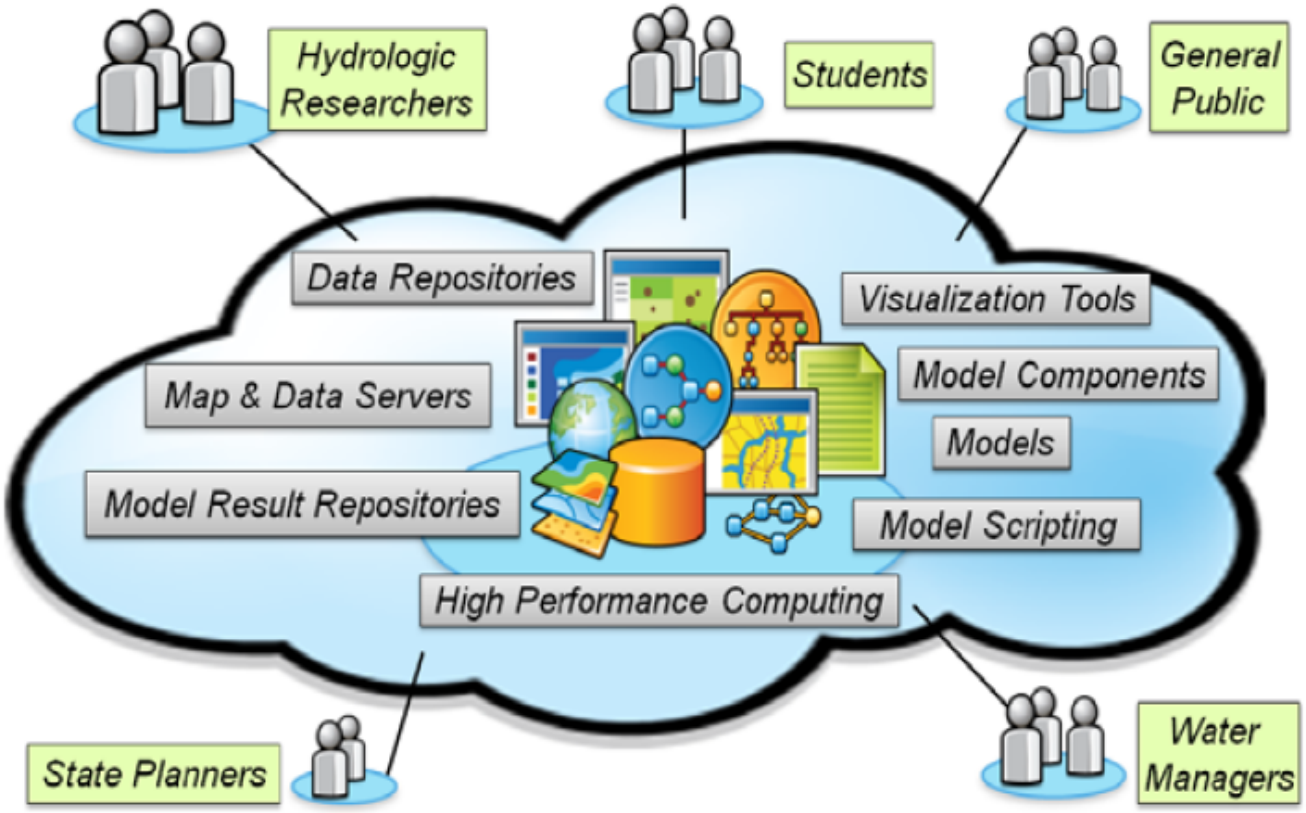
CI-WATER
A Utah-Wyoming Cyberinfrastructure
Water Modeling Collaboration

Brigham Young University Research Contributions

Objective #2: Enhance access to data- and computationally-intensive modeling

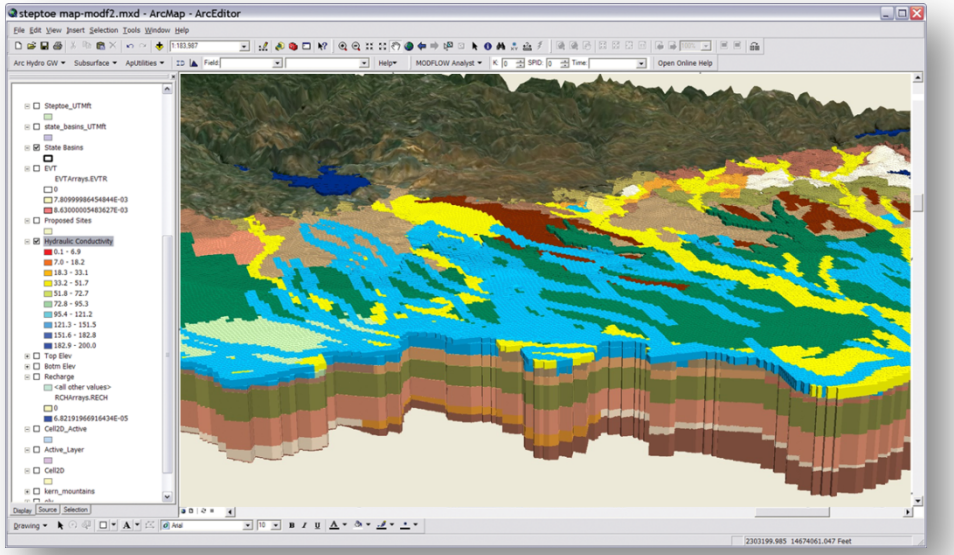
Enhance Access



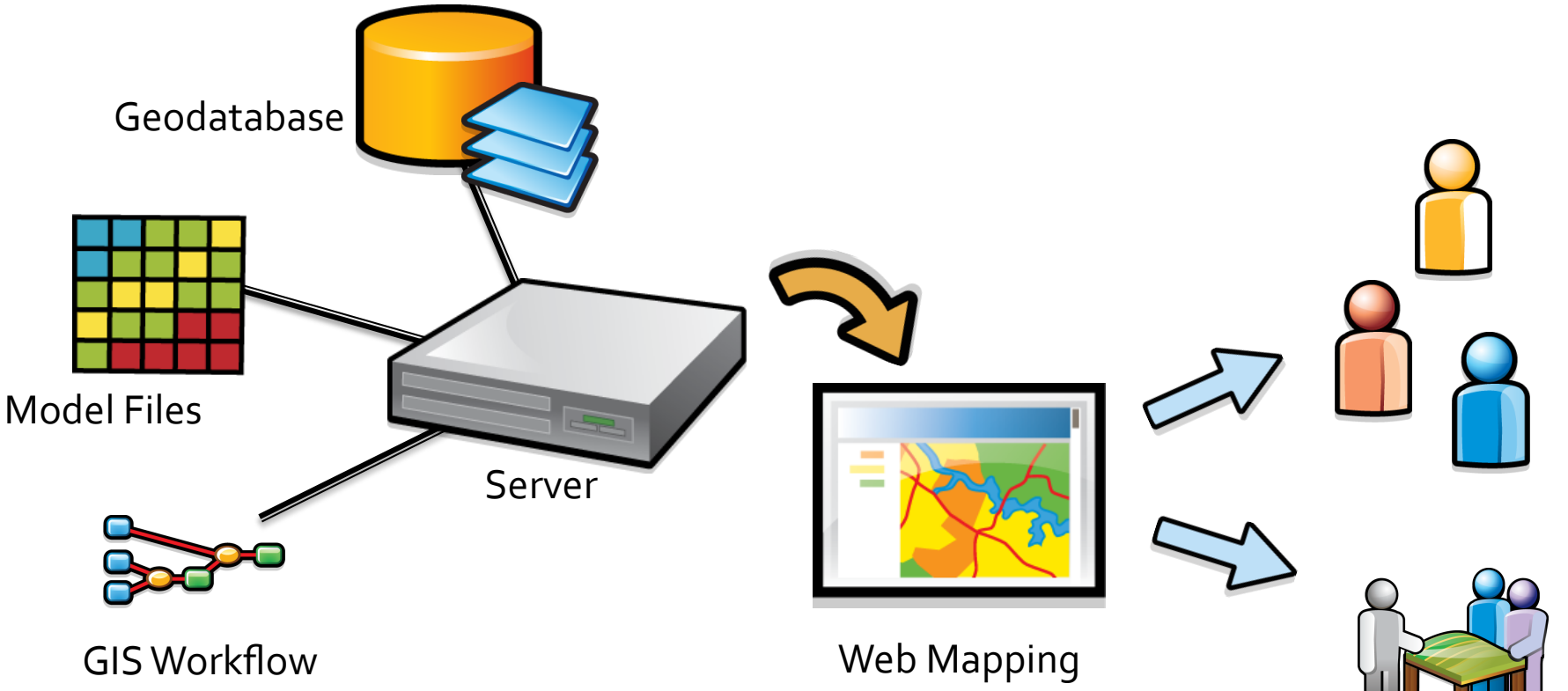
Goal is to provide and use these tools to enhance the capacity for water resource planning and management in the Utah-Wyoming region

