Upper Rio Grande Water Operations Model

Present & Future Work

May 3, 2011

US Army Corps of Engineers
BUILDING STRONG®
ALBUQUERQUE DISTRICT

URGWOM Website

http://www.spa.usace.army.mil/urgwom/default.asp

Overview

- 5-Year Plan
- AWRA - November 7-10, 2011
  - http://www.awra.org/meetings/ABQ2011/
  - Upper Rio Grande NM Real-Time Watershed Modeling
  - Watershed Model
- Colorado Portion
- Middle Rio Grande
- Watershed Model
- Accounting Model
- Combined Forecast-Water Ops Model
- Lower Rio Grande

5-Year Plan

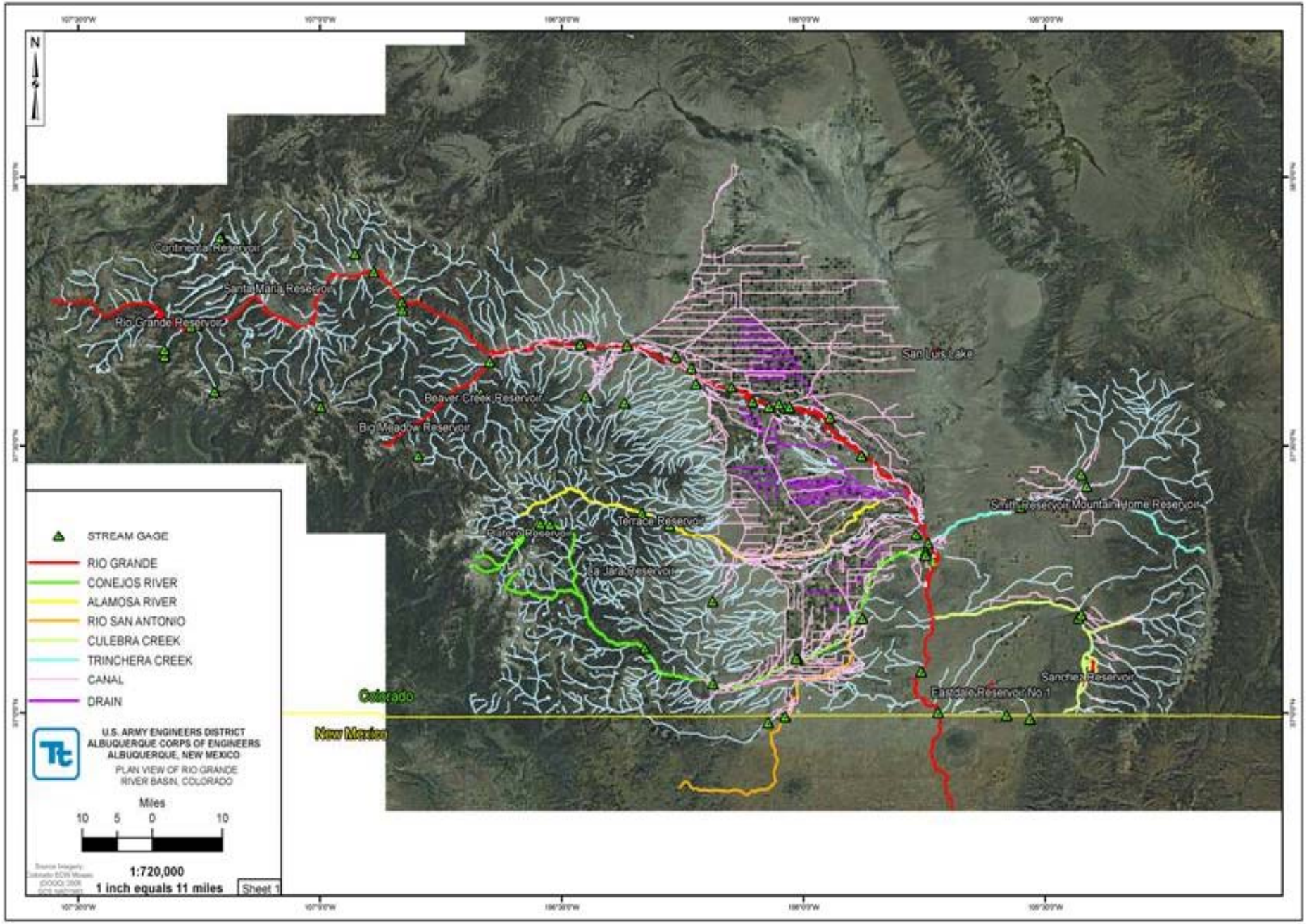
5-Year Plan

- **URGWOM Regular Activities**
  - Rules Development
  - Database Management
  - Monthly Model Maintenance
  - URGWOM Technical Review (2012)
  - Update Survey of Vegetated Areas (2012)
- **URGWOM Enhancement & Development**
  - Rules Efficiency
  - Watershed Model
  - Colorado Portion
  - Middle Valley Model Improvements
  - Real-Time Water Operations Model

5-Year Plan

- **URGWOM Enhancement & Development**
  - Accounting Model Enhancements
  - Accounting Controller Solution Research
  - Lower Rio Grande Model Enhancements
  - Monthly Timestep RiverWare Model Development
  - Water Quality Simulation Capability to Groundwater Objects
- **Planning Support**
  - MRGES Collaborative Program Modeling (BA/BO)
  - Development of Monthly Powersim Scoping Model

Colorado Portion


N
Continental Reservoir
Santa Maria Reservoir
Rio Grande Reservoir
Beaver Creek Reservoir
Big Meadow Reservoir
San Luis Lake
Terrace Reservoir
Platoro Reservoir
La Jara Reservoir
Sanchez Reservoir
Colorado
New Mexico
STREAM GAGE
RIO GRANDE
CONEJOS RIVER
ALAMOSA RIVER
RIO SAN ANTONIO
CULEBRA CREEK
TRINCHERA CREEK
CANAL
DRAIN
U.S. ARMY ENGINEERS DISTRICT
ALBUQUERQUE CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO
PLAN VIEW OF RIO GRANDE
RIVER BASIN, COLORADO
Miles
10 5 0 10
1:720,000
1 inch equals 11 miles
Sheet 1

Current URGWOM Methods

- Flows currently based on historical gage data at Lobatos (historical year in a synthetic sequence)
- Upcoming year inflows adjusted to match forecast volume
- Assumption operations match historical operations

Admin of Colo. DWR District 20

- ~ 200 ditches administered (Apr 1 – Oct 31)
- Diversion from river to eight main canals
  - ►Rio Grande canal provides water to 32 ditches
- Various water user associations regulate head gates from main canals and laterals

Rio Grande Compact – Conejos

- Delivery obligation for the Conejos River is computed as function of Conejos Index Supply
  - Conejos Index Supply = Mogote Gage + Los Pinos Gage near Ortiz + San Antonio River Gage at Ortiz
    - April - October
- Actual delivery to Rio Grande is gaged near Las Sauces, CO

Rio Grande Compact – Rio Grande

- Delivery computed as a function of Rio Grande flow at Del Norte
- Delivery is based on gaged river flow at Lobatos minus the flow from Conejos River

Other Rio Grande Tributaries

- Culebra Creek basin is administered - flows do not reach the Rio Grande
- La Jara River and Alamosa River do not affect Compact administration & operations have not changed over time
- Trincheras Creek flows are ~ 75 cfs

Groundwater

- Shallow aquifer and a deep confined aquifer
- Groundwater use has not impacted administration
- Groundwater use clearly impacts river flows
- Permitting for groundwater use began in 1965 with rights administered since 1969
  - ► A metering program underway for groundwater wells

Platoro Reservoir

- Project water is stored at Platoro Reservoir if Article VII is not in effect
- Direct flow storage may occur at Platoro
- Up to 10,000 ac-ft may be stored for the Compact
- Allocations of water available to purchase are set based on the amount of land in the District

Rio Grande, Santa Maria, & Continental Reservoirs

- Storage is fairly low in priority
  - ▶ Storage may occur for a few days or a couple weeks
  - ▶ Direct flow storage decree
    - Diversion right is deferred & water is stored upstream
    - Used by same water user in same year
    - Storage for Compact to provide flexibility with meeting delivery requirement

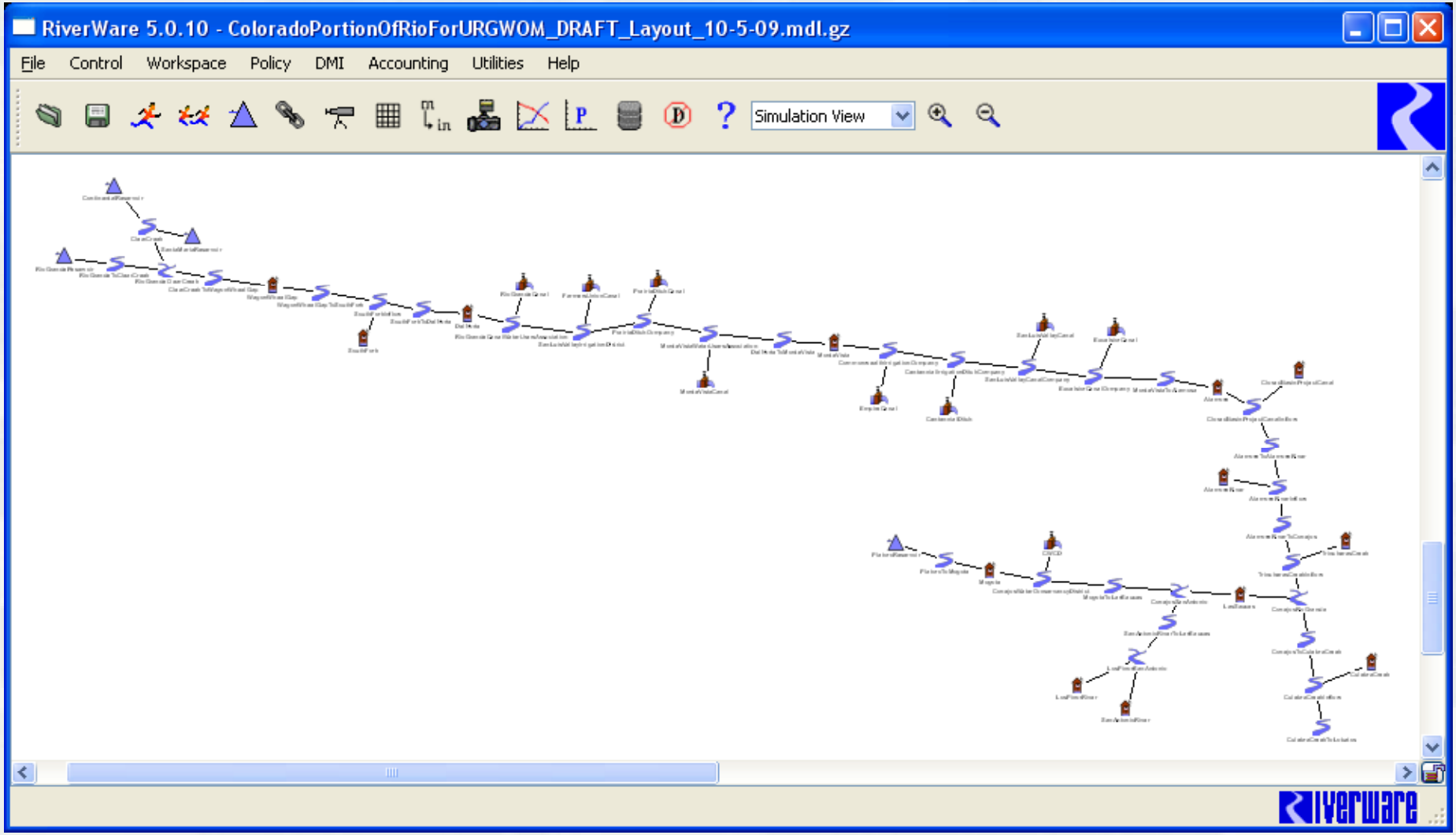
DRAFT Design Plan

- New portion set up independently at first
  - ► When models are merged,
    - the new rules would be added to solve at a higher priority
- Verify existing rules since the mainstem above the confluence now solves without rules
  - ► Impacts on Rio Chama deliveries downstream

