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Big Lost River Valley, Previous Work: Hydrogeologic Framework, Seepage Study, and Groundwater Synoptic

U.S. Department of the Interior
U.S. Geological Survey

In cooperation with the Idaho Department of Water Resources

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"The ground water and surface water of the Big Lost River basin are so closely interrelated that they should be considered as a single resource"
(Crosthwaite and others, 1970a, p. 100)

Motivation

- Water users in the Big Lost River Basin are concerned about declining groundwater levels and declining streamflows
- Last comprehensive water resources review was done in 1970

Goals

- Improve hydrologic understanding
- Inform water rights administration
- Support groundwater-flow modeling

Approach

- Additional streamgages
- Hydrogeologic framework
- Surface water-groundwater interactions (seepage) study
- Groundwater-level synoptic
- Groundwater budget

Great work by Alexis Clark at the Idaho Geological Survey – look for a future MTAC talk on this part

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Hydrogeologic Framework

- What is it?
- Methods:
  - Borehole geophysics
  - Digitize well-driller reports
  - Interpret hydrogeologic units
  - Develop 3D hydrogeologic framework model
  - Describe groundwater occurrence and movement
- Published in:

  Zinsser (2021), SIR 20215078A

Previous Hydrogeologic Work

Early work focused on water delivery, with some geologic interpretation:

- Debler and others, 1931
- Livingston, 1931

Last comprehensive hydrogeologic investigation:

- Crosthwaite and others, 1970a
- Crosthwaite and others, 1970b

Comprehensive description of groundwater resources and geology in the Eastern Snake River Plain, including tributaries like the Big Lost River Valley:

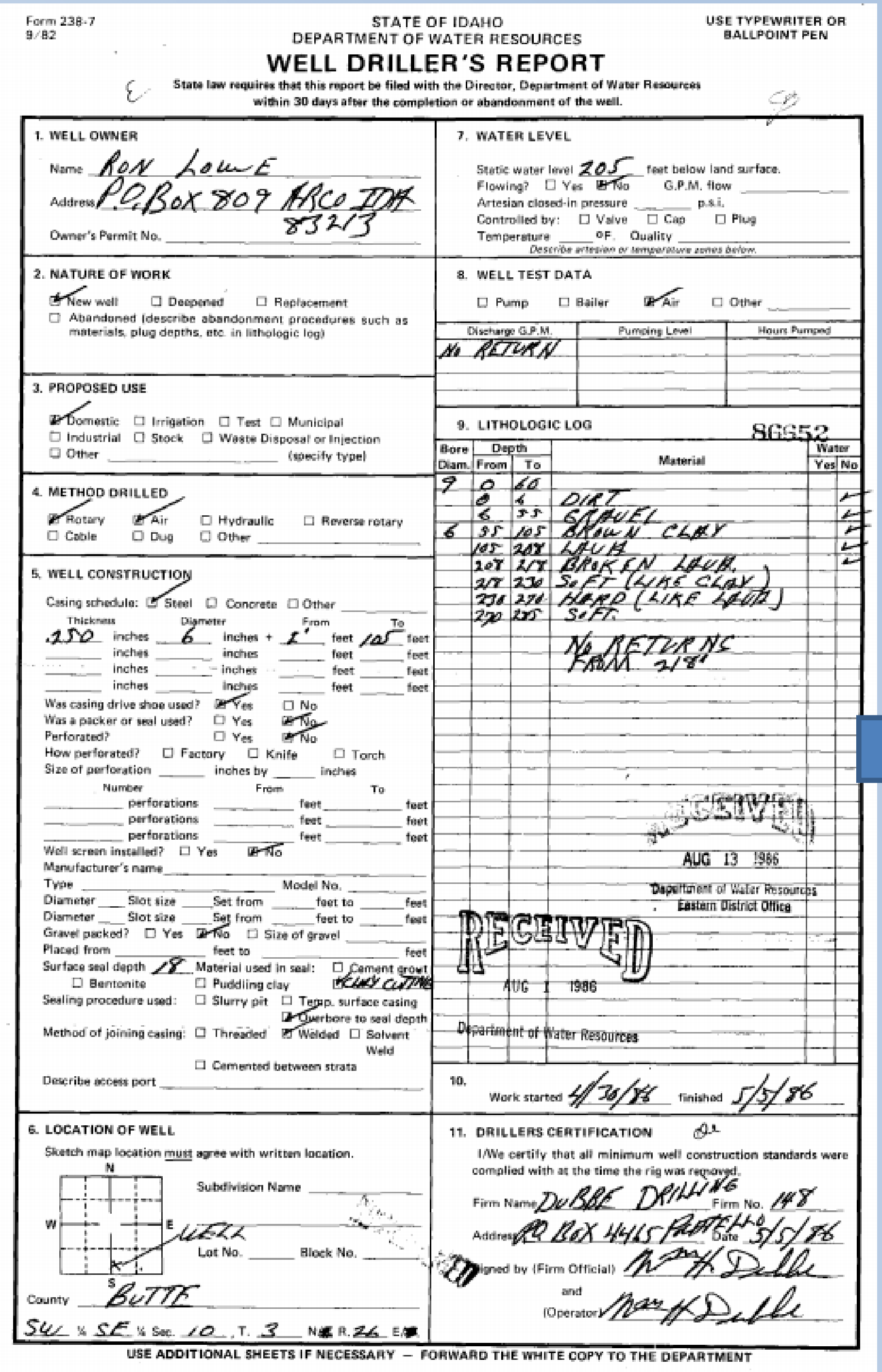
- Stearns and others, 1938

More recent evaluations of the impacts of groundwater pumping on surface water:

- Johnson and others, 1991
- Bassick and Jones, 1992
- Sukow, 2017

Well database

- Digitize paper logs
  - 604 wells, IDWR and USGS
  - Location details
  - Well construction
  - Lithology
- Lithologies used to define hydrogeologic units and build 3D model



Form 238-7
9/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT

USE TYPEWRITER OR BALLPOINT PEN

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER
Name RON LOWE
Address P.O. BOX 809 ARCO IDA 83213
Owner's Permit No.

2. NATURE OF WORK
☑ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE
☑ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other (specify type)

4. METHOD DRILLED
☑ Rotary ☑ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION
Casing schedule: ☑ Steel ☐ Concrete ☐ Other
Thickness .250 inches, Diameter 6 inches, From + 2' feet, To 105 feet
Was casing drive shoe used? ☑ Yes ☐ No
Was a packer or seal used? ☐ Yes ☑ No
Perforated? ☐ Yes ☑ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ____ inches by ____ inches
Well screen installed? ☐ Yes ☑ No
Manufacturer's name
Type Model No.
Diameter Slot size Set from feet to feet
Gravel packed? ☐ Yes ☑ No ☐ Size of gravel
Placed from feet to feet
Surface seal depth 18 Material used in seal: ☐ Cement grout ☐ Bentonite ☐ Puddling clay ☑ WELL CUTTINGS
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☑ Overbore to seal depth
Method of joining casing: ☐ Threaded ☑ Welded ☐ Solvent Weld
☐ Cemented between strata
Describe access port

6. LOCATION OF WELL
Sketch map location must agree with written location.
Subdivision Name
Lot No. Block No.
County BUTTE
SW ¼ SE ¼ Sec. 10, T. 3 N, R. 26 E

7. WATER LEVEL
Static water level 205 feet below land surface.
Flowing? ☐ Yes ☑ No G.P.M. flow
Artesian closed-in pressure p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature °F. Quality
Describe artesian or temperature zones below.

8. WELL TEST DATA
☐ Pump ☐ Bailer ☑ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
NO RETURN		

9. LITHOLOGIC LOG 86652

Bore Diam.	From	To	Material
9	0	60	
	0	6	DIRT
	6	35	GRAVEL
6	35	105	BROWN CLAY
	105	208	LAVA
	208	217	BROKEN LAVA
	217	230	SOFT (LIKE CLAY)
	230	270	HARD (LIKE LAVA)
	270	285	SOFT

NO RETURNS FROM 218'

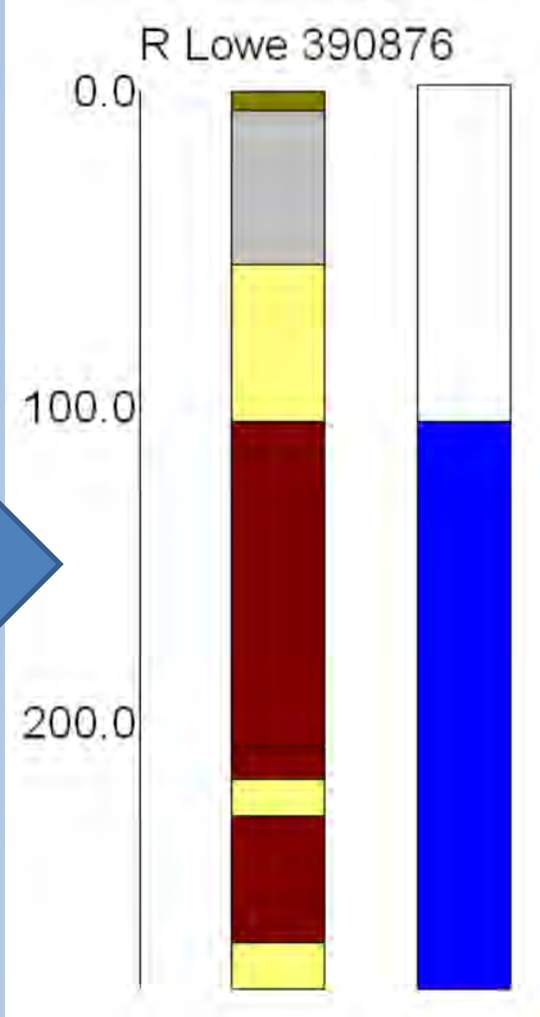
RECEIVED AUG 13 1986 Department of Water Resources Eastern District Office

RECEIVED AUG 1 1986 Department of Water Resources

10. Work started 4/30/86 finished 5/5/86

11. DRILLERS CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.
Firm Name DUBBE DRILLING Firm No. 148
Address PO BOX 4415 POCATELLO Date 5/5/86
Signed by (Firm Official)
and
(Operator)

