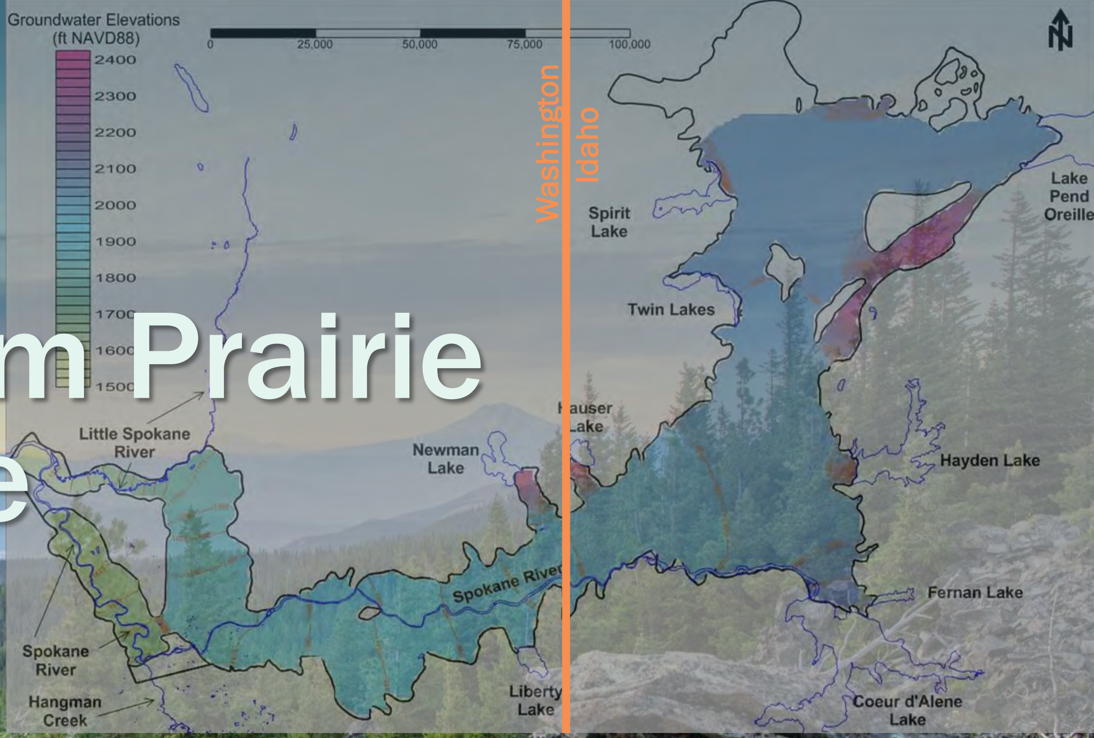
Updating the Spokane Valley–Rathdrum Prairie Aquifer Model for Climate Forecasting and Growth



John J. Porcello, LHG

Expo 50 H20 Symposium

Spokane, WA

May 30, 2024

GSI Water Solutions, Inc.

Got Water?

Yesterday and today: Yes!

A few decades from now: Yes … if we plan ahead!

What is a Regional Aquifer Model?

- Simulates the two key physical aspects of the aquifer
  - The plumbing
    - Geology
    - Permeability of aquifer soils/sediments and streambeds
  - The water in the plumbing
    - Recharge locations, rates, monthly/seasonal/annual variability
    - Groundwater withdrawals (pumping for water supply needs)
    - Natural discharge mechanisms for groundwater
      - Including exchanges with Spokane River and Little Spokane River

Why Update an Aquifer Model? What Will That Give Us?

1. Evolving uses of the model
    - Regional scale, wellfield scale
    - Resource management in an era of climate change
    - Water supply reliability and vulnerability assessments
2. Better technology
    - Better spatial resolution
    - Better vertical resolution
    - More robust simulation (e.g., stream/aquifer interactions)

Models in the SVRP (USGS, 1981)

- Coarse spatial resolution
- Washington focus
- 2D model (1 layer)
- Software limited
  - No standardized code
  - No visualization

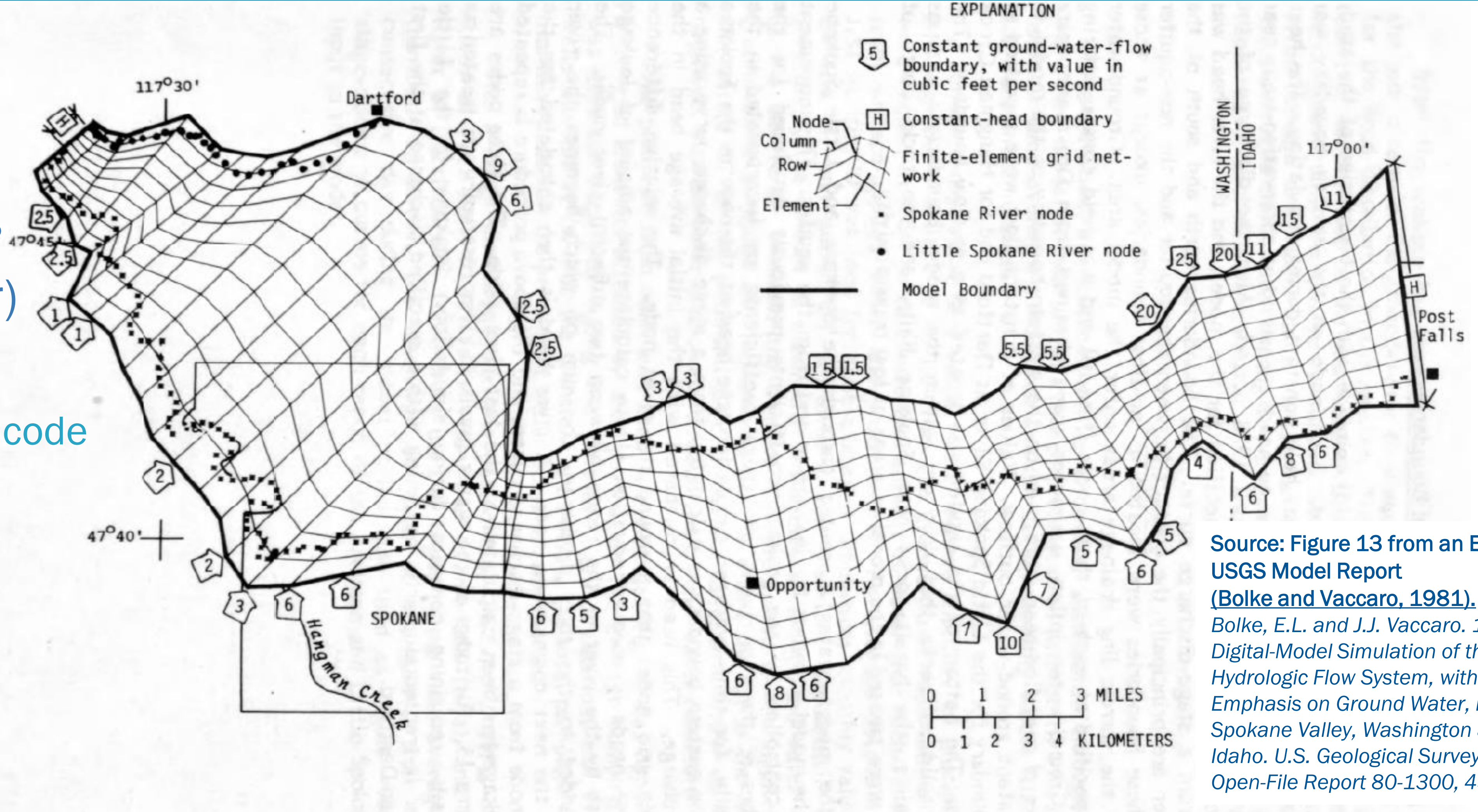
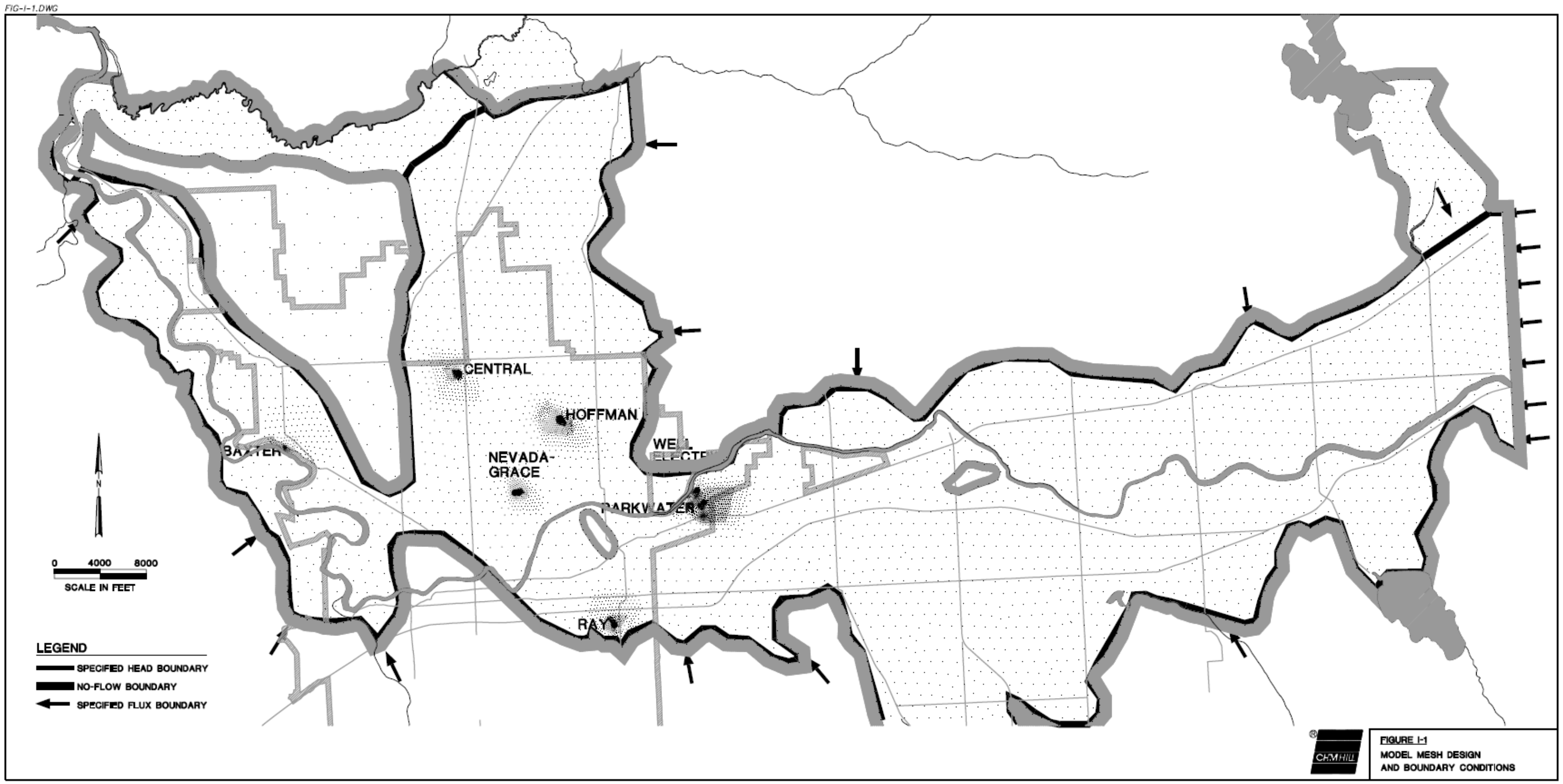


FIGURE 13.--Model grid network, boundary conditions used in the model, and river nodes for the Spokane and Little Spokane Rivers.