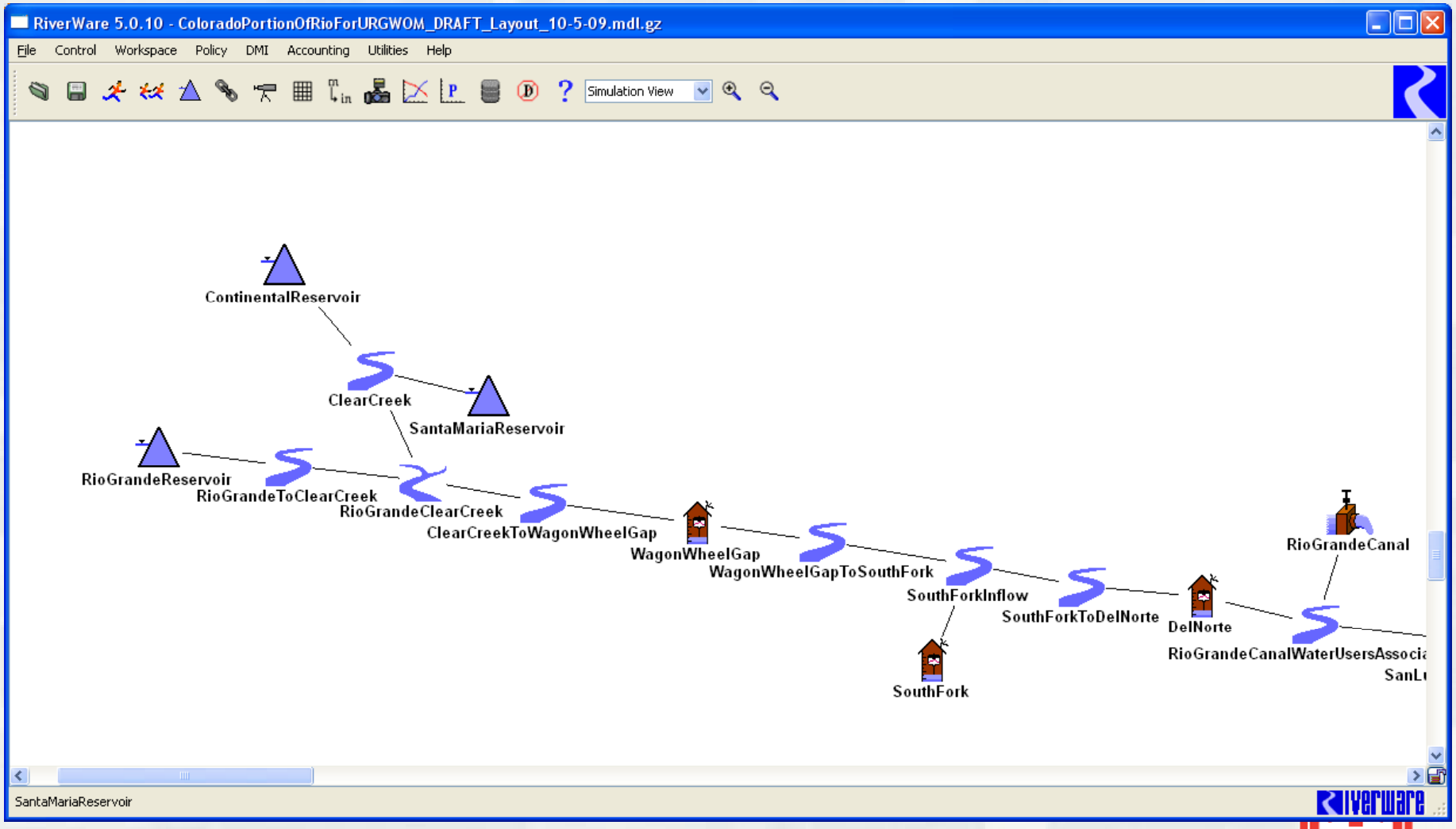
DRAFT Design Plan

- Colorado portion would all merge into a primary native Rio Grande account at Lobatos
- PROPOSED to improve results for analyzing actual conditions in New Mexico
- NOT PROPOSED to analyze administrative actions in Colorado