USE ADDITIONAL SHEETS IF NECESSARY — FORWARD THE WHITE COPY TO THE DEPARTMENT



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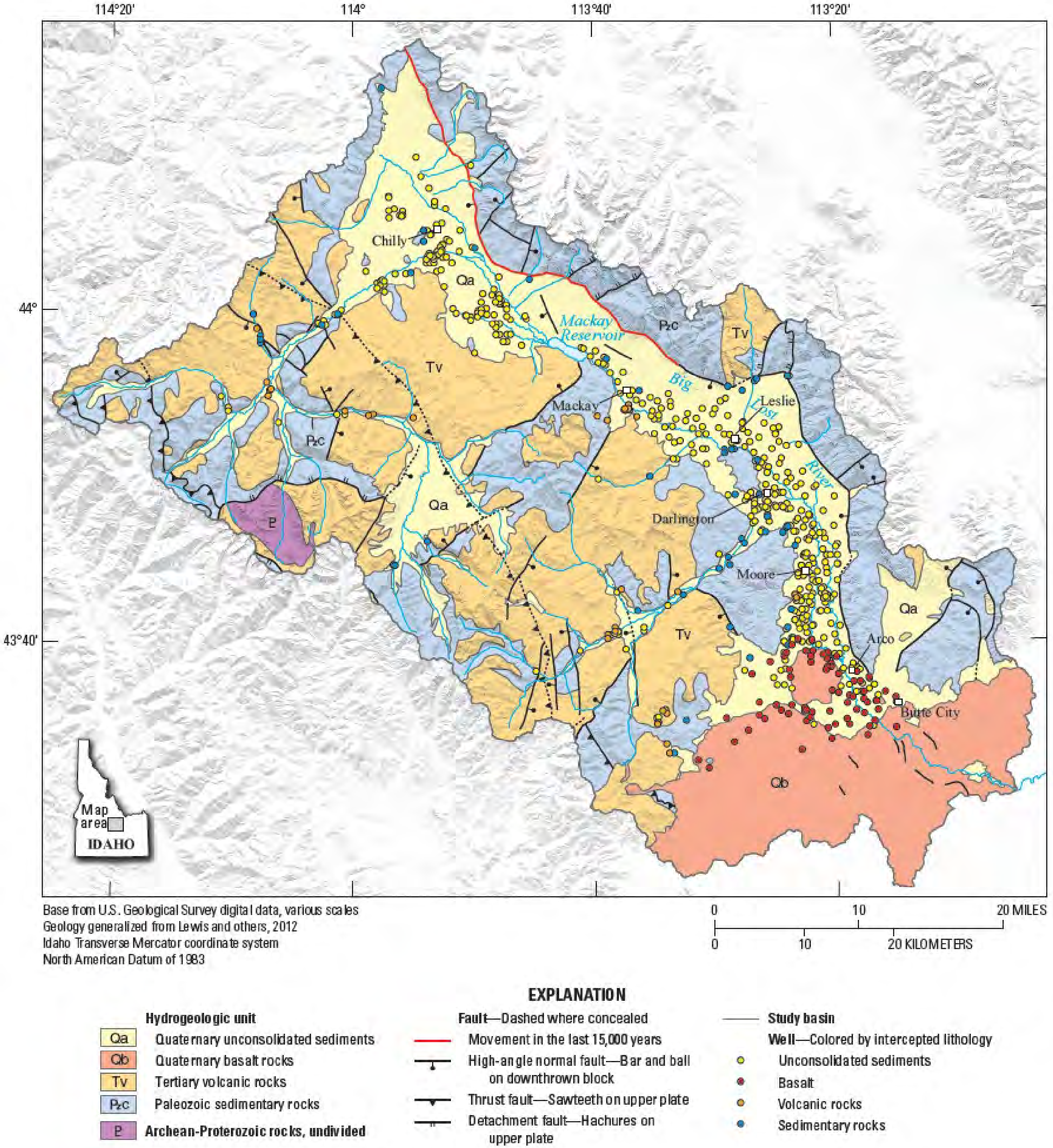
Hydrogeologic Units

1. Quaternary unconsolidated sediments
2. Quaternary basalt rocks
3. Tertiary volcanic rocks
4. Paleozoic sedimentary rocks

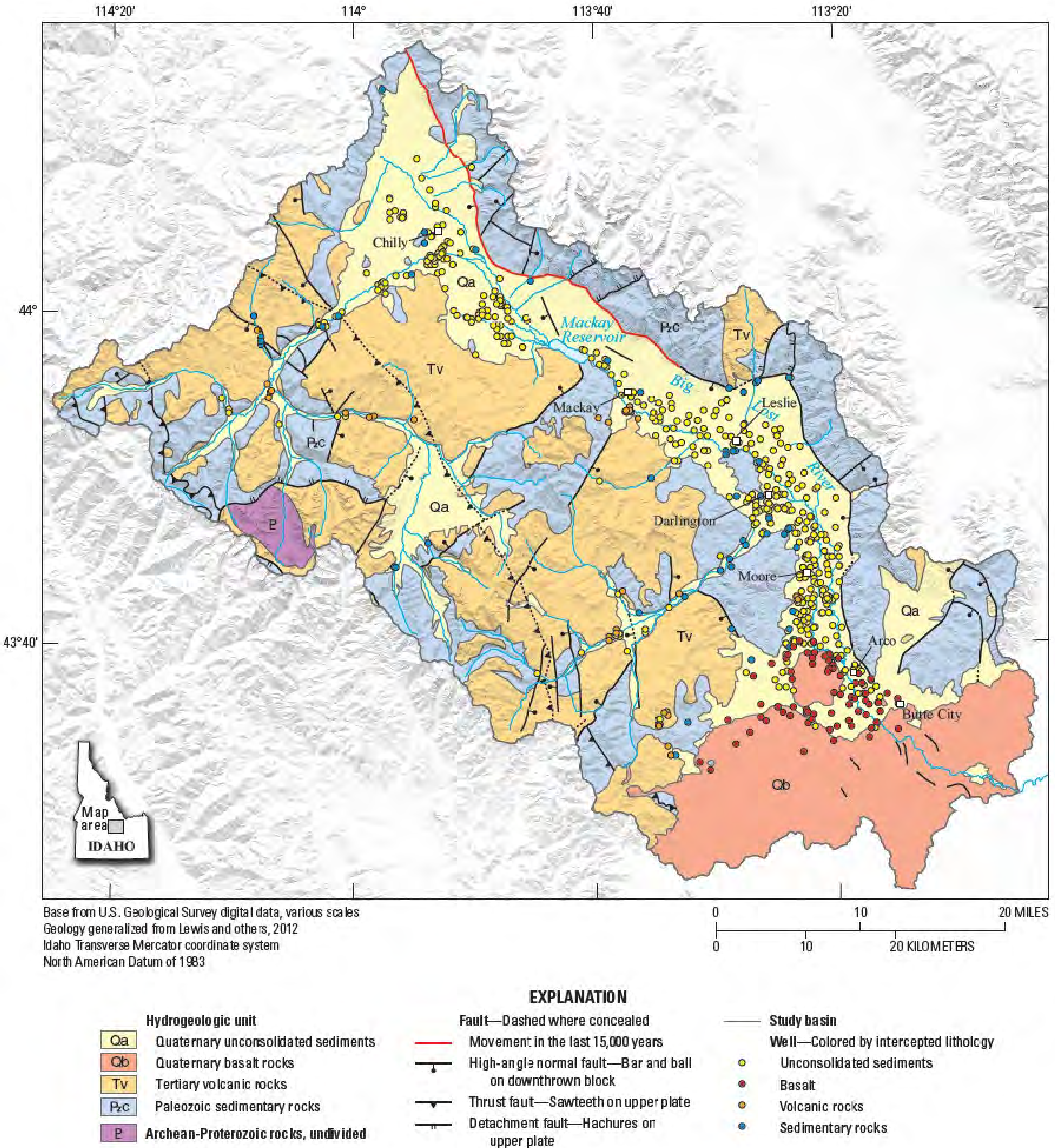
- o Surface extent defined based on state-wide geologic mapping
- o Used 3D hydrogeologic framework model to define cross-sectional extents



Hydrogeologic Units

Quaternary unconsolidated sediments

- Comprise the main alluvial aquifer
- Fluvial, alluvial and glacial sediments
- Variable depth, 200 - 5,000 ft



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Hydrogeologic Units

Quaternary basalt rocks
- South end of valley
- Interbedded with sediments
- Can be productive

Paleozoic sedimentary rocks
- Range-front rocks
- Mostly carbonate rocks
- Main bedrock aquifer

Tertiary volcanic rocks
- Challis volcanics
- Locally important where faulted/fractured

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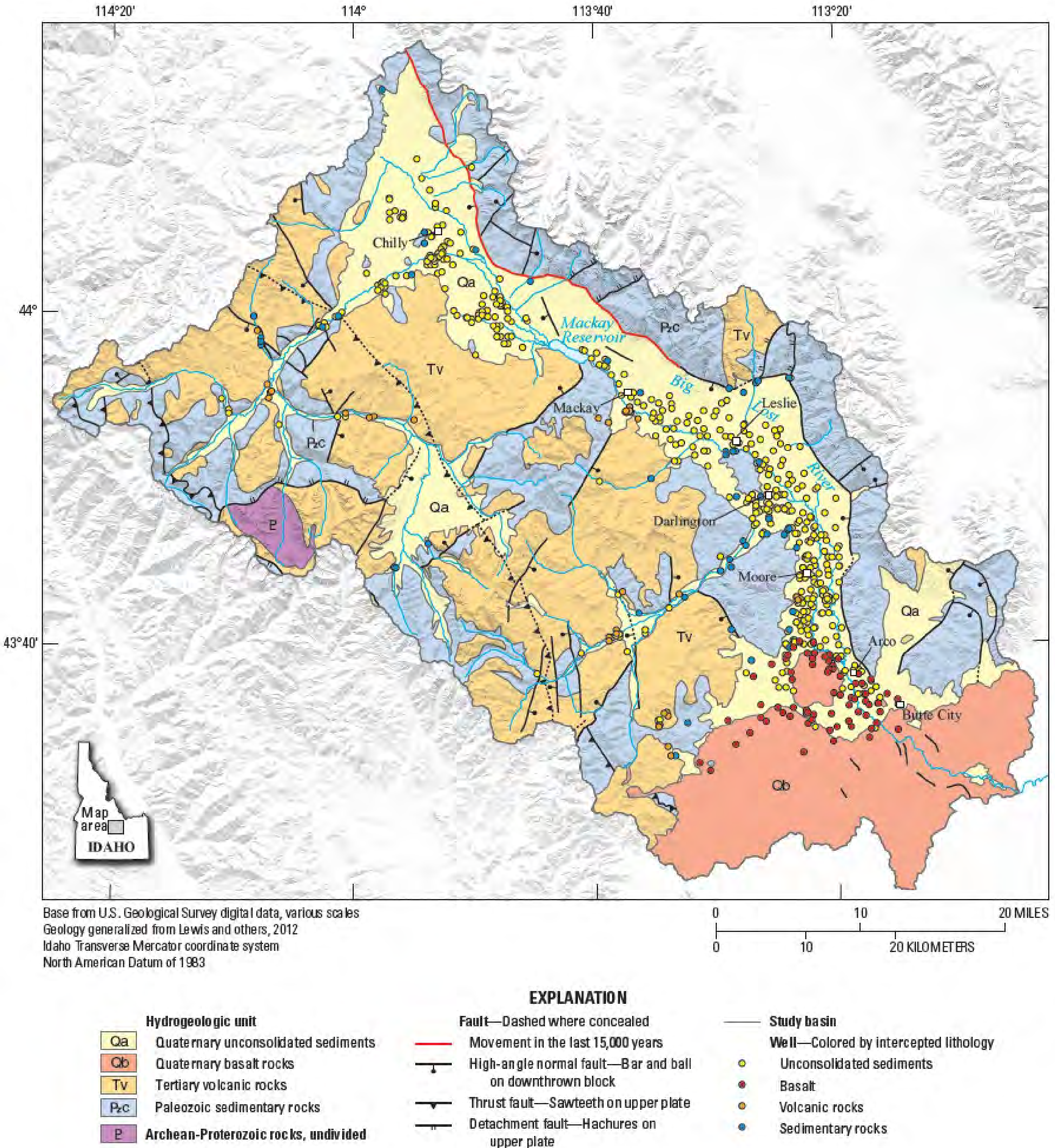

3D Hydrogeologic Framework Model

- Built in RockWorks™ 17
- Categorical lithology model, interpolates lithology between wells
- Iterative process
- Model estimation parameters:
  - Highest probability algorithm
  - 200 m x 200 m x 15.2 m grid
  - 2,000 m horizontal search distance
  - 15.2 m vertical search distance
  - Declustering
- Spatial domain:
  - Constrained to alluvial aquifer
  - Constrained to surface topography