Source: Figure 13 from an Early USGS Model Report (Bolke and Vaccaro, 1981).
Bolke, E.L. and J.J. Vaccaro. 1981. Digital-Model Simulation of the Hydrologic Flow System, with Emphasis on Ground Water, in the Spokane Valley, Washington and Idaho. U.S. Geological Survey Open-File Report 80-1300, 43 p.

Models in the SVRP (City of Spokane, 1998)

- Fine spatial resolution
- Washington only
- 3D model (3 layers)
- Used Dutch software (MicroFEM)
    - Visualization built in
    - Very stable (doesn't crash)
    - Easy to delineate capture zones for water supply wells (wellhead protection planning)



Source: Figure I-1 from the City of Spokane Wellhead Protection Report (CH2M HILL, 1998).

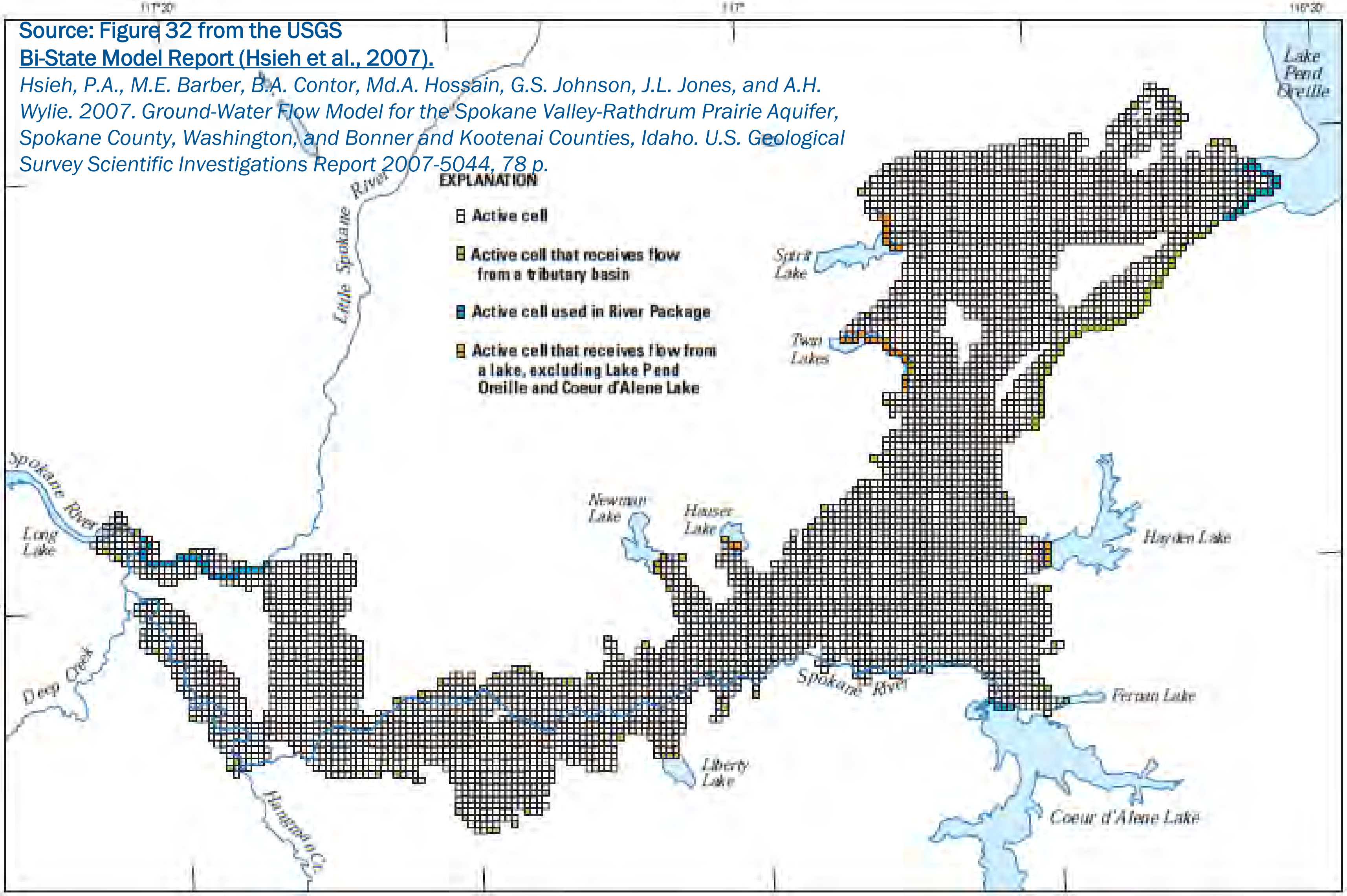
CH2M HILL. 1998. City of Spokane Wellhead Protection Program Phase 1 – Technical Assessment Report. Prepared in association with Dally Environmental, Fujitani Hilts and Associates, and SeisPulse Development Corporation. February 1998.

Models in the SVRP (USGS Bi-State Model, 2007)

- Medium spatial resolution
- Entire SVRP Aquifer
- Mixed 2D/3D model
  - 1 layer in and east of City of Spokane
  - 3 layers north of City of Spokane
- Used USGS software
  - MODFLOW
  - Widely used
  - Visualization available
  - Could be unstable (crash-prone)

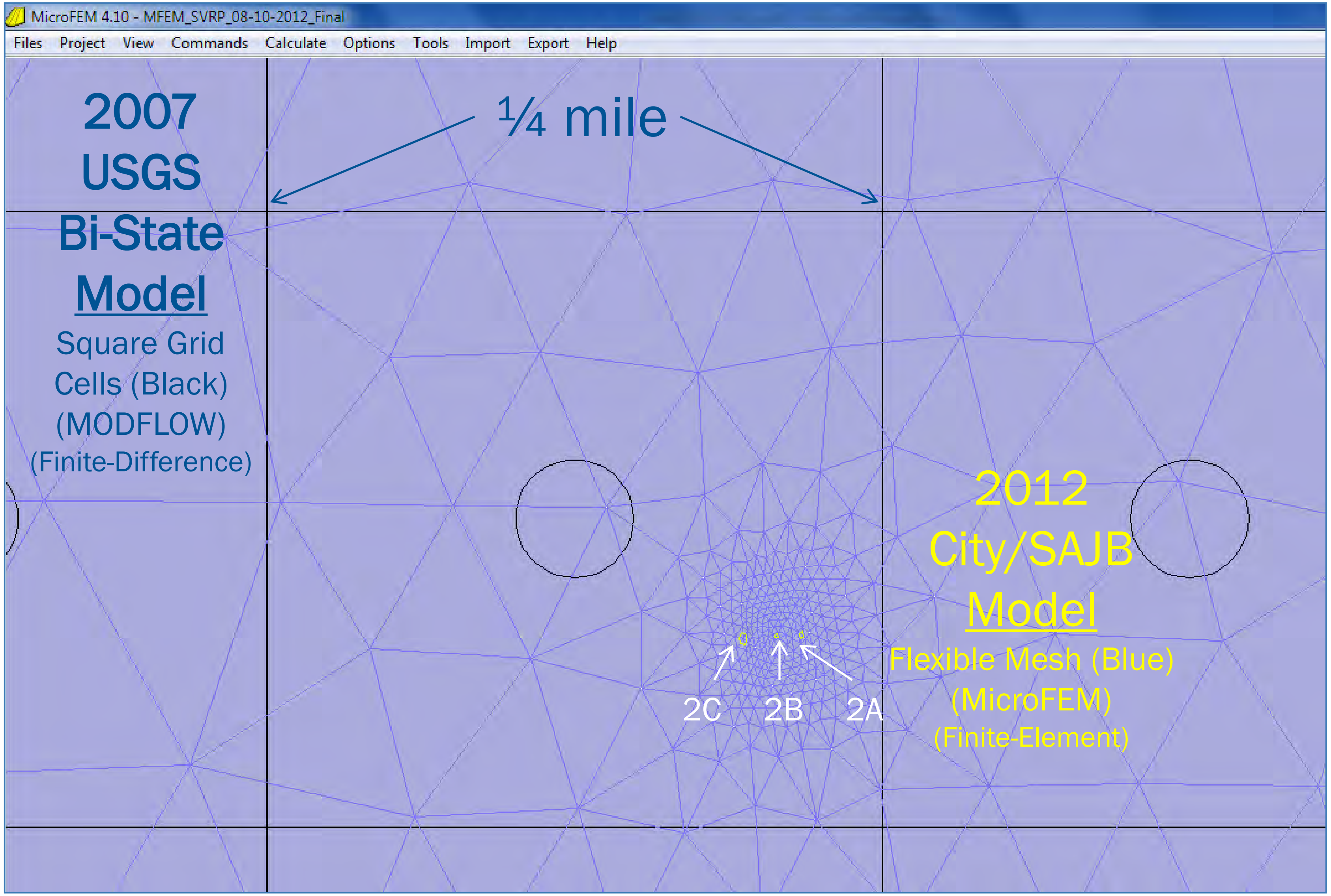
Source: Figure 32 from the USGS Bi-State Model Report (Hsieh et al., 2007).

Hsieh, P.A., M.E. Barber, B.A. Contor, Md.A. Hossain, G.S. Johnson, J.L. Jones, and A.H. Wylie. 2007. Ground-Water Flow Model for the Spokane Valley-Rathdrum Prairie Aquifer, Spokane County, Washington, and Bonner and Kootenai Counties, Idaho. U.S. Geological Survey Scientific Investigations Report 2007-5044, 78 p.