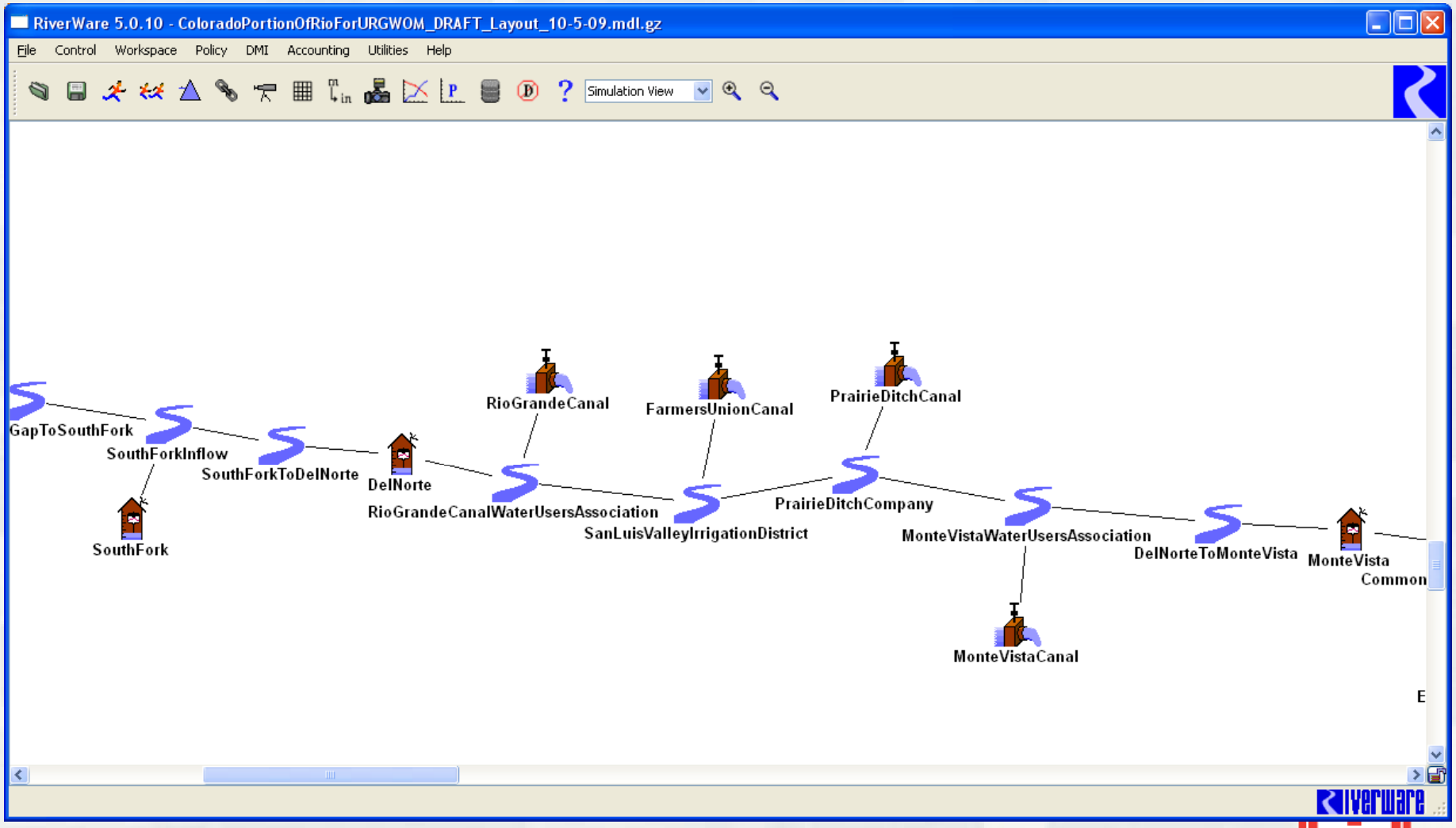
Initial Layout



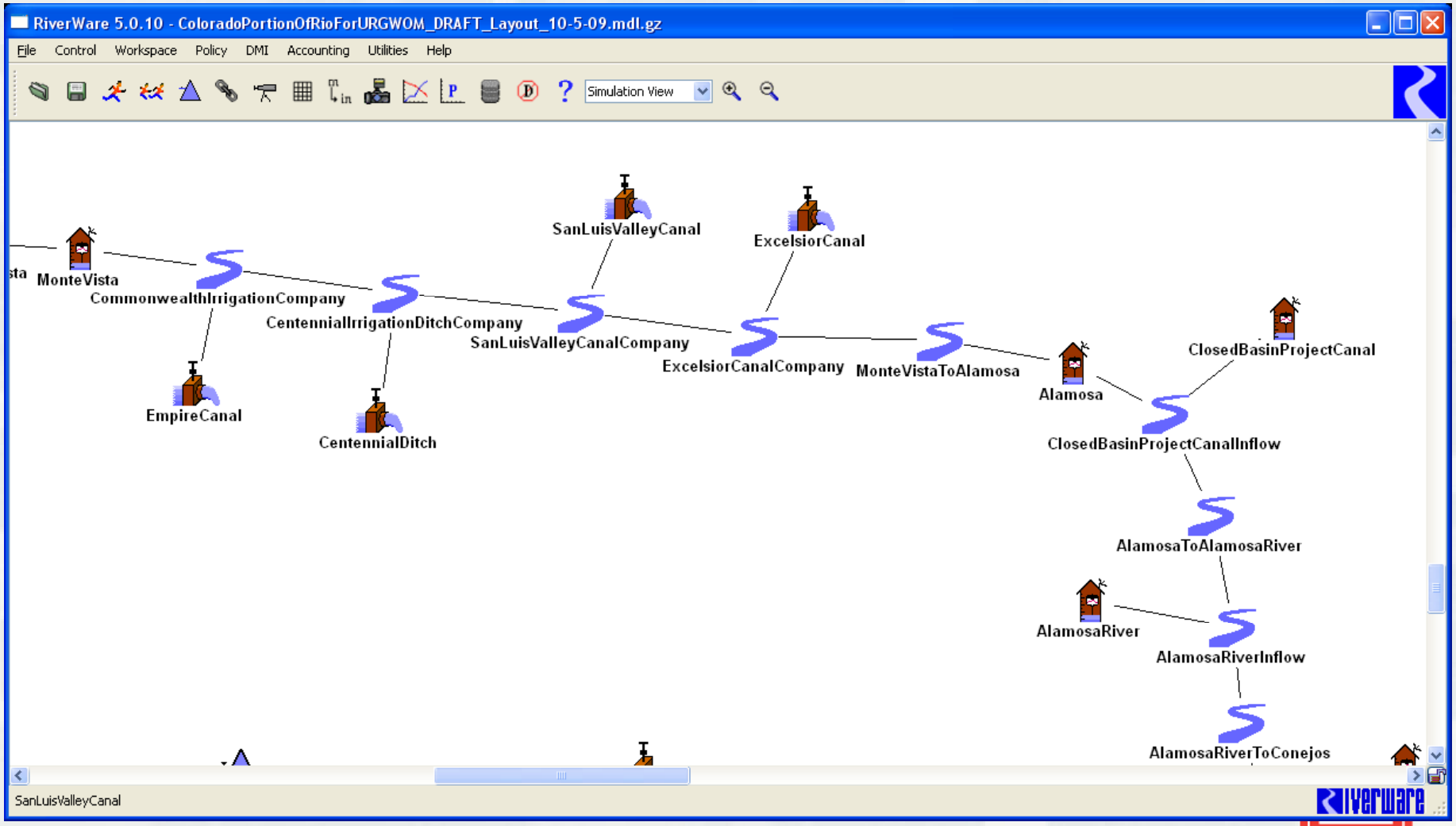
Initial Layout Detail



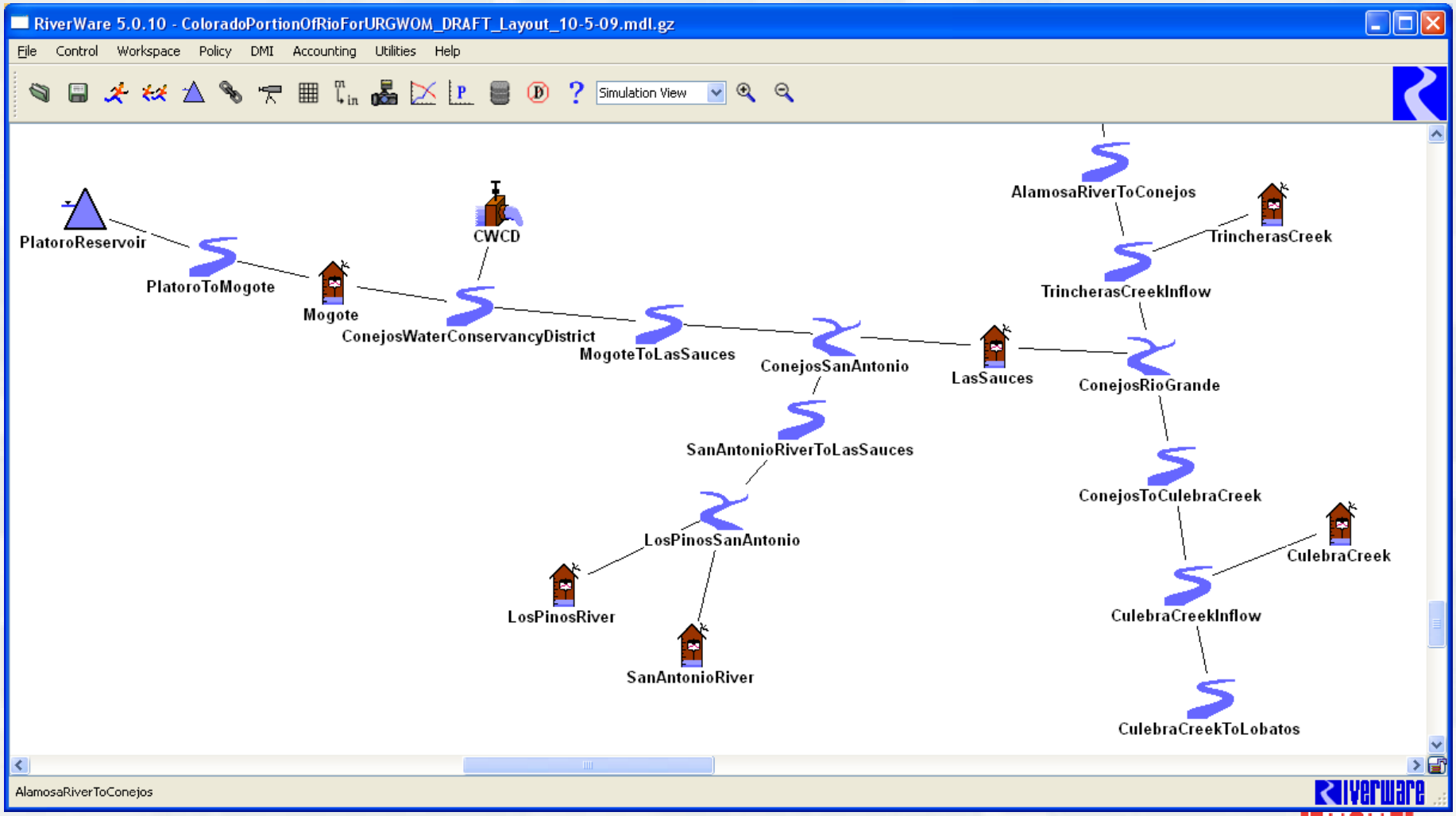
Initial Layout Detail



Initial Layout Detail



Initial Layout Detail



Middle Rio Grande

Upper Rio Grande Watershed

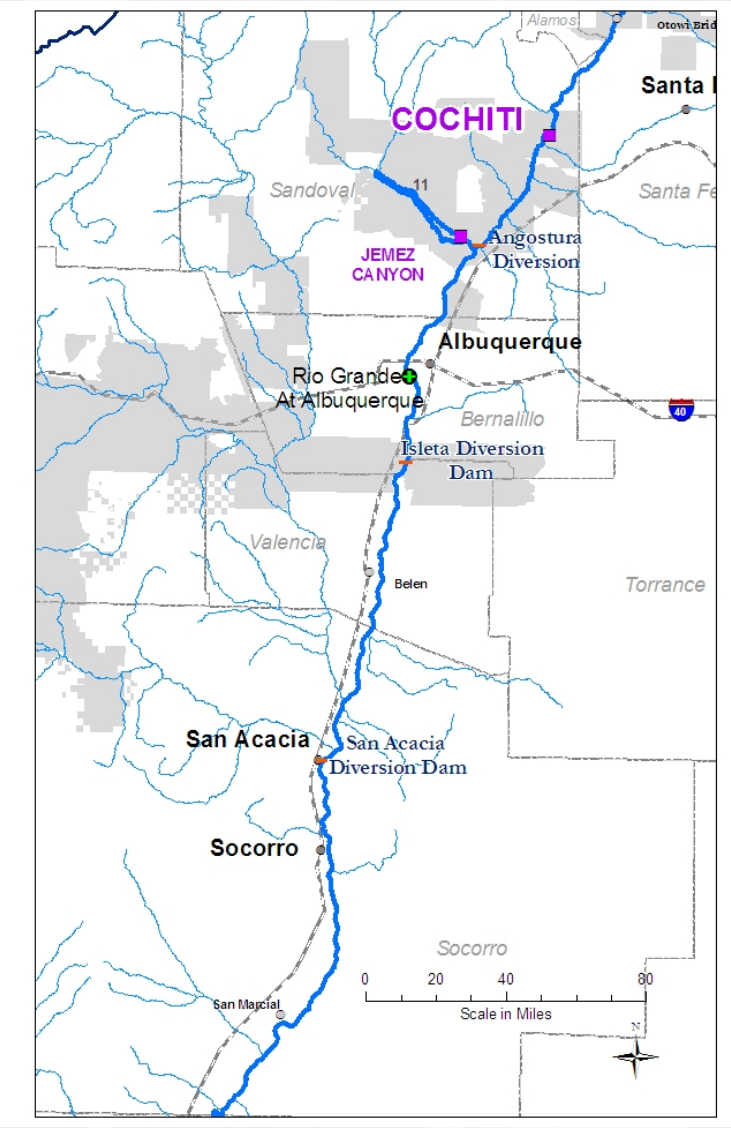
URGWOM Modeled from Colorado state-line to Texas state-line

<u>Middle Rio Grande</u>
between Cochiti Dam
and Elephant Butte Reservoir

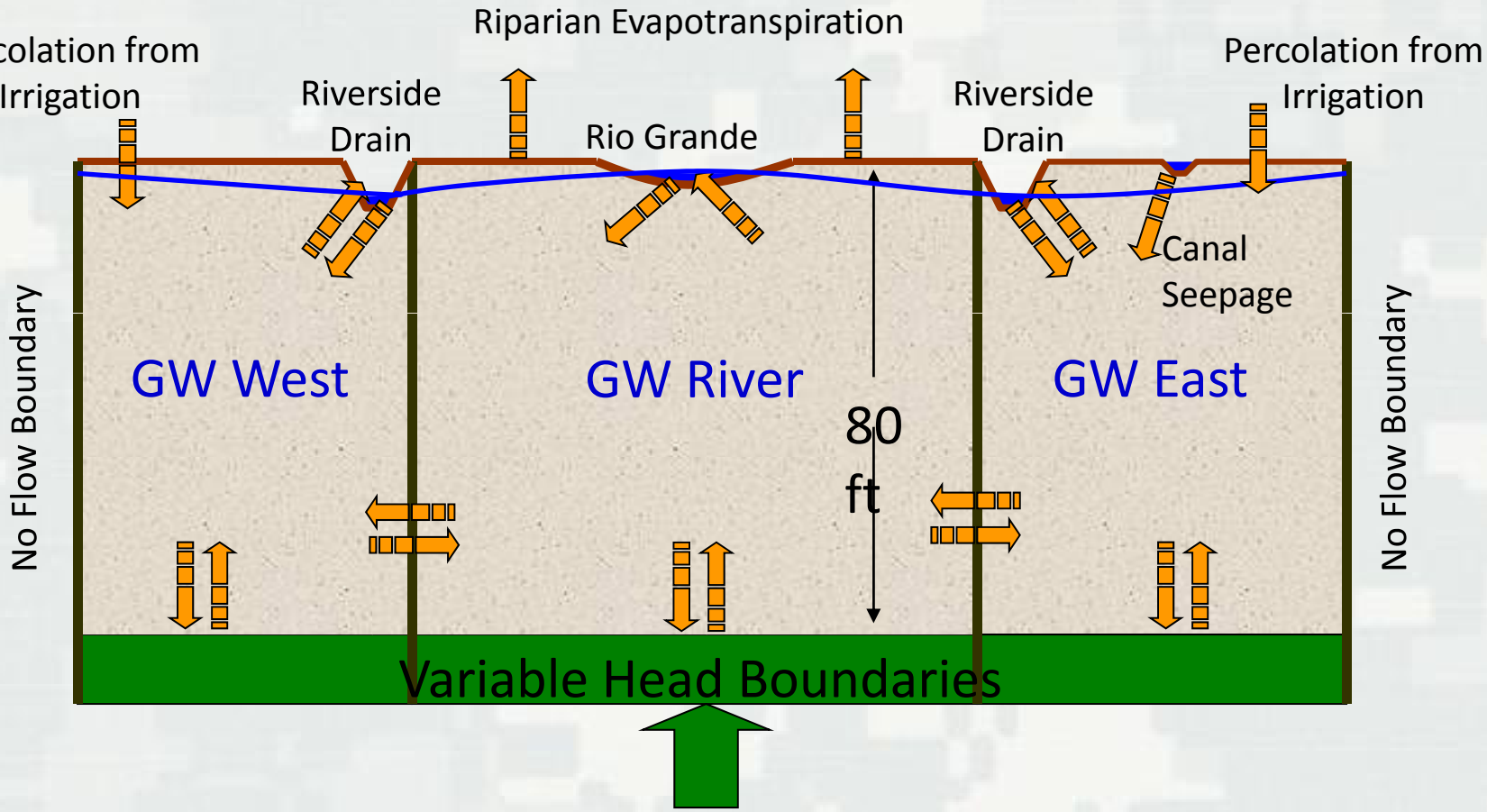
Upper Rio Grande Basin

System in Middle Valley

- River Channel
- Riparian Vegetation
- Riverside Drains
- Levees and Spoil Banks
- Irrigation System



