OREGON
WATER RESOURCES DEPARTMENT

Groundwater Study

Information Sharing and Community Gathering

October 25, 2018

OREGON WATER RESOURCES DEPARTMENT

Why are we here?

- Introduction to people, process, information
  - What we're up to and what it all means
- Share information
  - This information belongs to all of us
- Say 'thank you'
  - Lots of help from lots of people
- Build trust
  - "Progress moves at the speed of trust"

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I'm Harmony...this is my dad

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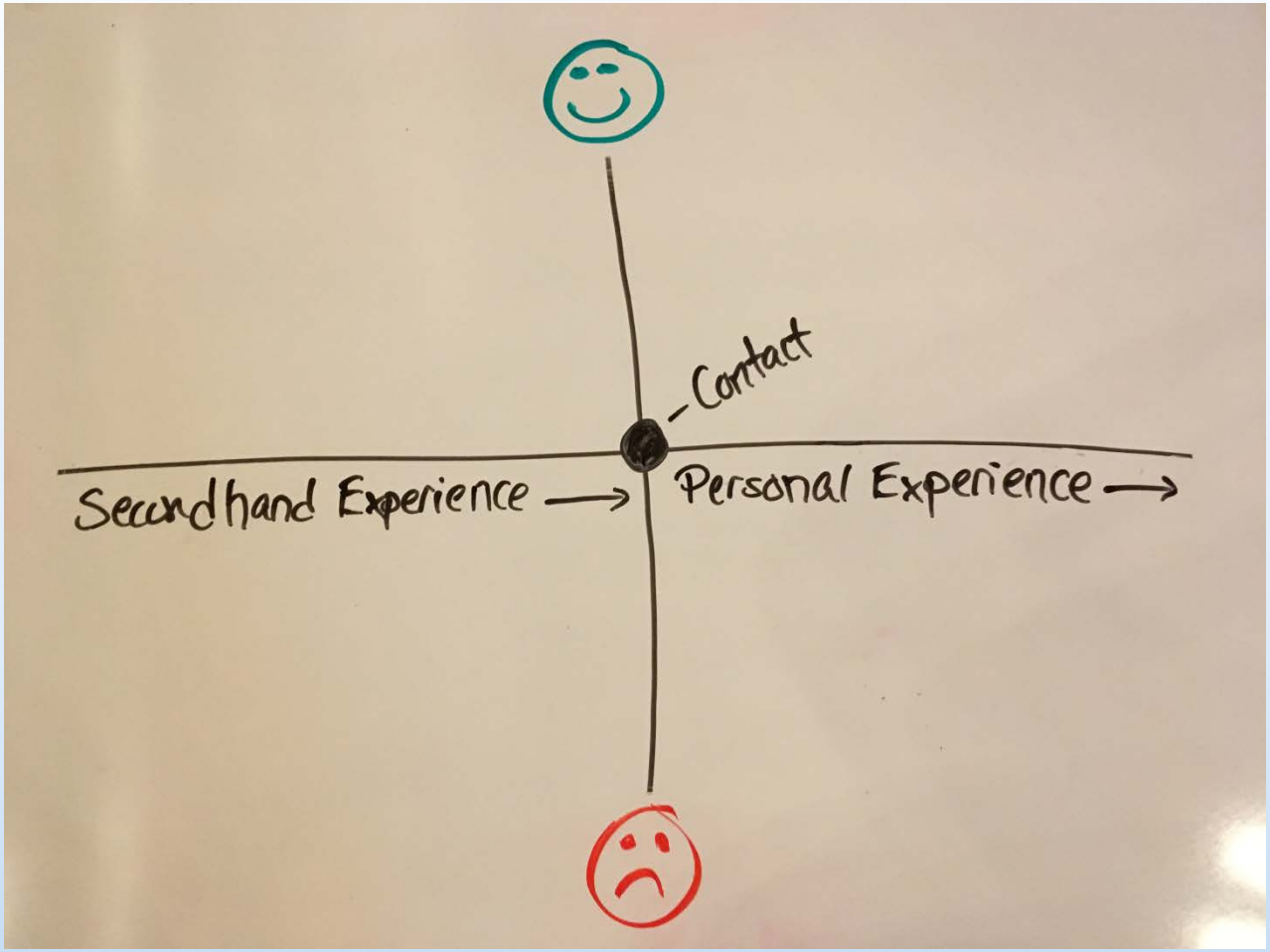
Basic theory of trust



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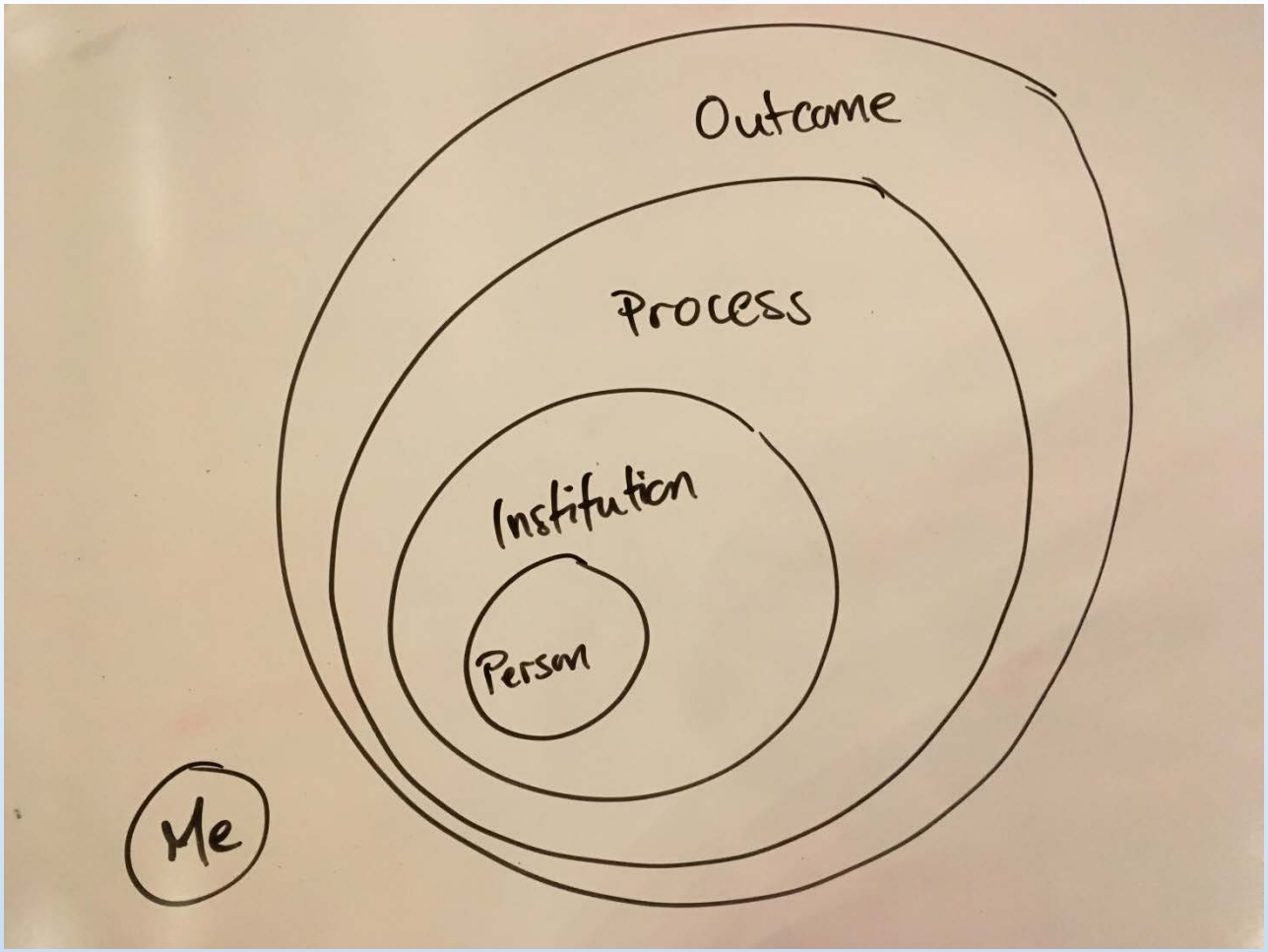
How do we build trust?



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Ground rules

- Be nice
- Share the time and space
- Lead with your curiosity
- There are no stupid questions
- Help people understand where you're coming from
- Focus on the science – we're not here to make management decisions

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Logistics

- First half - lightning presentations
- Second half - break out tables
- Make yourself comfortable
  - Bathrooms, food, drinks

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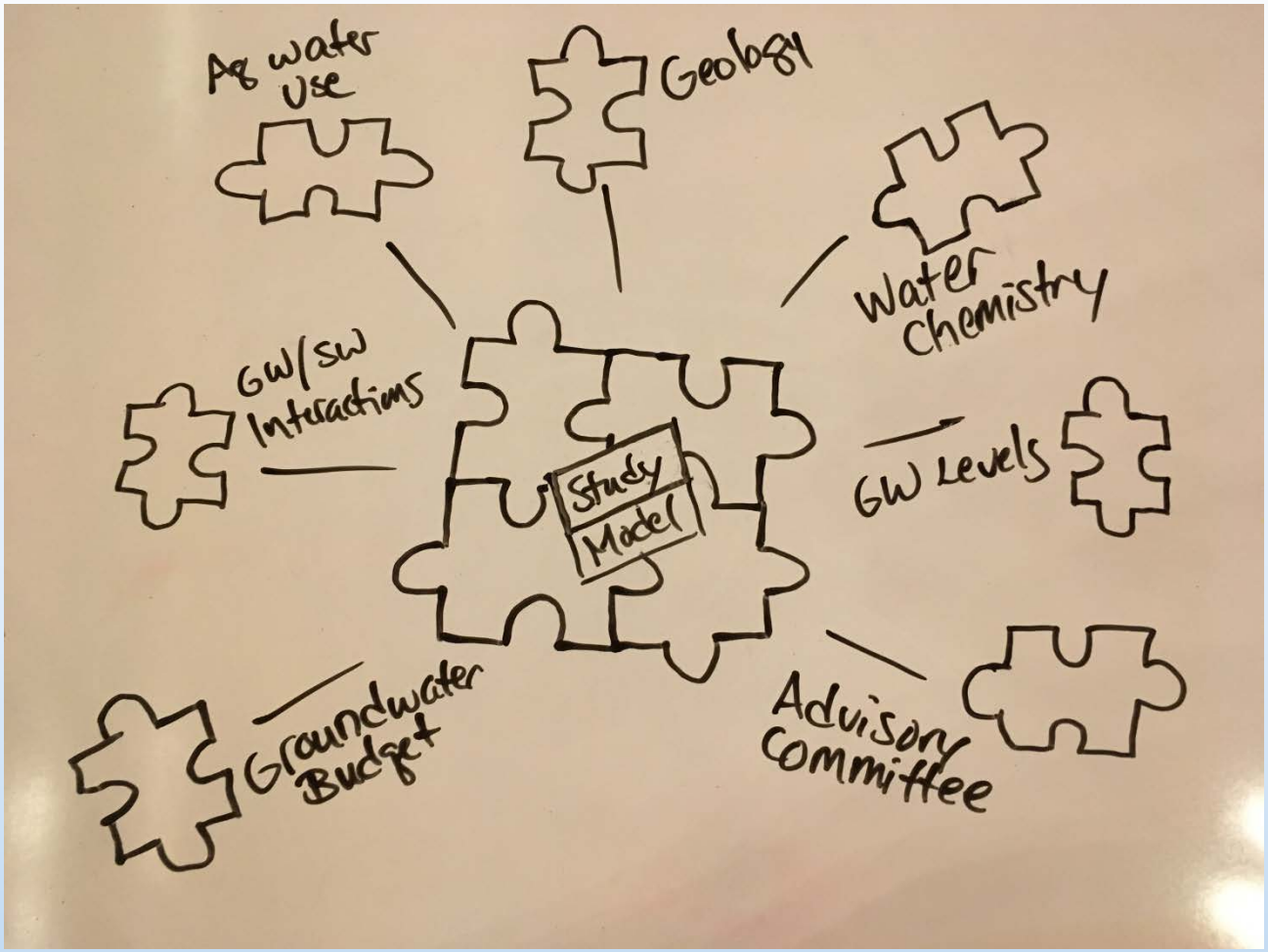
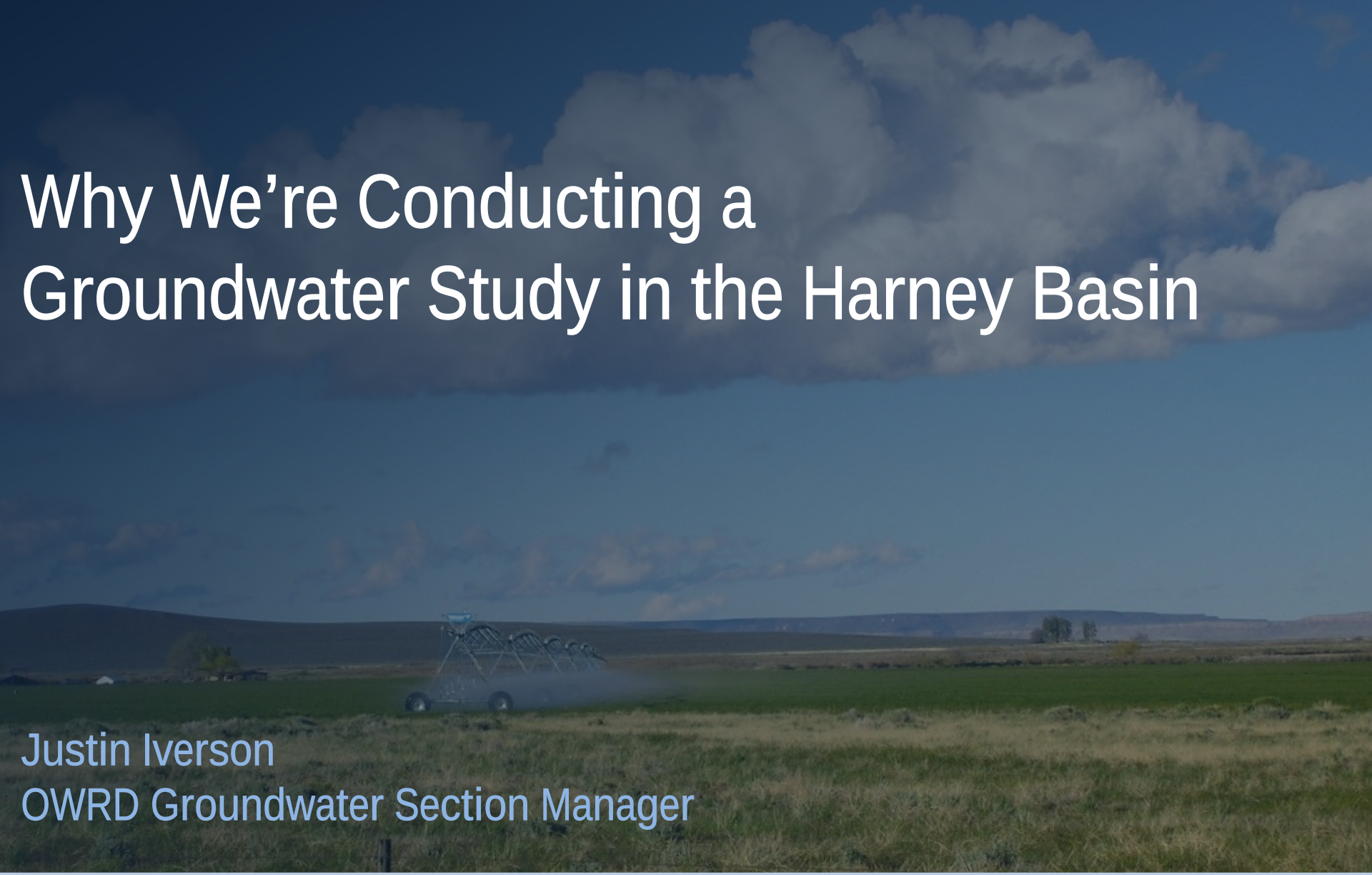
Road map to the evening



Why We're Conducting a Groundwater Study in the Harney Basin



Justin Iverson
OWRD Groundwater Section Manager

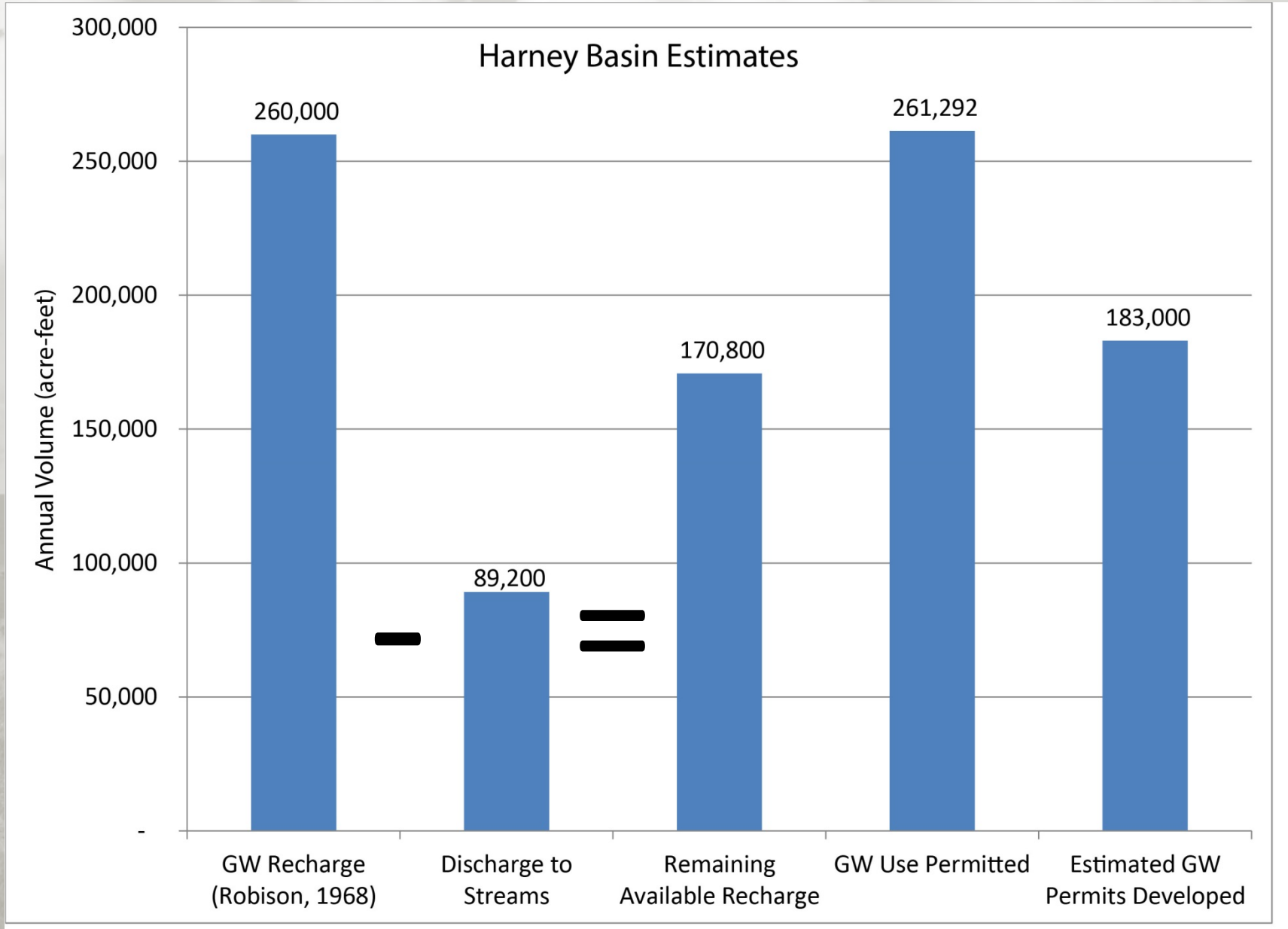
OREGON WATER RESOURCES DEPARTMENT

Burns, Oregon
October 25, 2018

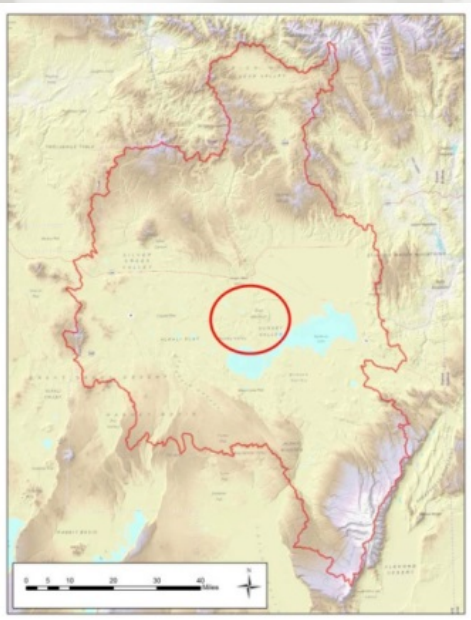
Introductions

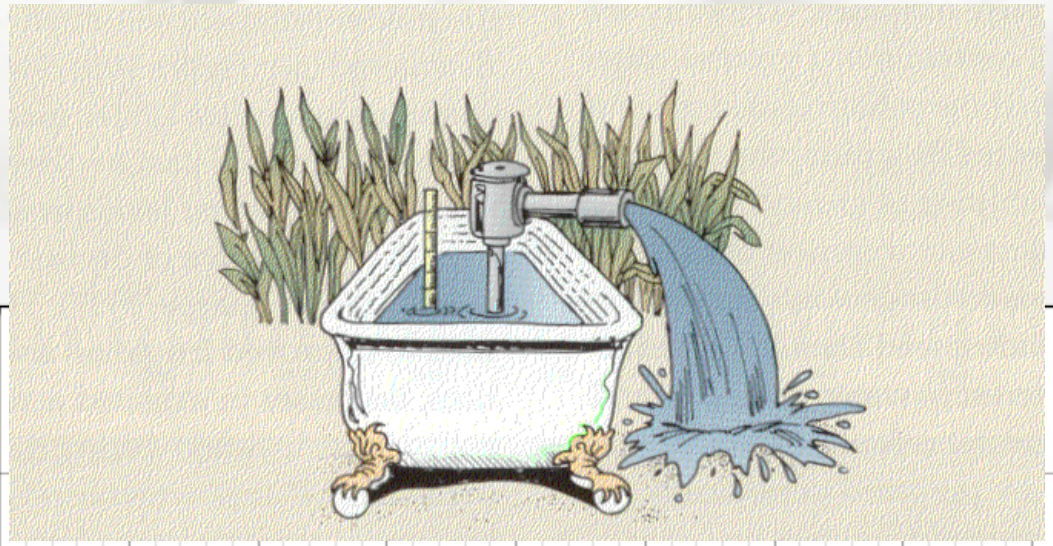
Why? – Groundwater is a Vital Primary Resource

Background – Initial Water Balance



Background – Water Level Trends



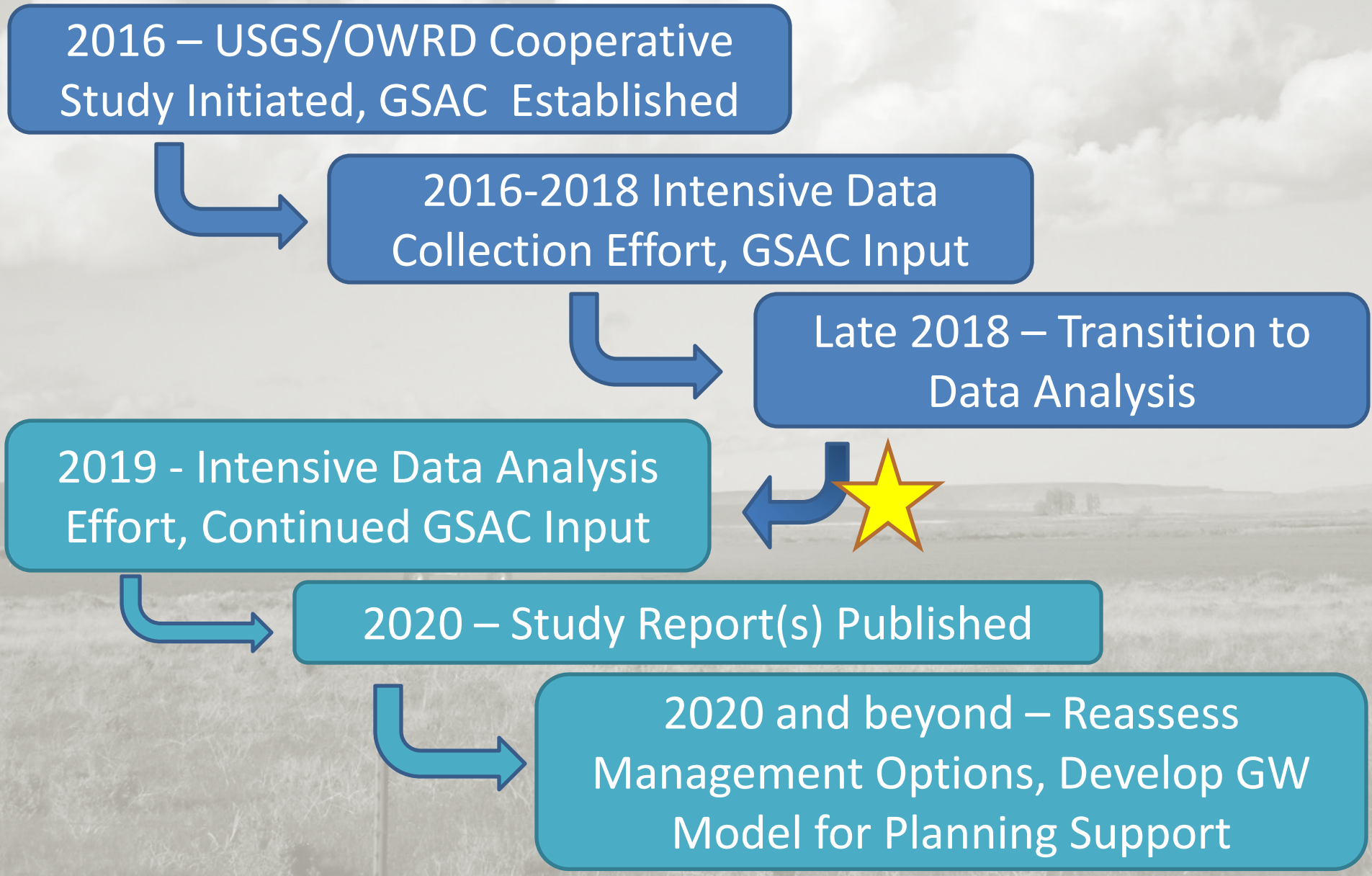


~1955 --- Time ---> Today

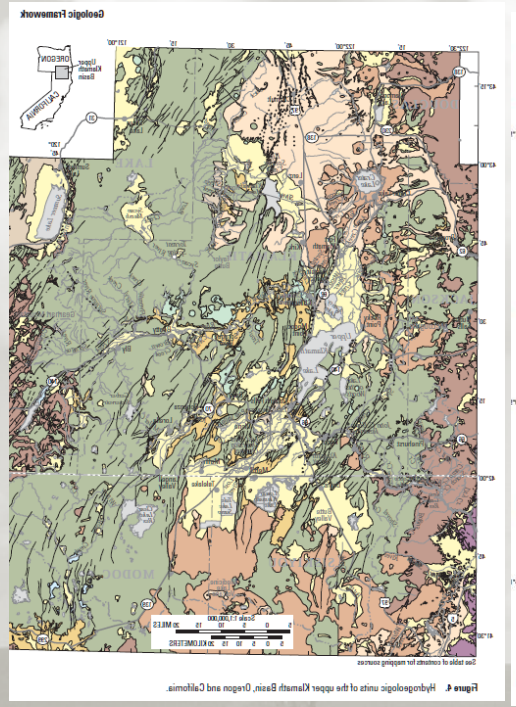
Background - Rulemaking

- Basin rules adopted in April 2016 to:
  - Protect existing groundwater users
  - Initiate a basin-wide groundwater study to develop a more detailed and commonly accepted understanding of the hydrologic system in the Harney Basin
  - Convene a local Groundwater Study Advisory Committee (unique)

Groundwater Basin Study - Timeline



Groundwater Basin Study - Reports



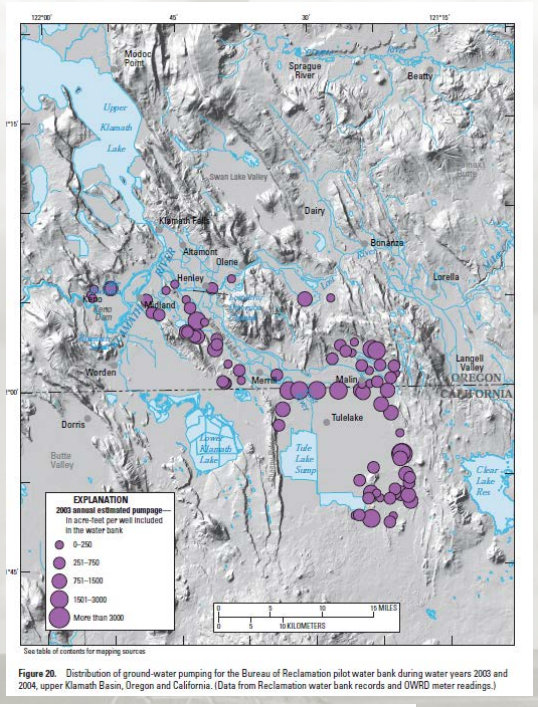
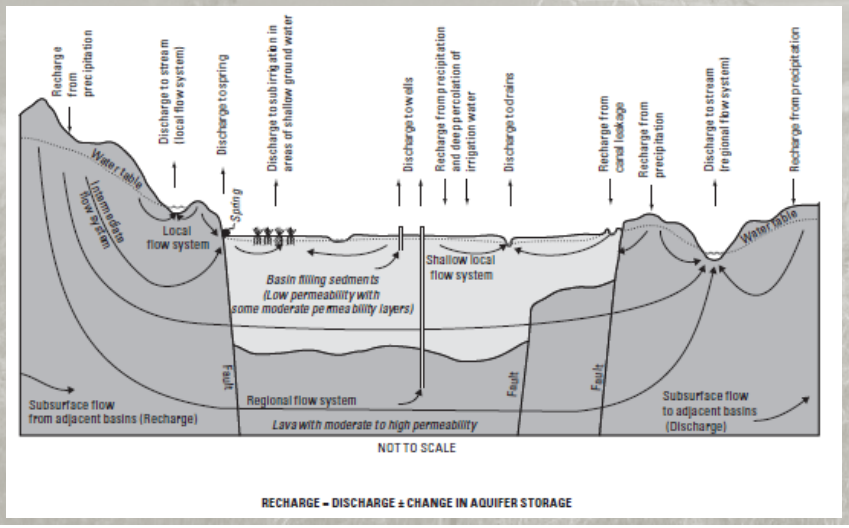


Figure 20. Distribution of ground-water pumping for the Bureau of Reclamation pilot water bank during water years 2003 and 2004, upper Klamath Basin, Oregon and California. (Data from Reclamation water bank records and OWRD meter readings.)