Challenges

1. Every model is unique
2. Large datasets
3. Spatial data
4. Remote resources

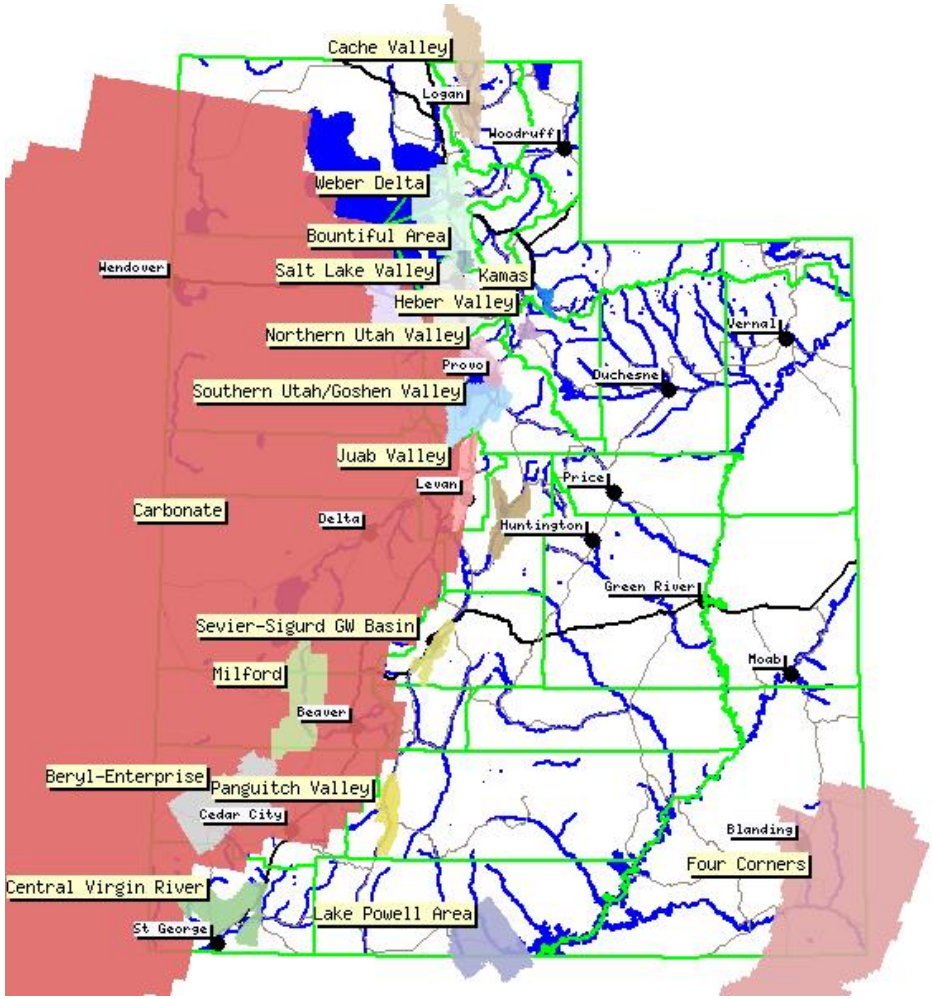


Proposed Solution



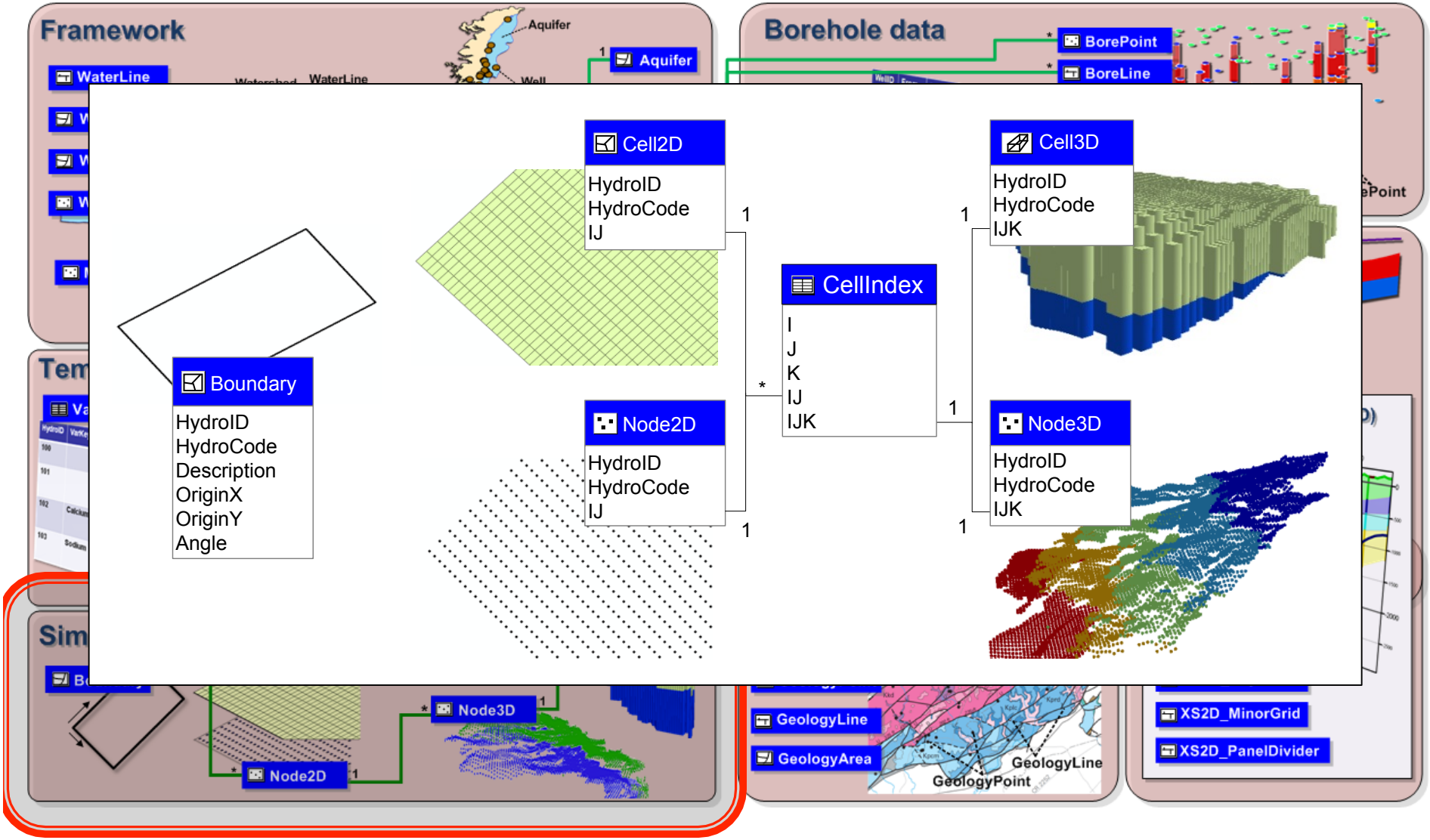
Cloud-Based Modeling and Visualization

Prototype: Utah Division of Water Rights



- 31 MODFLOW models used for impact analysis
- Challenges
  - Modeling expertise
  - Software installation and maintenance
  - User error
  - Cost

Arc Hydro Groundwater Data Model



MODFLOW DATA MODEL v3.0

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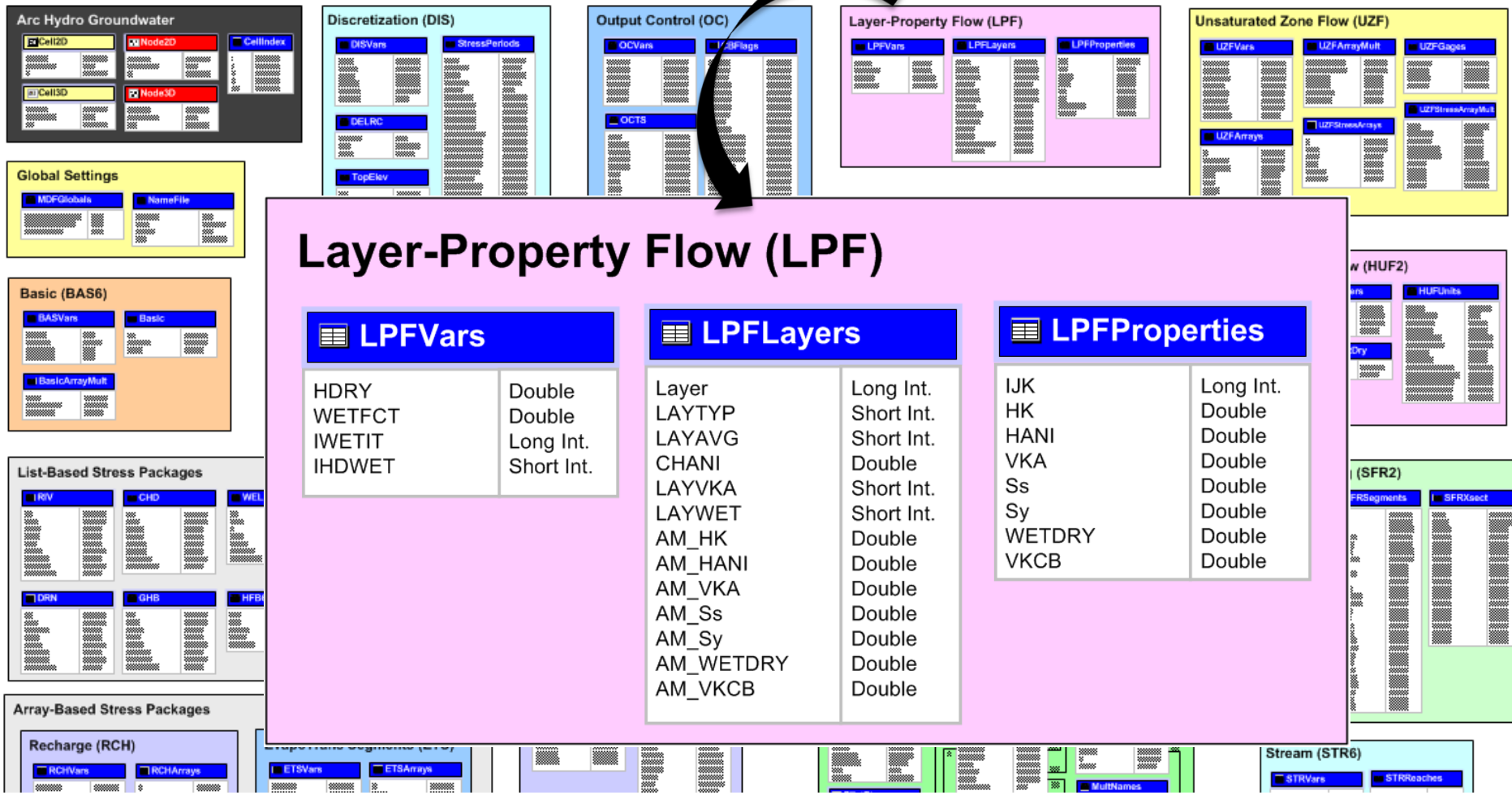
Last updated: May 16, 2011



Layer-Property Flow (LPF)

LPFVars

HDRY	Double
WETFCT	Double
IWETIT	Long Int.
IHDWET	Short Int.

LPFLayers

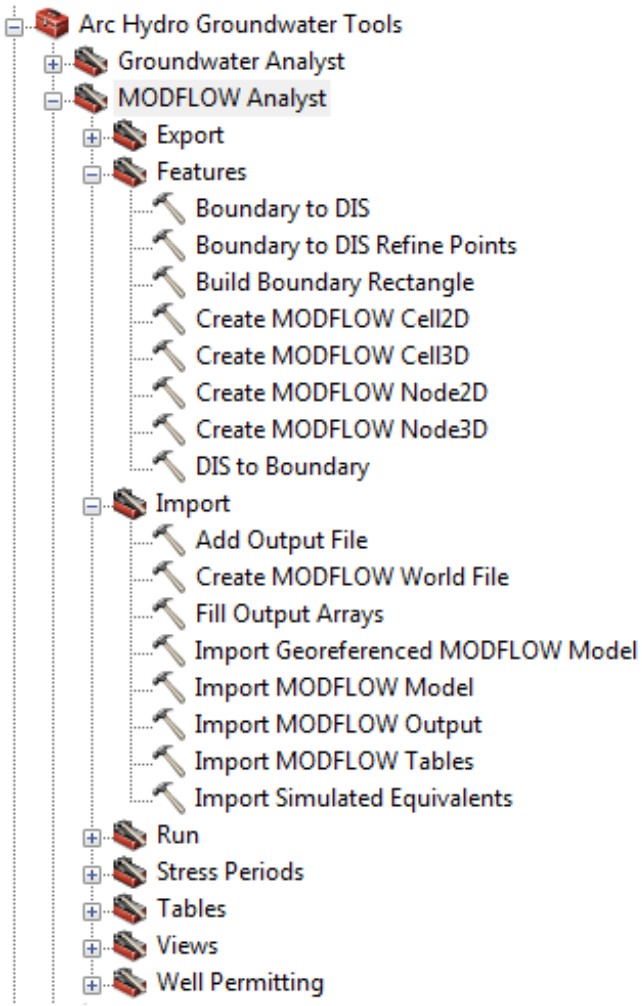
Layer	Long Int.
LAYTYP	Short Int.
LAYAVG	Short Int.
CHANI	Double
LAYVKA	Short Int.
LAYWET	Short Int.
AM_HK	Double
AM_HANI	Double
AM_VKA	Double
AM_Ss	Double
AM_Sy	Double
AM_WETDRY	Double
AM_VKCB	Double

LPFProperties

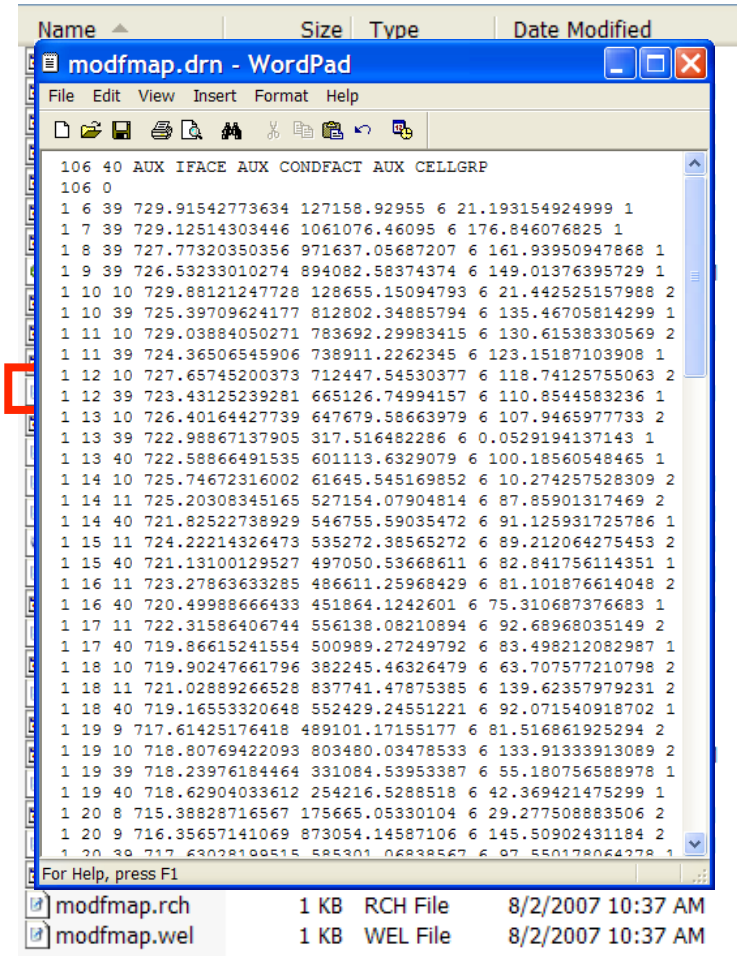
IJK	Long Int.
HK	Double
HANI	Double
VKA	Double
Ss	Double
Sy	Double
WETDRY	Double
VKCB	Double

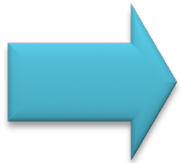
MODFLOW Analyst Tools

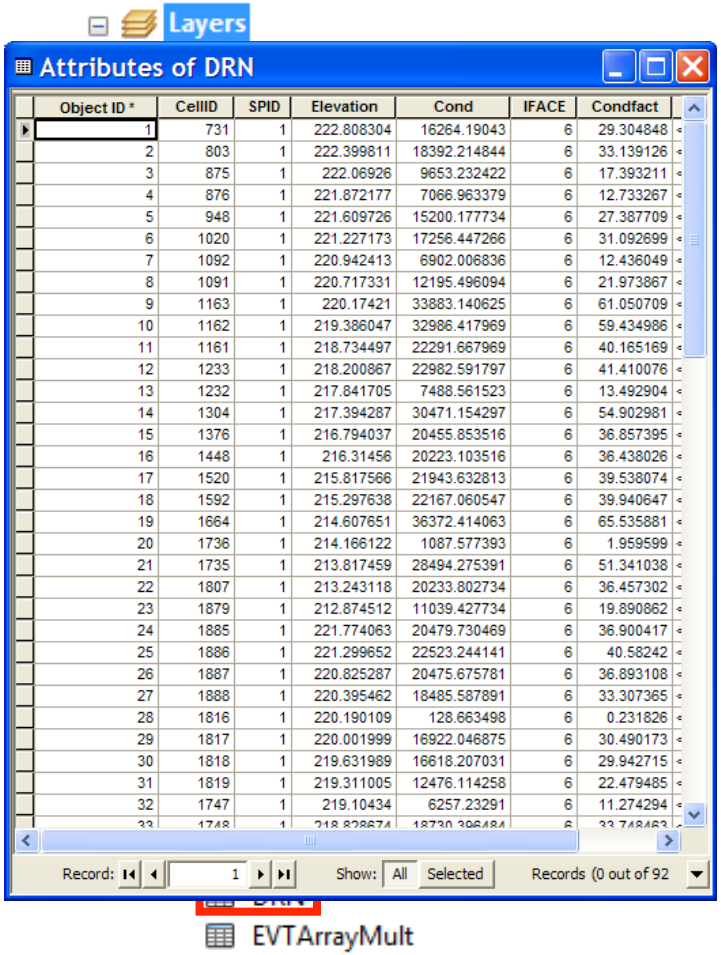
- Developed as geoprocessing (GP) tools
- Classes of tools
  - Import
  - Export
  - Visualization/Map Layers
  - Model editing
  - Building package input
  - Working with transient input/ solutions



