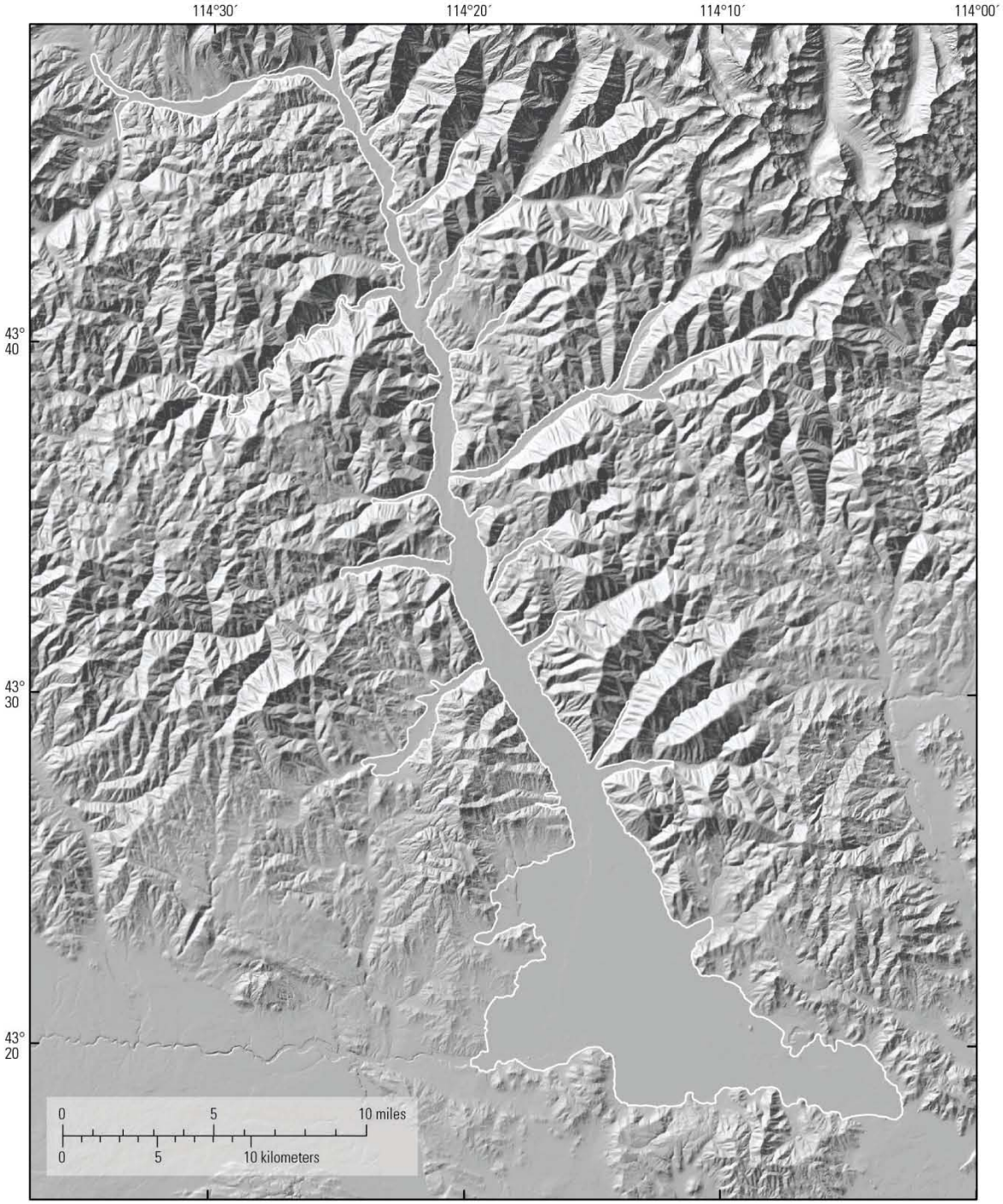
Wood River Valley Modeling Technical Advisory Committee: Preliminary Model Construction

Jason C. Fisher

U.S. Geological Survey
Idaho Department of Water Resources



Coordinate system:

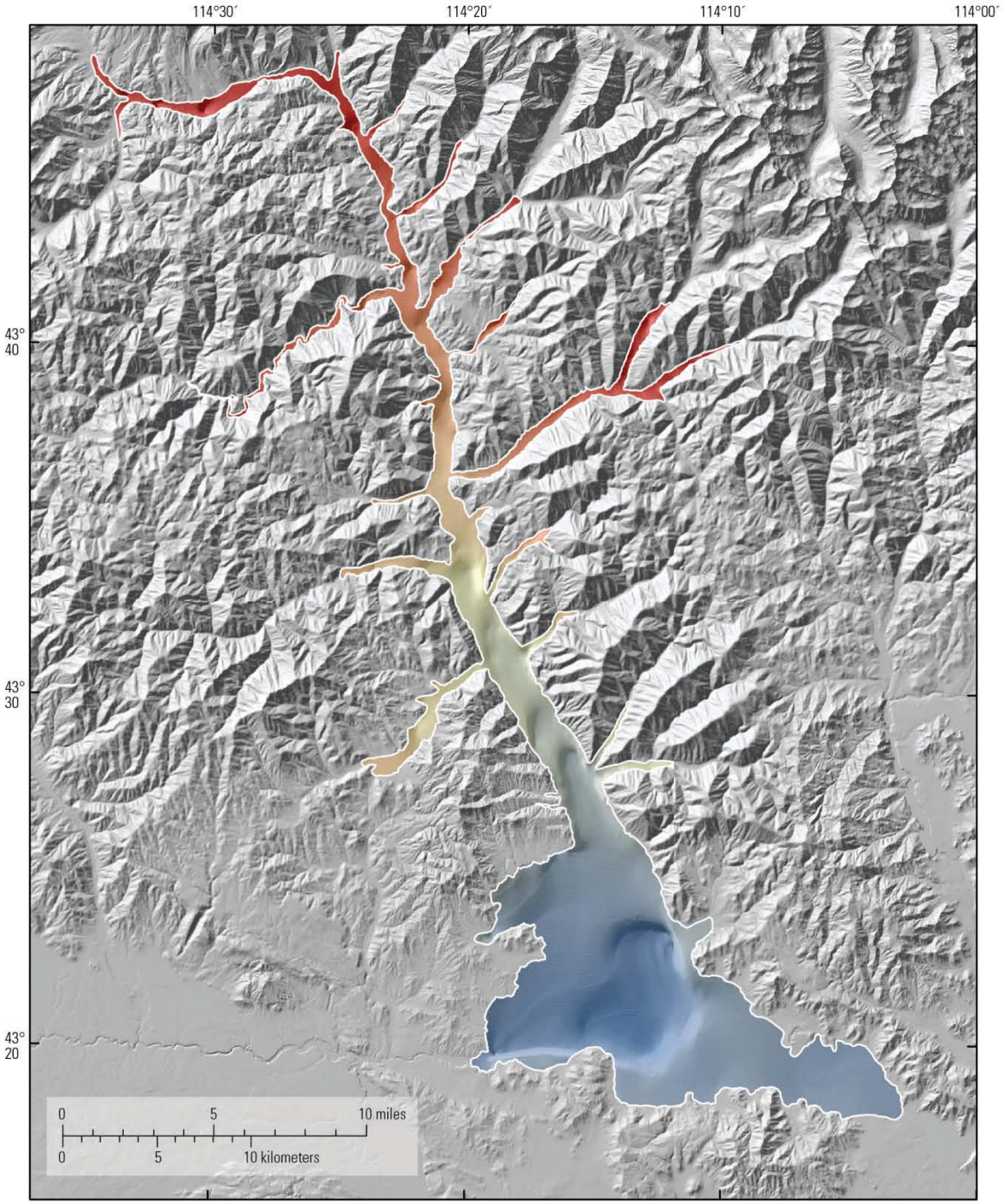
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

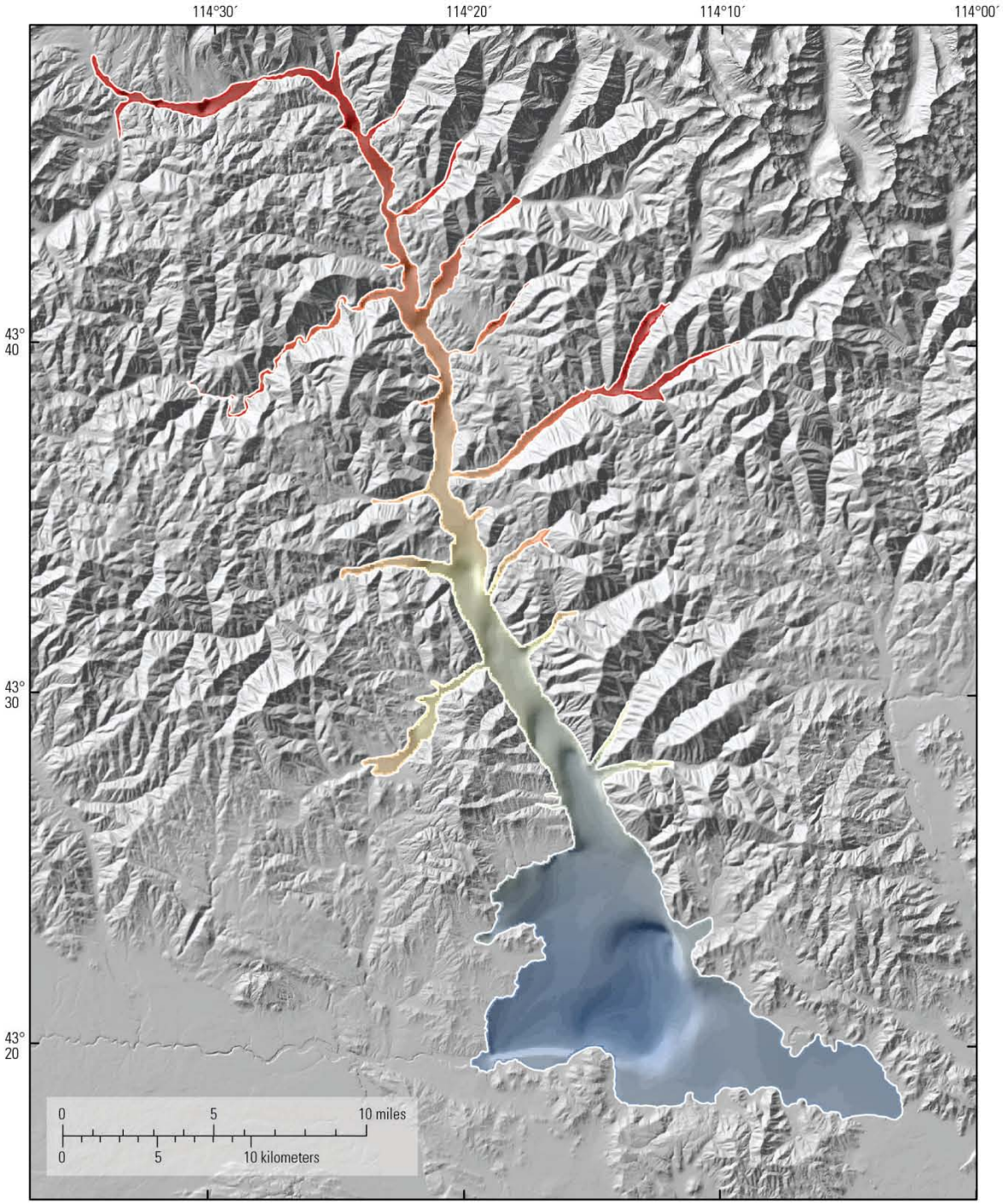
Aquifer extent (SIR 2012-5053)

Base of alluvium aquifer raster:

Resolution: about 26 meters
SIR 2012-5053

2,071 meters

1,392 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

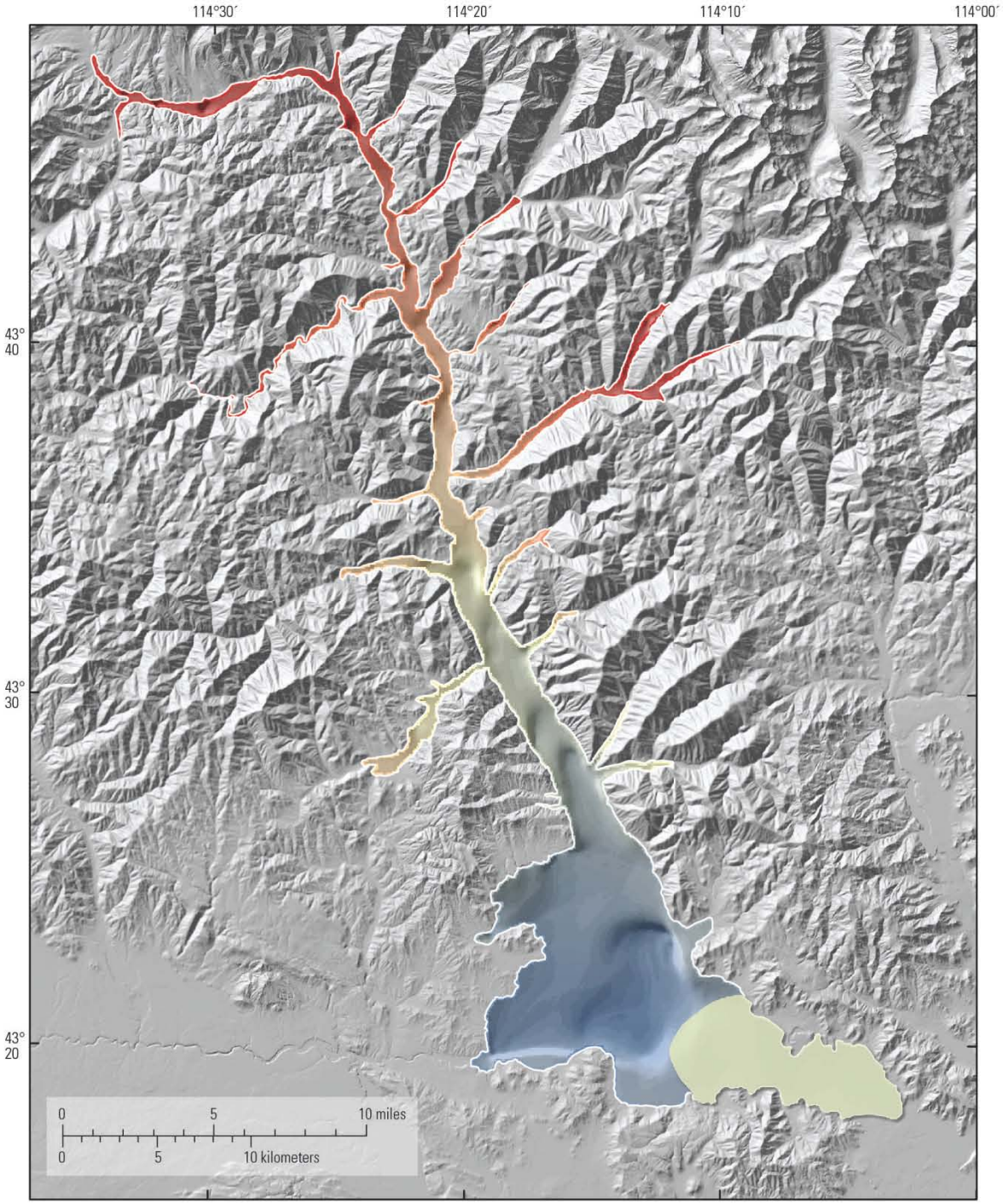
Aquifer extent (SIR 2012-5053)

Base of alluvium aquifer raster:

Model resolution: 100 meters

2,071 meters

1,392 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

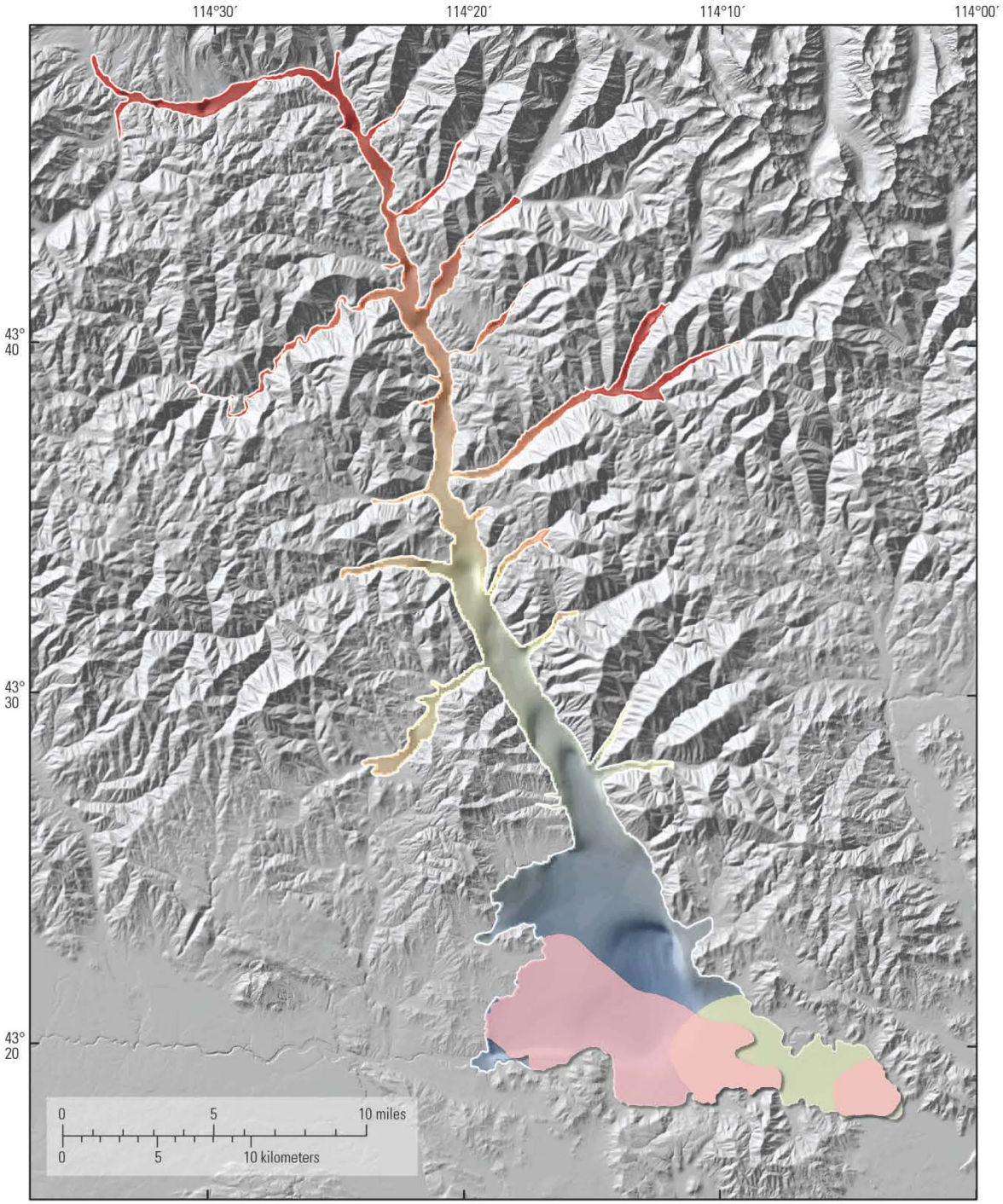
Basalt extent (SIR 2007-5258)

