Snake River Plain Model Upgrade

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Introduction

- Model History
- How We Got Here
- Collaborators
- What’s New
- Data Sources
- Model Details
- Model Calibration

Model History

- Original Model Built in 1970s
  - Built by University of Idaho/IDWR
  - Used Home-Grown Modeling Code
  - Calibrated using 1980 Conditions
- Converted to MODFLOW in 1997
- Model Expanded to Include Henrys Fork

How We Got Here

- Increased Need for Conjunctive Management
  - Recognized Model is Best Tool
  - Concerns About Model Accuracy and Documentation of Changes
- Original Model Calibrated to 1980 Conditions
- Water Budget not Balanced
- Model Not Well Documented

How We Got Here (cont'd)

- Need for Enhanced Model
- Eastern Snake Hydrologic Modeling Committee Formed in 1998
- Assessed Modeling Needs in Basin
- Idaho Power Volunteered Matching Funds
- Idaho Legislature 3-Year Appropriation

Collaborators

- Idaho Department of Water Resources
  - Paul Castelin, Program Manager
  - Garth Newton
  - John Lindgren
  - Hal Anderson
  - Dick Lutz
  - Brenda Gilliland

- Idaho Water Resources Research Institute
  - Donna Cosgrove, Technical Lead
  - Bryce Contor
  - Allan Wylie
  - Gary Johnson
  - Rodger Jensen
  - Rick Allen

Collaborators (cont'd)

- Idaho Power
  - Jon Bowling
  - Pete Vidmar
- U.S. Geological Survey
  - Dave Clark
  - Steve Lipscomb
  - Pat Lambert
  - Jon Hortness

Collaborators (cont'd)

- Bureau of Reclamation
  - R. D. Schmidt
  - Jim Oakleaf
- Outside Consultants (representing interest groups)
  - Chuck Brockway
  - Chuck Brendecke
  - Greg Sullivan
- Calibration Consultant
  - John Doherty

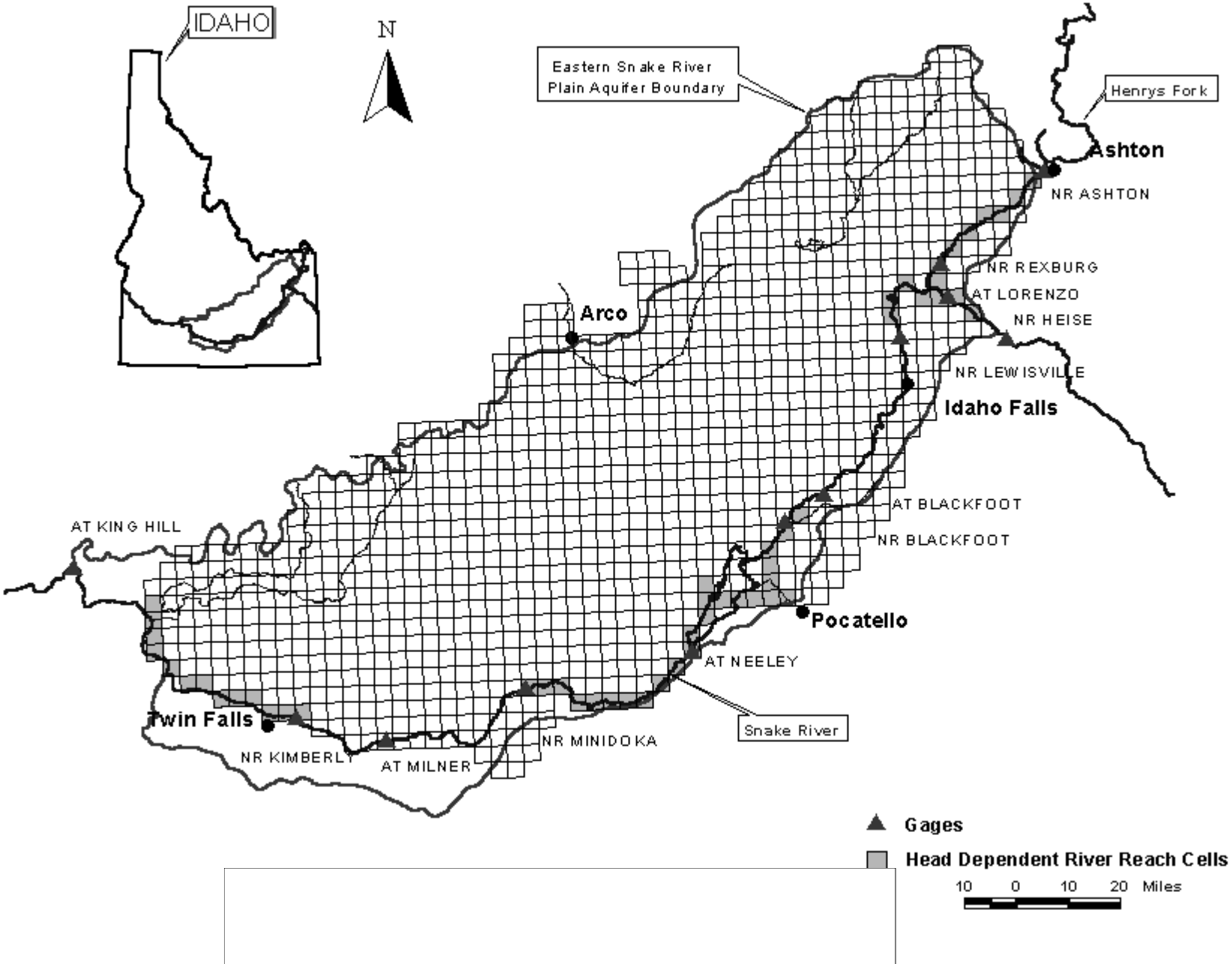
Approach

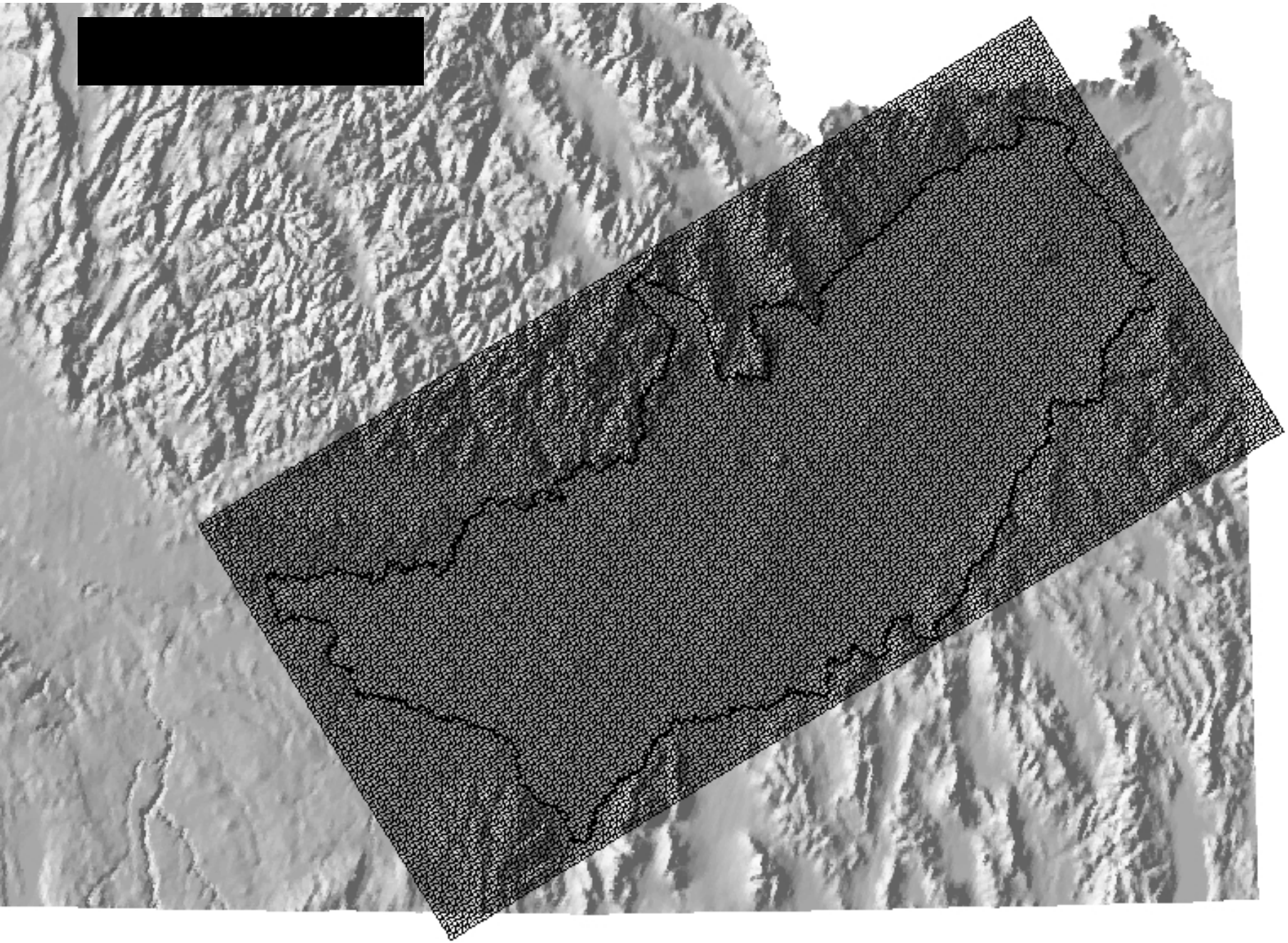
- IDWR and IWRRI led the effort
  - Weekly or bi-weekly video conferences
- ESHMC Reviewed Design Decisions
  - Quarterly Meetings
  - Design Documentation
- Open Review
  - Provided Critical Feedback
  - Fostered Acceptance by all Parties

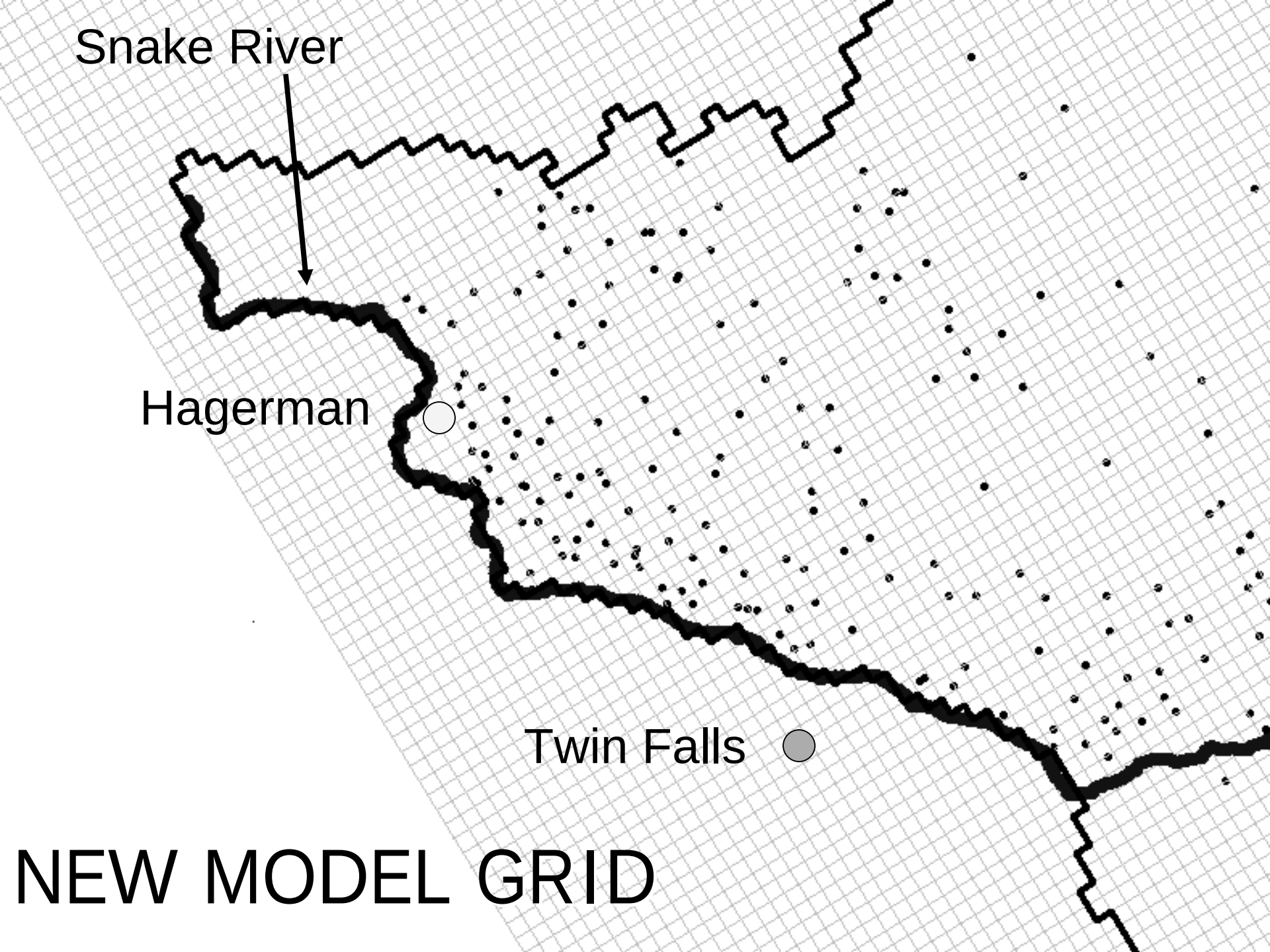
What’s New

- 22-Year Recharge/Discharge Data Set
- Smaller Grid Size
  - 1 mile x 1 mile
  - Approximately 11,000 Active Cells
- Better River Representation
- Calibration Using Automated Tools
  - Matches to Thousands of Data Points

Original Model Grid



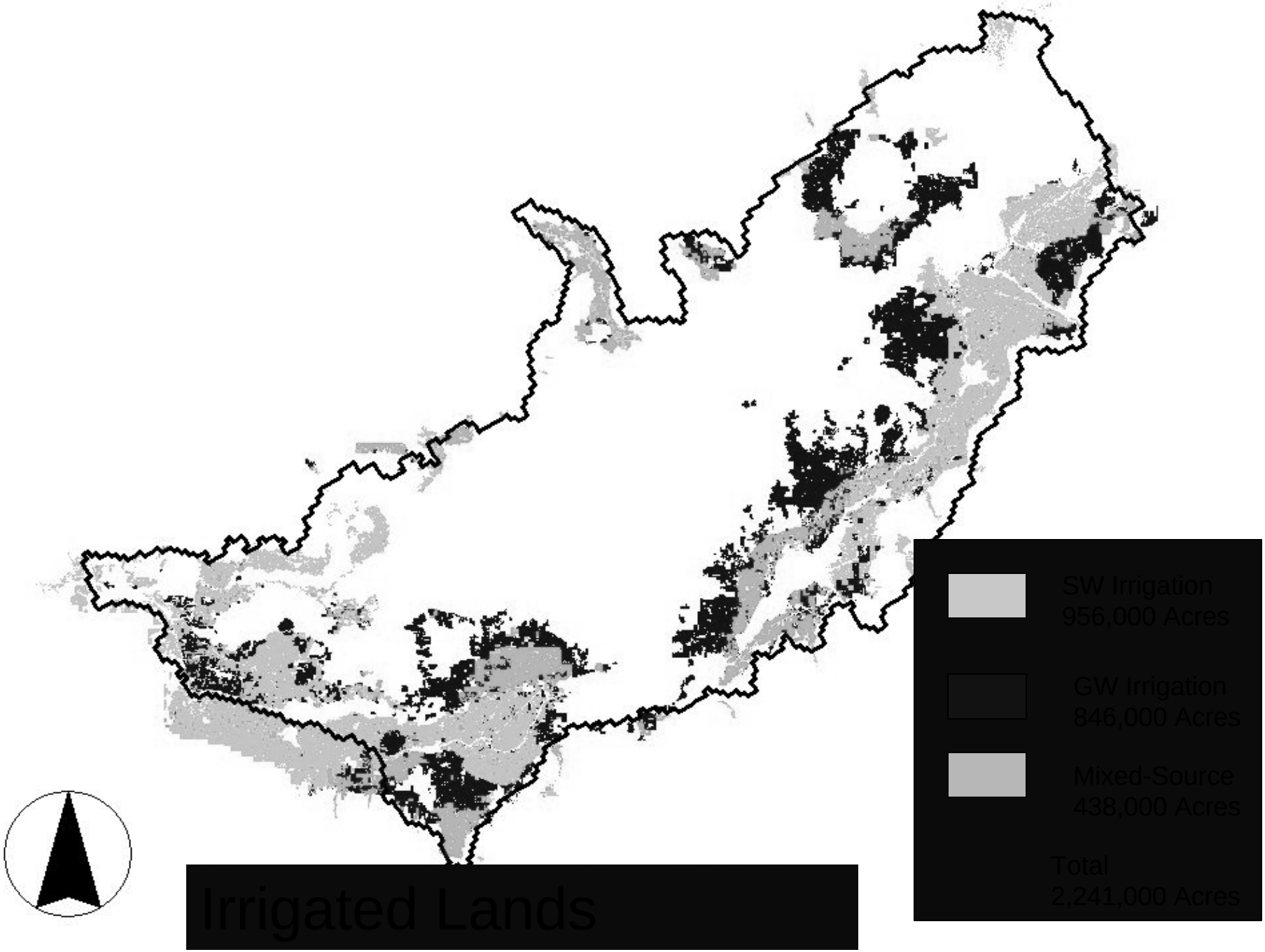




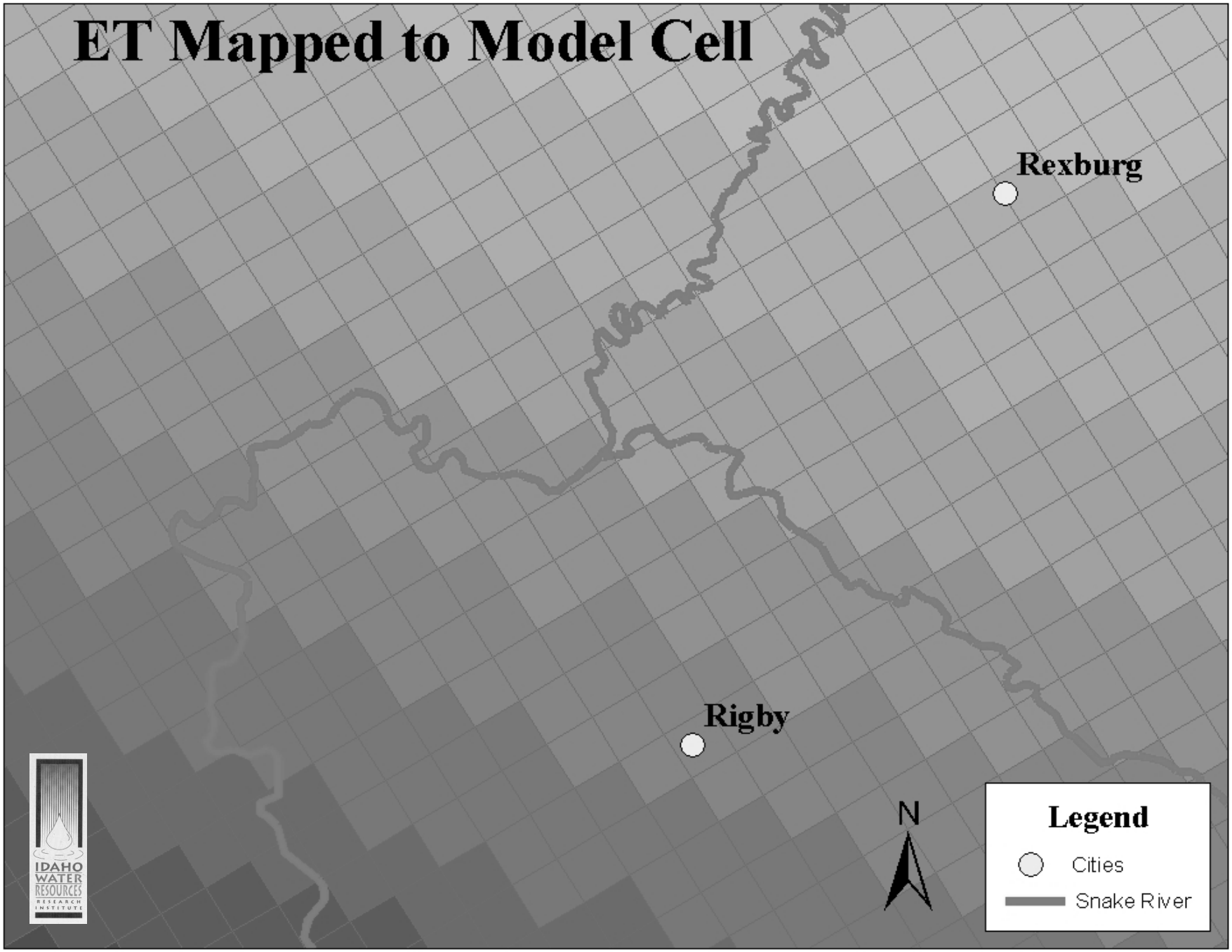
NEW MODEL GRID

Data Sources

- Previous Reports
  - USGS Snake Plain Reports
  - IDWR Reports
  - IWRRI Reports
- USGS Stream Gage and Water Level Data
- IDWR GIS Data
- Watermaster Records
- National Weather Service
- National Agriculture Statistics Service