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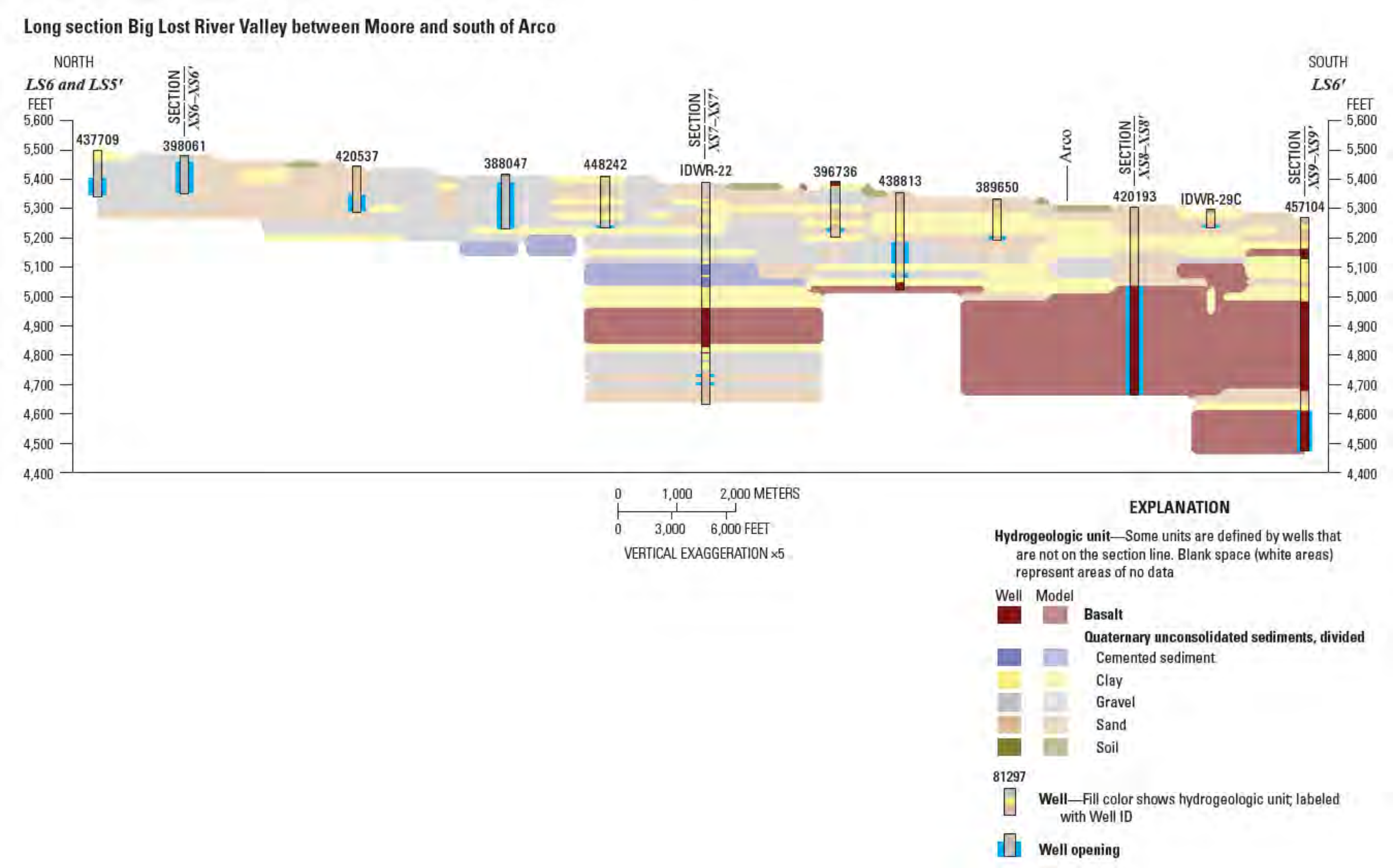
3D Hydrogeologic Framework Model

Use model to understand:

- Occurrence,
- Connectivity, and
- Properties of water-yielding units
- Extents of confining units
- Conceptual framework for future groundwater model



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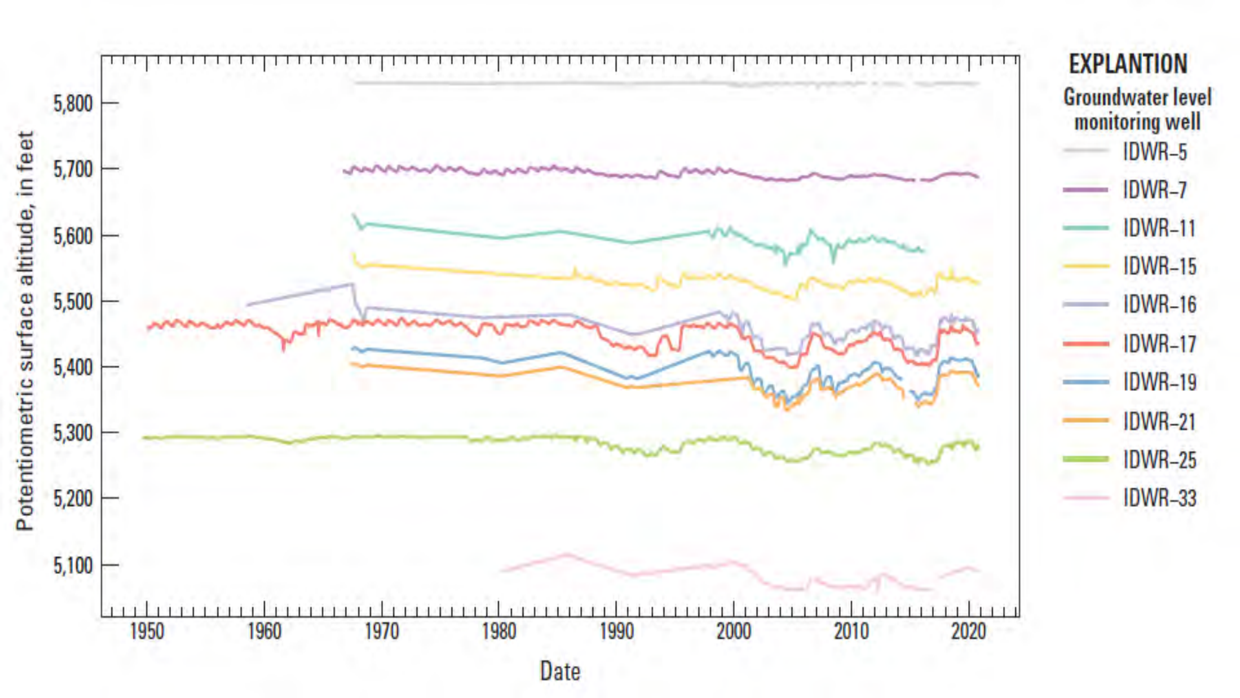
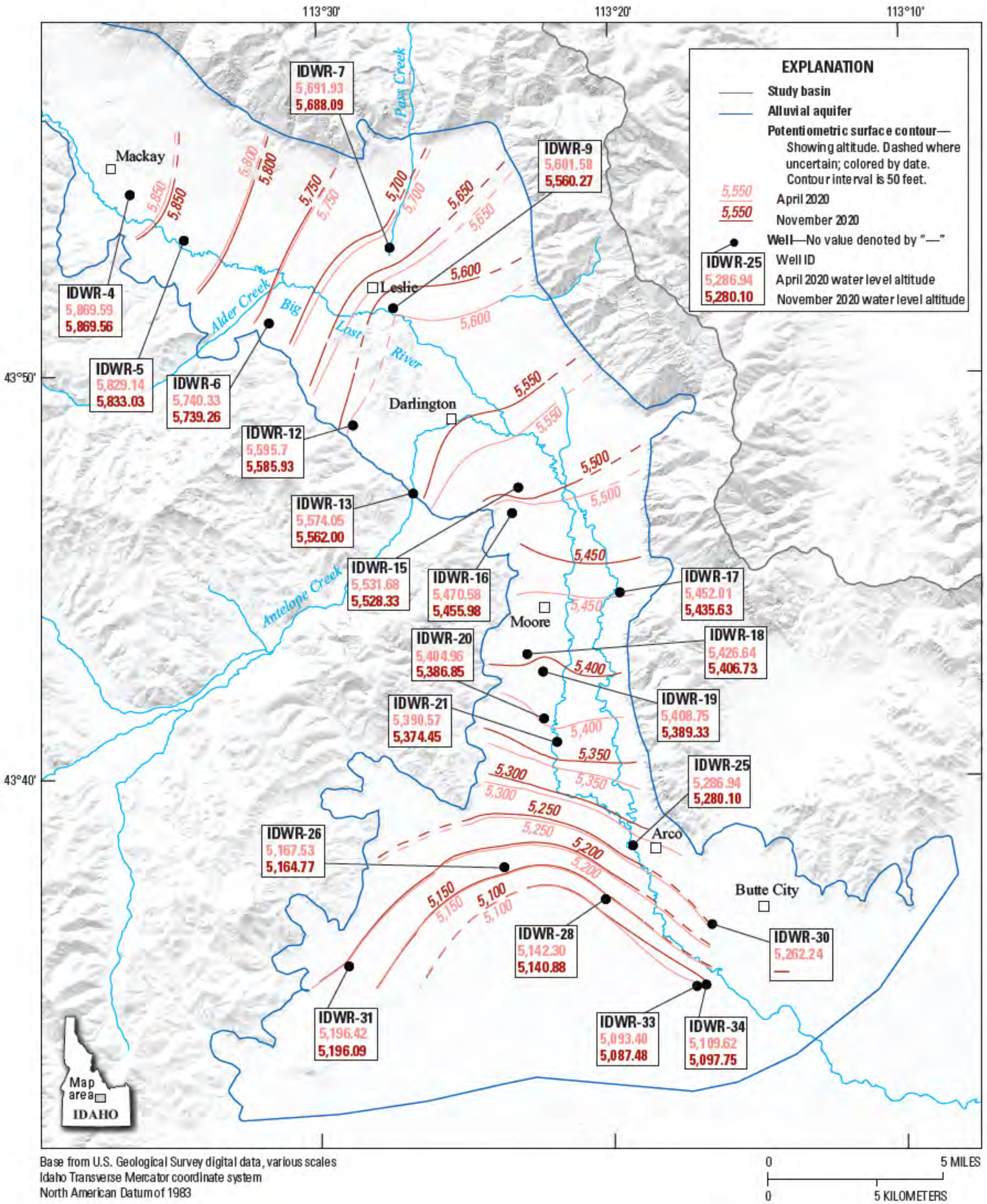
Groundwater Occurrence and Movement

Substantial fluctuations in groundwater levels between Leslie and past Moore





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Groundwater-Level Synoptic

- What is it?
- Methods:
  - o Groundwater-level measurements
  - o High-accuracy survey
  - o Spring and fall 2022
  - o 177 wells
  - o Develop potentiometric-surface maps
  - o Describe groundwater occurrence, movement and change
- Data already in NWIS
- Maps will be published Fall 2023