Models in the SVRP (City of Spokane & Spokane Aquifer Joint Board [SAJB], 2012)

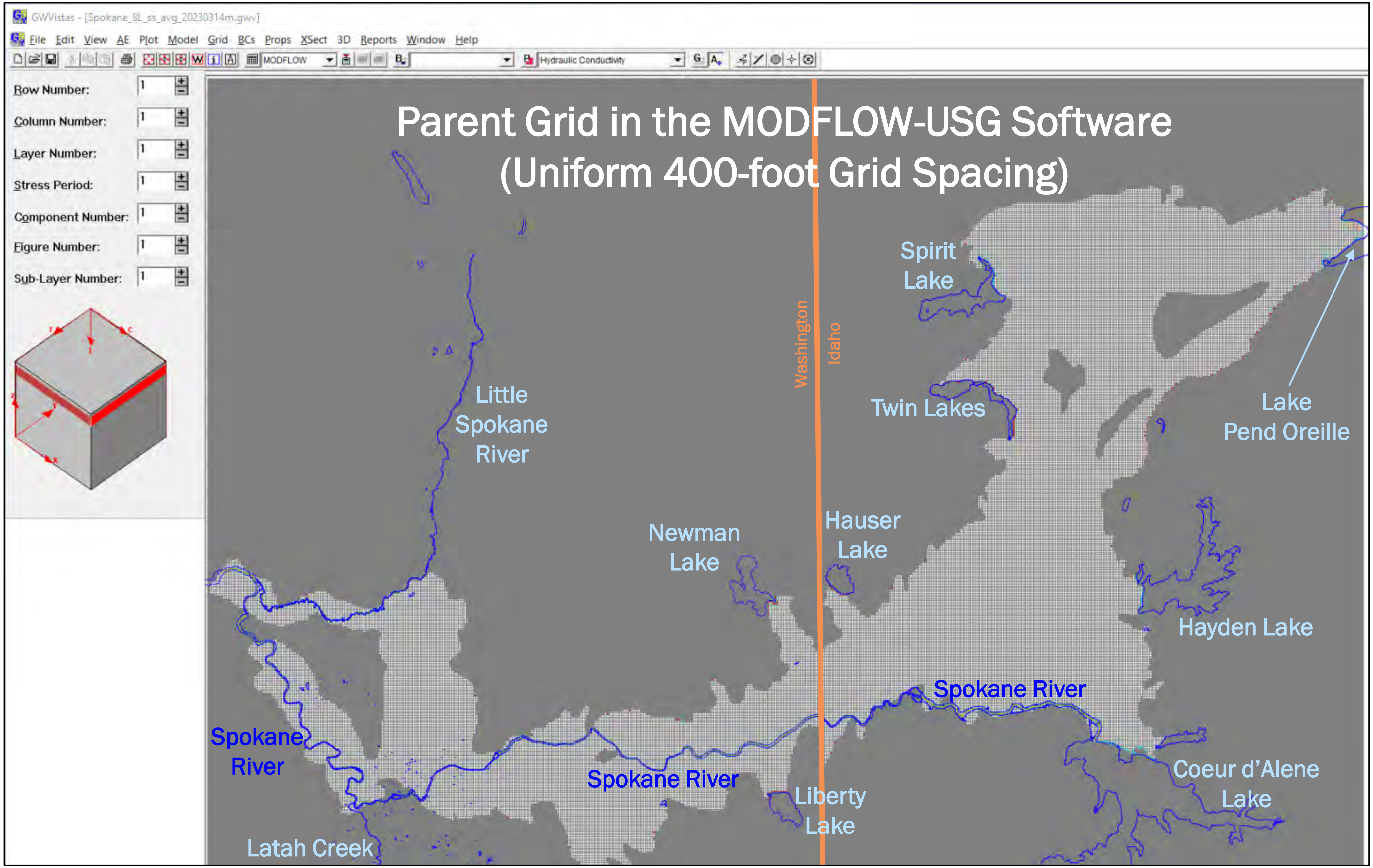
- Fine spatial resolution
- Entire SVRP Aquifer
- 3D model
  - Initially 3 layers
  - Then 8 layers
- Still using MicroFEM Dutch software
  - Visualization
  - Stability
  - Ease of use



Source: GSI Water Solutions, City of Spokane, and Spokane Aquifer Joint Board (SAJB)

Spatial Resolution

Newest Model for City of Spokane in 2024

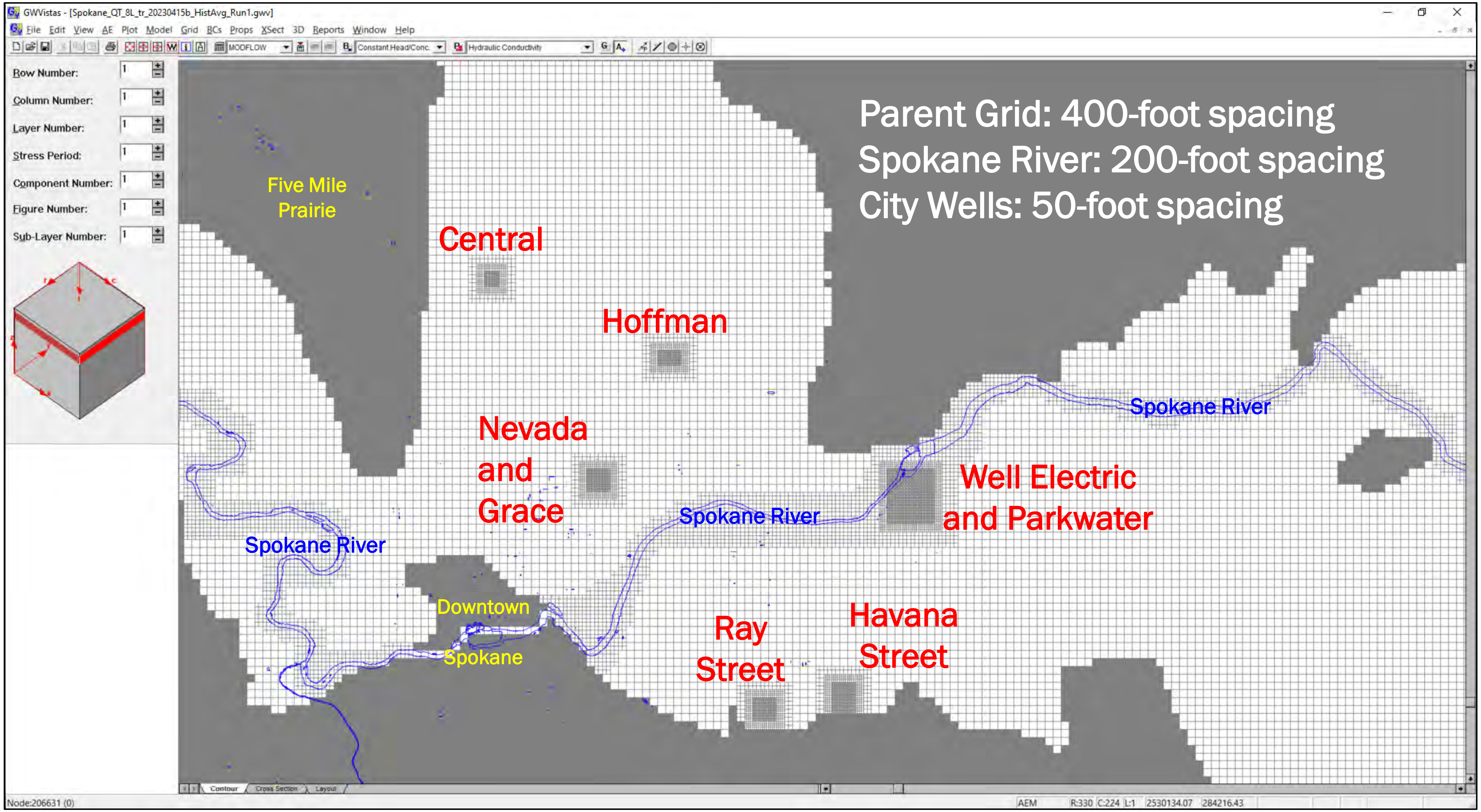


Source: GSI Water Solutions and City of Spokane

GSI Water Solutions

Spatial Resolution

Newest Model for City of Spokane in 2024



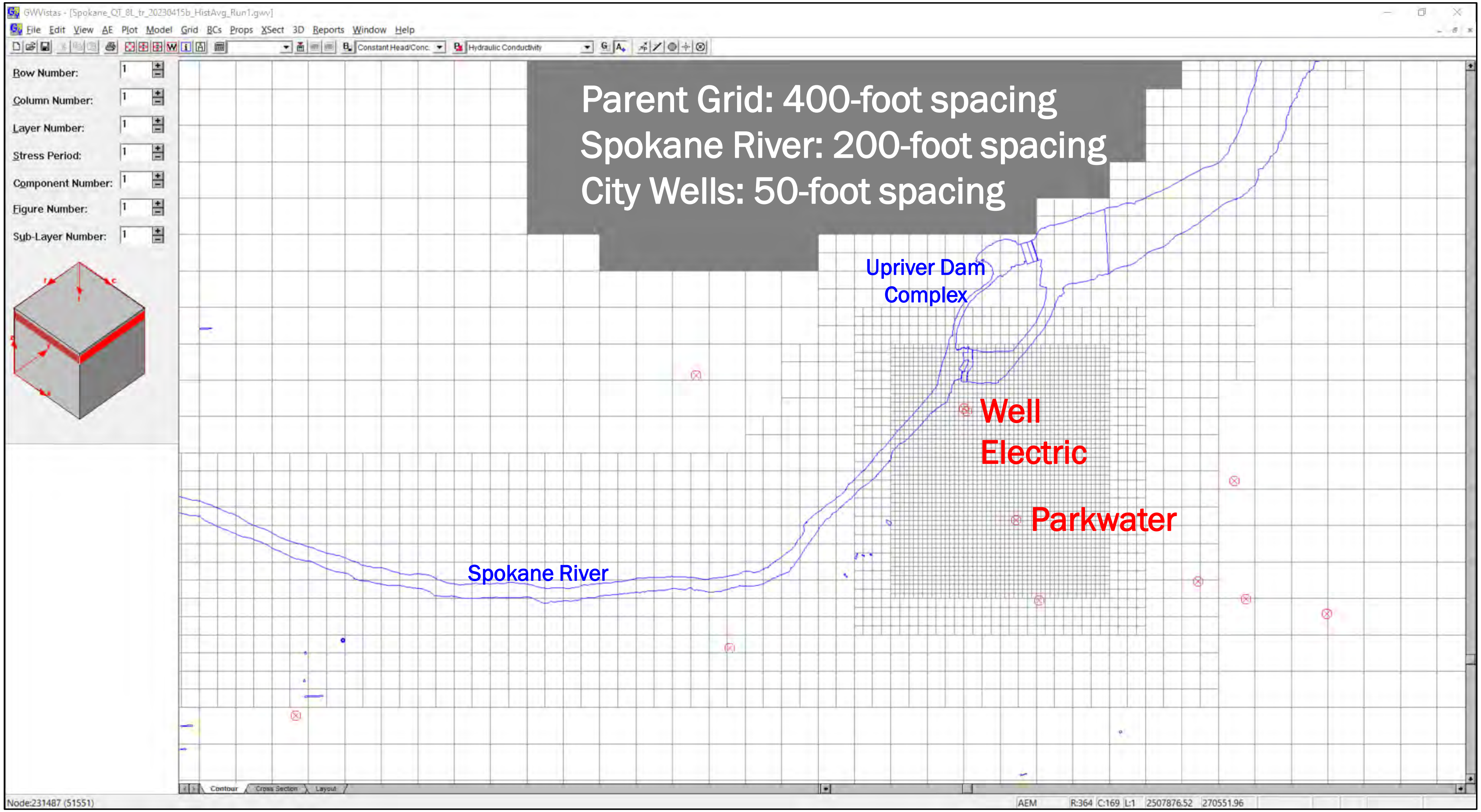
Source: GSI Water Solutions and City of Spokane