SW Irrigation
956,000 Acres
GW Irrigation
846,000 Acres
Mixed-Source
438,000 Acres
Total
2,241,000 Acres
Irrigated Lands

ET Mapped to Model Cell



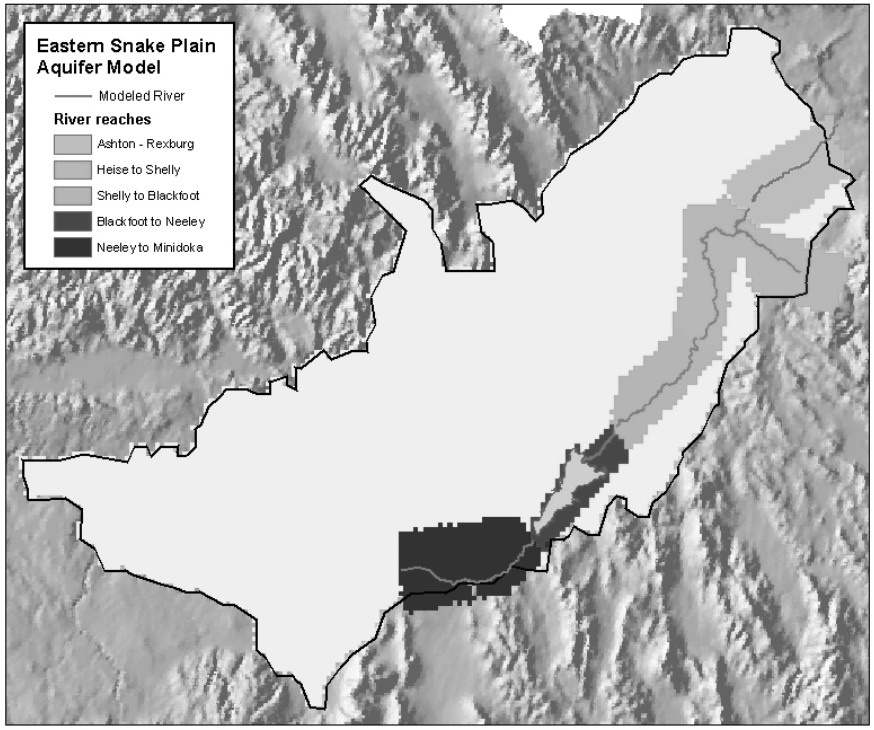
Field Data Collected

- Three Synoptic Water Level Measurements
  - Conducted by USGS
- Acoustic Doppler Stream Gaging
  - Conducted by Idaho Power and USGS
- Irrigation Return Flows
  - Conducted by Idaho Power
- Conducted Field Interviews with Canal Company Managers

Model Details

- Numerical Model Using USGS Modflow
- 104 Rows, 209 Columns, Single Layer
- Represented Aquifer as Confined System
  - Generally Accepted as Unconfined
  - Behaves More Like Confined System
- Five Snake River Reaches
- Six Spring Reaches (Thousand Springs Area)

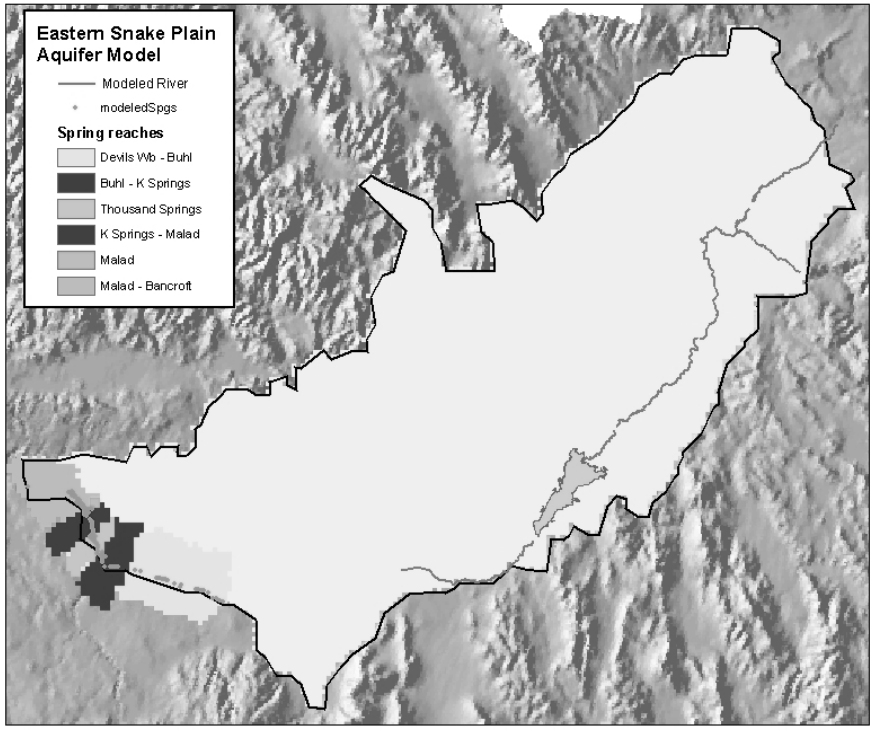
Snake River



- 5 river reaches above Minidoka
  - Ashton to Rexburg
  - Heise to Shelly
  - Shelly to Blackfoot
  - Blackfoot to Neeley
  - Neeley to Minidoka

230 river cells

Springs



- 6 Spring reaches
  - Devils Washbowl – Buhl
  - Buhl – Thousand Springs
  - Thousand Springs
  - Thousand Springs – Malad
  - Malad
  - Malad – Bancroft

45 drain cells

Model Calibration

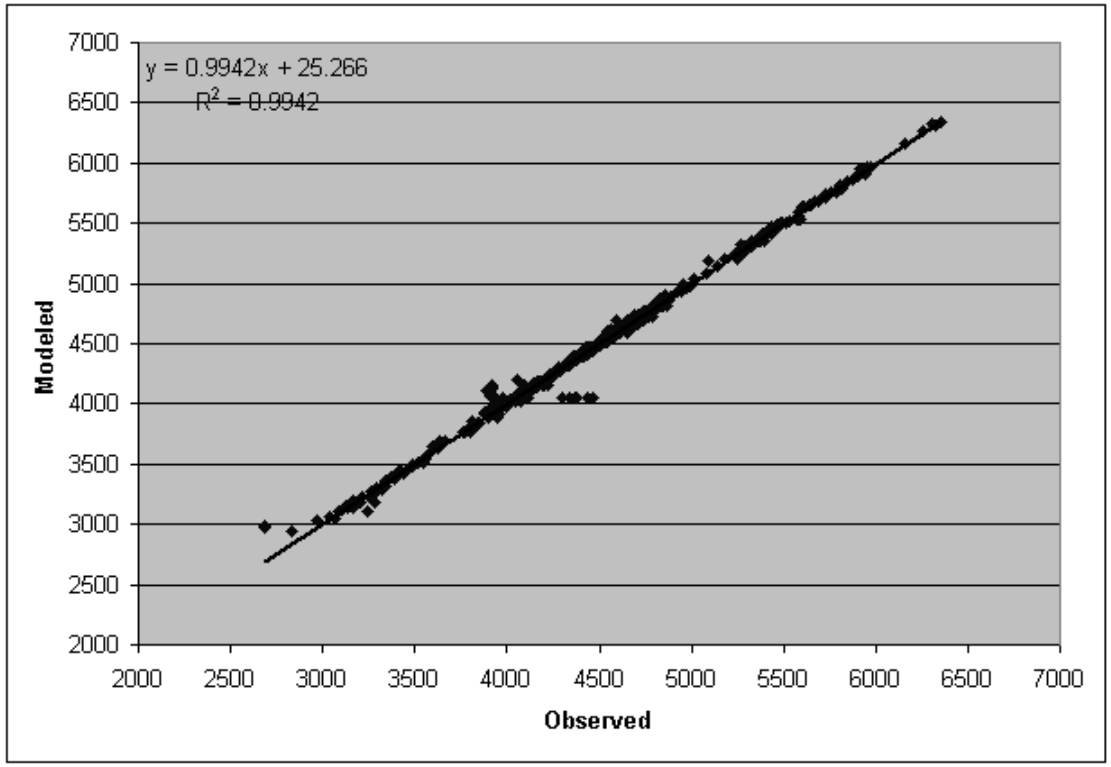
- Calibrated to 22 Years of Data
  - Data Represented in 6-Month Increments
- Calibrated Model Parameters
  - Transmissivity
  - Storativity
  - River and Spring Conductance
  - Spring Elevation
- Used PEST Parameter Estimation Software
  - Initially Calibrated Steady State
  - Ultimately Coupled Steady State and Transient

Model Calibration (cont'd)

- Measured Observations
  - Hydraulic head targets
  - River reach gains and losses
  - Individually Measured Springs
- Calibration Method
  - Seasonal Changes in Aquifer Water Levels
  - Long Term Trends in Water Levels
  - Changes in Spring Discharge
  - Mean and Standard Deviation of Spring Discharge

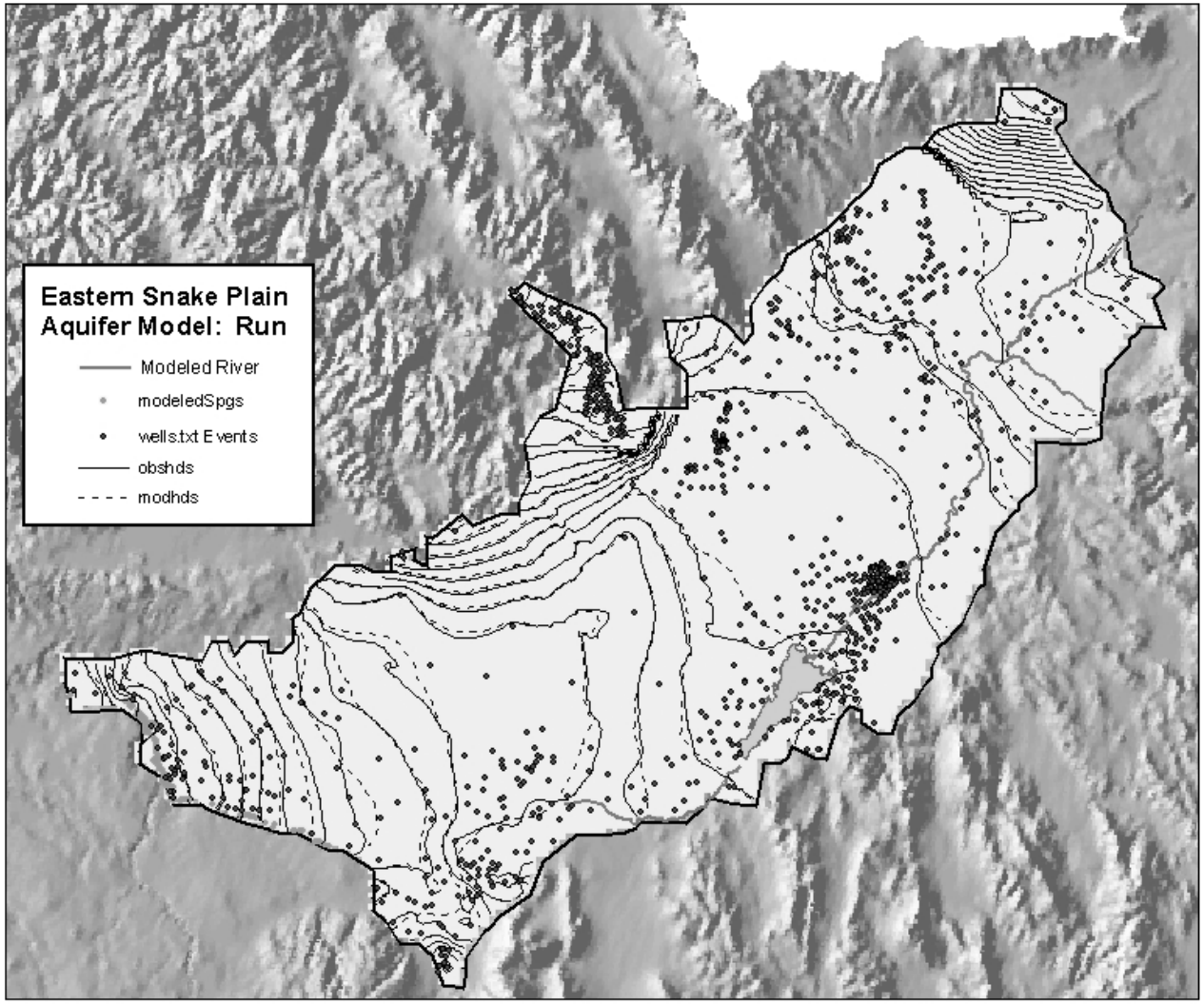
Calibration Results

Steady State Head Matches

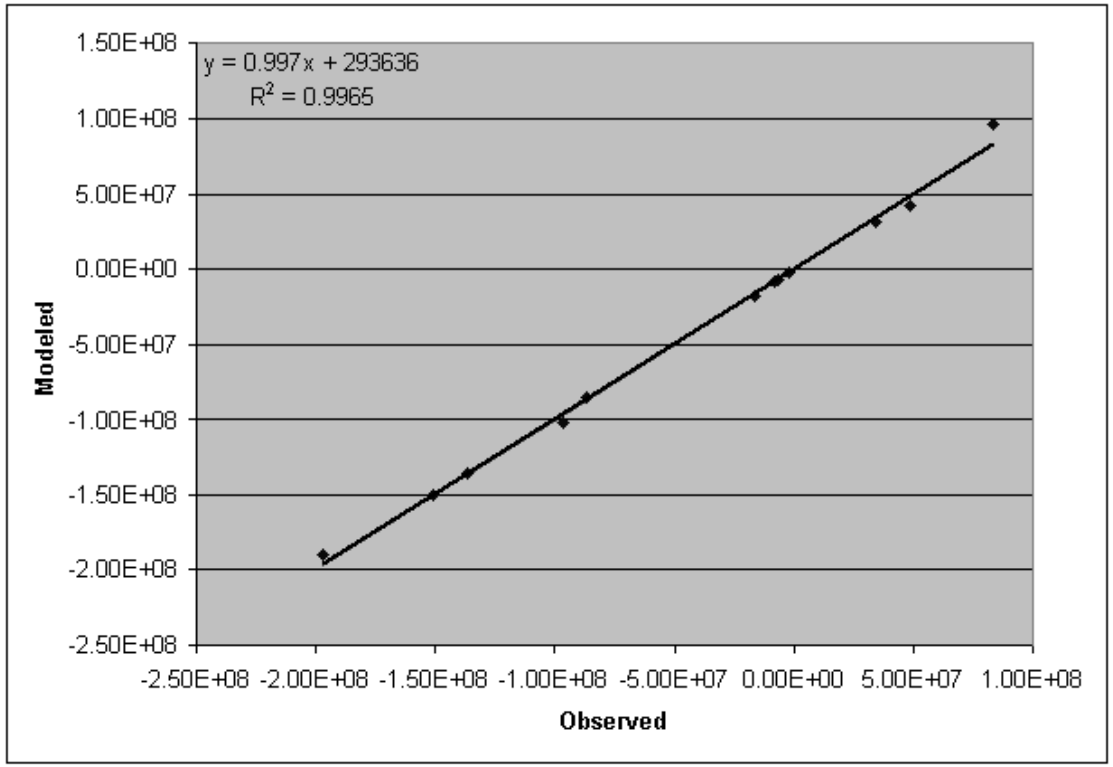


- Head
  - Pink line is 45°
  - If this were a perfect match
    - Y=1x + 0
    - R^2 = 1