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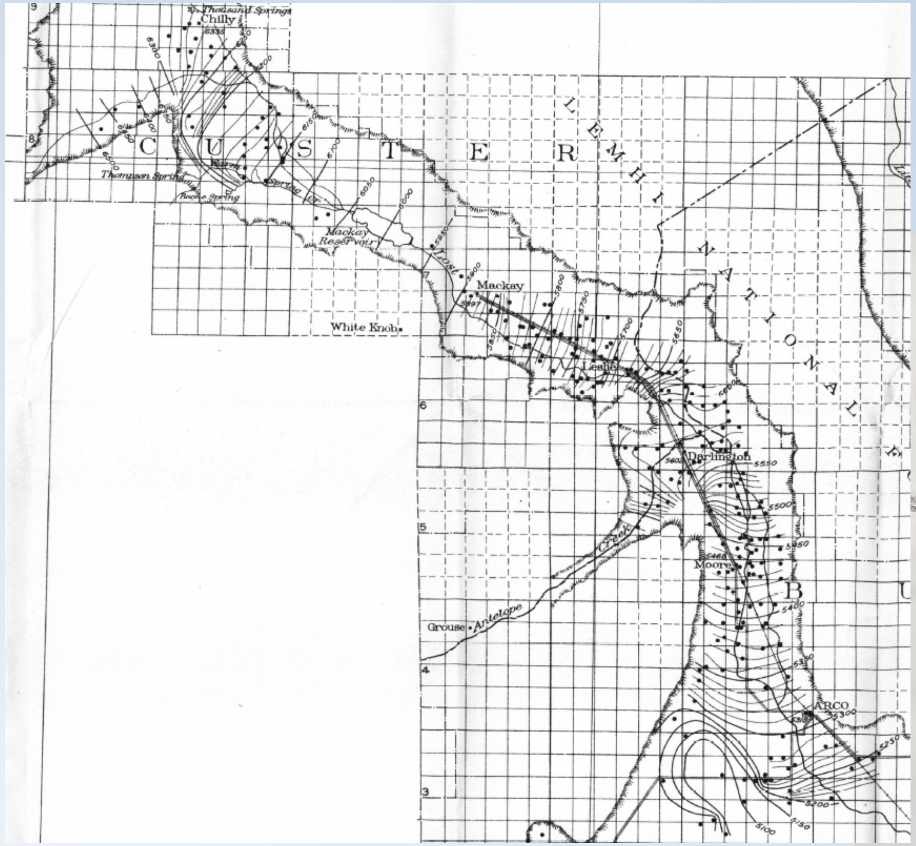
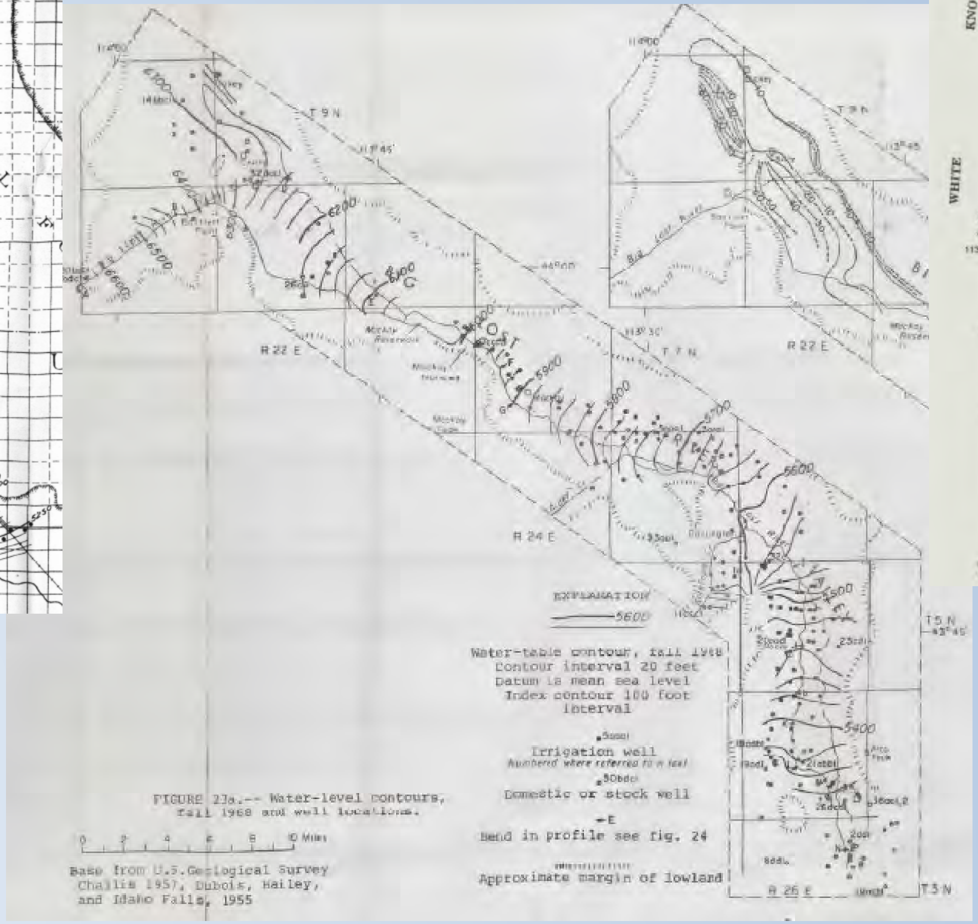
Previous Groundwater-Level Synoptics