USGS
science for a changing world

Prepared in cooperation with the Oregon Water Resources Department

Ground-Water Hydrology of the Upper Klamath Basin, Oregon and California

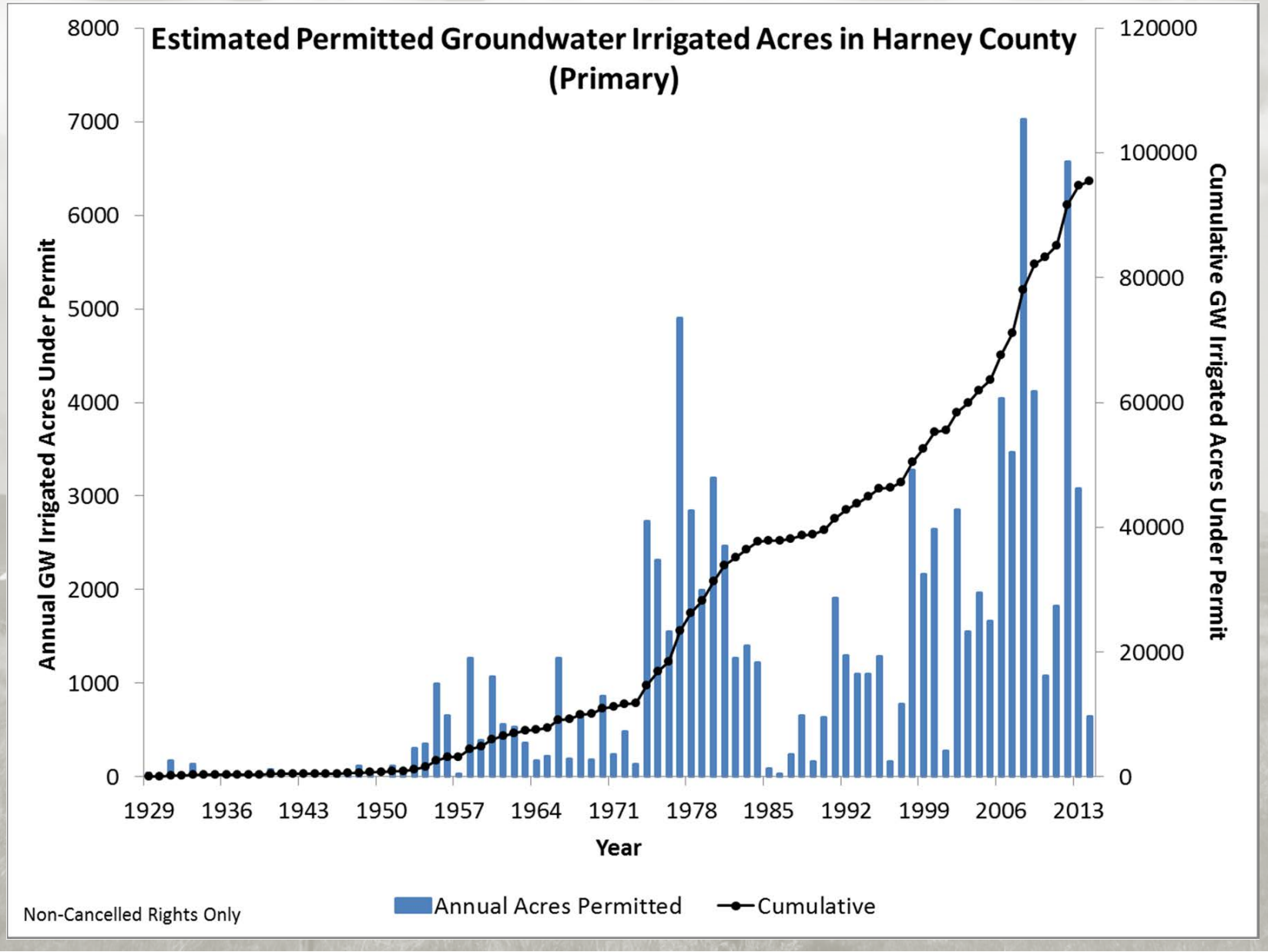
Scientific Investigations Report 2007–5050
Version 1.1, April 2010

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

Open House

- **<u>Come talk with me about:</u>**
  - Events leading up to the study
  - Study design, partners, and independent complementary studies occurring in the basin
  - Study schedule, integration with other work in the basin
  - My introduction to and excitement about “The Harney County Way” - Collaborative Summit last May with the High Desert Partnership

Background – Groundwater Development



Groundwater Basin Study

- Study Objectives:
  - Develop a commonly accepted and accurate understanding of the hydrologic system in the Harney Basin.
  - Plan and conduct the Study in coordination with a local Groundwater Study Advisory Committee (not the norm).

Groundwater Basin Study

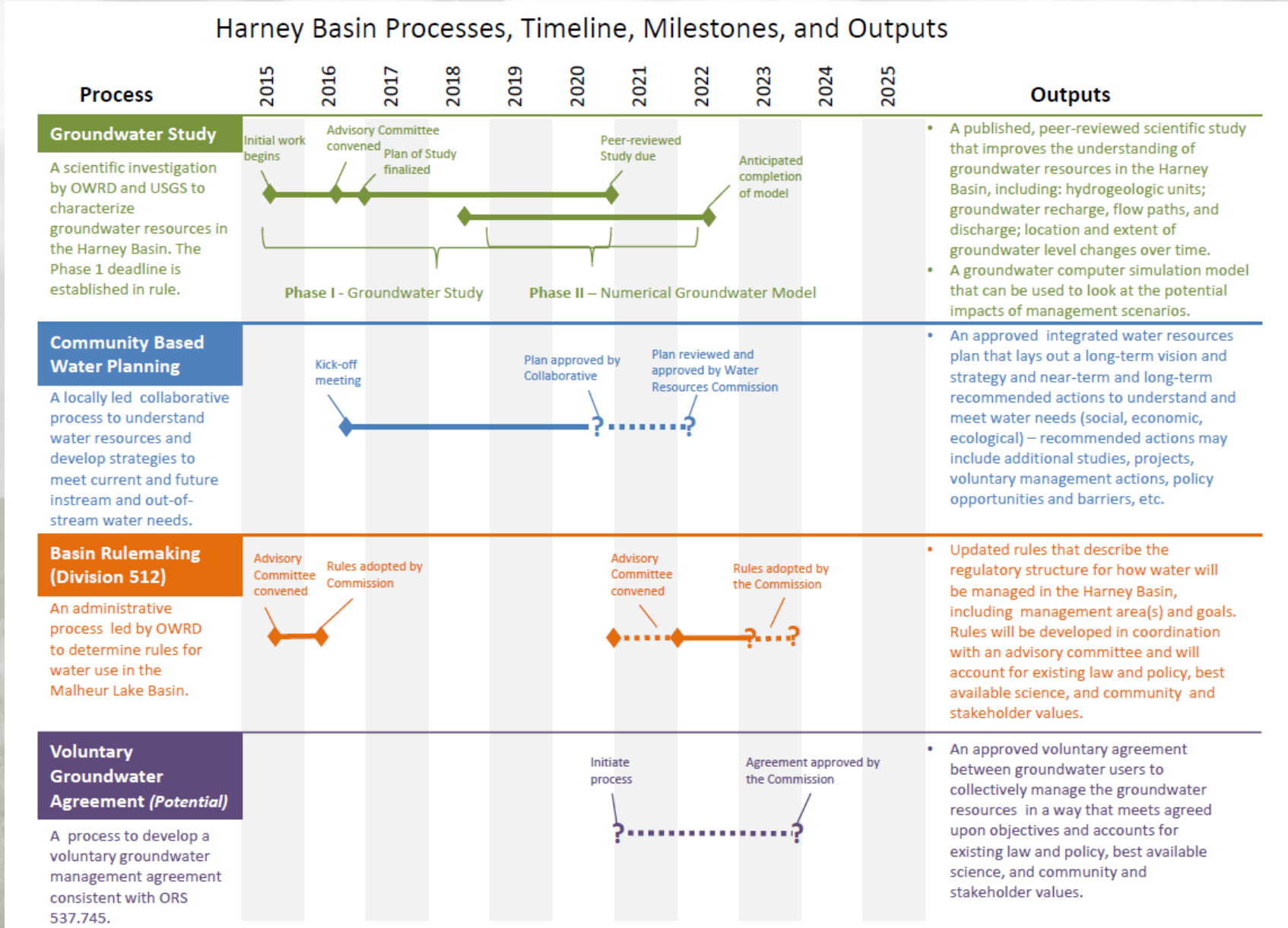
- Technical Objectives:
  - Gather and assess existing data
  - Collect new data required to better define the hydrogeologic system
  - Develop a detailed water budget
  - Develop an improved conceptual model of the Harney Basin groundwater-flow system

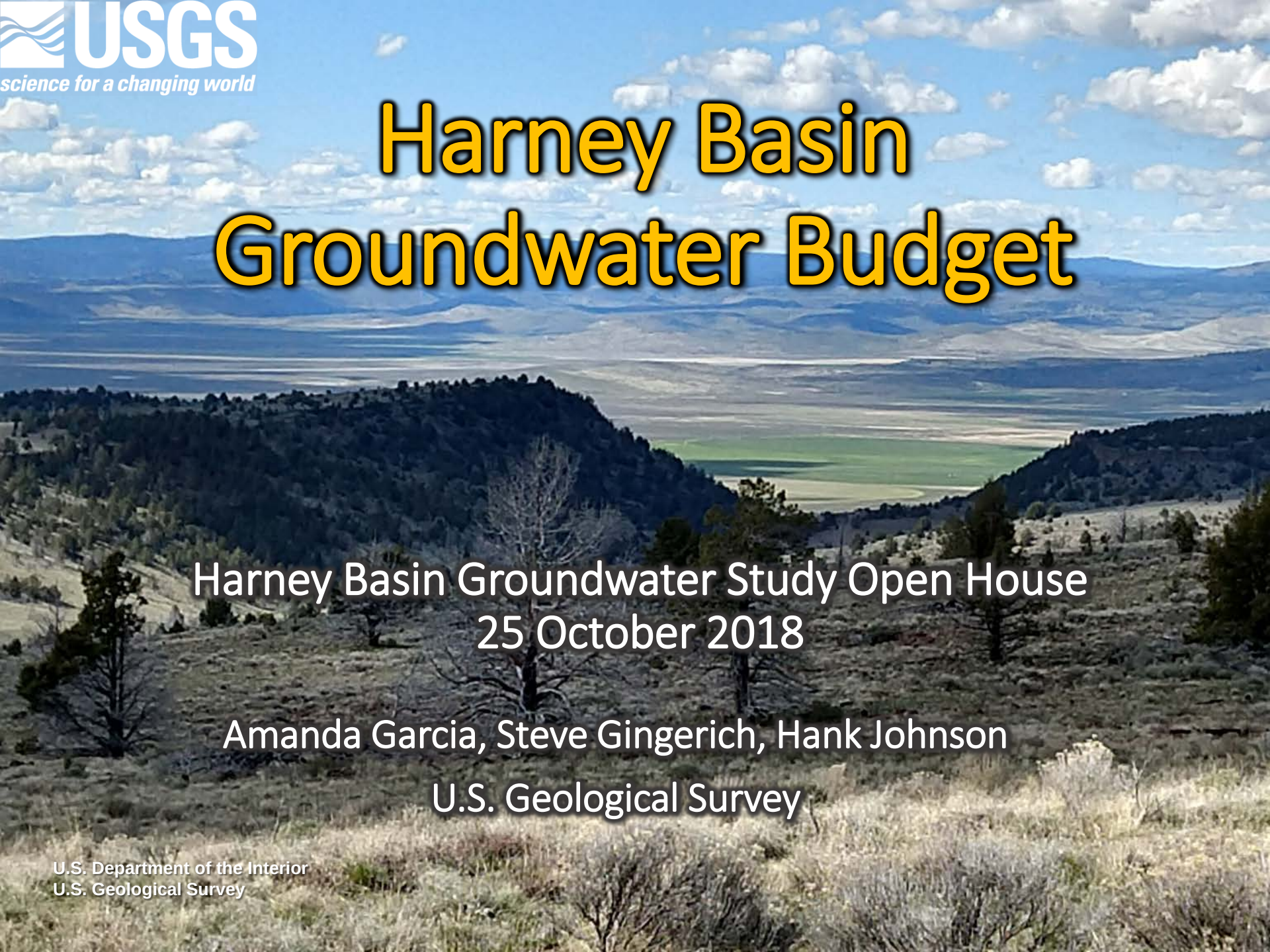
Groundwater Basin Study

- Study Cooperators:
  - Oregon Water Resources Department (OWRD)
  - United States Geological Survey (USGS)
  - Local involvement through the Groundwater Study Advisory Committee and Watershed Council
  - Other contracted studies (DOGAMI) and independent studies (Crane School/PSU, DEQ, OSU, UNR-DRI, TNC) will add to this work

Schedule and Big Picture

Harney Basin Processes, Timeline, Milestones, and Outputs




USGS
science for a changing world
Harney Basin
Groundwater Budget
Harney Basin Groundwater Study Open House
25 October 2018
Amanda Garcia, Steve Gingerich, Hank Johnson
U.S. Geological Survey
U.S. Department of the Interior
U.S. Geological Survey

A Little Background…

USGS

Groundwater Budget

Image source: Microsoft PowerPoint Clip Art Gallery
Used with permission from Microsoft.

USGS

IN

OUT

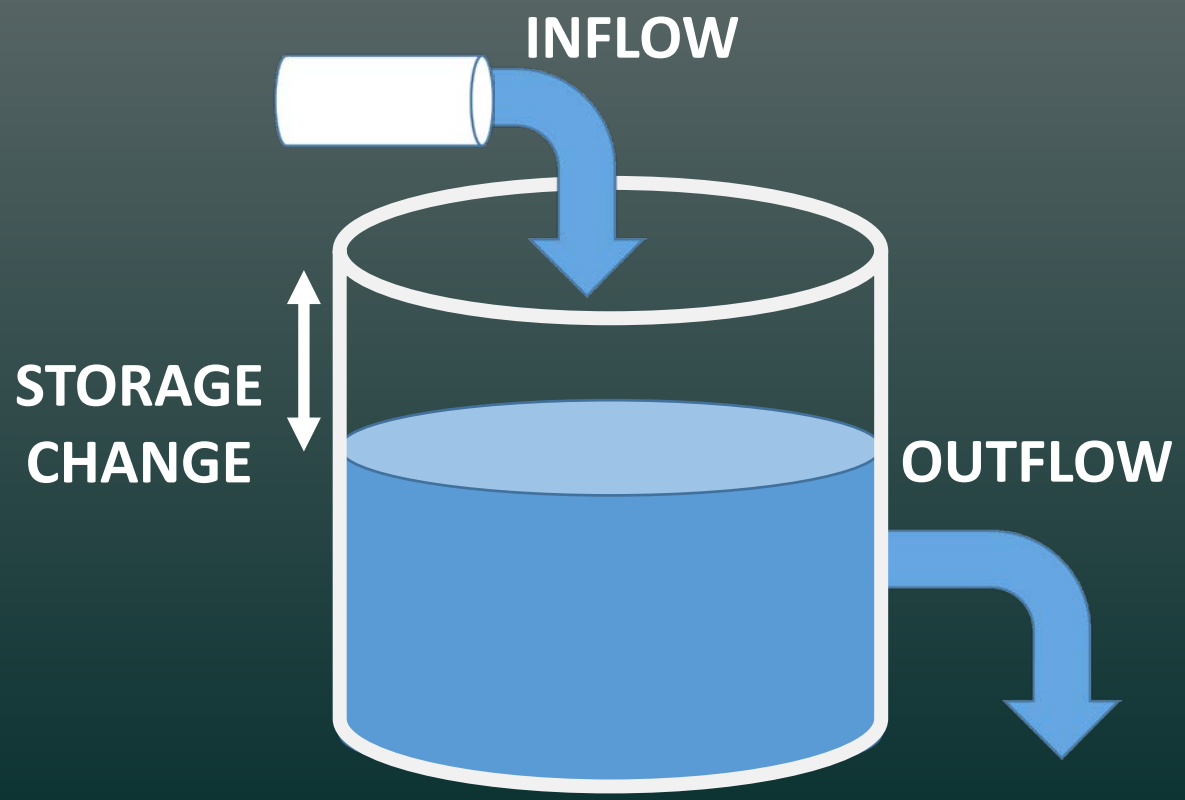
Image sources: Microsoft PowerPoint Clip Art Gallery
Used with permission from Microsoft.

NET CHANGE IN ACCOUNT

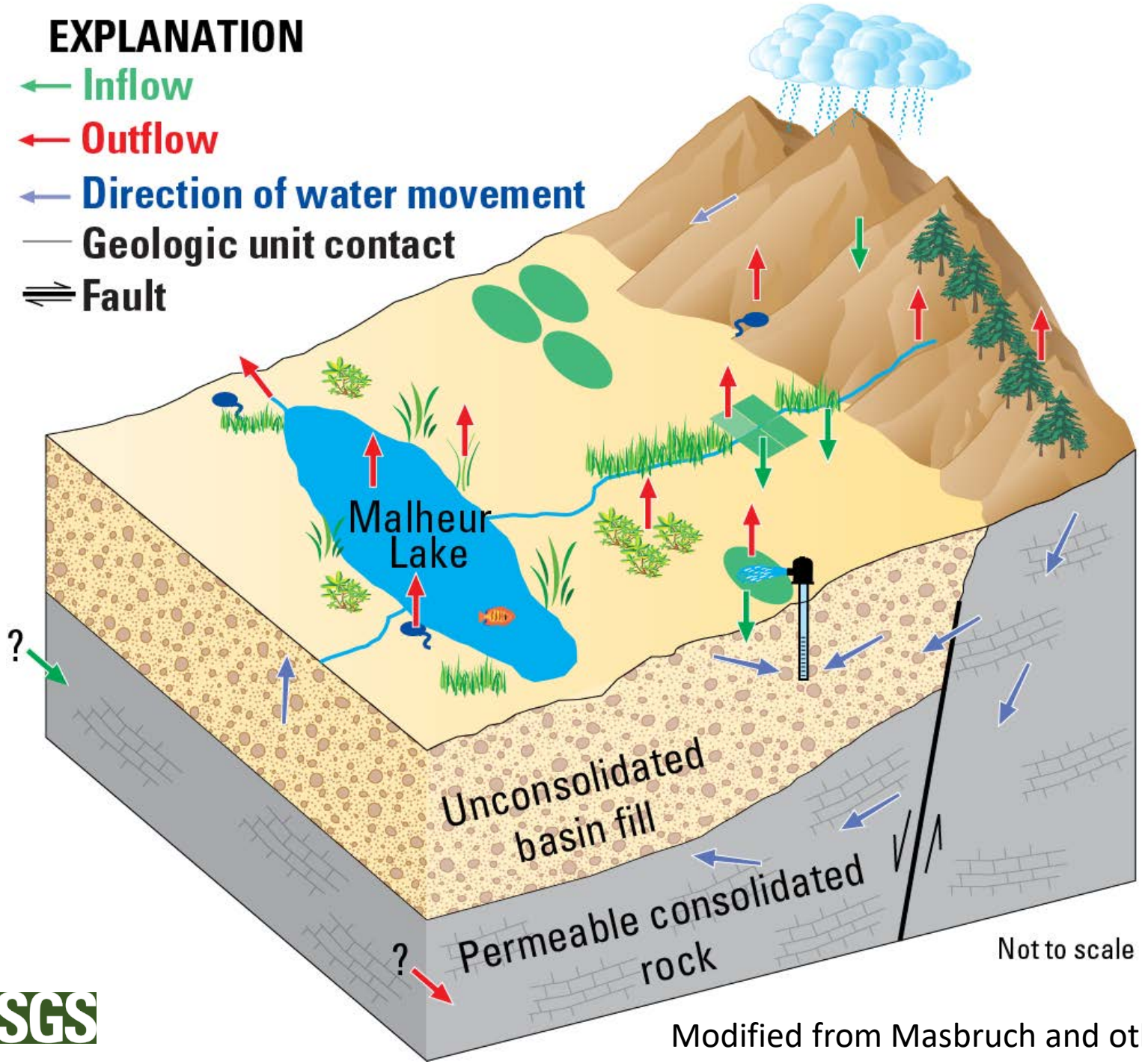
USGS

Basin Groundwater Budget

↓INFLOW = ↑OUTFLOW ± CHANGE IN STORAGE

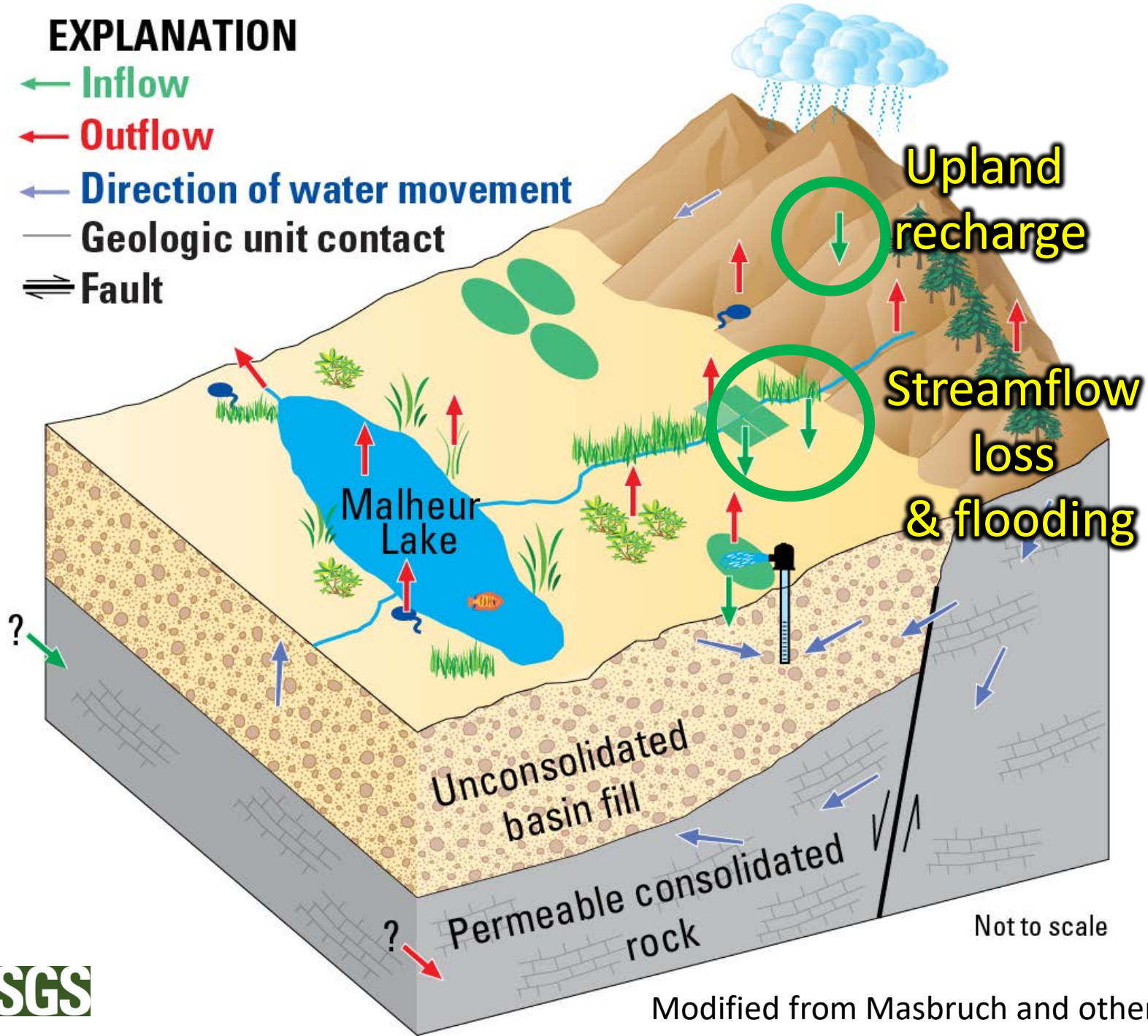


USGS



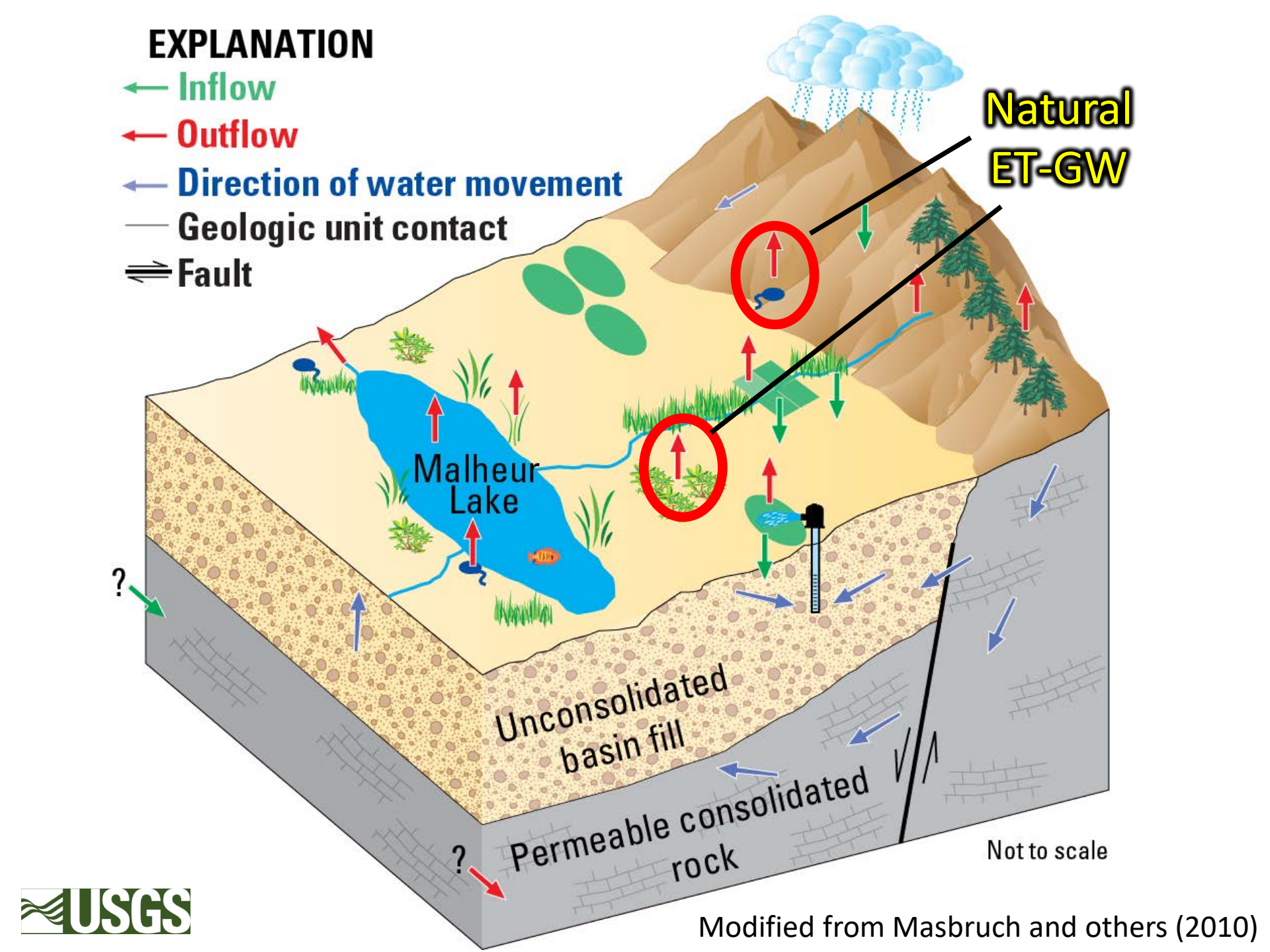
USGS

Modified from Masbruch and others (2010)