Steady State Water Table

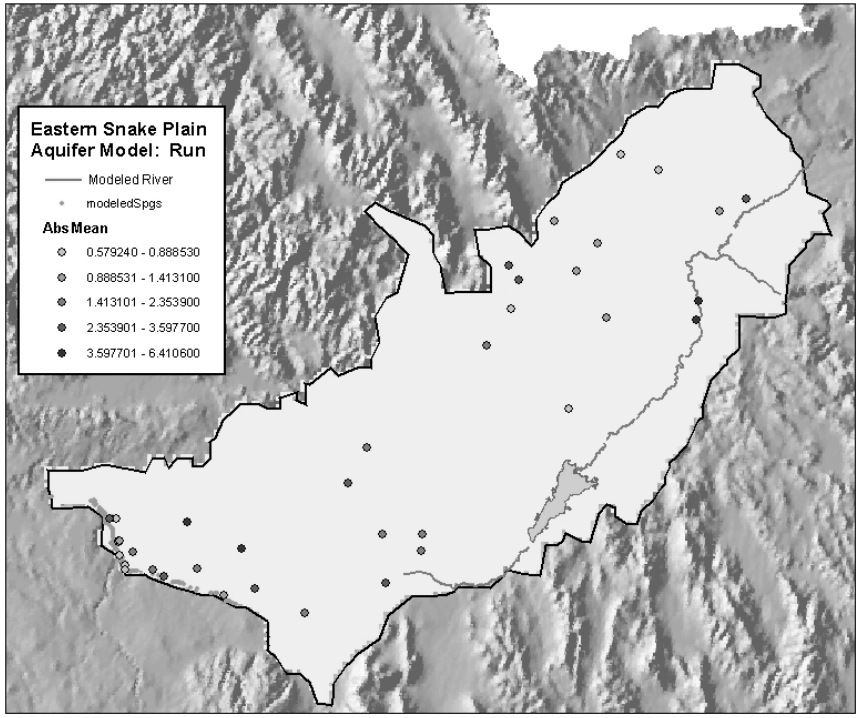


Steady State River Gains and Losses



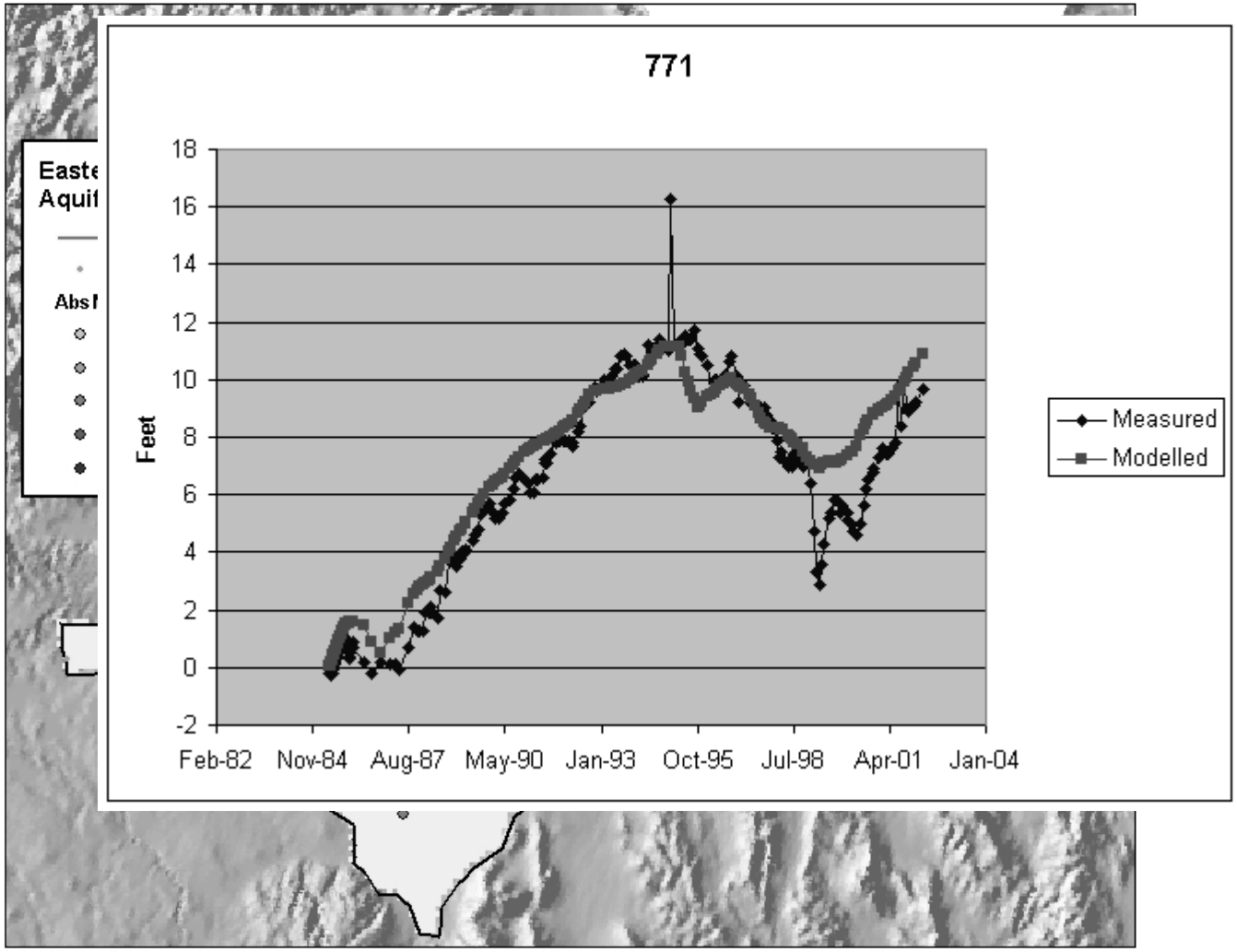
- Gain and loss match
  - Pink line is 45°
  - If this were a perfect match
    - Y=1x + 0
    - R^2 = 1

Transient Seasonal Data Set

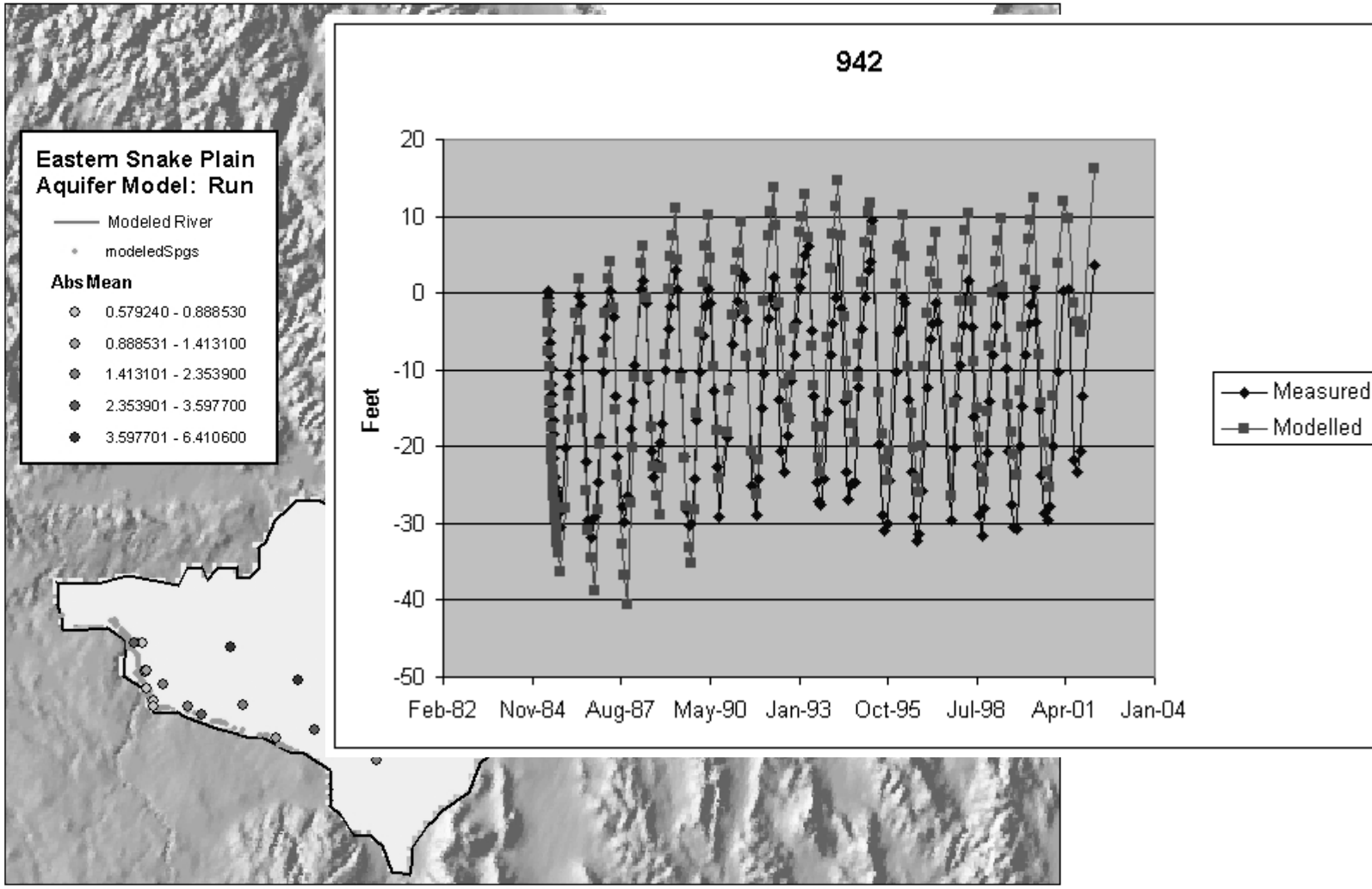


- Hundreds to thousands of observations
  - Lots of data
  - Limited spatial coverage

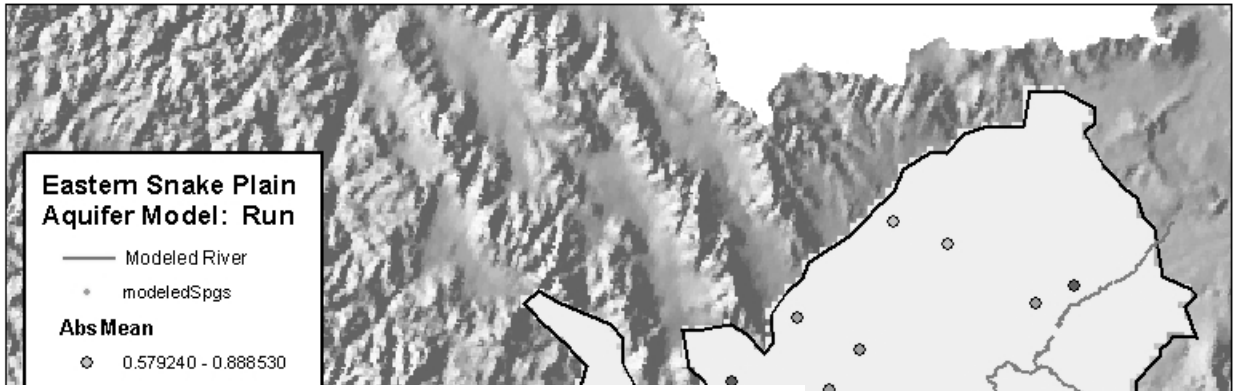
Transient Seasonal Data Set

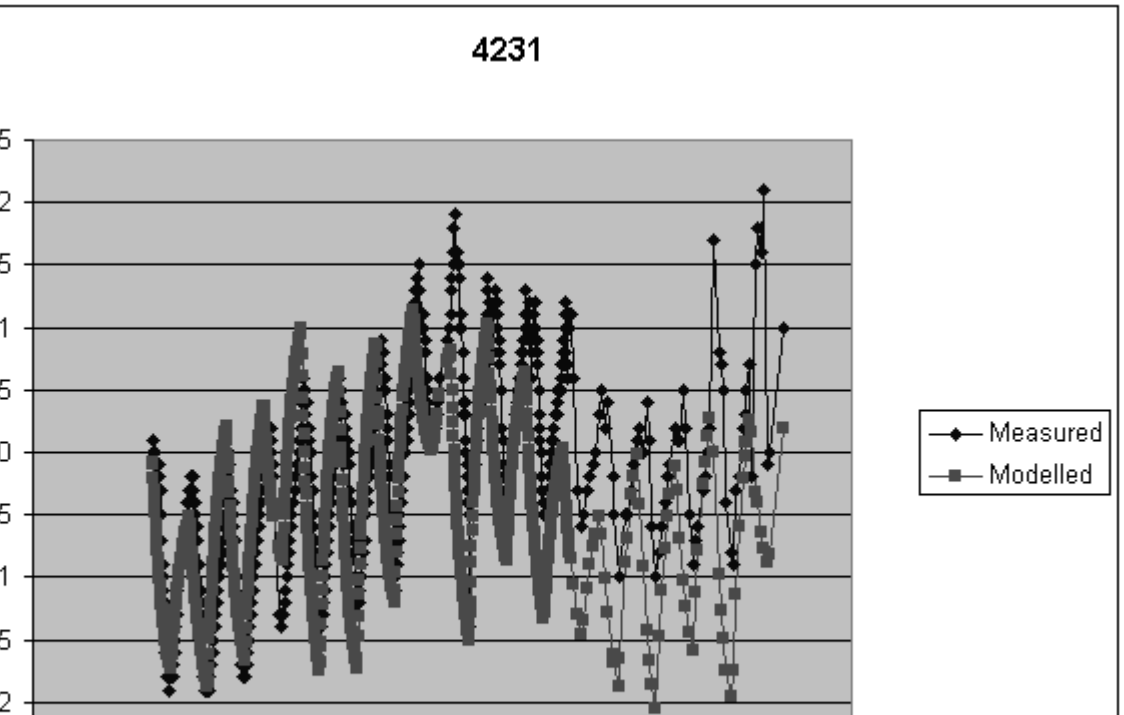


Transient Seasonal Data Set

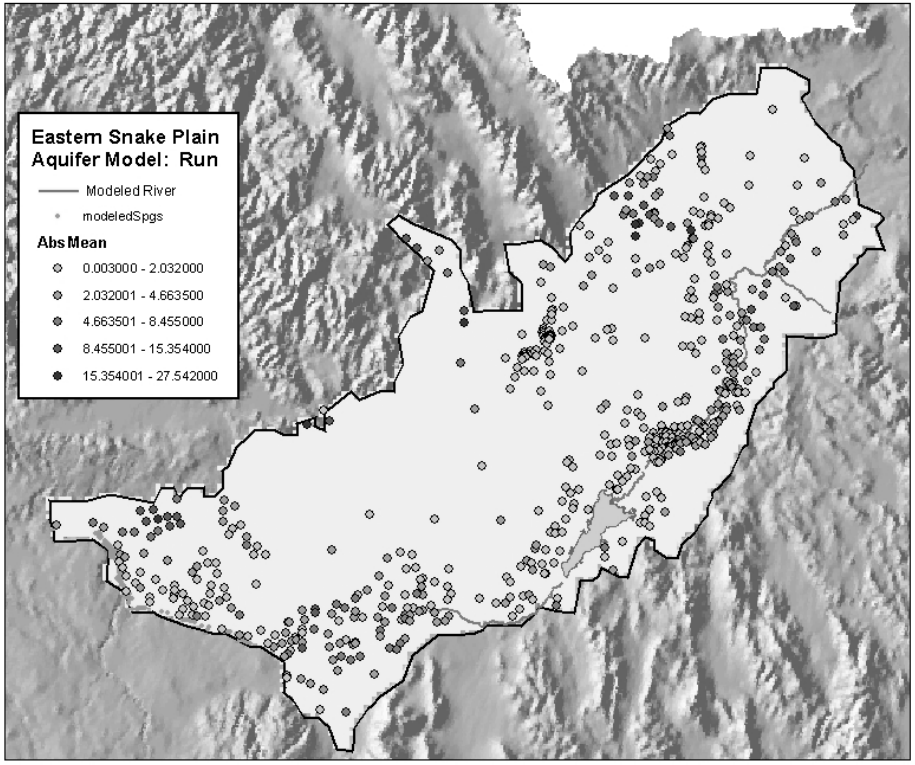


Transient Seasonal Data Set



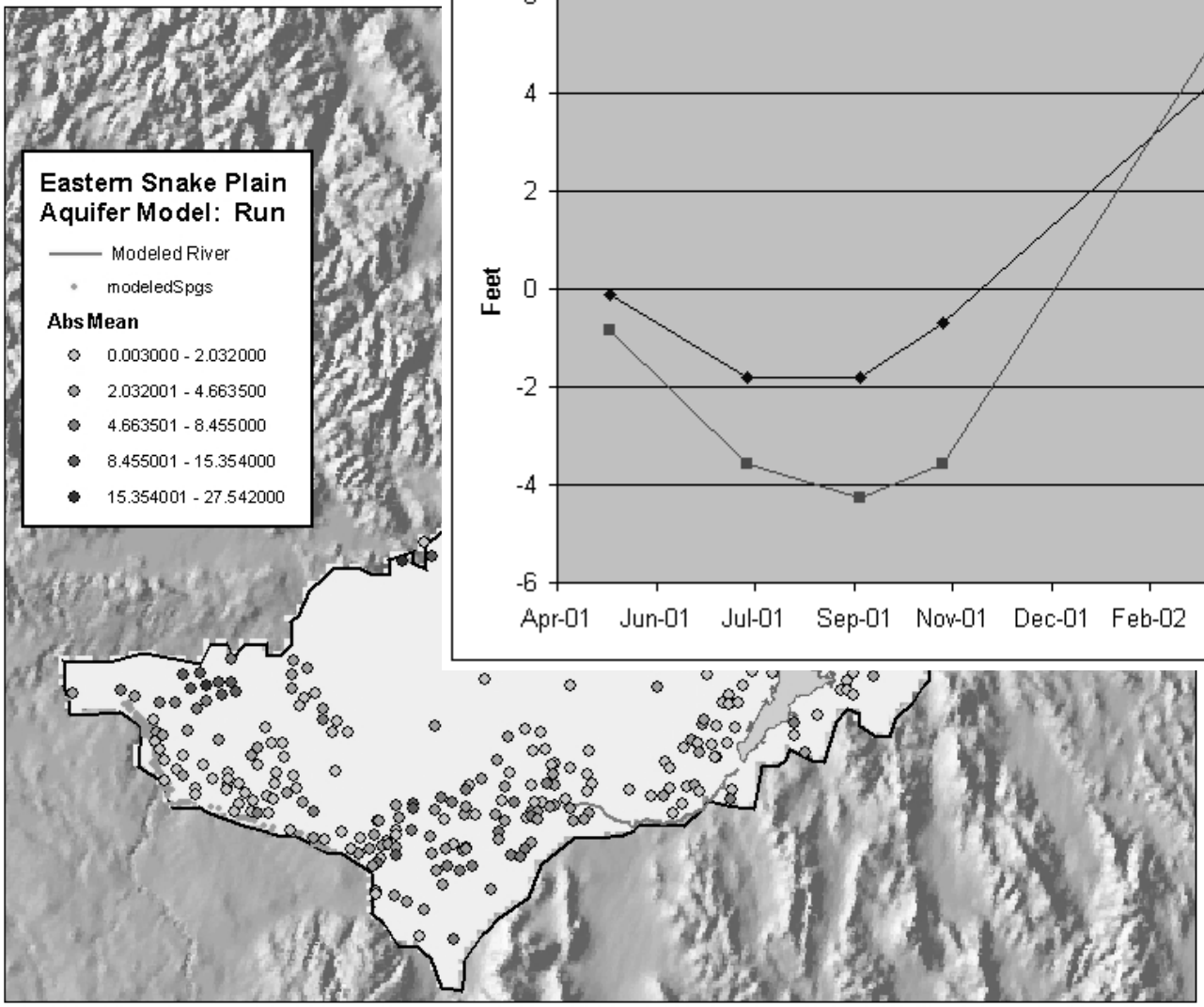


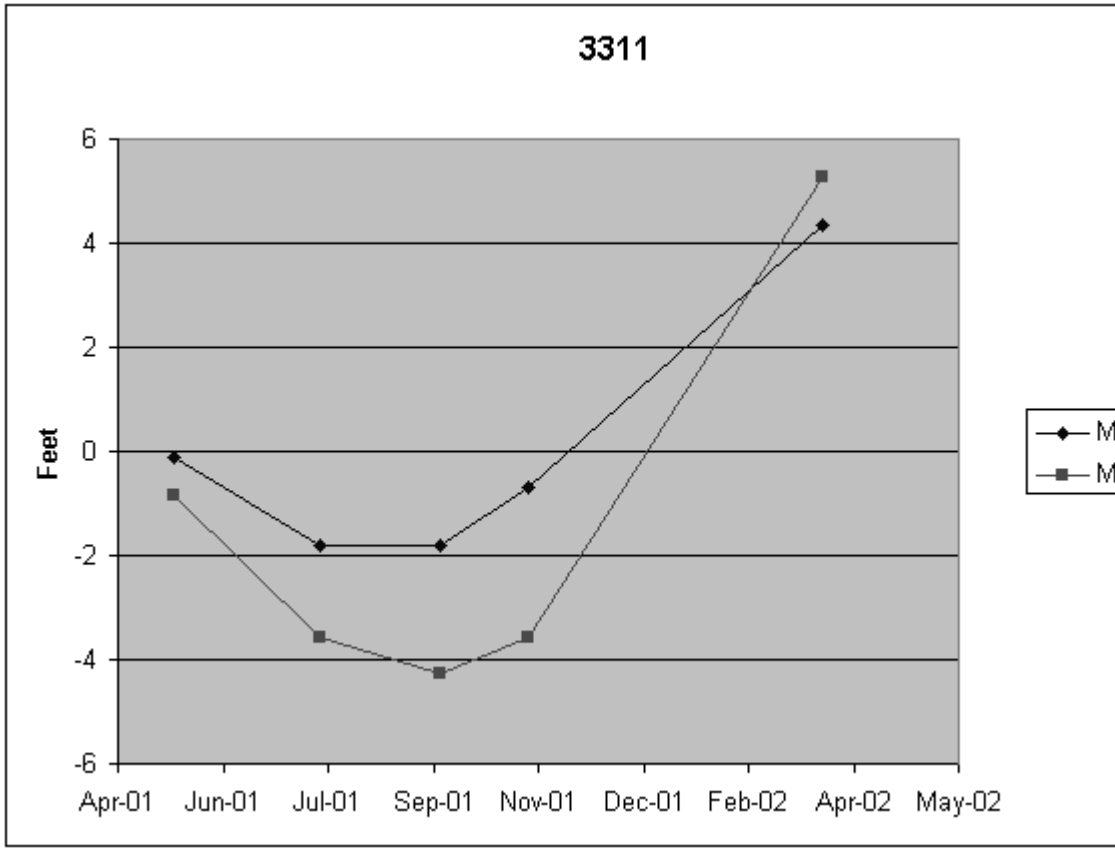
Mass Measurement



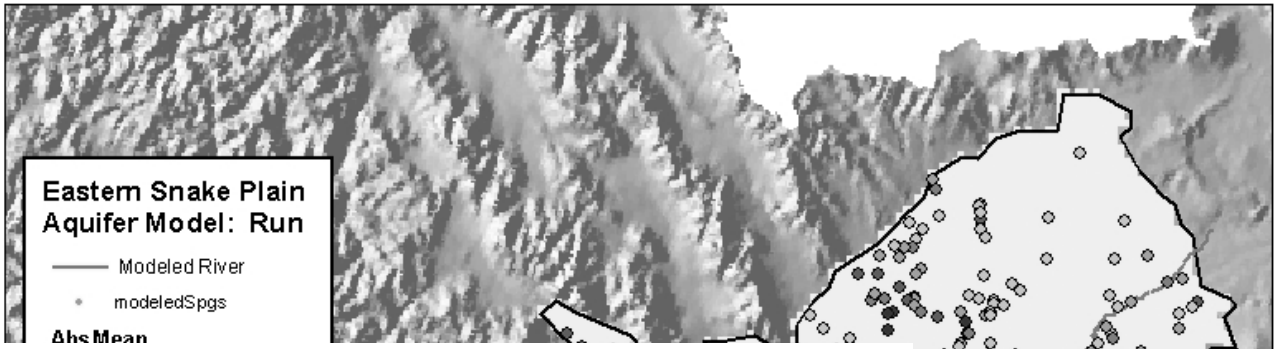
- Observations collected on behalf of this modeling effort
  - 3/1/2001 –5/8/2002