Import MODFLOW Model Tool







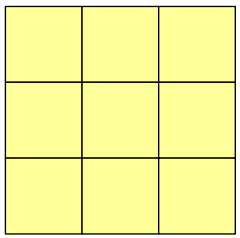
INPUT **OUTPUT**

Make MODFLOW Features Tool

Attributes of DRN

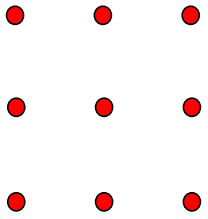
Object ID *	CellID	SPID	Elevation	Cond
1	731	1	222.808304	16264.19043
2	803	1	222.399811	18392.214844
3	875	1	222.06926	9653.232422
4	876	1	221.872177	7066.963379
5	948	1	221.609726	15200.177734
6	1020	1	221.227173	17256.447266
7	1092	1	220.942413	6902.006836
8	1091	1	220.717331	12195.496094
9	1163	1	220.17421	33883.140625
10	1162	1	219.386047	32986.417969
11	1161	1	218.734497	22291.667969
12	1233	1	218.200867	22982.591797
13	1232	1	217.841705	7488.561523
14	1304	1	217.394287	30471.154297
15	1376	1	216.794037	20455.853516

+



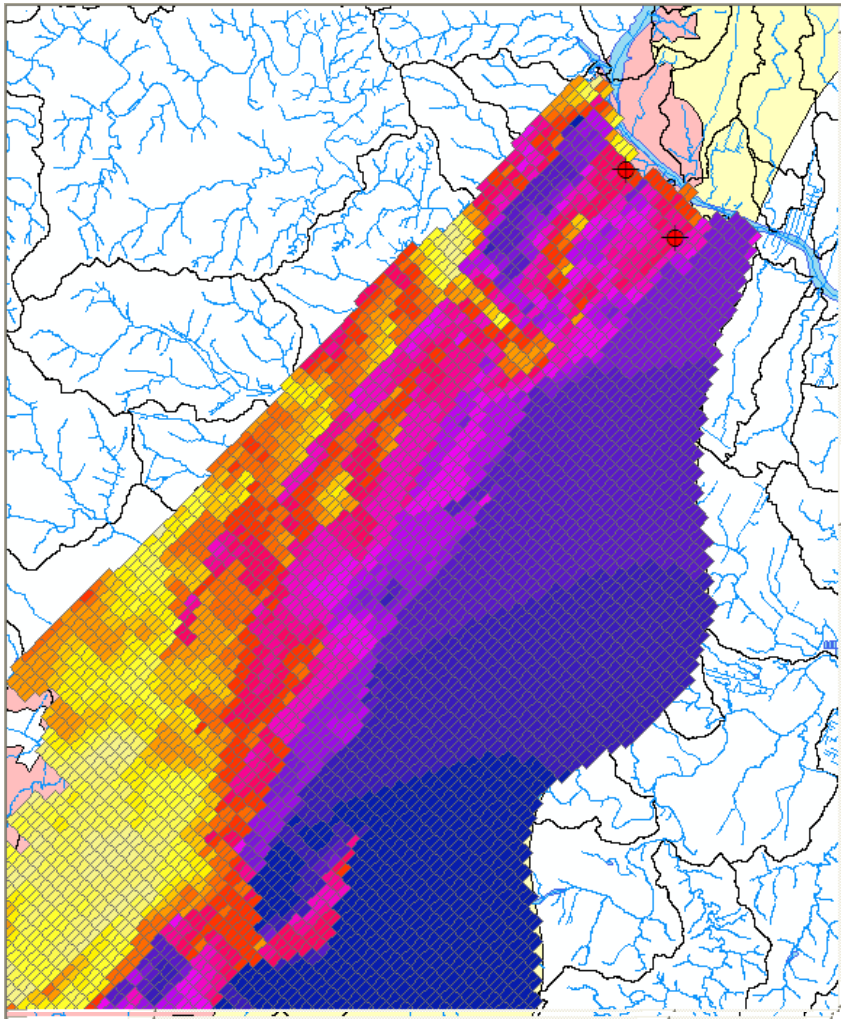
Cell2D

Or



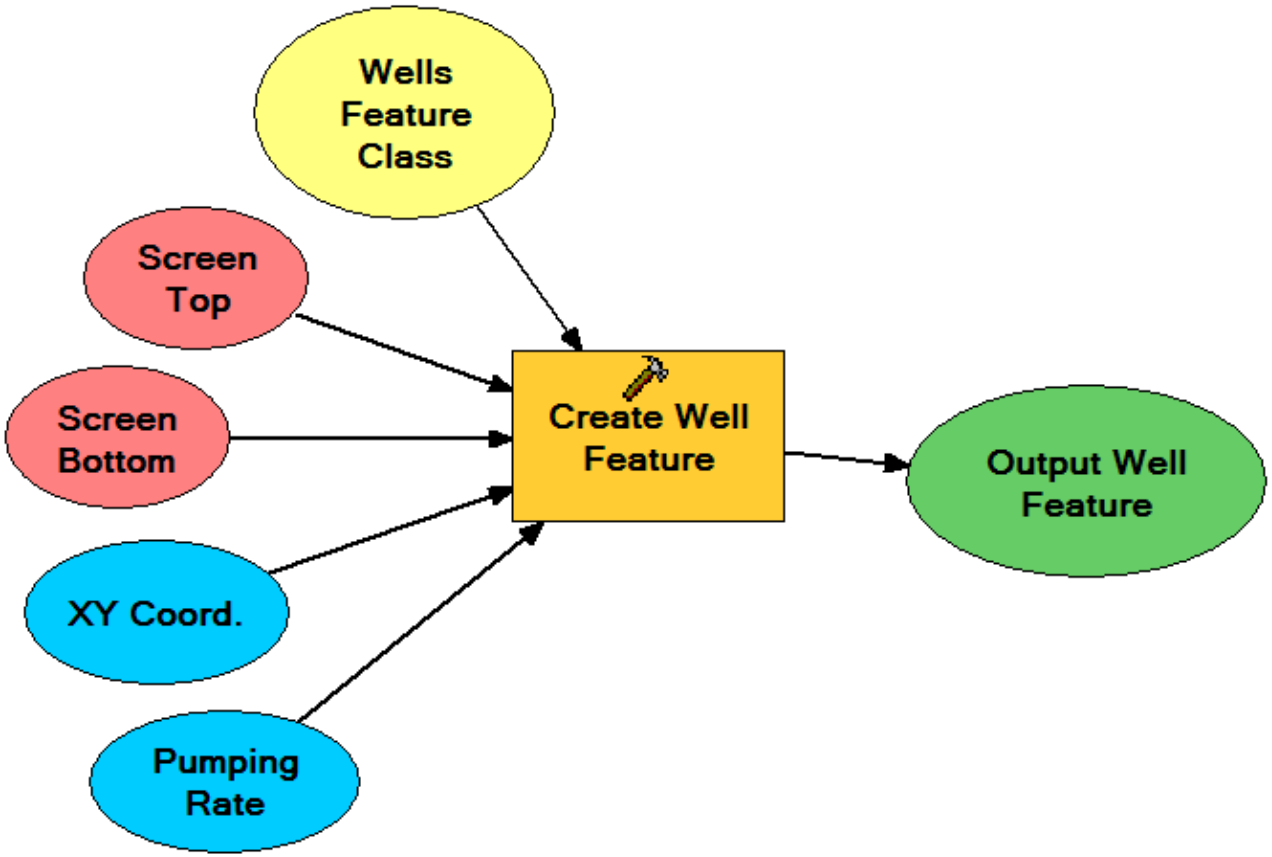
Node2D

INPUT



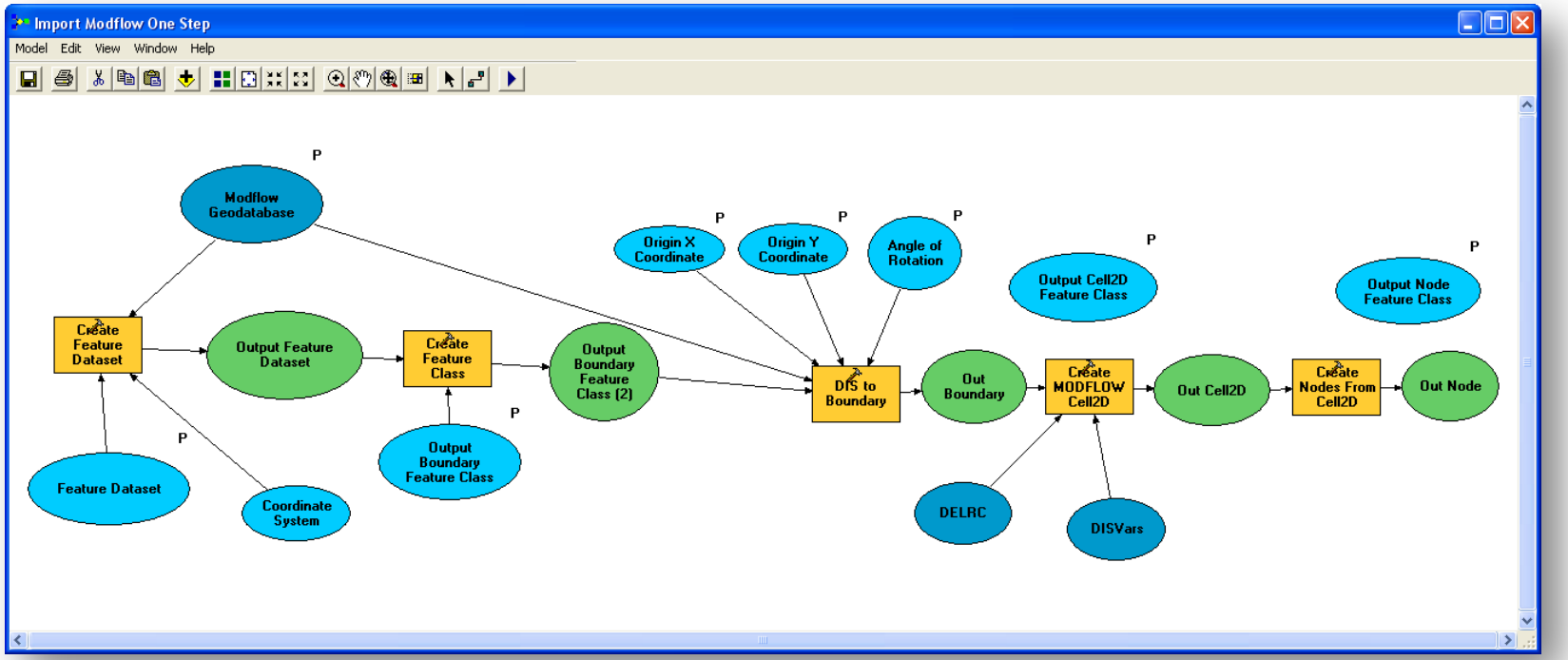
OUTPUT

Geoprocessing Tools

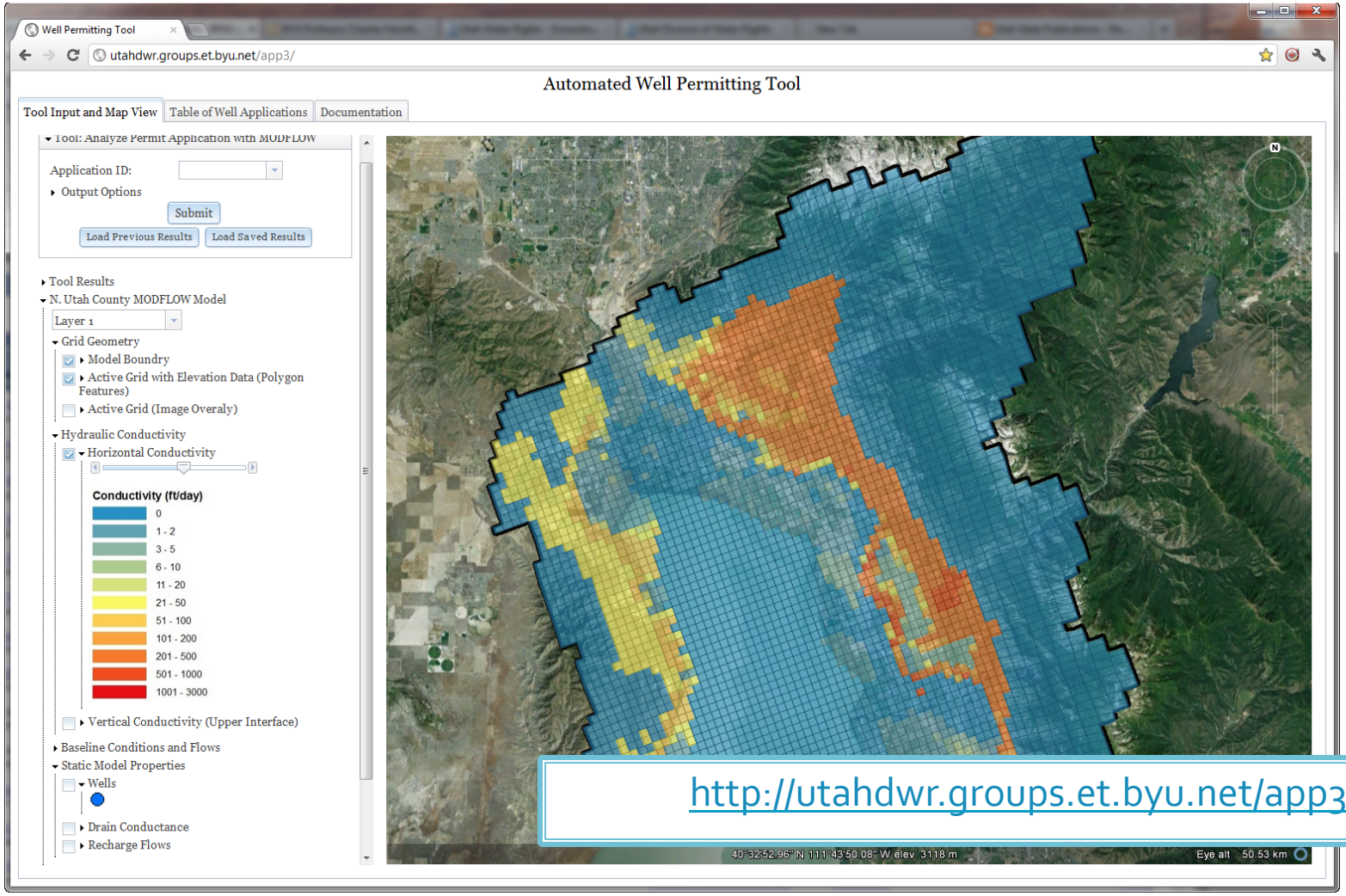


Geoprocessing Tools - Workflows

- GP tools enable the development of workflows as models or scripts
- Extendable – You can create your own workflows
- Leverage low-level tools to create new tools

