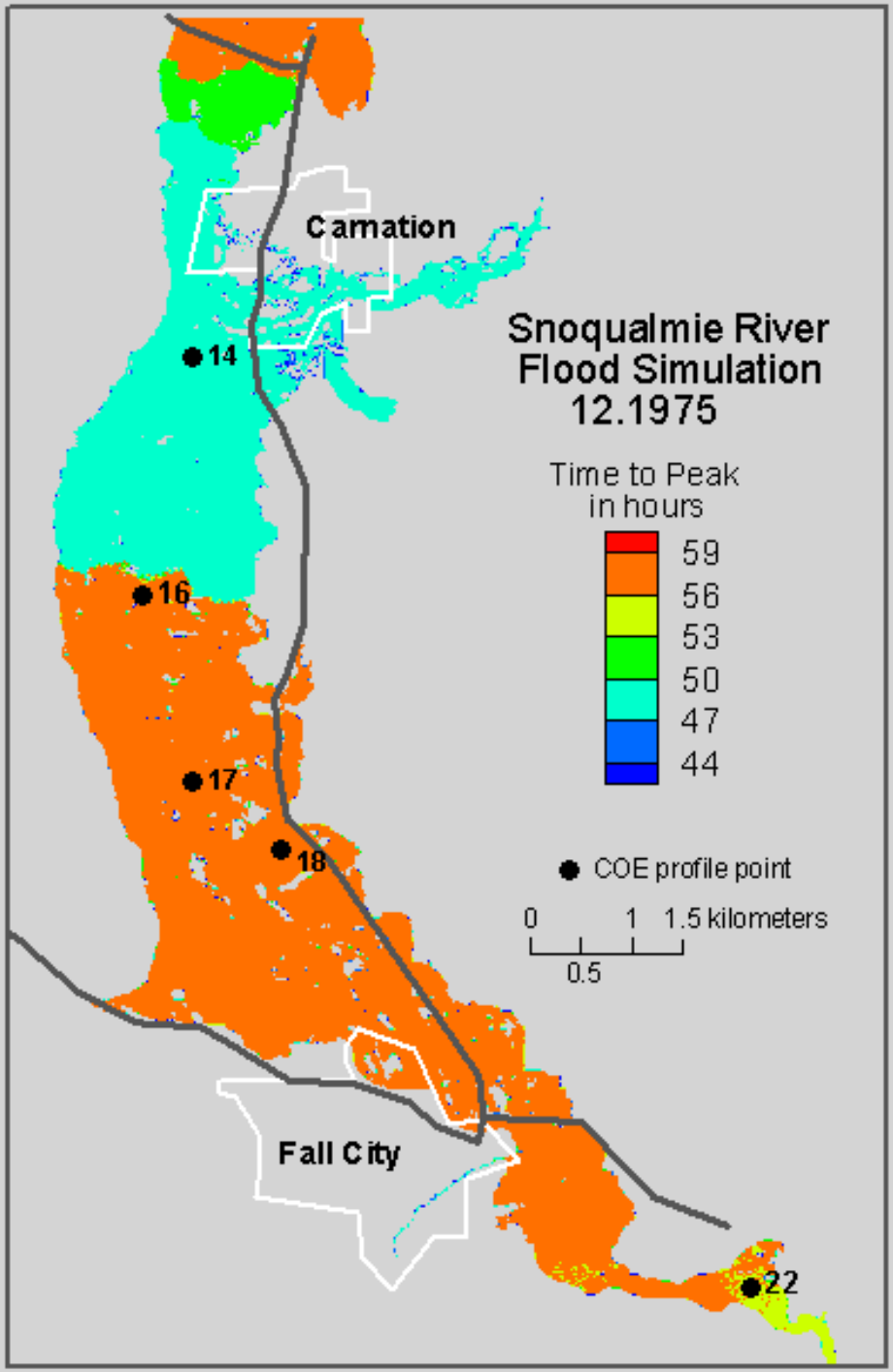
Carnation
Snoqualmie River
Flood Simulation
12.1975
Time to Peak
in hours
59
56
53
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47
44
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22
COE profile point
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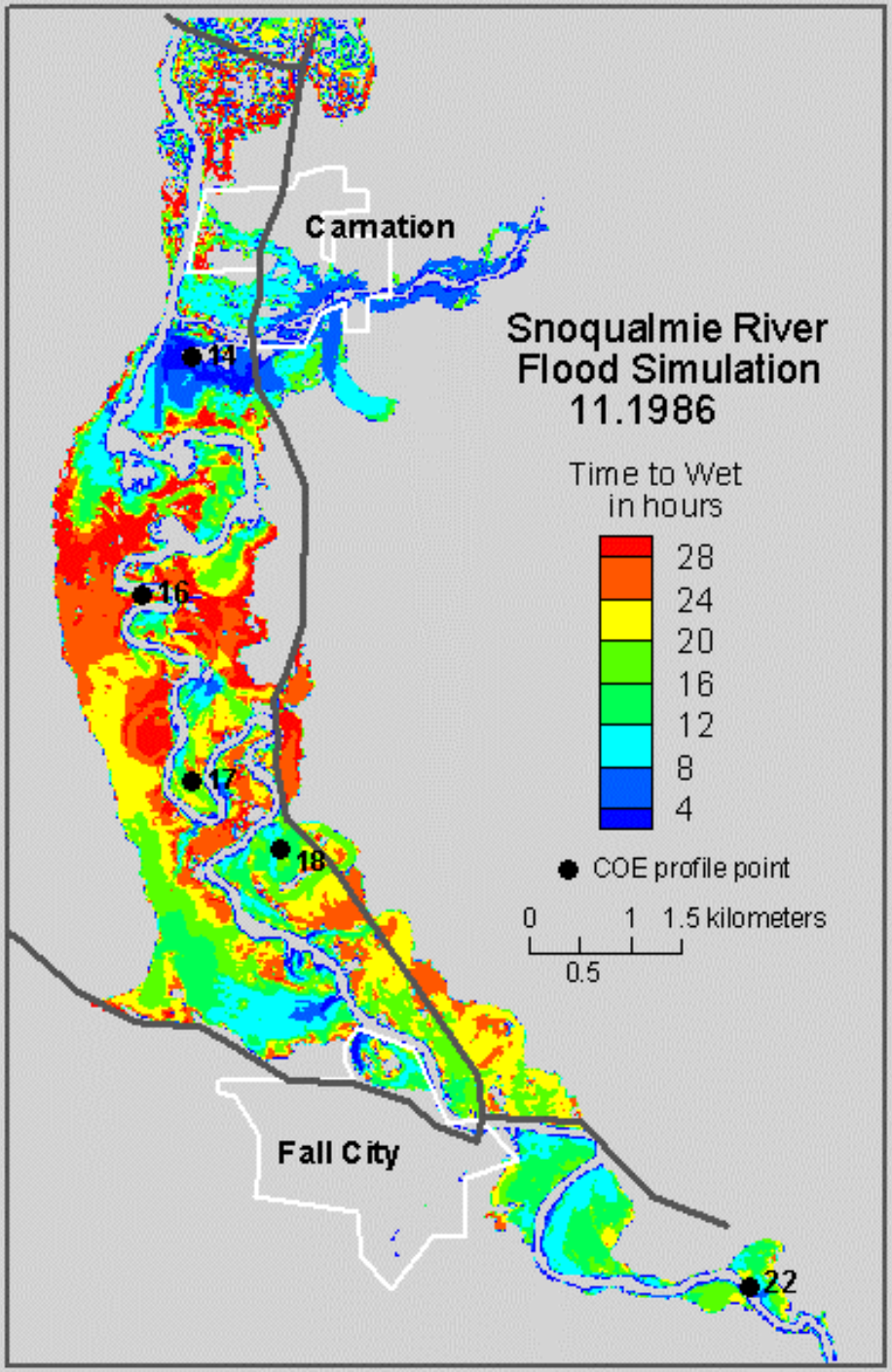
Fall City


Carnation
Snoqualmie River
Flood Simulation
11.1986
Time to Wet
in hours
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COE profile point
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1.5 kilometers
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Fall City

On-going Work

- Additional validation--pressure transducers in flood plain
- Univ. of WA collaboration
  - 2-D validation methods
  - Continuous modeling (UnTrim; pseudo FE)
  - Improved precip and hydrologic models
- National Weather Service 1-D vs 2-D comparison
- Flood Hazard Map Modernization
- Research vs Operational (NWS) Tools