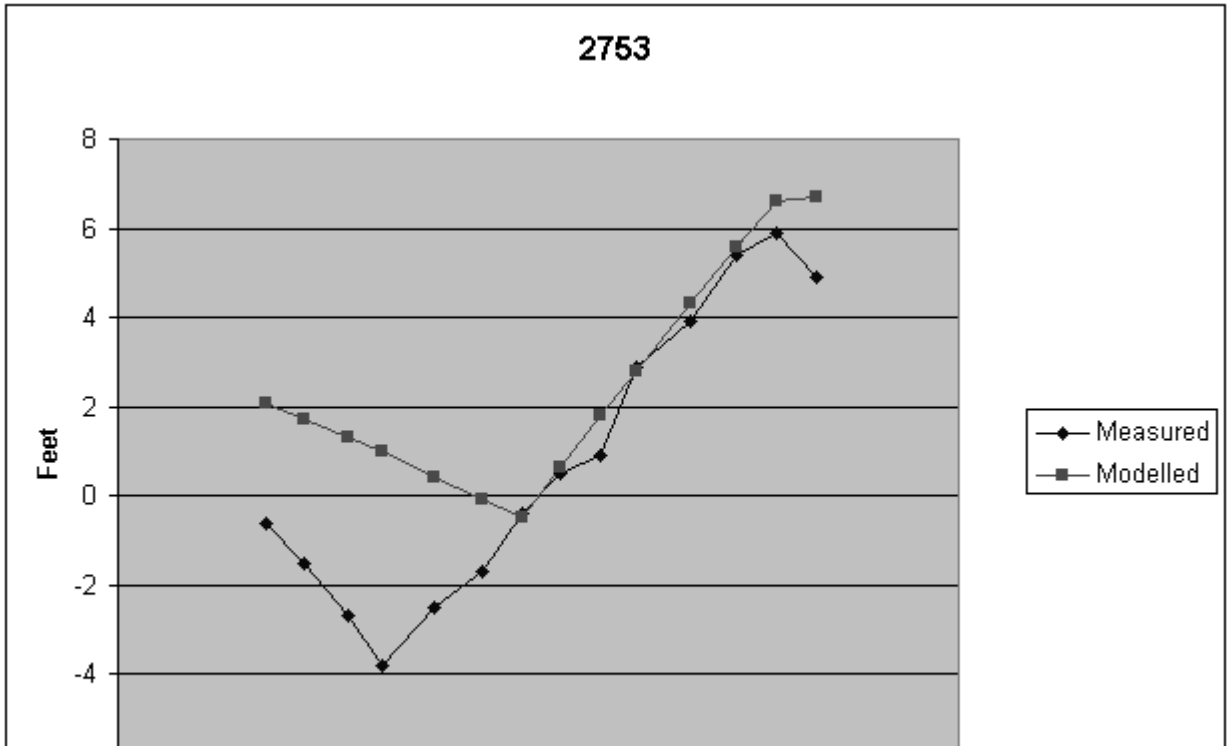
Mass measu


Eastern Snake Plain Aquifer Model: Run
Modeled River
modeledSpgs
Abs Mean
0.003000 - 2.032000
2.032001 - 4.663500
4.663501 - 8.455000
8.455001 - 15.354000
15.354001 - 27.542000


3311
Feet
6
4
2
0
-2
-4
-6
Apr-01
Jun-01
Jul-01
Sep-01
Nov-01
Dec-01
Feb-02
Apr-02
May-02

Mass measurement (tran116)





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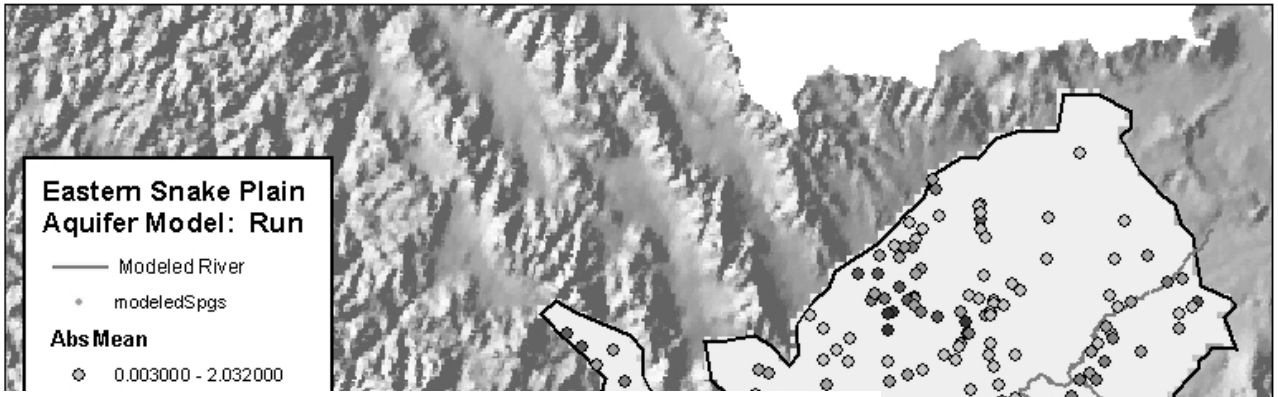
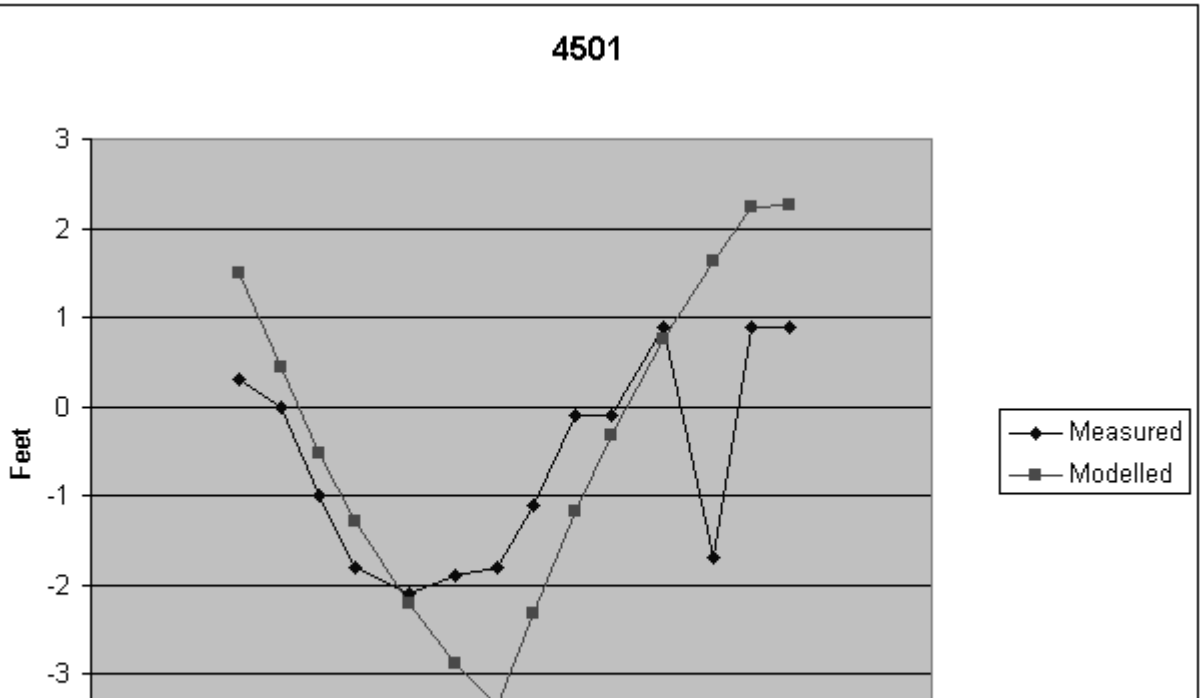
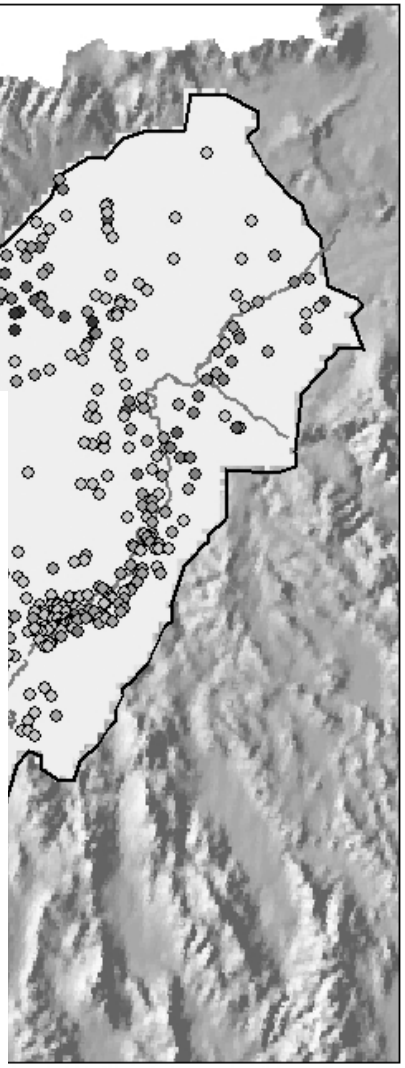
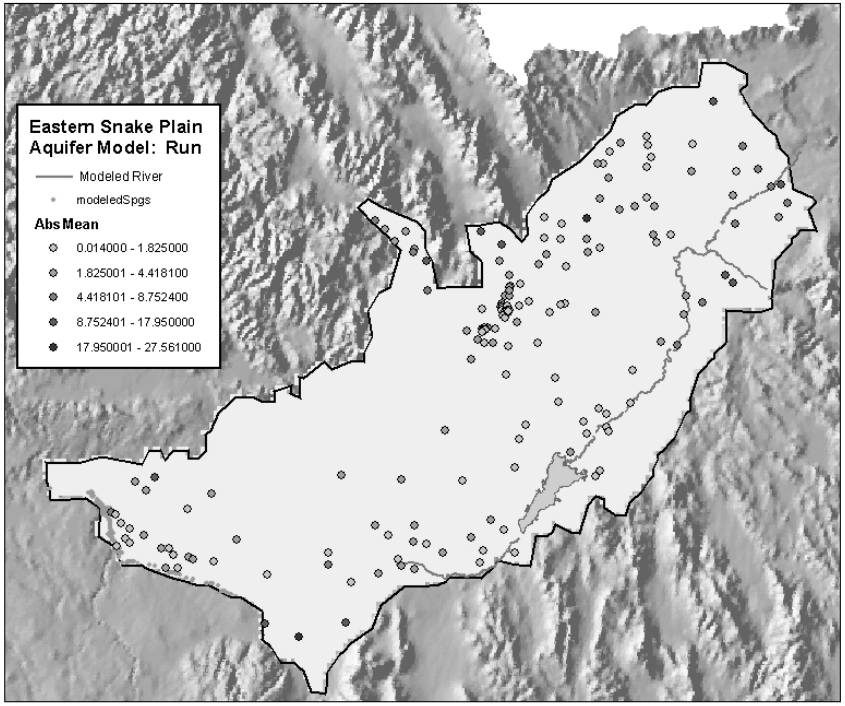