Base of alluvium aquifer raster:

Model resolution: 100 meters

2,071 meters

1,392 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

Basalt extent (SIR 2007-5258)

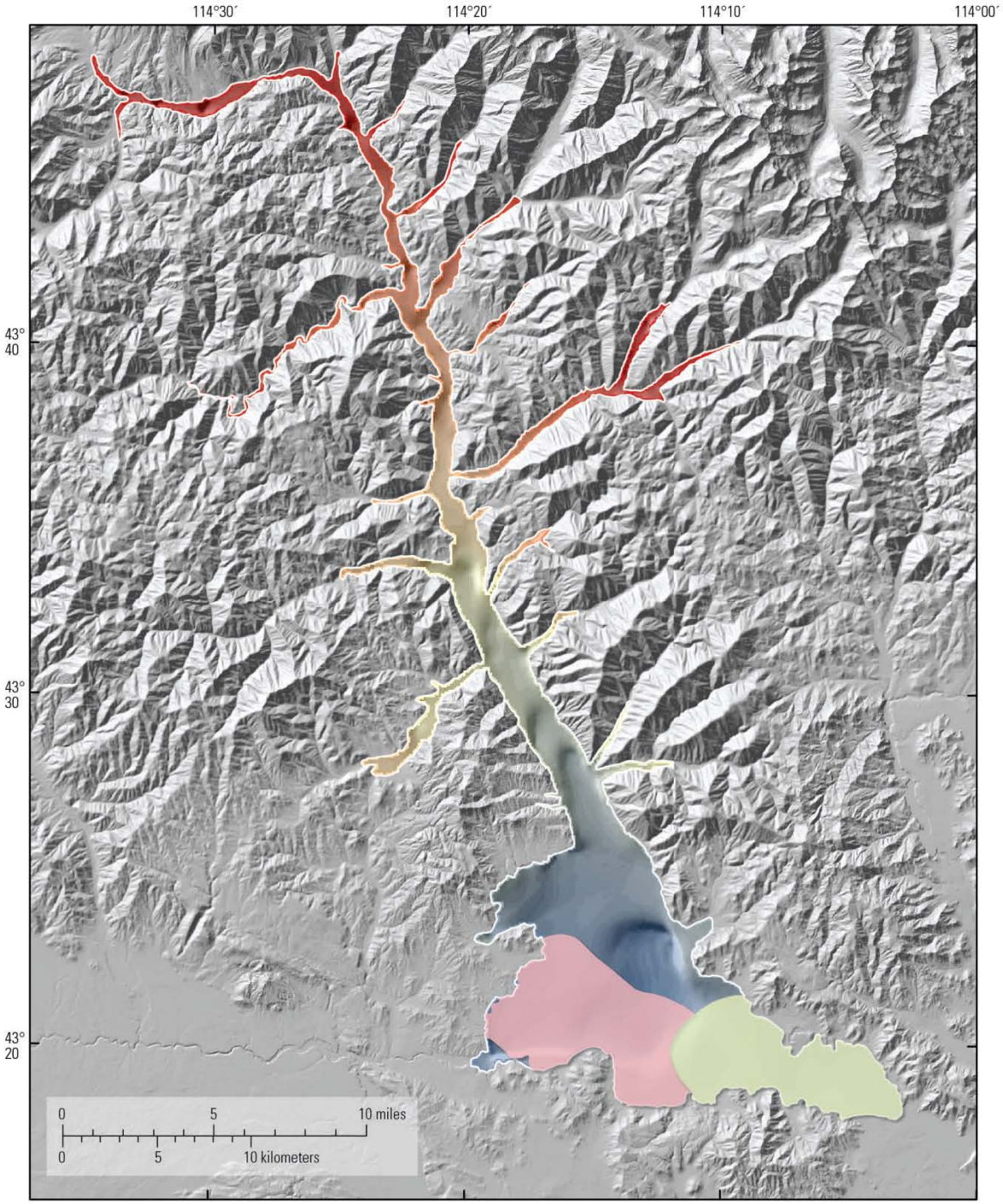
Aquitard extent (OFR 1977-456)

Base of alluvium aquifer raster:

Model resolution: 100 meters

2,071 meters

1,392 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

Basalt extent (SIR 2007-5258)

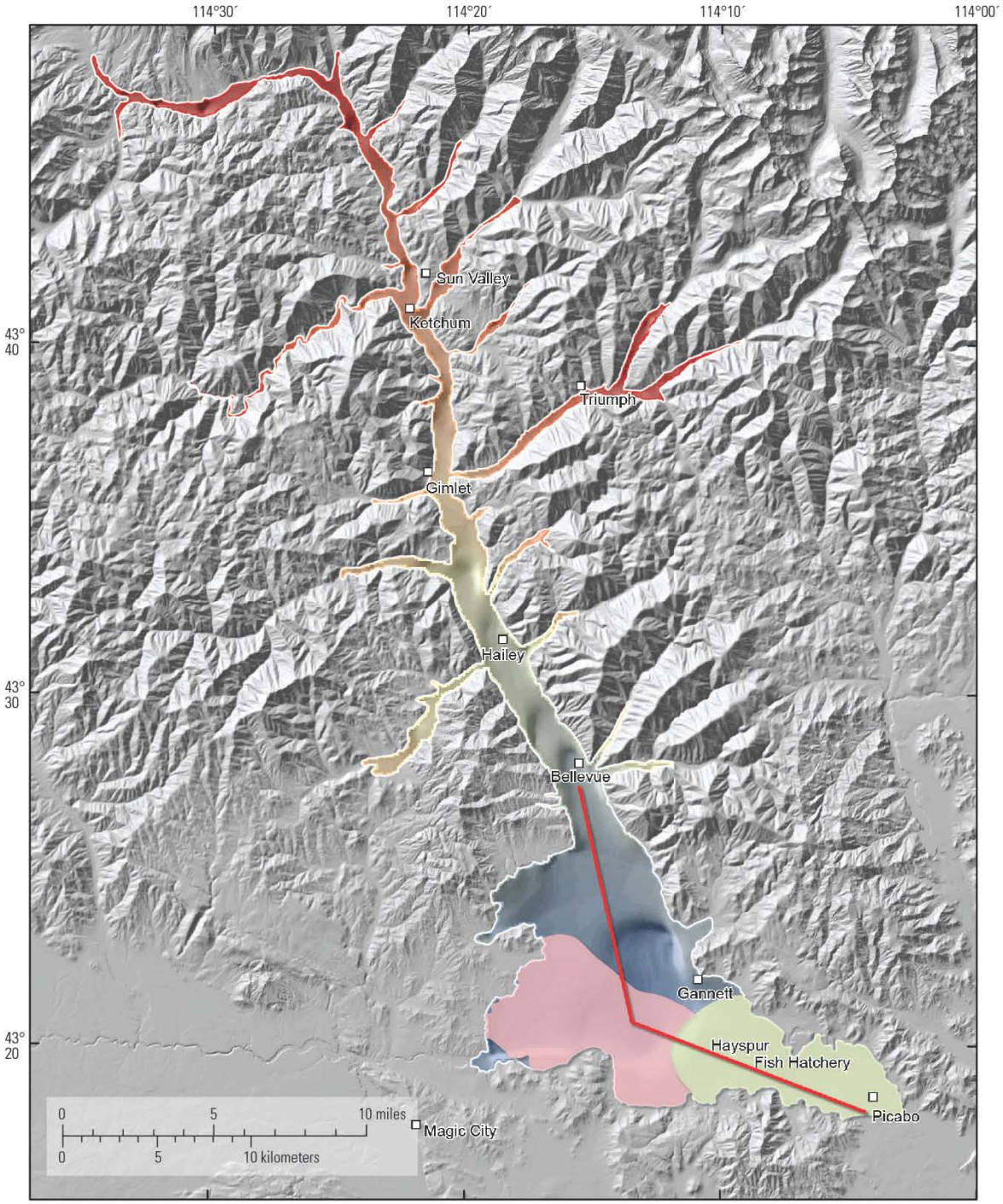
Aquitard extent (Modified)

Base of alluvium aquifer raster:

Model resolution: 100 meters

2,071 meters

1,392 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

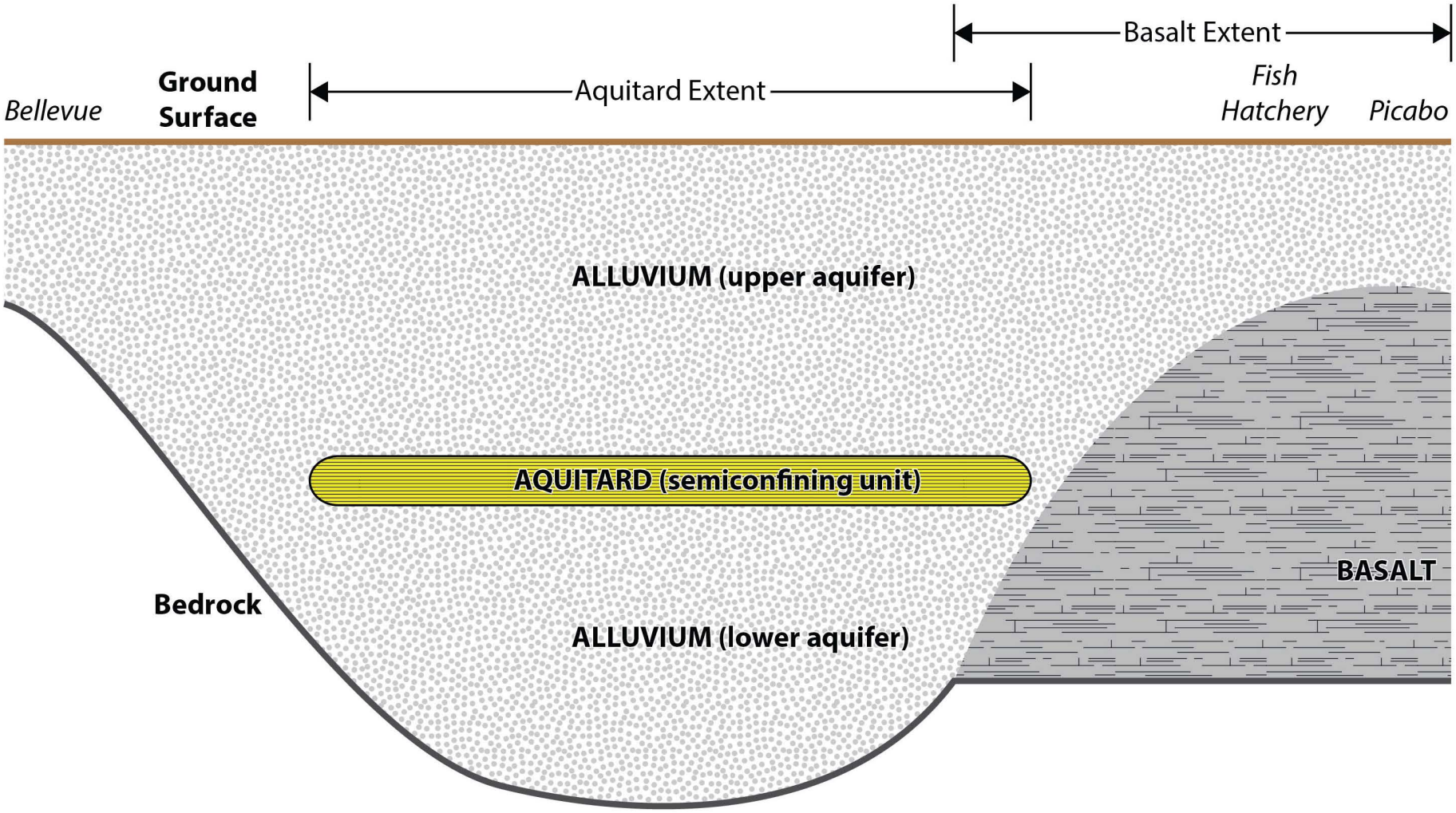
- Aquifer extent (SIR 2012-5053)
- Basalt extent (SIR 2007-5258)
- Aquitard extent (Modified)
- Trace of section

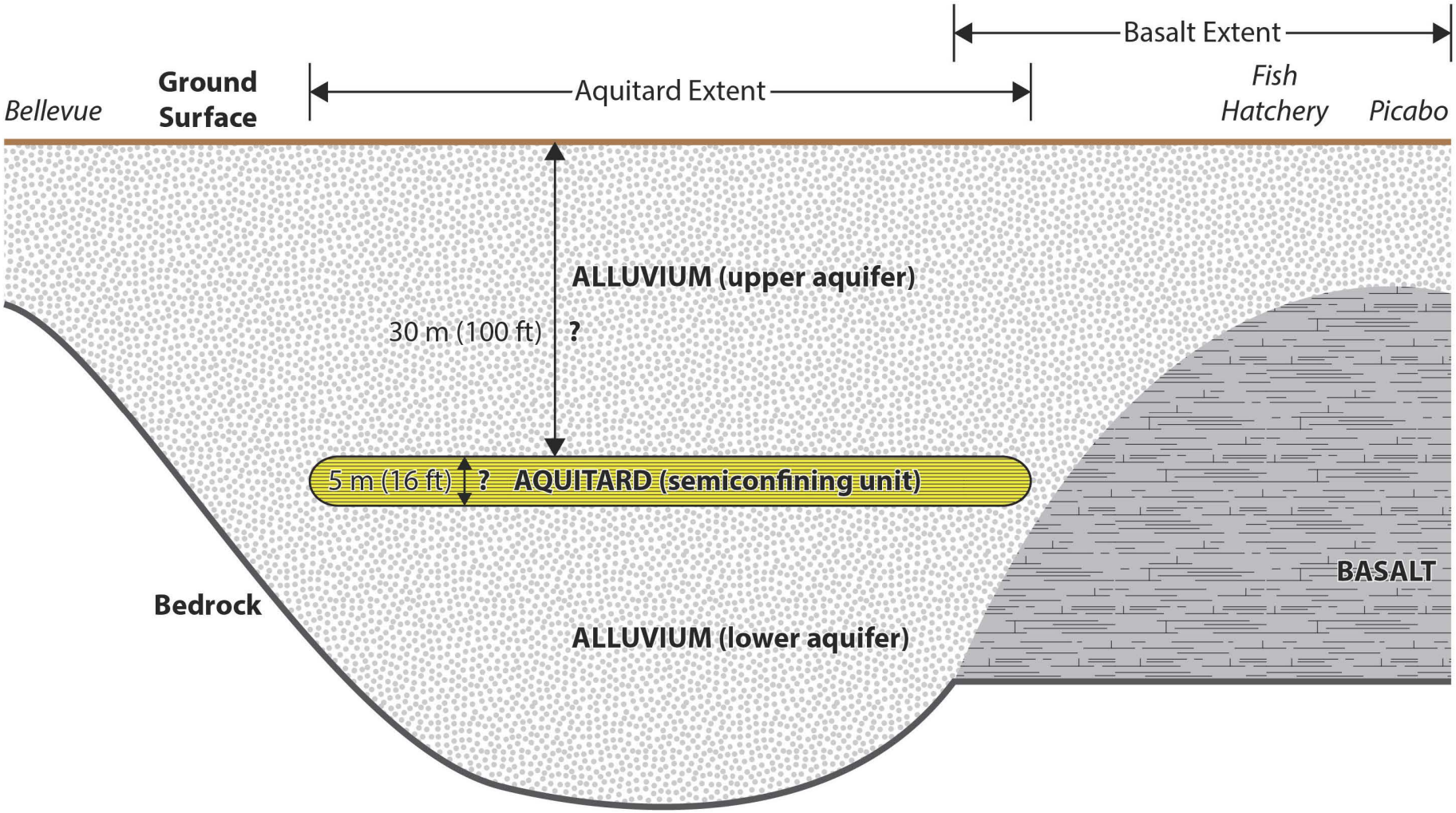
Base of alluvium aquifer raster:

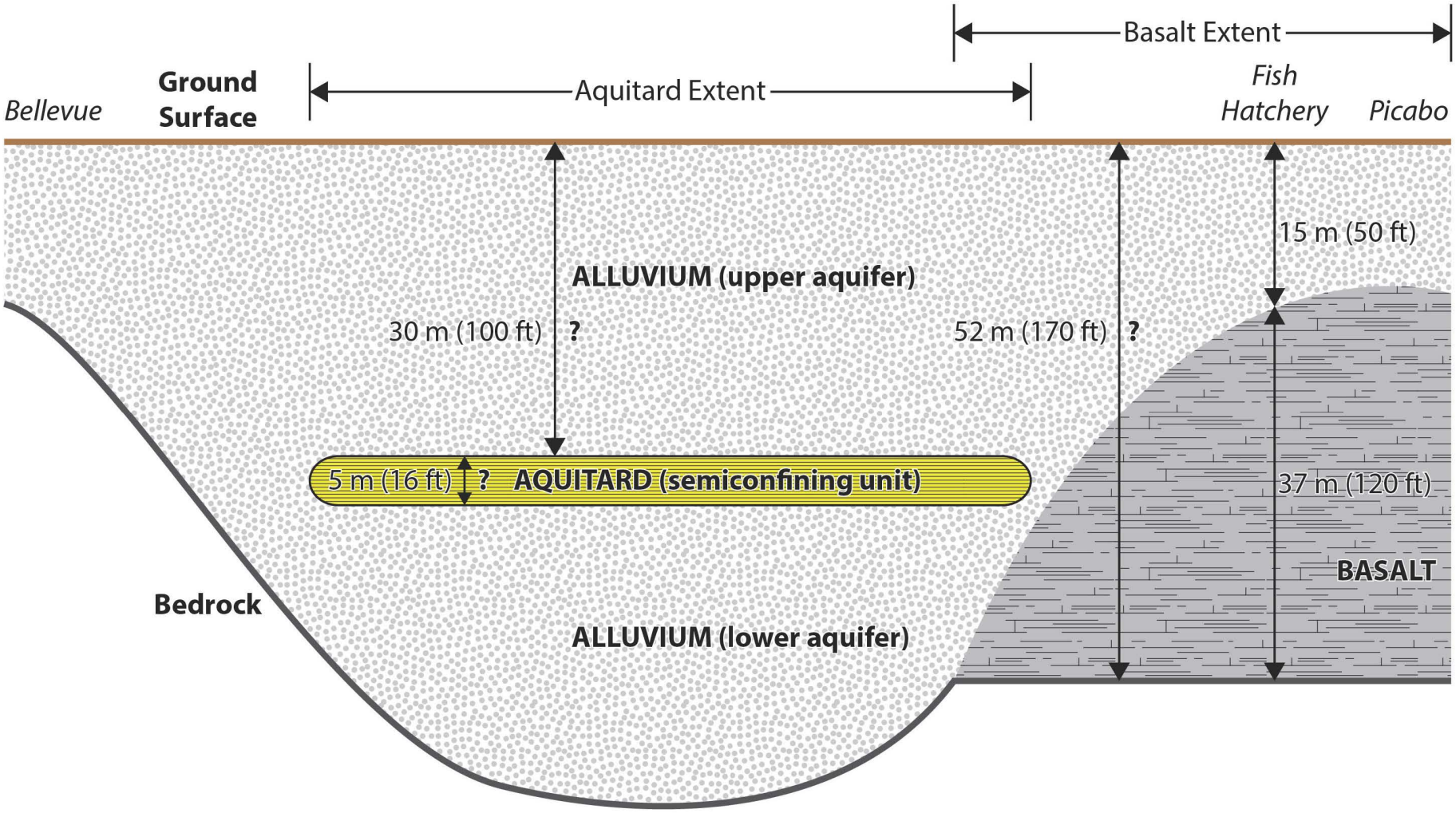
Model resolution: 100 meters

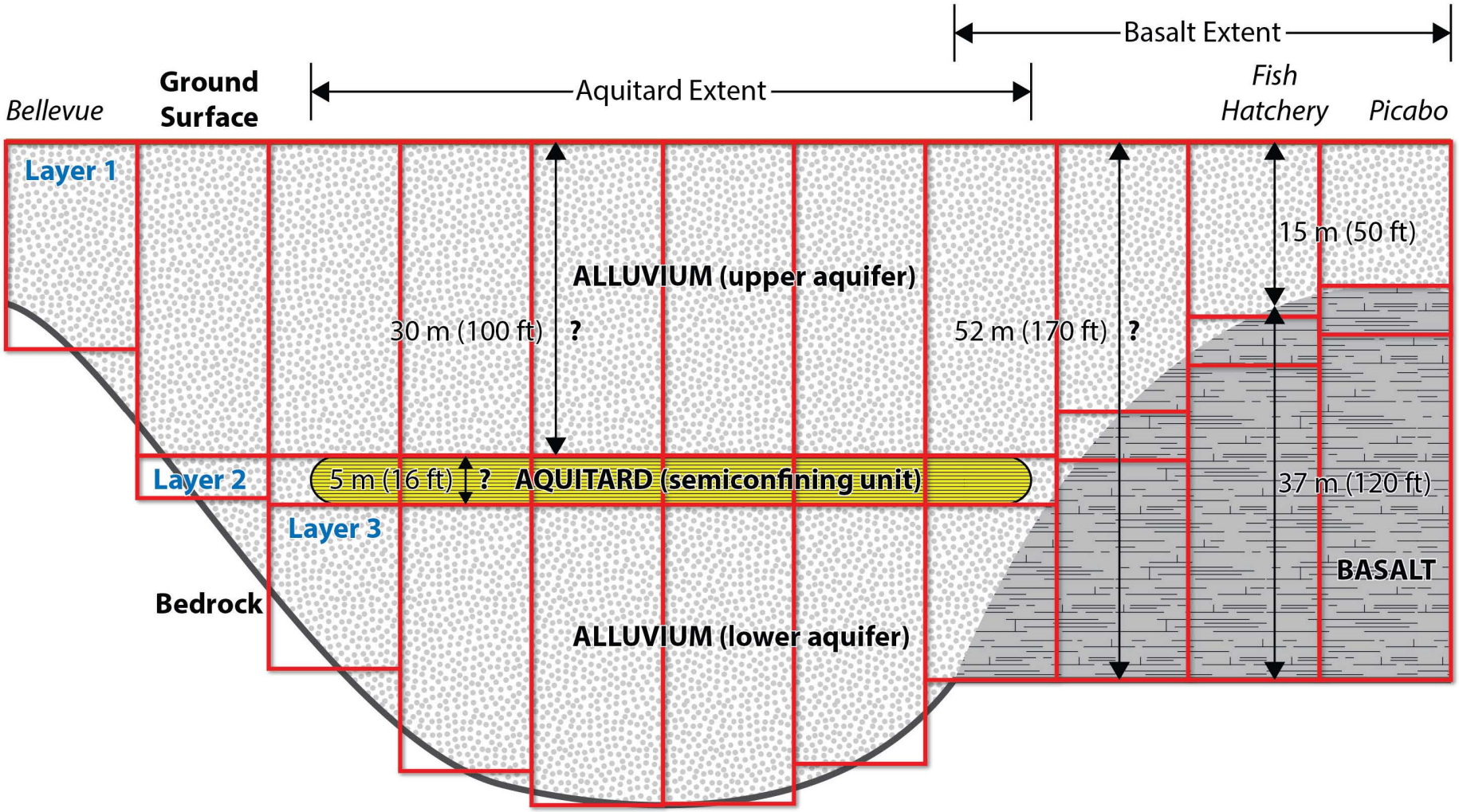
2,071 meters

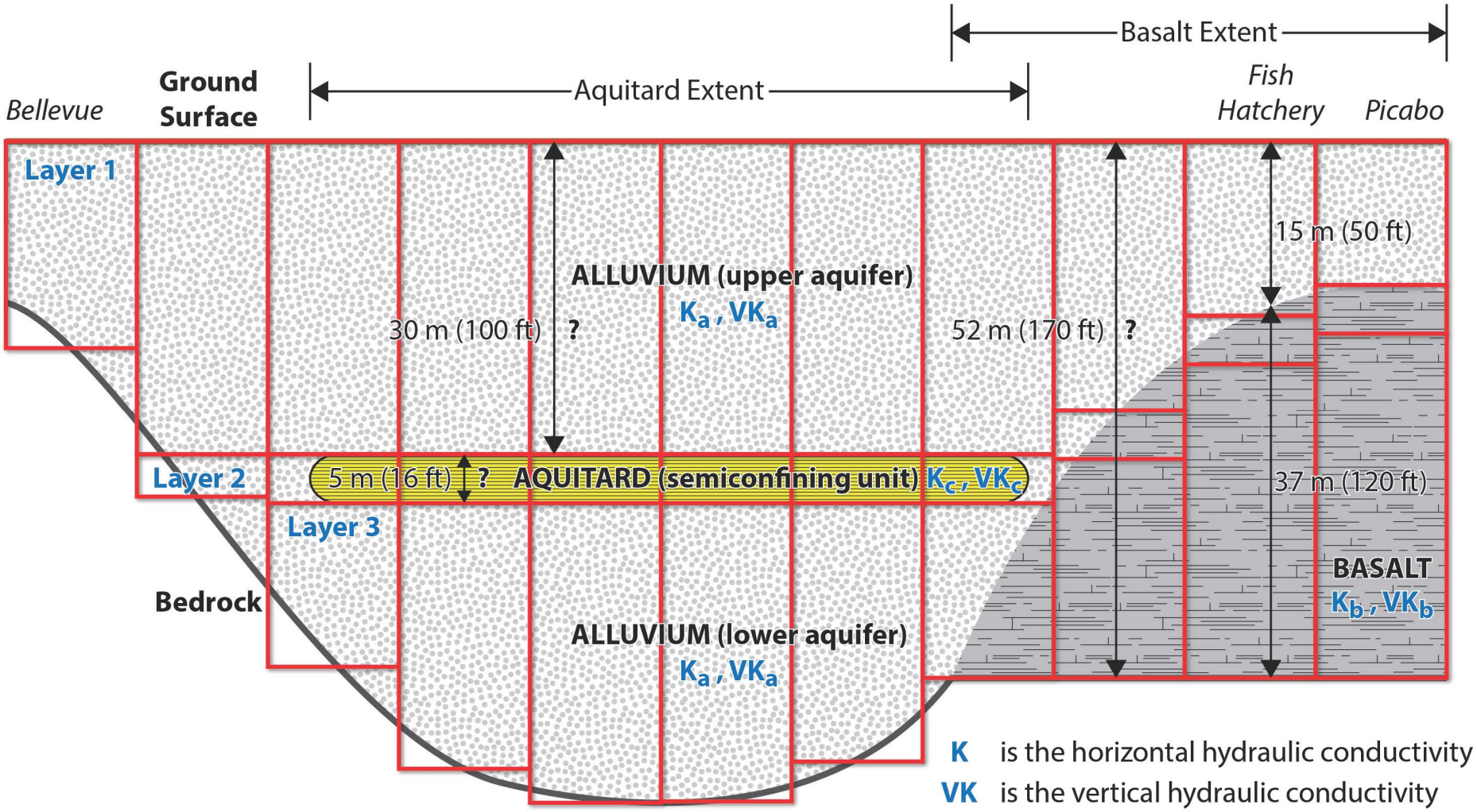
1,392 meters

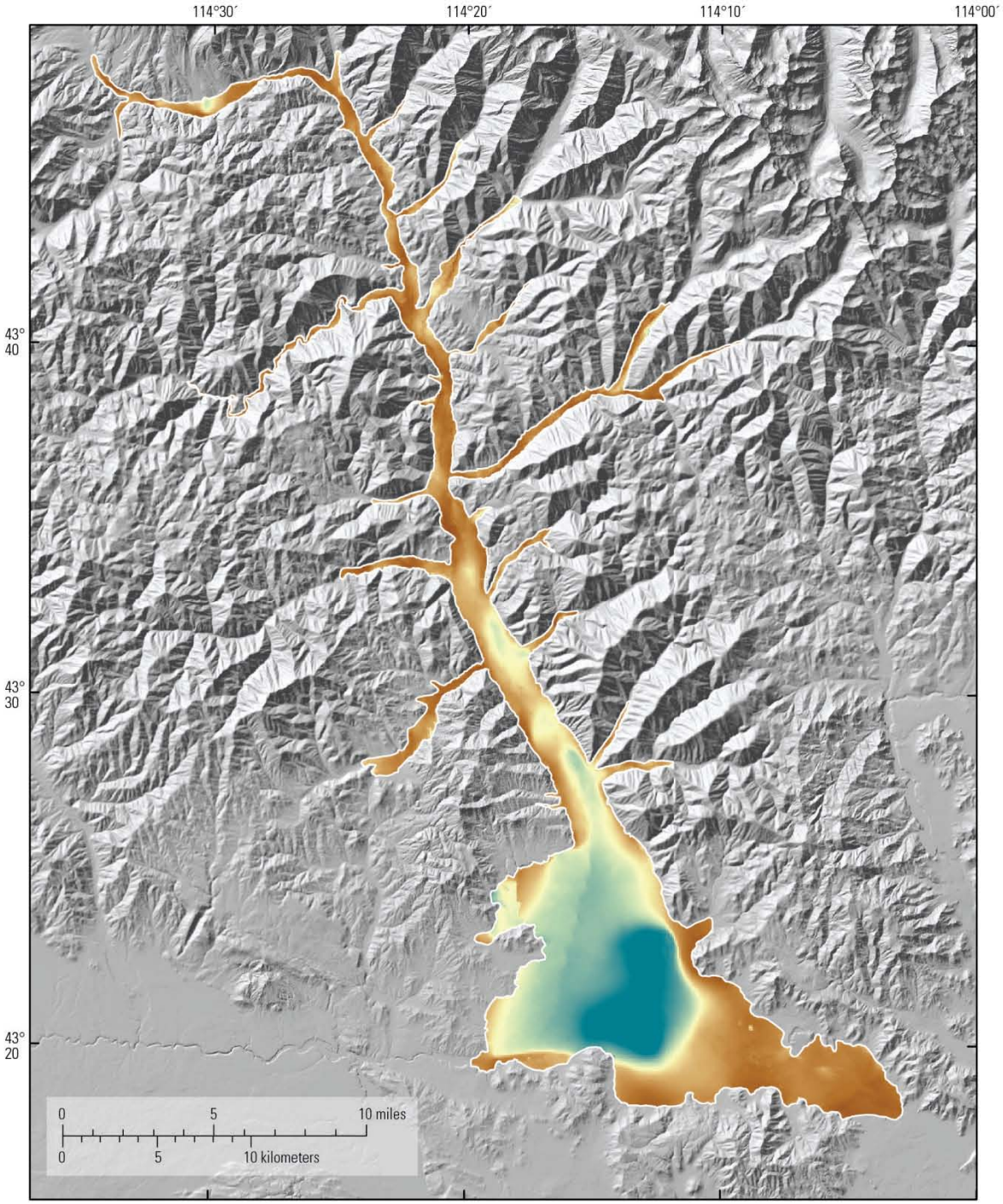

Basalt Extent
Ground Surface
Aquitard Extent
Bellevue
Fish Hatchery
Picabo
ALLUVIUM (upper aquifer)
AQUITARD (semiconfining unit)
BASALT
Bedrock
ALLUVIUM (lower aquifer)


Basalt Extent
Ground Surface
Aquitard Extent
Bellevue
Fish Hatchery
Picabo
ALLUVIUM (upper aquifer)
30 m (100 ft) ?
5 m (16 ft) ? AQUITARD (semiconfining unit)
BASALT
Bedrock
ALLUVIUM (lower aquifer)


Basalt Extent
Ground Surface
Aquitard Extent
Bellevue
Fish Hatchery
Picabo
15 m (50 ft)
ALLUVIUM (upper aquifer)
30 m (100 ft) ?
52 m (170 ft) ?
5 m (16 ft) ? AQUITARD (semiconfining unit)
37 m (120 ft)
BASALT
Bedrock
ALLUVIUM (lower aquifer)


Basalt Extent
Aquitard Extent
Bellevue
Ground Surface
Fish Hatchery
Picabo
Layer 1
ALLUVIUM (upper aquifer)
30 m (100 ft) ?
52 m (170 ft) ?
15 m (50 ft)
Layer 2
5 m (16 ft) ? AQUITARD (semiconfining unit)
37 m (120 ft)
Layer 3
BASALT
Bedrock
ALLUVIUM (lower aquifer)


Basalt Extent
Aquitard Extent
Bellevue
Ground Surface
Fish Hatchery
Picabo
Layer 1
Layer 2
Layer 3
Bedrock
ALLUVIUM (upper aquifer)
K_a , VK_a
30 m (100 ft) ?
52 m (170 ft) ?
15 m (50 ft)
5 m (16 ft) ? AQUITARD (semiconfining unit) K_c , VK_c
37 m (120 ft)
BASALT
K_b , VK_b
ALLUVIUM (lower aquifer)
K_a , VK_a
K is the horizontal hydraulic conductivity
VK is the vertical hydraulic conductivity



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

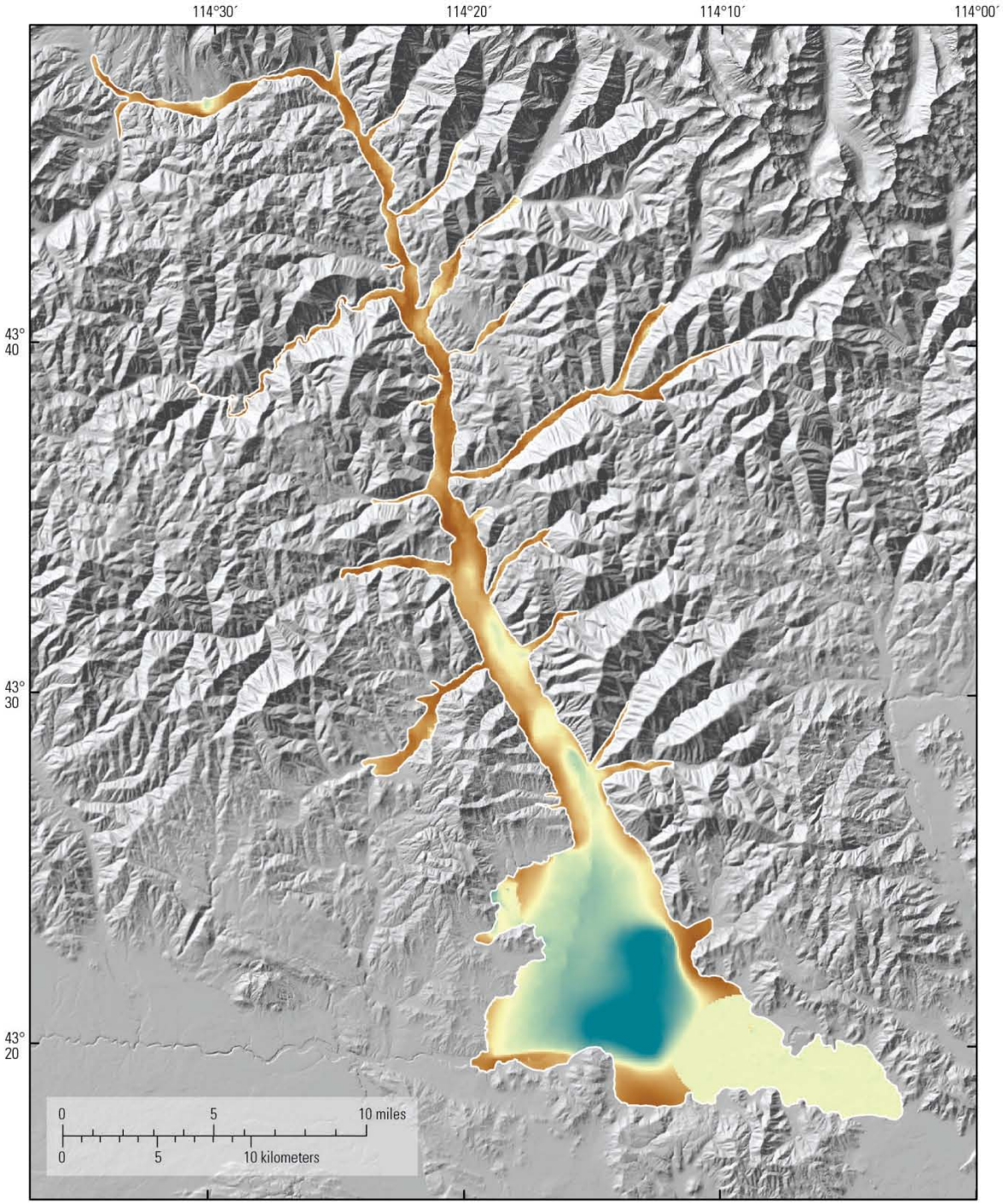
Aquifer extent (SIR 2012-5053)

Thickness of alluvium aquifer raster:

Model resolution: 100 meters

105 meters

0 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

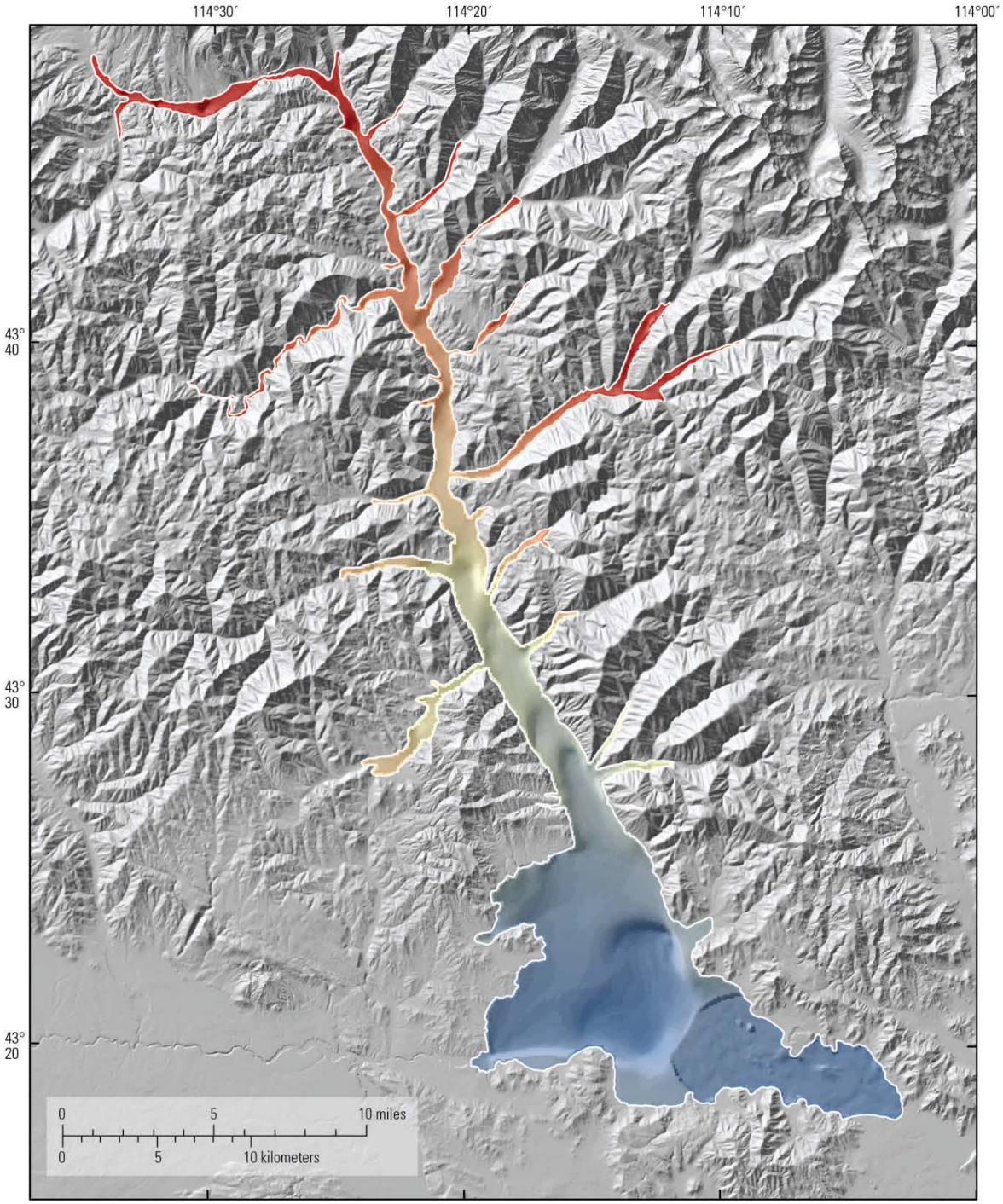
Aquifer extent (SIR 2012-5053)

Thickness of modeled aquifer raster:

Model resolution: 100 meters

105 meters

0 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

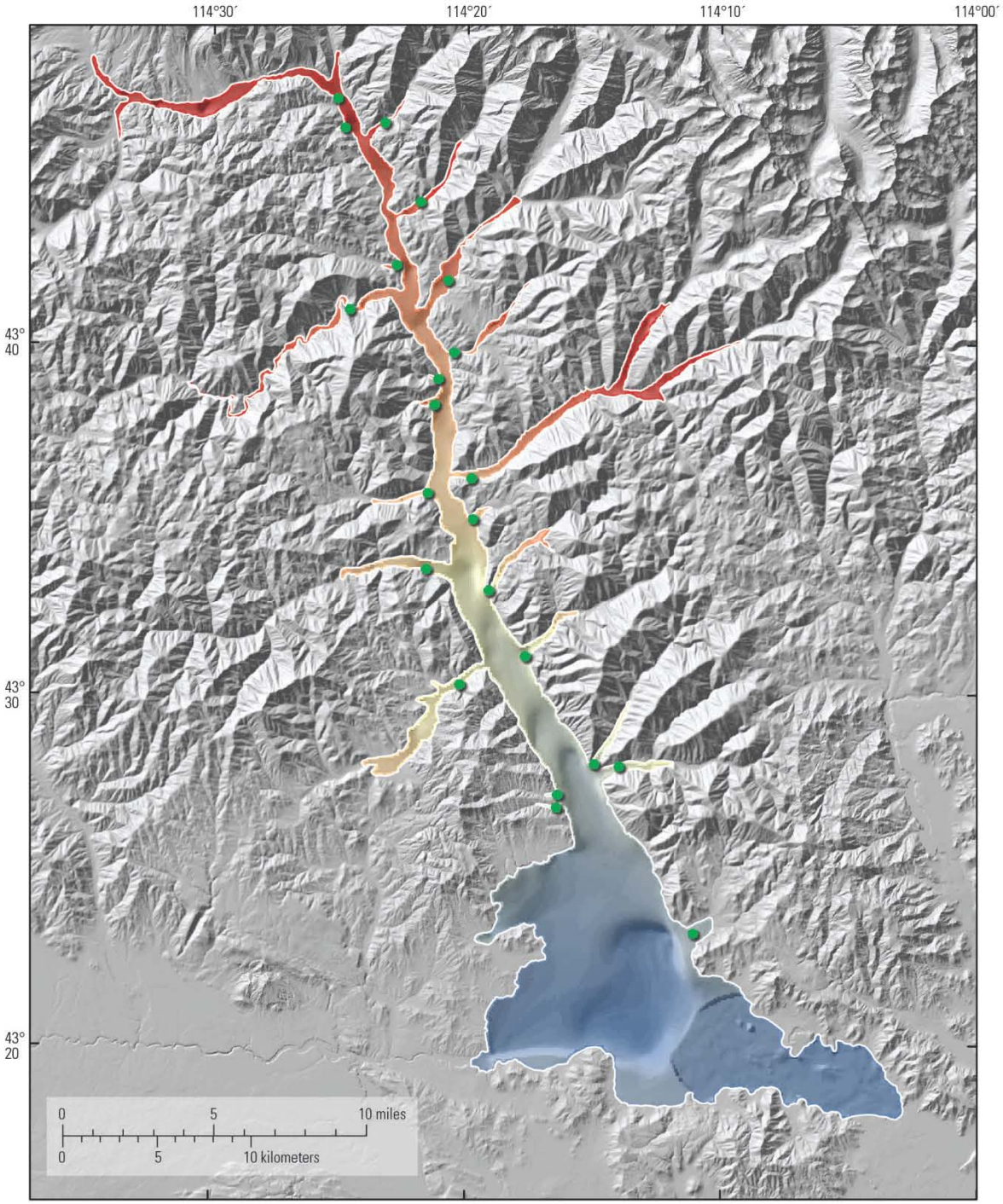
Aquifer extent (SIR 2012-5053)

Base of modeled aquifer raster:

Model resolution: 100 meters

2,071 meters

1,392 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

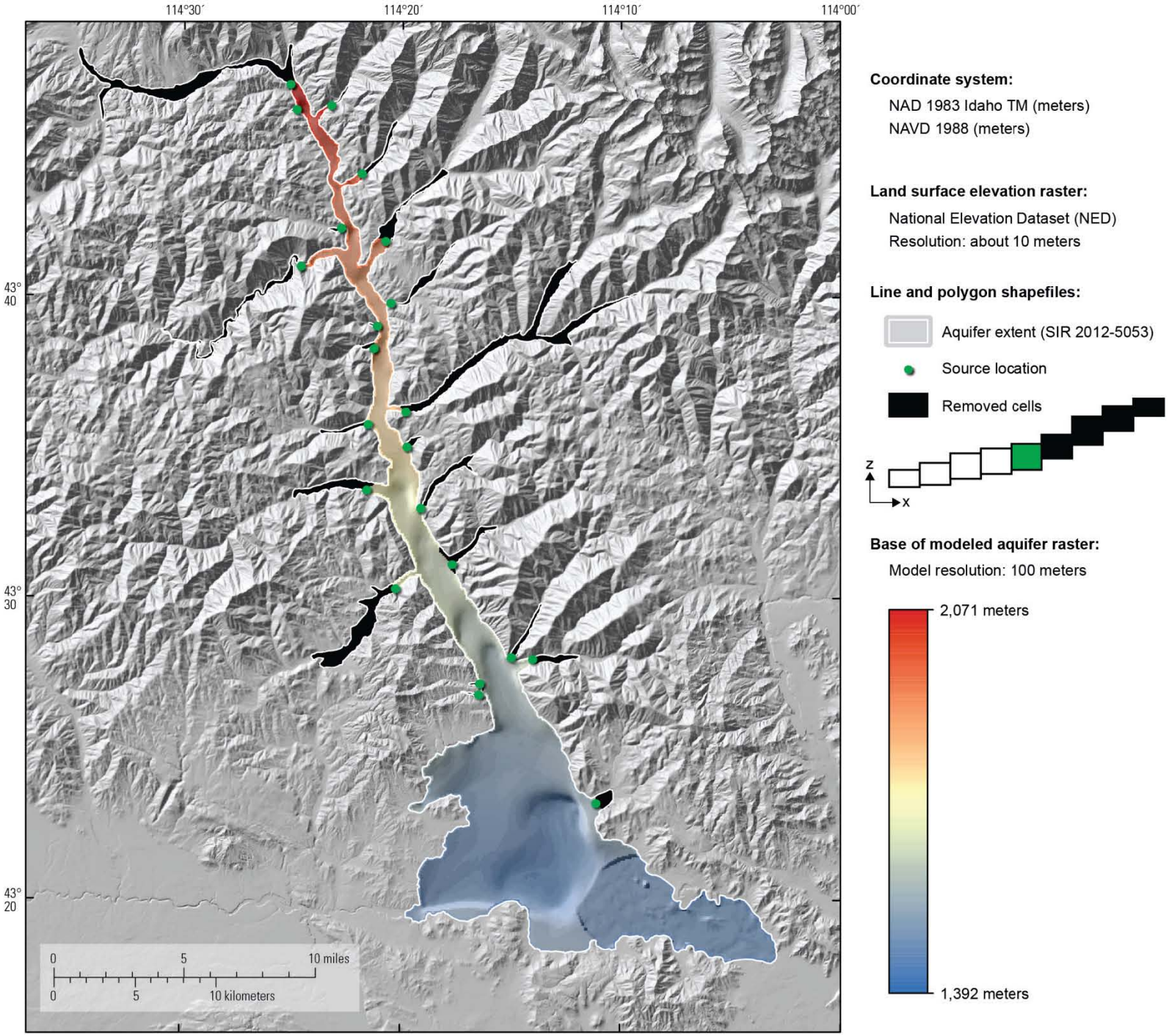
Source location

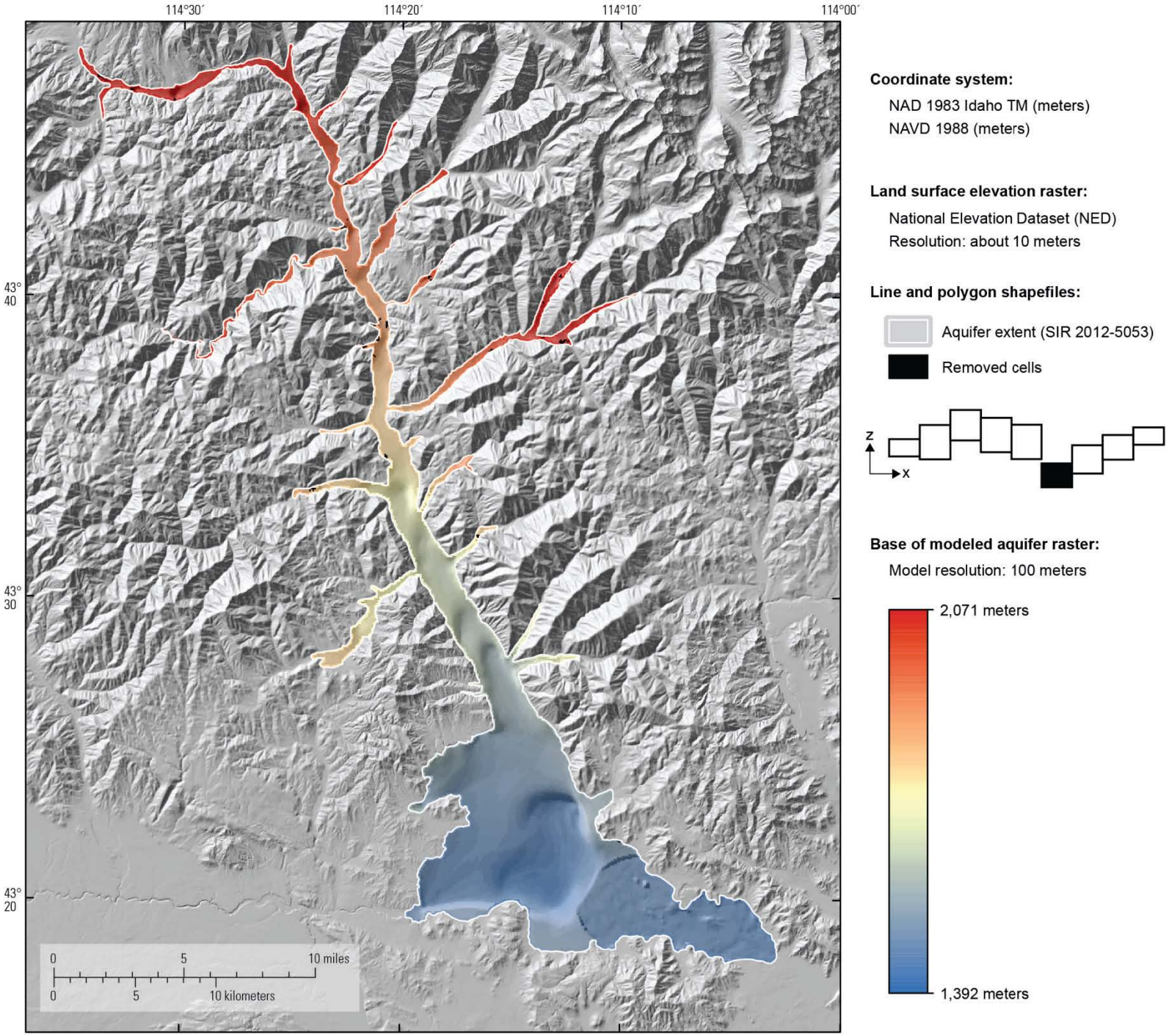
Base of modeled aquifer raster:

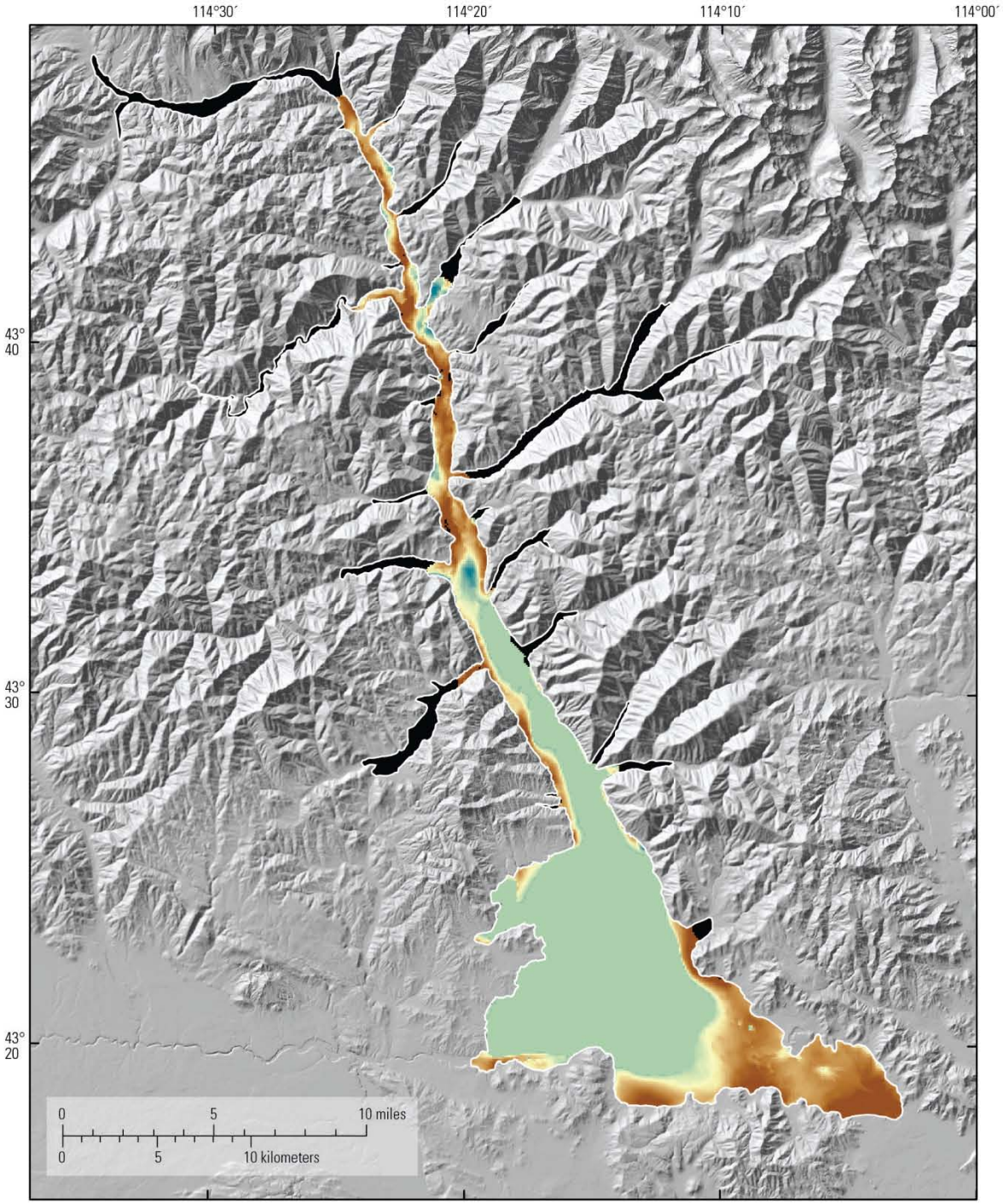
Model resolution: 100 meters

2,071 meters

1,392 meters


114°30′
114°20′
114°10′
114°00′
43° 40
43° 30
43° 20
0
5
10 miles
0
5
10 kilometers
Coordinate system:
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)
Land surface elevation raster:
National Elevation Dataset (NED)
Resolution: about 10 meters
Line and polygon shapefiles:
Aquifer extent (SIR 2012-5053)
Source location
Removed cells
z
x
Base of modeled aquifer raster:
Model resolution: 100 meters
2,071 meters
1,392 meters


114°30′
114°20′
114°10′
114°00′
43° 40
43° 30
43° 20
0
5
10 miles
0
5
10 kilometers
Coordinate system:
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)
Land surface elevation raster:
National Elevation Dataset (NED)
Resolution: about 10 meters
Line and polygon shapefiles:
Aquifer extent (SIR 2012-5053)
Removed cells
z
x
Base of modeled aquifer raster:
Model resolution: 100 meters
2,071 meters
1,392 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