Stearns and others, 1938

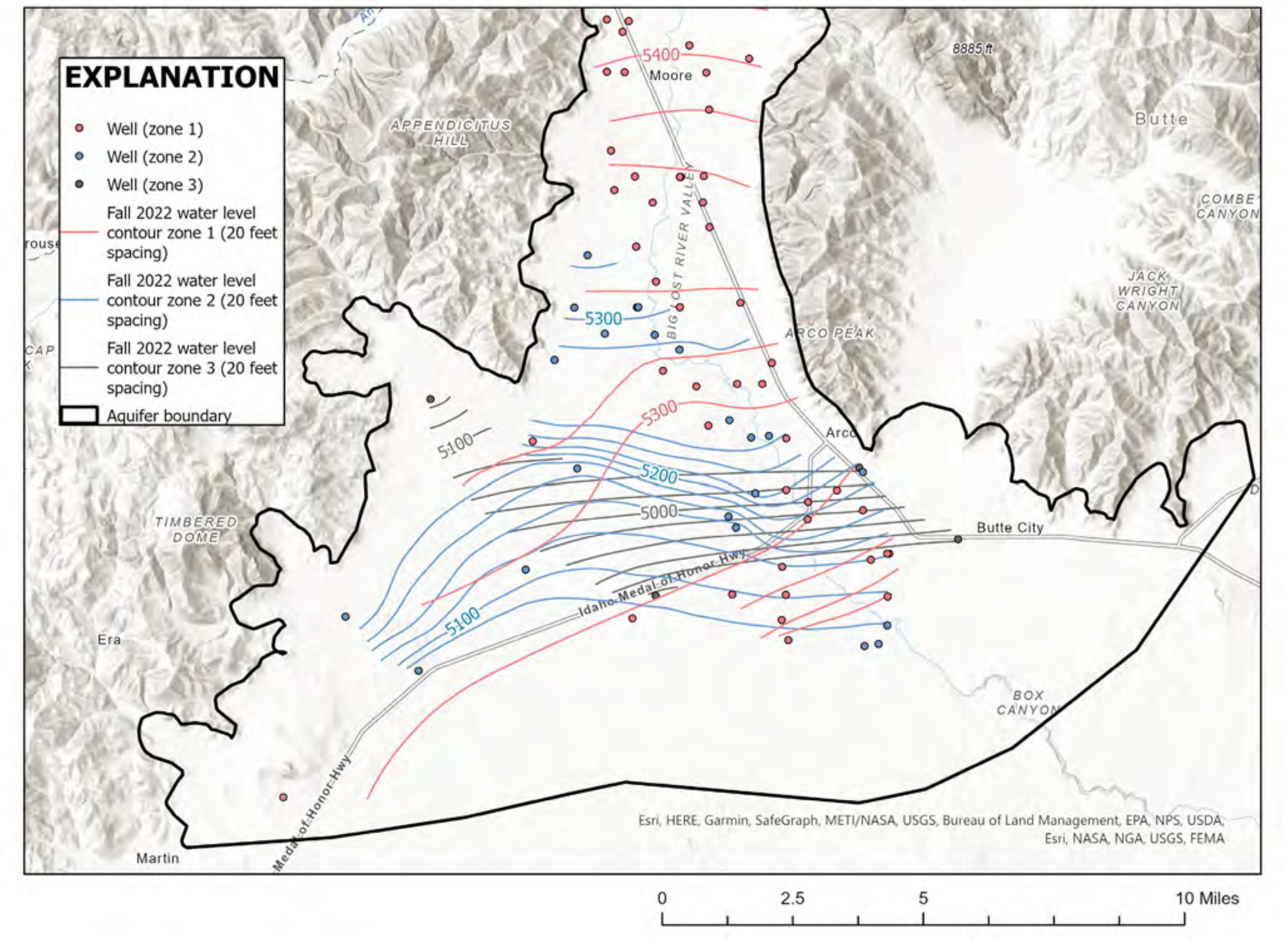


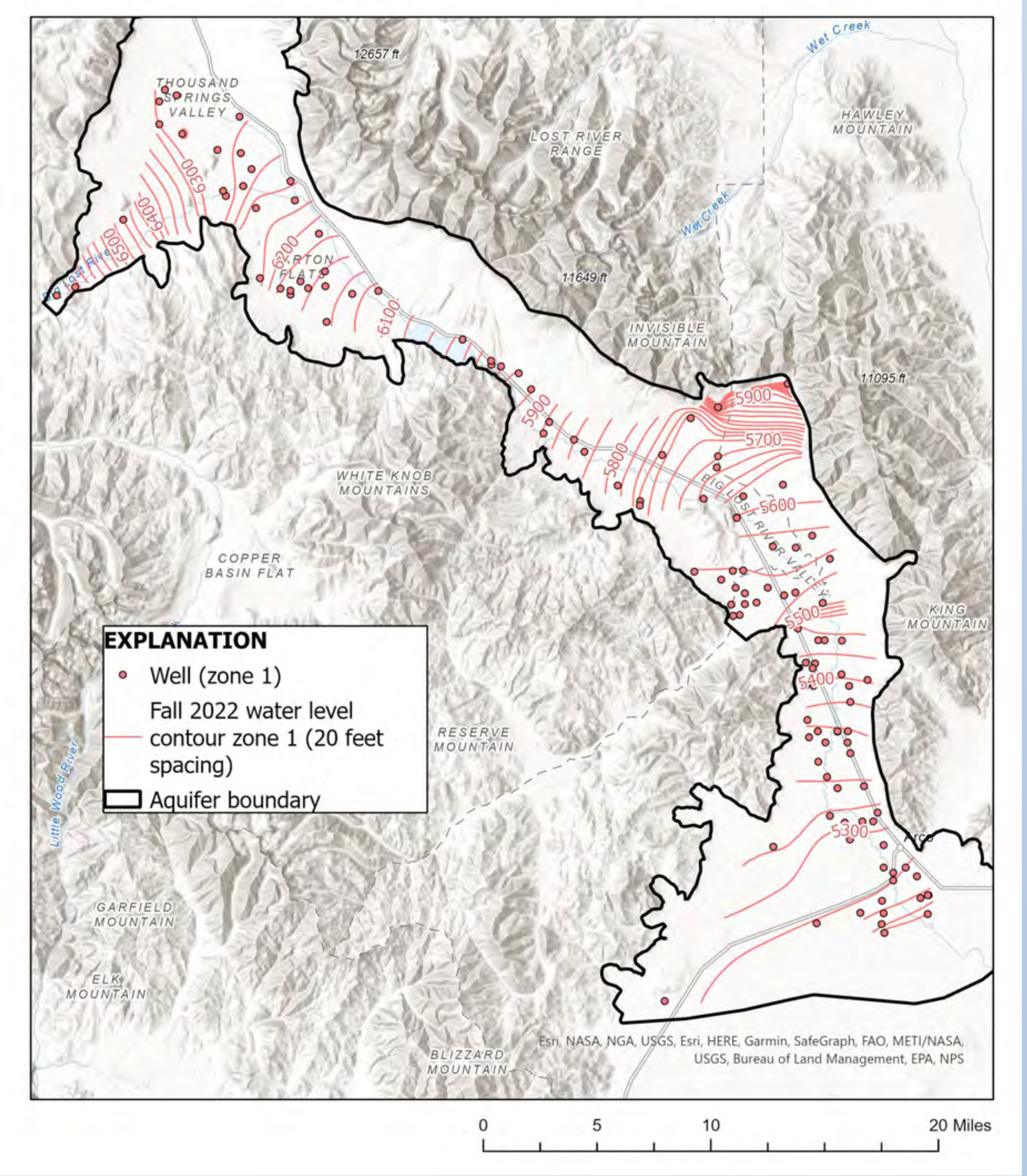
Crosthwaite and others, 1970a



Bassick and Jones, 1992

Groundwater Levels
Fall 2022





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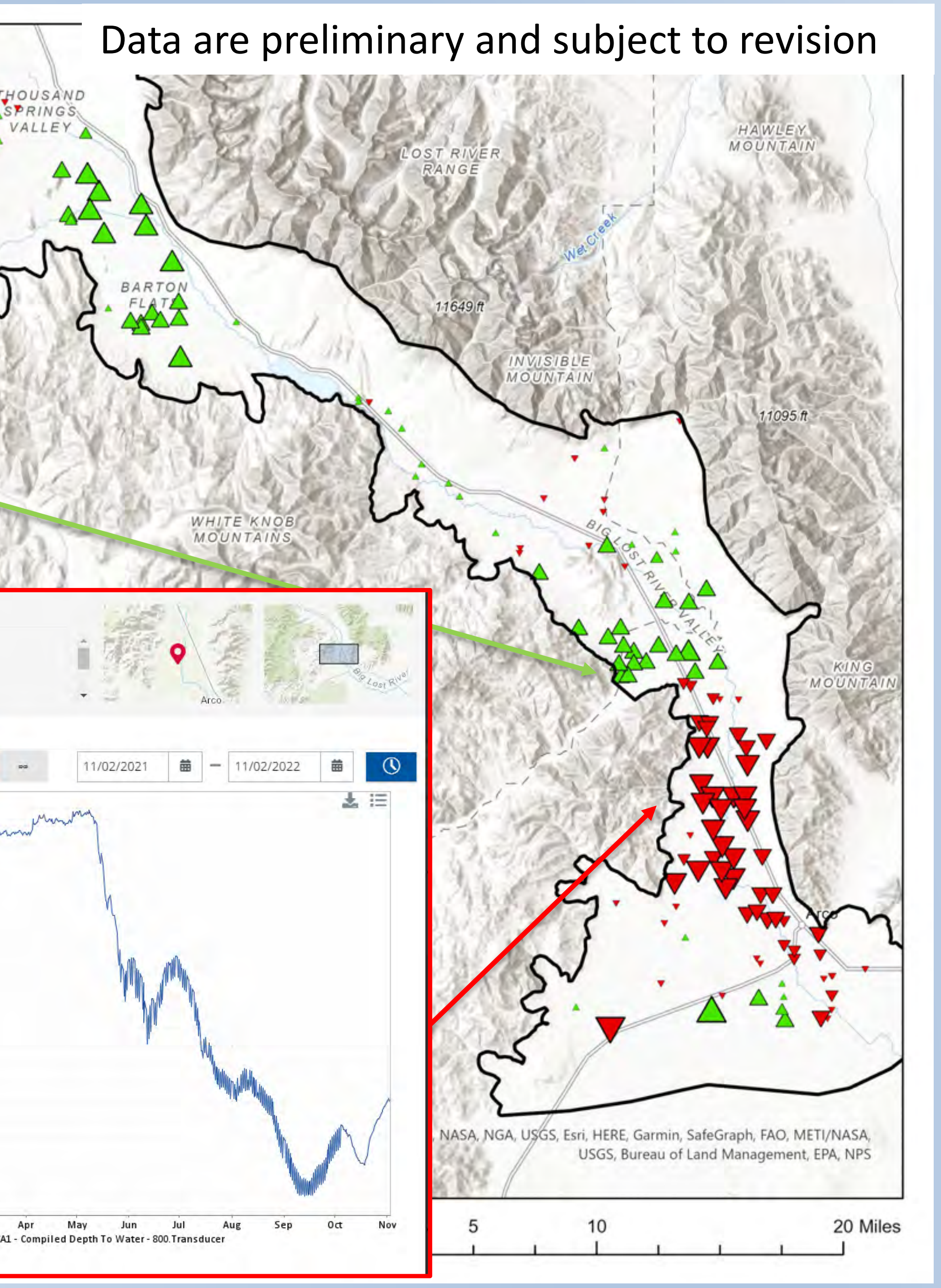
Data are preliminary and subject to revision

Groundwater Levels Change Spring 2022 to Fall 2022

Increases in some areas, decreases in others



Data from IDWR, Groundwater Data Portal

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Seepage Study

- What is it?
- Methods:
  - o Streamflow measurements on mainstem locations, tributaries/returns, and diversions
  - o Four events – March 2019, October 2019, October 2020, March 2021
  - o Pre- and post-irrigation season conditions
- Published in:

  Dudunake and Zinsser (2021), SIR 20215078B

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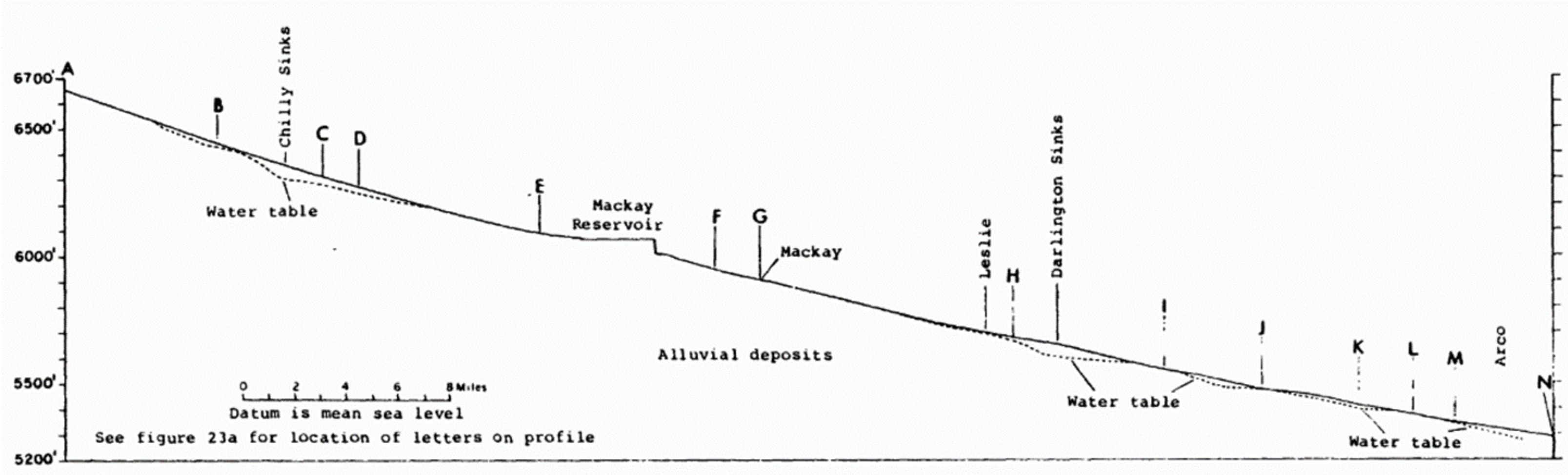
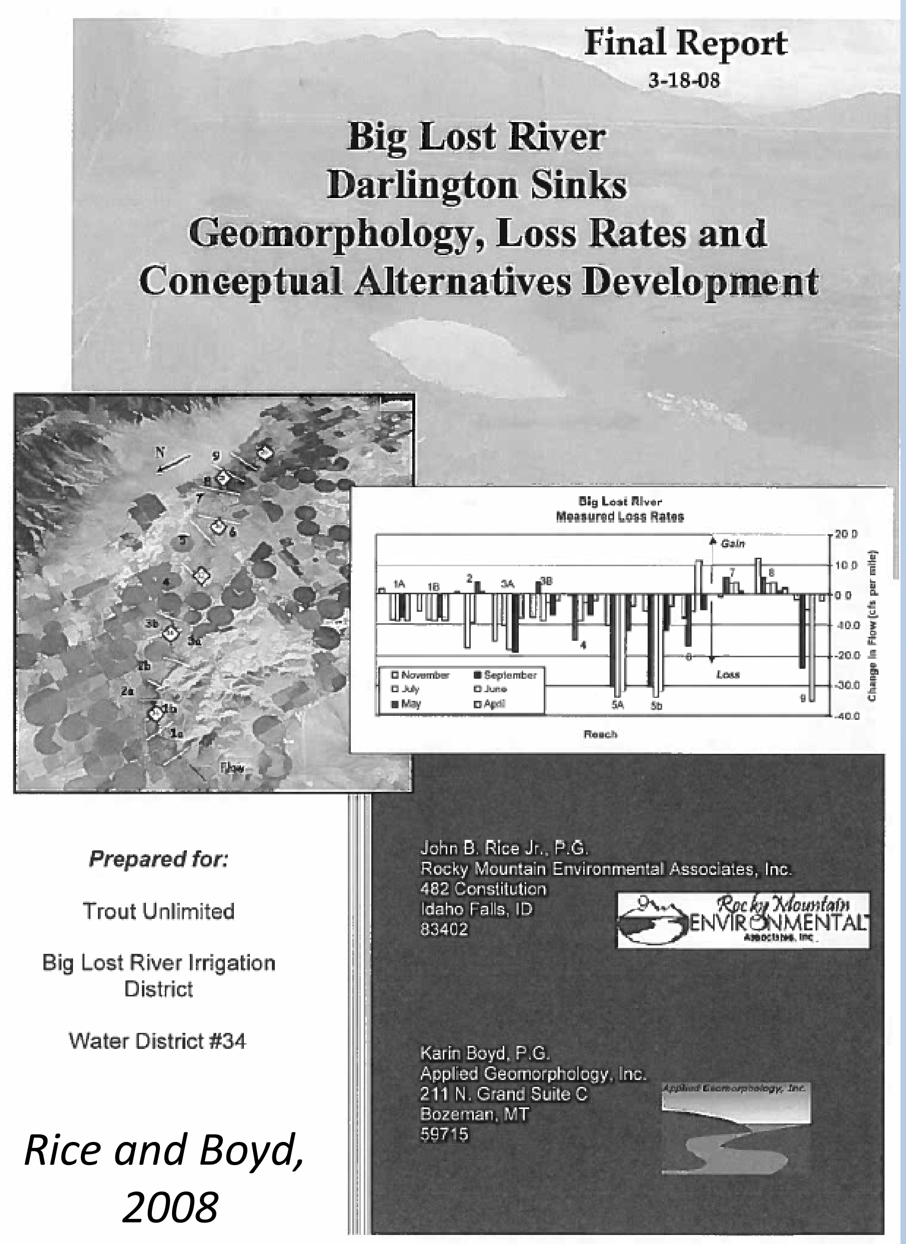
Previous Seepage Observations and Studies

do not return such waters to the valley. There is however much reason to believe that the waters lost in the Darlington sinks merely pass through the Antelope Creek delta and return in part to the river in the vicinity of the Moore dam. If this be true, then a by-pass