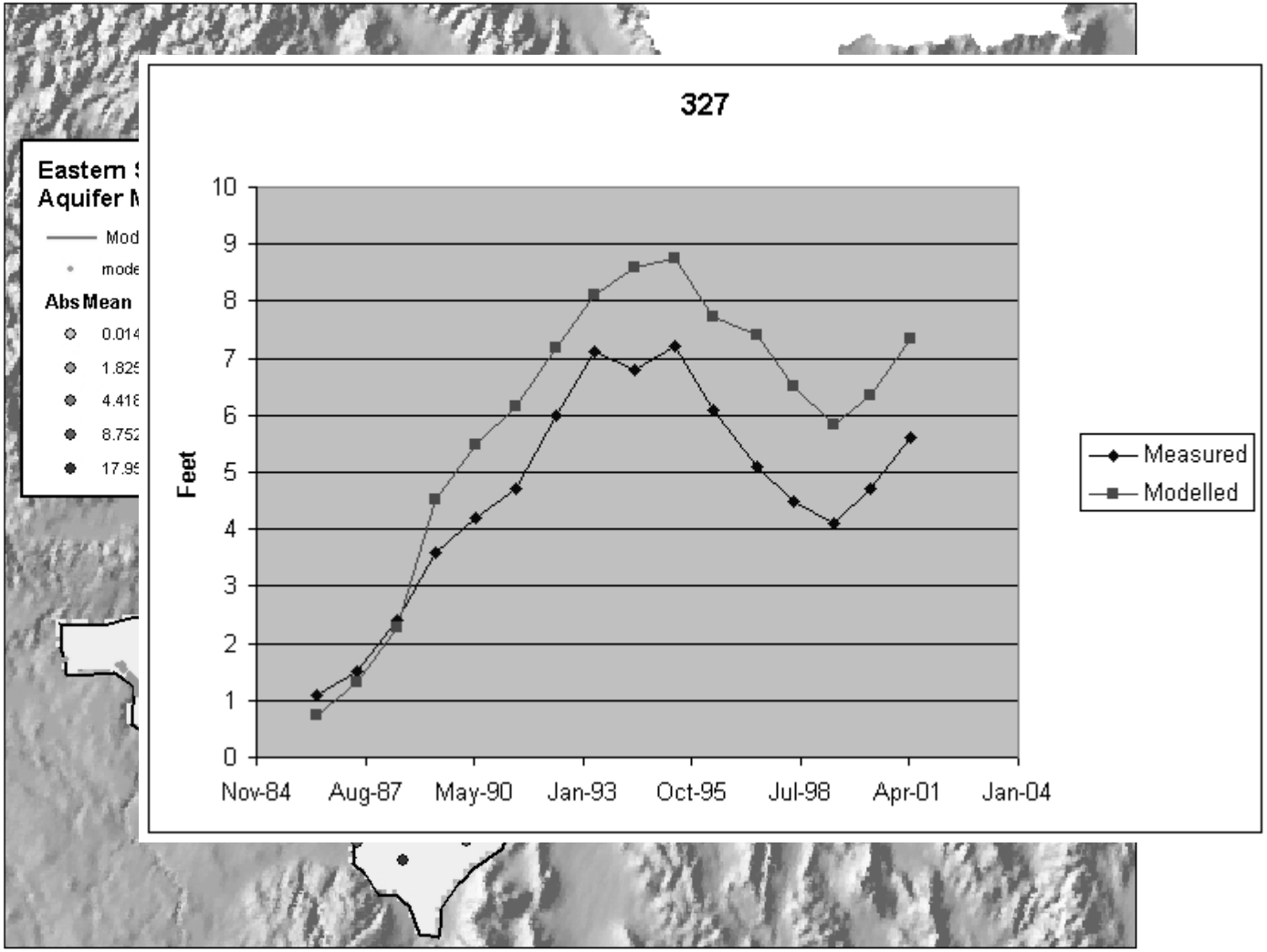


Long Term Trend

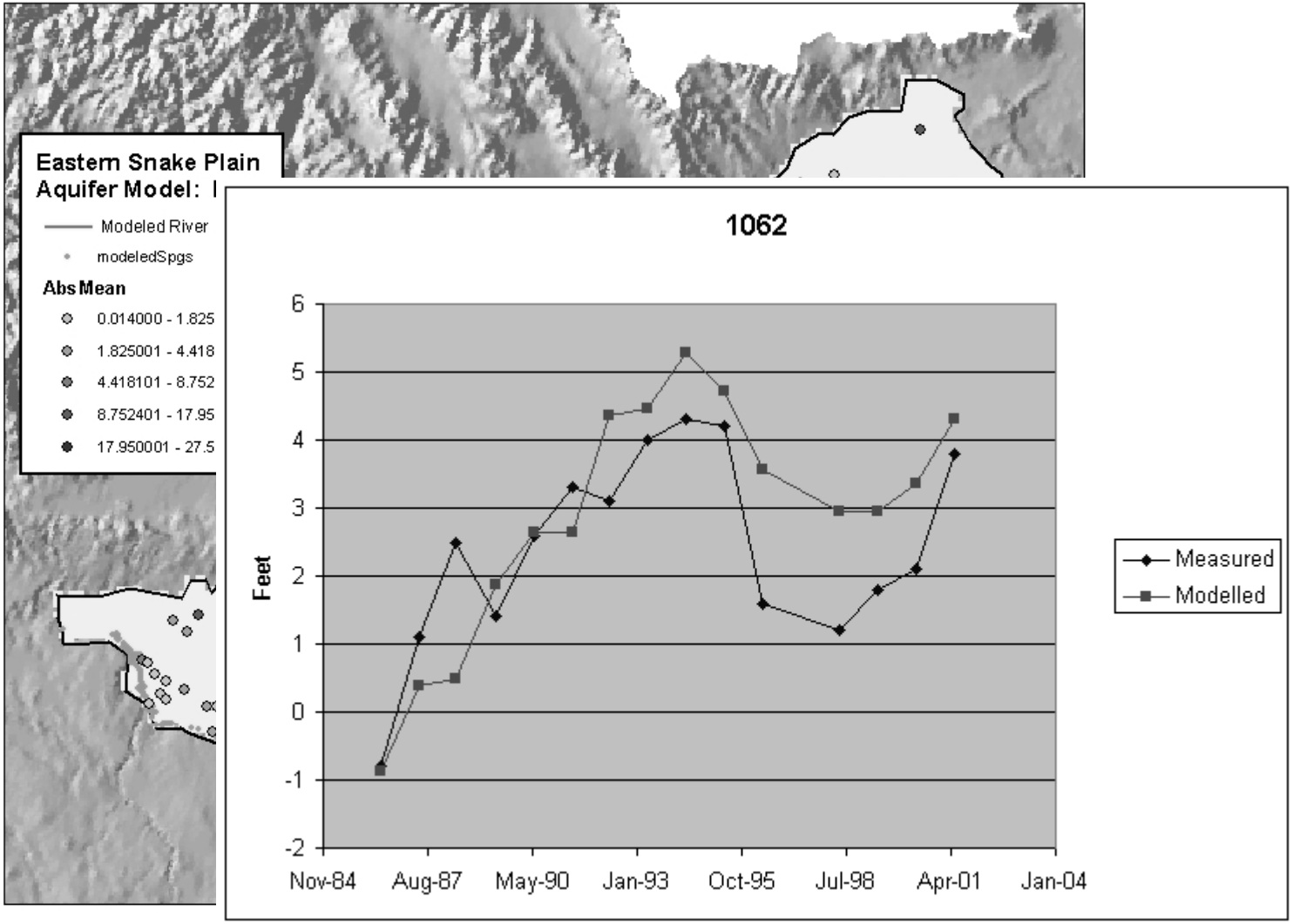


- Annual observations in wells

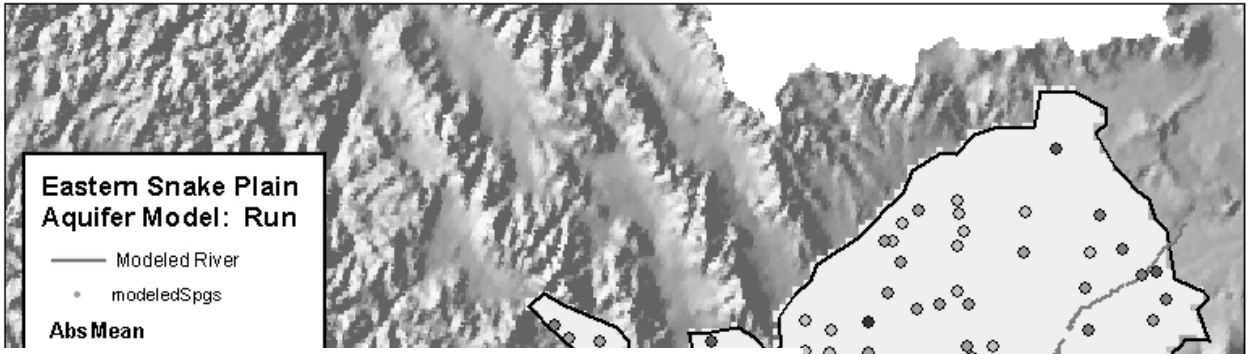
Long Term Trend

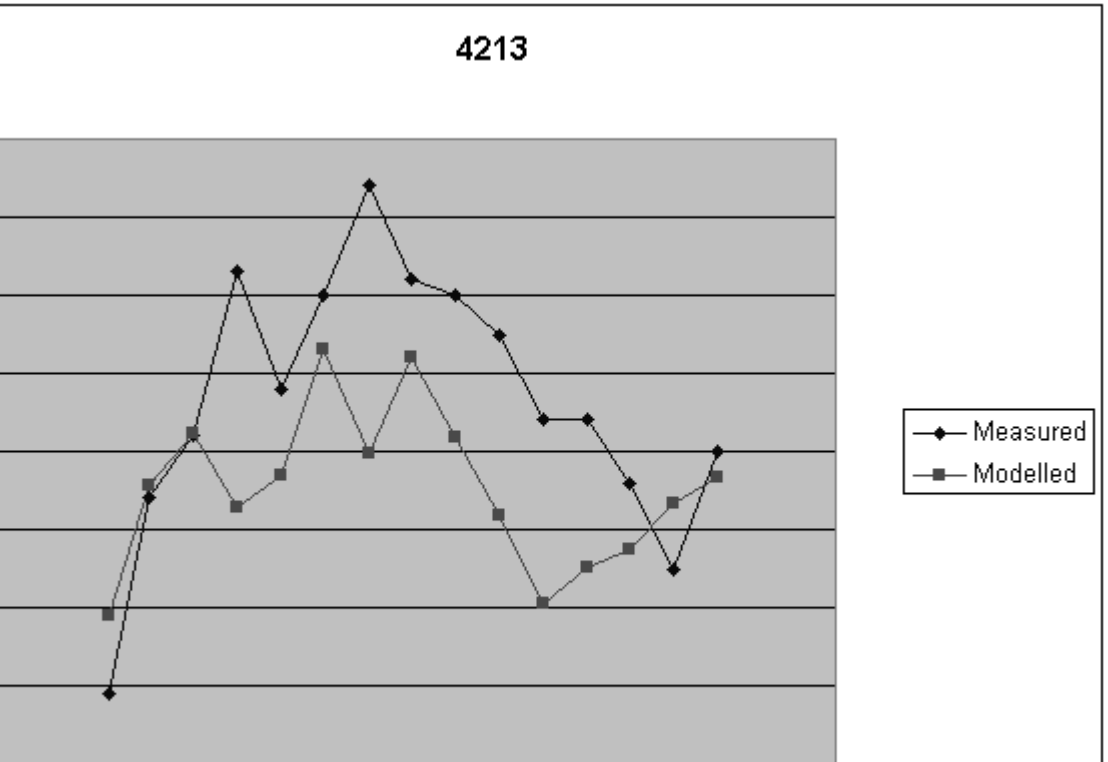


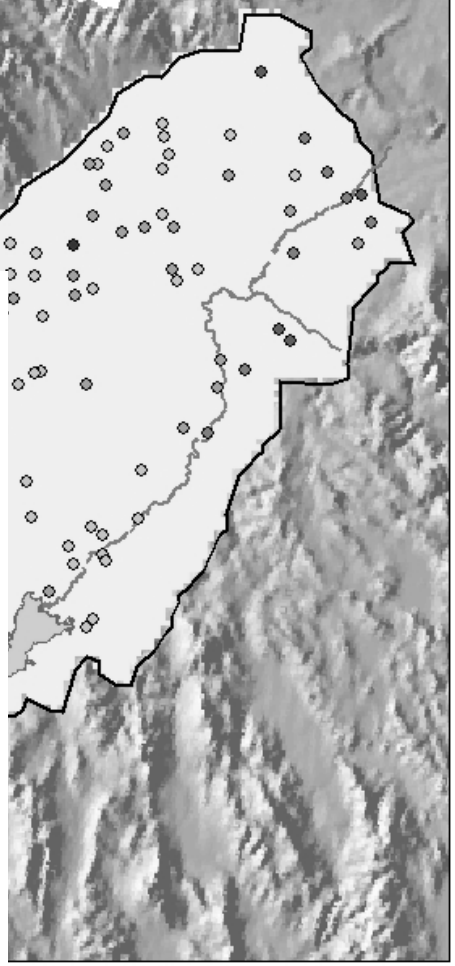
Long Term Trend



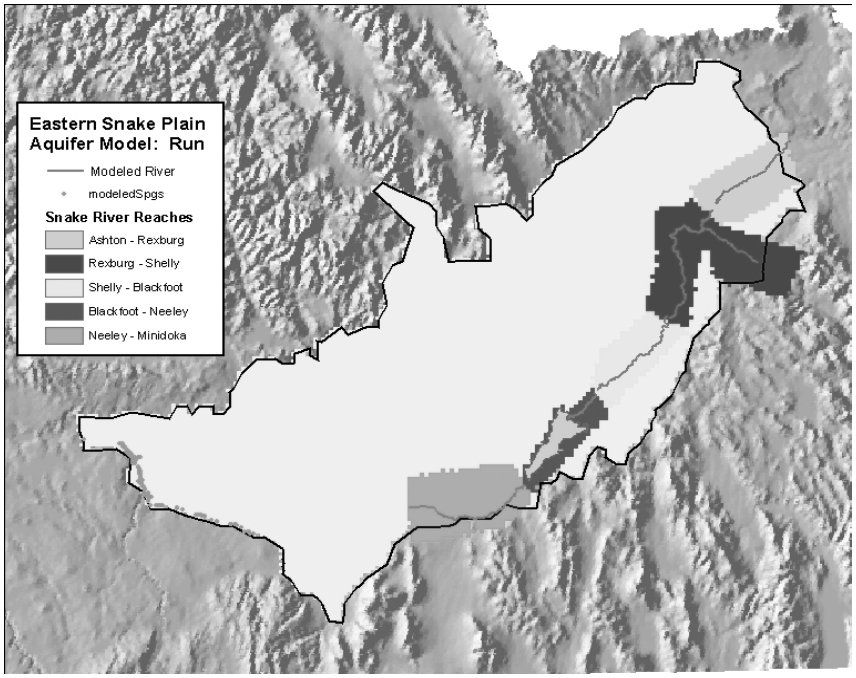
Long Term Trend







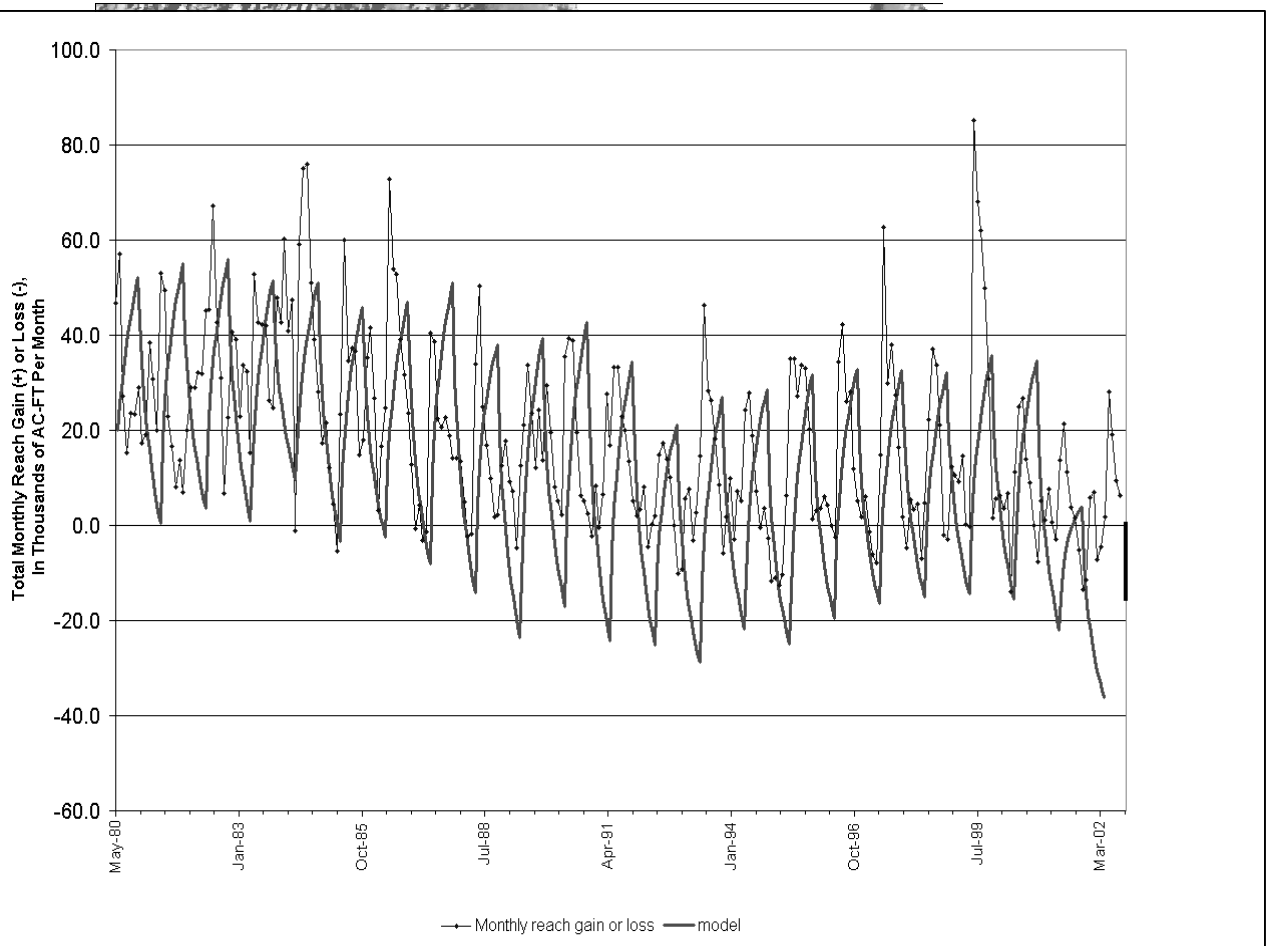
Upper Snake River



- Snake River reaches

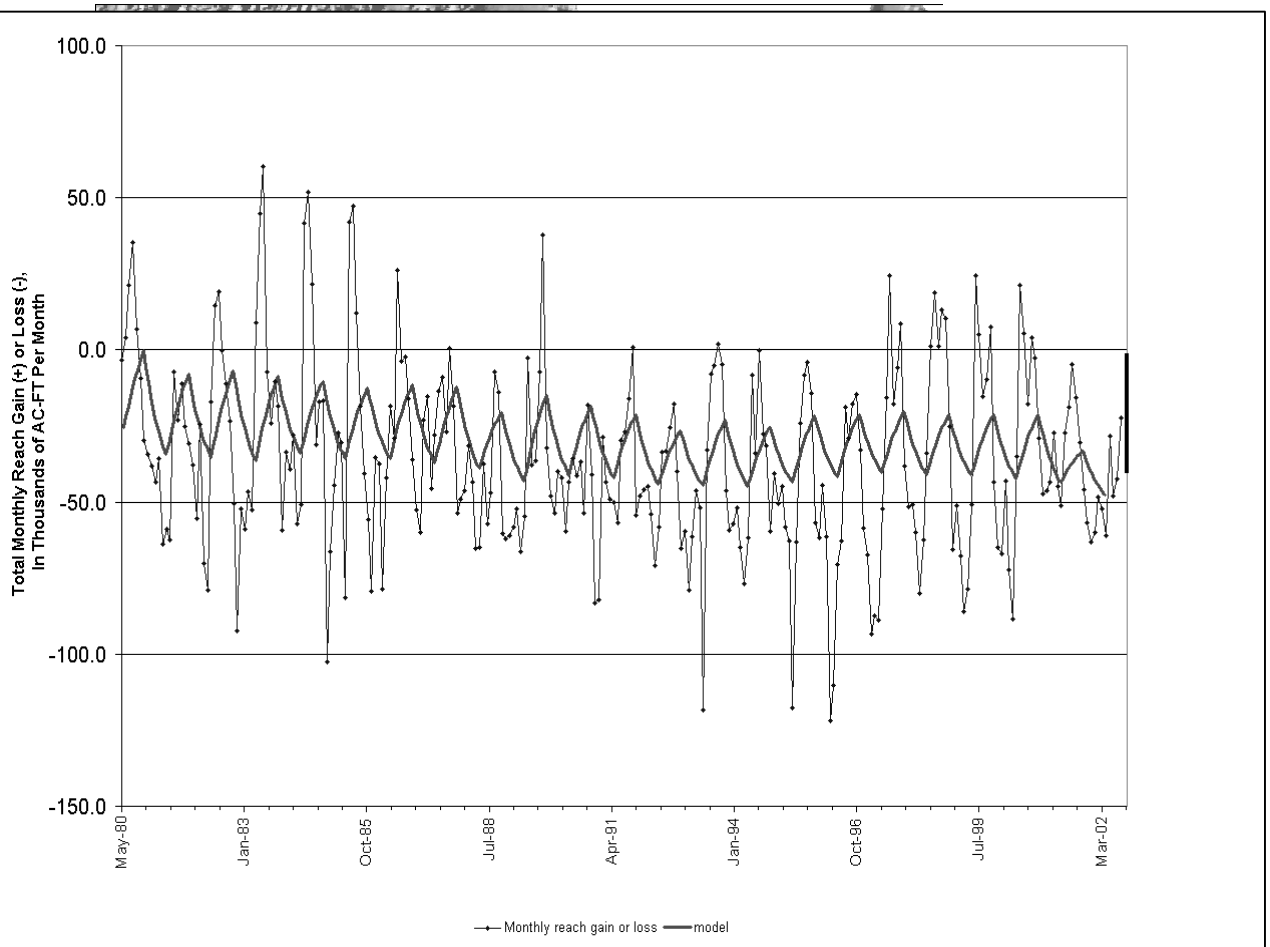
Snake River (tran116)

- Ashton to Rexburg



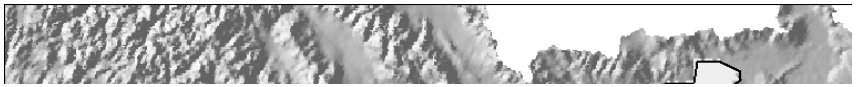
Snake River (tran116)