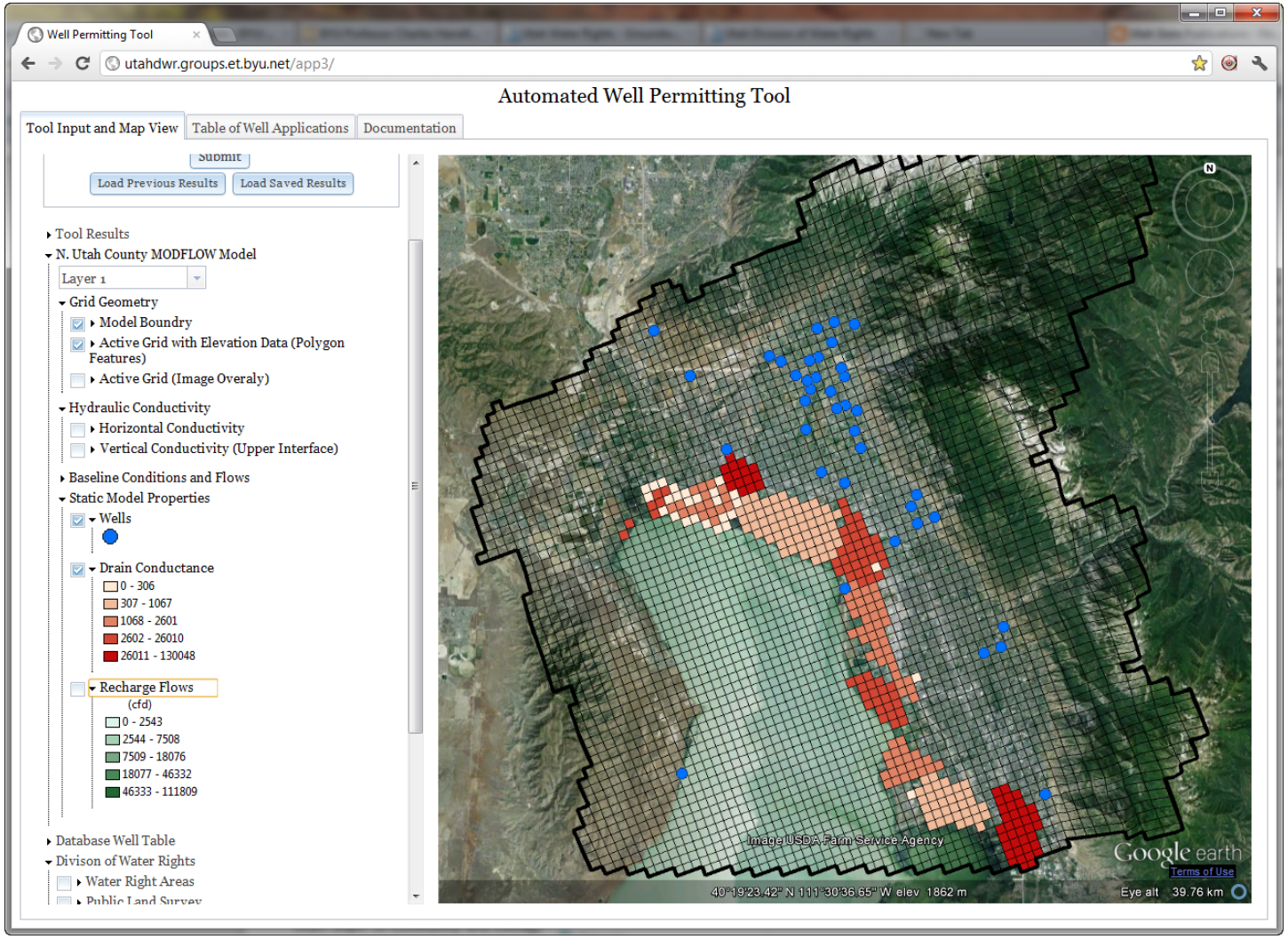


Web Interface



http://utahdwr.groups.et.byu.net/app3/

Static Model Data



Map Layers from UDWR Server

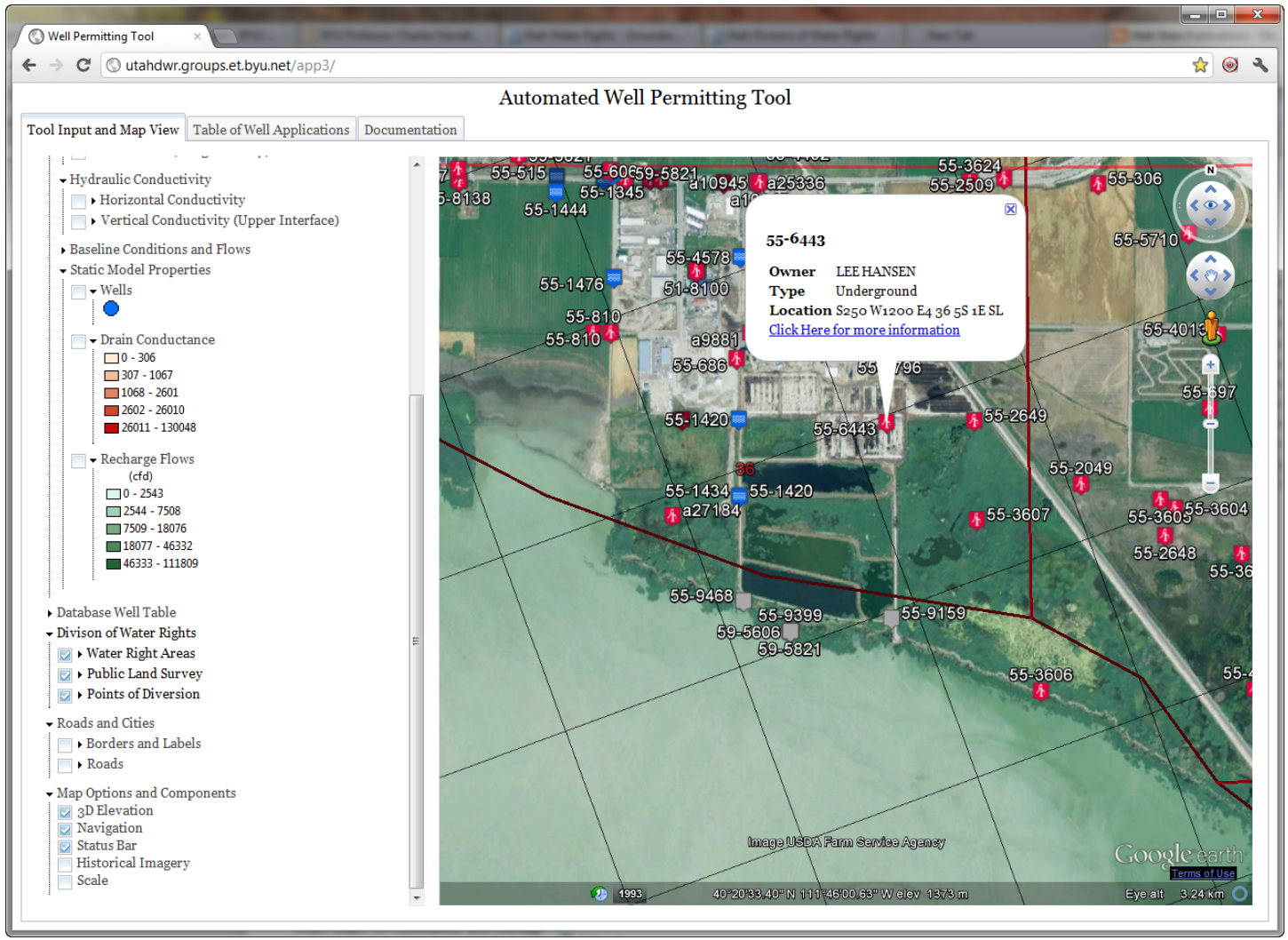
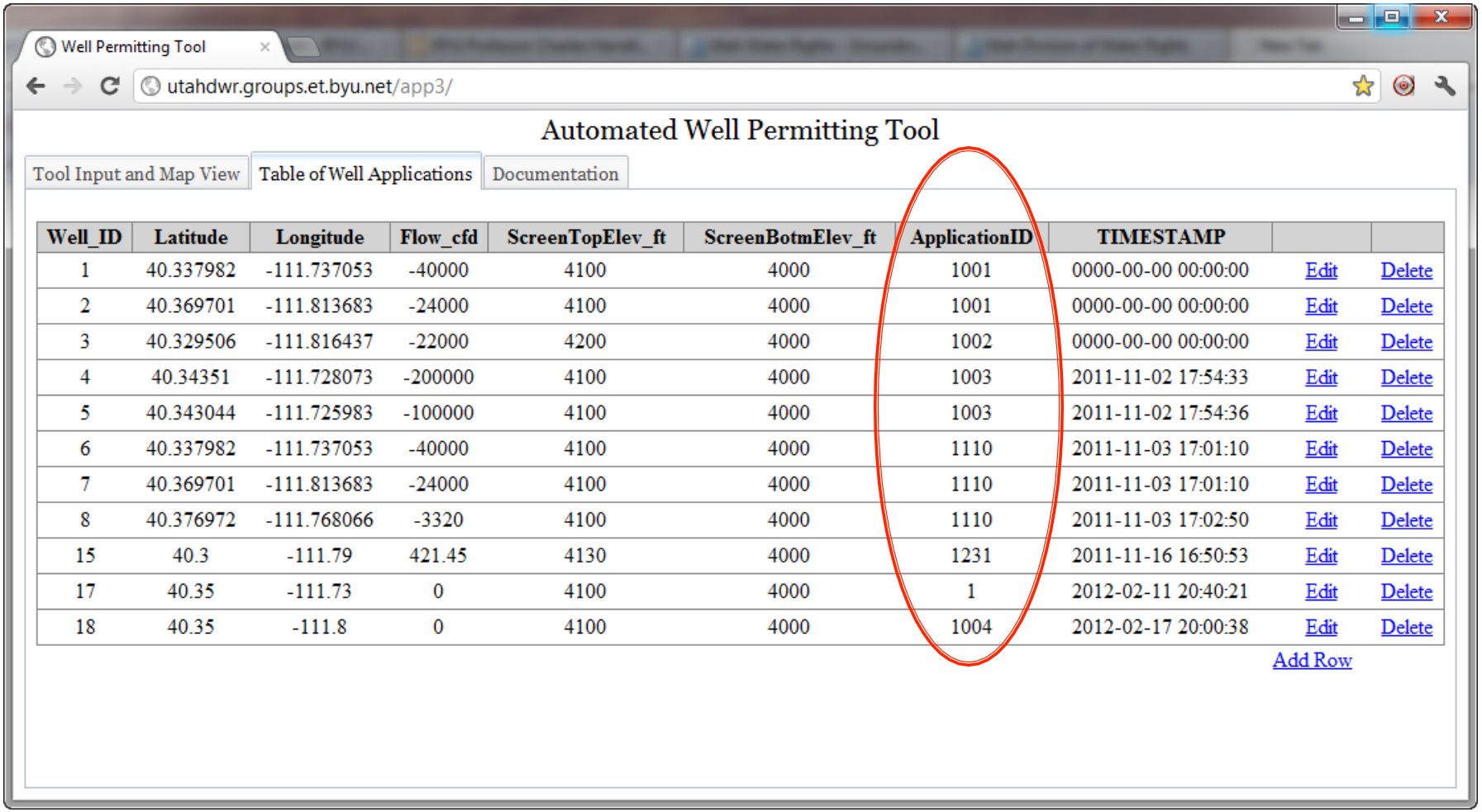