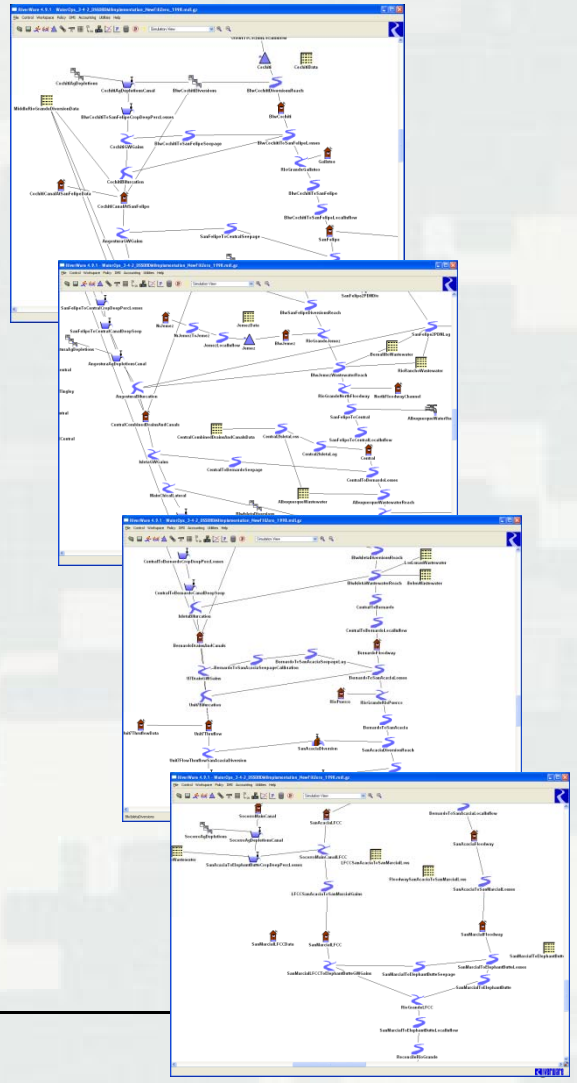
Groundwater-Surface Water Interaction



Head Dependant Flow

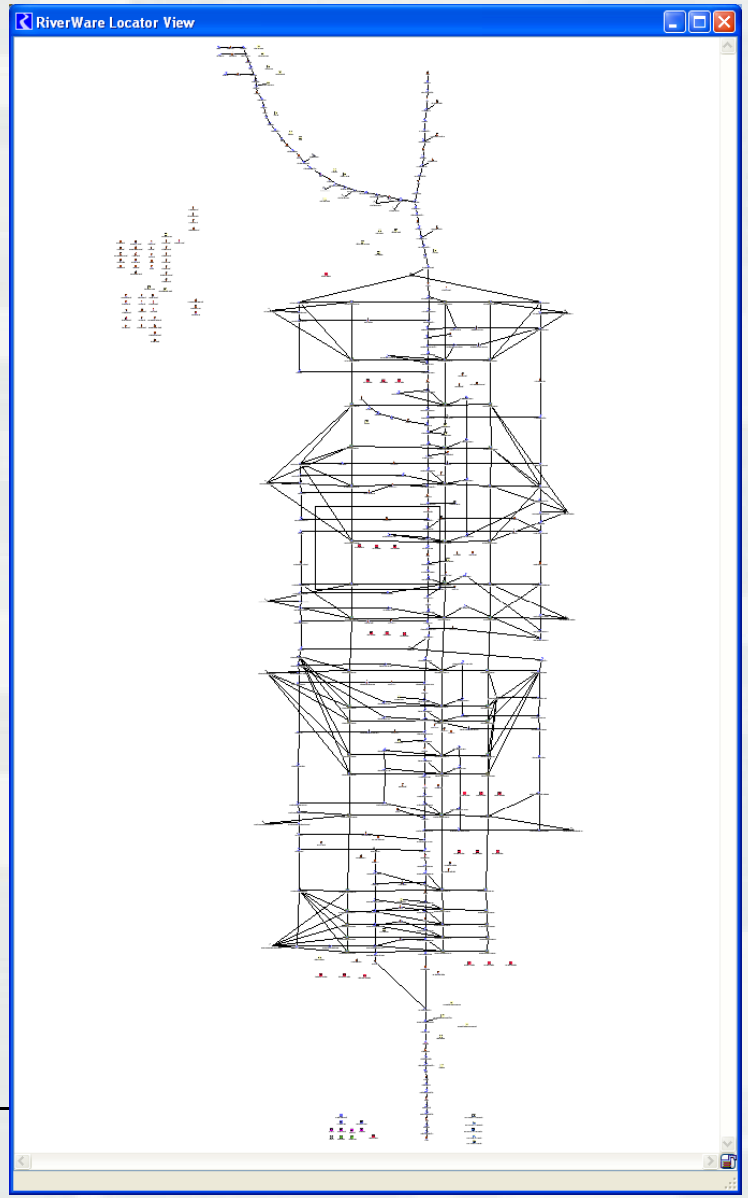
Physical System in Model

- Previous representation of the physical system in URGWOM
  - ►Uses regression relations for river seepage
  - ►Feedback loop used to calibrate flow in the river and drains
  - ►Flow input needed for feedback loop

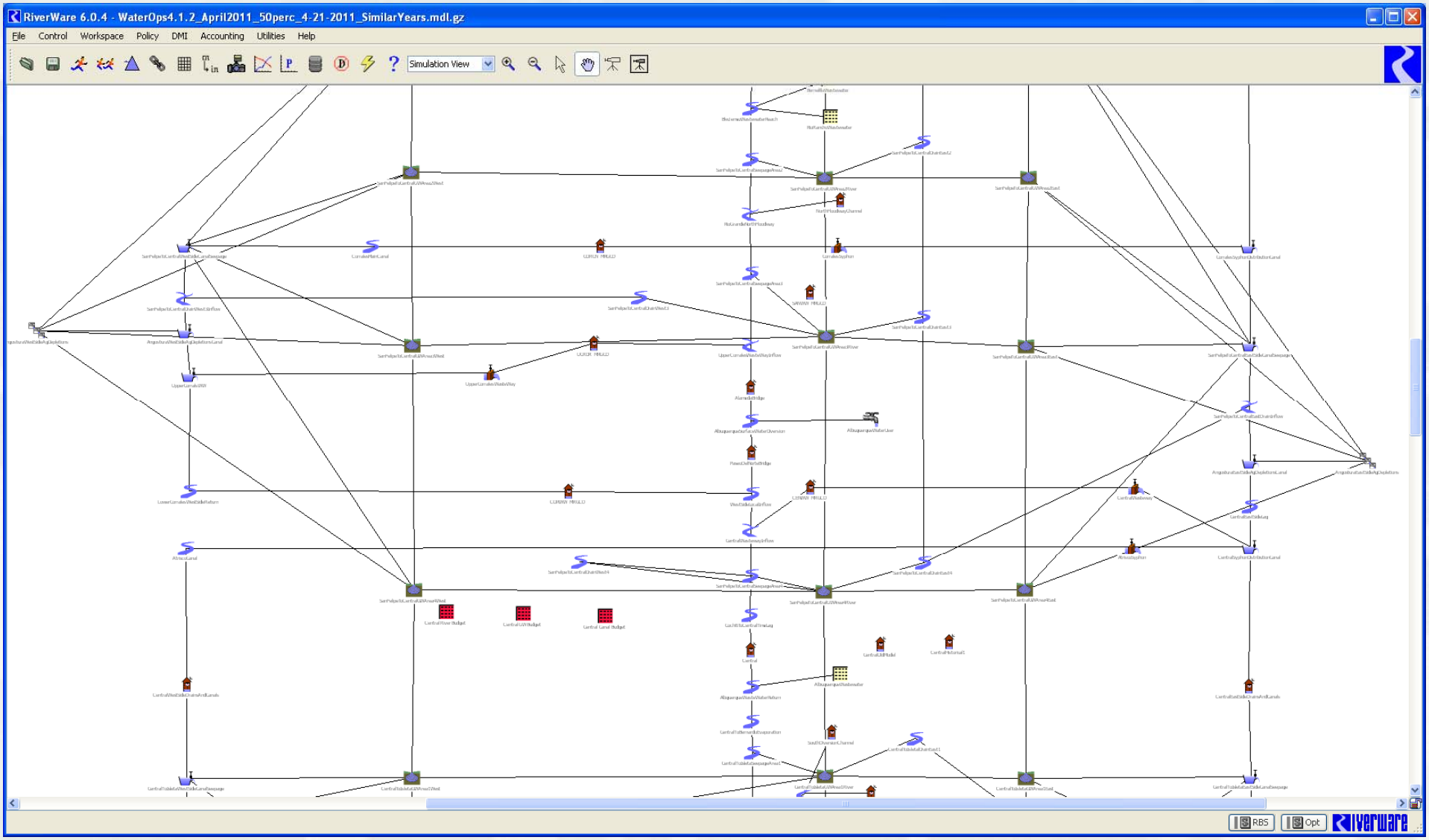


Physical System in Model

- New representation of the physical system in URGWOM
  - ►Compute seepage from reach objects
  - ►Compute groundwater flow between groundwater objects
  - ►Compute head dependent flux from shallow aquifer and deep aquifer



Physical System in Model Detail



Seepage from Reach Objects

- Seepage computed based on head differential between river and shallow aquifer level using Darcy's equation

$$Seepage = \Delta H * Conductance$$

$$Conductance = K * L * w / m$$

  - K = hydraulic conductivity
  - L = reach length
  - w = reach width
  - m = bed thickness

► River head based on a stage-discharge relationship.