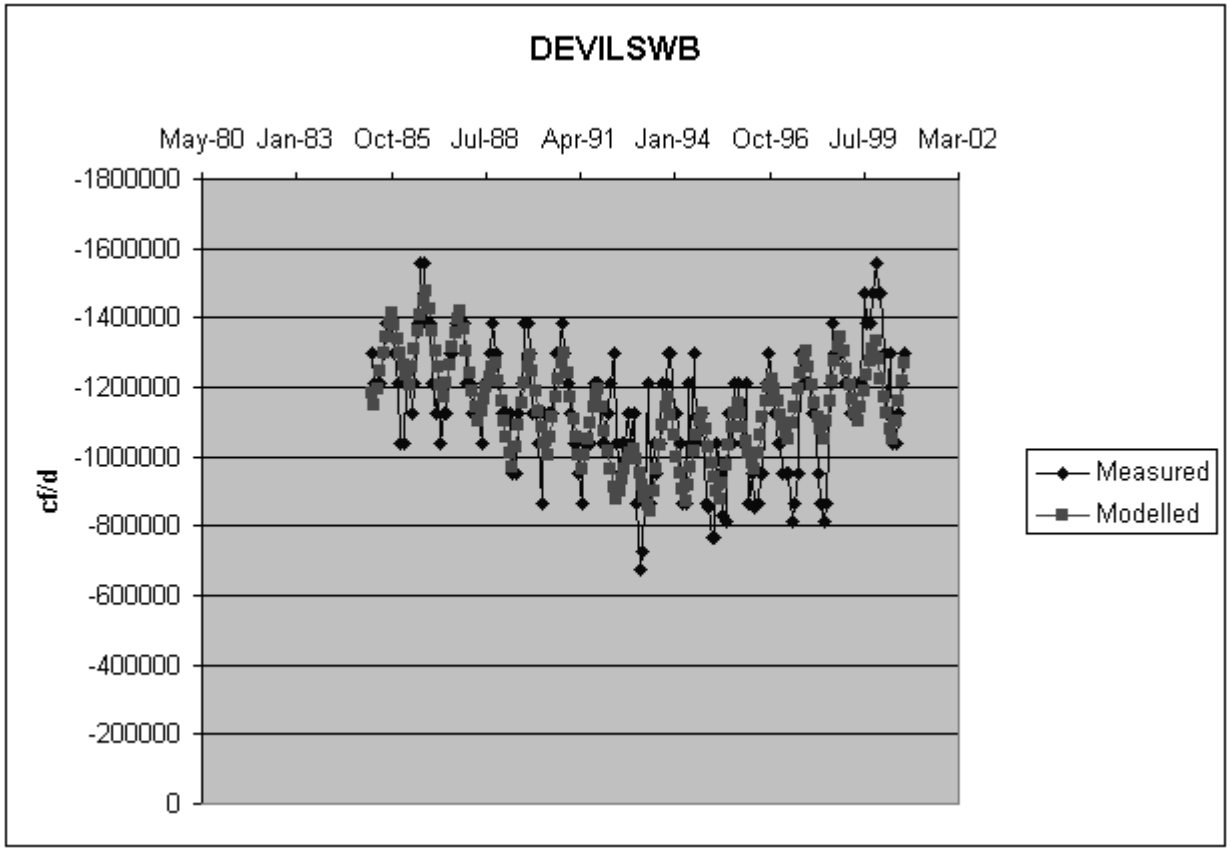
- Heise to Shelly



Measured Springs

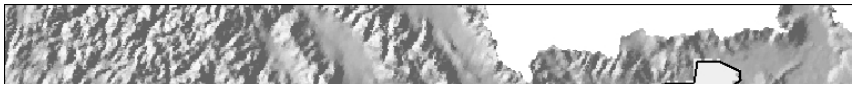
- Devils Washbowl

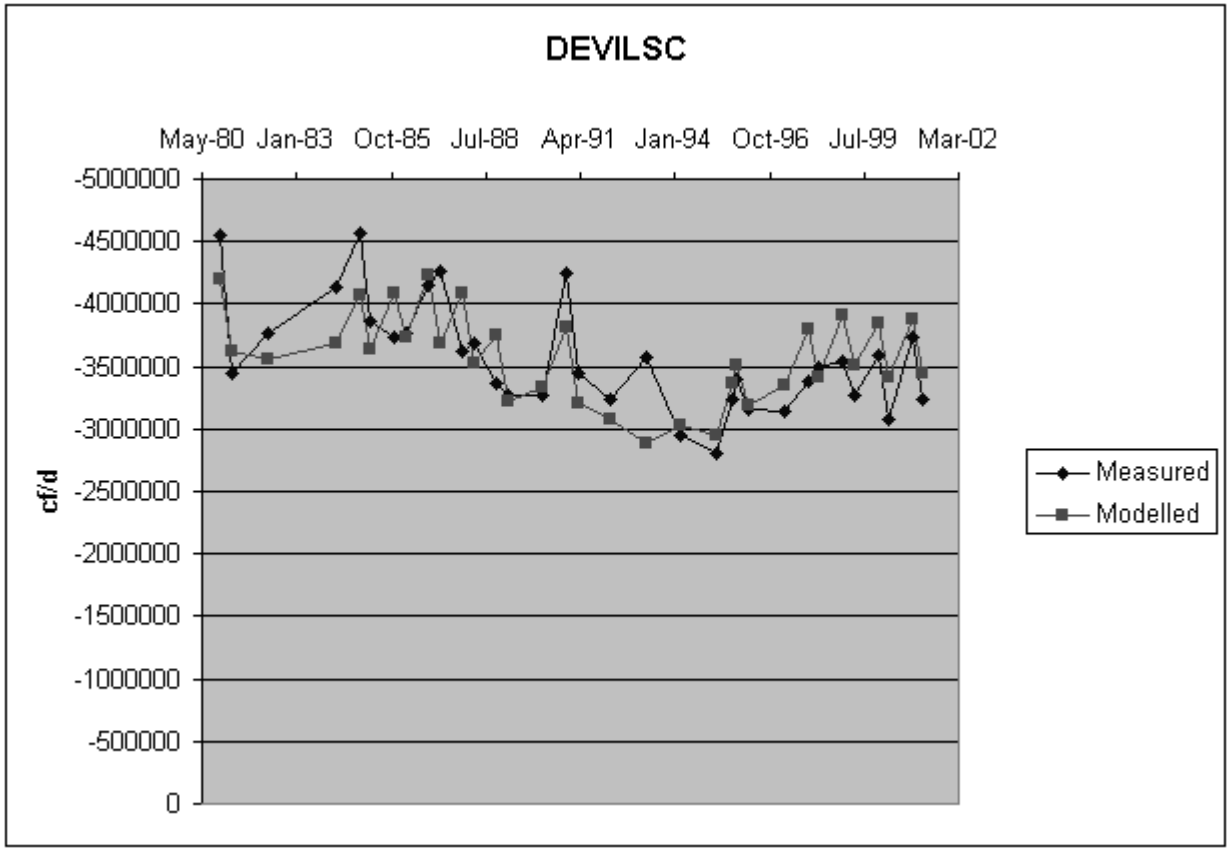




Measured Springs

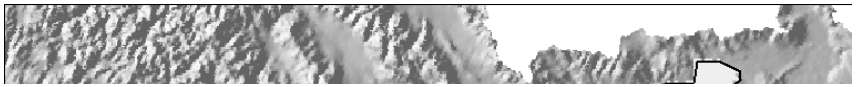
- Devils Corral

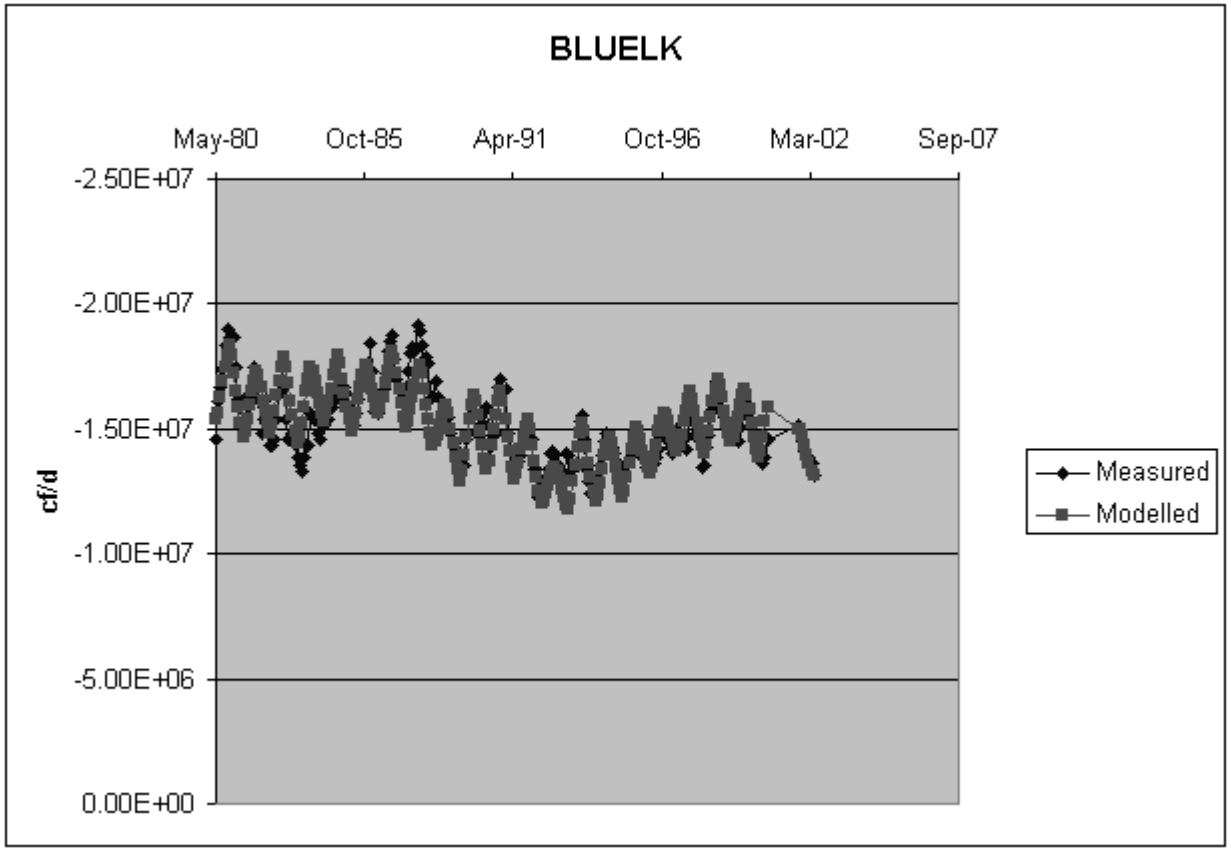




Measured Springs

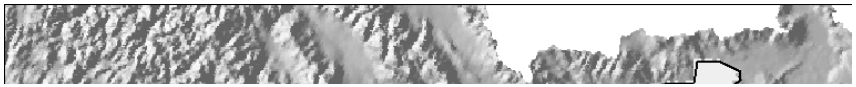
- Blue Lakes

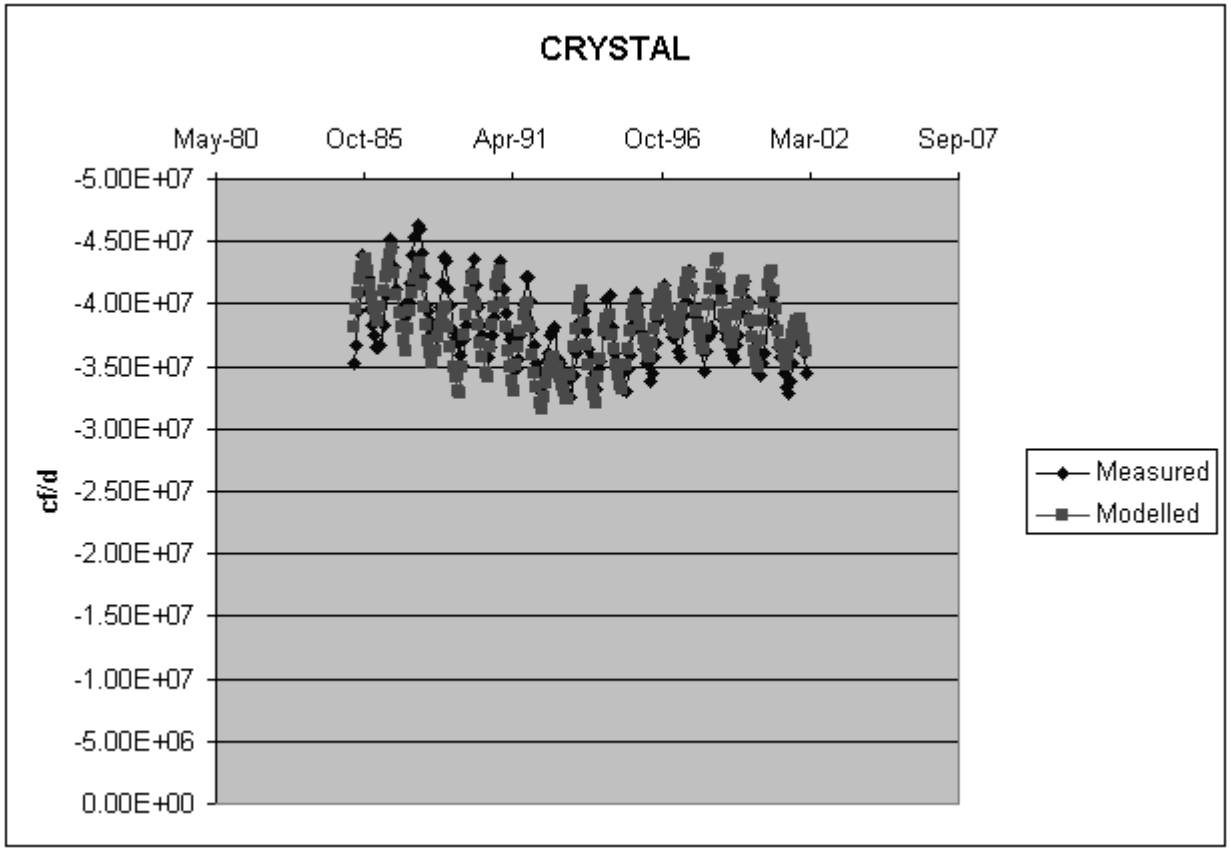




Measured Springs

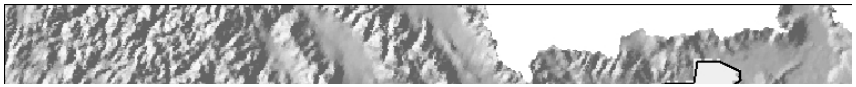
- Crystal Springs

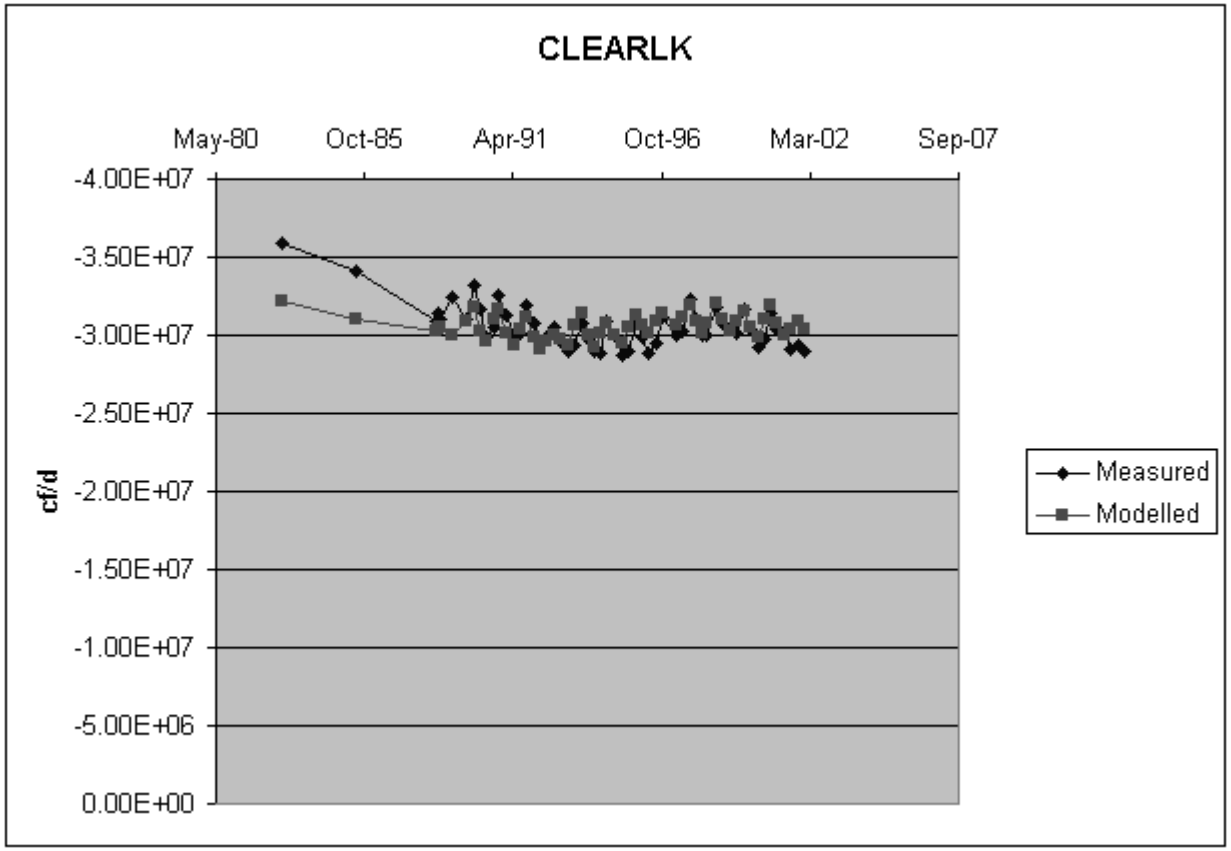




Measured Springs

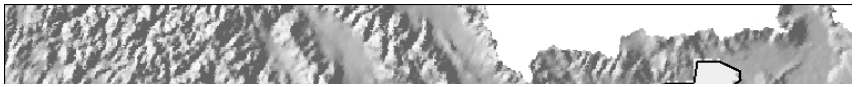
- Clear Lakes

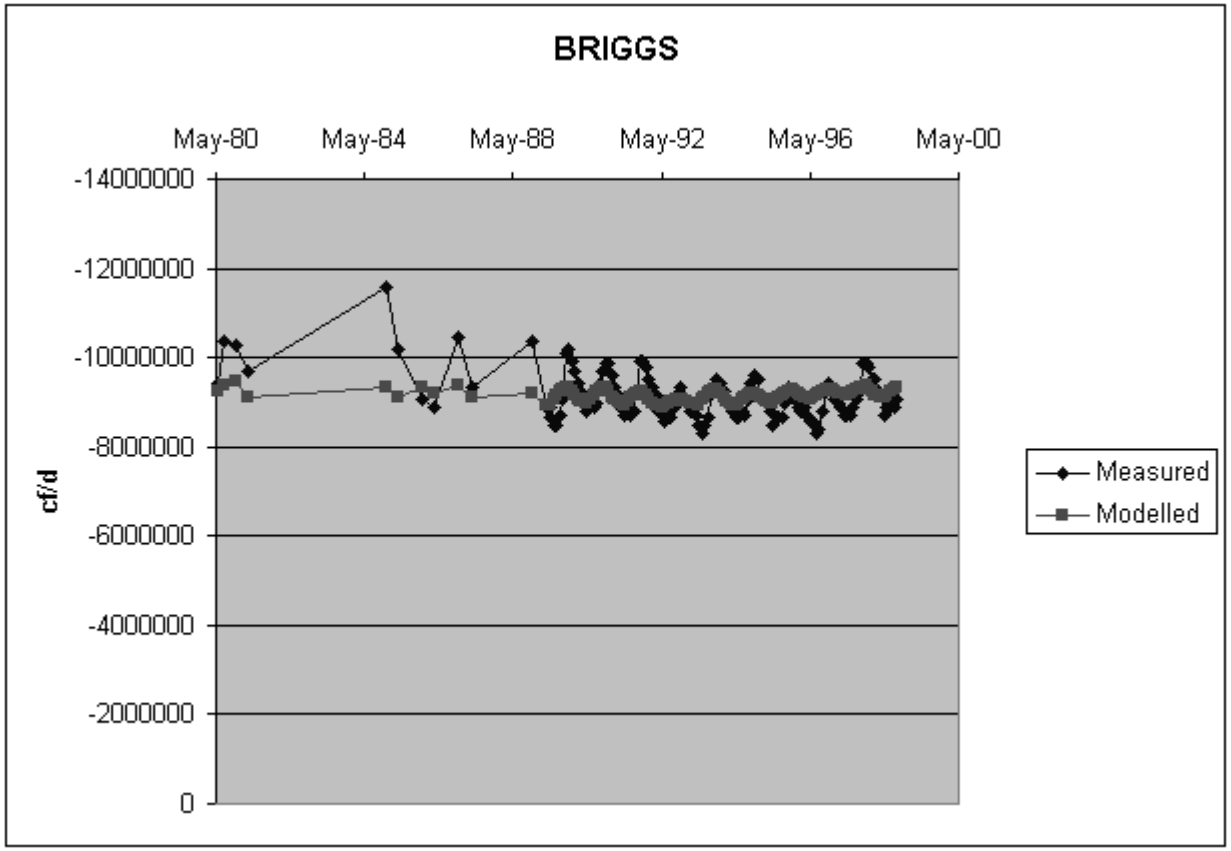




Measured Springs