USGS

Modified from Masbruch and others (2010)



USGS

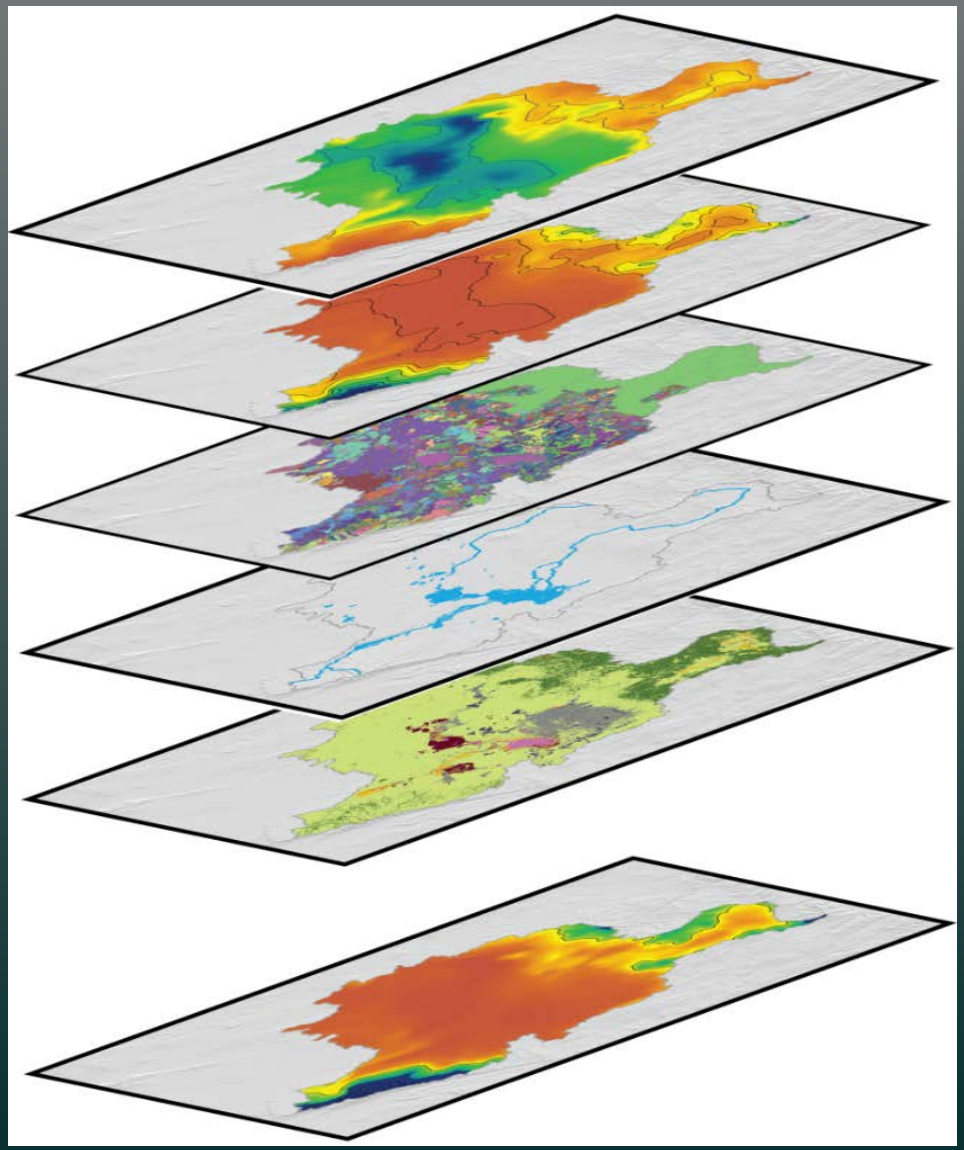
Modified from Masbruch and others (2010)

Recharge Estimation

- Precipitation
- Evapotranspiration (ET)
- Soils
- Runoff
- Land cover
- Flood maps

↓

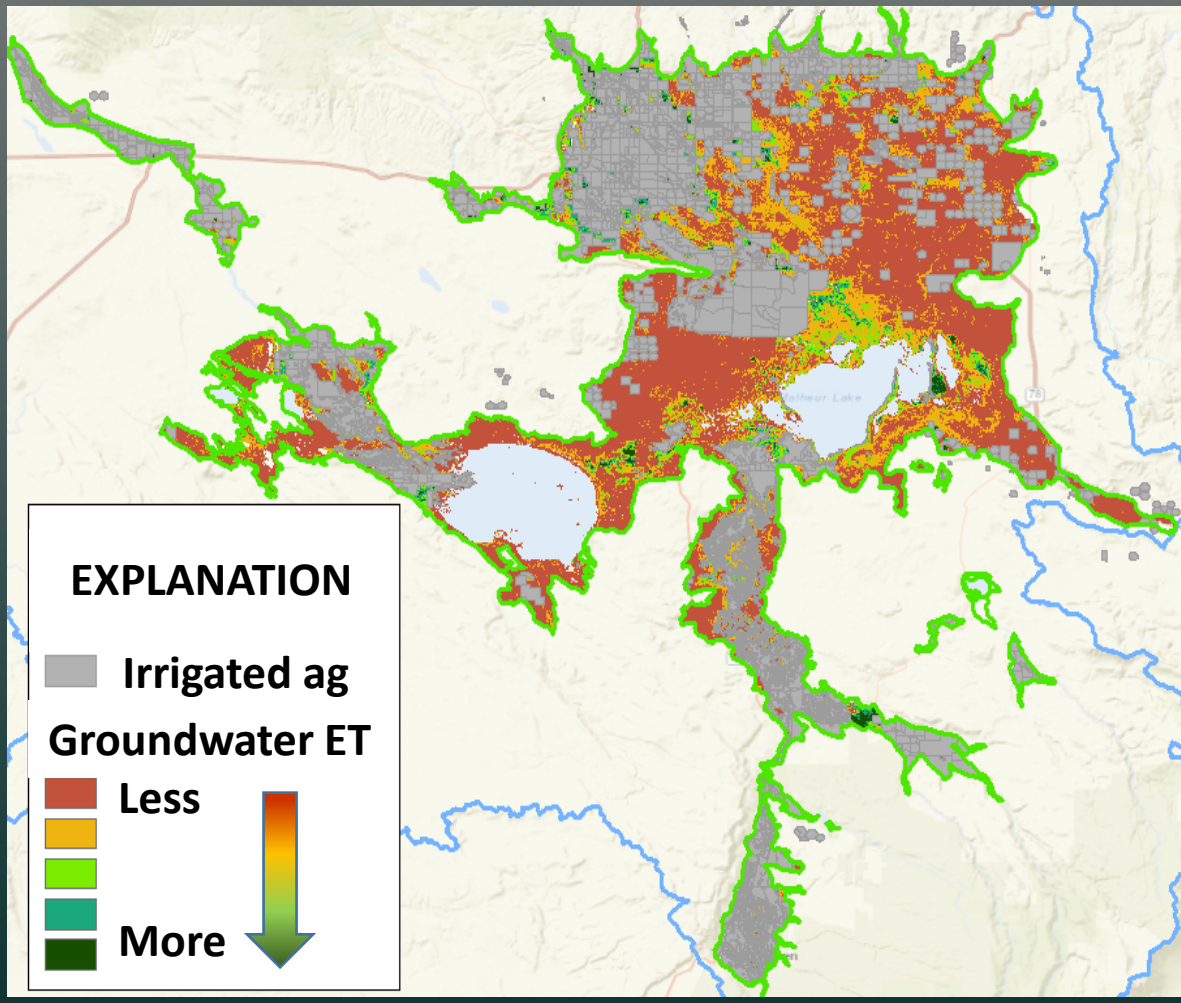
- Recharge



USGS

Discharge Estimation

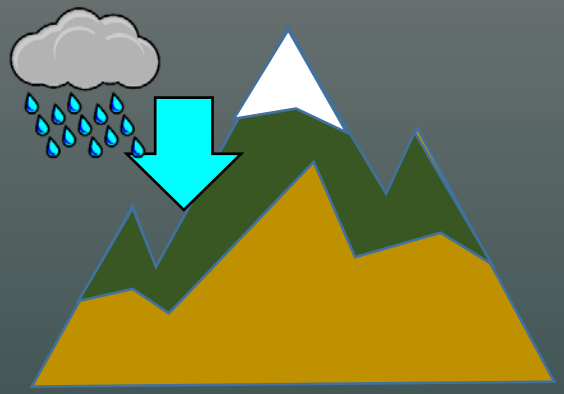
- Natural groundwater evapotranspiration (ET)
  - Vegetation maps
  - Weather data
  - ET data
  - Field verification



USGS

Total Recharge (Preliminary Estimate)

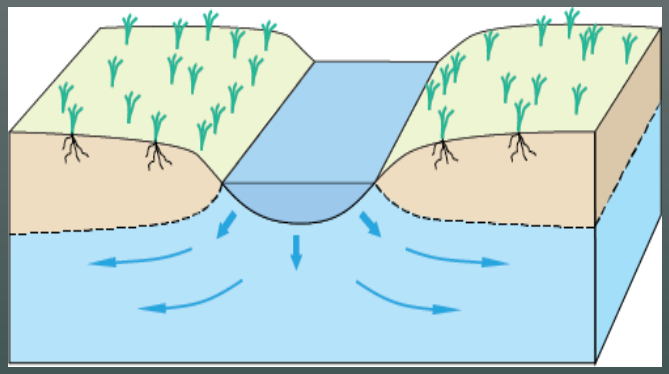
Upland recharge



~120,000 acre-ft/yr (AFY)

+

Streamflow loss

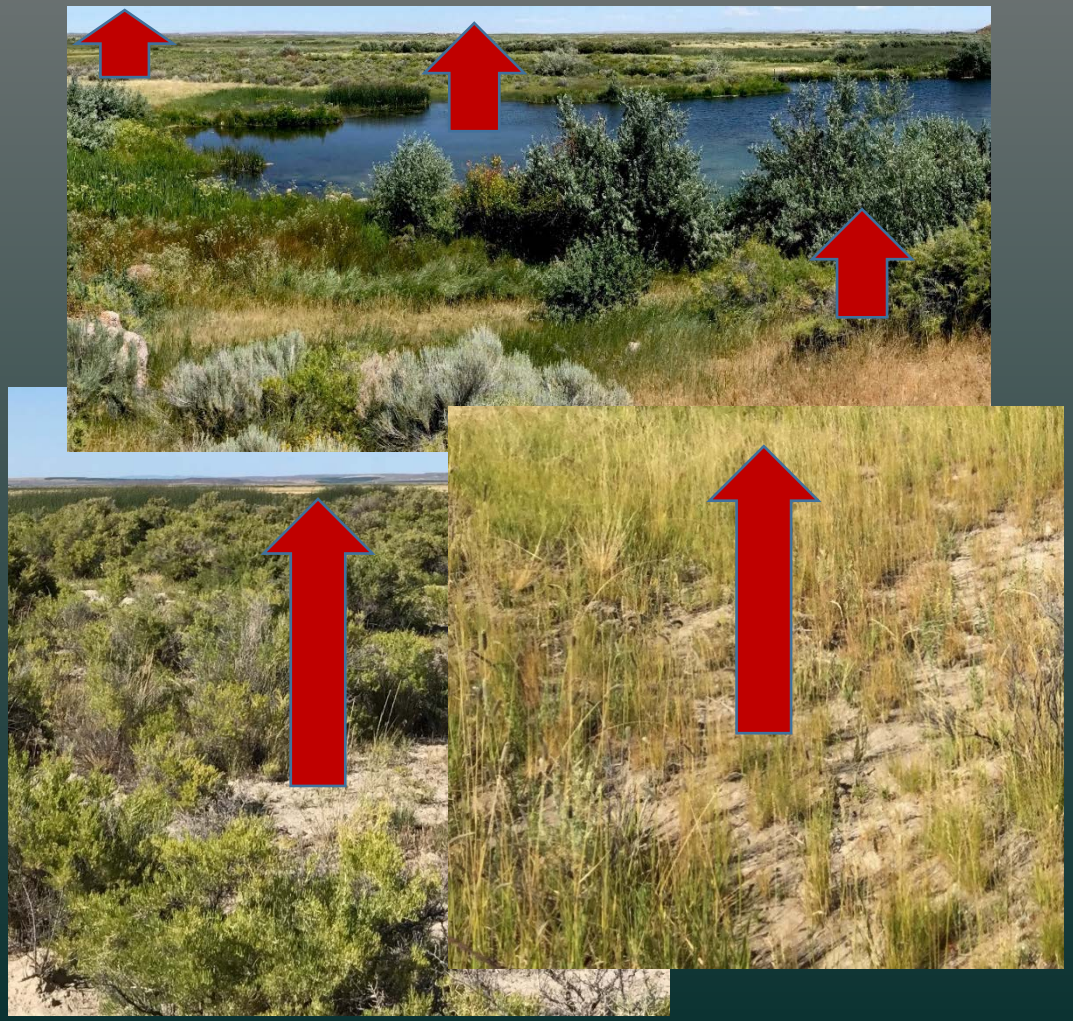


~40,000 –100,000 AFY

Total recharge ≈ 160,000 – 220,000 AFY

Similar to range in previous estimates (170,000 – 260,000 AFY)

Natural Groundwater Discharge by Evapotranspiration (Preliminary Estimate)



190,000 – 220,000 acre-ft/yr (AFY)

- **Similar to recharge est.**
- **Within previous est. range (170,000 – 260,000 AFY)**

USGS

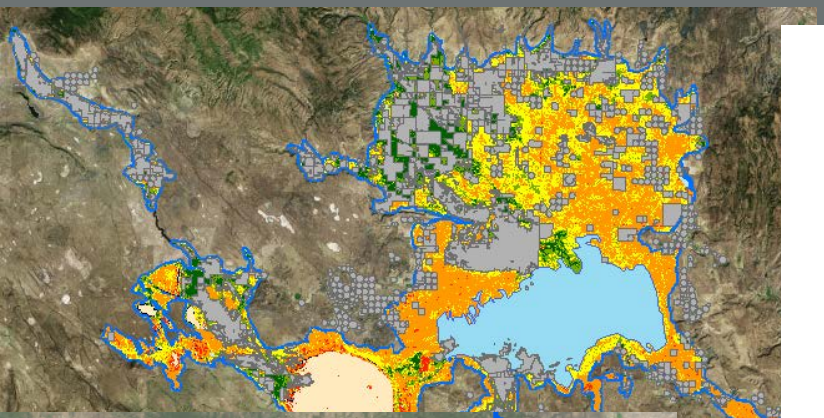
Unpublished data, subject to revision. Do not cite.

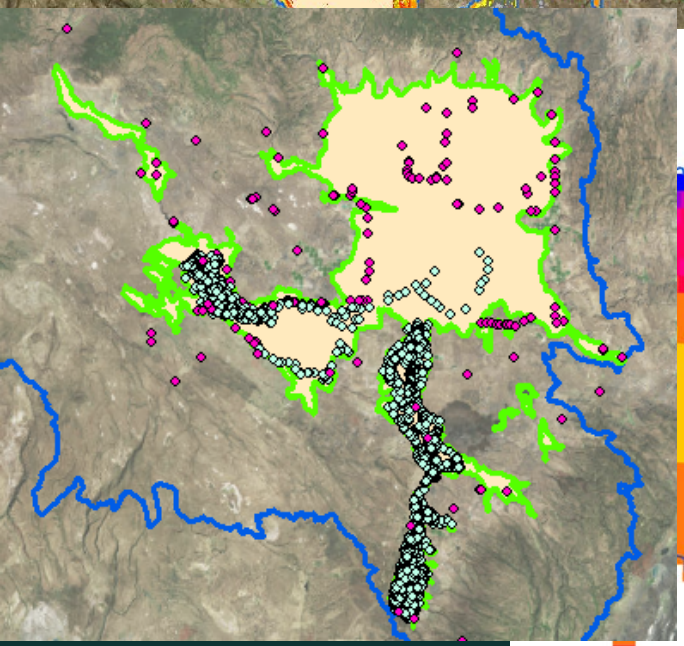
Next Steps

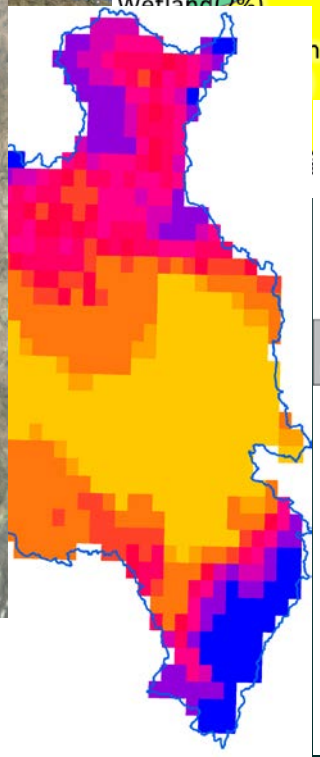
- Refine estimates using satellite and measured data
- Evaluate distributions of recharge and discharge across the basin

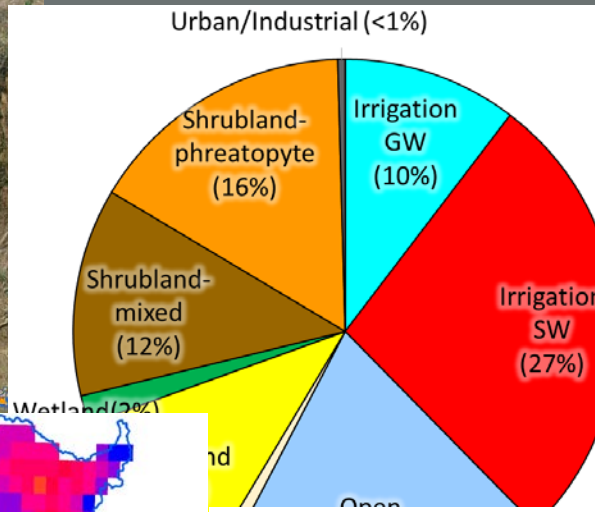
USGS

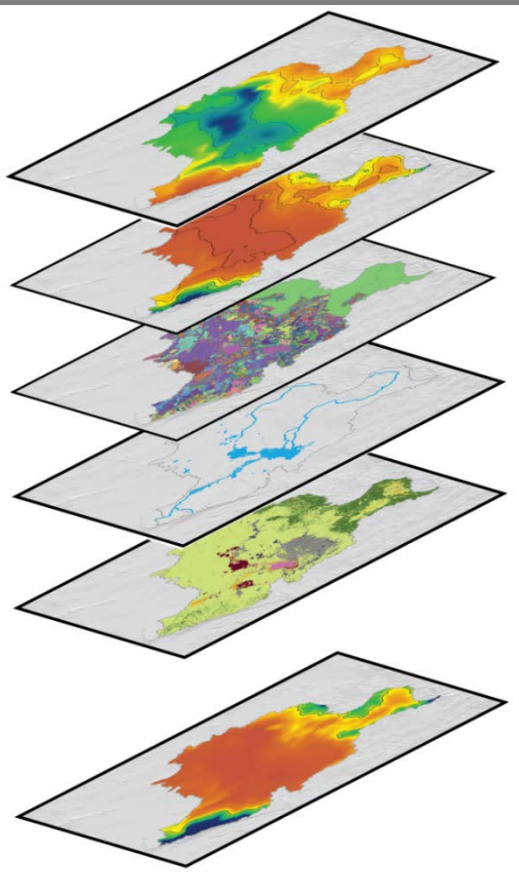
Come See How Estimates Are Being Made

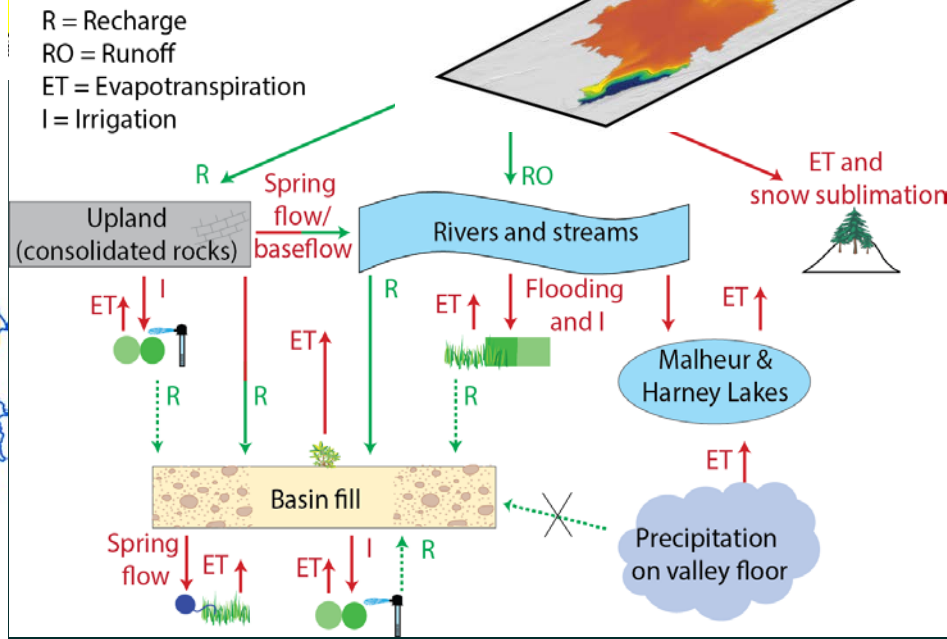












USGS

Surface Water/Groundwater Interactions In the Harney Basin (seepage runs)

Jonathan La Marche
OWRD Hydrologist

Burns, Oregon
October 25, 2018

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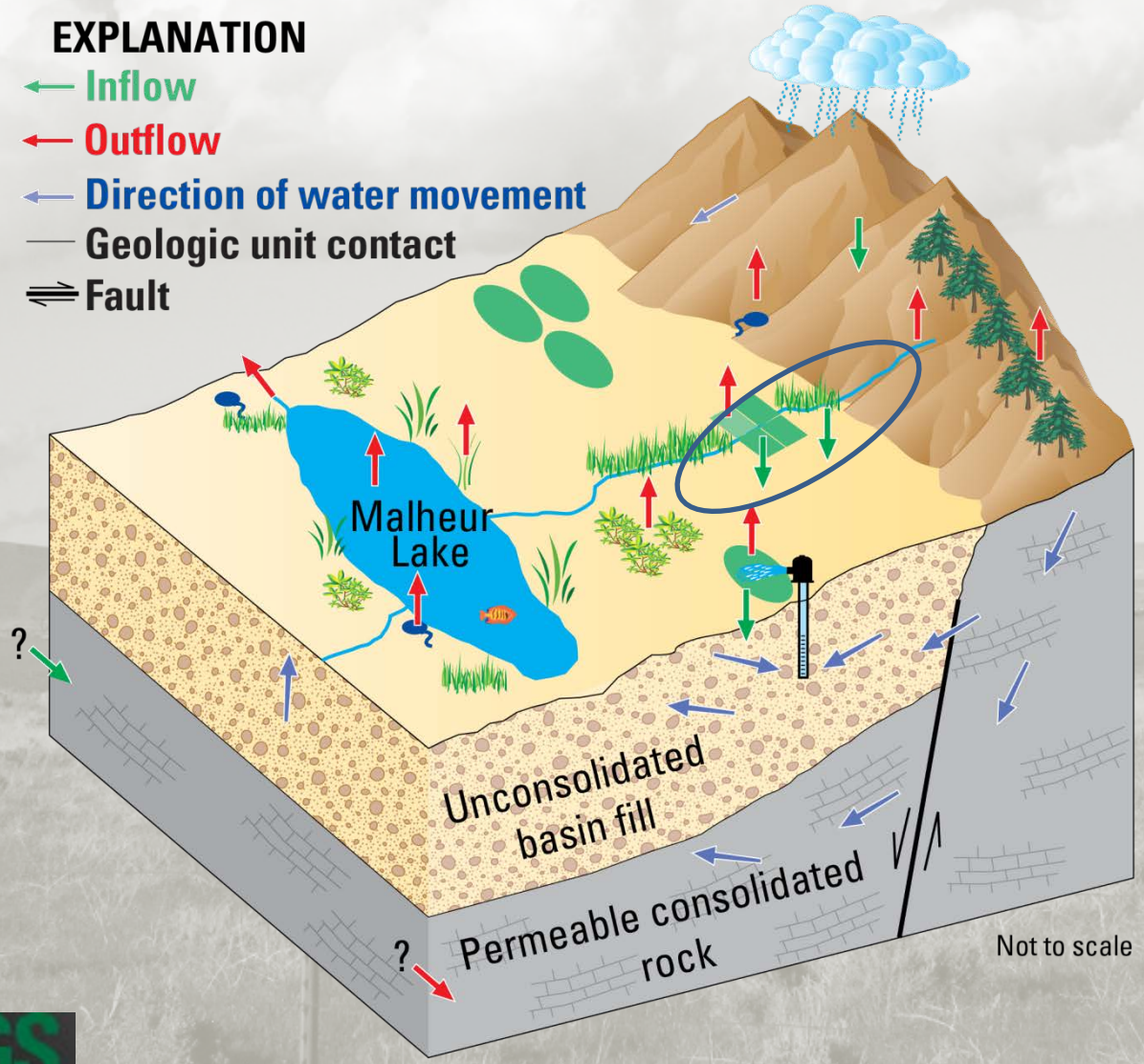
GW/SW Interactions

- Introductions

BSME

MSCE

GW/SW Interactions: Why do we care?