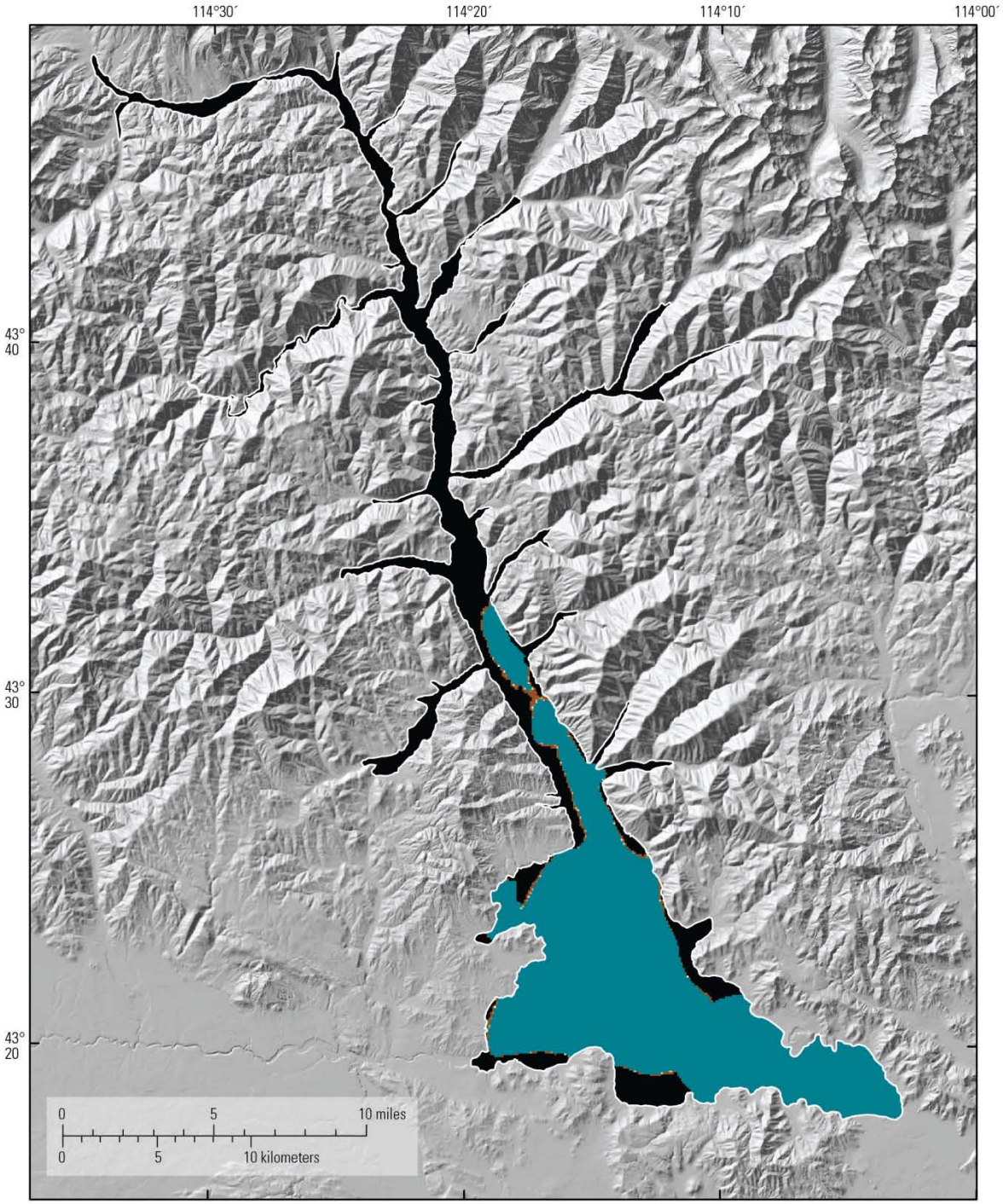
No flow

Thickness of model layer 1 raster:

Model resolution: 100 meters

62 meters

2 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

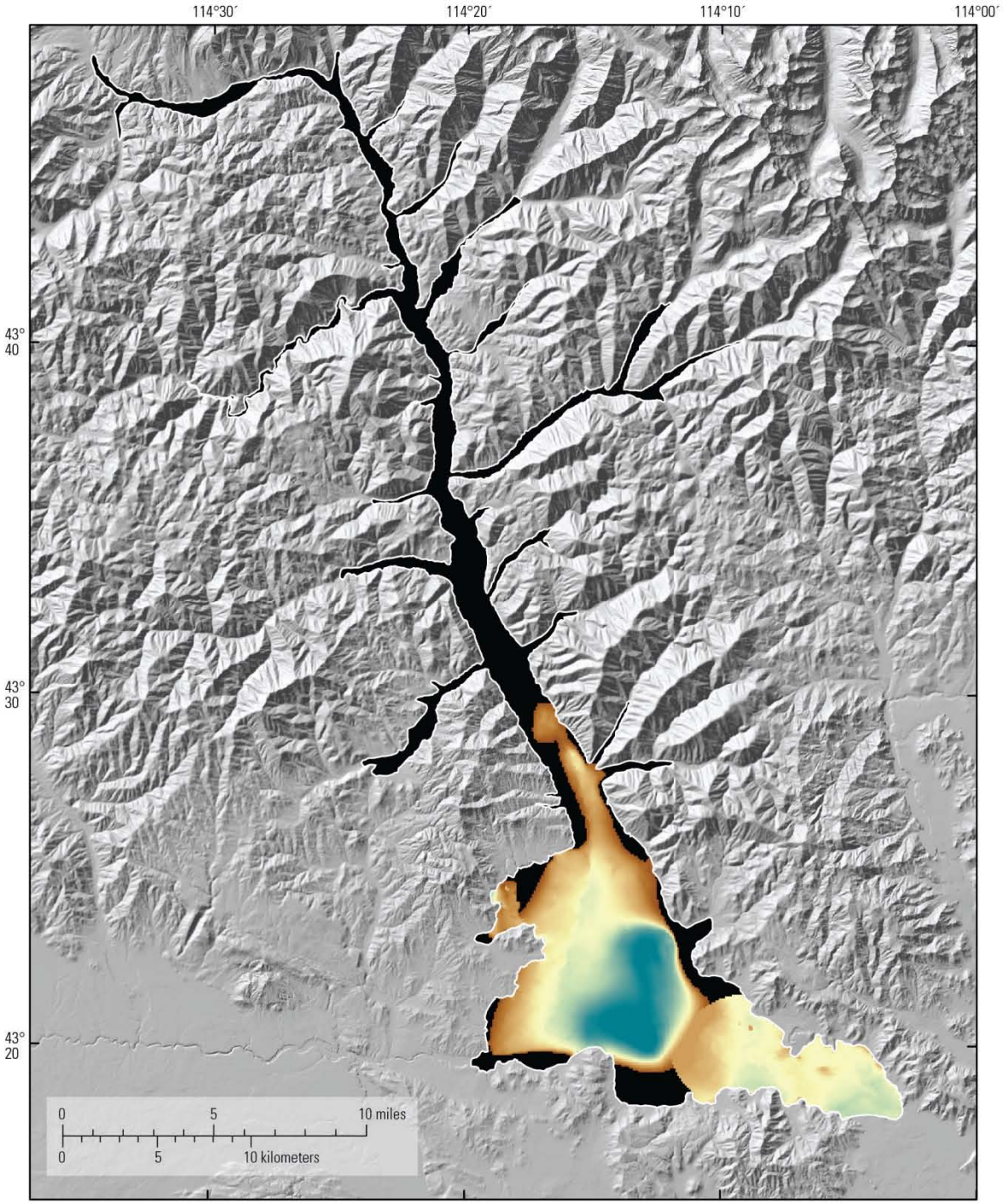
No flow

Thickness of model layer 2 raster:

Model resolution: 100 meters

5 meters

2 meters



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

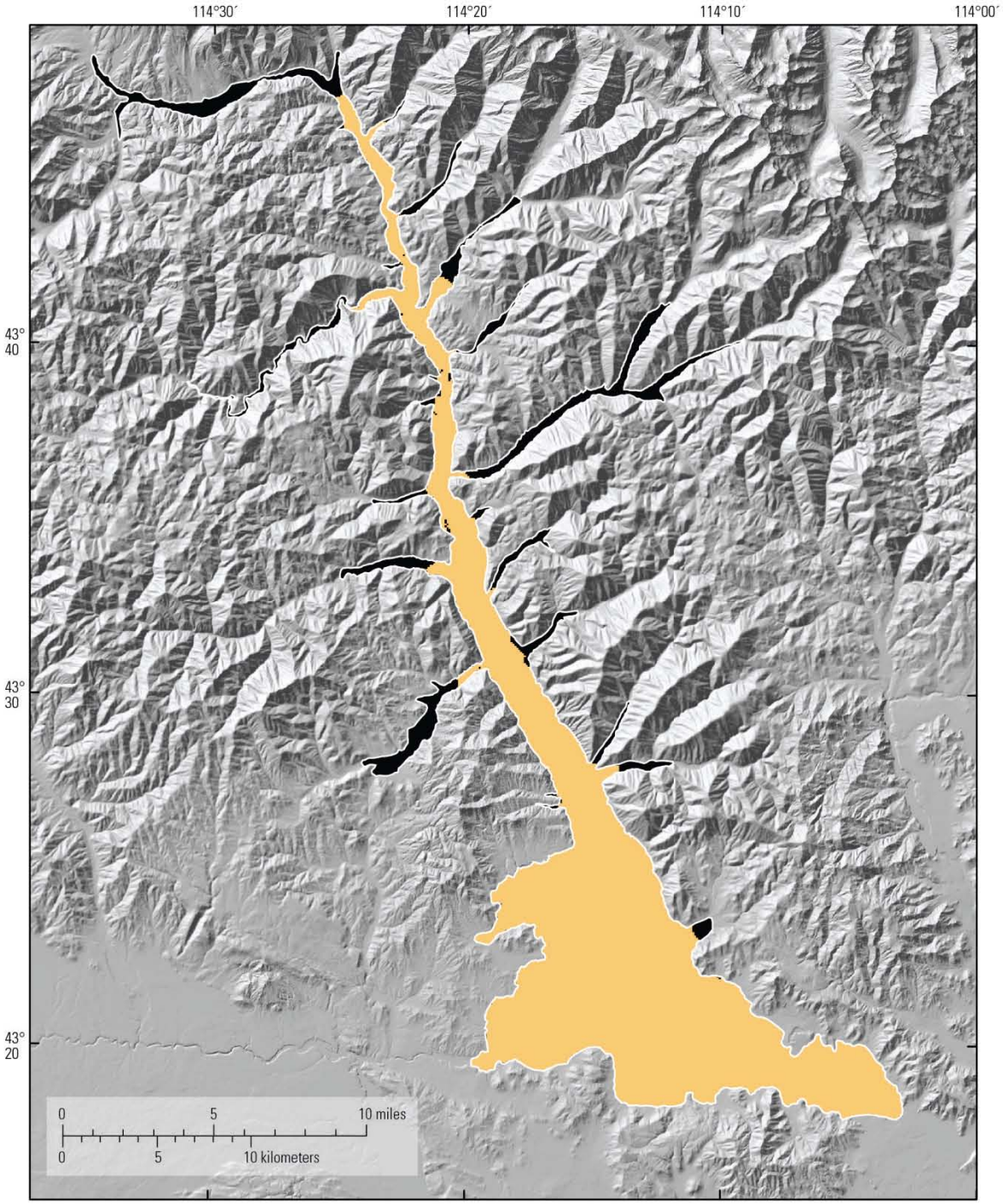
No flow

Thickness of model layer 3 raster:

Model resolution: 100 meters

76 meters

7 meters



Coordinate system:

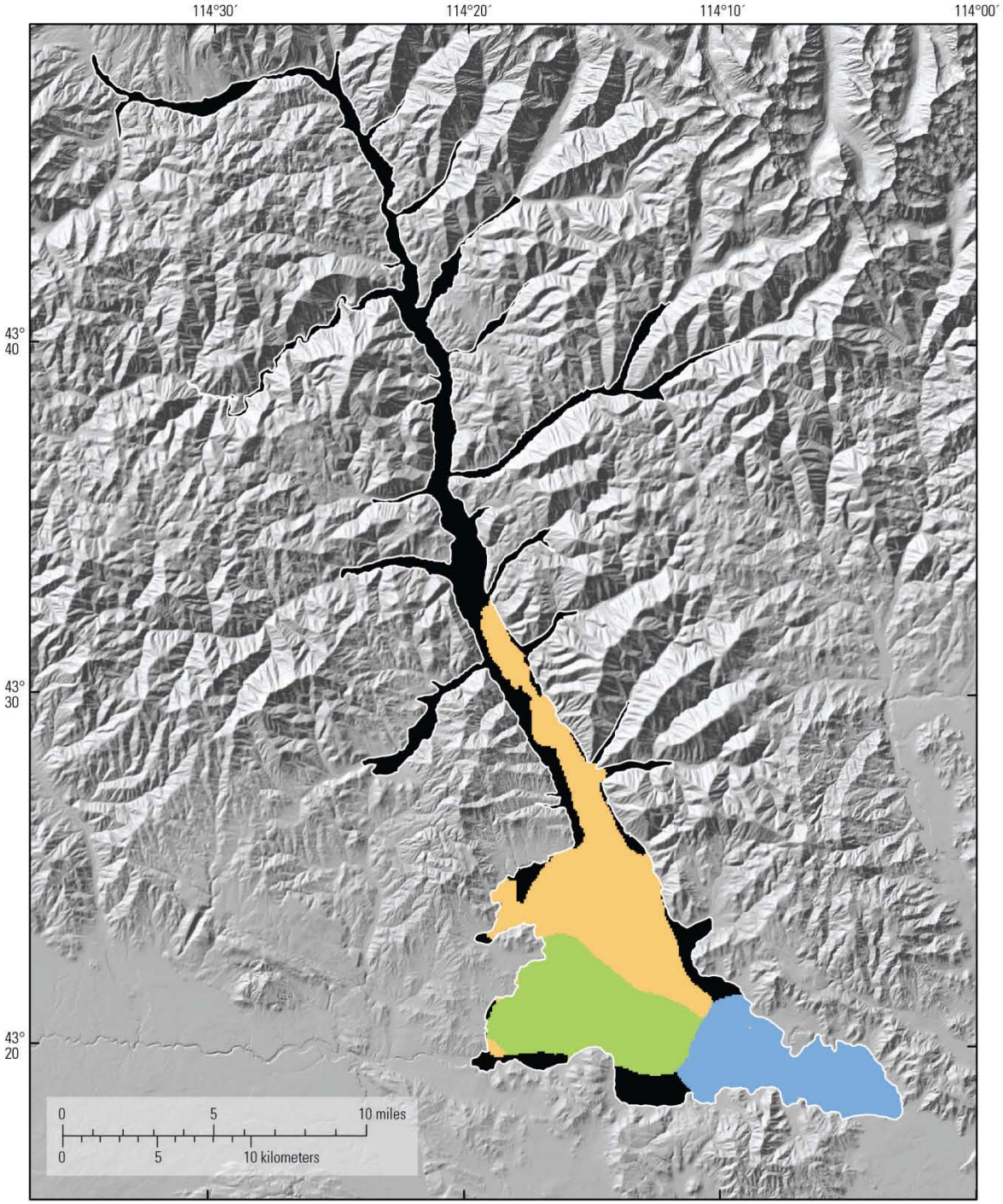
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)
No flow
Alluvium (Model layer 1)



Coordinate system:

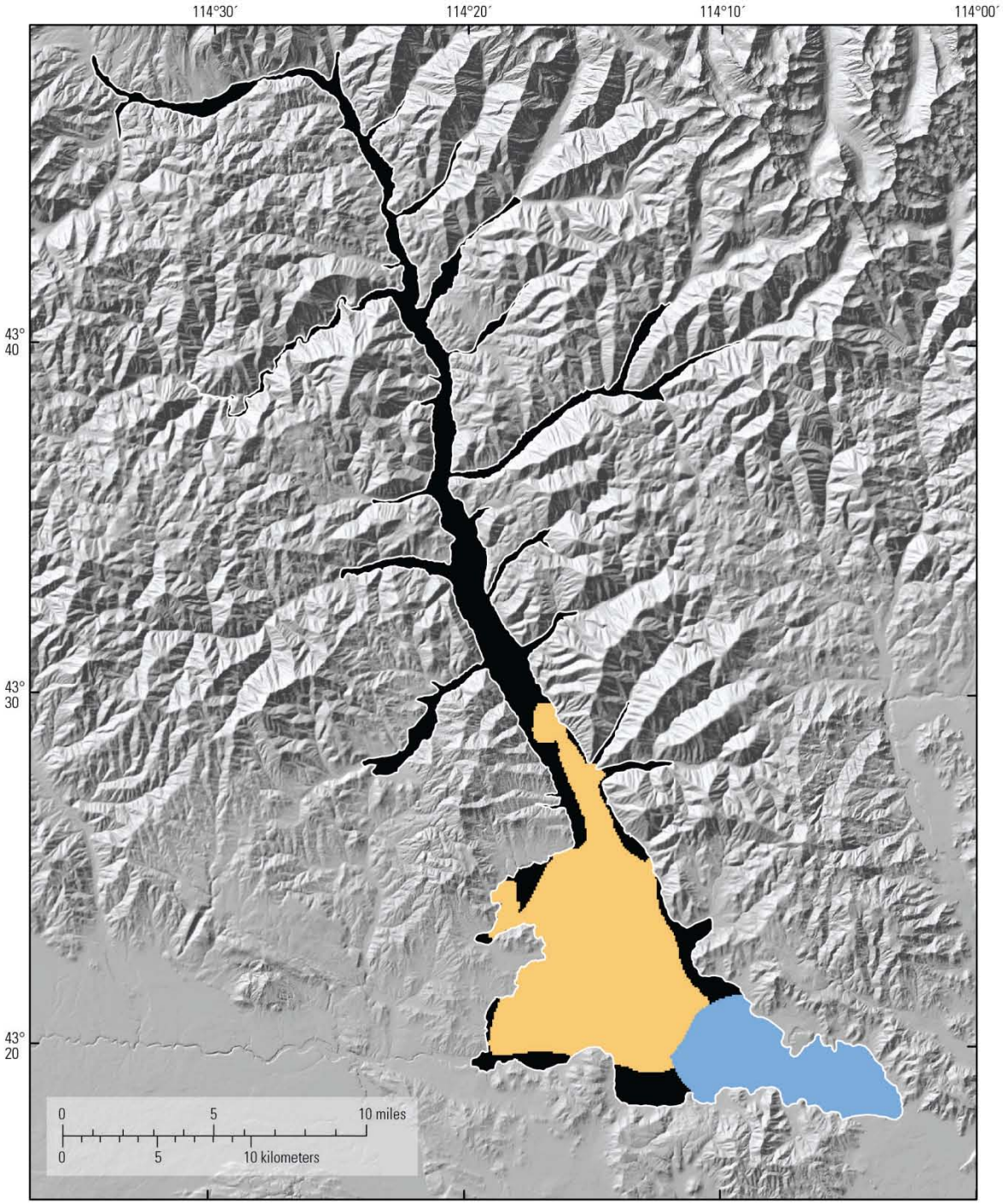
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