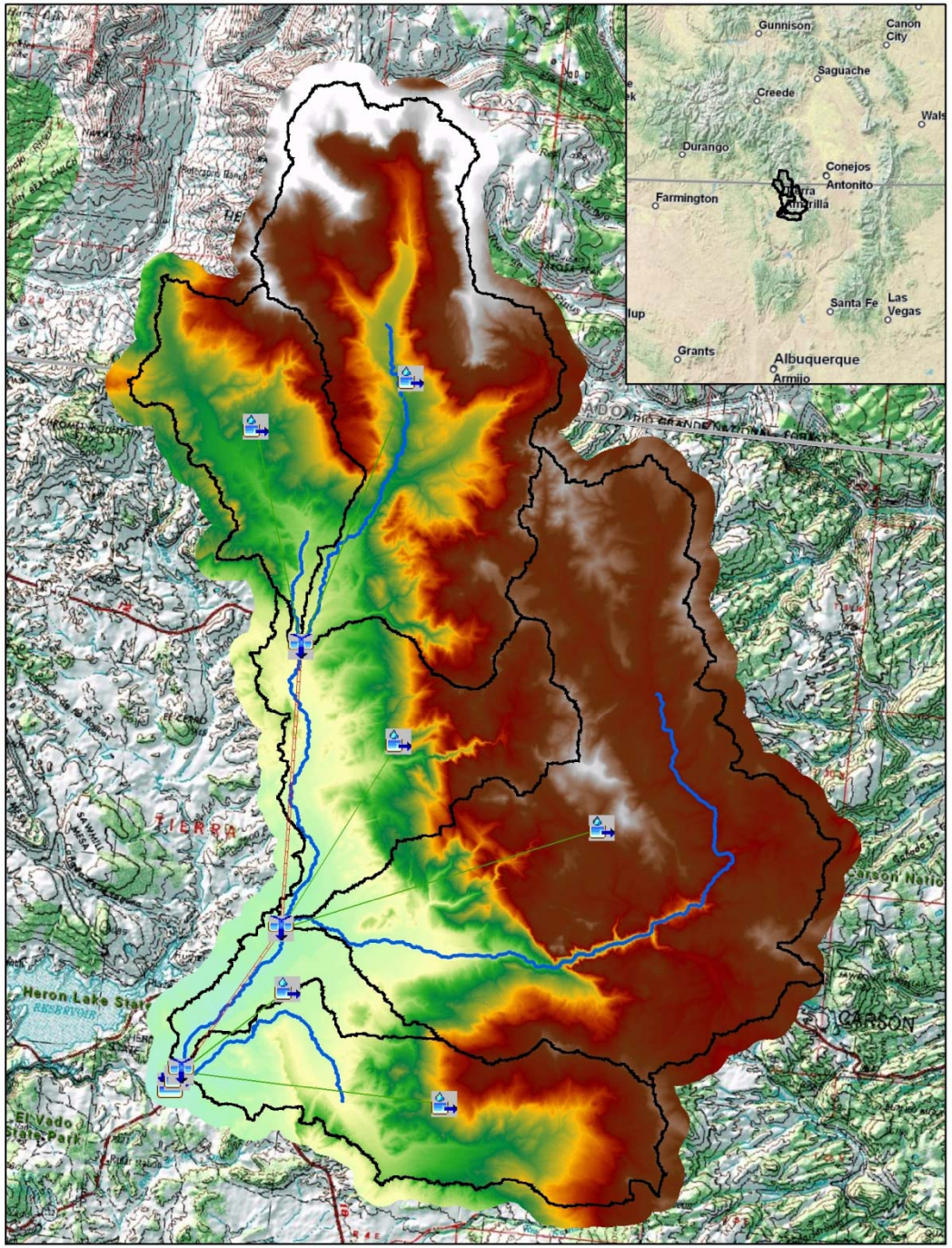
URGWOM

- Simulates operations/releases
  - ►Target flows at locations in the Middle Valley
  - ►Other conditions for other ecological considerations
  - ►Deliveries to water users
  - ►Accounting
  - ►Flows to Elephant Butte Reservoir
- Daily time step
- Simulated river flows significantly affected by groundwater-surface water interaction methods

Watershed Model

La Puente Test Case

- Headwaters
- Ungaged
- Unregulated
  - ►Small reservoirs
  - ►Small diversions
- Major input

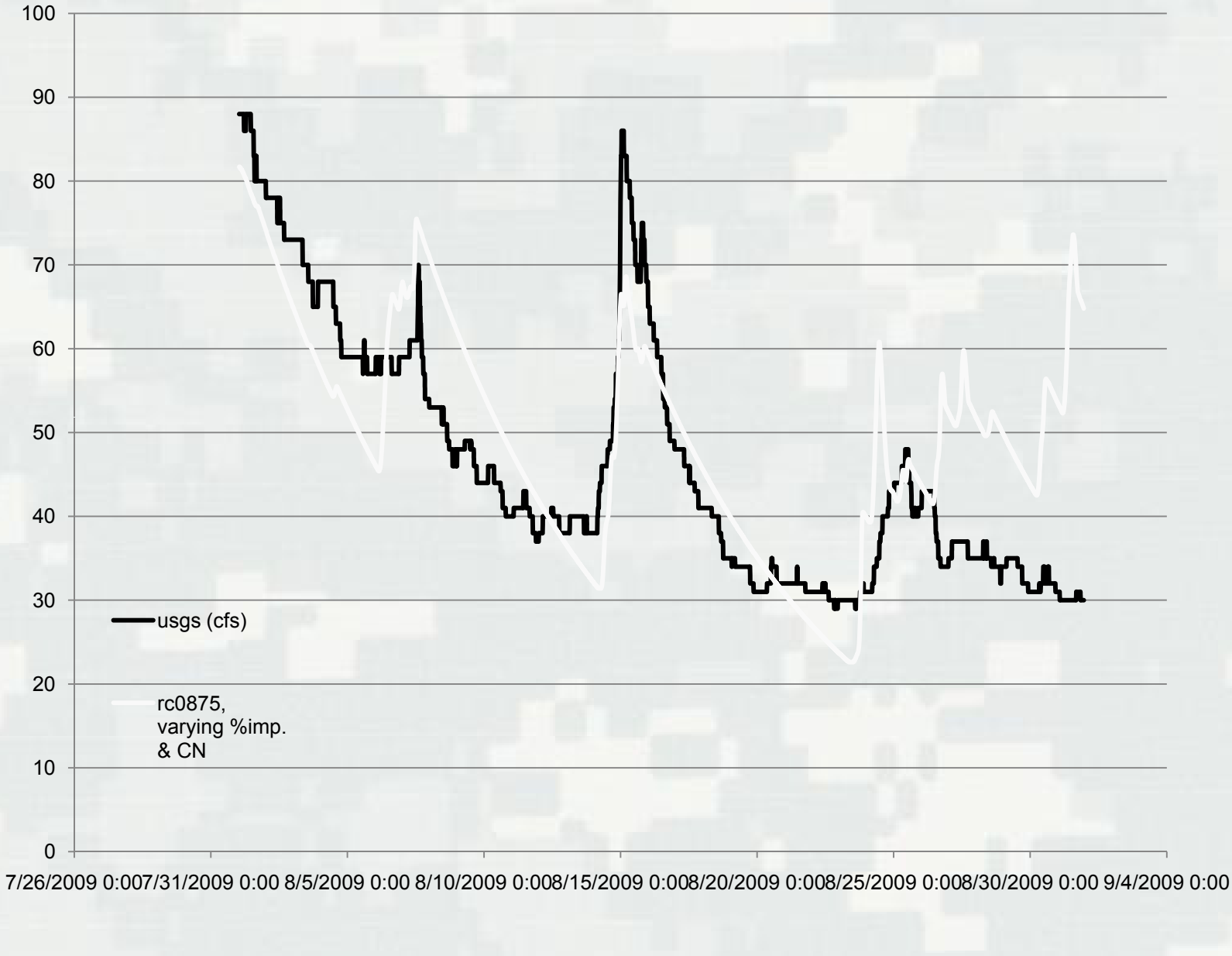


Loss Method: SCS Curve Number

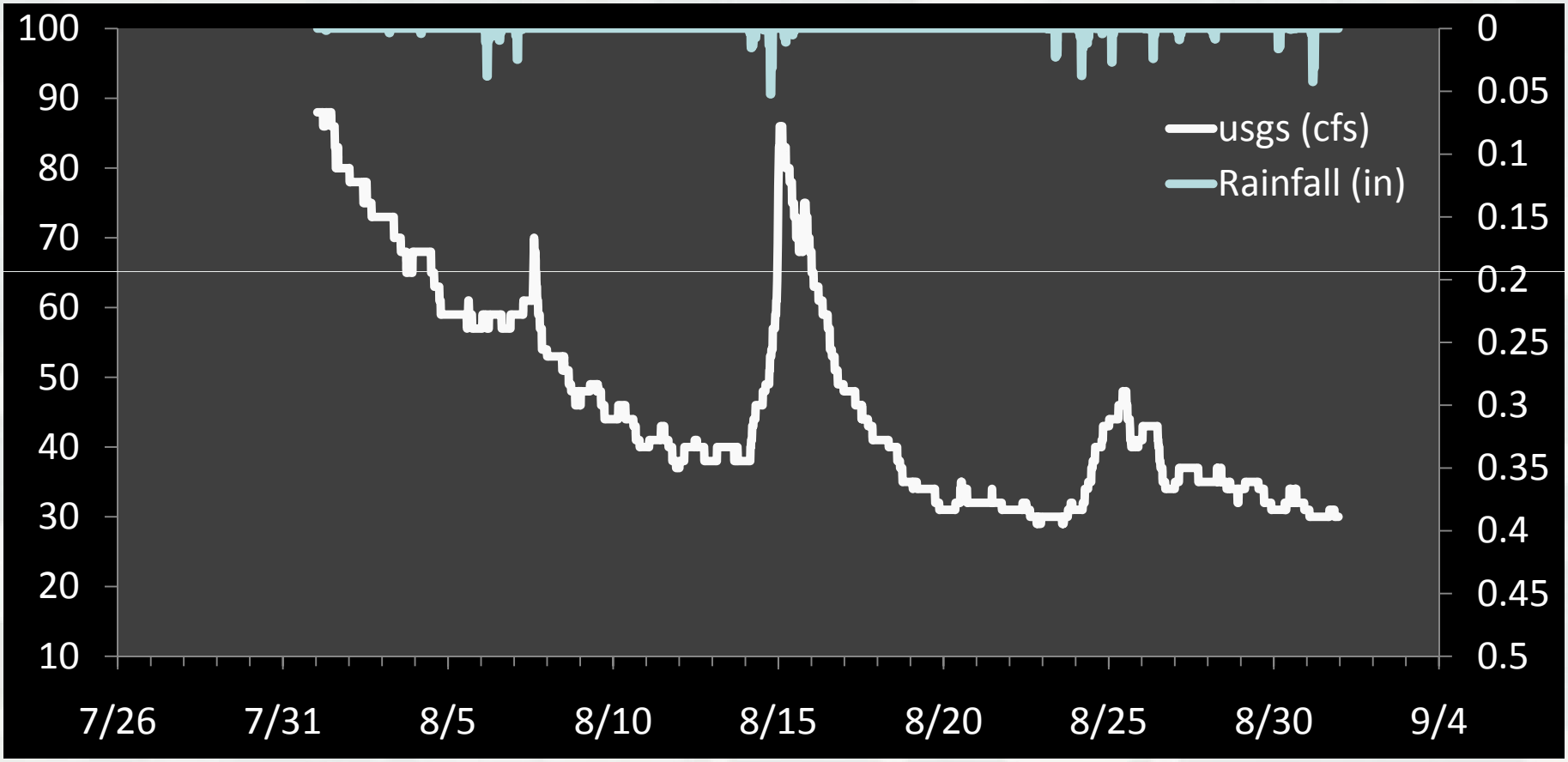
- Equation parameters
  - P_e = Excess Precipitation
  - P = Accumulated rainfall
  - S = Potential maximum retention
    - S = (25,400 – 254 * CN) / CN
  - I_a = Initial abstraction = 0.2 * S
  - CN = Curve Number
    - $CN_{composite}$ = sum (A_i * CN_i) / sum A_i
      - CN = 30 (very permeable)
      - CN = 100 (impervious cover)
- CN 60 - 70 is reasonable range