Report of the Board of Engineers on Big Lost River Idaho,
Debler and others, 1931, p. 4



[Water Resources in the Big Lost River Basin, South-Central Idaho, Crosthwaite and others, 1970a, p. 73]



Rice and Boyd, 2008

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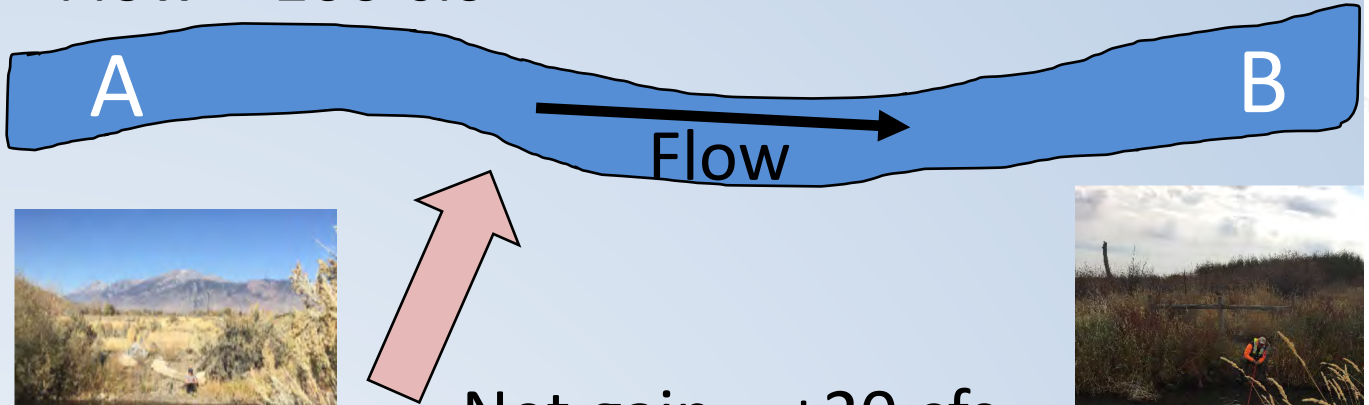
Measure change in surface water flow to estimate groundwater exchange

Flow = 100 cfs

Flow = 120 cfs



Net gain = +20 cfs

$$Net\ surface\ water\ gain\ or\ loss\ =\ Q_d - I - Q_u + O,$$

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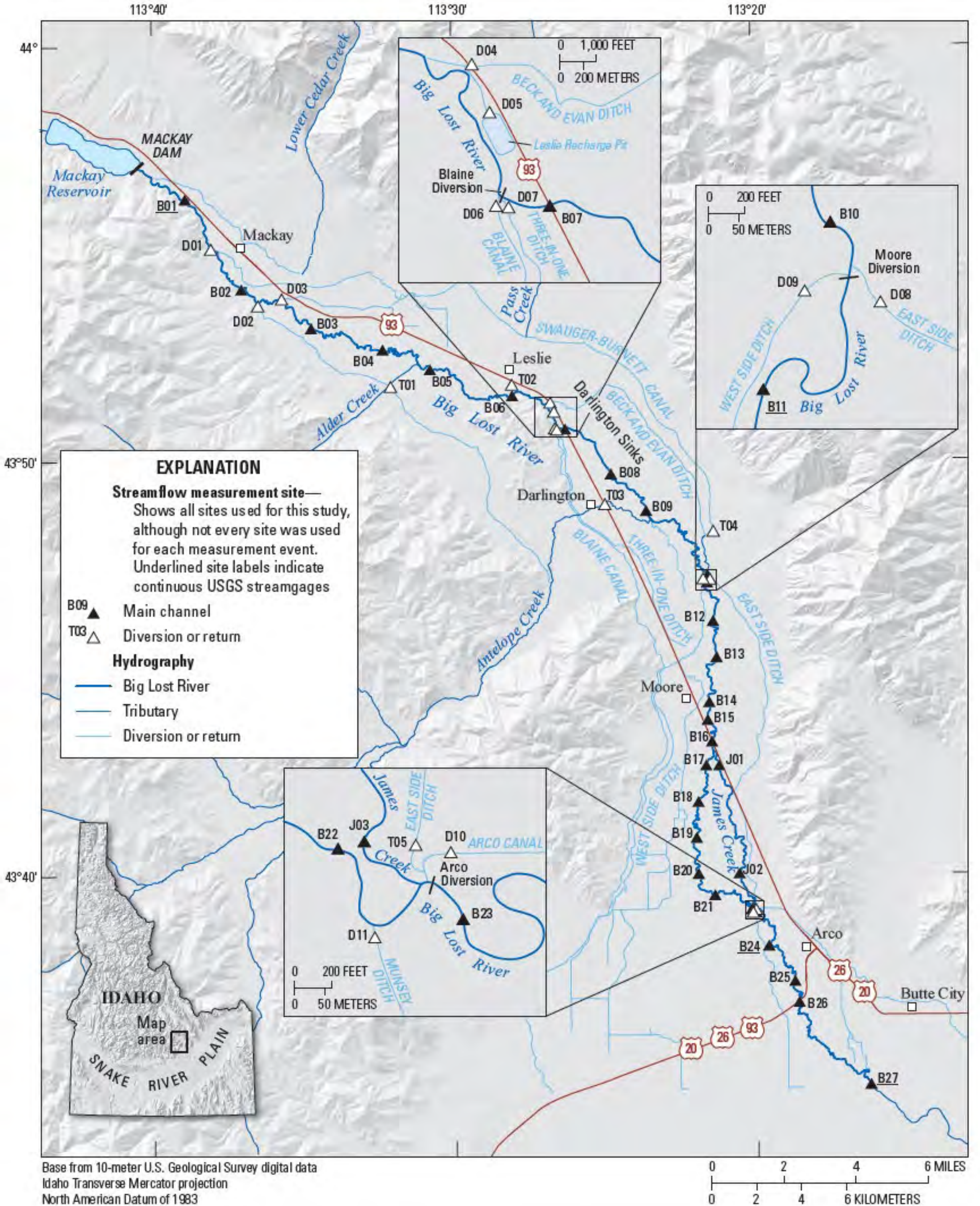
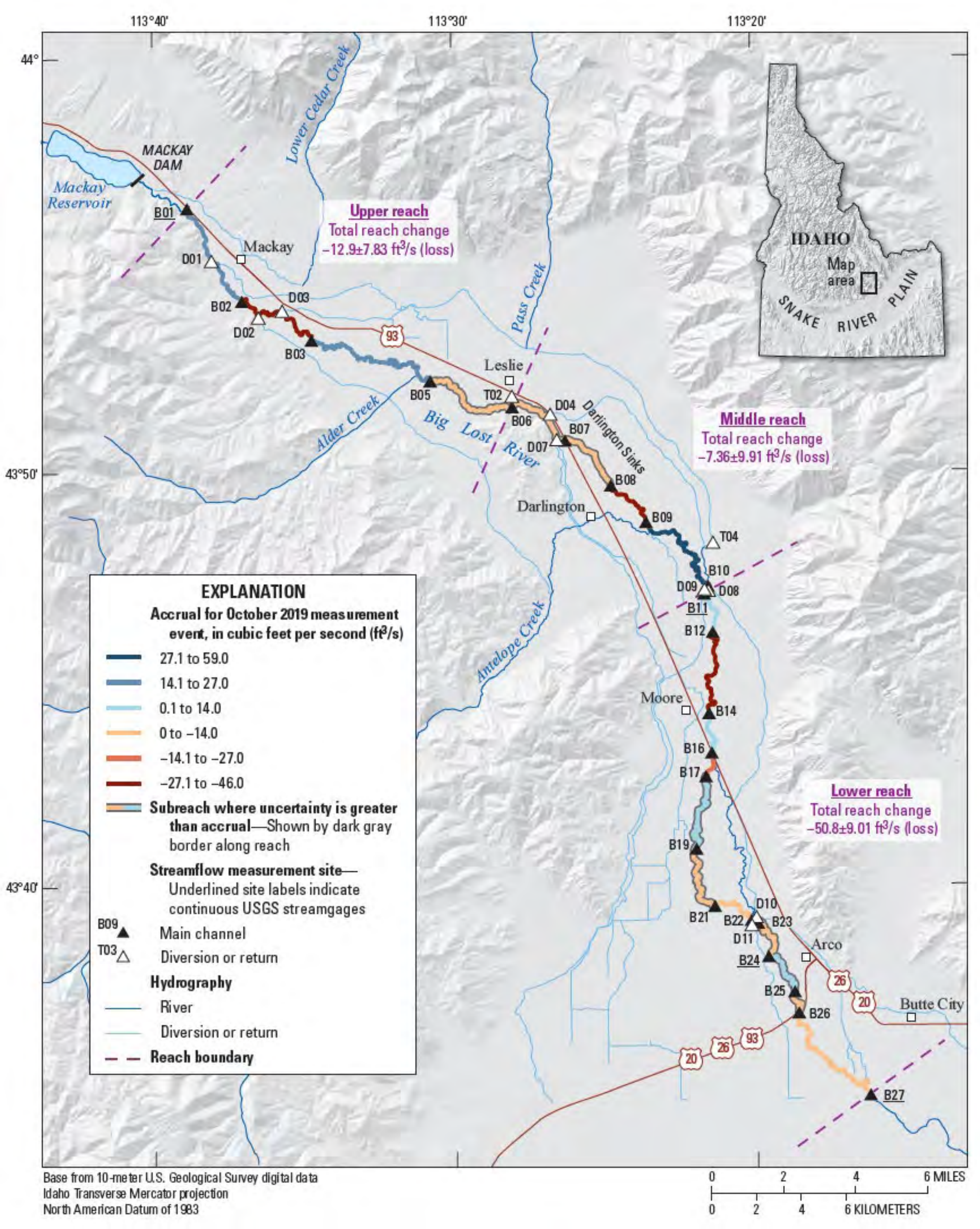


October 2019 Results

- Large gains and losses though Mackay
- Large losses through Darlington Sinks
- Large gains above the Moore Diversion
- Smalls gains and losses from Moore to Arco
- Overall, ~70 cfs to groundwater



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October 2020 Results

- Smaller, uncertain gains and losses through Mackay
- Larger losses in the Darlington Sinks
- No gains at the Moore Diversion
- No water in Big Lost River below the Moore Diversion
- Overall, ~95 cfs to groundwater