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GW/SW Interactions: Methods

Water Level$_{deep}$ >
Water Level$_{shallow}$

Downstream Flow
>Upstream Flow

Downstream Flow
< Upstream Flow

Level$_{shallow}$
ter Level$_{deep}$

Chemistry Data
Vegetation

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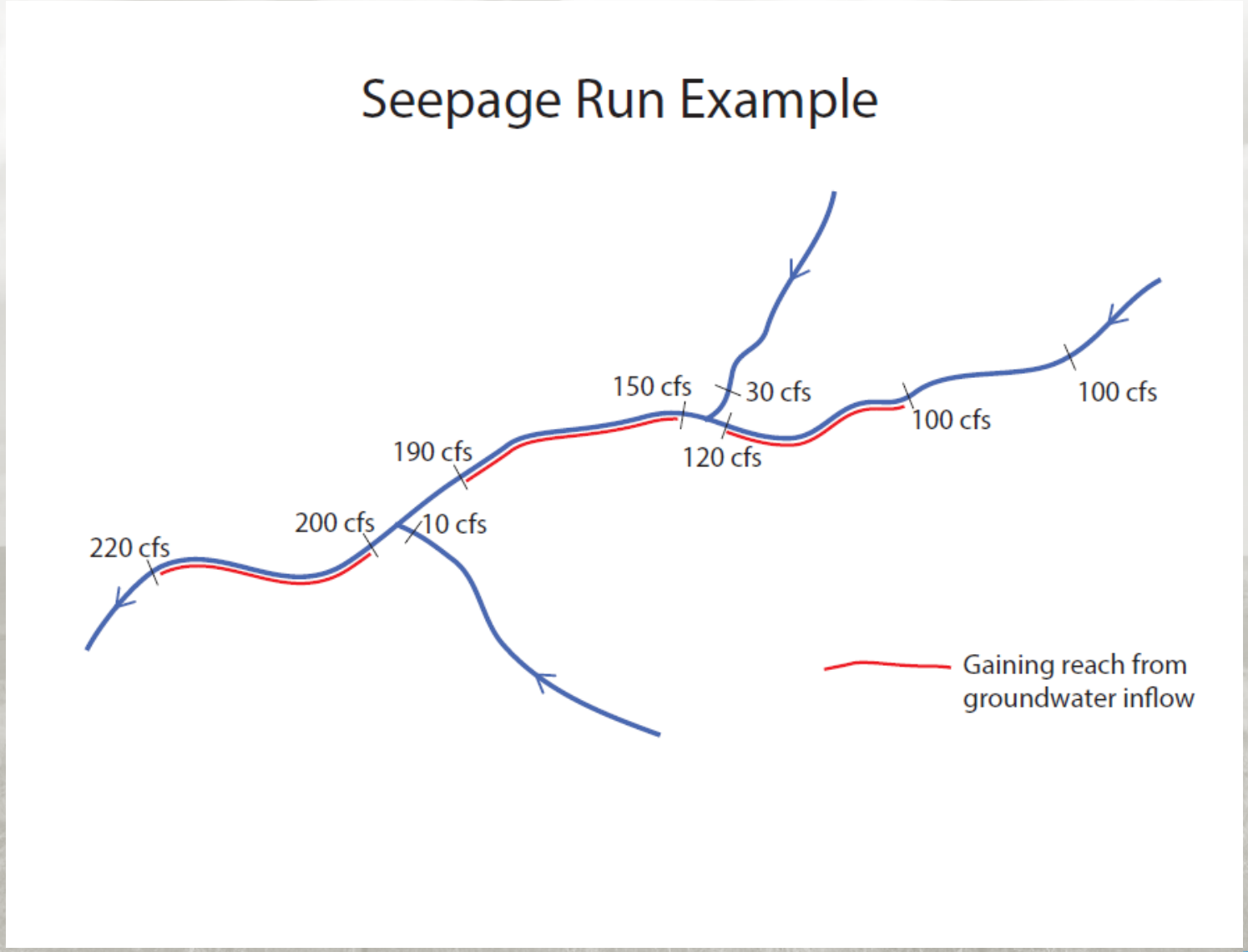
Approach

Seepage Run



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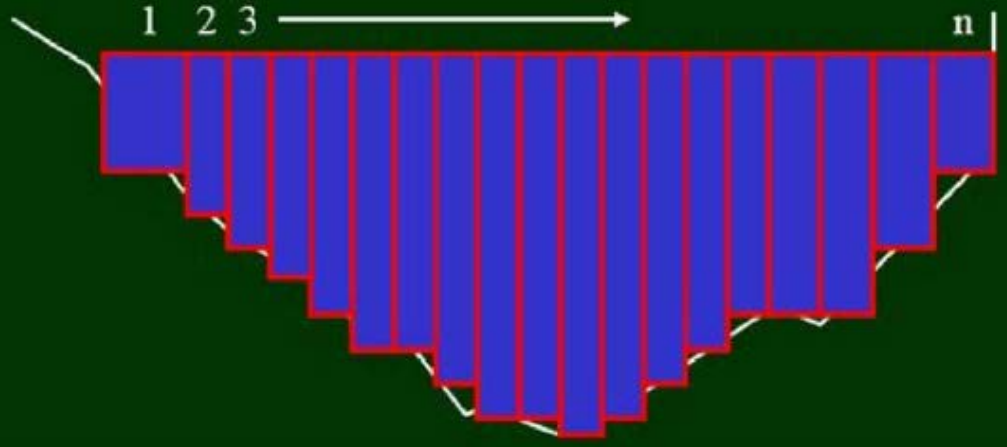
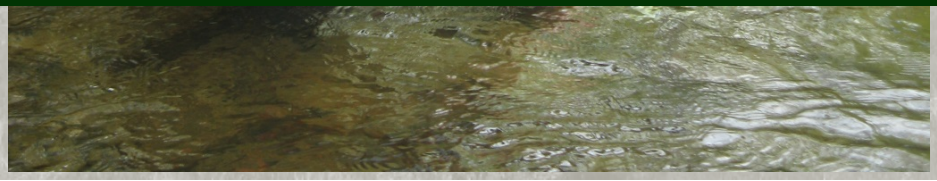
Discharge Measurement

Total Discharge = $((Area_1 \times Velocity_1) + (Area_2 \times Velocity_2) + \ldots\ldots (Area_n \times Velocity_n))$



A schematic diagram of a discharge measurement



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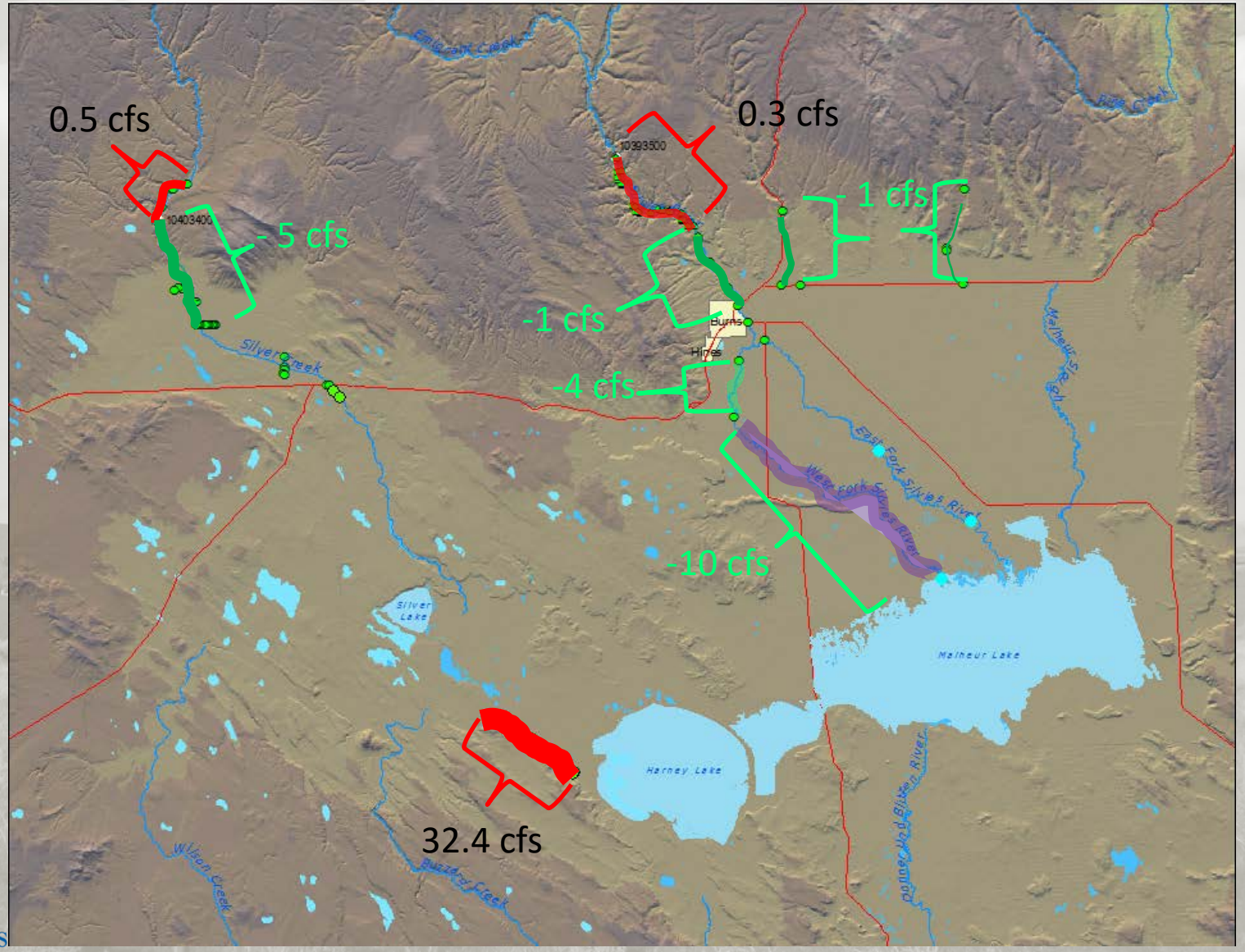
Preliminary Seepage Runs Results



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GW/SW Interactions

- See me if you have:
  - questions about discharge measurements or stream gaging.
  - questions about seepage runs.
  - observations related to GW/SW interactions or surface water seepage

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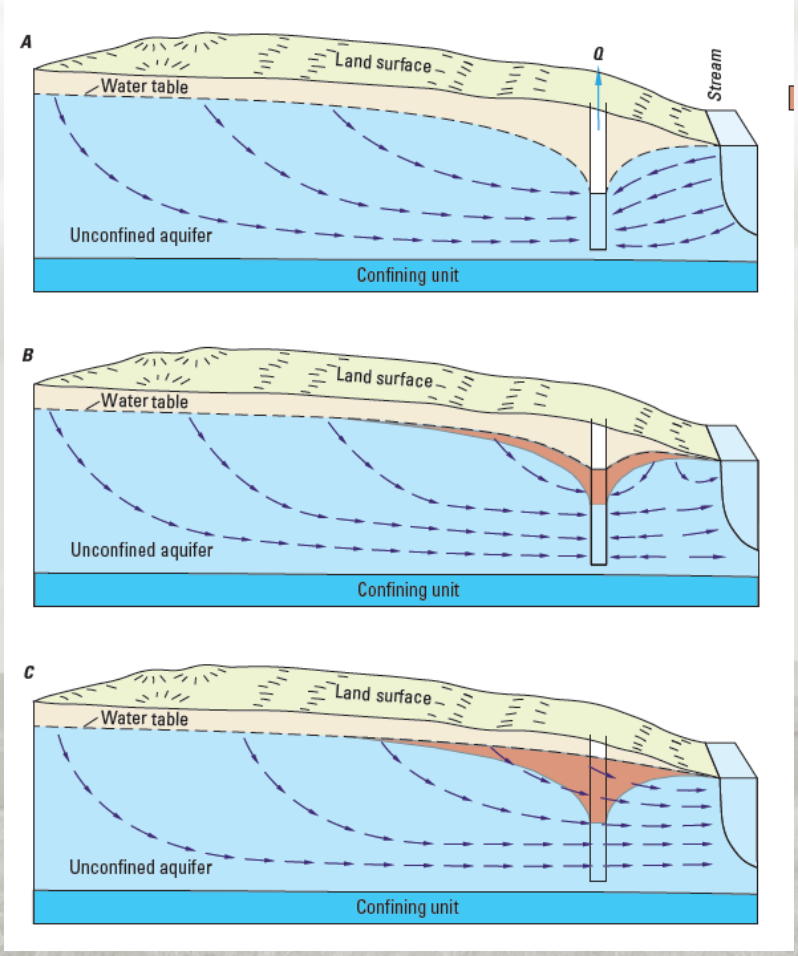
Additional Slides for potential Q/A



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Irrigation Water Use in the Harney

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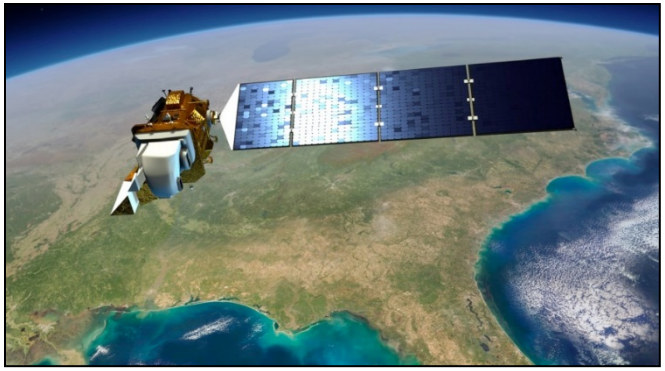

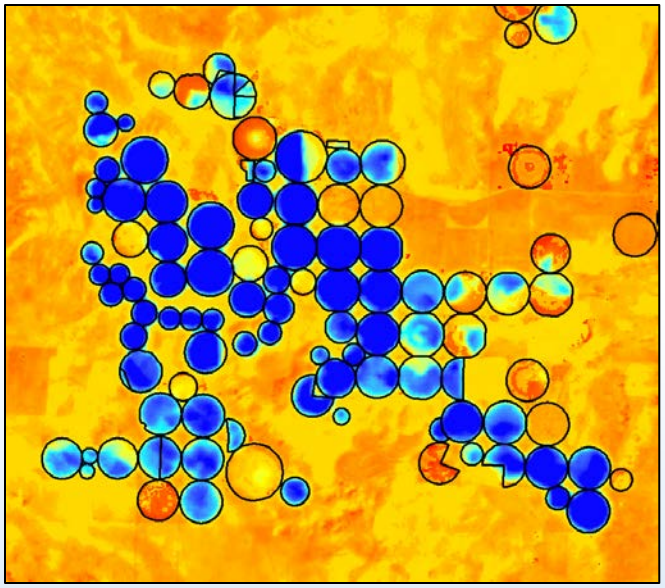

Jordan Beamer, Hydrologist

Harney Groundwater Study Town Hall

Burns, OR October 25, 2018

OREGON WATER RESOURCES DEPARTMENT

Introductions

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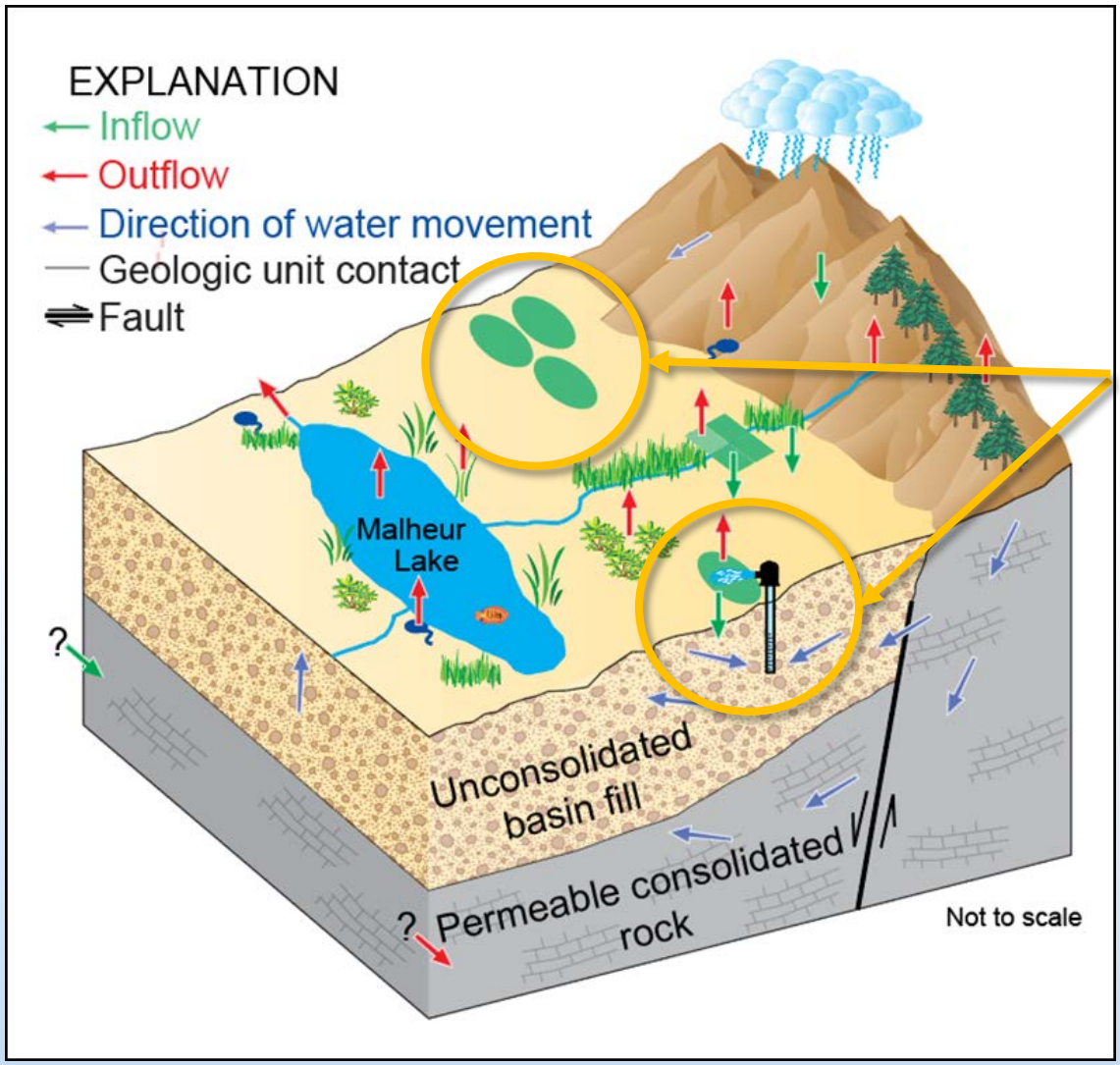
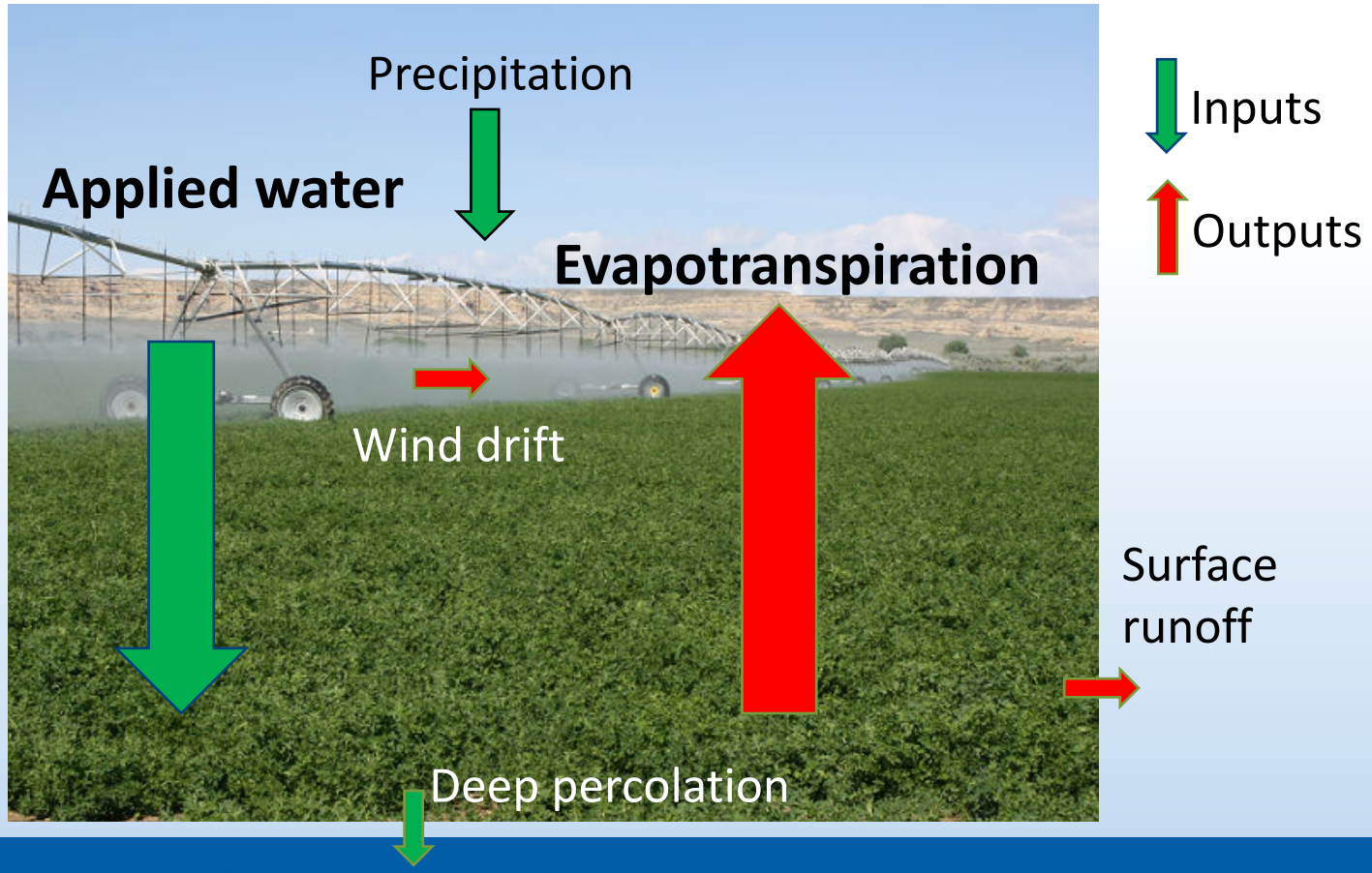
Basin Water Budget



Groundwater Pumping for Irrigation

Irrigation Water Use

- Evapotranspiration (ET = evaporation + plant transpiration) data used to estimate irrigation use and pumpage



Source: http://www.teachingfromthetractor.com/alfalfa-seed-established-fields/

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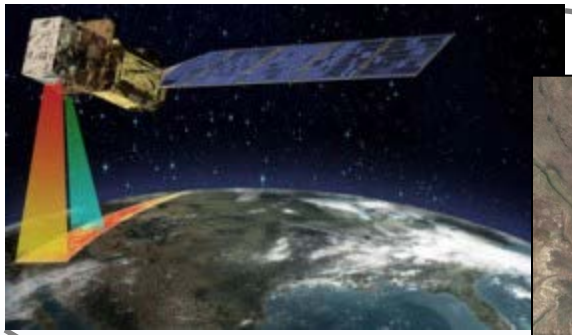
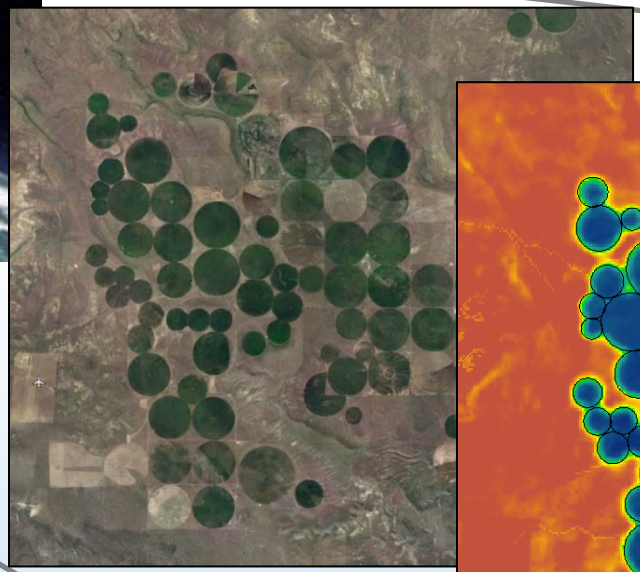
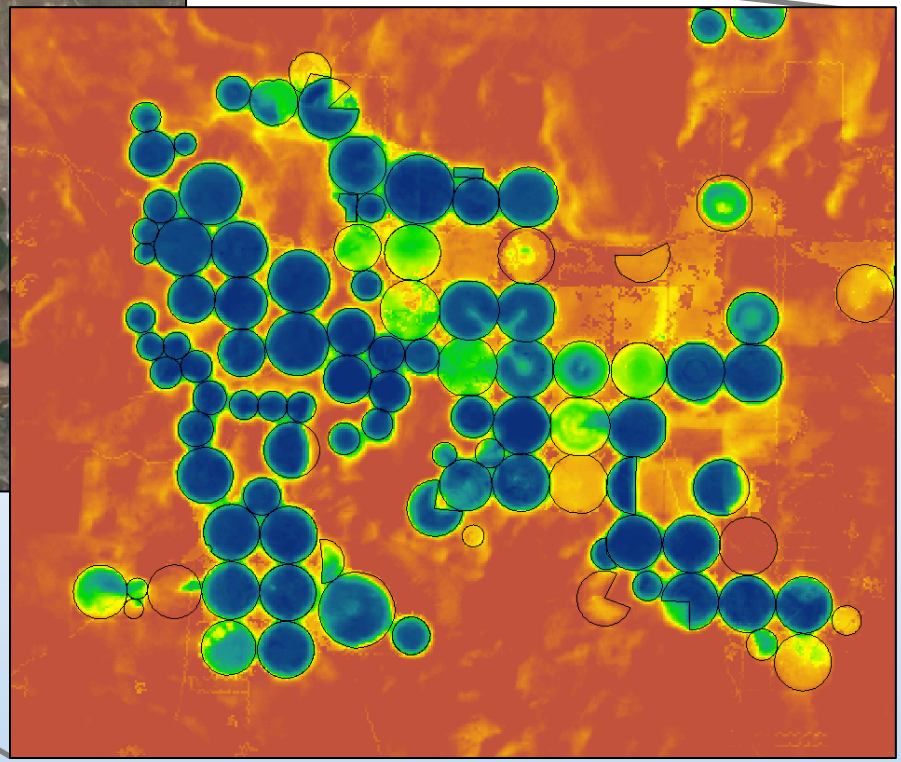
Images of Water Use