CITY OF SPOKANE

GSI Water Solutions

Spatial Resolution

Newest Model for City of Spokane in 2024



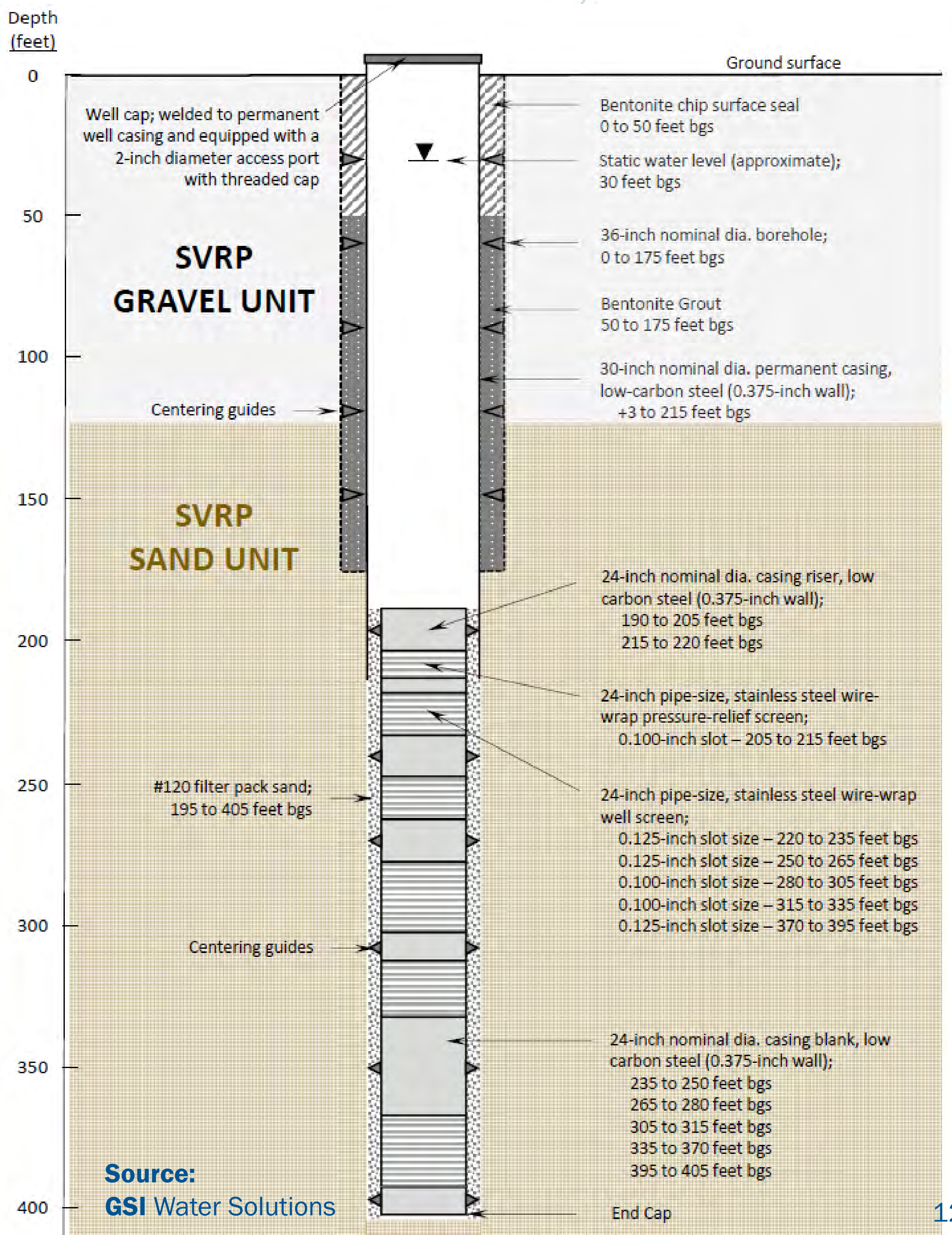
Source: GSI Water Solutions and City of Spokane

GSI Water Solutions

Deep-Zone Exploration and Initial Well Design Concept

Well Electric Well Station

Source:
Landau Associates



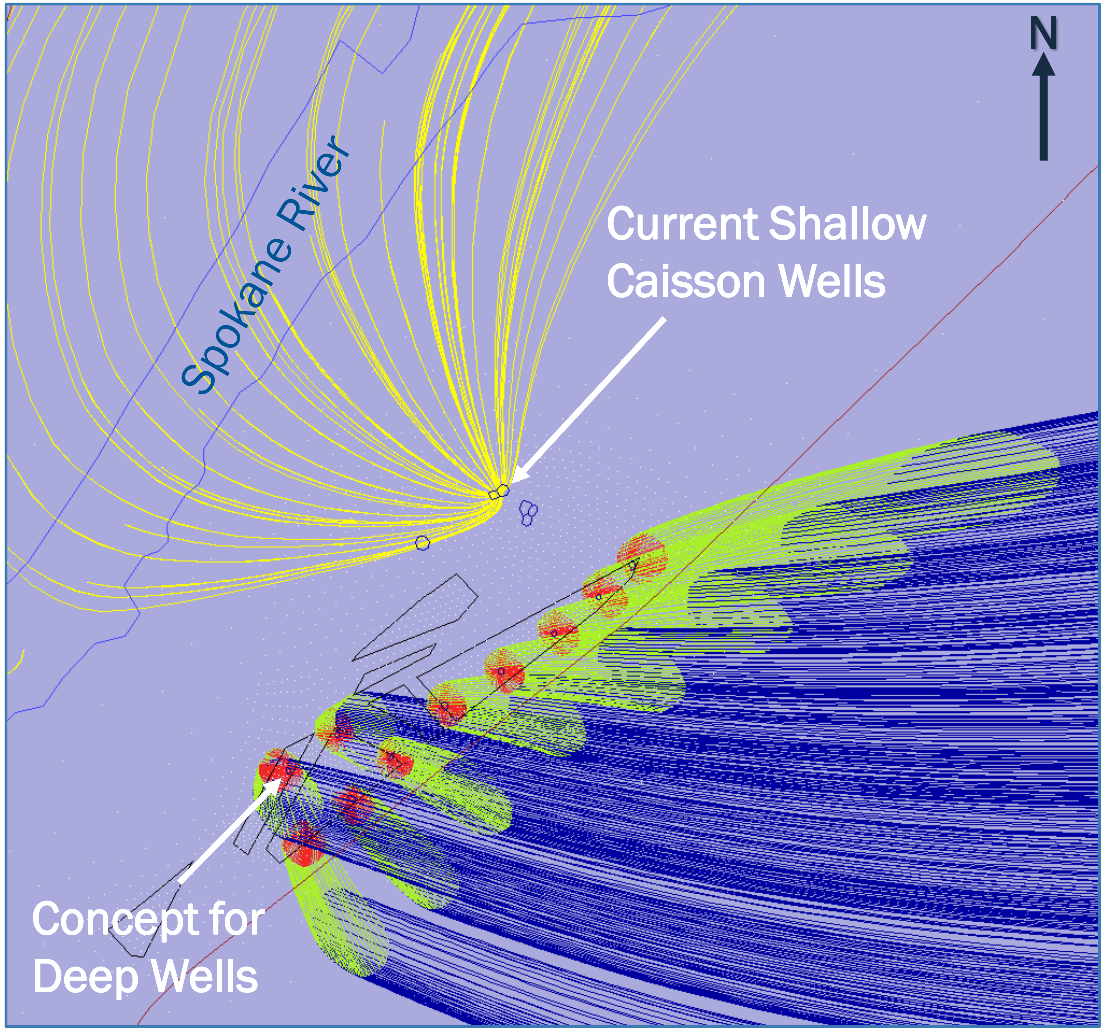
Source:
GSI Water Solutions

CITY OF SPOKANE

GSI Water Solutions

3D Flowpaths to Shallow vs. Deep Wells
(City of Spokane's Well Electric Well Station)

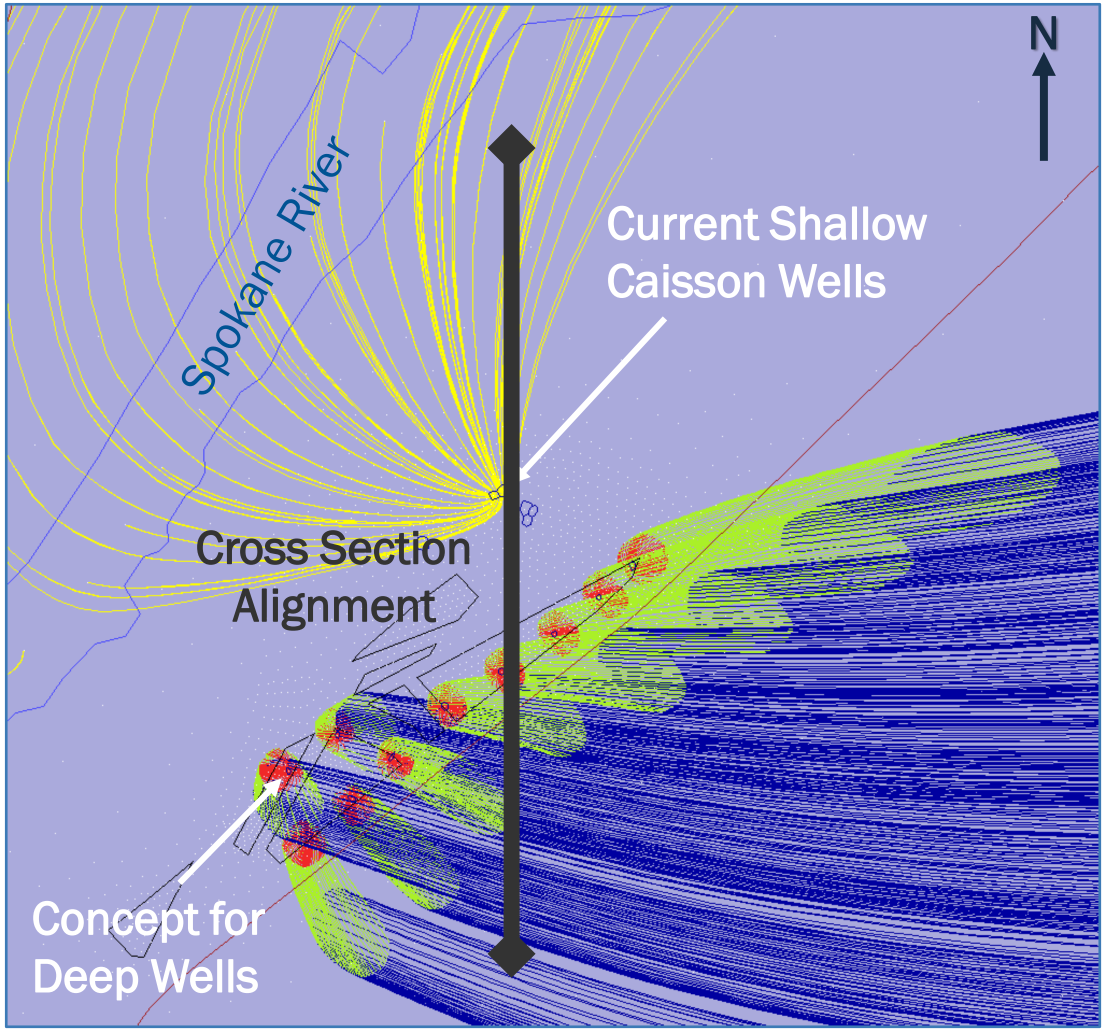
Map View



Different Flowpath Colors Represent Different Depth Zones in the Aquifer

3D Flowpaths to Shallow vs. Deep Wells
(City of Spokane's Well Electric Well Station)