Loss Method: Impervious %

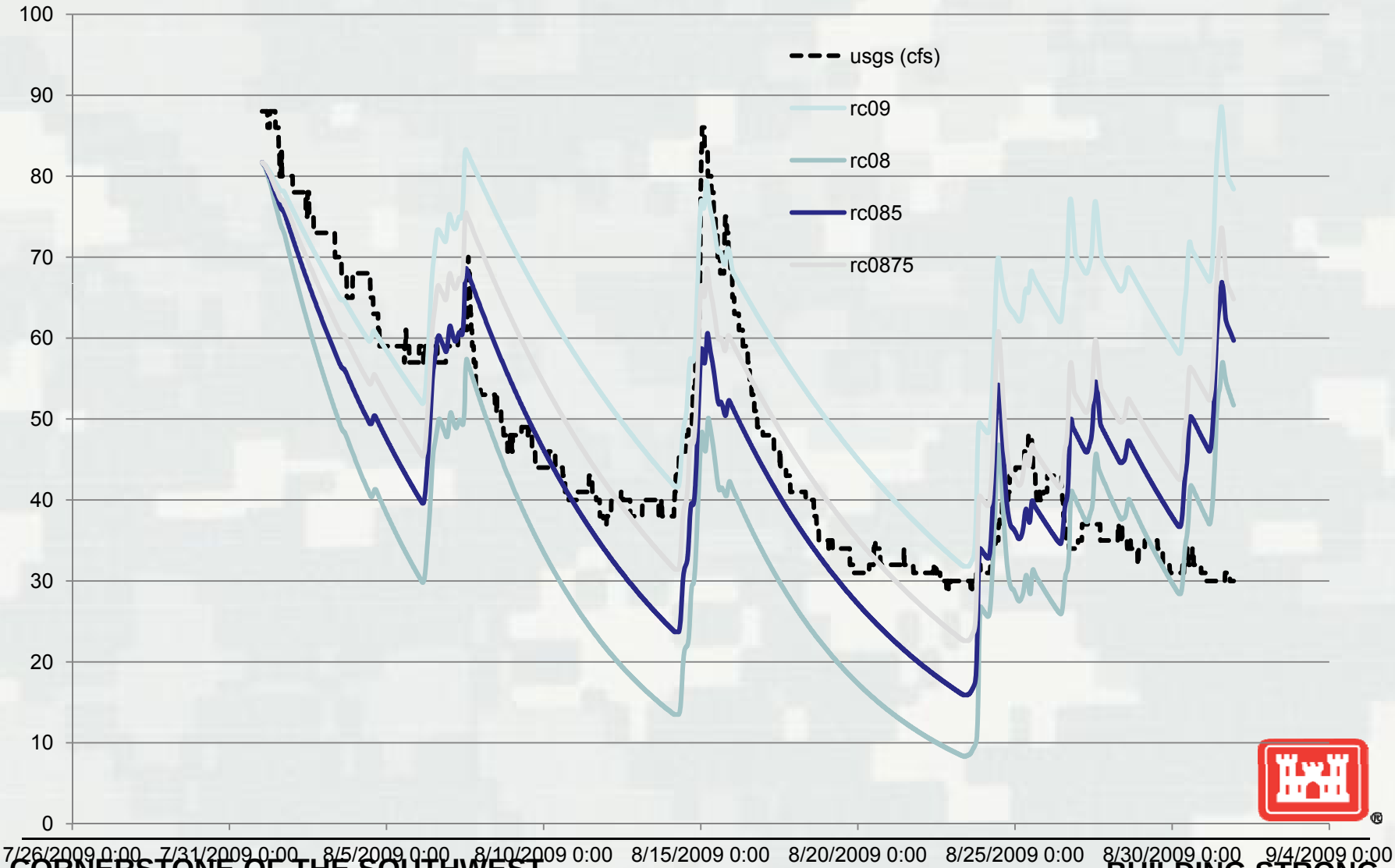
- Percentage of impervious area
- Increase in % of impervious area leads increase in runoff


100
90
80
70
60
50
40
30
20
10
0
usgs (cfs)
rc0875,
varying %imp.
& CN
7/26/2009 0:00
7/31/2009 0:00
8/5/2009 0:00
8/10/2009 0:00
8/15/2009 0:00
8/20/2009 0:00
8/25/2009 0:00
8/30/2009 0:00
9/4/2009 0:00

La Puente August 2009



Baseflow Methods

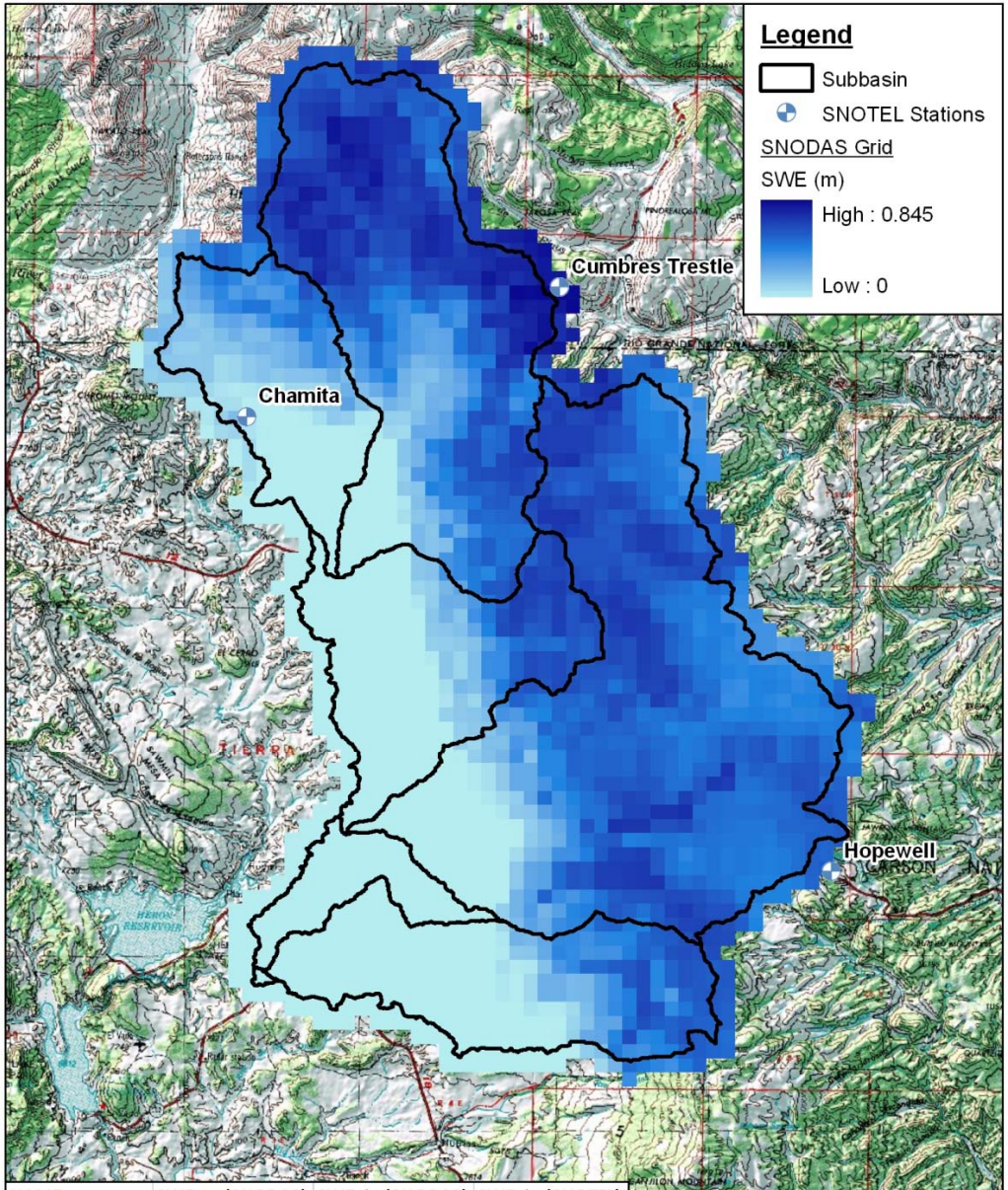


Future Work

Snowmelt runoff

SNODAS vs. SNOTEL

- Good Match
  - ►Cumbres Trestle 10,040’
  - ►Hopewell 10,000’
  - ►Bateman 9,300’
- Poor Match
  - ►Chamita 8,400’

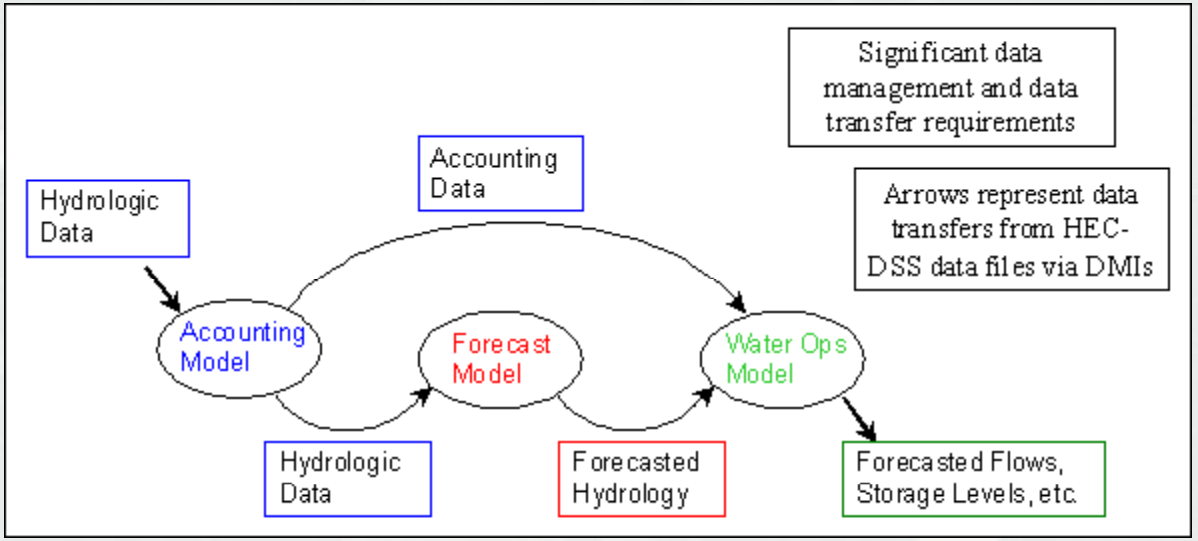


NAME	SWE_m (SNODAS)	SWE_in (SNODAS)	SWE_in (SNOTEL)
Cumbres Trestle	0.83	32.72	33.60
Chamita	0.041	1.61	6.60
Hopewell	0.52	20.63	20.80
Bateman	0.25	9.92	12.30