Table of Well Applications



Well_ID	Latitude	Longitude	Flow_cfd	ScreenTopElev_ft	ScreenBotmElev_ft	ApplicationID	TIMESTAMP		
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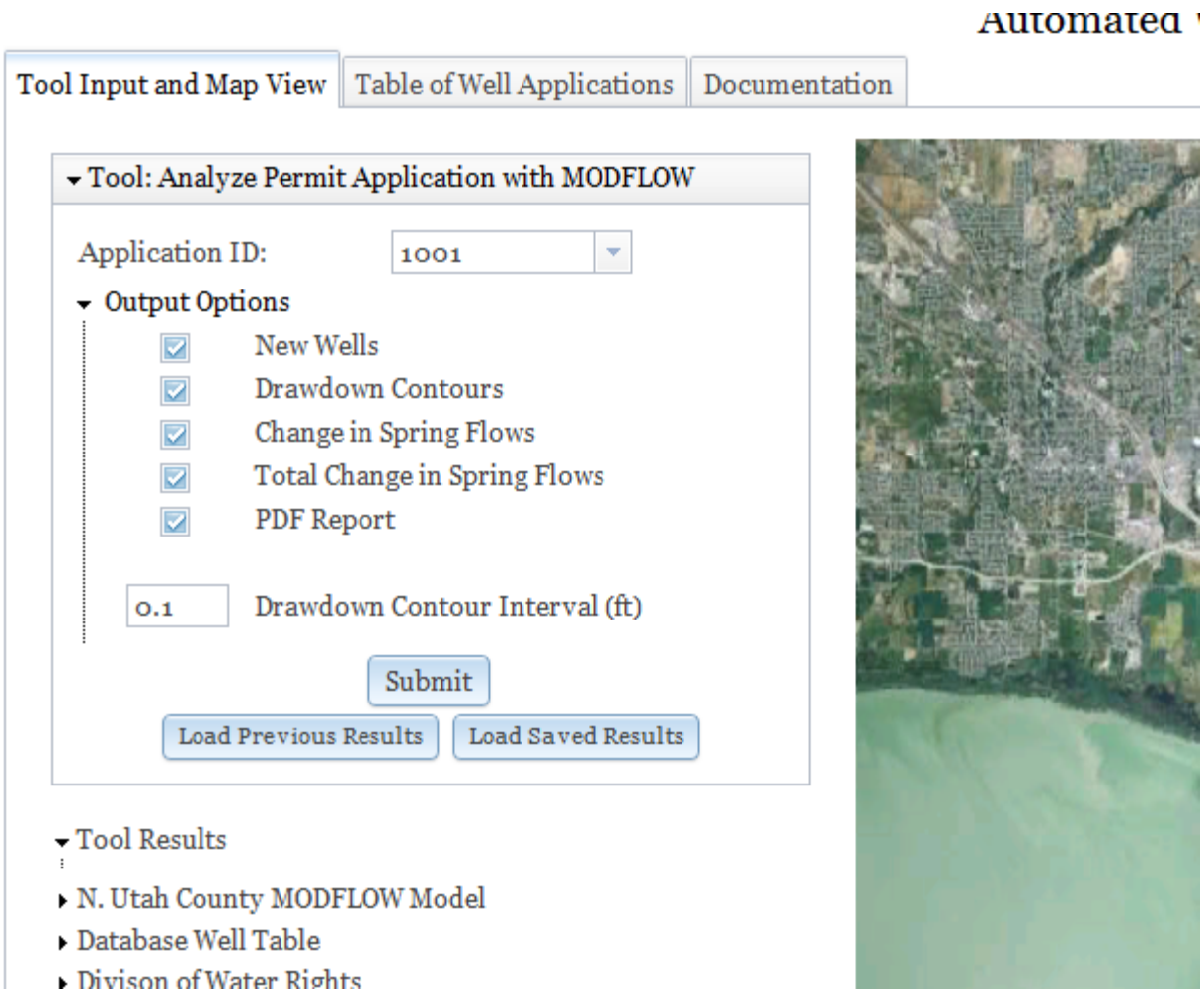
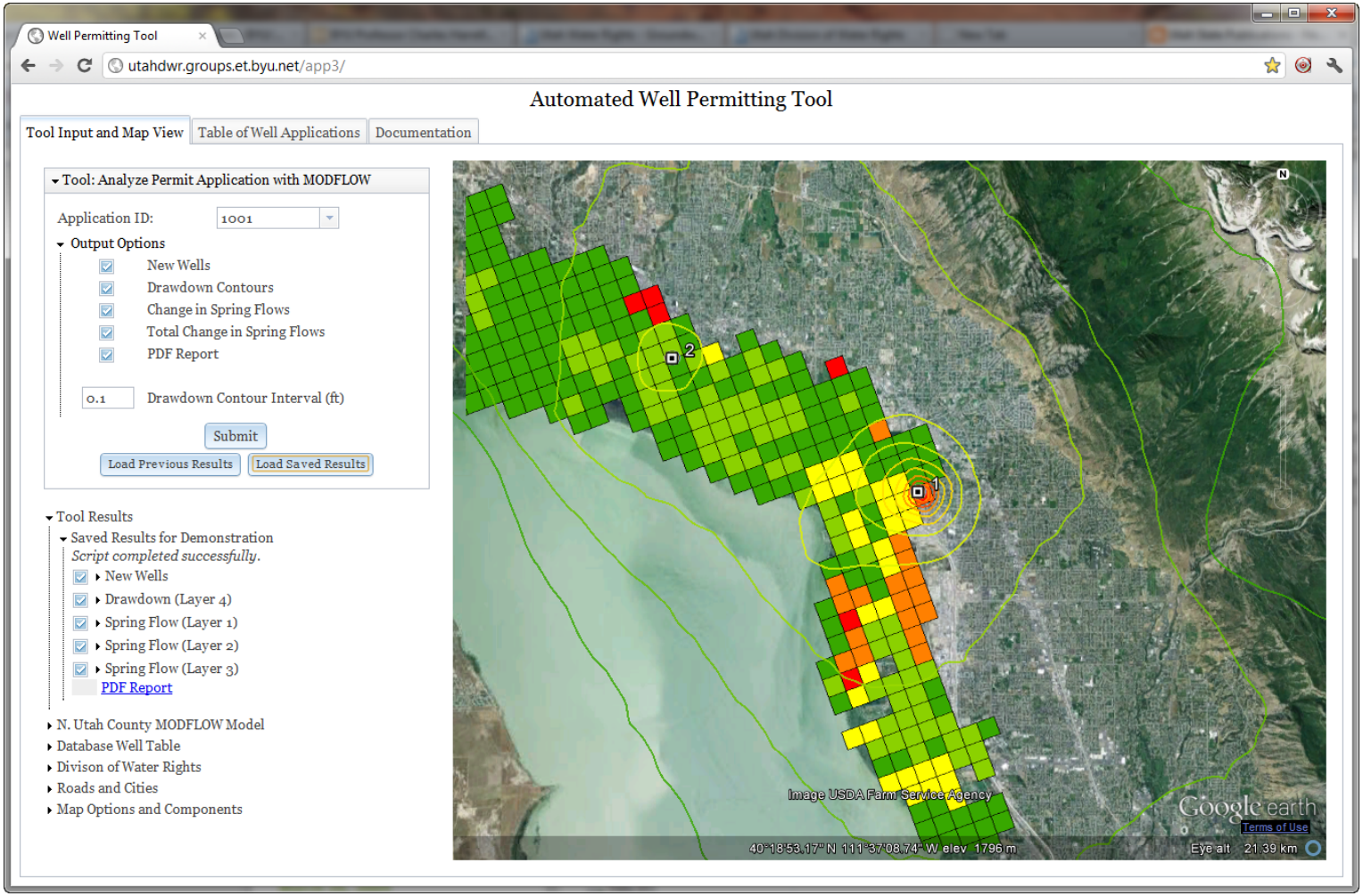
2	40.369701	-111.813683	-24000	4100	4000	1001	0000-00-00 00:00:00	Edit	Delete
3	40.329506	-111.816437	-22000	4200	4000	1002	0000-00-00 00:00:00	Edit	Delete
4	40.34351	-111.728073	-200000	4100	4000	1003	2011-11-02 17:54:33	Edit	Delete
5	40.343044	-111.725983	-100000	4100	4000	1003	2011-11-02 17:54:36	Edit	Delete
6	40.337982	-111.737053	-40000	4100	4000	1110	2011-11-03 17:01:10	Edit	Delete
7	40.369701	-111.813683	-24000	4100	4000	1110	2011-11-03 17:01:10	Edit	Delete
8	40.376972	-111.768066	-3320	4100	4000	1110	2011-11-03 17:02:50	Edit	Delete
15	40.3	-111.79	421.45	4130	4000	1231	2011-11-16 16:50:53	Edit	Delete
17	40.35	-111.73	0	4100	4000	1	2012-02-11 20:40:21	Edit	Delete
18	40.35	-111.8	0	4100	4000	1004	2012-02-17 20:00:38	Edit	Delete