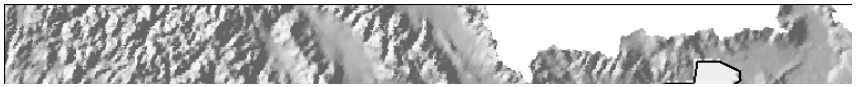
- Briggs Spring

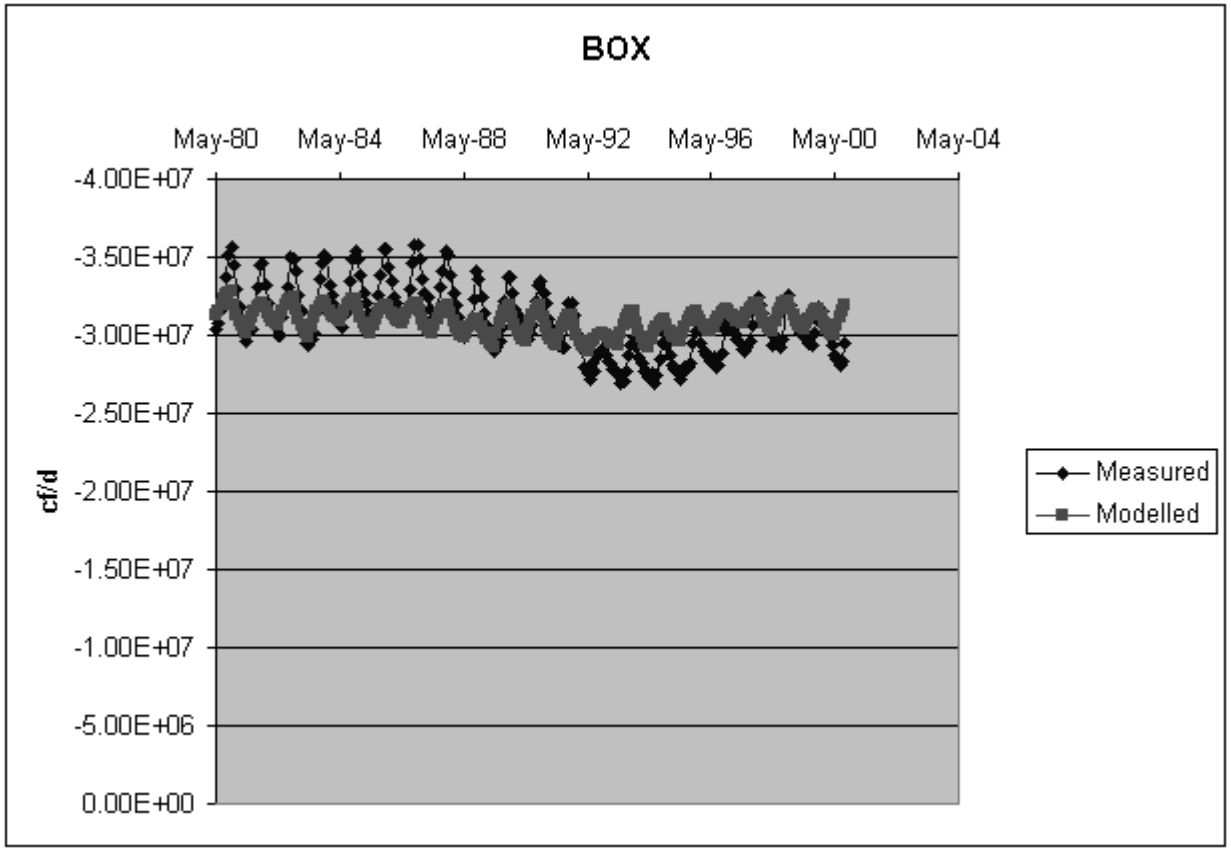




Measured Springs

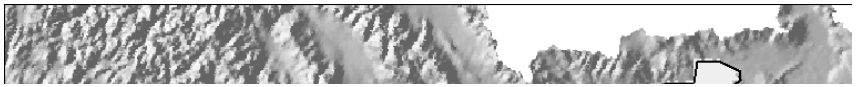
- Box Canyon Spring

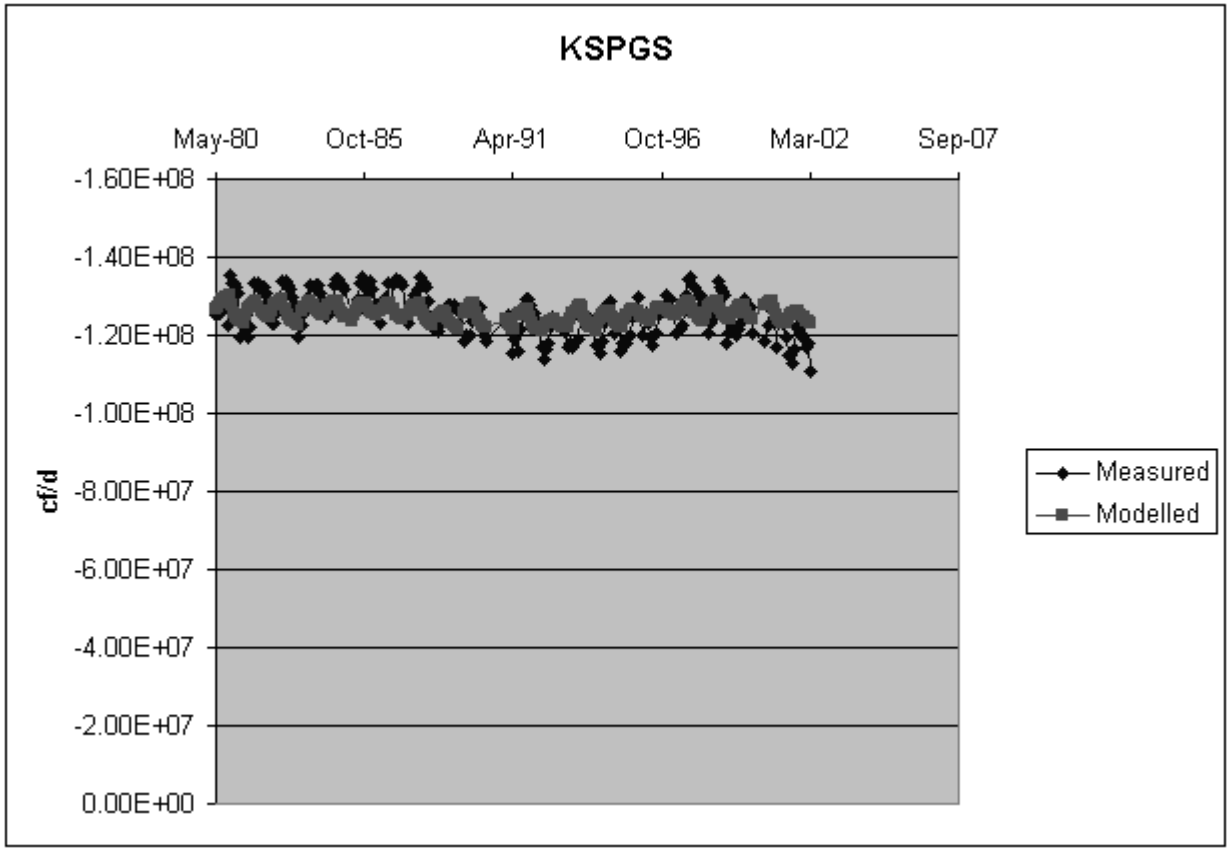




Measured Springs

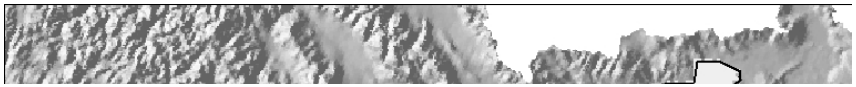
- Thousand Springs

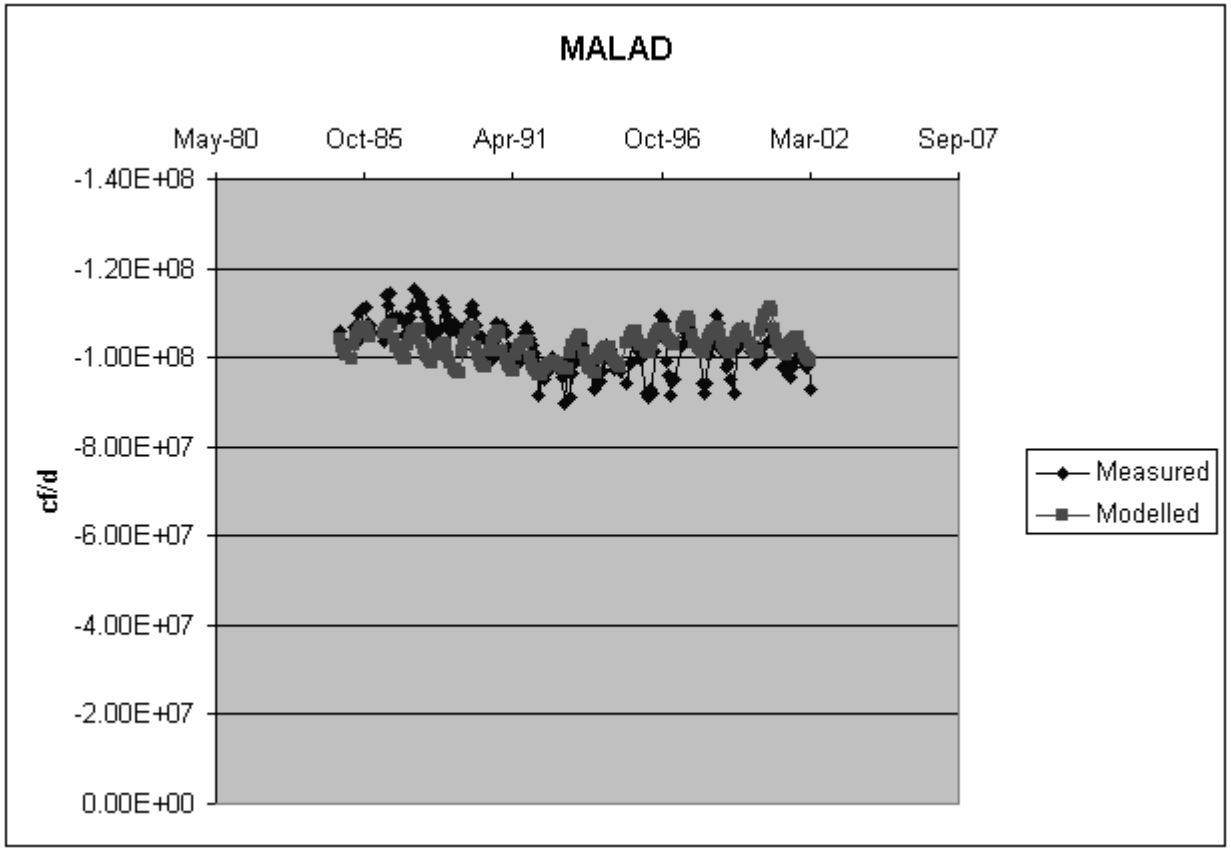




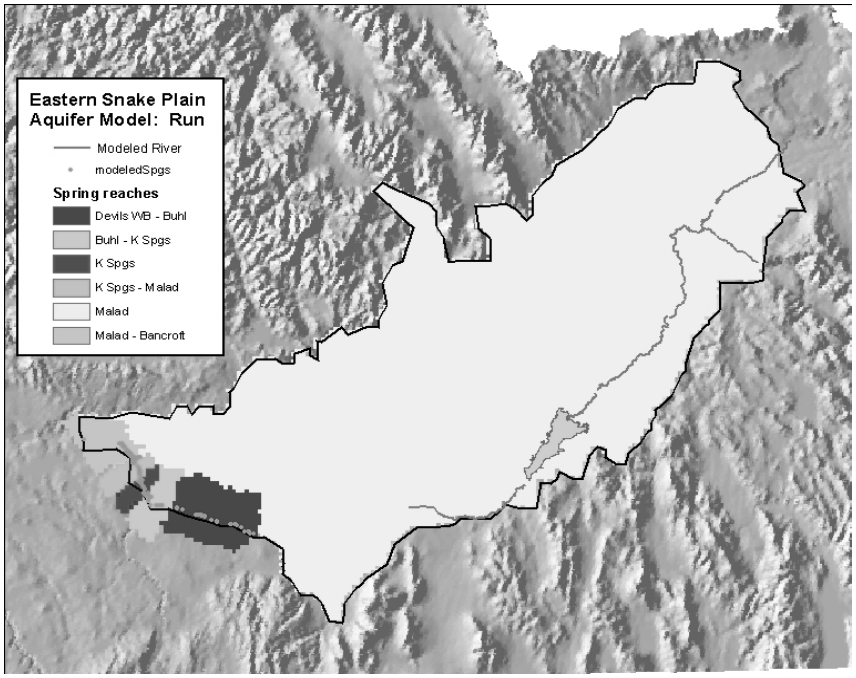
Measured Springs

- Malad



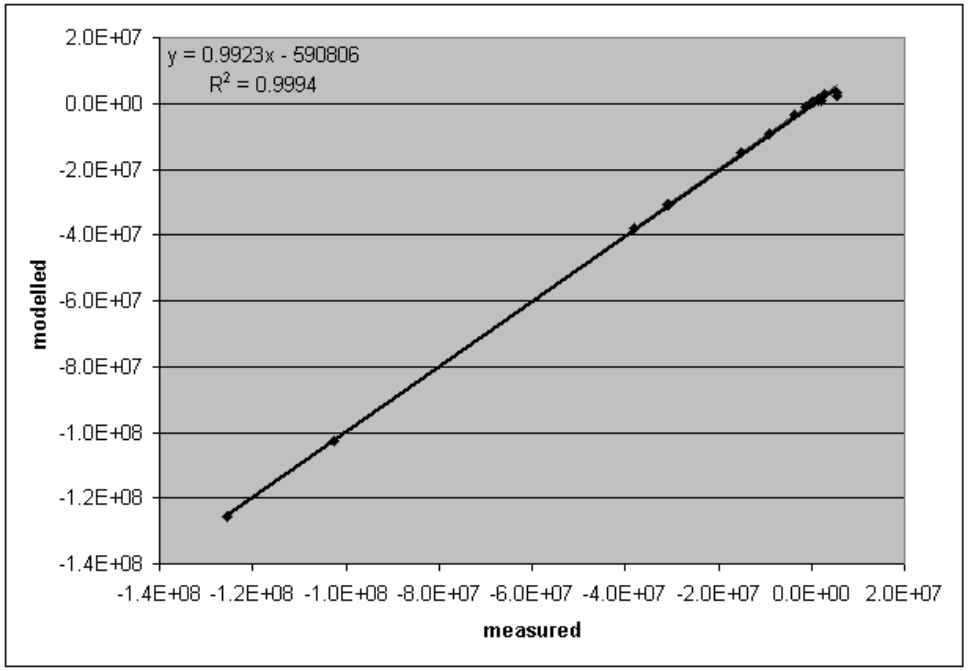


Spring Reaches



- Spring reach gain plots

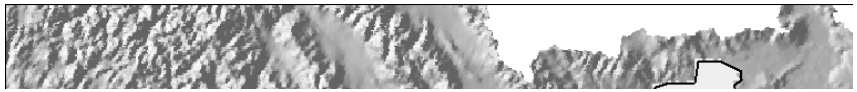
Spring Targets

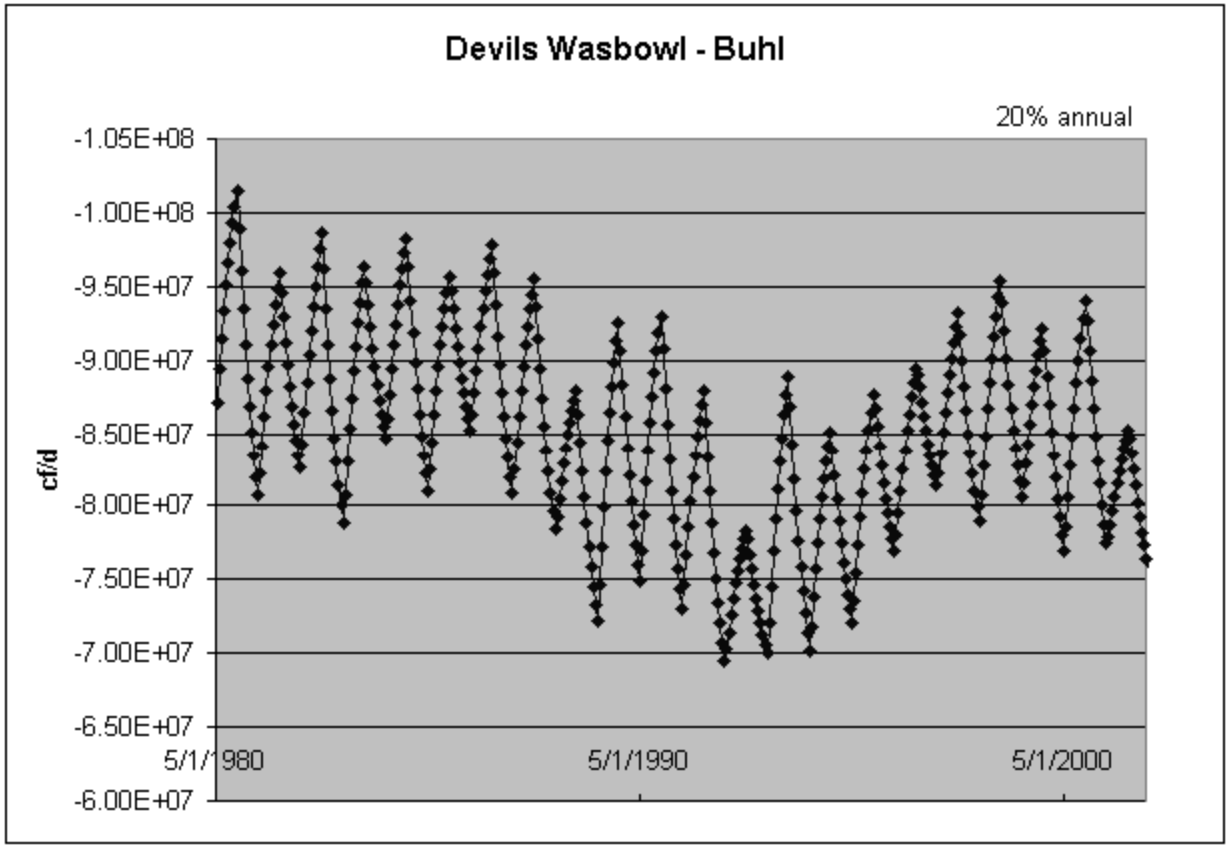


- Spring targets
  - Pink line is 45°
  - If this were a perfect match
    - Y=1x + 0
    - $R^2 = 1$