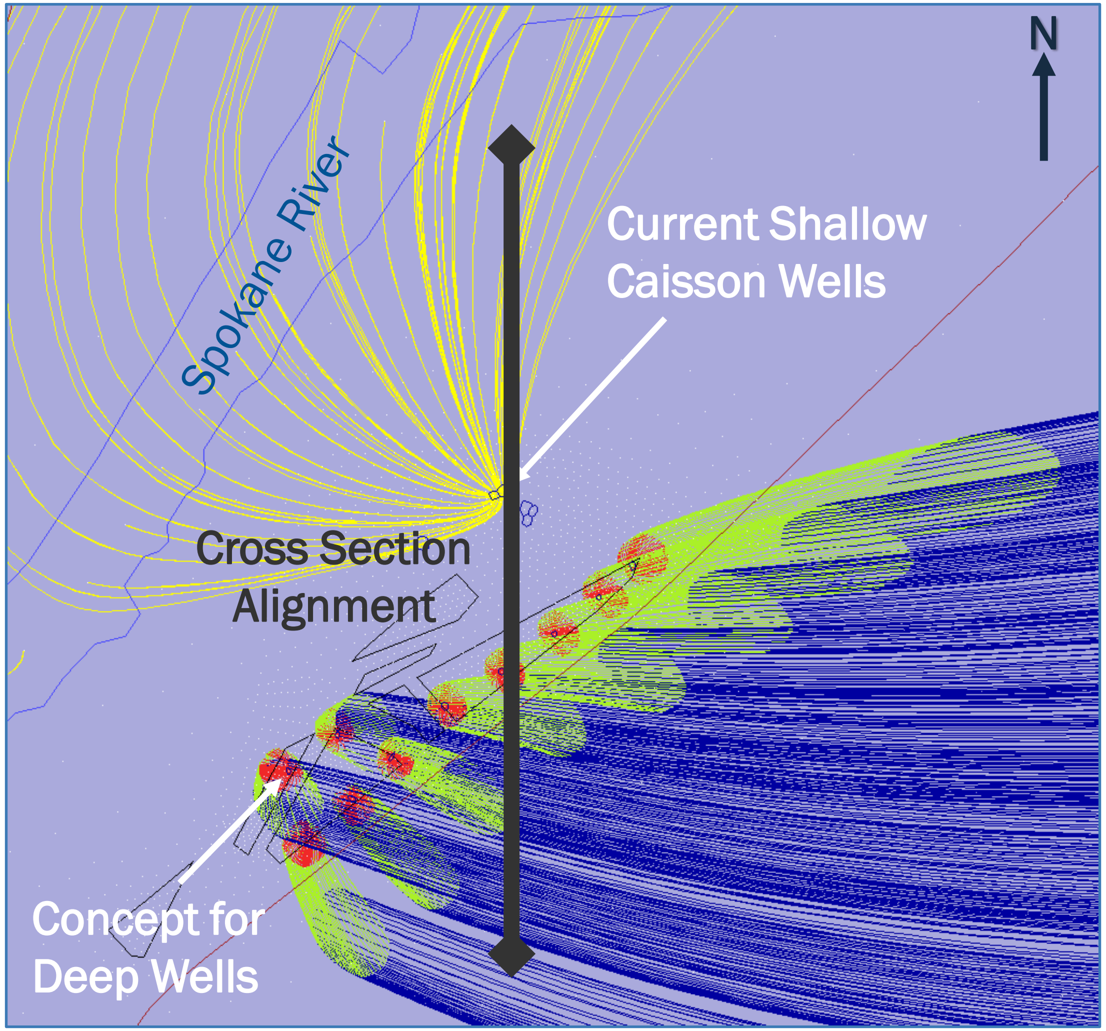
Map View



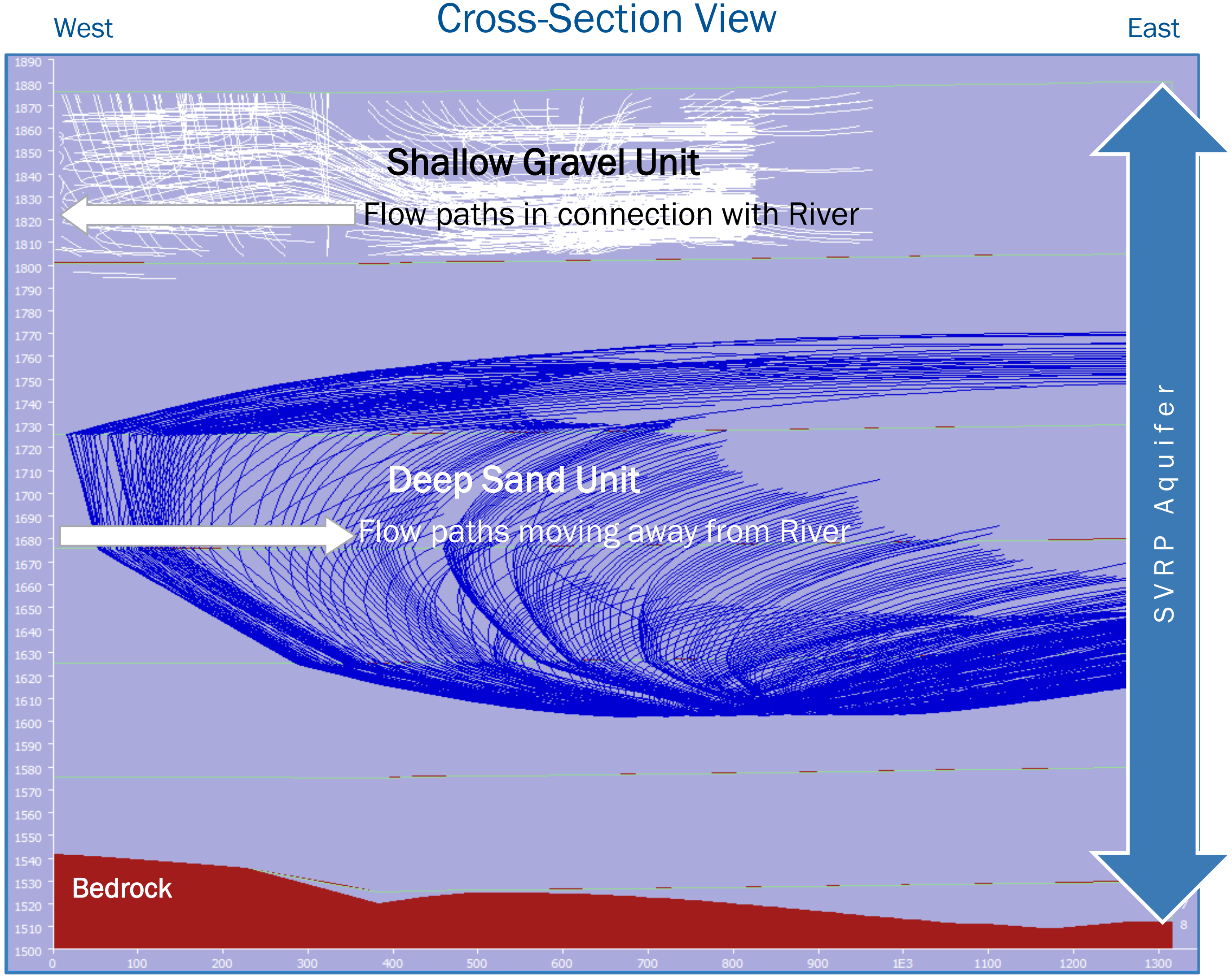
Different Flowpath Colors Represent Different Depth Zones in the Aquifer

3D Flowpaths to Shallow vs. Deep Wells
(City of Spokane's Well Electric Well Station)

Map View



Cross-Section View

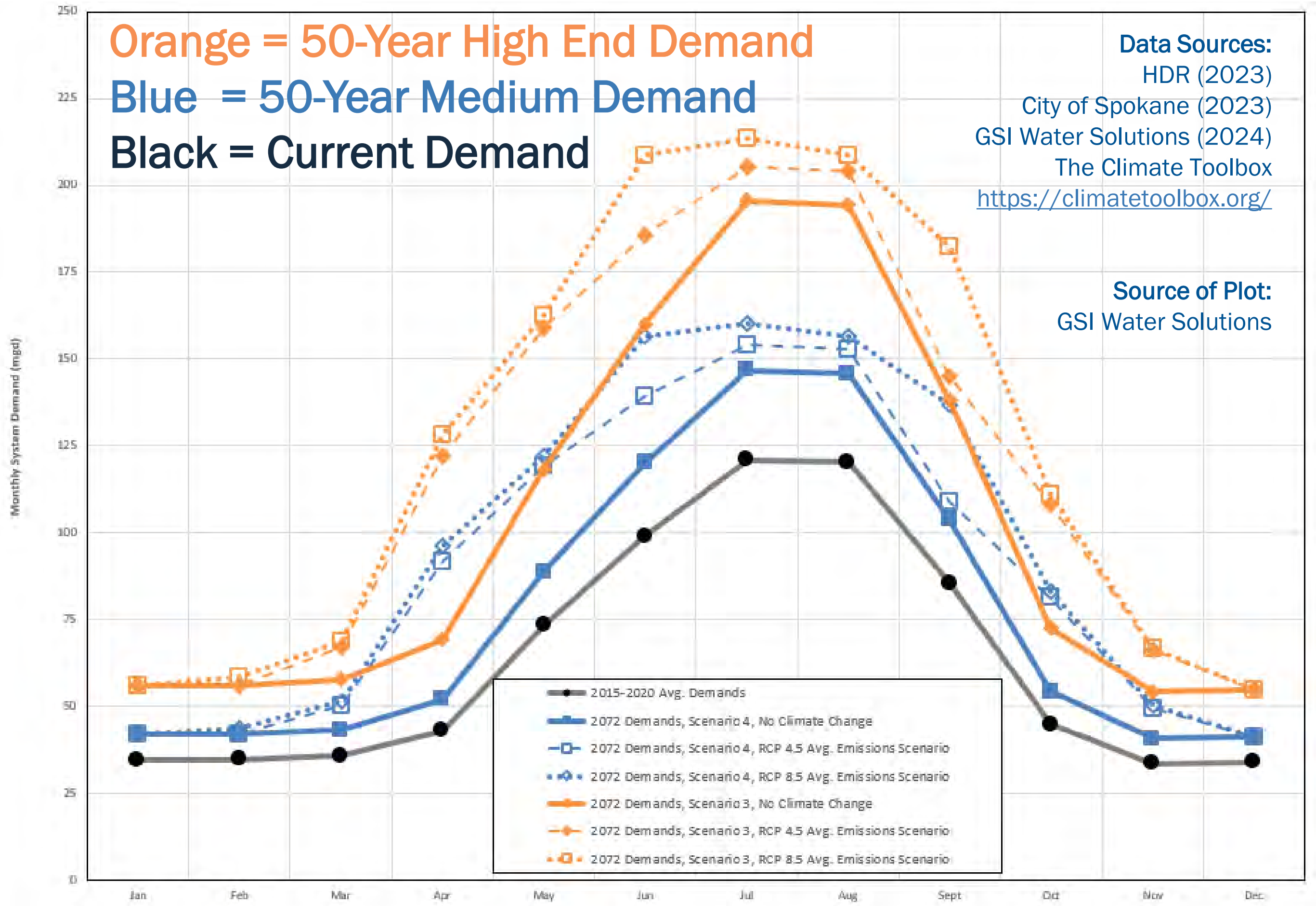


Different Flowpath Colors Represent Different Depth Zones in the Aquifer

How Does a Regional Aquifer Model Help with Water Supply Resiliency Planning?