Add Row

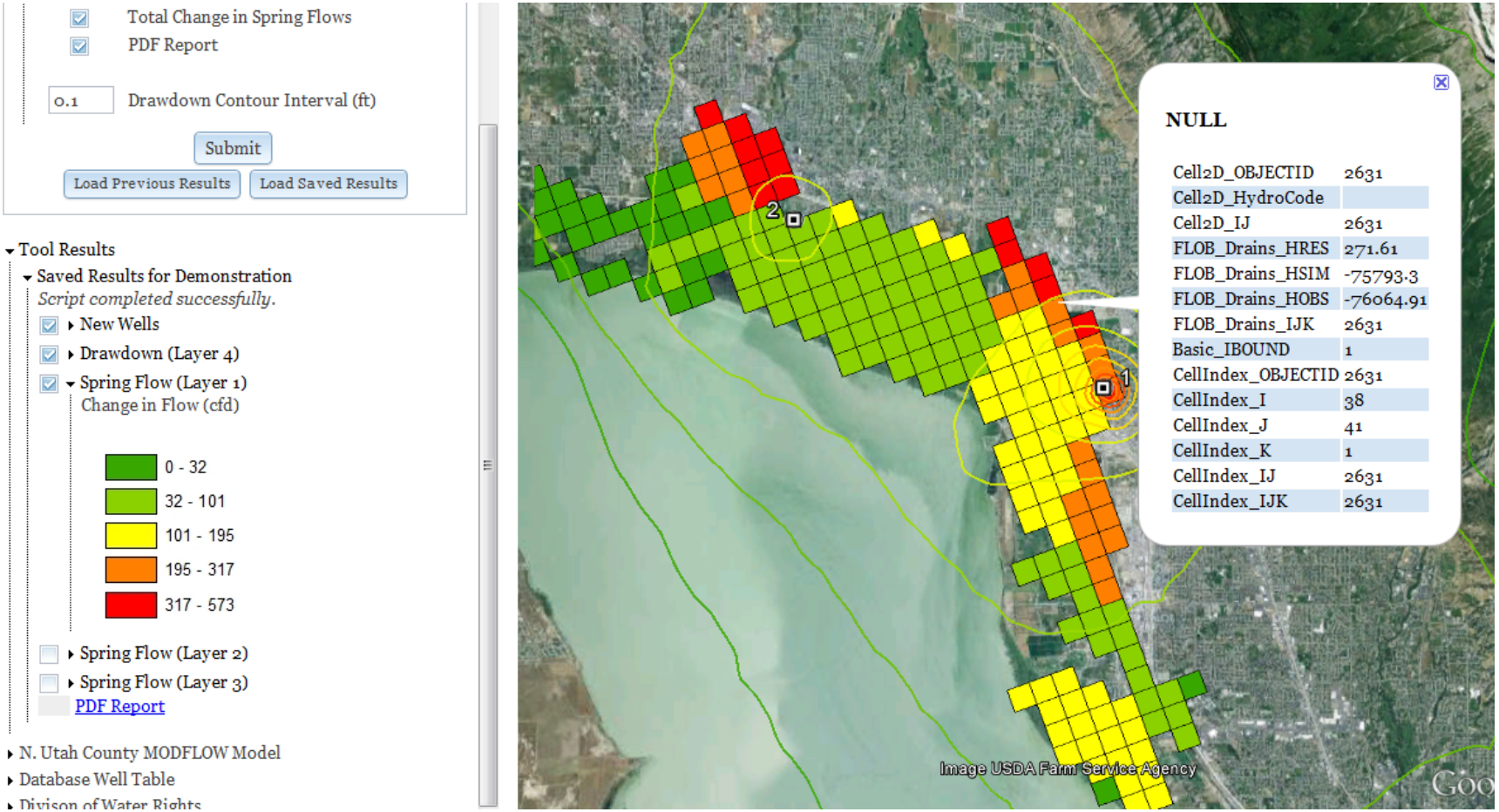
Submitting a Model Run



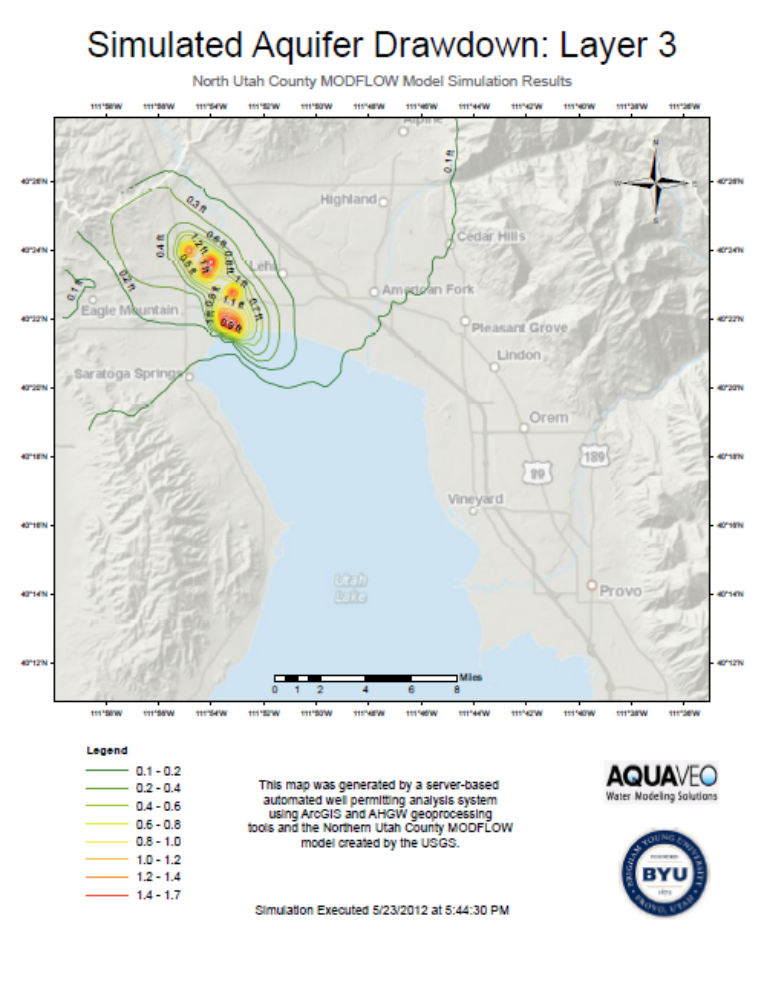
Model Results

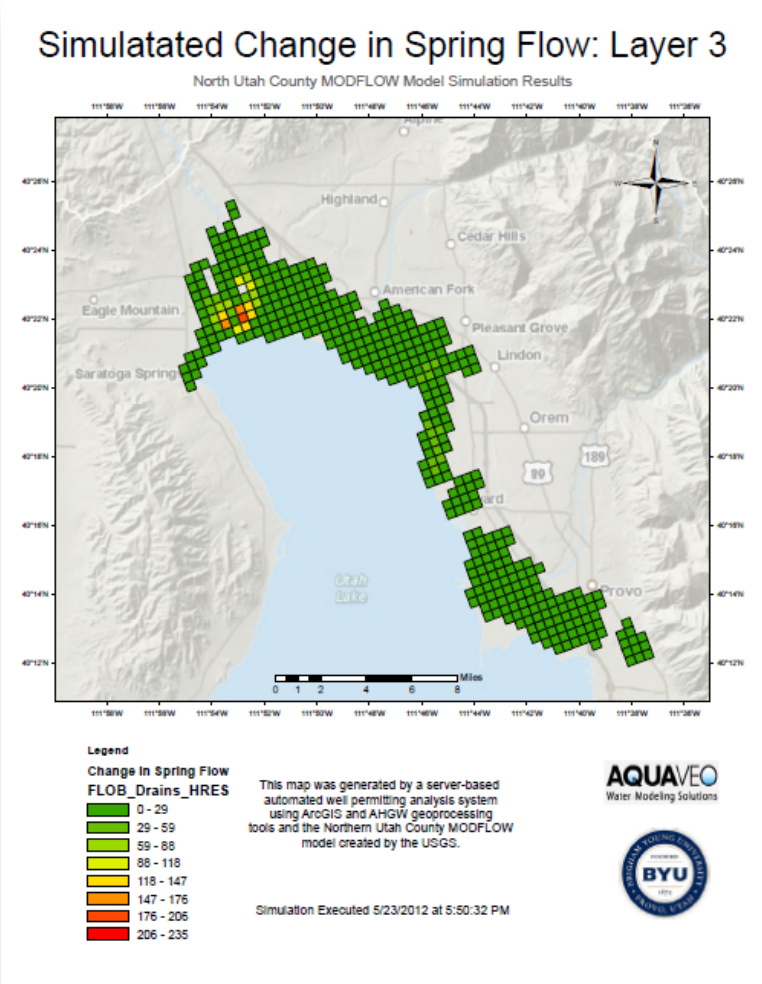


Impact on Springs



PDF Output

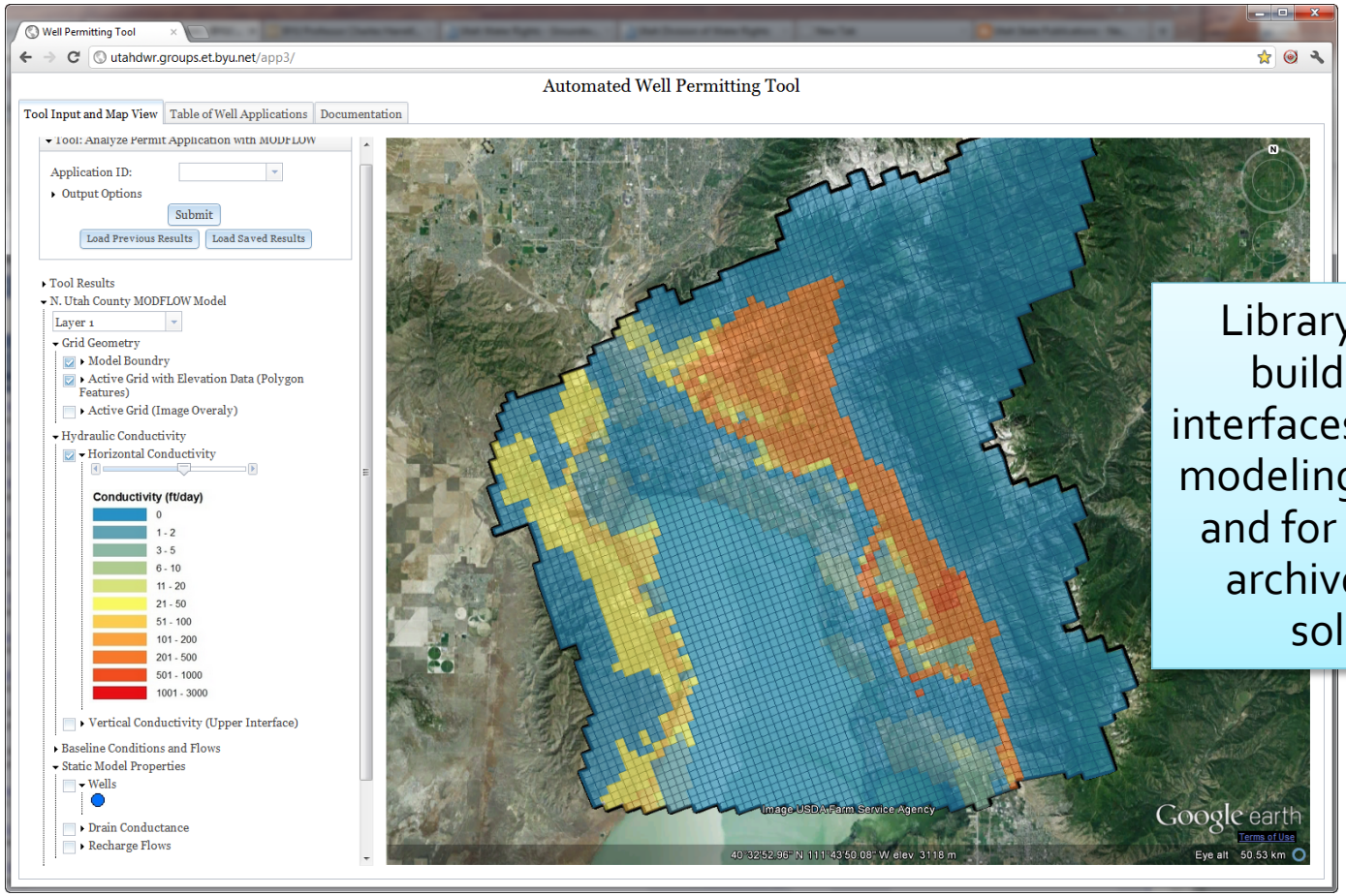

Simulated Aquifer Drawdown: Layer 3
North Utah County MODFLOW Model Simulation Results
Highland
Cedar Hills
Lehi
American Fork
Eagle Mountain
Pleasant Grove
Lindon
Saratoga Springs
Orem
Vineyard
Provo
Utah Lake
Miles
Legend
0.1 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.0
1.0 - 1.2
1.2 - 1.4
1.4 - 1.7
This map was generated by a server-based automated well permitting analysis system using ArcGIS and AHGW geoprocessing tools and the Northern Utah County MODFLOW model created by the USGS.
Simulation Executed 5/23/2012 at 5:44:30 PM
AQUAVEO
Water Modeling Solutions
BYU


Simulatated Change in Spring Flow: Layer 3
North Utah County MODFLOW Model Simulation Results
Highland
Cedar Hills
American Fork
Eagle Mountain
Pleasant Grove
Lindon
Saratoga Springs
Orem
Provo
Utah Lake
Miles
Legend
Change in Spring Flow
FLOB_Drains_HRES
0 - 29
29 - 59
59 - 88
88 - 118
118 - 147
147 - 176
176 - 206
206 - 235
This map was generated by a server-based automated well permitting analysis system using ArcGIS and AHGW geoprocessing tools and the Northern Utah County MODFLOW model created by the USGS.
Simulation Executed 5/23/2012 at 5:50:32 PM
AQUAVEO
Water Modeling Solutions
BYU

BYU CI-WATER Tools

- Two primary components
  - Cloud-Based Simulation Web Interface API
  - Model Scripting Tools

Cloud-Simulation API



Library (API) for building web interfaces to scripted modeling workflows and for visualizing archived model solutions

Cloud-Based Water Level Mapping Utility

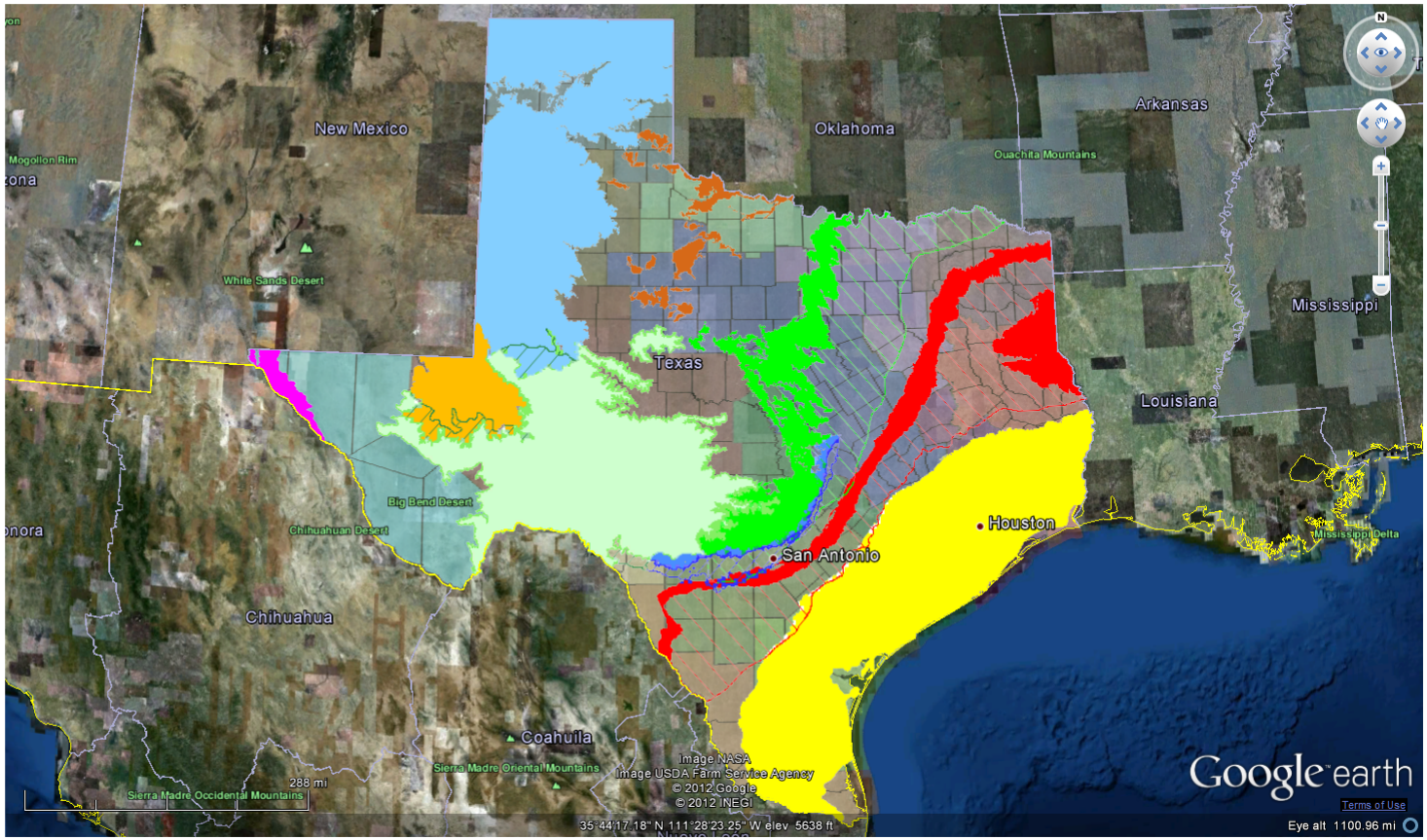
- Inputs
  - Sub-region (aquifer, district, county, etc.)
  - Date (or range of dates)
- Output
  - Water level and/or drawdown maps