- Aquifer extent (SIR 2012-5053)
- No flow
- Alluvium (Model layer 2)
- Basalt (Model layer 2)
- Clay (Model layer 2)



Coordinate system:

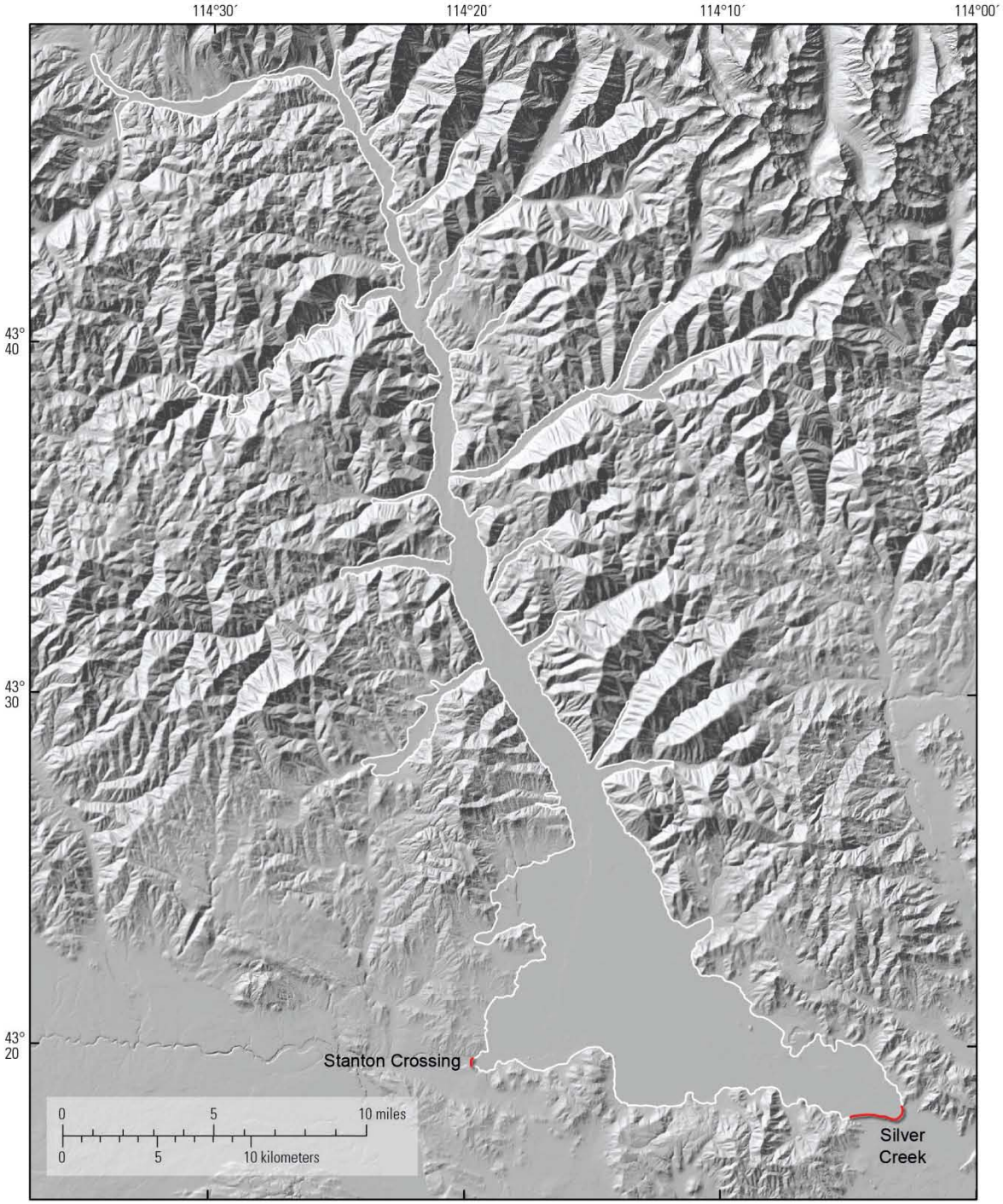
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

- Aquifer extent (SIR 2012-5053)
- No flow
- Alluvium (Model layer 3)
- Basalt (Model layer 3)



Coordinate system:

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NAVD 1988 (meters)

Land surface elevation raster:

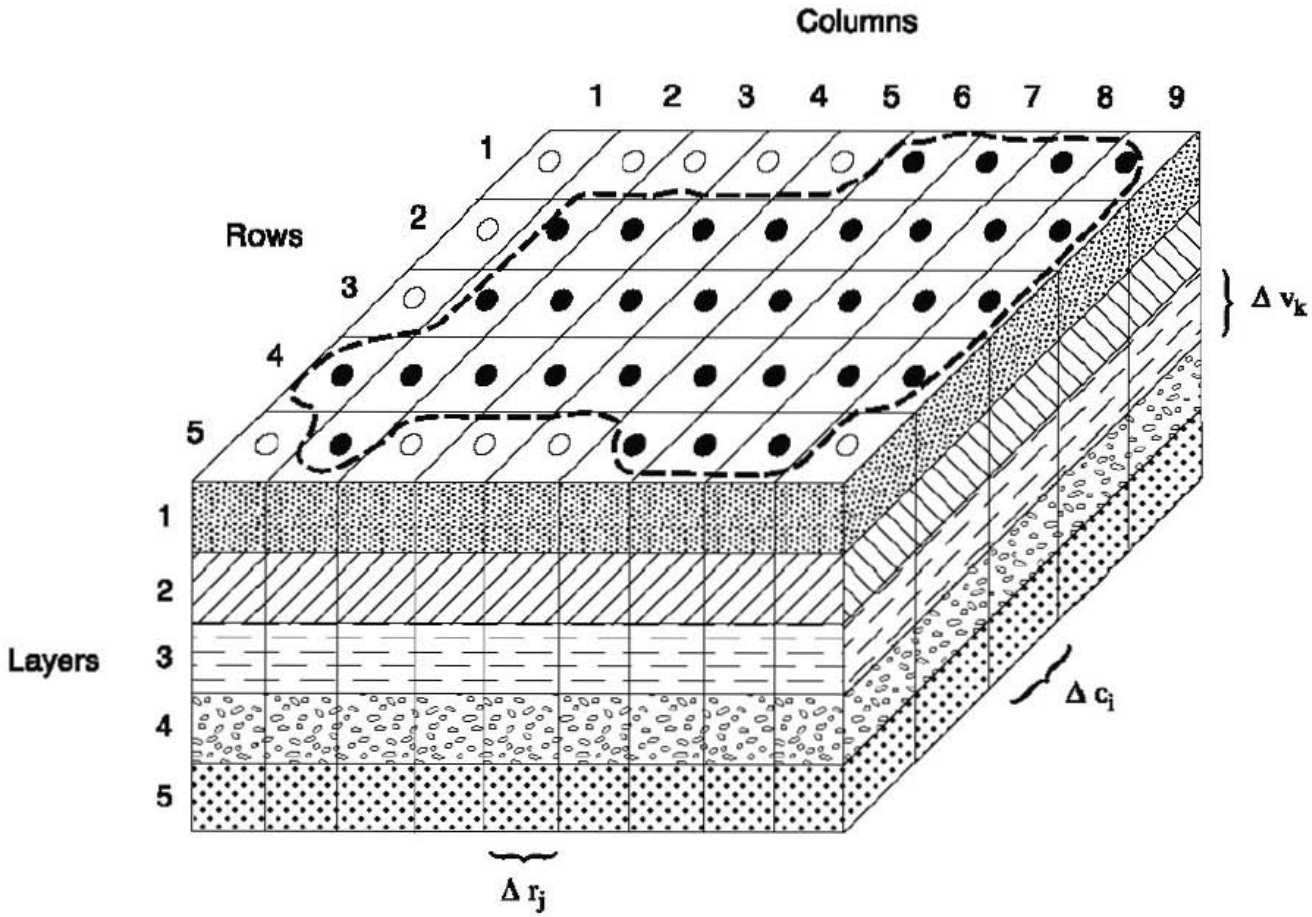
National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

Groundwater outflow

MODFLOW-2005, The U.S. Geological Survey Modular Ground-Water Model—the Ground-Water Flow Process



USGS
science for a changing world

Groundwater Resources Program

Prepared in collaboration with AMEC

MODFLOW–USG Version 1: An Unstructured Grid Version of MODFLOW for Simulating Groundwater Flow and Tightly Coupled Processes Using a Control Volume Finite-Difference Formulation

Chapter 45 of
Section A, Groundwater
Book 6, Modeling Techniques

MODFLOW-2005

Groundwater flow process:

- **Basic**
- **Discretization**
- **Zone**

Groundwater flow packages:

- **Layer-Property Flow** → **Block-Centered Flow**

Boundary condition packages:

- General-Head Boundary
- Streamflow-Routing
- Time-Variant Head
- Evapotranspiration
- Well
- Drain

Solvers:

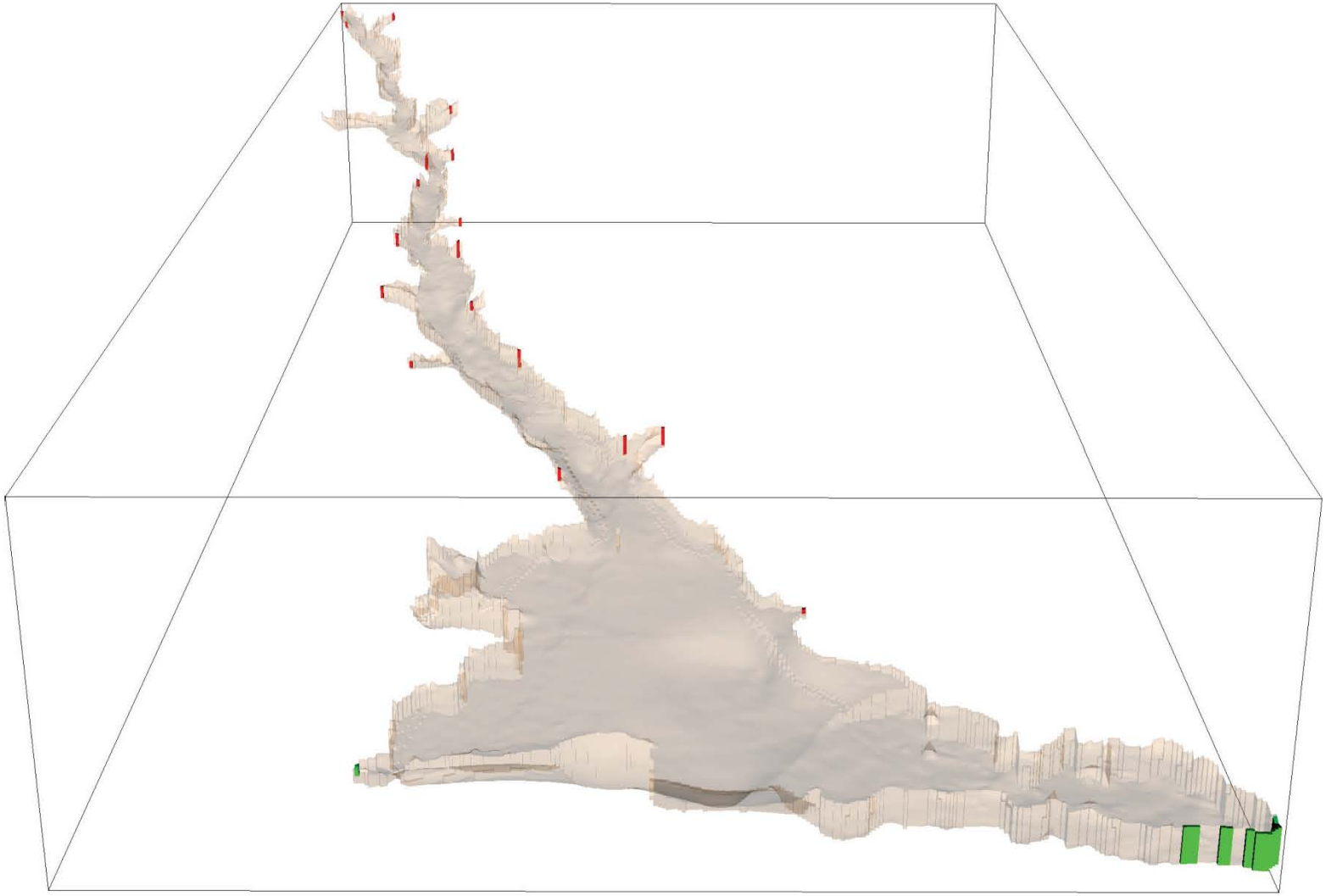
- PCG Method

Output control:

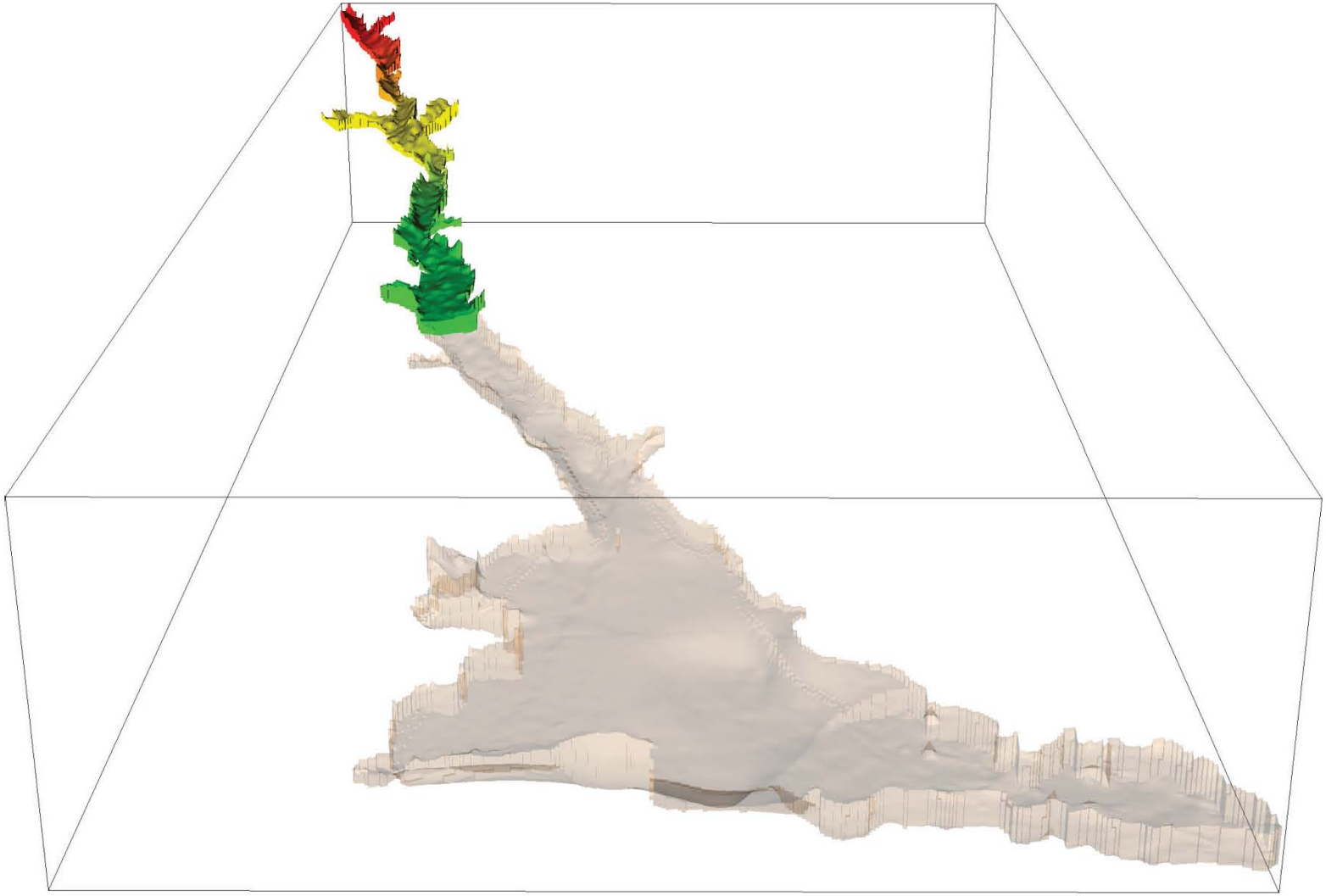
- Output Control Option

MODFLOW-2005 Run

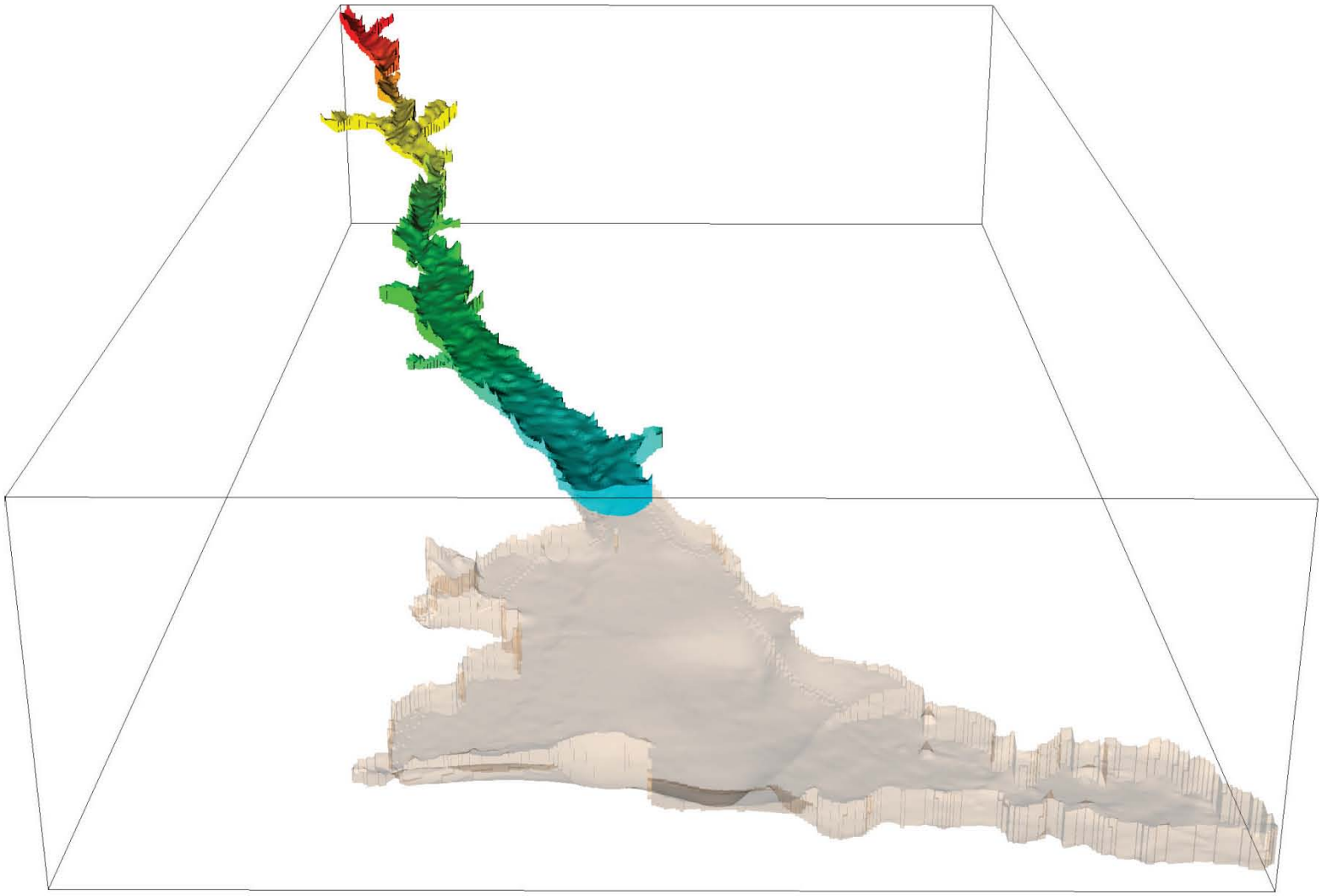
- Steady-state simulation
- Model layer 1 is convertible, layers 2 and 3 are confined
- Initial hydraulic heads at 95% saturation in layer 1
- Horizontal conductivity (*provisional values*):
  - $K_{alluvium}$ = 30.48 m/d
  - K_{basalt} = 86.40 m/d
  - $K_{clay} = 8.64 \times 10^{-7}$ m/d
- Vertical conductivity: VK = K / 1000
- Conductance for head-dependent cells: $C = (K \Delta x \Delta z) / (\Delta x)$
- Boundary heads for head-dependent cells is specified using initial conditions