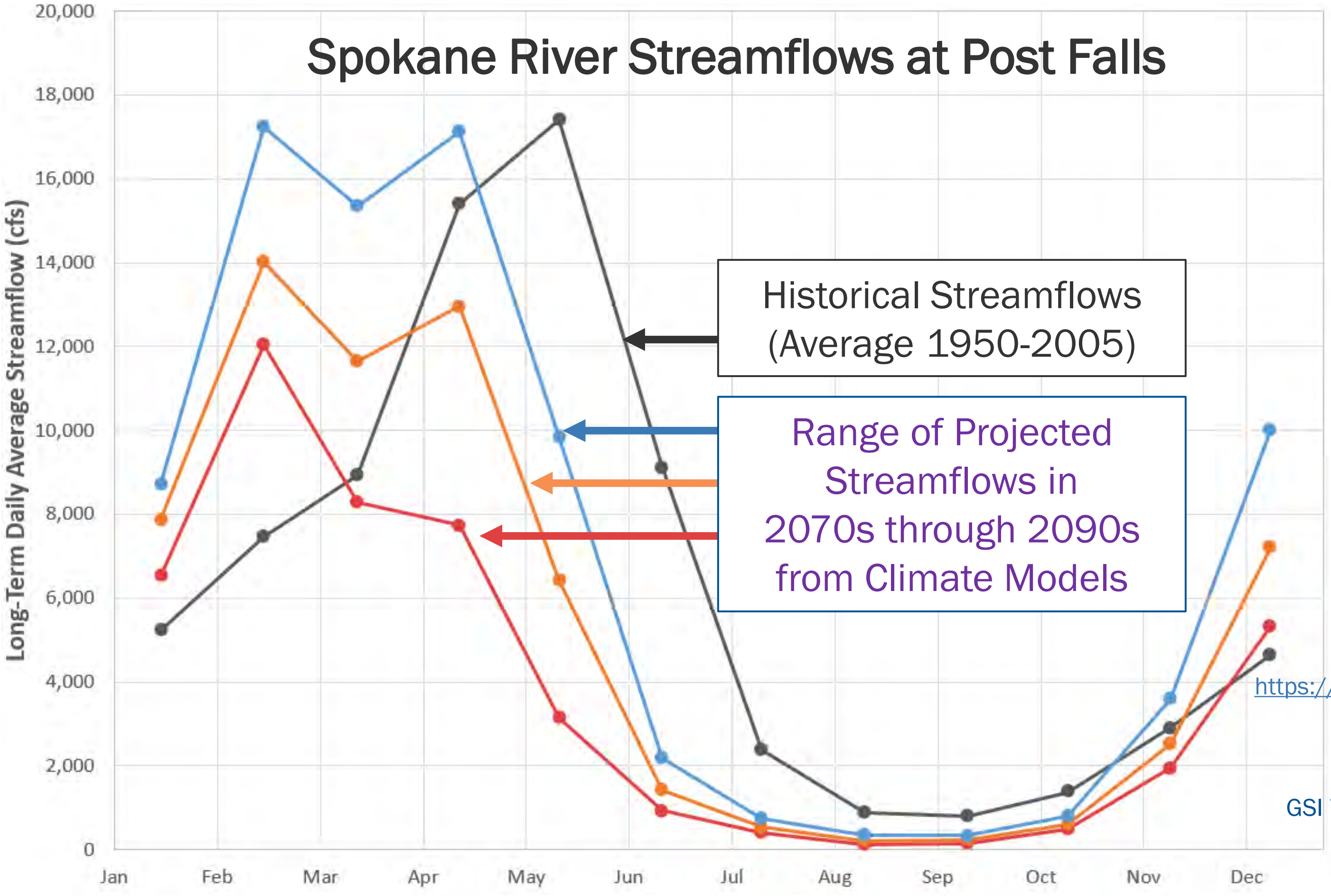
We can change groundwater pumping demands

- Locations
- Volumes
- Monthly/seasonal variations
- Climate effects on water demands



How Does a Regional Aquifer Model Help with Water Supply Resiliency Planning?

We can change natural hydrologic inputs that are affected by a changing climate

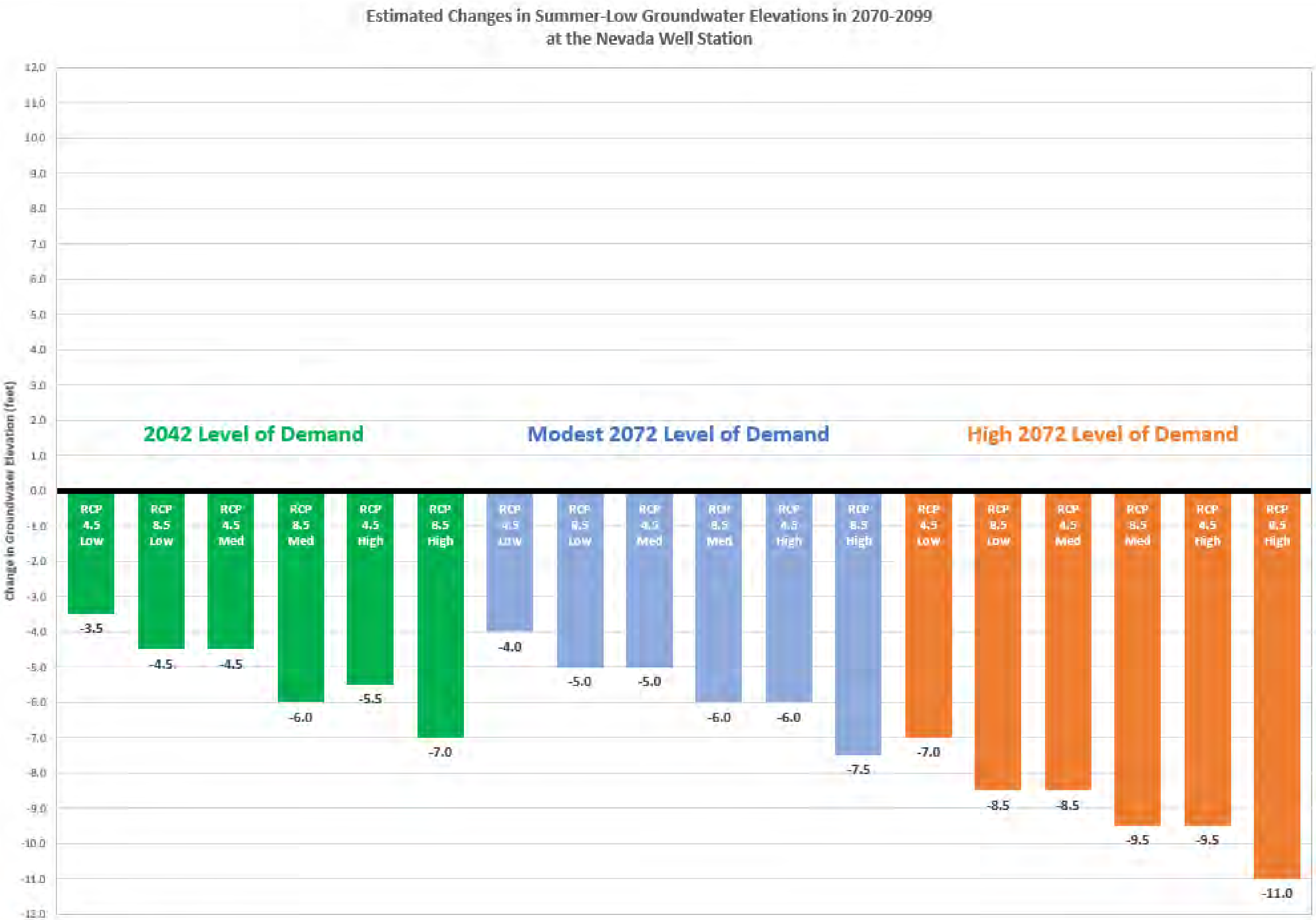


Data Source:
The Climate Toolbox
https://climatetoolbox.org/

Source of Plot:
GSI Water Solutions and City of Spokane

Case Study:

Assessment of the Nevada Well Station



GSI Water Solutions, Inc.

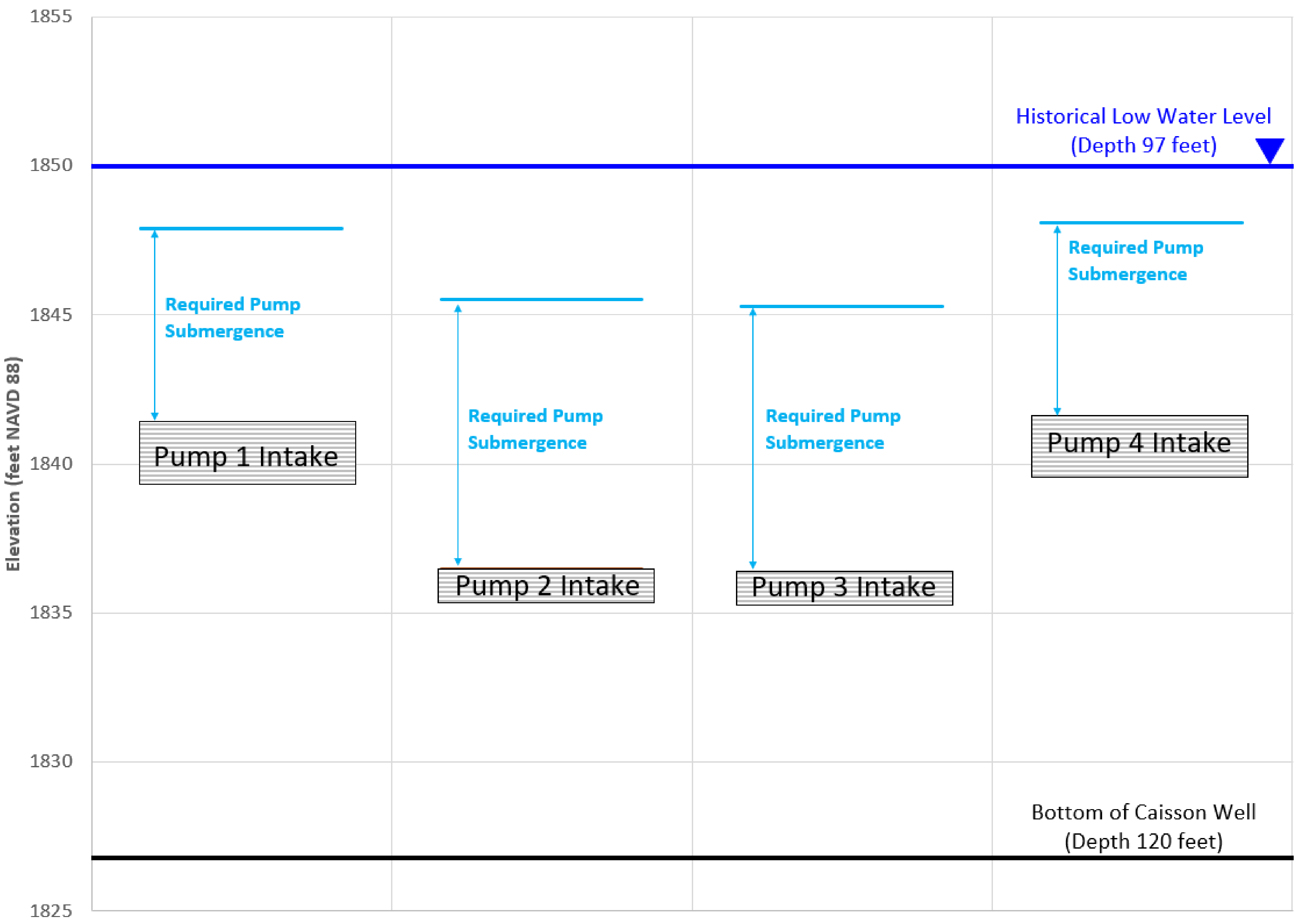
Note: RCP = Representative Concentration Pathway for future greenhouse gas emissions