Web Interface

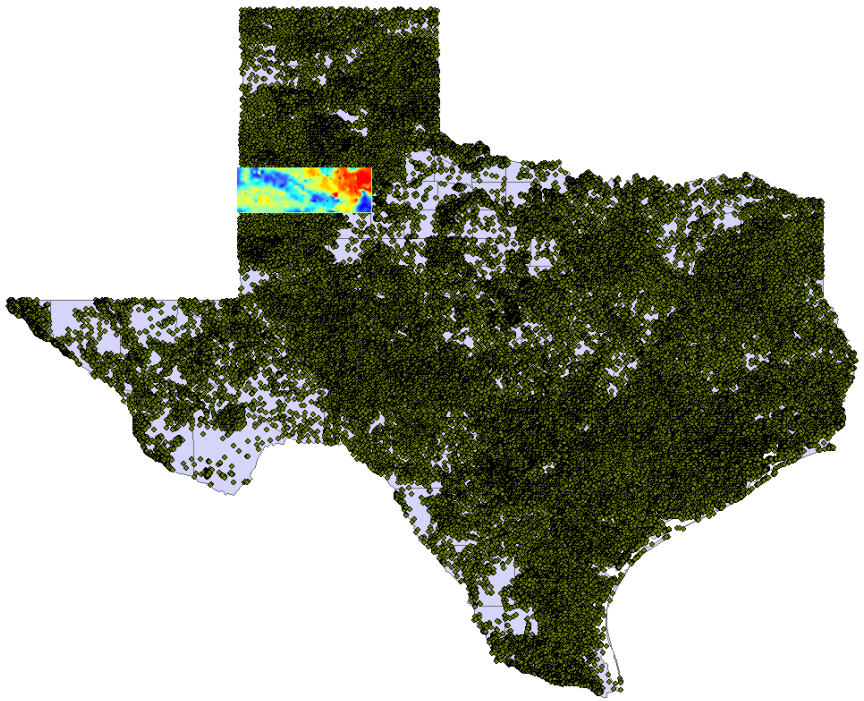
Automated Water Table Mapping Tool

Tool Input and Map View | New

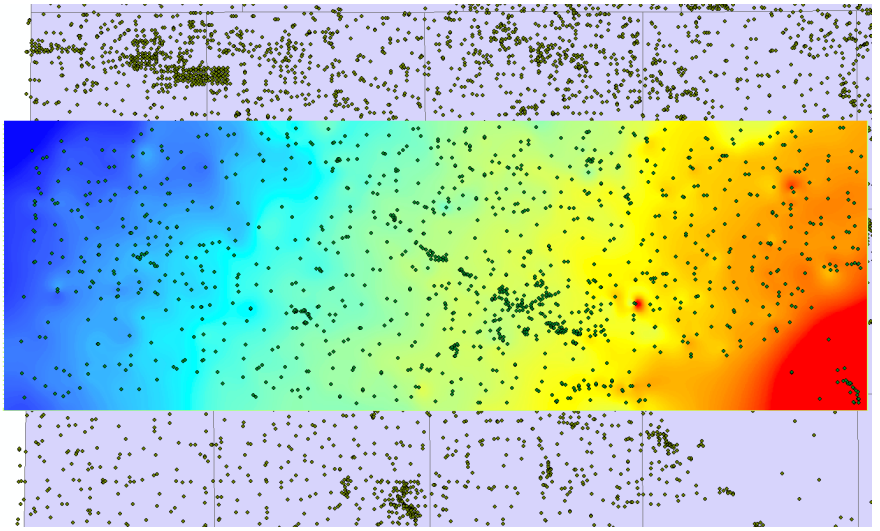
- Tool: Generate Water Table Maps
  - Select By: Aquifer
  - Area: Region F
  - Start Date:
  - End Date:
  - Output Options
    - Annimation
    - PDF Report
  - Submit
- Tool Results
- Map Layers
  - Boundaries
    - Major Aquifers
      - Pecos Valley
      - Seymour
      - Gulf Coast
      - Carrizo - Wilcox (outcrop)
      - Carrizo - Wilcox (subcrop)
      - Hueco - Mesilla Bolson
      - Ogallala
      - Edwards - Trinity Plateau (outcrop)
      - Edwards - Trinity Plateau (subcrop)
      - Edwards BFZ (outcrop)
      - Edwards BFZ (subcrop)
      - Trinity (outcrop)
      - Trinity (subcrop)
    - Wells (not working)
    - State Boundary
    - Counties
    - Water Planning Areas



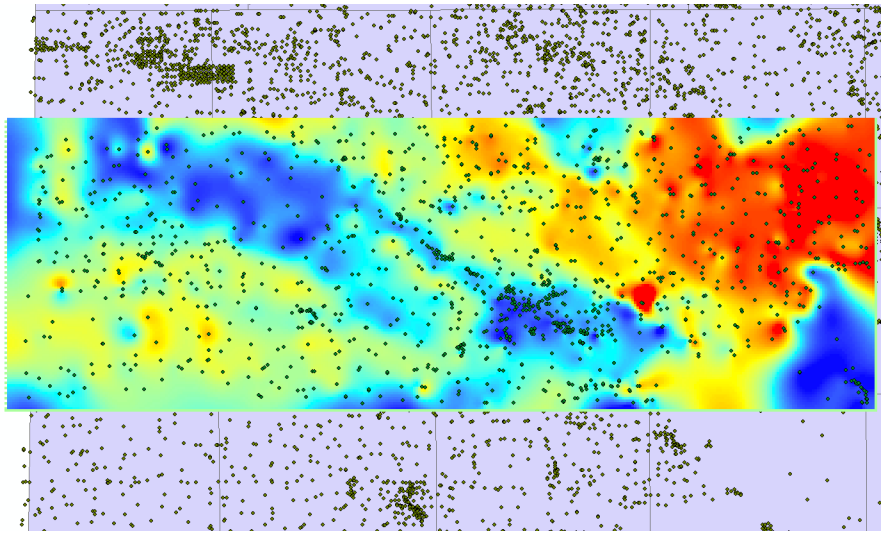
Sample Maps

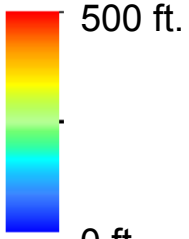


Groundwater Surface Elevation

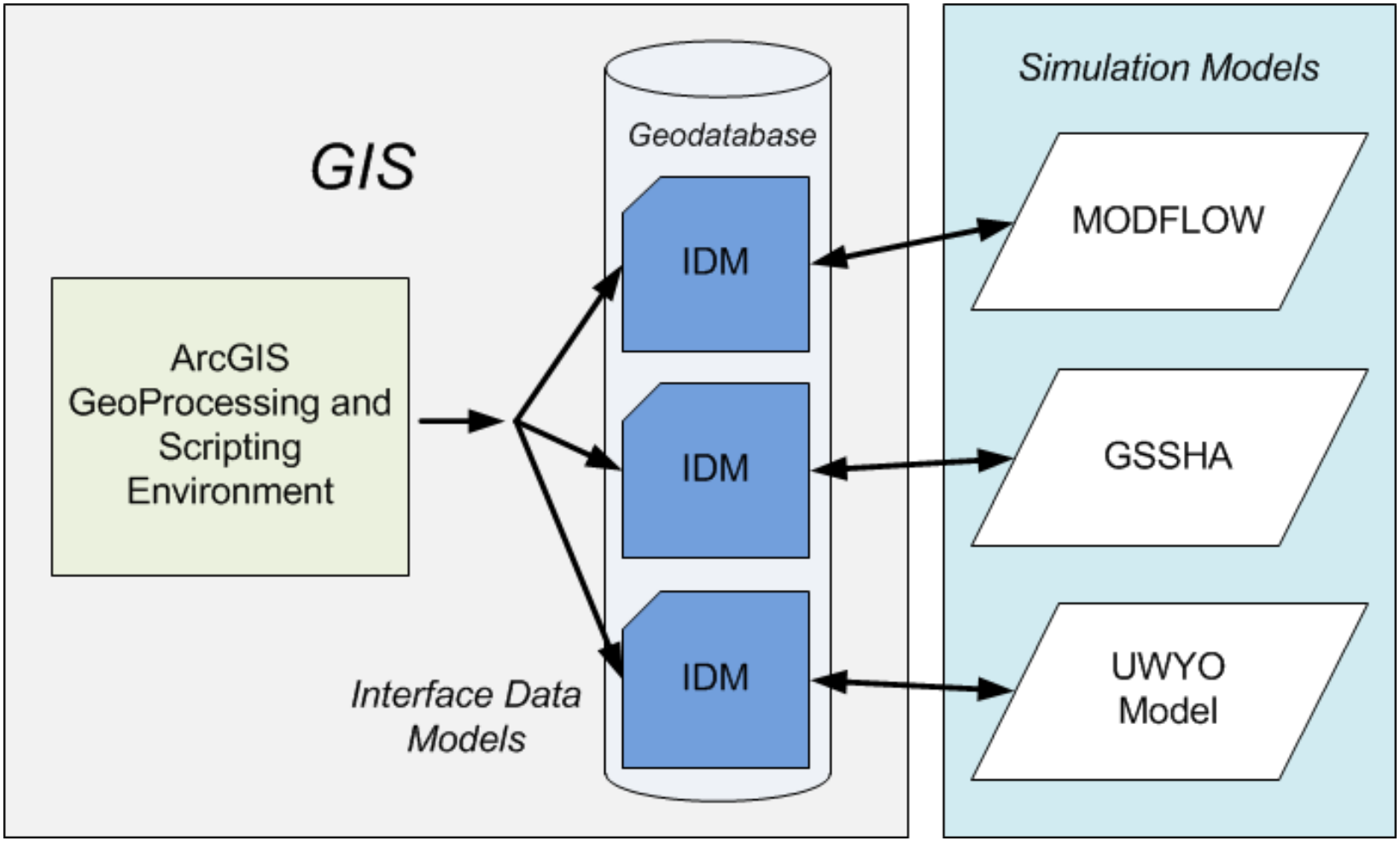


Depth to Groundwater



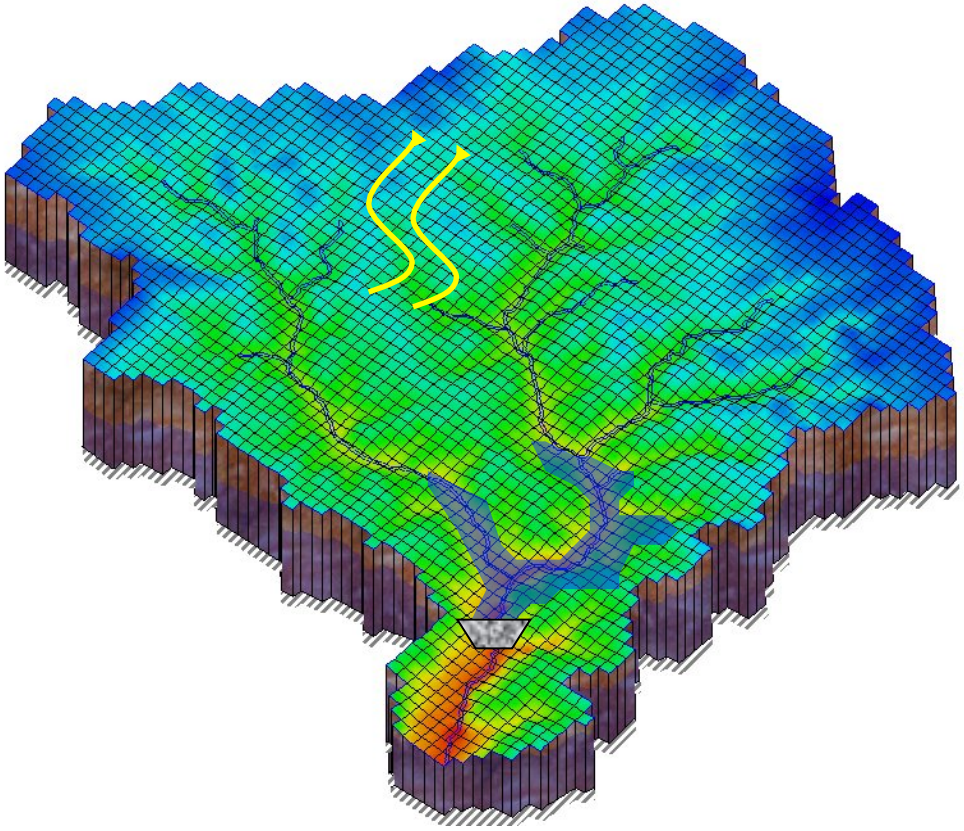


Model Scripting Tools



GSSHA Data Model and Tools

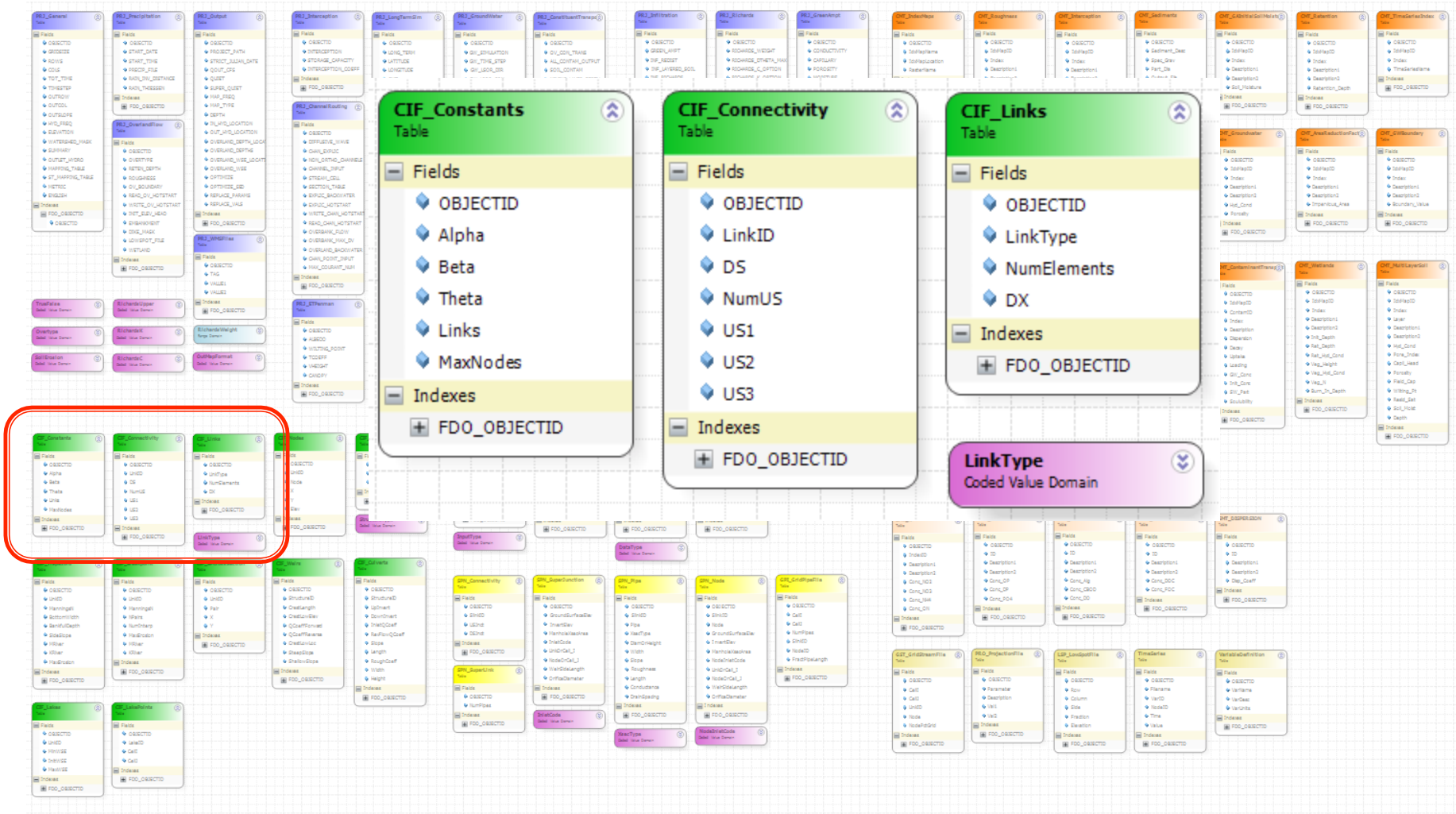
Gridded Surface/Subsurface Hydrologic Analysis (GSSHA) model