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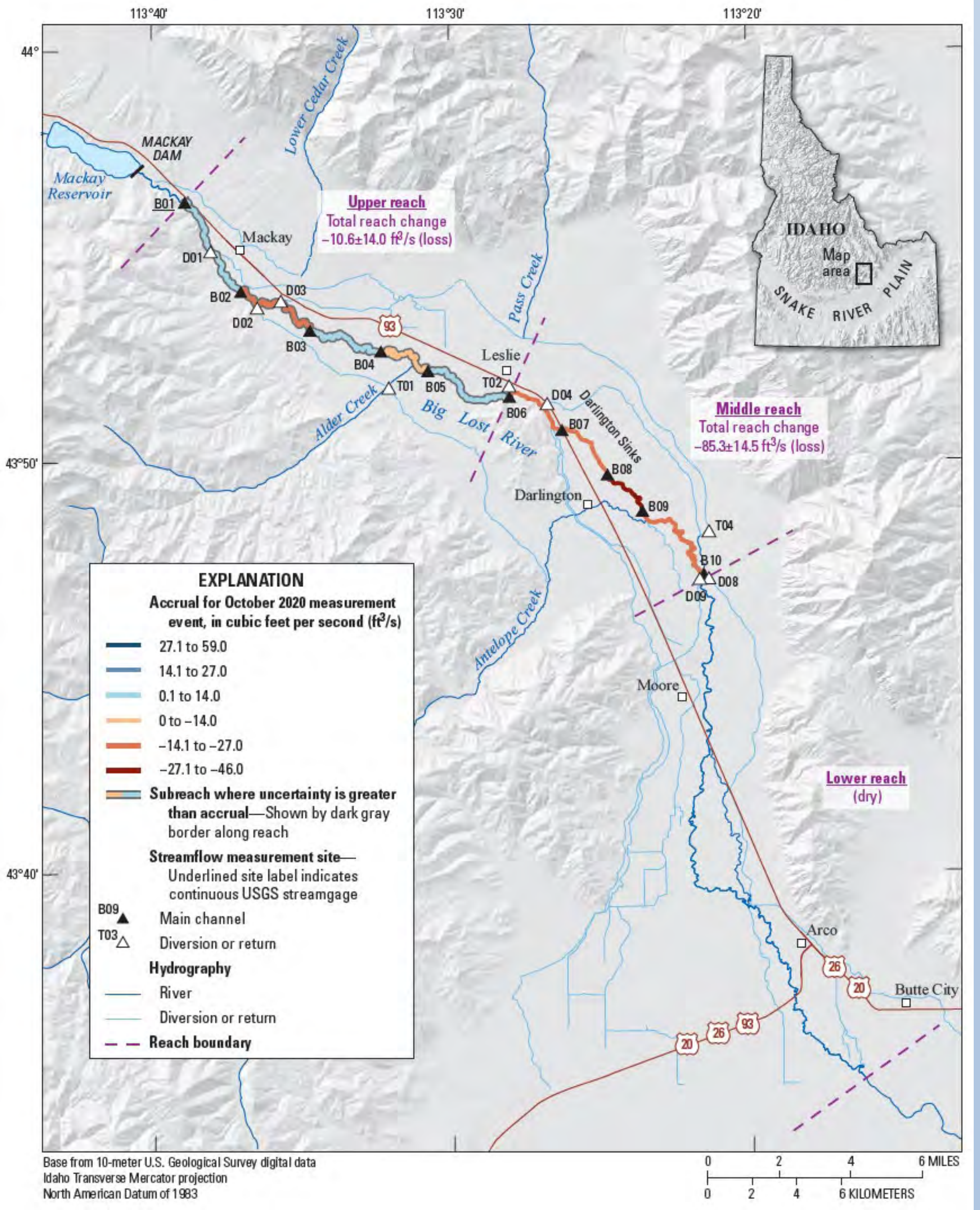
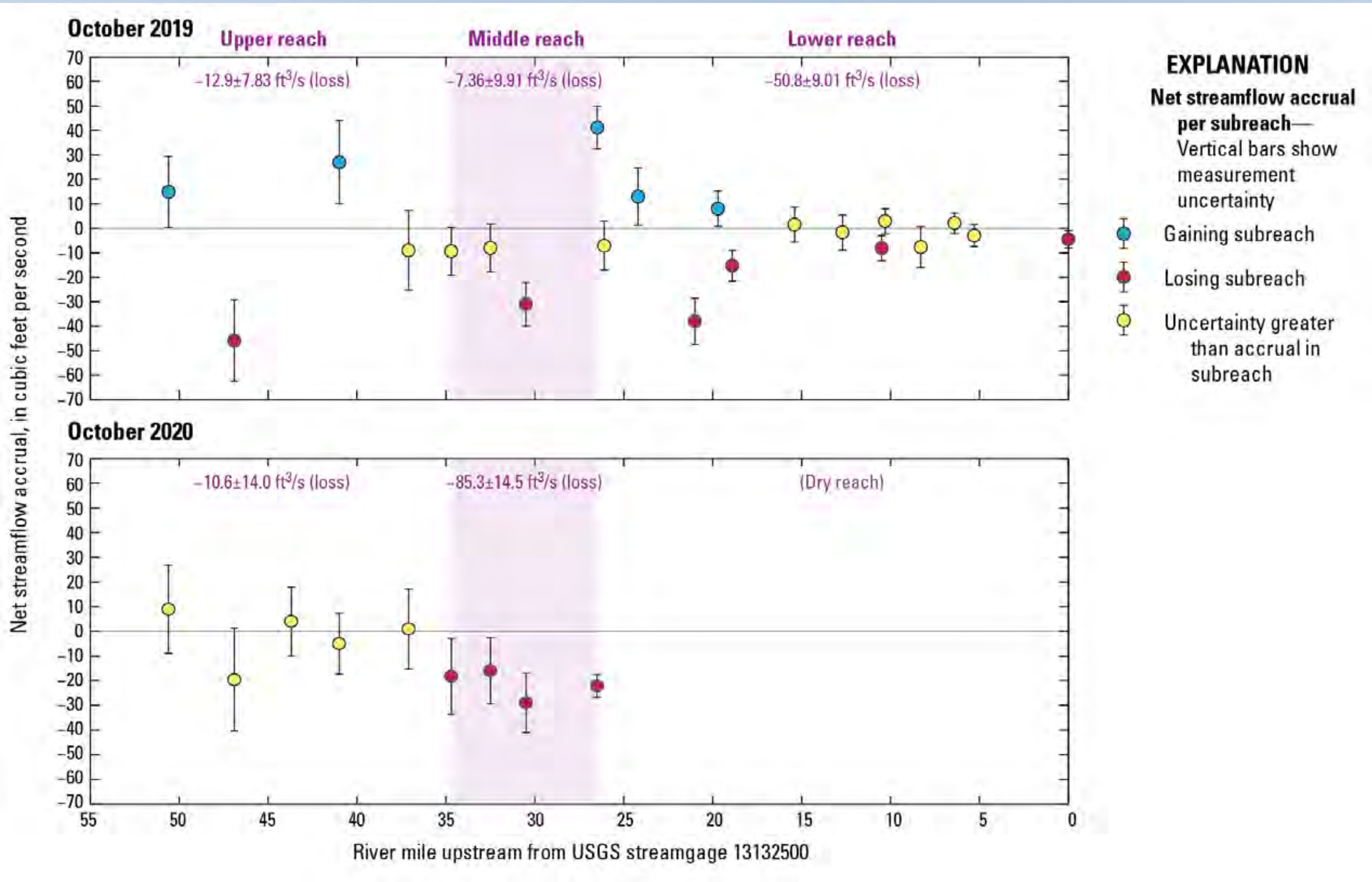


October 2019 vs. October 2020 Results

- Spatial similarities:
  - o Gains and losses through Mackay
  - o Large losses in Darlington Sinks

- Seasonal differences:
  - Management
  - Magnitudes
  - Gain (2019) vs. loss (2020) above Moore Diversion



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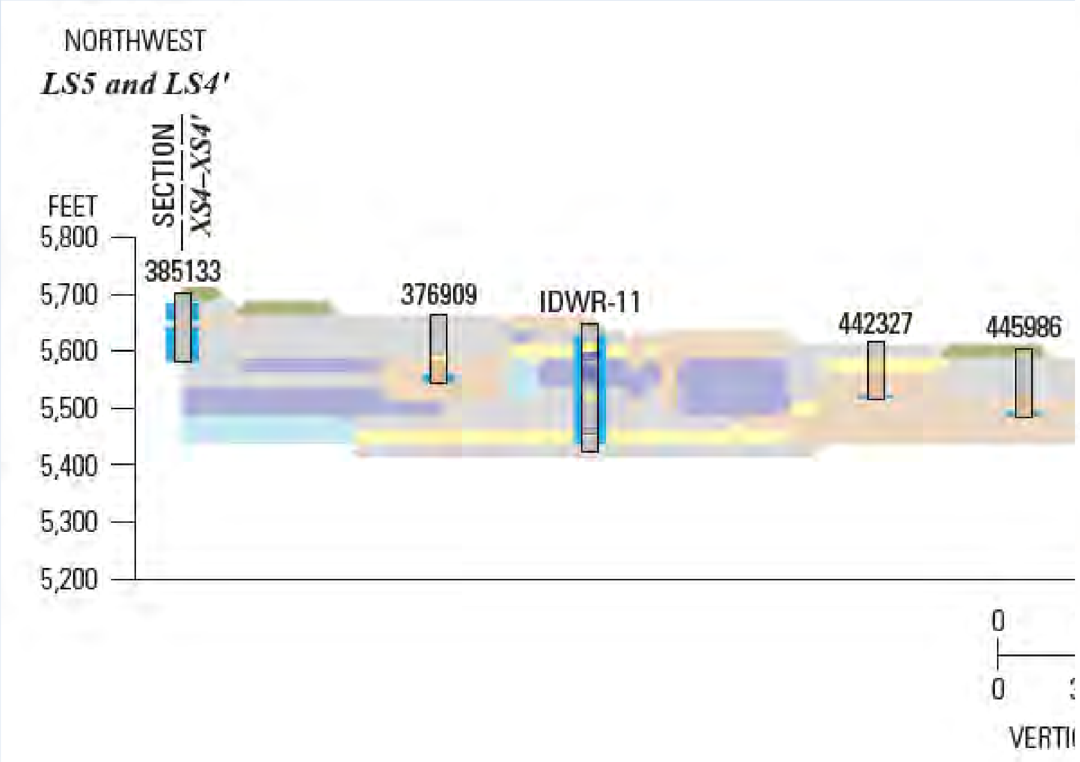
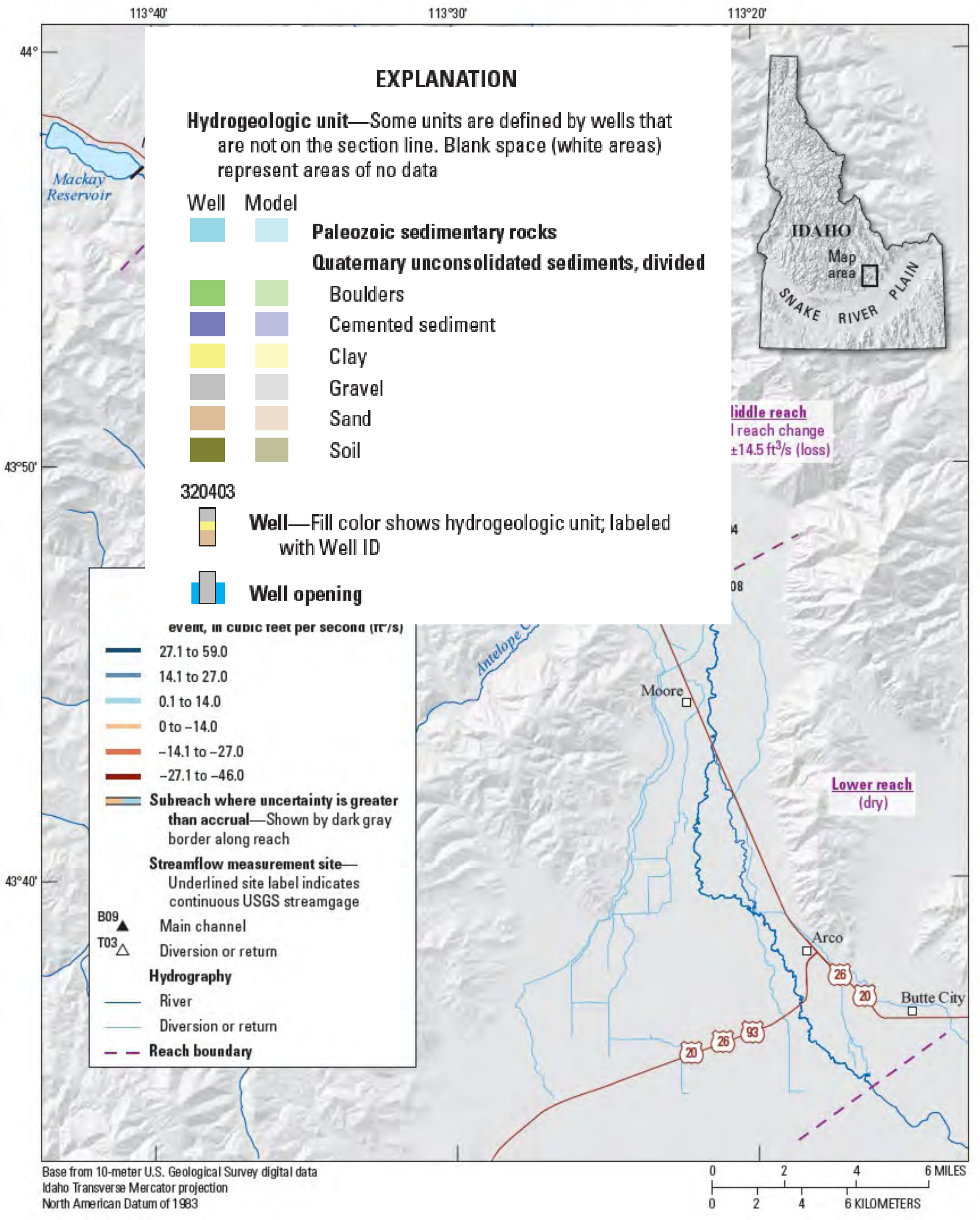
Hydrogeologic controls on river gains and losses