- We use satellite imagery to map irrigated areas and model actual crop water use over study area and period (1991-2016)







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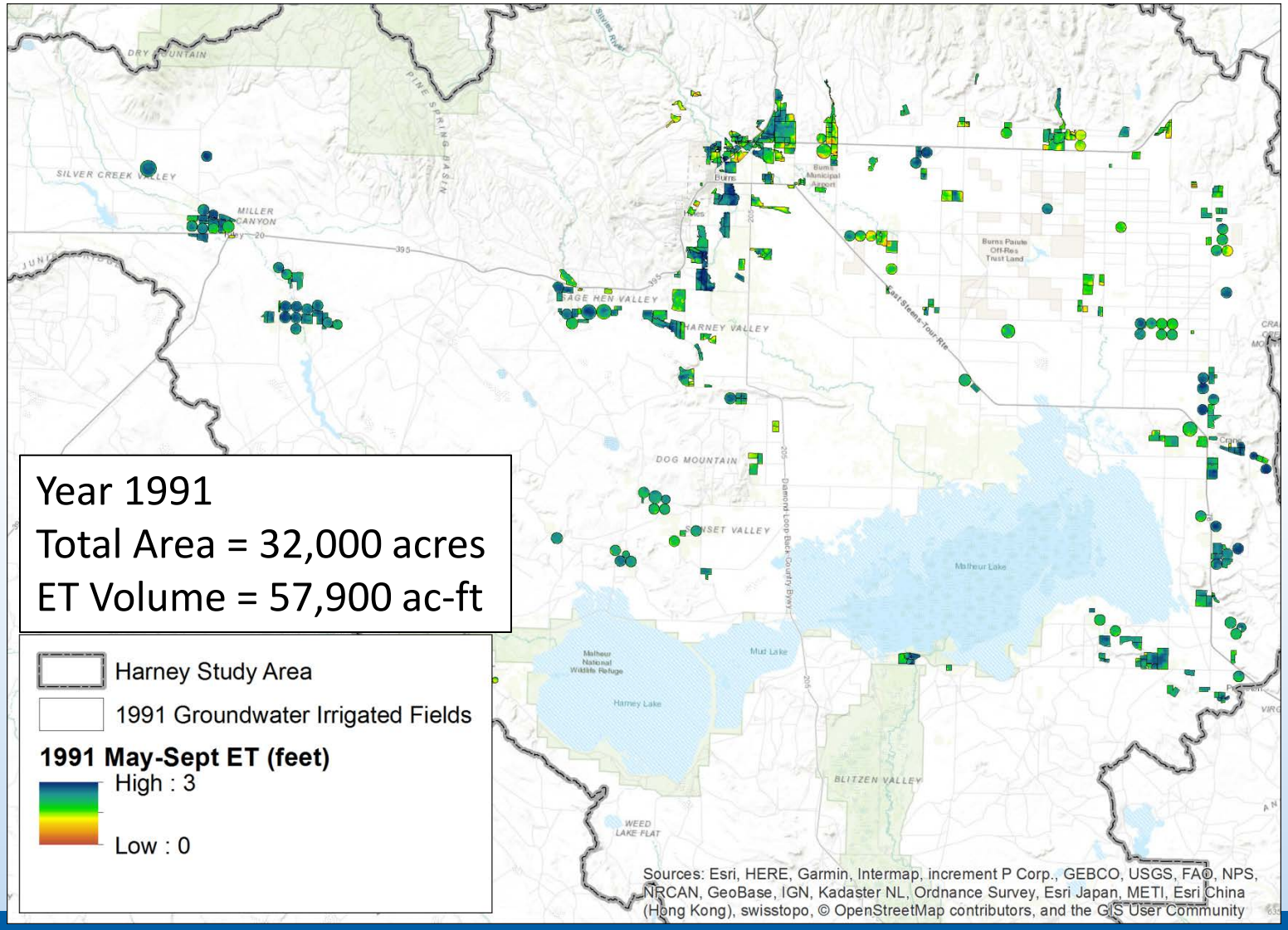
Preliminary Results



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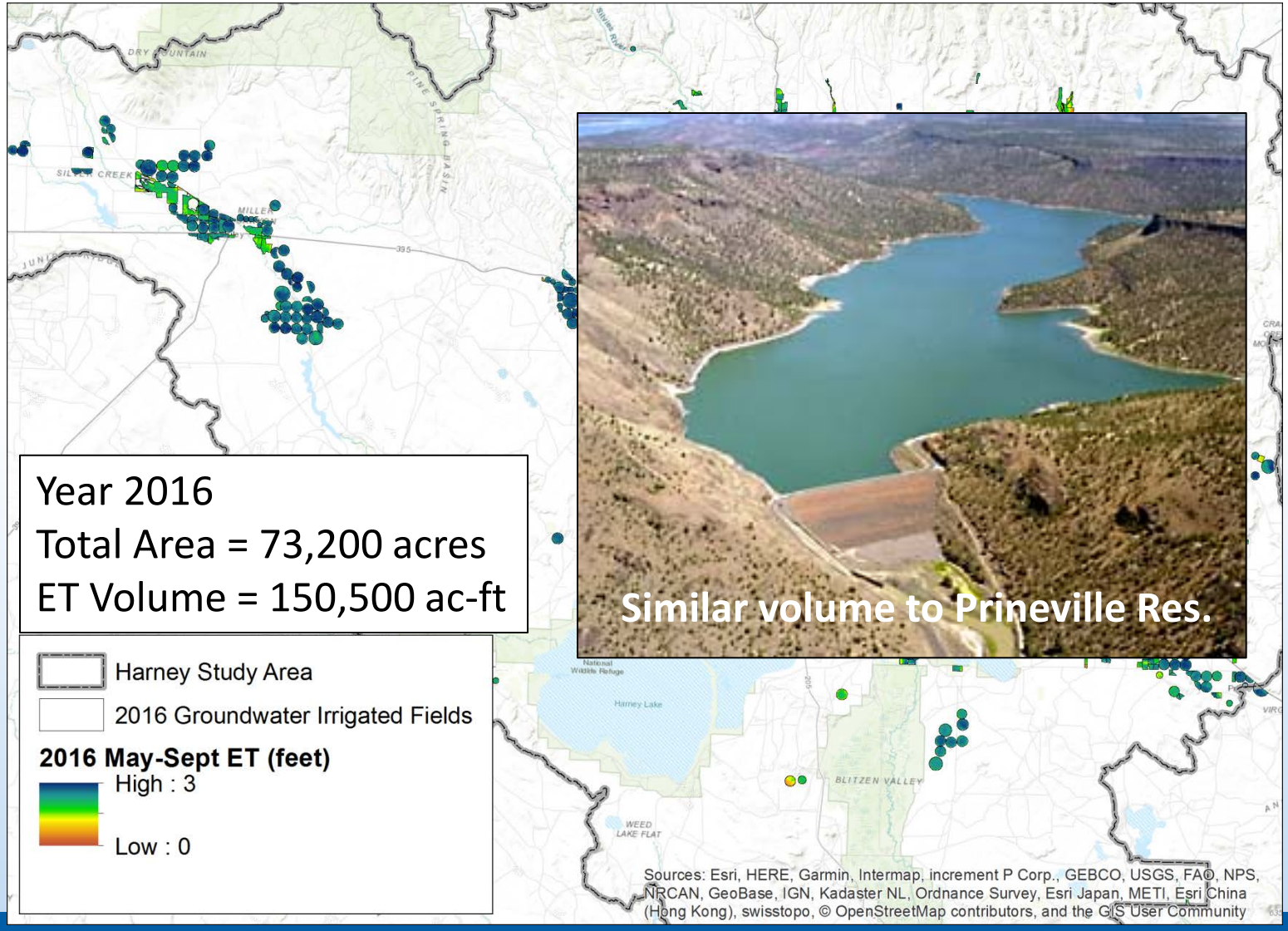
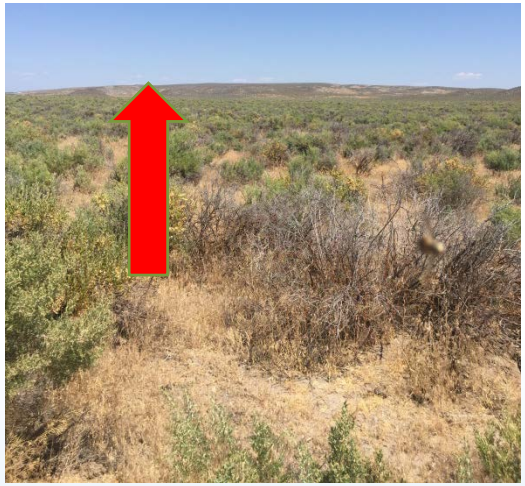
Preliminary Results



GW Discharge Estimate

Natural ET-GW



190,000 – 220,000 AF

+

Crop ET-GW

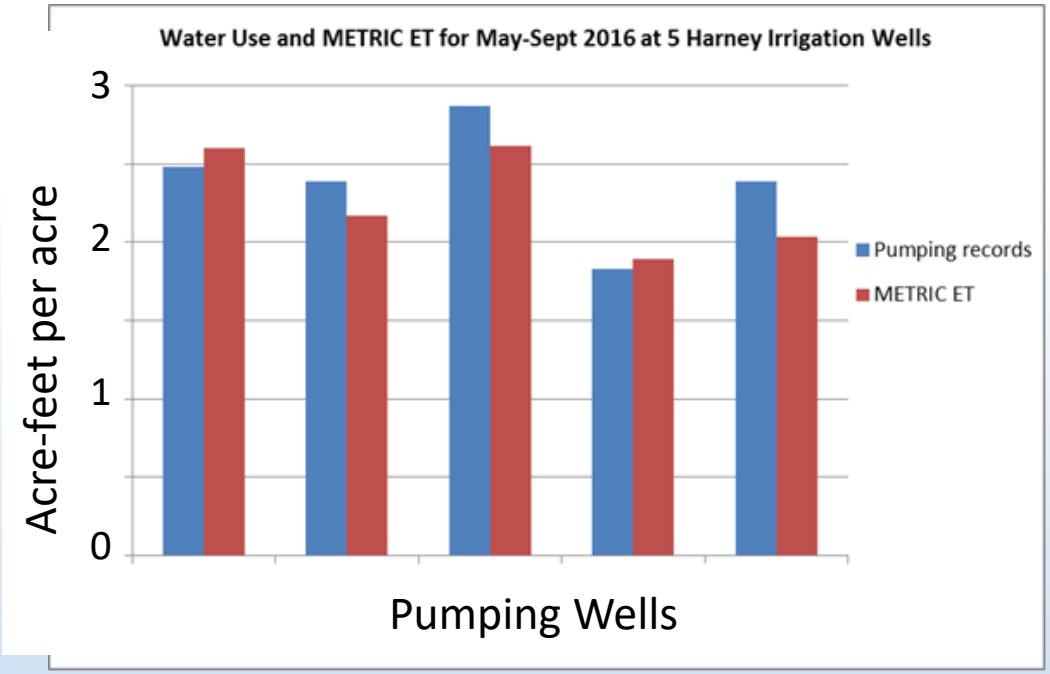
110,000 – 150,000 AF

Total discharge ≈ 300,000 – 370,000 AF

Outside est. recharge range (160,000-220,000 AF)

Next Steps

Compare Reported Pumping Volumes vs Satellite-based ET



Validate Satellite-based ET with ground-based measurements

Questions? Come talk with me about:

Satellite-based water use maps:
https://github.com/DRI-WSWUP/pymetric

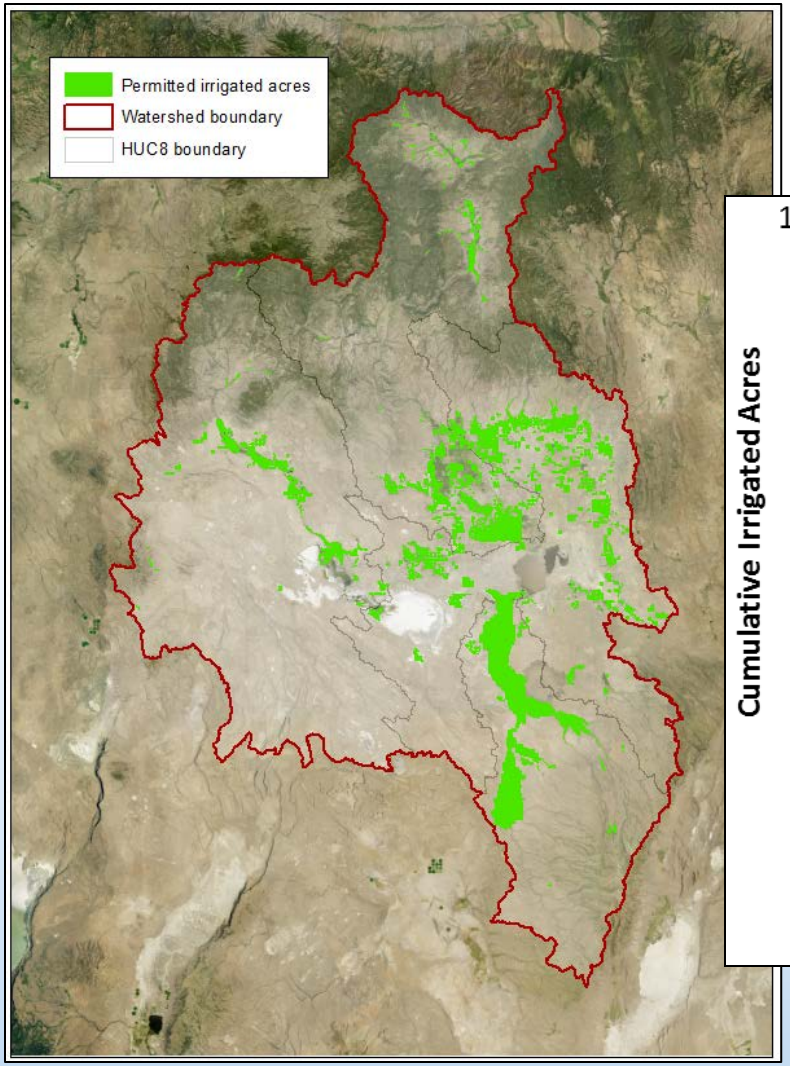
Local agricultural weather data:
https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?orocrn

OWRD's water use reporting program:
https://www.oregon.gov/OWRD/programs/WaterRights/Reporting/WUR/Pages/default.aspx

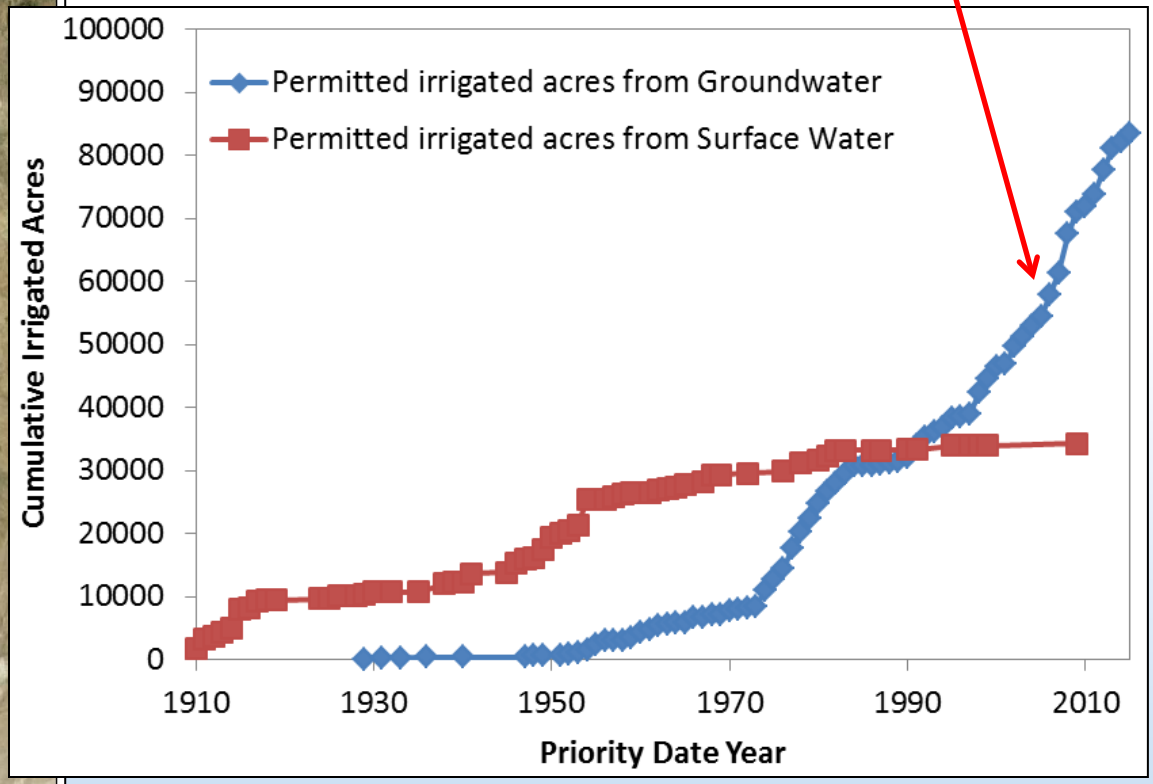
Jordan Beamer, OWRD
503-986-0836
jordan.p.beamer@oregon.gov

OREGON WATER RESOURCES DEPARTMENT

Background

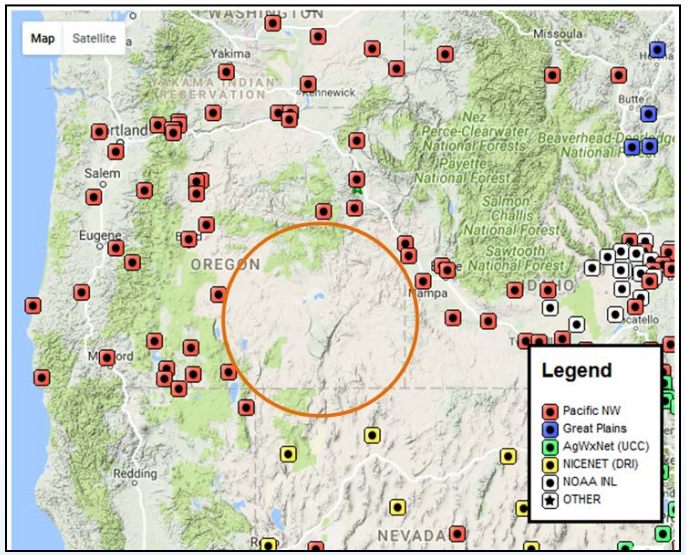


Doubling of permitted acres from GW 1995-2015

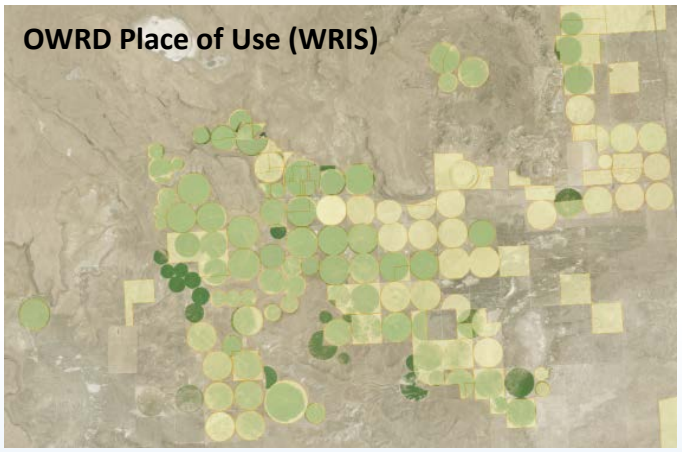


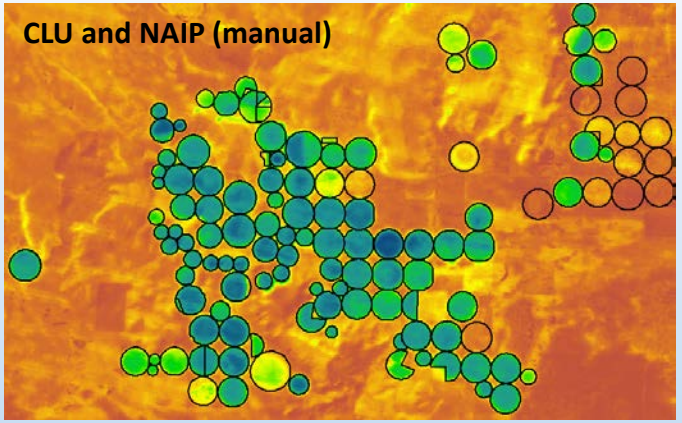
Initial challenges

Need ground-based weather data



Need to map actively irrigated fields (thanks Mellony!)





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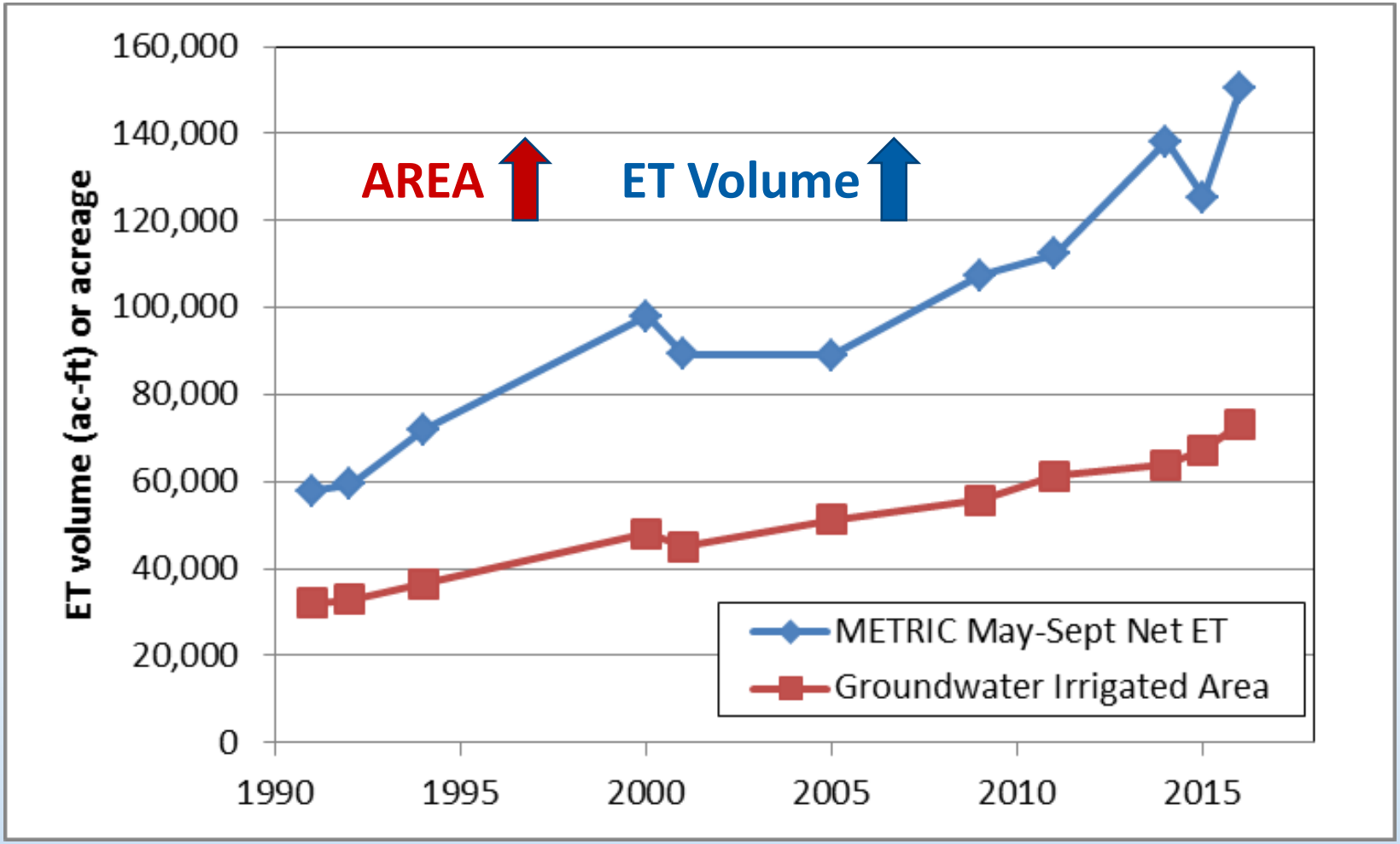
Preliminary Results



11-year average May-Sept net ET rate = 1.9 ft

OREGON WATER RESOURCES DEPARTMENT

Cuenca Tables

- Table of growing season, total crop ET and net irrigation requirements, for crops grown in region 20 (Harney county).