Accounting Model

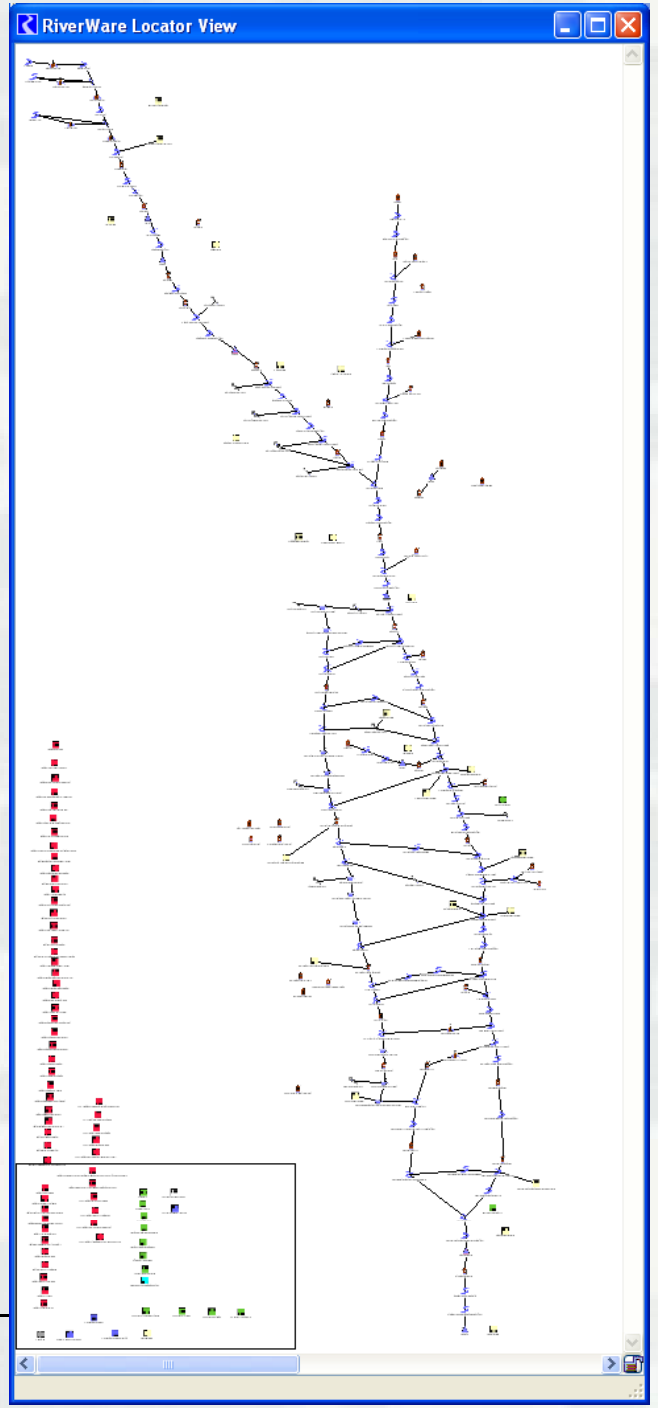
Accounting Model

- Basis for other models within URGWOM
- Accounting of water use in the New Mexico portion of Rio Grande Basin



Accounting Model

- Data sent by COE to BOR
  - Streams, reservoirs, etc.
- BOR
  - Performs data QC
  - Runs Accounting Model
  - Electronic transfer of model
    - COE, NMISC
- COE
  - Performs monthly forecast
  - Updated Water Operations



Combined Model

Combined Forecast-Water Ops

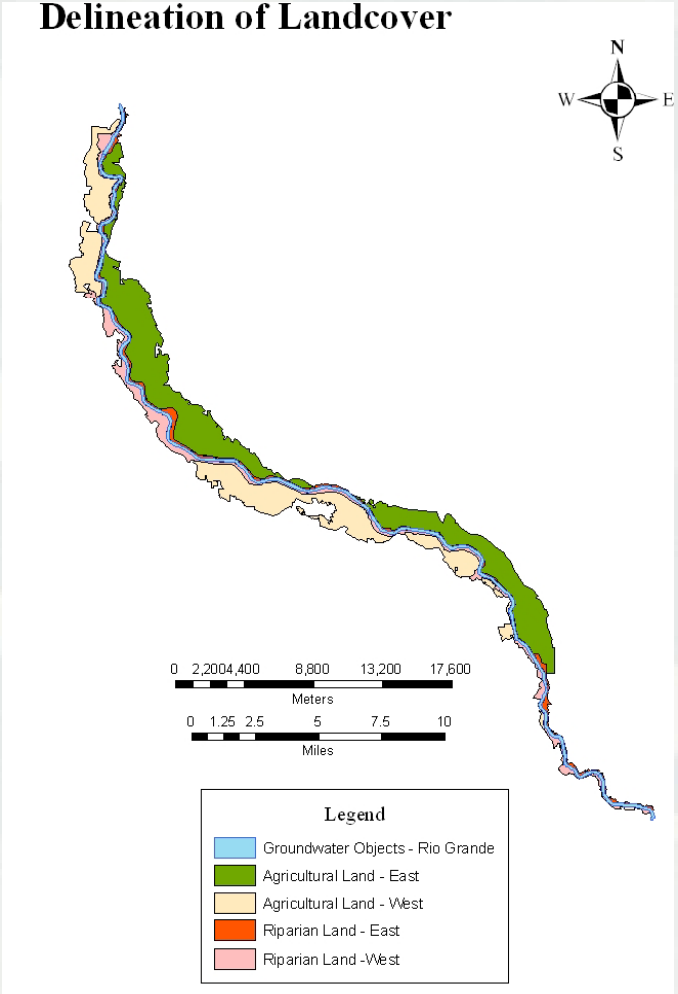
- Integrates forecast and water ops models
- Currently forecast is output to a temp DSS and overwritten with each new forecast
  - ► Each month, each sequence
- Not used due to software quirks
  - ► Init Rules flag not differentiated with user input