Spring Reaches

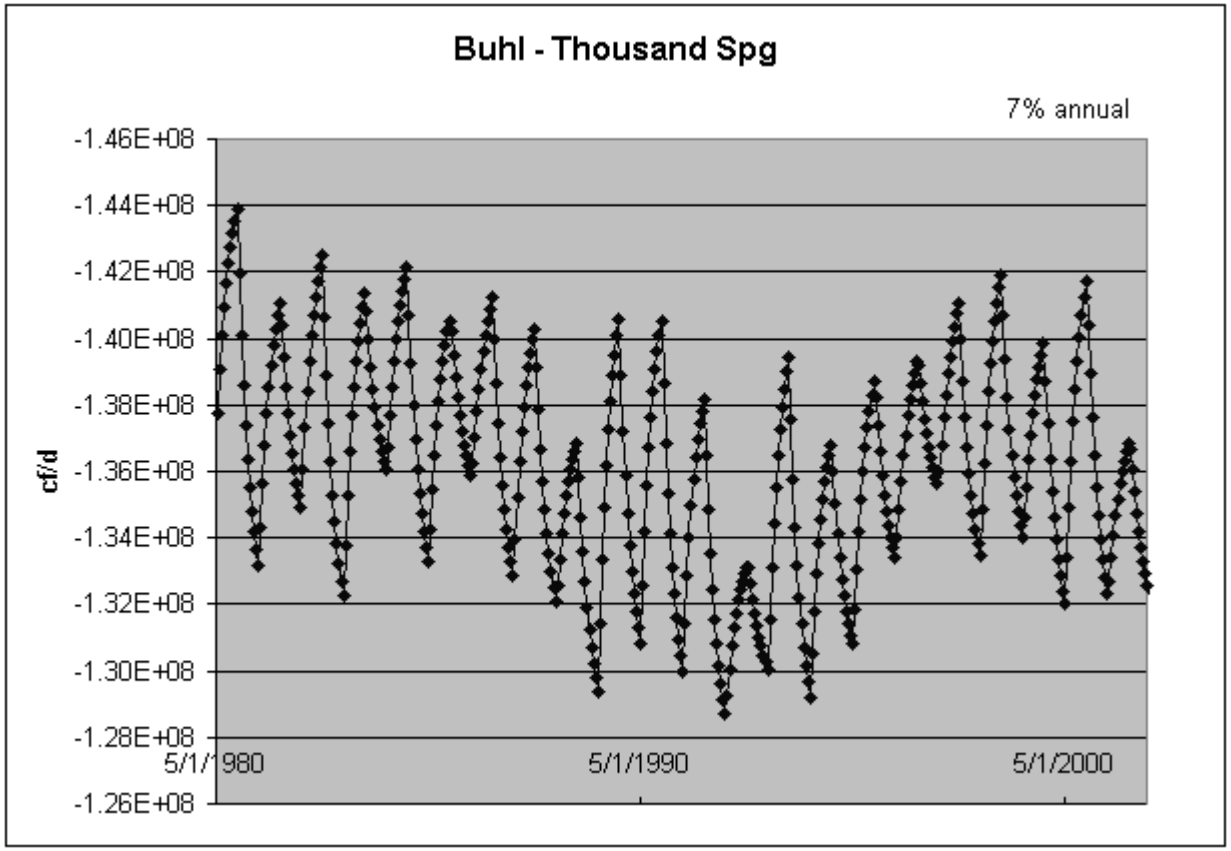
- Devils Washbowl to Buhl





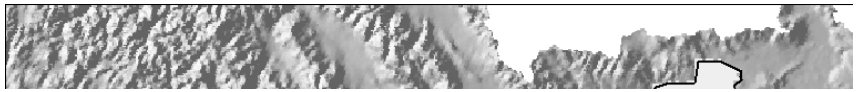
Spring Reaches

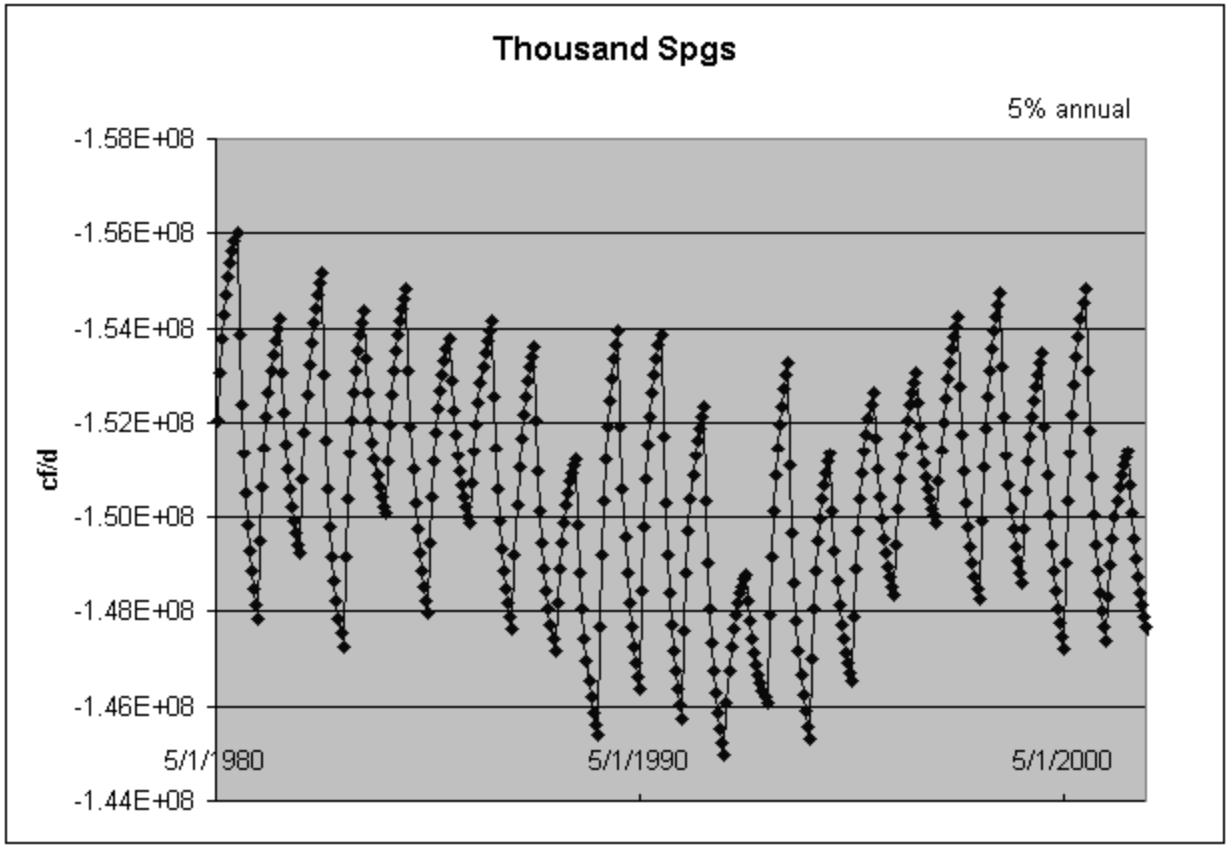
- Buhl to Thousand Springs



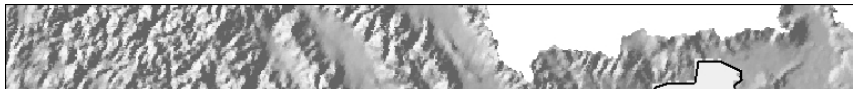
Spring Reaches

- Thousand Springs

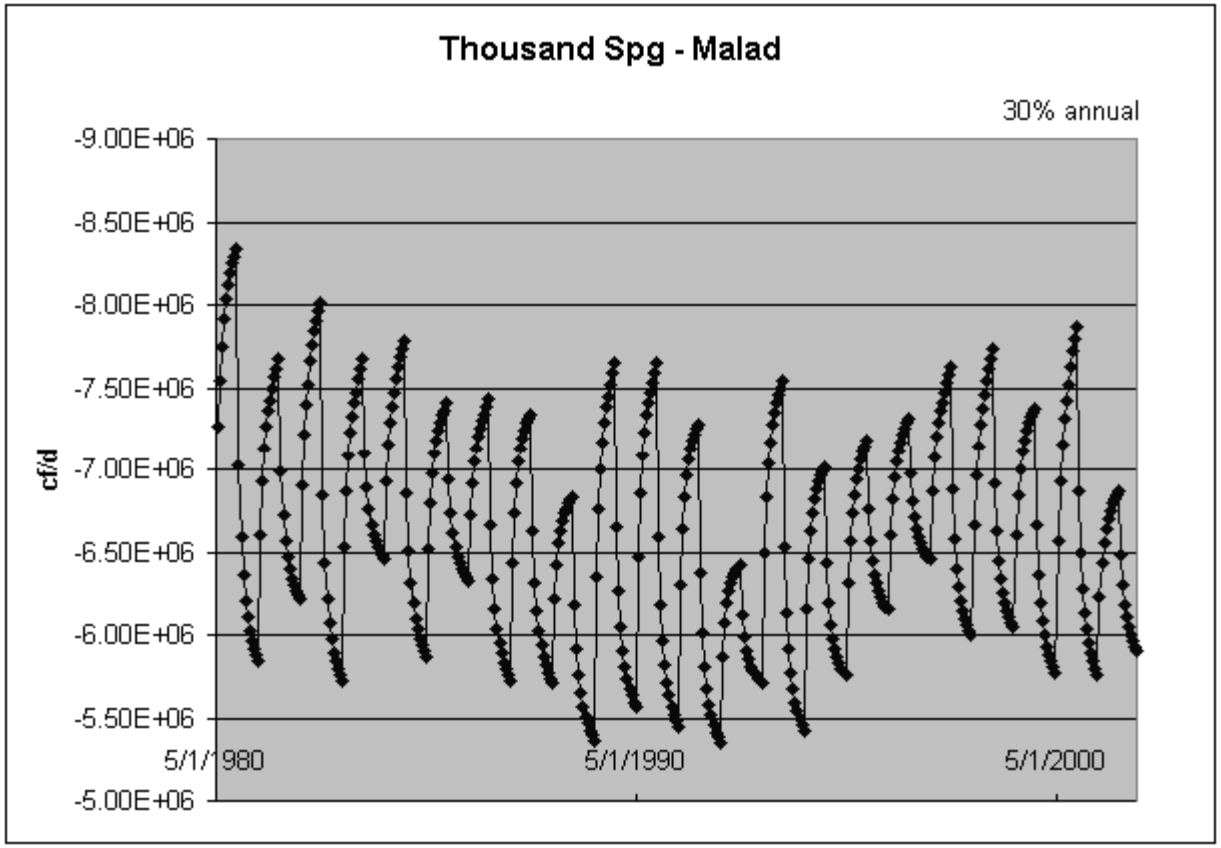




Spring Reaches

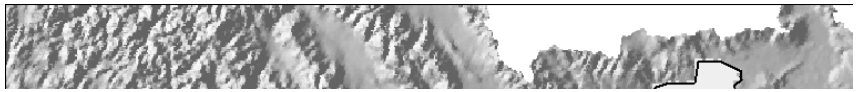


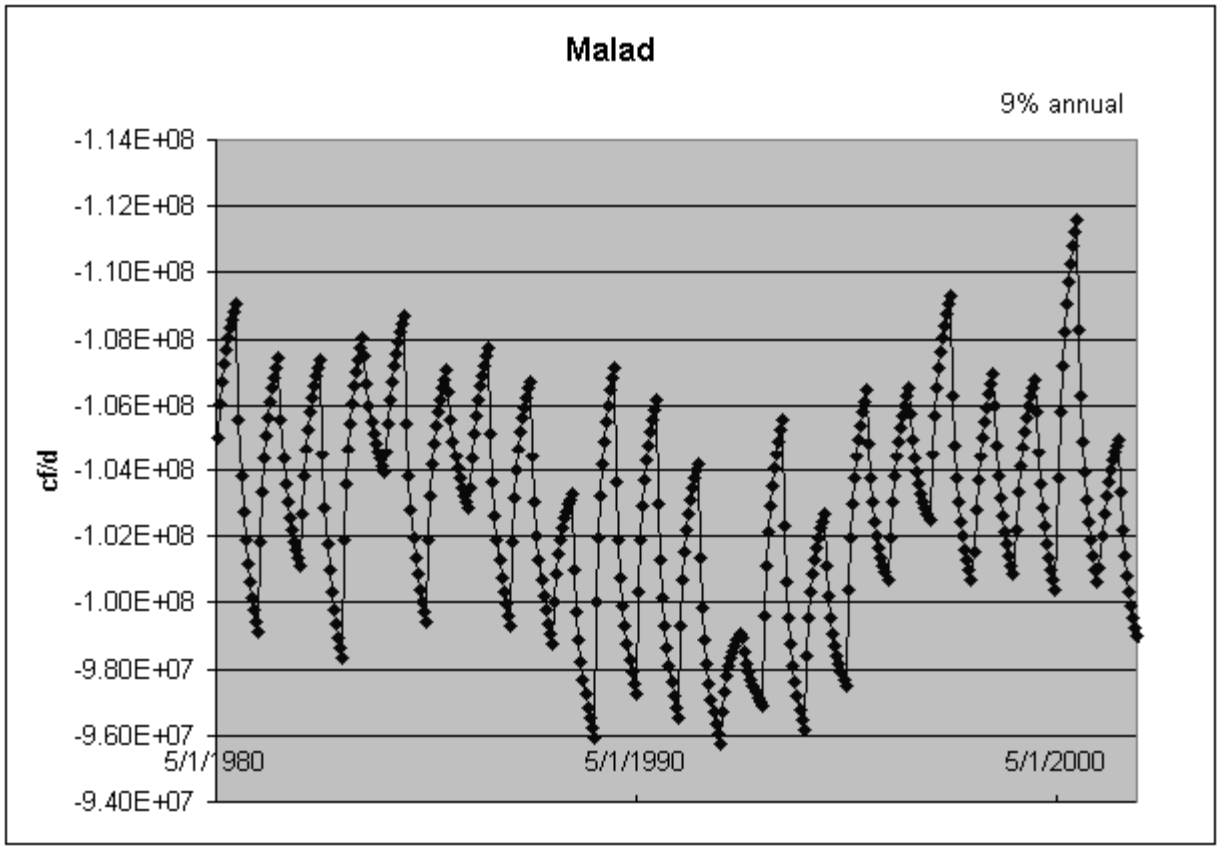
- Thousand Springs to Malad



Spring Reaches

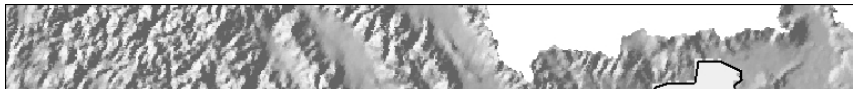
- Malad

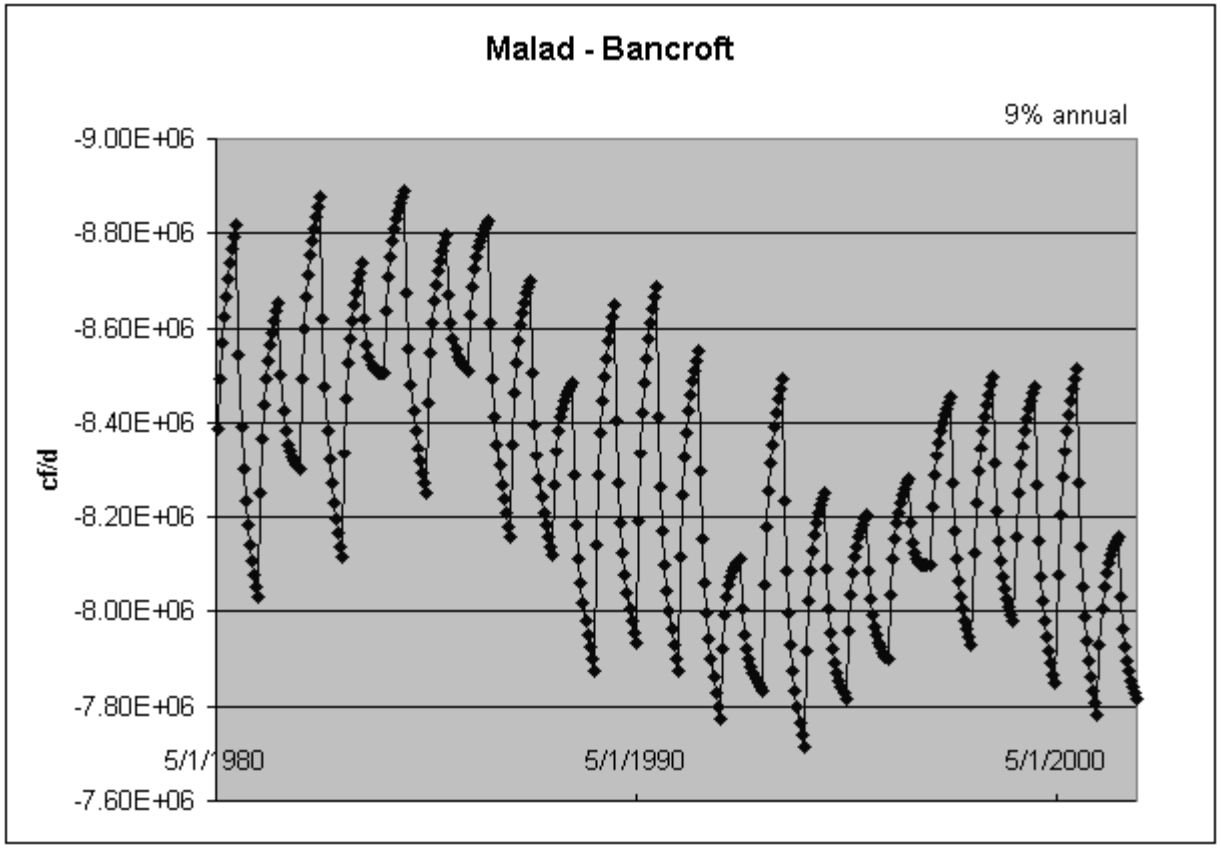




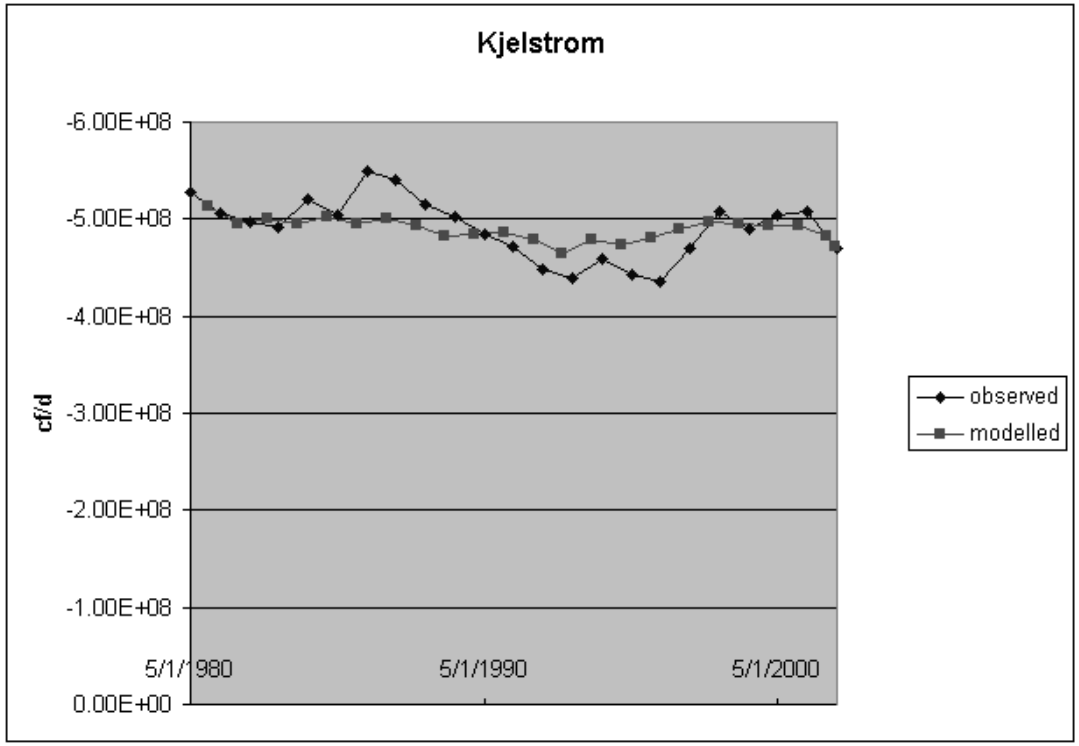
Spring Reaches

- Malad to Bancroft





Spring Reaches



- Comparison with Kjelstrom calculations of average annual spring discharge

Summary

- Model Enhancement Collaborative Effort
  - Many Organizations and Technical Personnel
- Calibration Very Successful
- Model Results Not Perfect
  - Best Tool Available
- Regional Model
  - Model Use Should be Regional
  - Not Appropriate for Highly Local Application

More Information?

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