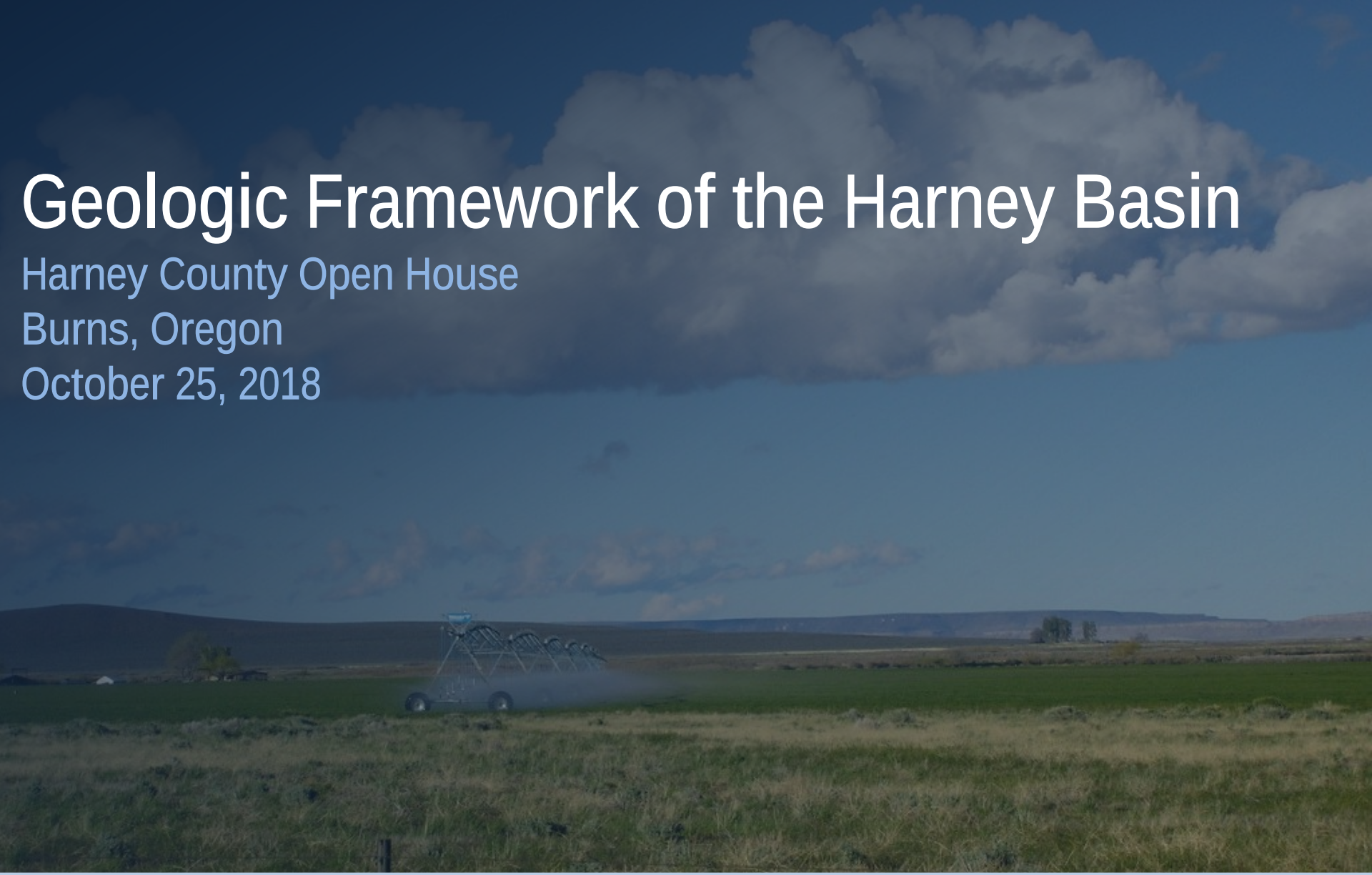
			19 out of 20 years, 95% probability				5 out of 10 years, 50% probability			
Crop	Growing Season	Percent of Net IRR outside May-Sept	May-Sept Crop ET (mm)	May-Sept Crop ET (ft)	May-Sept Net IRR (mm)	May-Sept Net IRR (ft)	May-Sept Crop ET (mm)	May-Sept Crop ET (ft)	May-Sept Net IRR (mm)	May-Sept Net IRR (ft)
Alfalfa Hay	May 15-Aug 30	0	538	1.77	520	1.71	480	1.57	434	1.42
Spring Grain	May 10-Sept 15	0	581	1.91	565	1.85	522	1.71	474	1.56
Winter Grain	Apr 5-Aug 10	8%	508	1.67	482	1.58	452	1.48	398	1.31
Mint	Mar 30-Aug 7	8%	538	1.77	512	1.68	478	1.57	423	1.39
Pasture	Apr 1-Oct 15	15%	745	2.44	713	2.34	664	2.18	571	1.87

Cuenca 50% Alfalfa rate: 73,200 acres * 1.42 ft = 104,000 AF

Cuenca 50% Pasture rate: 73,200 acres * 1.87 ft = 137,000 AF

Geologic Framework of the Harney Basin

Harney County Open House
Burns, Oregon
October 25, 2018



Darrick Boschmann, Hydrogeologist
Oregon Water Resources Department

My background

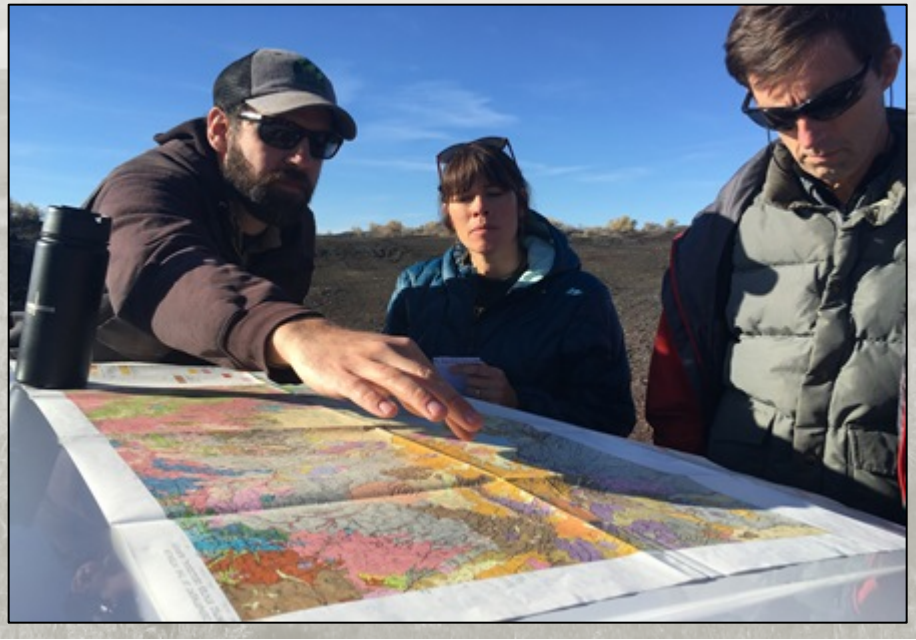
Portland State
UNIVERSITY

Oregon State
University

My role in the study

My Tasks:

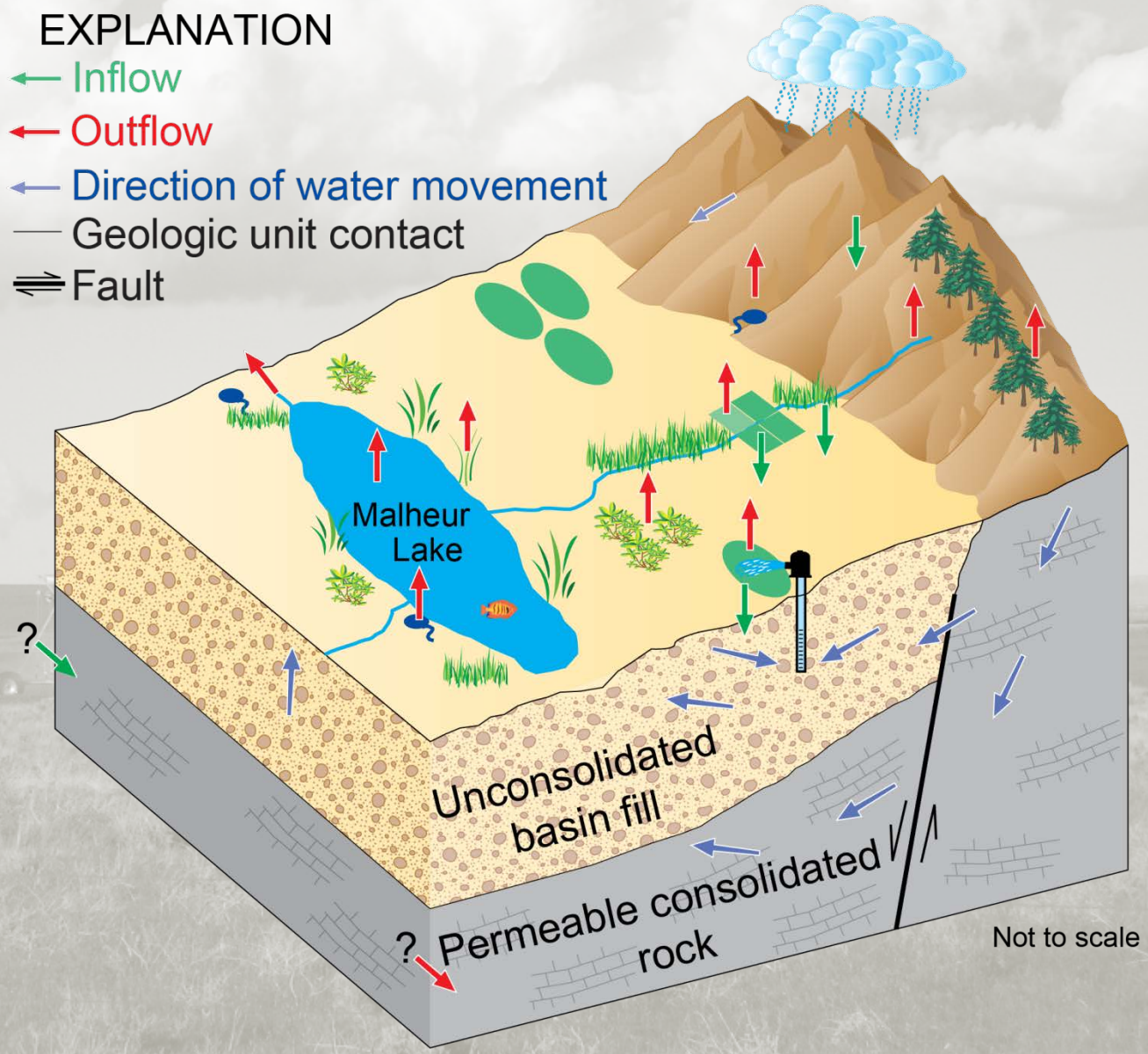
- Rocks
- Wells
- Maps



Why does this matter?

My Tasks:

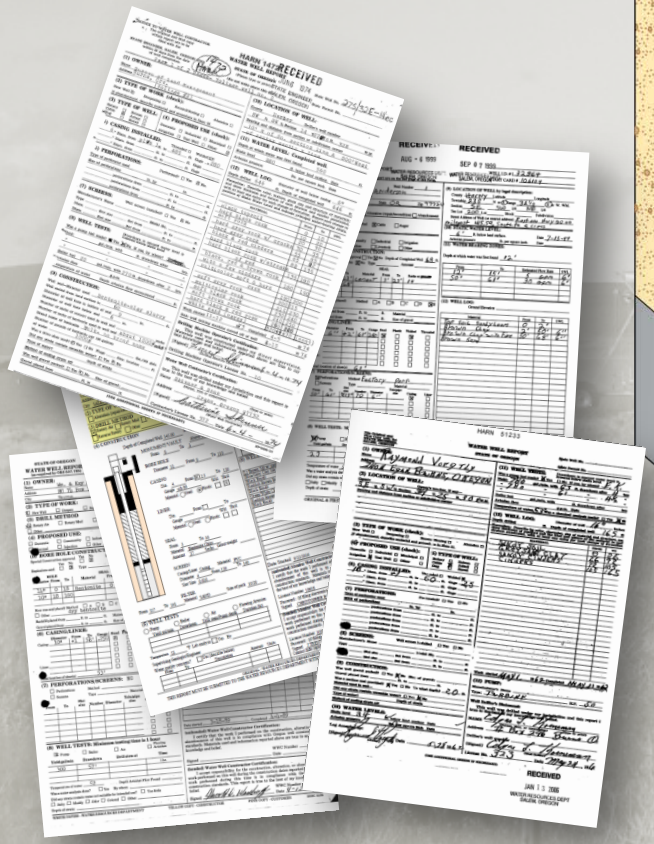
- Rocks
- Wells
- Maps

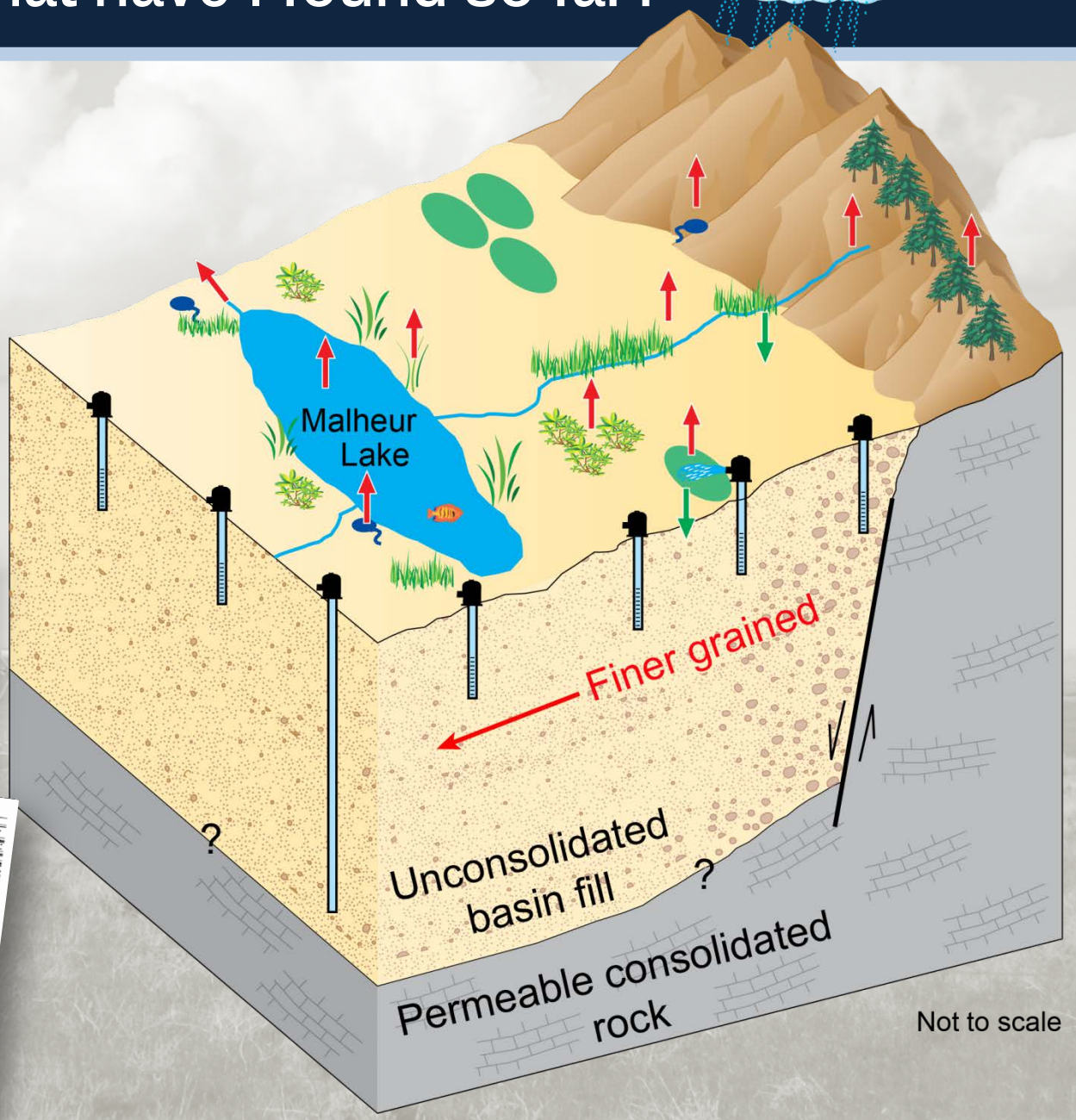


What have I found so far?

Basin Fill:

- Finer toward lake
- Very thick (3,800'+)

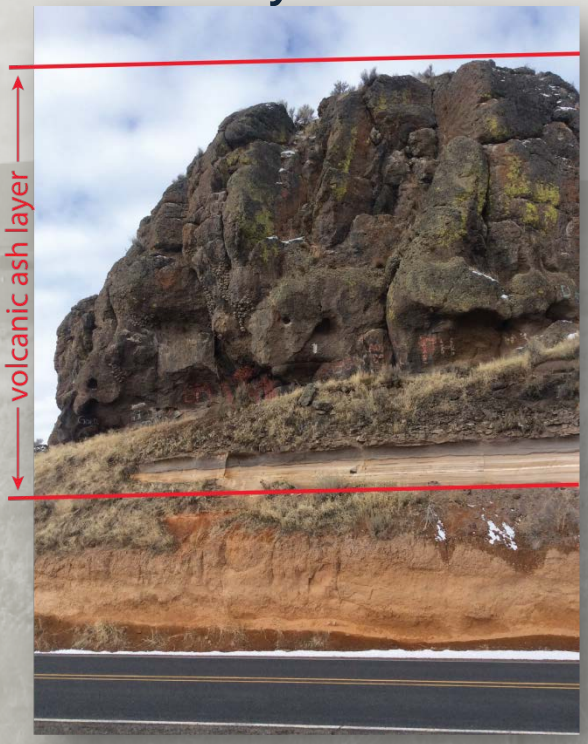


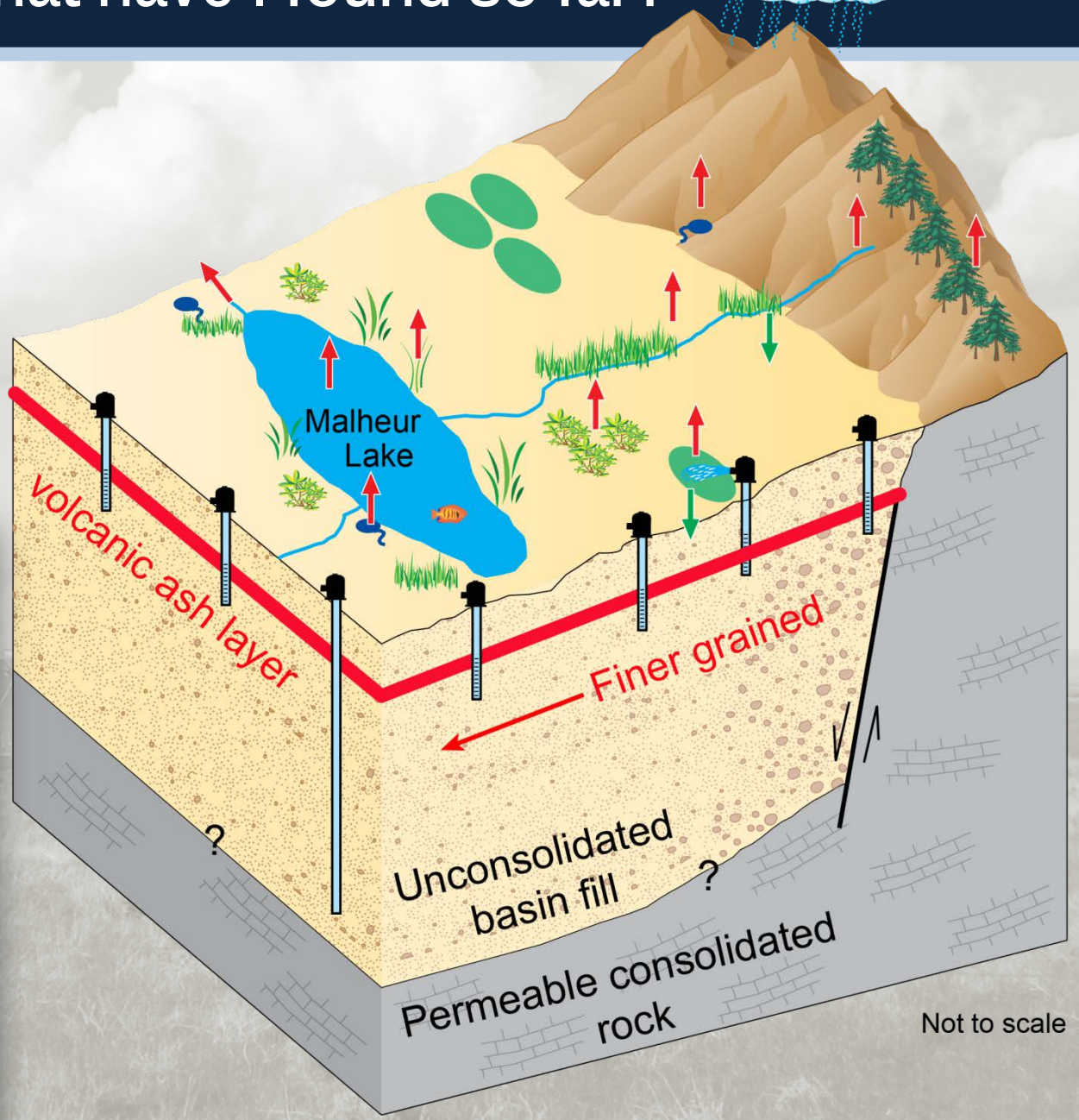


What have I found so far?

Basin Fill:

- Very thick (3,800'+)
- Finer toward lake
- Ash layer





What's next?

- Analyze cuttings from recent drilling
- Continued well log analysis
- Continued geologic mapping (DOGAMI)
- Finalize geologic map compilation
- Synthesize data for hydrostratigraphy

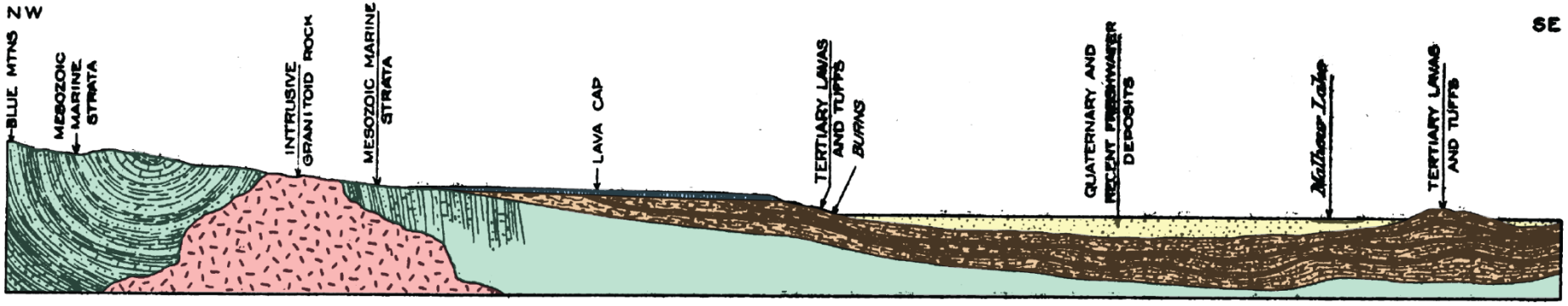
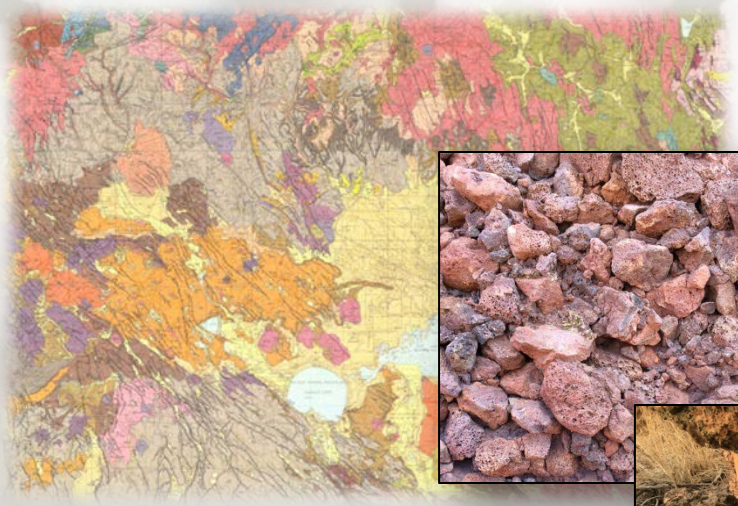
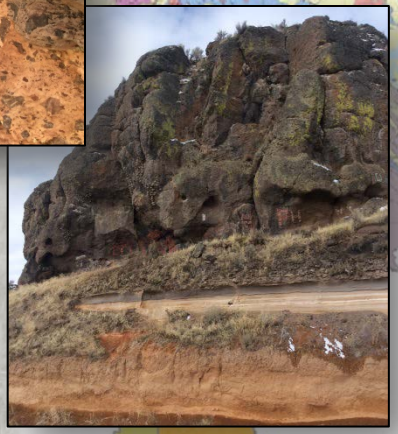


Fig. 2. Generalized northwest-southeast sketch section through Burns, Oregon. Vertical scale greatly exaggerated.

Buwalda, 1921

Why should you come talk to me?





Thank You

Darrick Boschmann, Hydrogeologist
Oregon Water Resources Department

USGS
science for a changing world

Sources and Age of Groundwater in Harney Basin

Hank Johnson

USGS Oregon Water Science Center

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

y-197

UNITED STATES GEOLOGICAL SURVEY

WATER RESOURCES BRANCH

Description prepared corr 7/29/18 DATE.

by JFH.

Description of Station on Cucamonga {Creek / ~~River~~} at

near Diamond --post-office, State of Oregon

Established Mar. 14, 1911, by O. C. Faulkner, assisted by F. C. Dillard

Name of observer, Prim Ortega (Tebo), post-office address, Diamond, Ranch.

pay, $ Vol., occupation, retired Buckaroo, distance, 3 mi., time of daily observation,

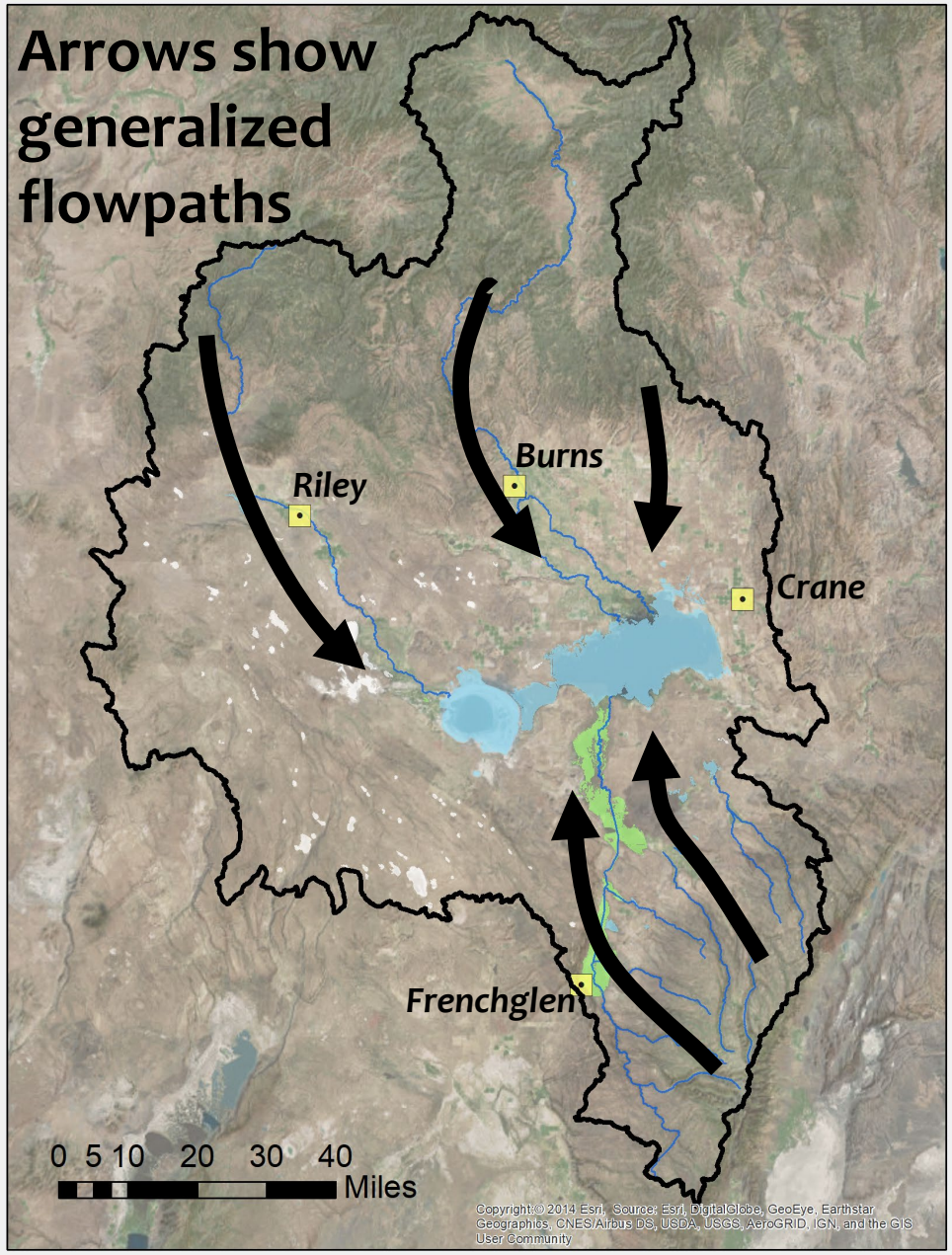
Description and location of the gage. If chain-gage give length from end of weight to the marker.

Inclined staff gage 0-6 feet on left bank ~~1"x4" board driven well into bed of creek and nailed to~~

~~4" pillow~~, 50 feet above an east and west fence and about 1 mile above old Cummings house, in NW¼ Sec. 7, T 30 S, R 33 E.