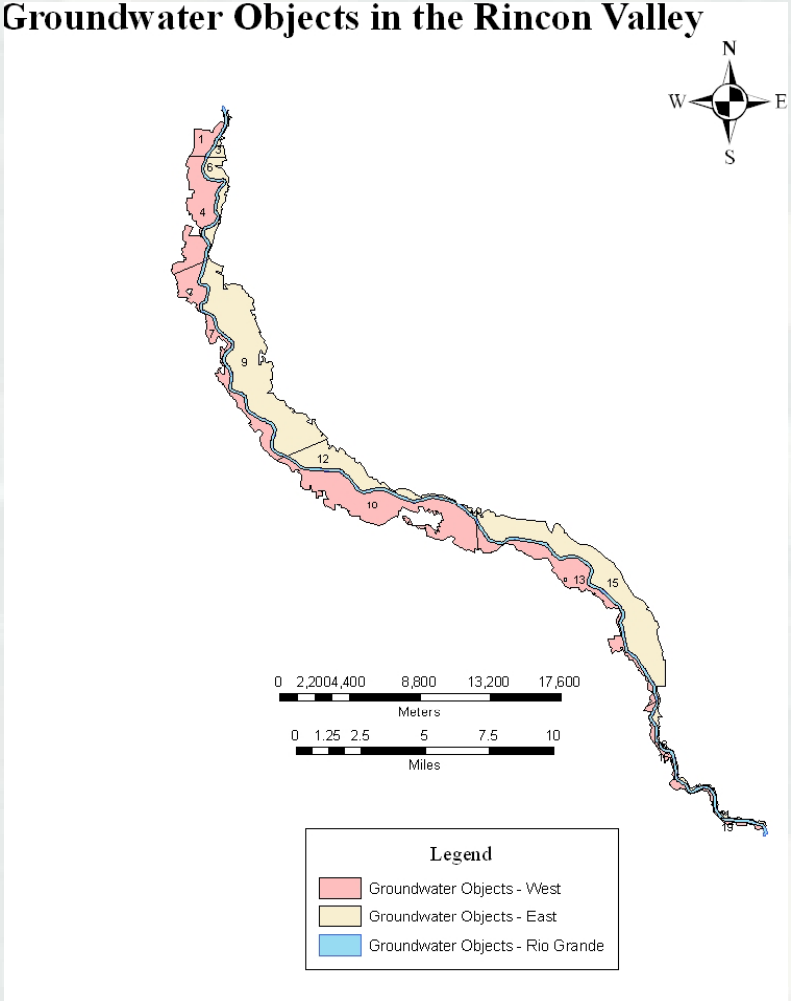
Lower Rio Grande

Current Work - LRG

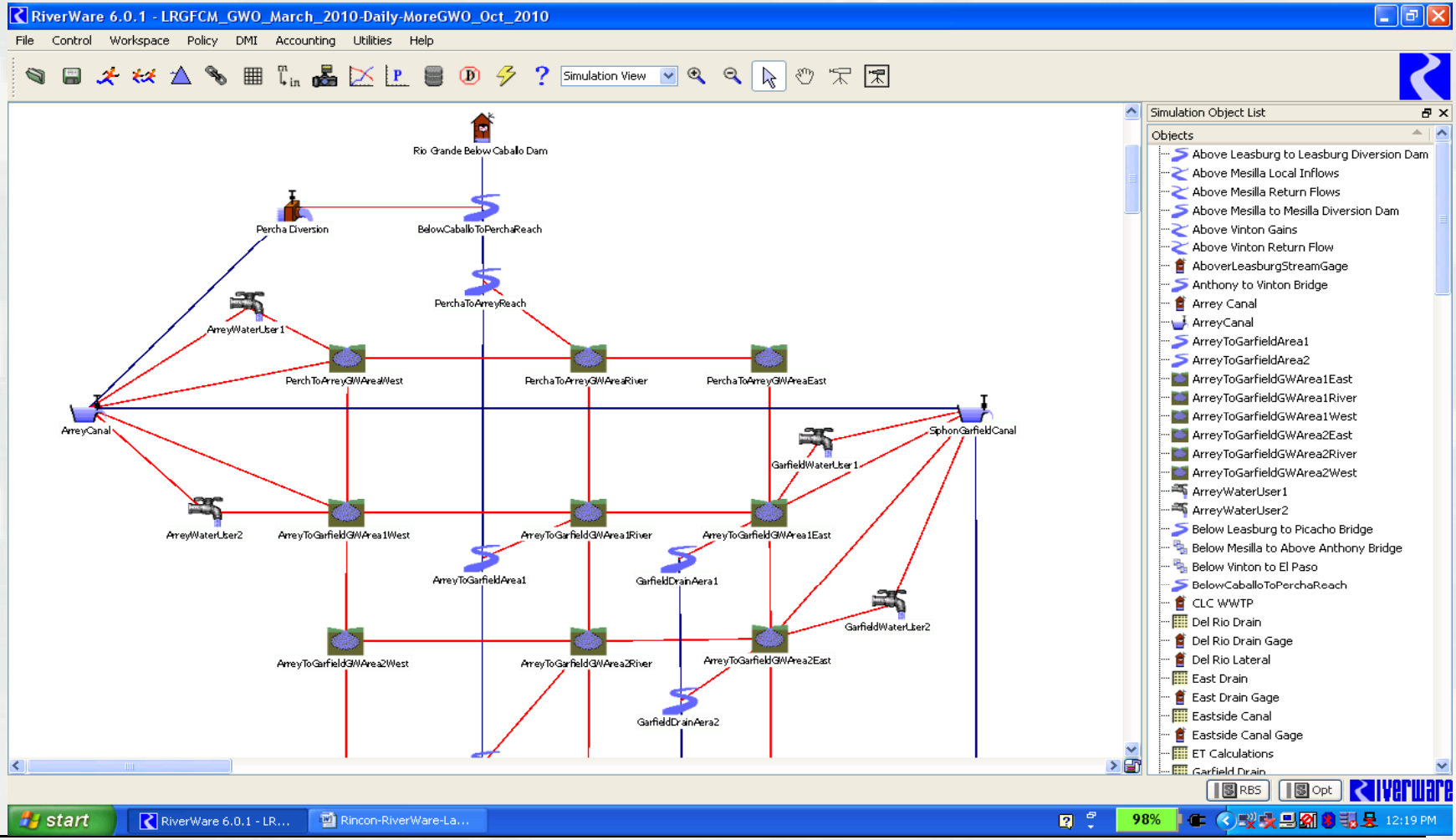
- **RiverWare Model for Rincon Valley and Mesilla Basin**
  - Surface water diversions linked to cropped area demand
  - Interactive groundwater objects linked to drain return flows
  - Expand the RiverWare model to represent the main canal system
  - Simulate river flow and water operations planning scenarios
  - Enhance coordinated water resources database
- **RiverWare Model for Lower El Paso Valley**
  - Compile flow and crop data
  - Develop the RiverWare model to simulate the river flow and water operations planning scenarios
  - Incorporate data into the coordinated water resources database
  - Evaluate USGS MODFLOW model for Hueco Bolson for SW/GW interaction

Model Layout for Rincon Valley

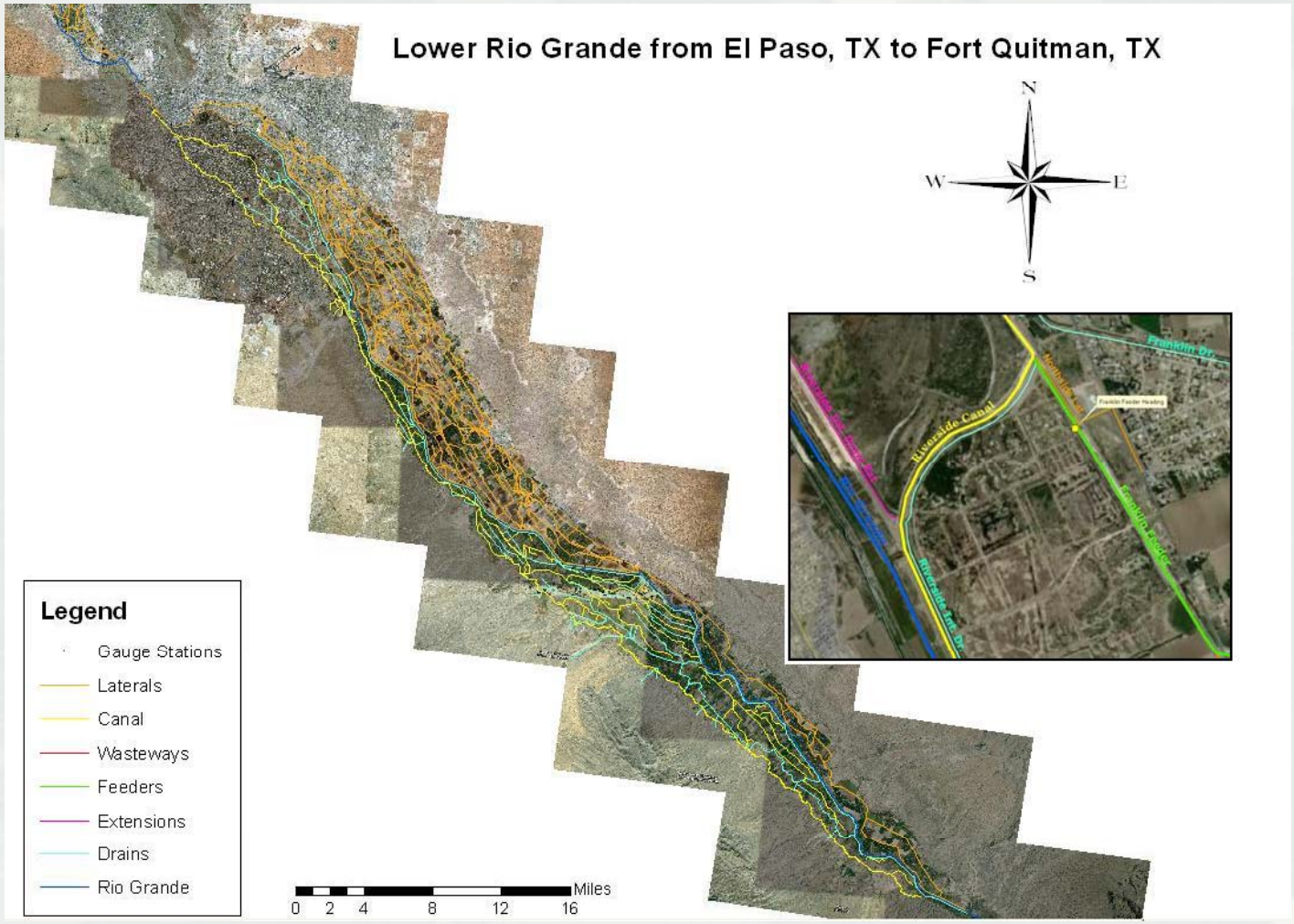




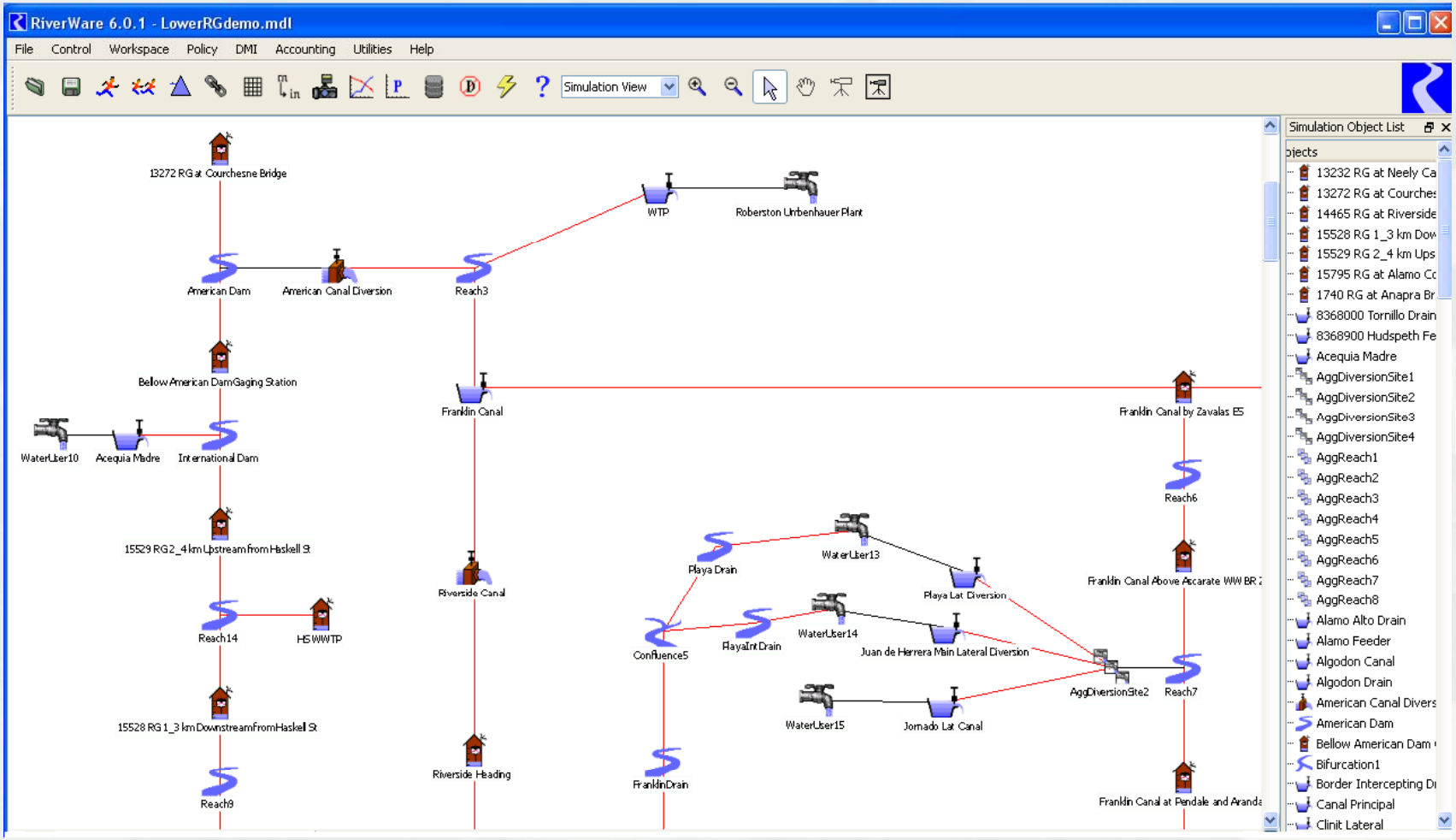
Model Layout for Rincon Valley



Model Layout for El Paso Valley



Model Layout for El Paso Valley



Future Plan

- **Enhancement of RiverWare Model for Rincon Valley and Mesilla Basin**
- **Further development of RiverWare Model for El Paso Valley**
- **Integrate the RiverWare models for both reaches**
  - Simulate flood planning for the Rio Grande Project area
  - Assess alternative water operations planning scenarios under different weather/climate conditions
  - Expansion to simulate the water quality for Rio Grande salinity control and management

Questions?