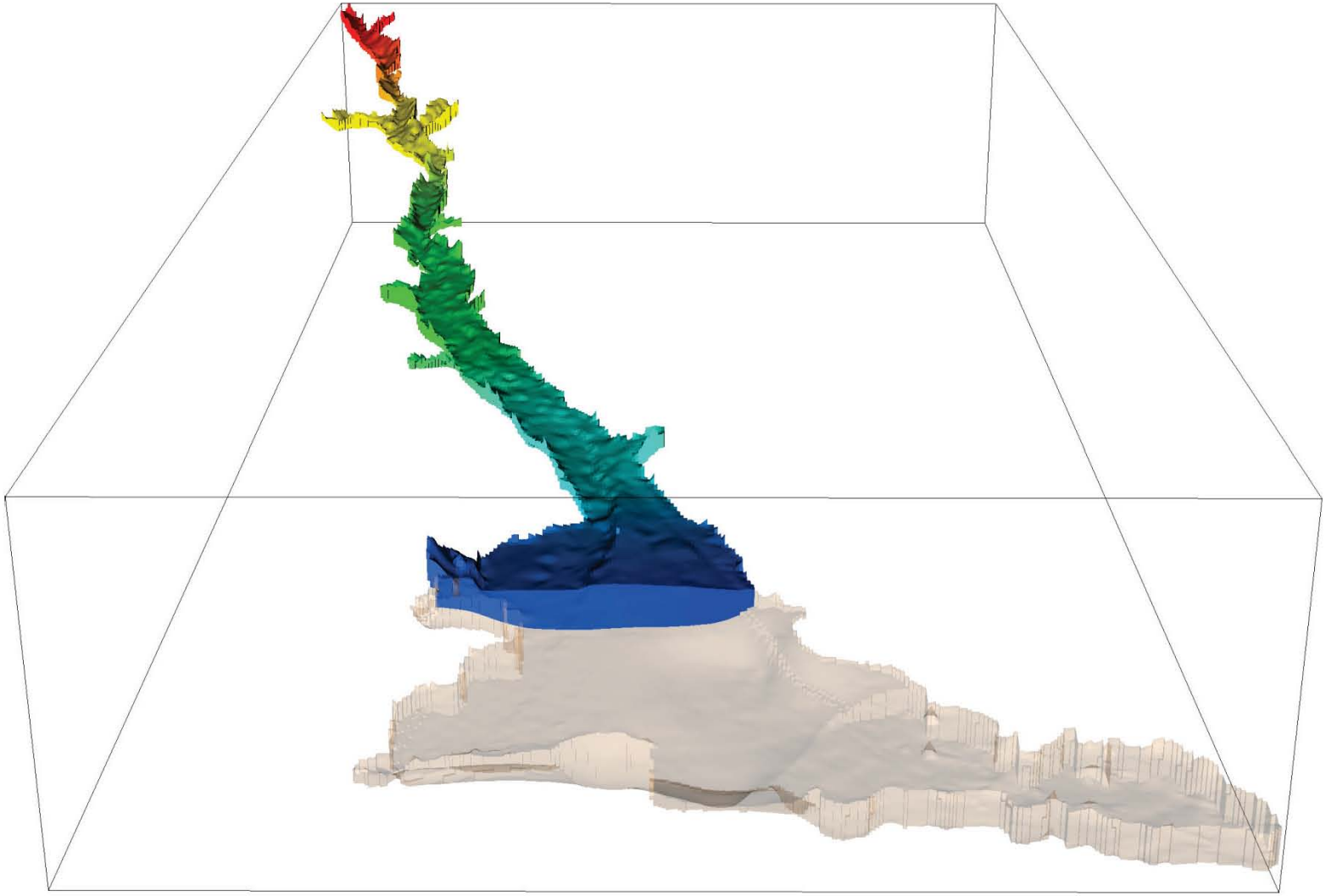


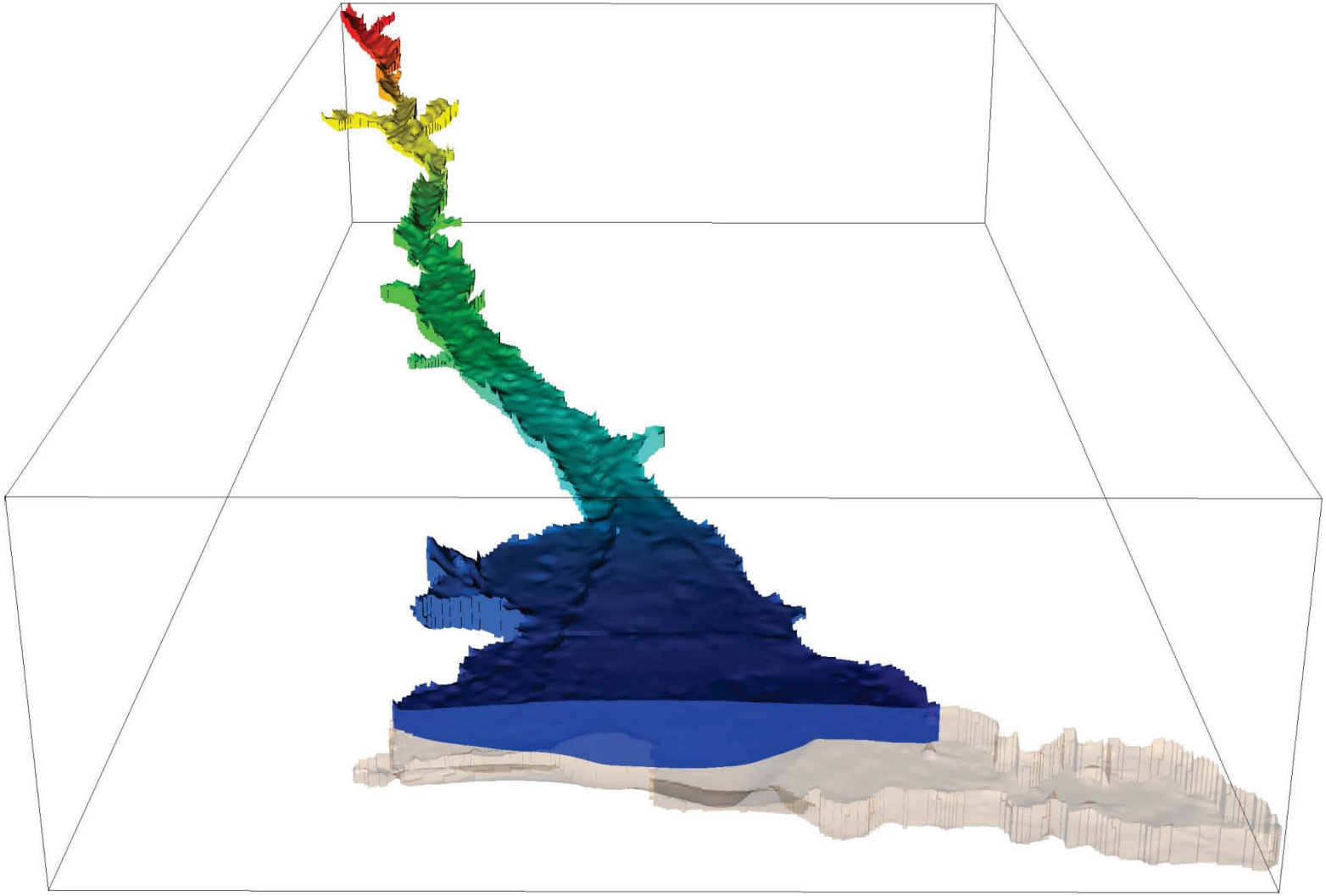
Vertical exaggeration is 20×

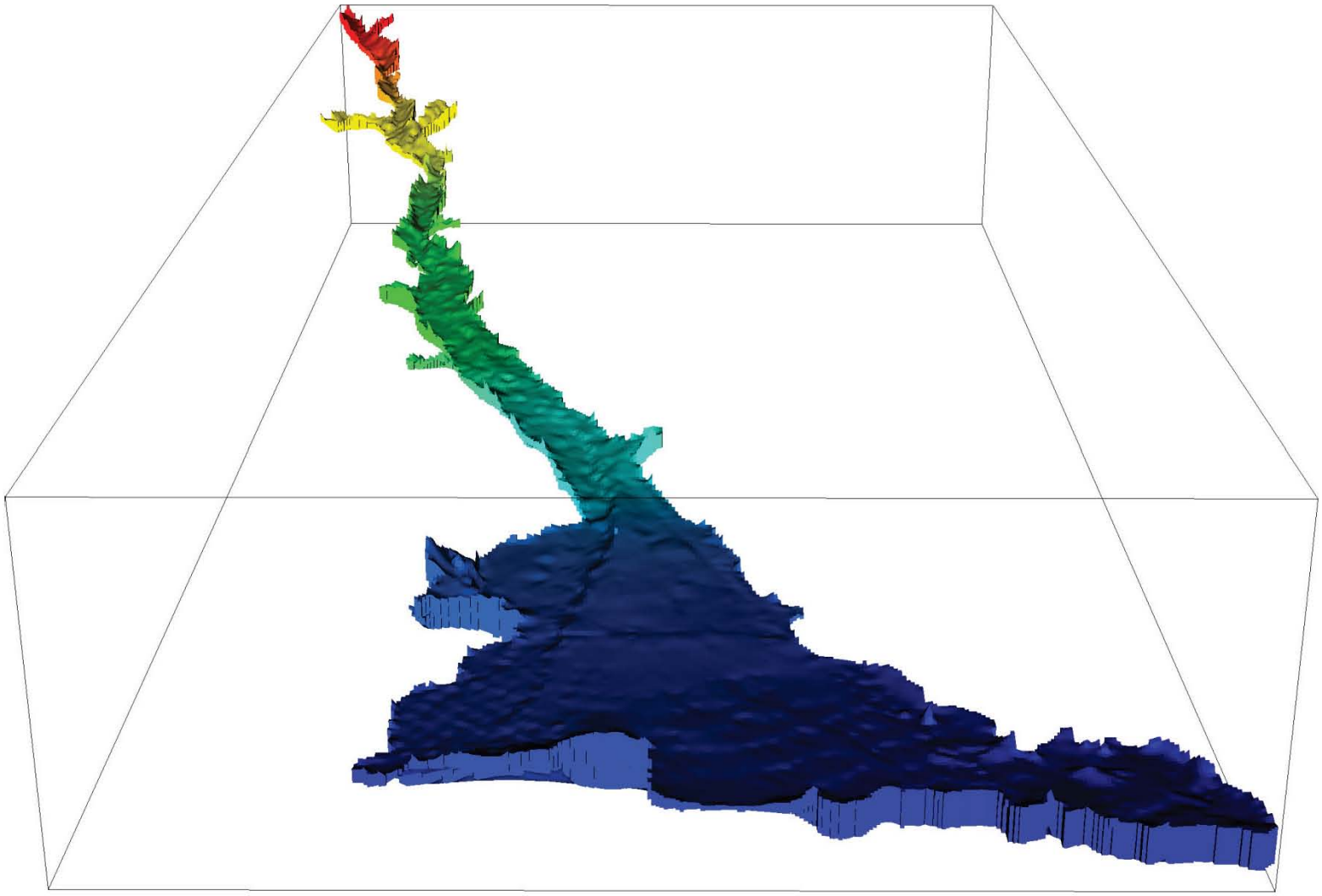


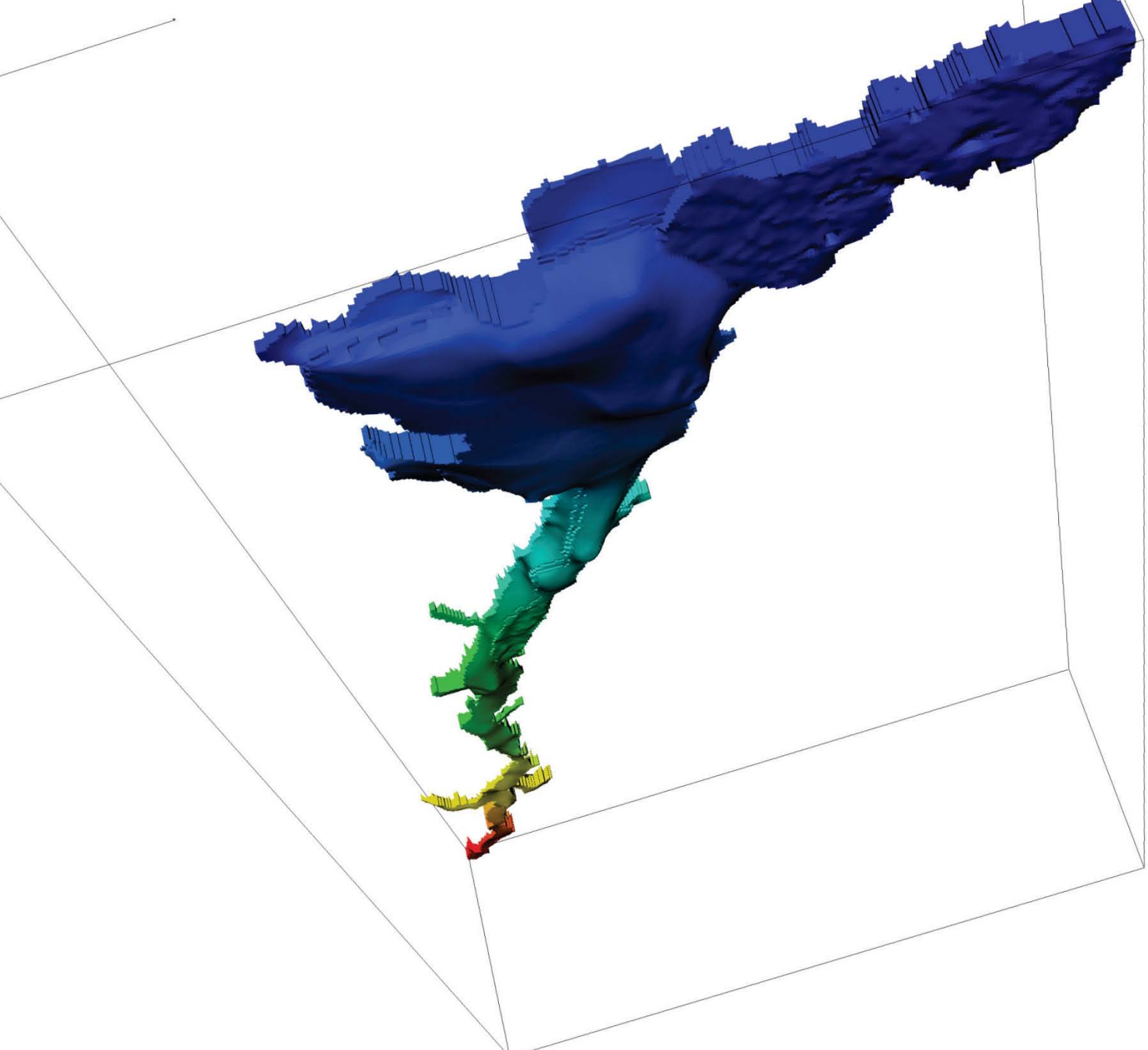
Simulated hydraulic heads

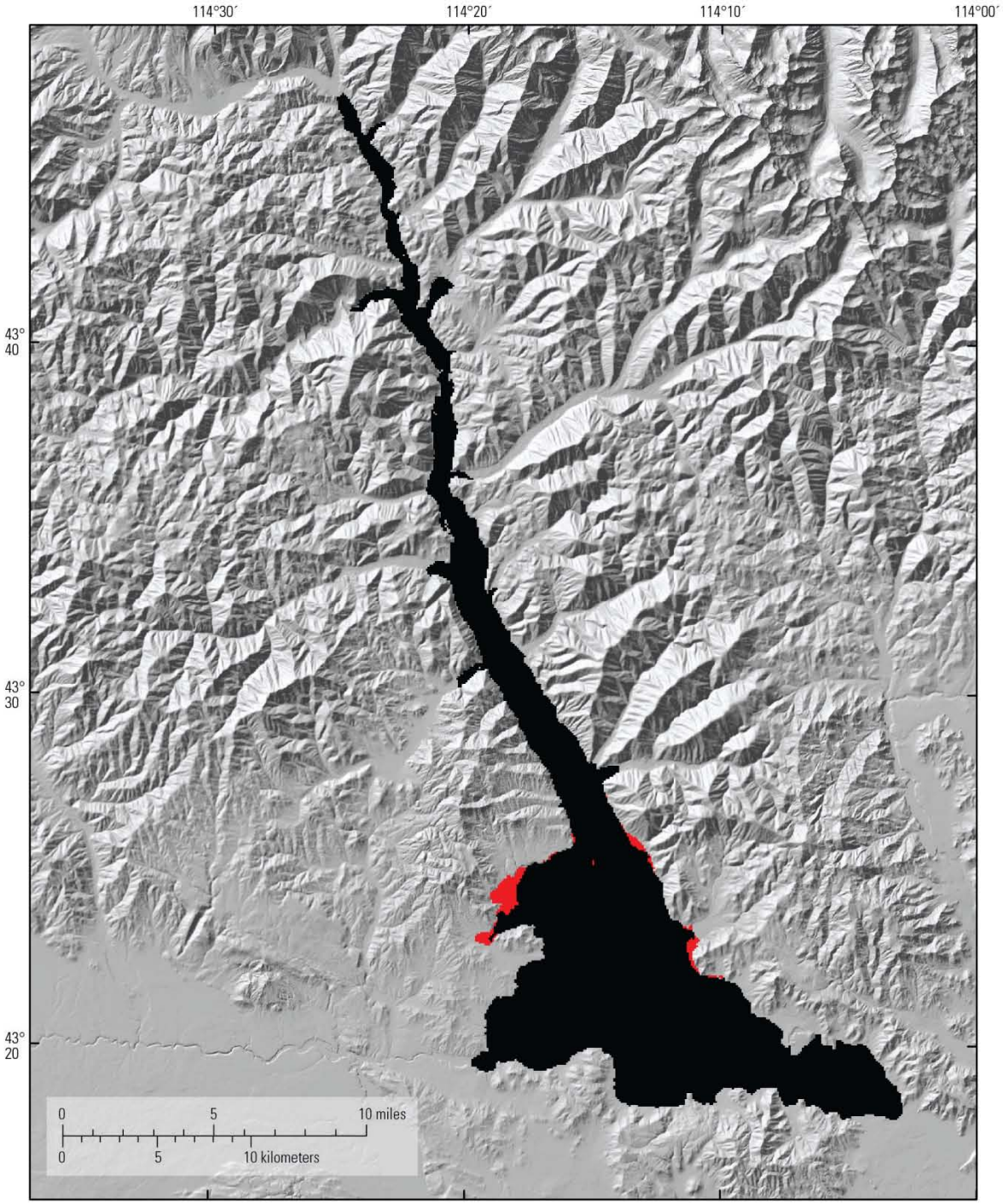












Coordinate system:

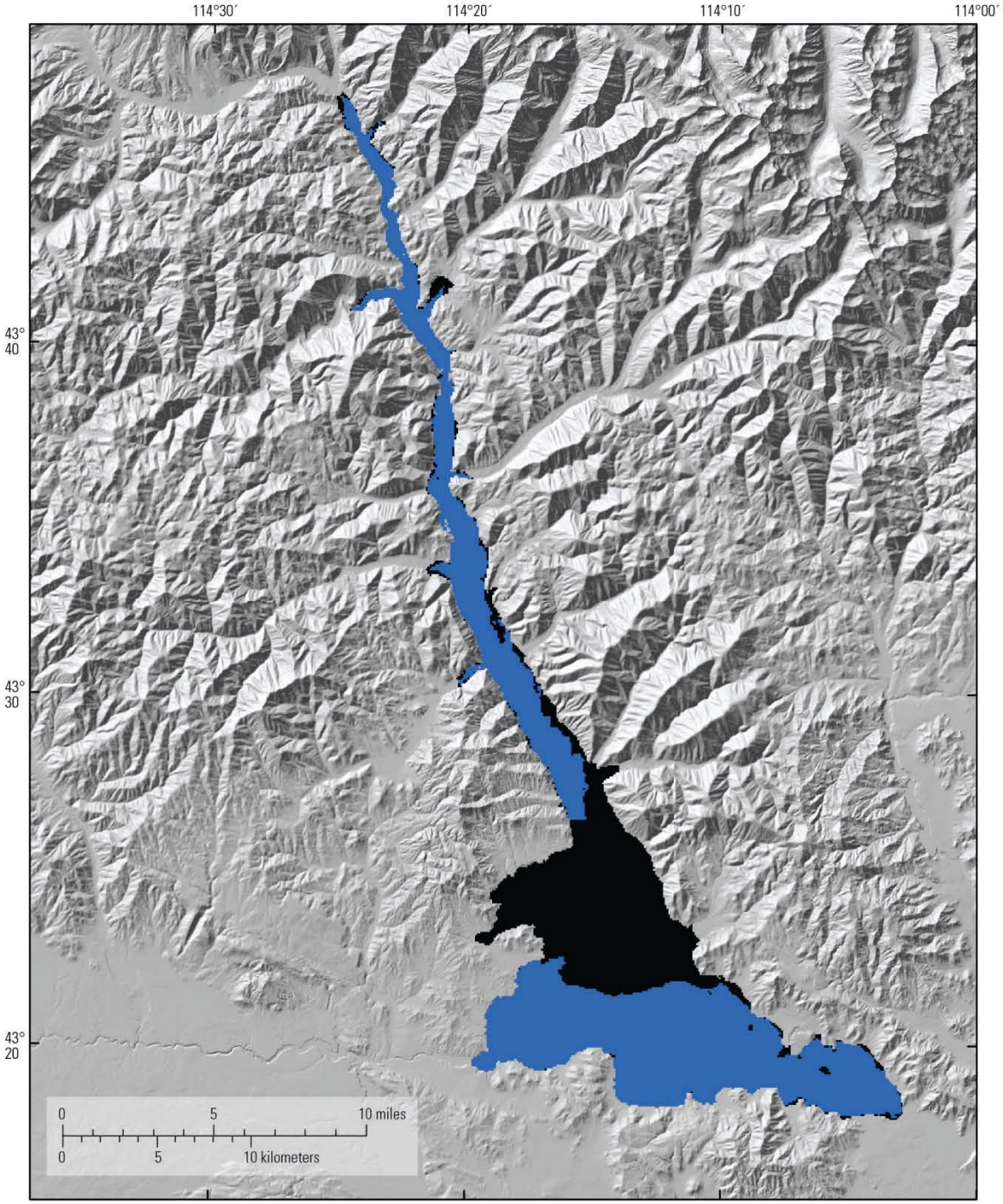
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Wet cell (Model layer 1)
Dry cell (Model layer 1)



Coordinate system:

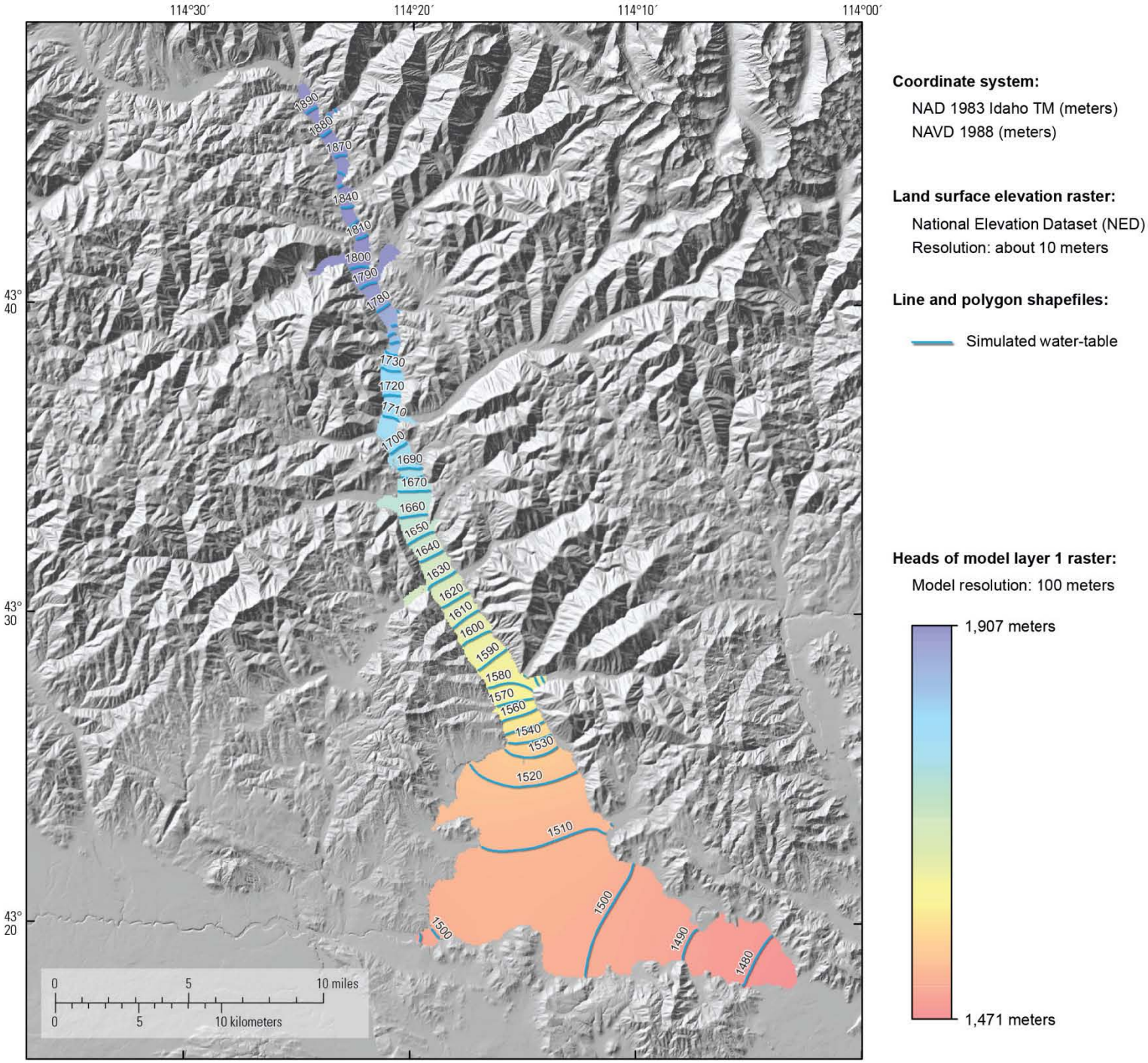
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

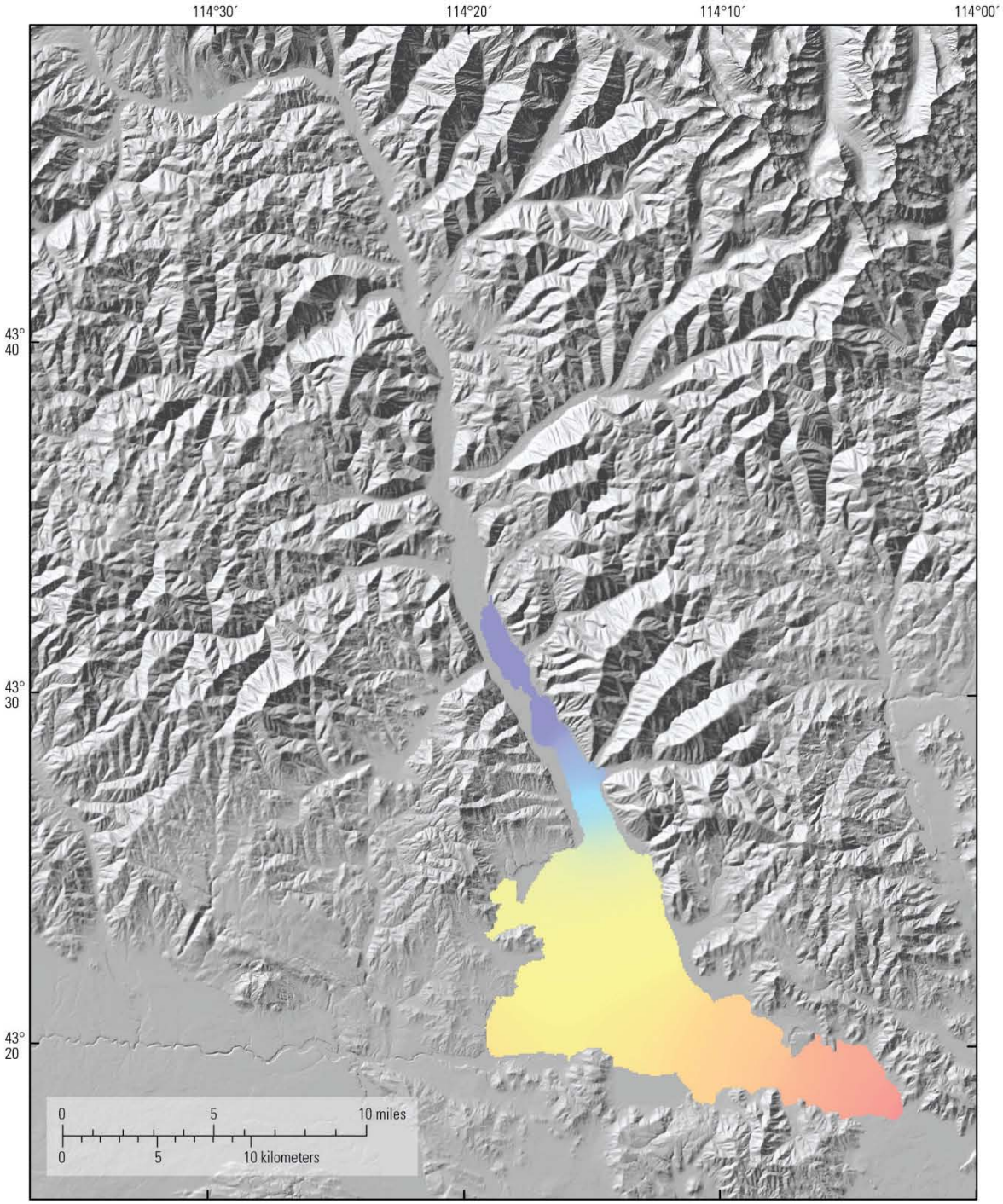
Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Not-saturated cell (Model layer 1)
Saturated cell (Model layer 1)


114°30′
114°20′
114°10′
114°00′
43° 40
43° 30
43° 20
1890
1880
1870
1840
1810
1800
1790
1780
1730
1720
1710
1700
1690
1670
1660
1650
1640
1630
1620
1610
1600
1590
1580
1570
1560
1540
1530
1520
1510
1500
1500
1490
1480
0 5 10 miles
0 5 10 kilometers
Coordinate system:
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)
Land surface elevation raster:
National Elevation Dataset (NED)
Resolution: about 10 meters
Line and polygon shapefiles:
Simulated water-table
Heads of model layer 1 raster:
Model resolution: 100 meters
1,907 meters
1,471 meters



Coordinate system:

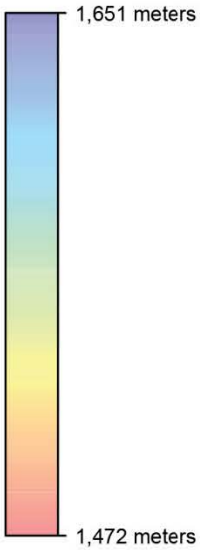
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

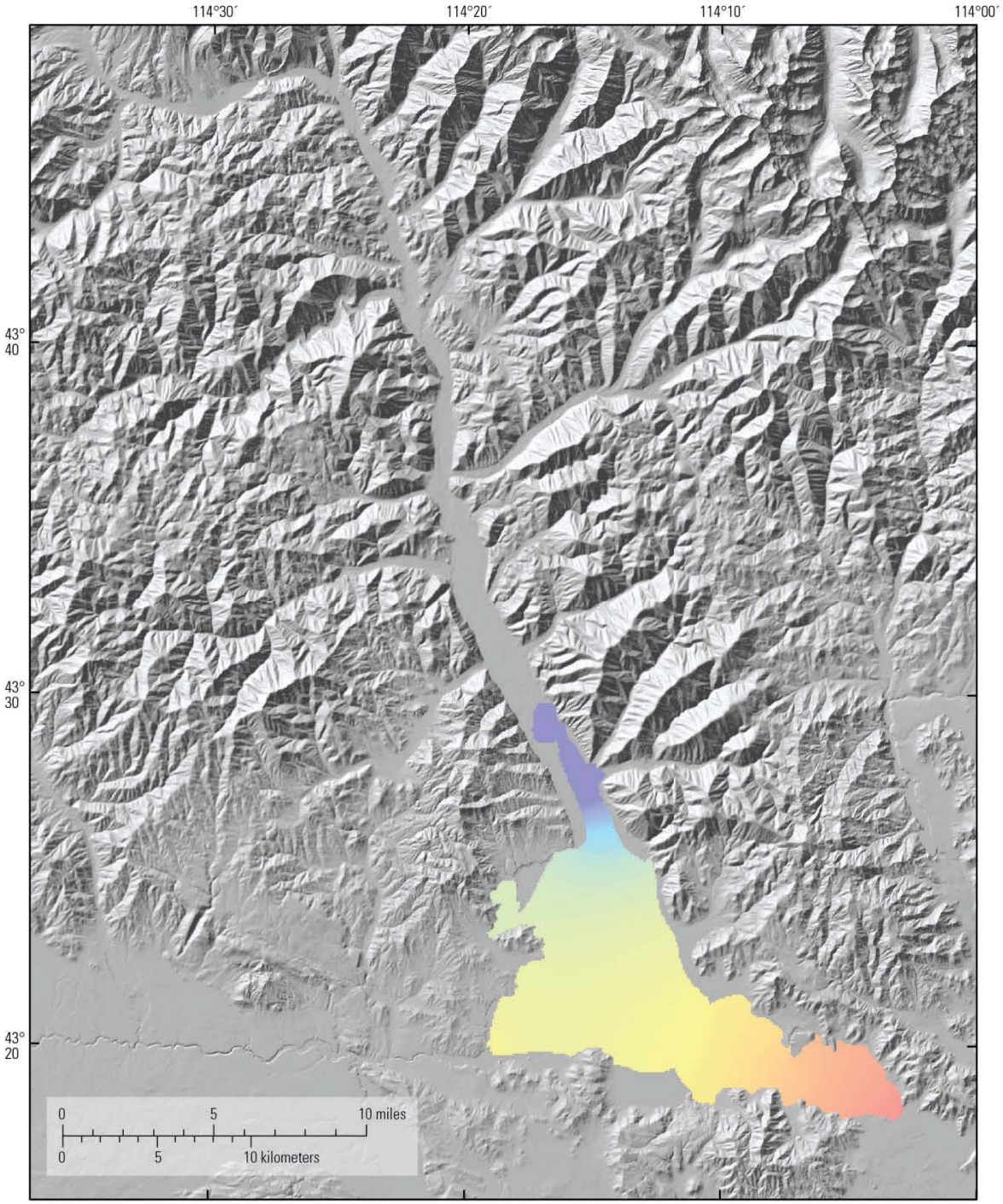
Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Heads of model layer 2 raster:

Model resolution: 100 meters





Coordinate system:

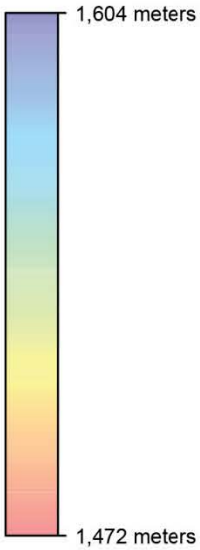
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Heads of model layer 3 raster:

Model resolution: 100 meters



Where to go next…

- Heads at source locations and initial conditions
- Precipitation and evapotranspiration
- Surface water
- Transient simulation (1995 – 2010)
- Model calibration (using well data and streamflow hydrographs)

git

git

bitbucket

bitbucket

github
SOCIAL CODING

Questions

USGS