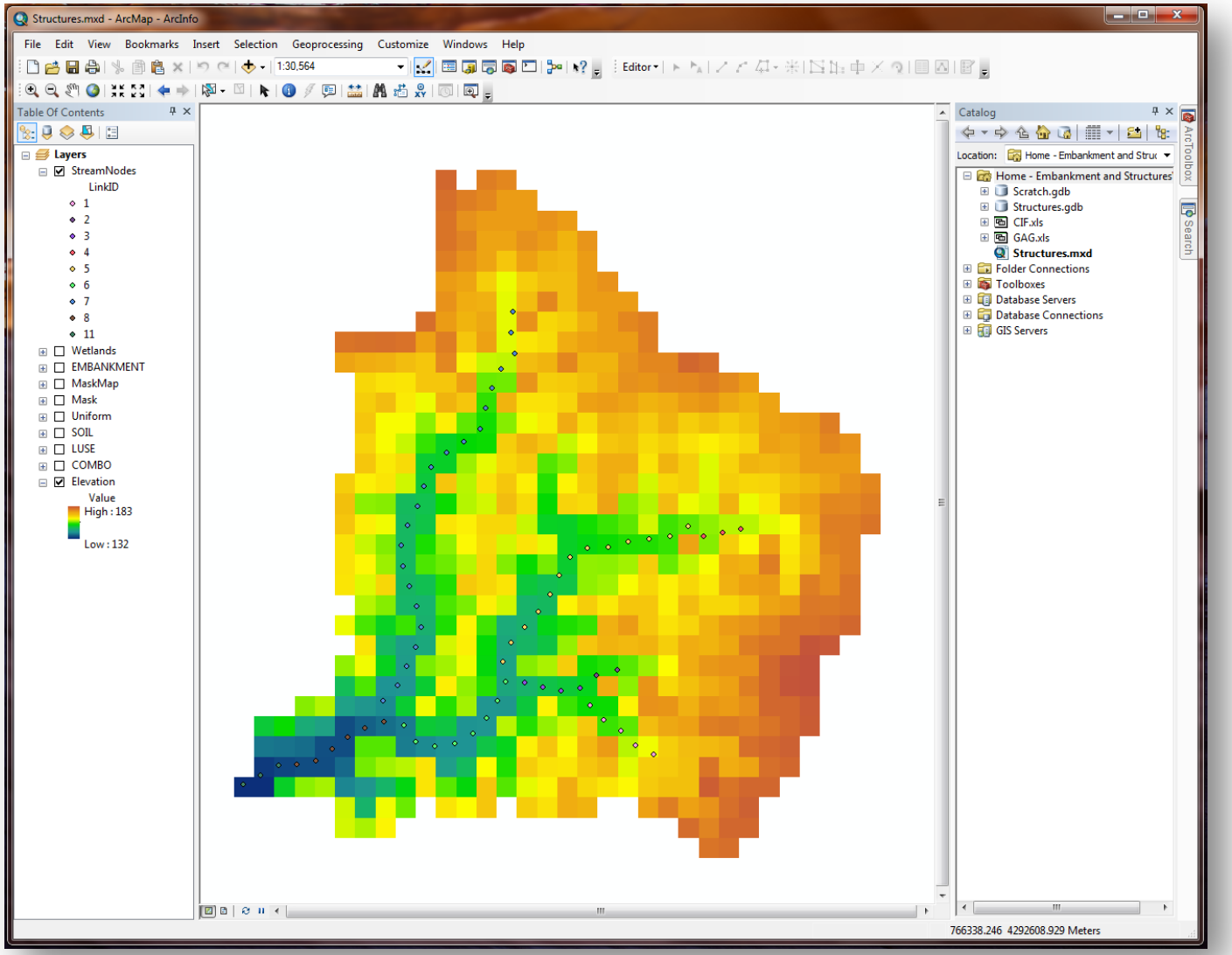
U.S. ARMY ENGINEER RESEARCH AND DEVELOPMENT CENTER
CERL GSL ITL TEC CRREL EL CHL

UNIVERSITY OF WYOMING
New Thinking

GSSHA Data Model

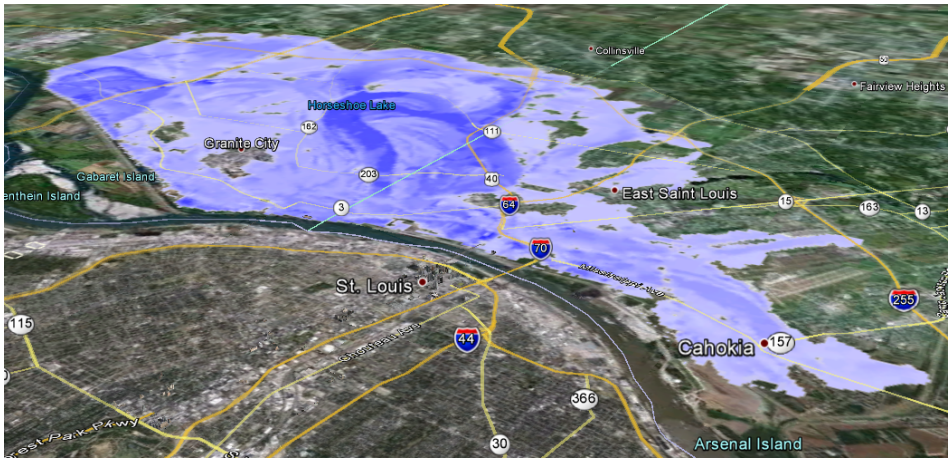


GSSHA Model File in ArcGIS

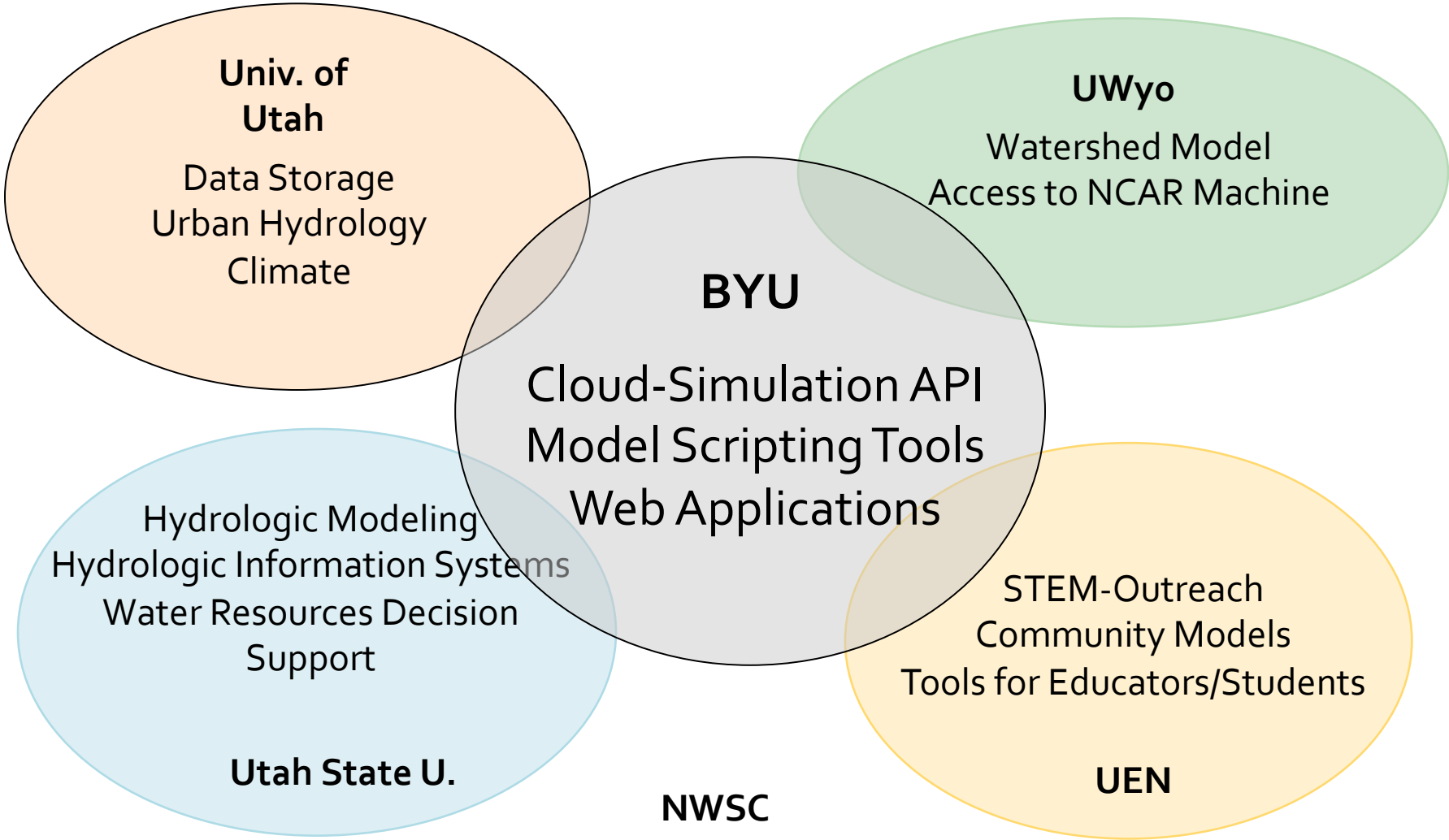


Applications

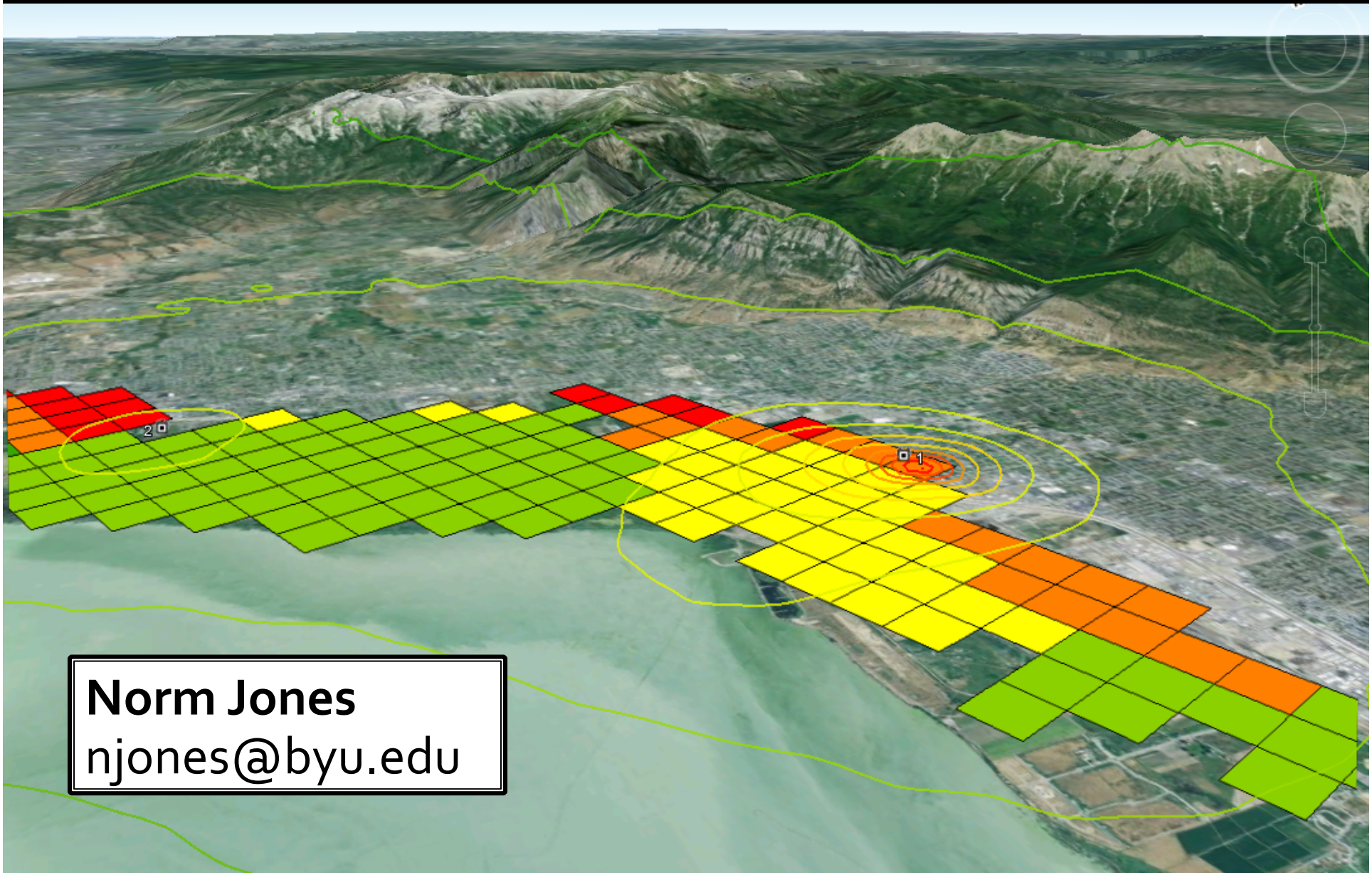
- Snowmelt
- Flooding
- Stormwater runoff
- Levee breach
- Burned area analysis



CI-WATER Integration



Thank you



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