- Persistent spatial pattern: losses at Darlington Sinks
  - o Wider basin
  - o Coarse substrate





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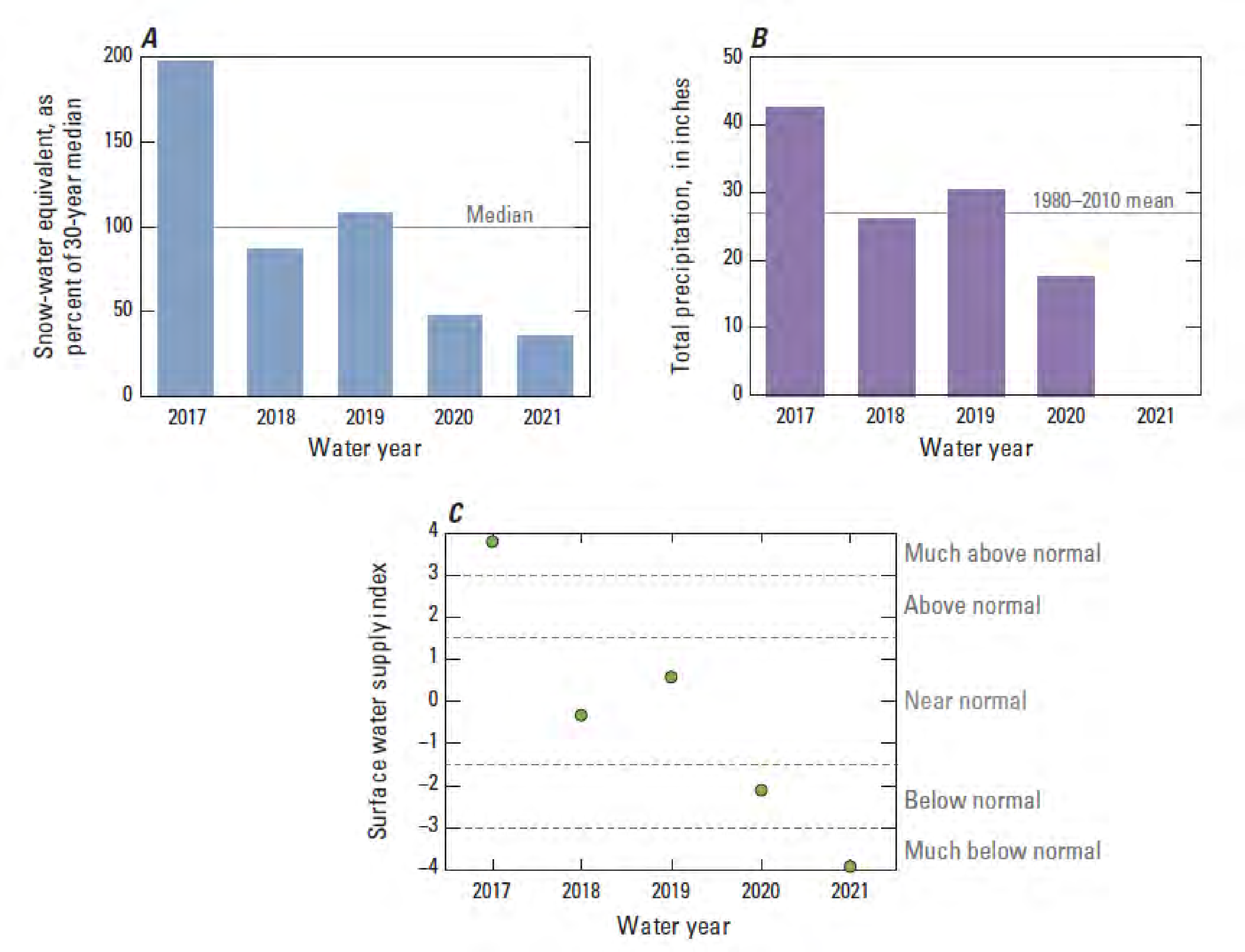
What made October 2020 different from October 2019?

Differences in:
- Water supply
- Water management
- Timing
  - 2019 study post-irrigation season (October 16-17)
  - 2020 at end of irrigation season (October 6-7)



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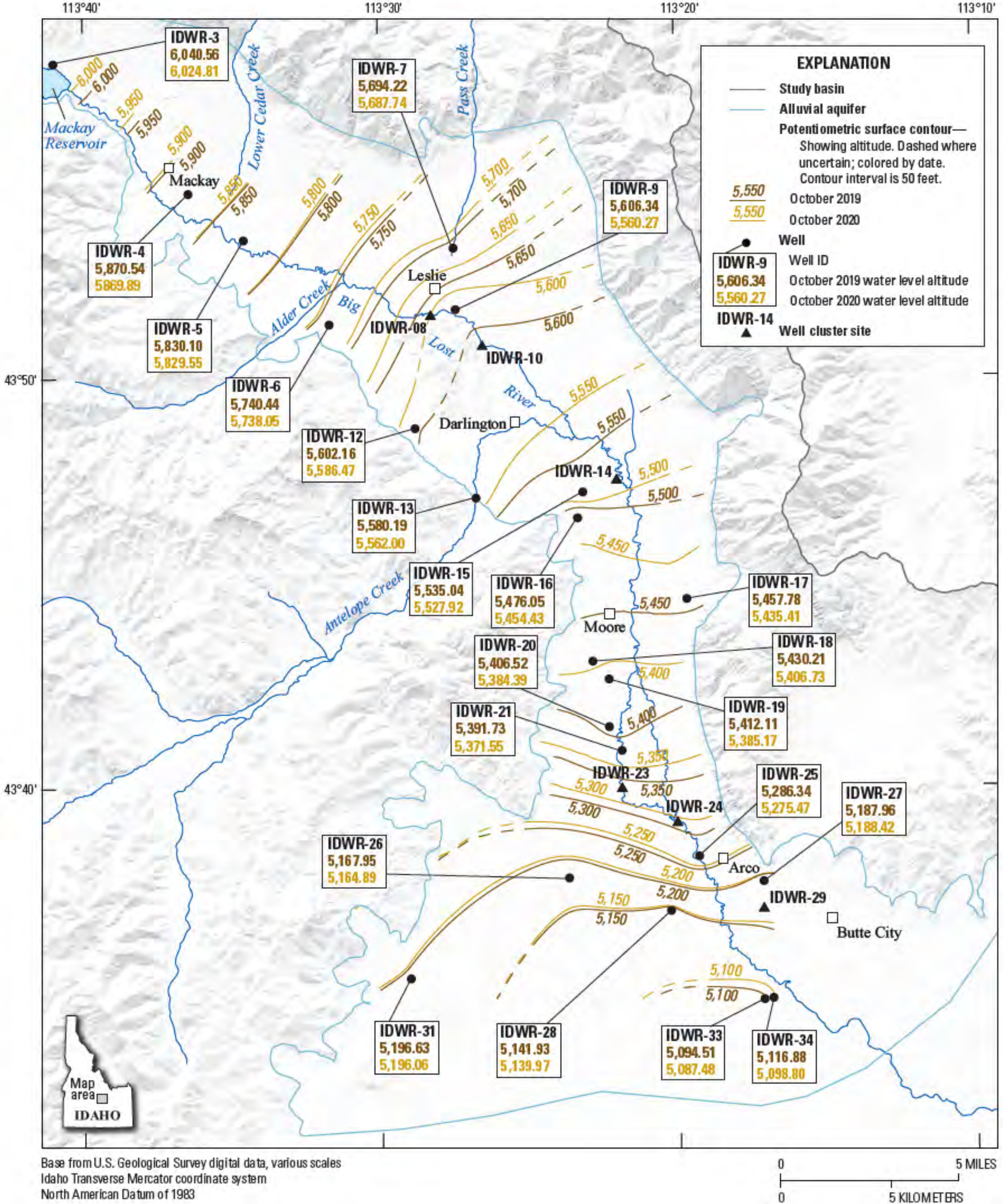
Seasonal controls on river gains and losses

- Variable seasonal patterns:
  gains or losses at Moore Diversion
  - Water supply
  - Recharge
  - Fluctuating groundwater surface elevations from Leslie to past Moore



Summary

- Quaternary unconsolidated sediments comprise the main aquifer

- River gains and losses vary spatially:
  - Variability in sediments
  - Variability in aquifer dimensions

- River gains and losses vary seasonally:
  - Water supply and management

- Losing river reaches are an important component of groundwater recharge *(see the Groundwater Budget and developing model for more on this!)*

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Questions?

Select Works Cited

Hydrogeologic Framework:

Zinsser 2021, SIR 20215078A

Database and model in ScienceBase

Surface Water-Groundwater Interactions:

Dudunake and Zinsser, SIR 20215078B

Data in NWIS

Groundwater-Level Synoptic:

Ducar and Zinsser, SIM (coming Fall 2023)

Data in NWIS

Water Budget:

Clark, SIR 20215078C

Data in report and on IDWR project site

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