Use natural chemistry of the groundwater to:

- Clarify flowpaths
  → **WHERE and HOW?**
- Estimate travel times
  → **HOW LONG?**
- Identify mixing
  → **SOURCES?**
- Calibrate numerical models



USGS

Sources and Age of Groundwater in Harney Basin

Why does this matter?

- Precipitation in uplands → Demand on basin floor
- Two regions of high precipitation
- Three main streams
- Basin floor is big bowl of sediment

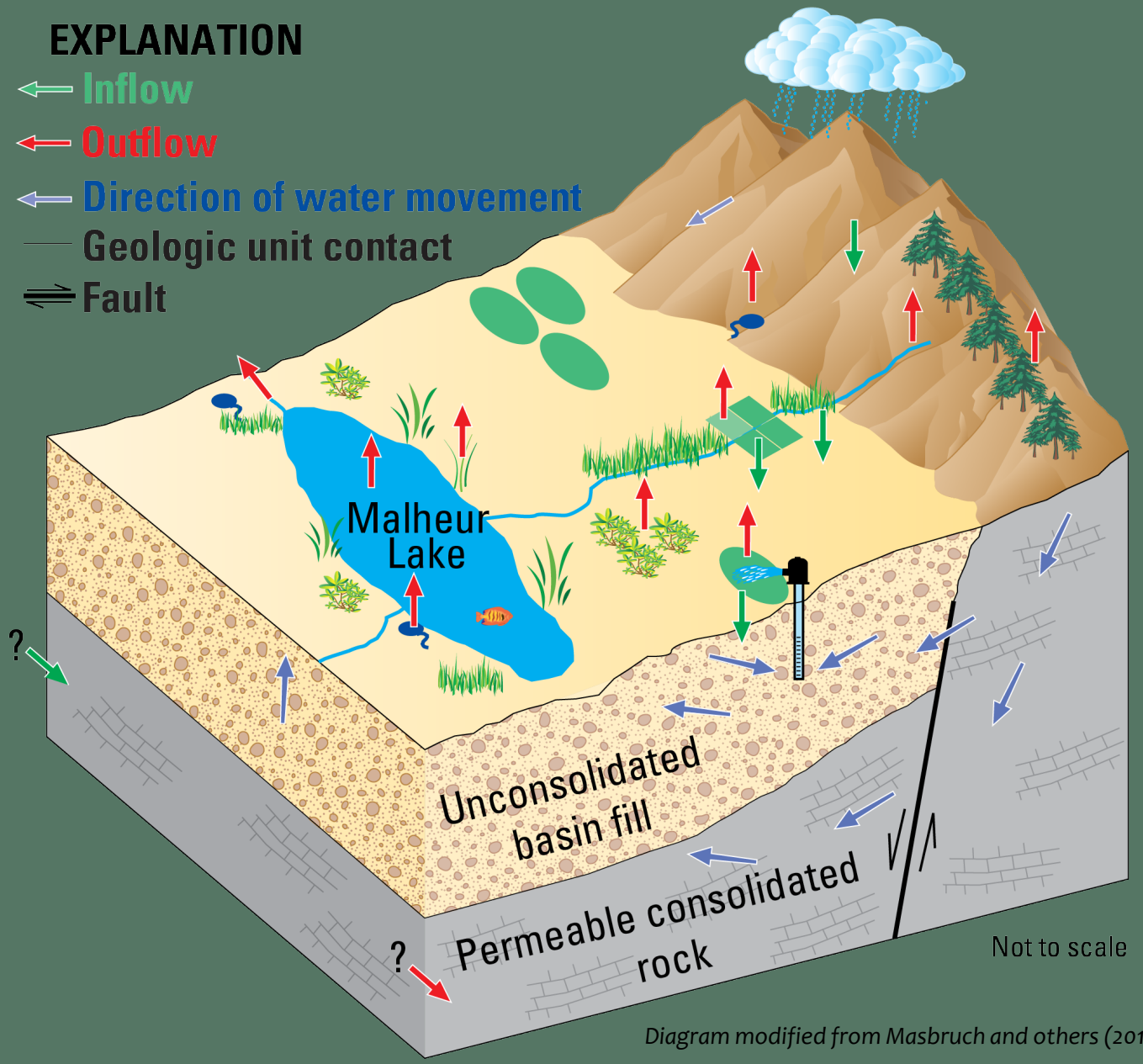


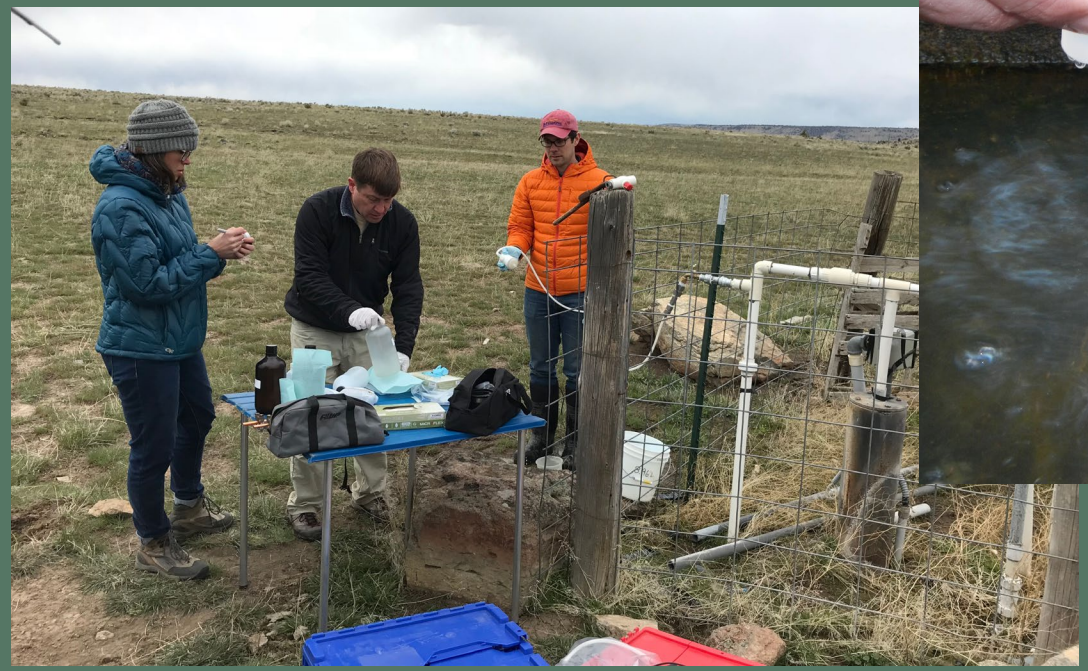
Diagram modified from Masbruch and others (2010)

USGS

Sources and Age of Groundwater in Harney Basin

Collect and measure chemistry in samples from:

- Springs
- Wells
- Streams during low flow



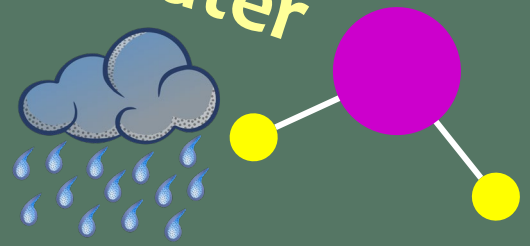
USGS

Sources and Age of Groundwater in Harney Basin

Recharging precipitation carries trace amounts of chemicals that can be used to determine the age of groundwater

Common ions such as calcium, sodium, and chloride

Stable isotopes of water

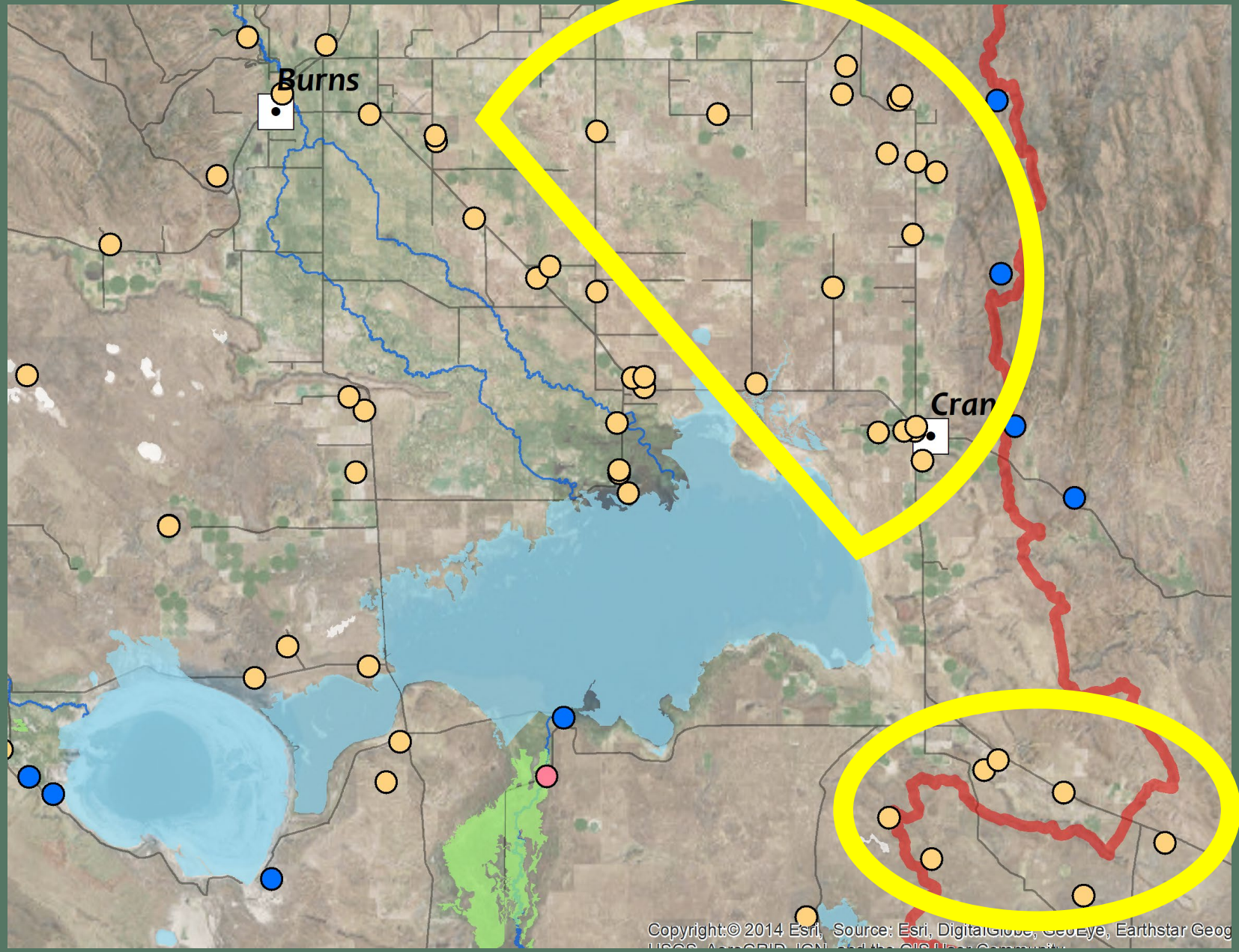


$^{1}H - ^{18}O - ^{1}H$

Clipart obtained from openclipart.org

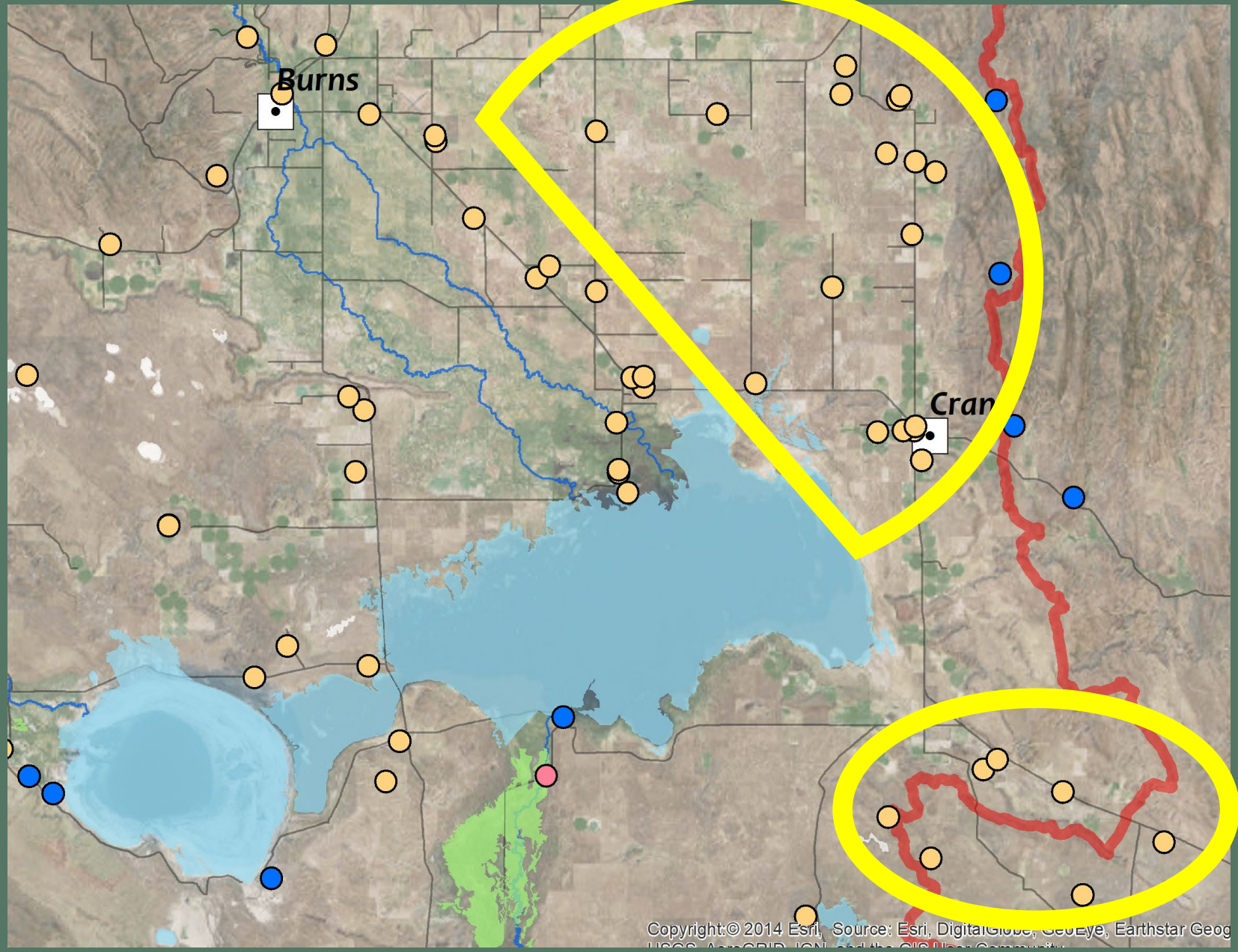
USGS

Sources and Age of Groundwater in Harney Basin



USGS

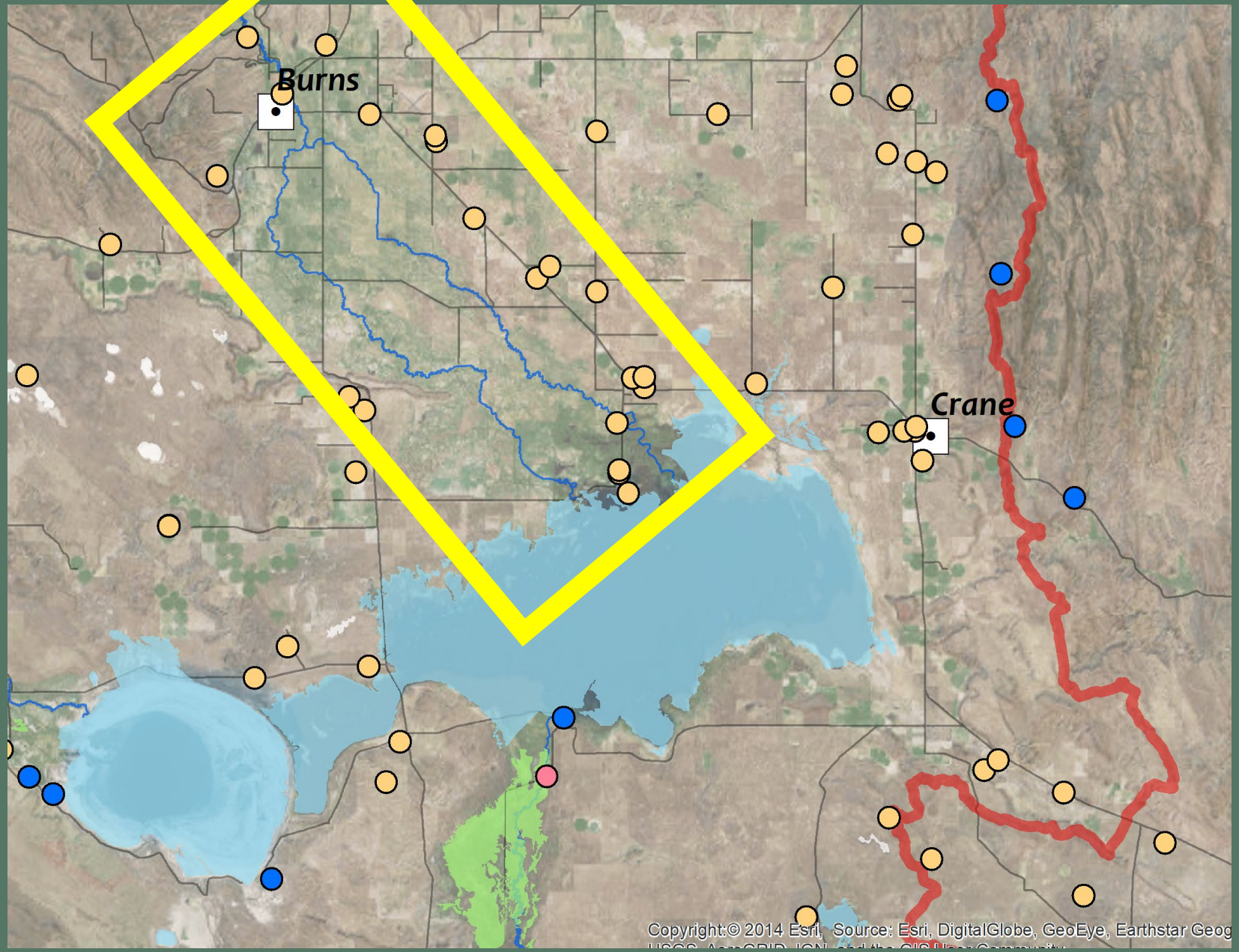
Sources and Age of Groundwater in Harney Basin



INDICATIONS OF PRE-MODERN WATER

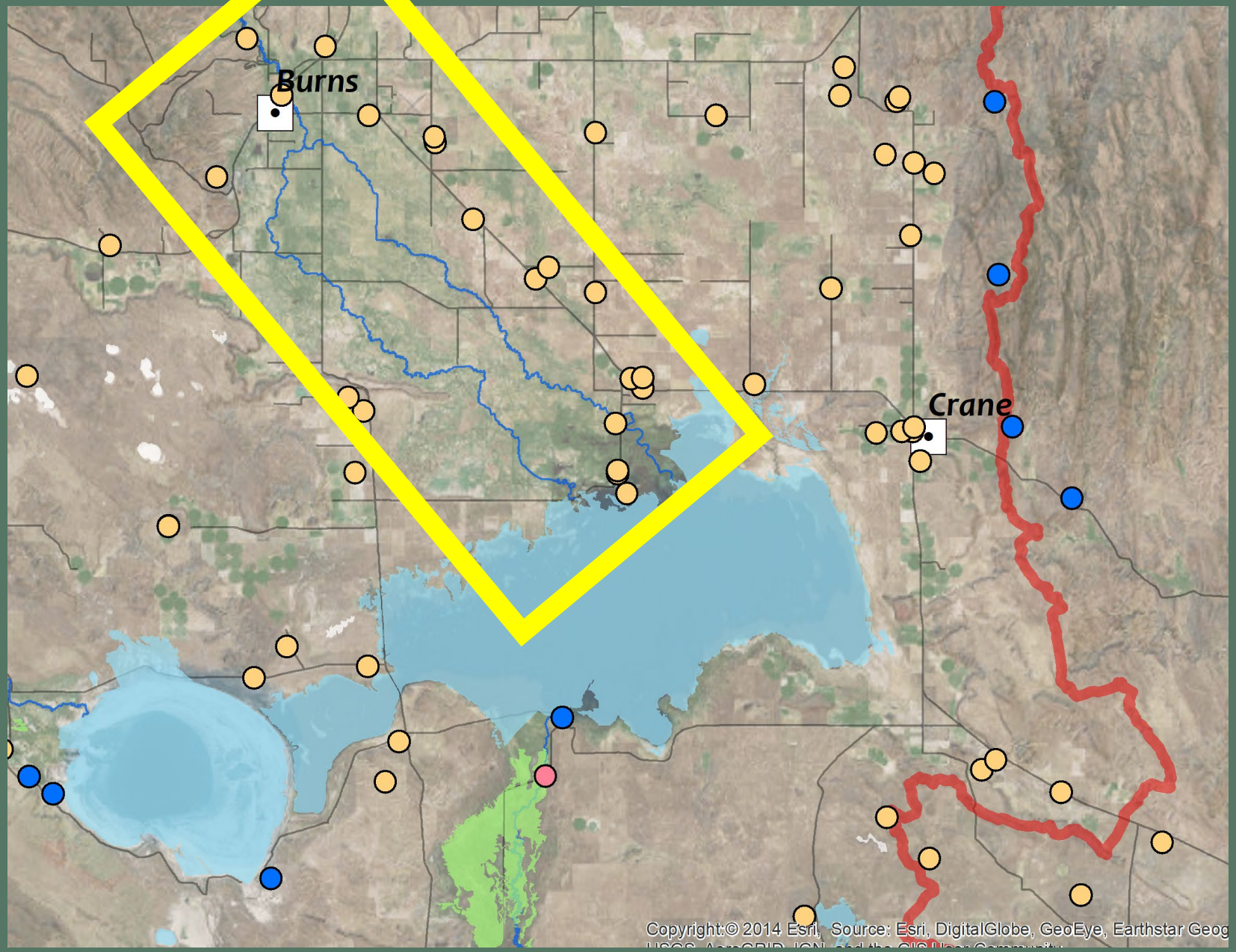
USGS

Sources and Age of Groundwater in Harney Basin



USGS

Sources and Age of Groundwater in Harney Basin

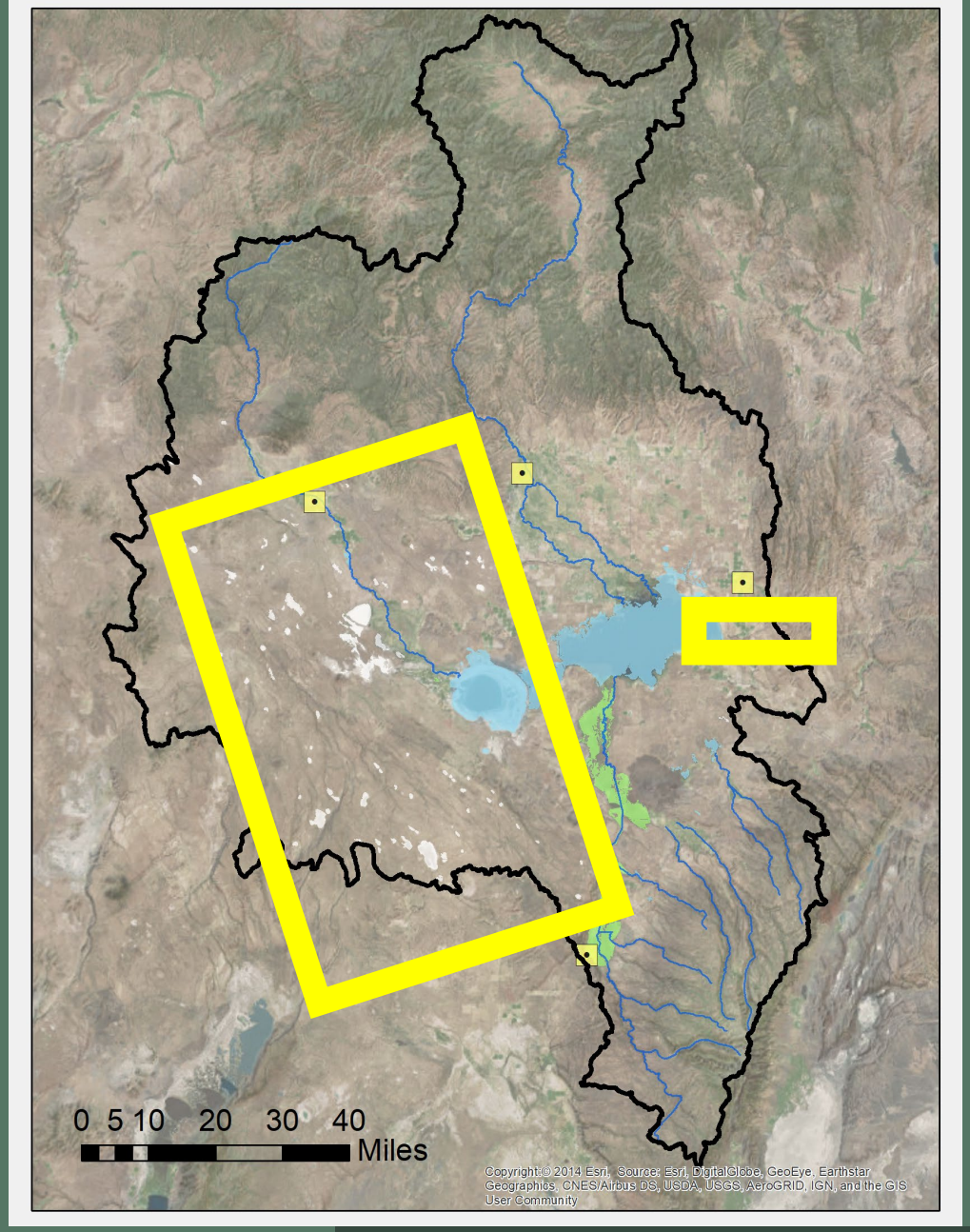


SILVIES RIVER RECHARGE ZONE

INDICATIONS OF MODERN WATER SITTING ATOP OLDER WATER

USGS

Sources and Age of Groundwater in Harney Basin



WORK IN PROGRESS

USGS

Sources and Age of Groundwater in Harney Basin

What's next?

- Evaluate results of ~60 new age tracer samples currently at lab
- Incorporate data from DEQ and Crane Union High School-Portland State University

Learn more about methods!

- Do we really know the age of water?

  (Spoiler – Yeah. We do.)
- Really?

  (Yep. Not kidding.)

Learn more about results!

"What about my well?!"

Ask me anything!