CITY OF SPOKANE

GSI Water Solutions

Case Study:

Assessment of the Nevada Well Station

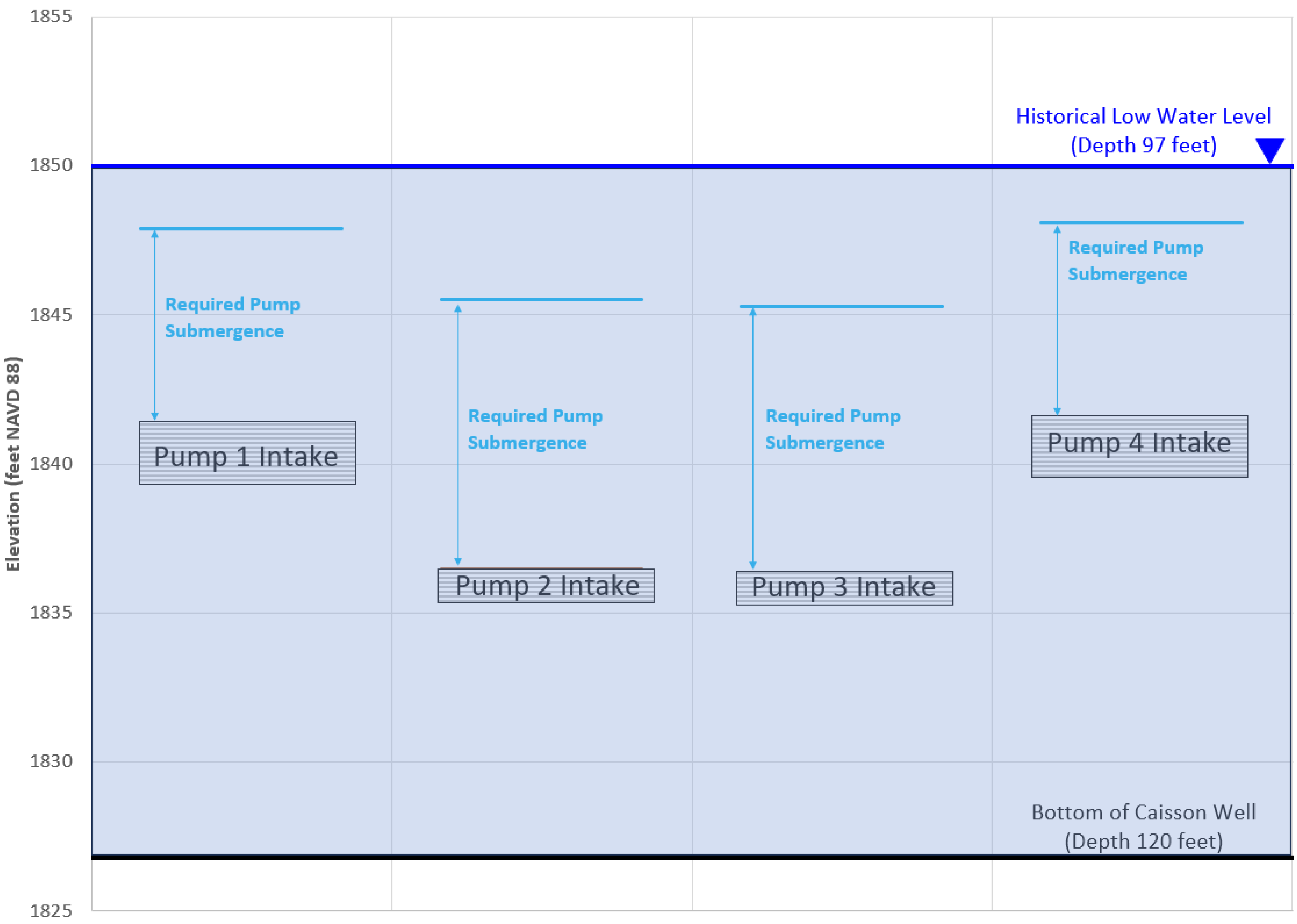


GSI Water Solutions

Case Study:

Assessment of the Nevada Well Station

Under Historical Conditions



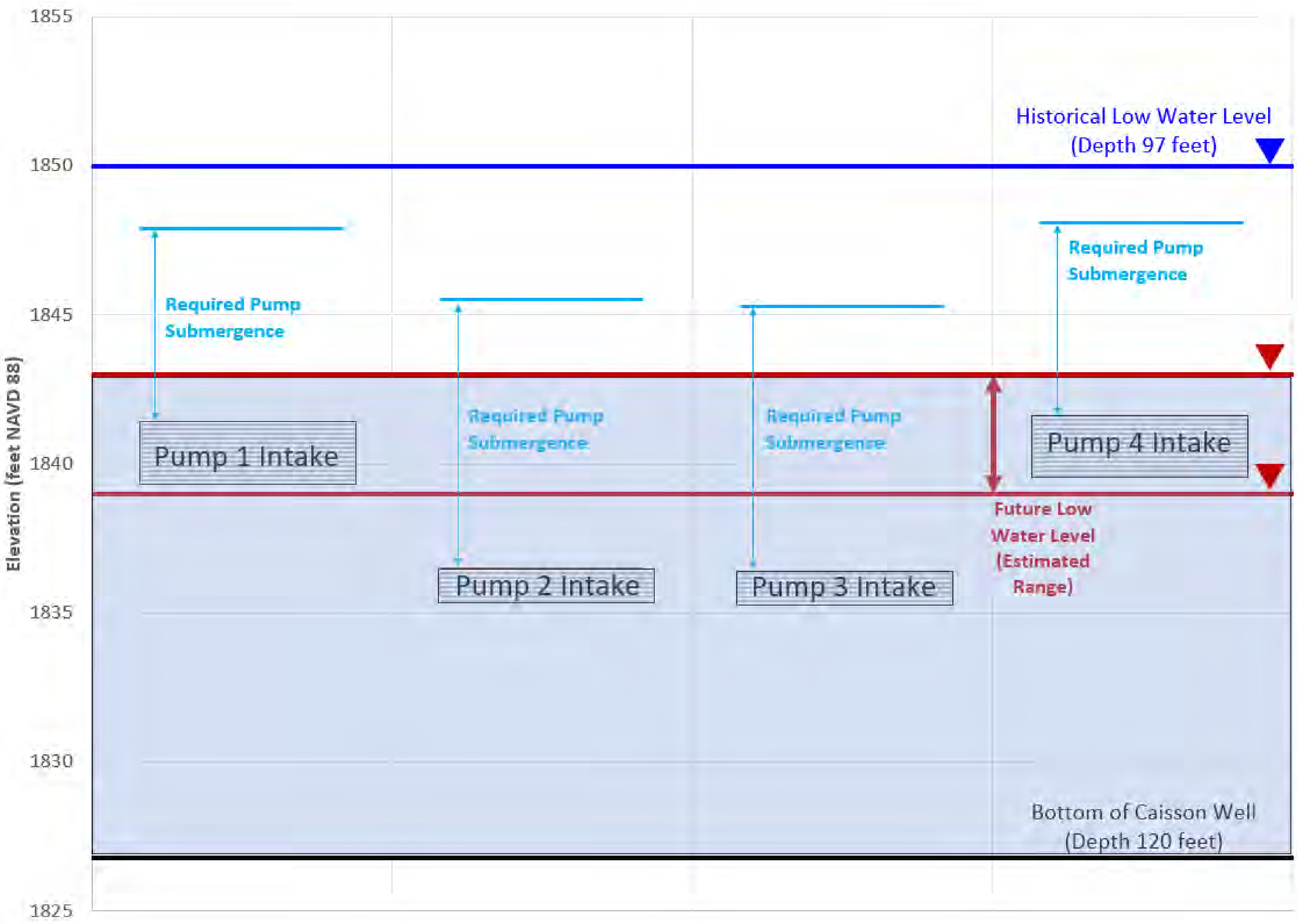
CITY OF SPOKANE

GSI Water Solutions

Case Study:

Assessment of the Nevada Well Station

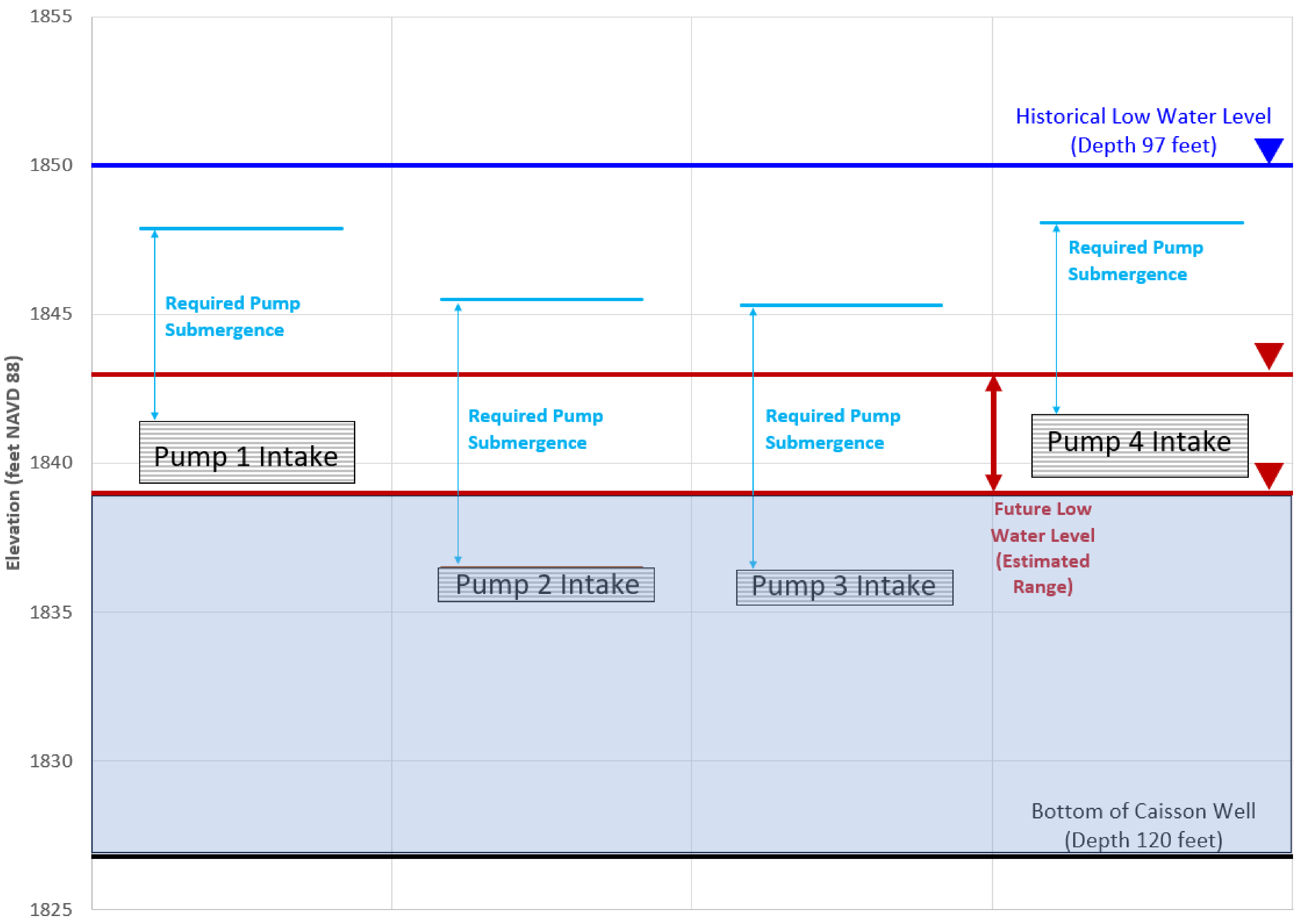
Under a 50-Year High-End Demand Scenario



Case Study:

Assessment of the Nevada Well Station

Under a 50-Year High-End Demand Scenario



CITY OF SPOKANE

GSI Water Solutions

Heavy Lifting by the Region's Water Providers, Resource Managers, and the Scientific Community

The Local Water Purveyors

Other Supporting Entities

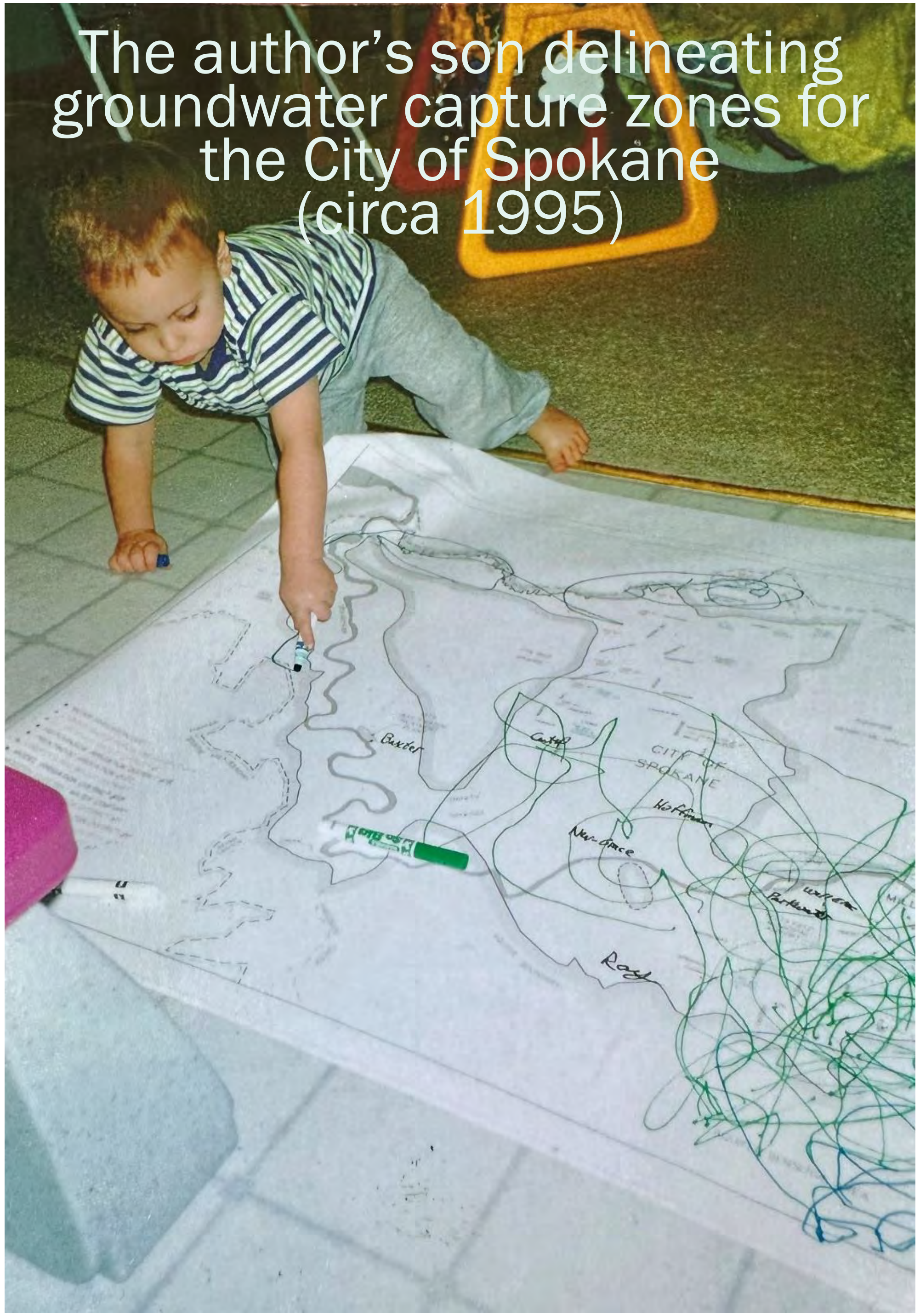
Other Local Water Providers and Water Resource Managers
Individual Water Purveyors in WA and ID
Spokane County Water Resources Department, WA

State and Local Agencies
Washington State Department of Health
Washington State Department of Ecology
Idaho Department of Water Resources
Idaho Department of Environmental Quality
Panhandle Health District, ID

Research Community
U.S. Geological Survey
USDA Natural Resources Conservation Service
Idaho Water Resources Research Institute
University of California, Merced

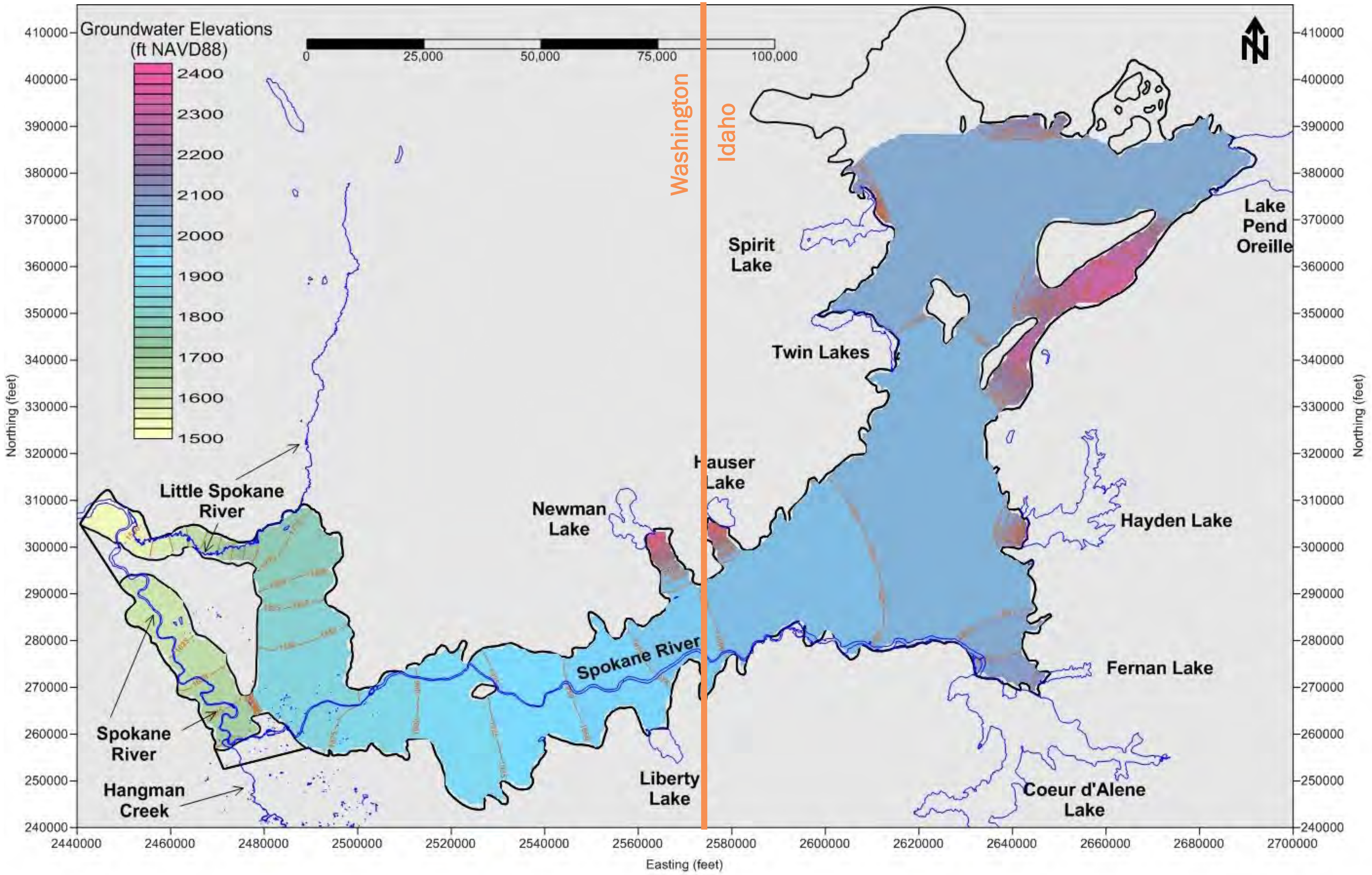
Other Professionals
Dr. Dale Ralston
Landau Associates
Consor North America
CH2M HILL
GSI Water Solutions

Why Use a Ground-Water Model for Water Supply Resiliency Planning?



The author's son delineating groundwater capture zones for the City of Spokane (circa 1995)

It's better to use a model than to wing it!



Source: GSI Water Solutions, City of Spokane, and Spokane Aquifer Joint Board (SAJB)

THANK YOU!

John Porcello, LHG
Principal Groundwater Hydrologist and Water Resources Consultant
GSI Water Solutions, Inc.
971.200.8523
jporcello@gsiws.com