"Stump the hydrologist"

End of Presentation

Harney Basin Groundwater Study

Harney Basin Groundwater Town Hall Meeting

Burns, Oregon

25 October 2018

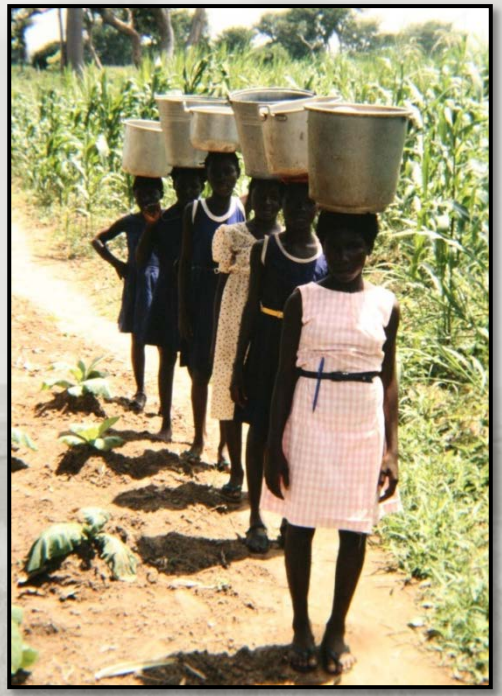
OREGON WATER RESOURCES DEPARTMENT

Jerry Grondin
OWRD Hydrogeologist

Introduction: Jerry Grondin

Oregon State University

OHIO UNIVERSITY 1804



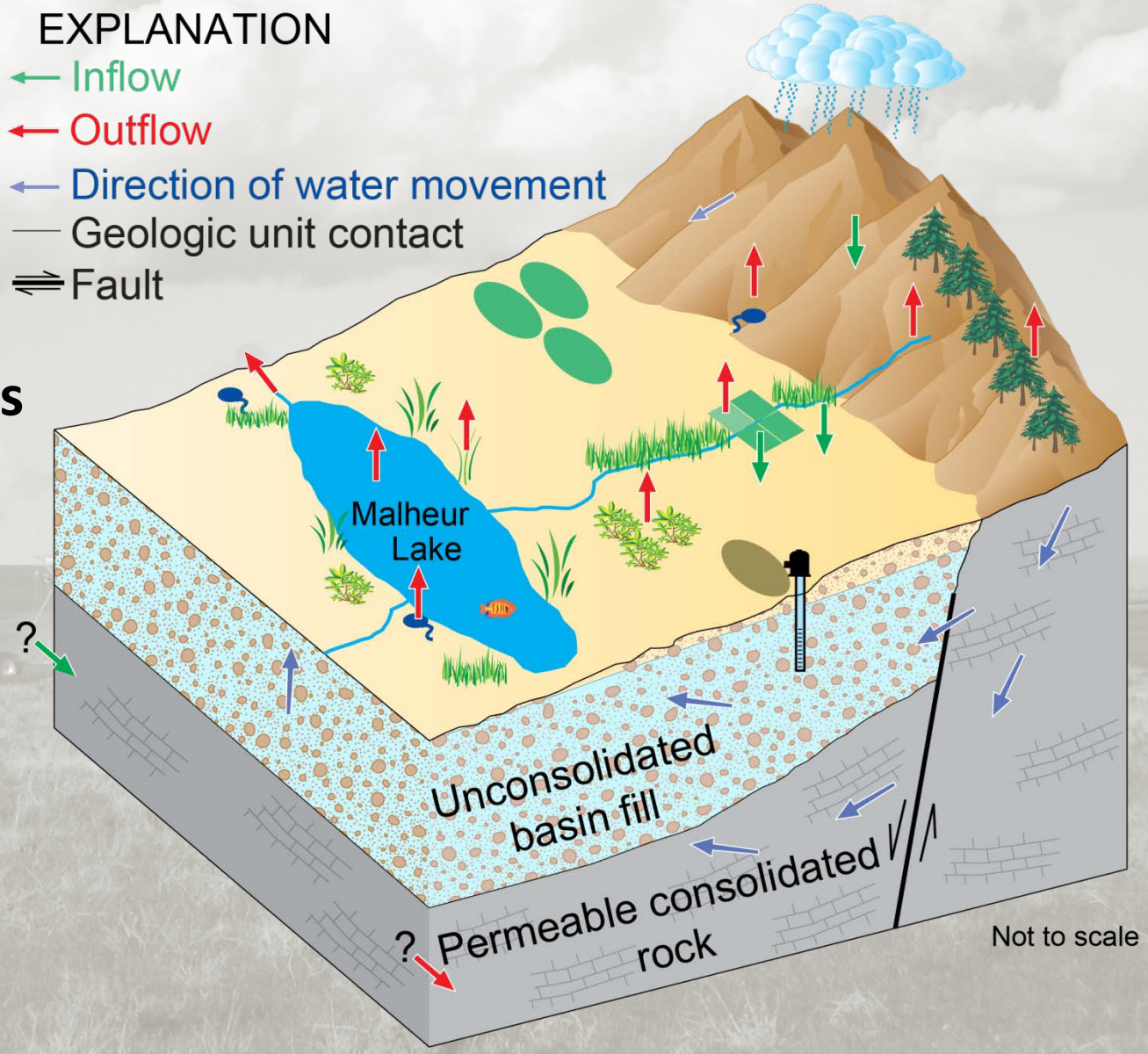
THE UNIVERSITY OF ARIZONA

University of Portland

Harney Basin GW Study: Grondin Tasks

Hydraulic Properties

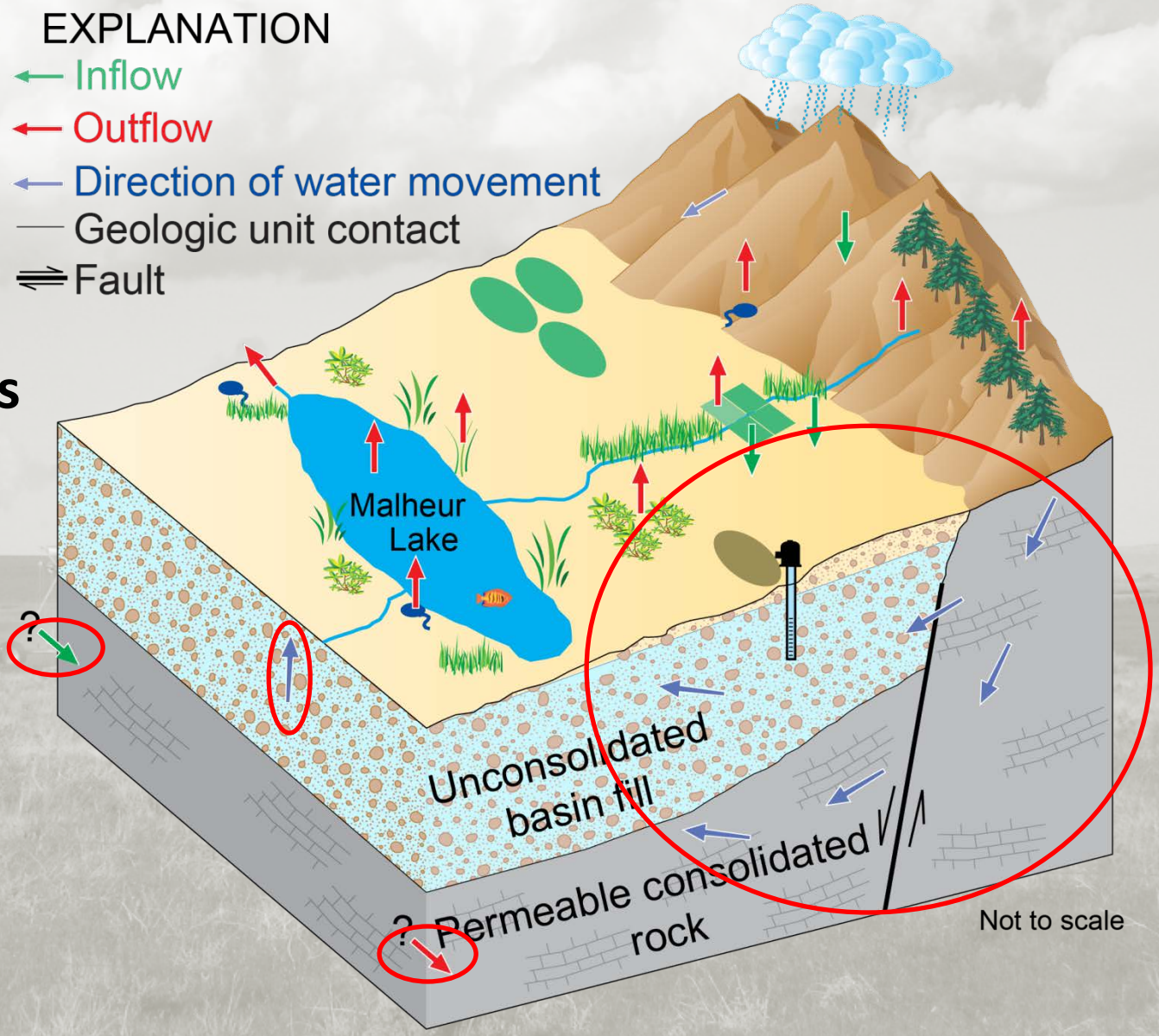
- Permeability
- Storage



Harney Basin GW Study: Grondin Tasks

Groundwater Levels

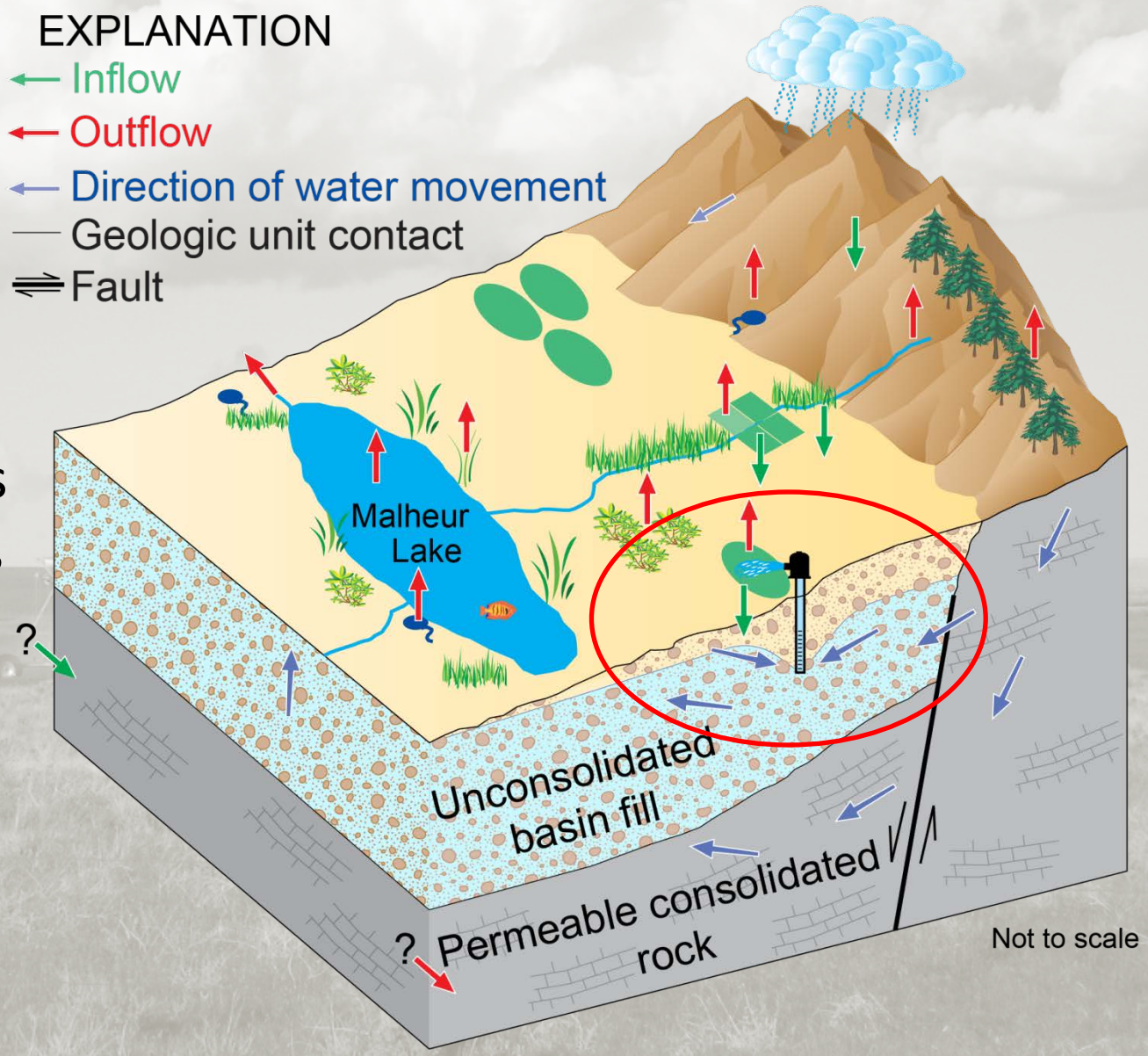
- Diagnostic Tool
- GW Connections
- GW Flow Paths
- GW Trends



Harney Basin GW Study: Grondin Tasks

GW Response

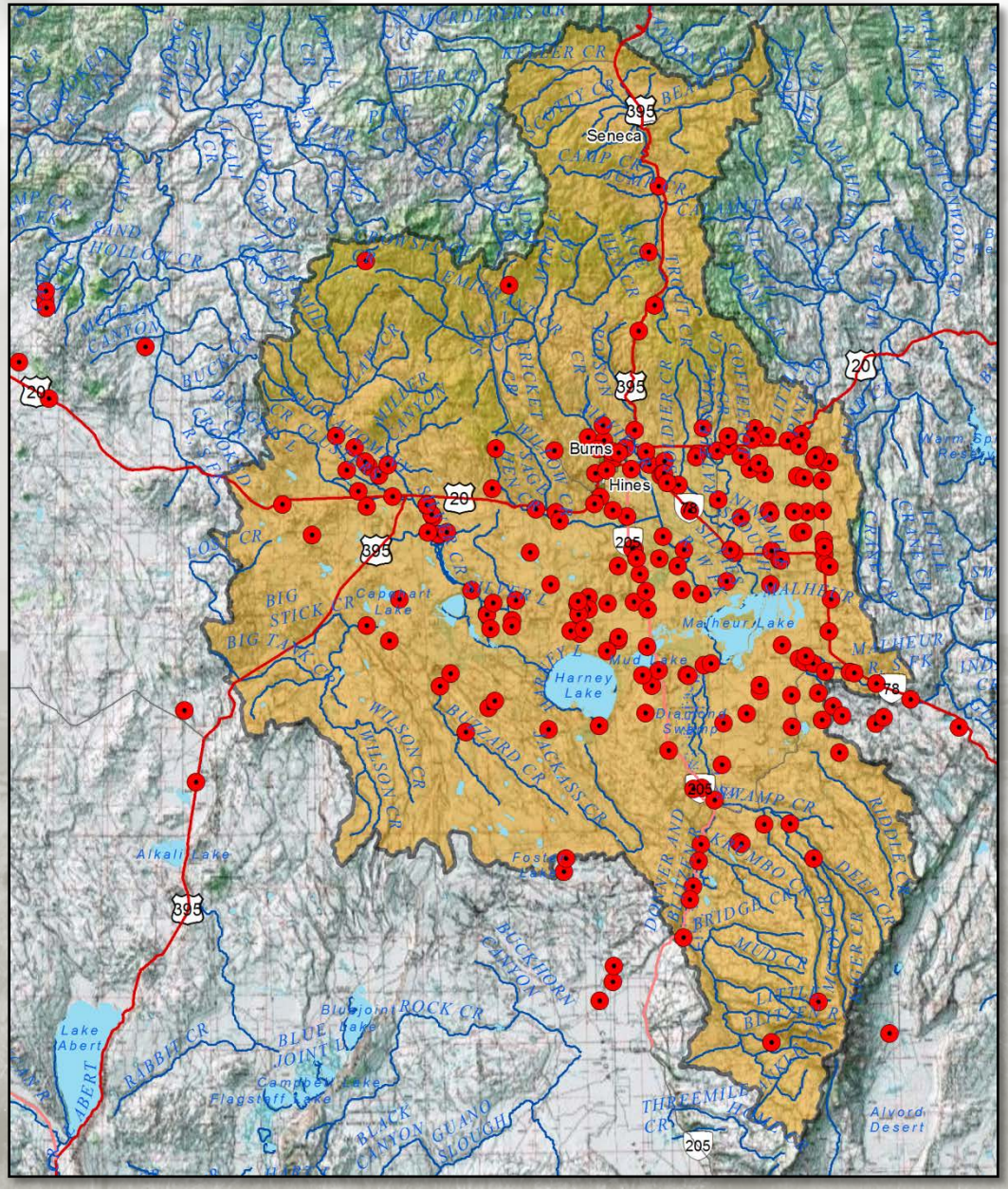
- Natural Influences
- Human Influences
- Seasonal
- Long-Term



Harney Basin Study Wells for GW Flow Maps

OWRD Synoptic Wells = 231

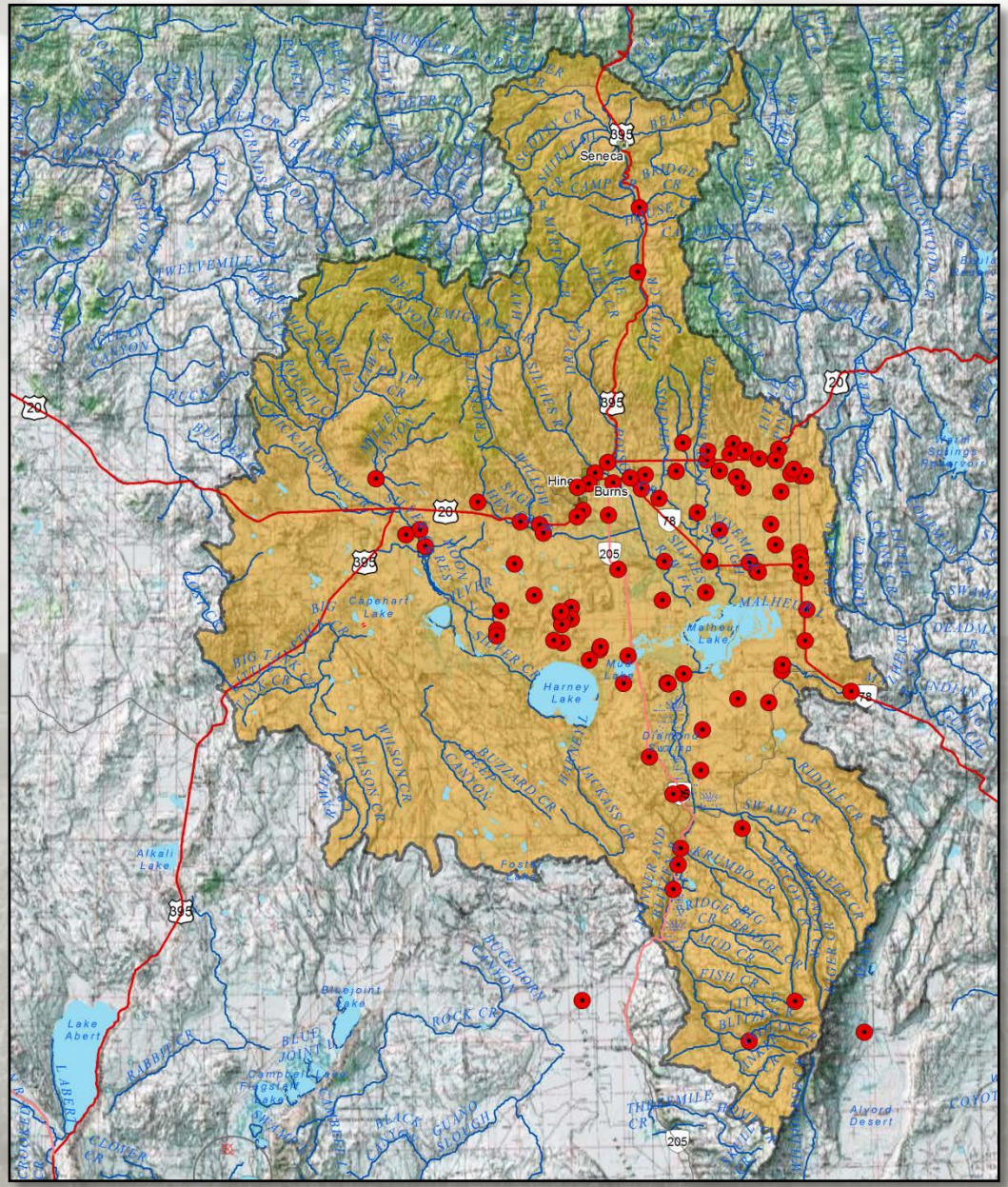
Harney Watershed Council Wells = 102 (not shown: Data Being Entered)



Harney Basin Study Wells for GW Trends

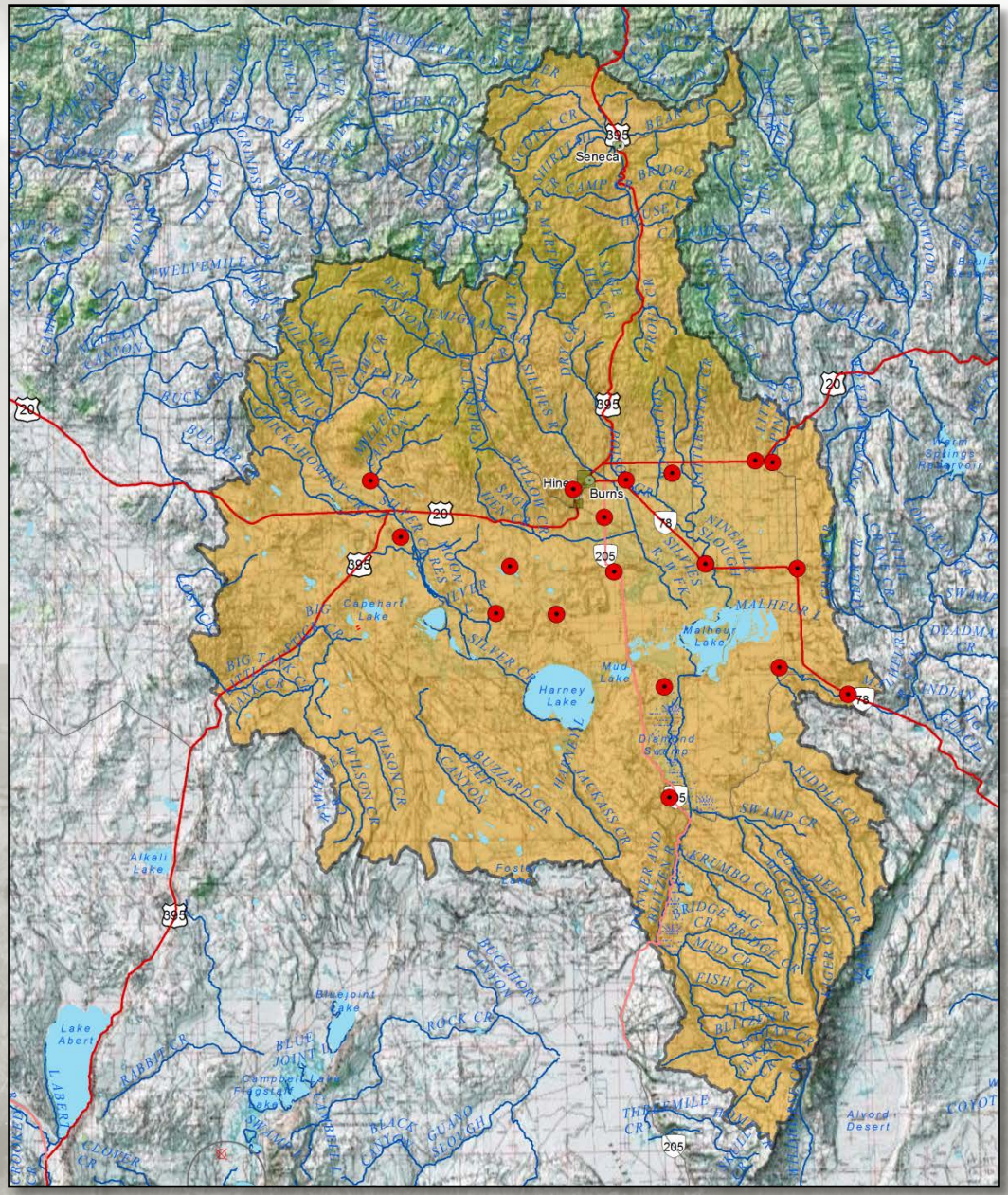
OWRD Quarterly Wells = 112

Harney Watershed Council Wells = 102 (not shown: Data Being Entered)



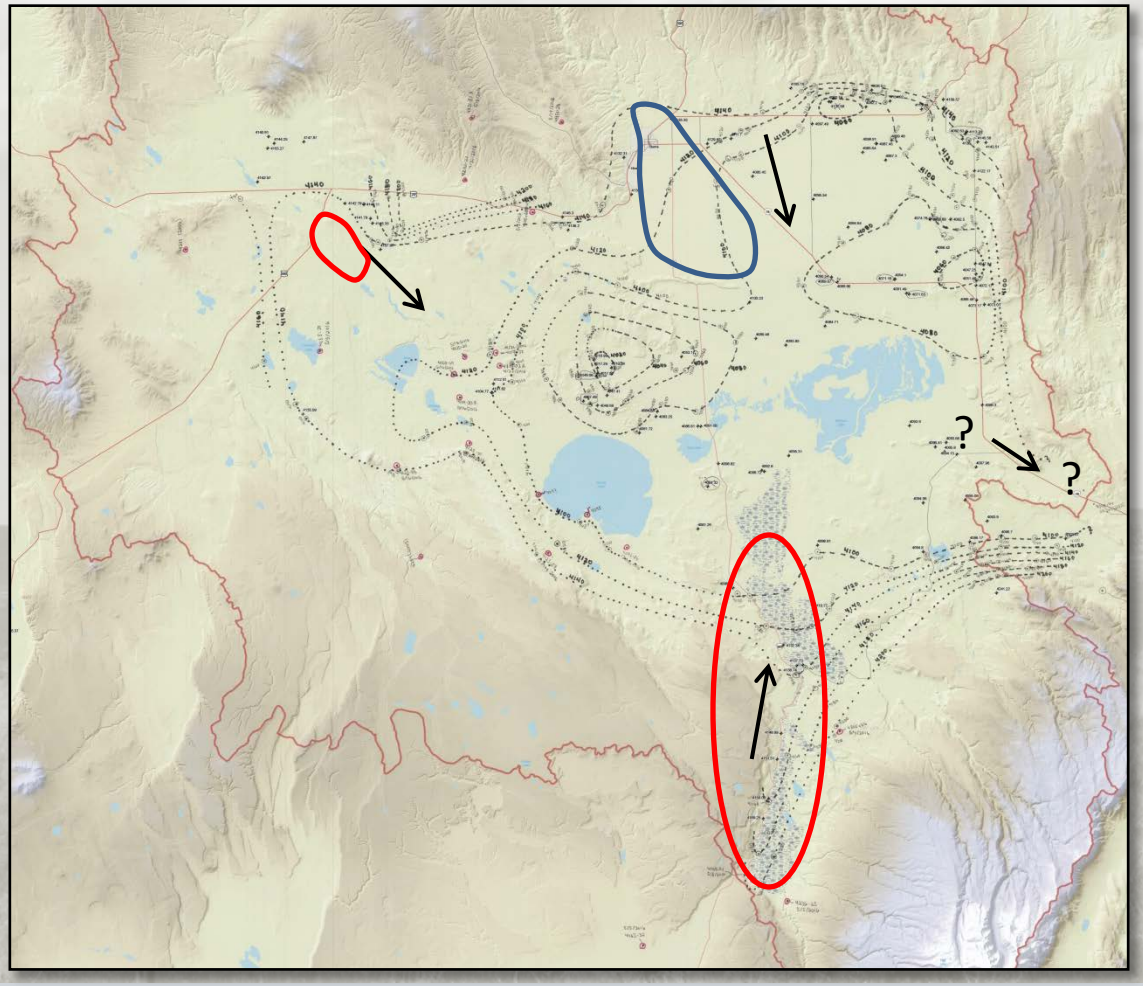
Harney Basin Study Wells for GW Trends

OWRD Recorder Wells = 24



Very Preliminary Groundwater Levels

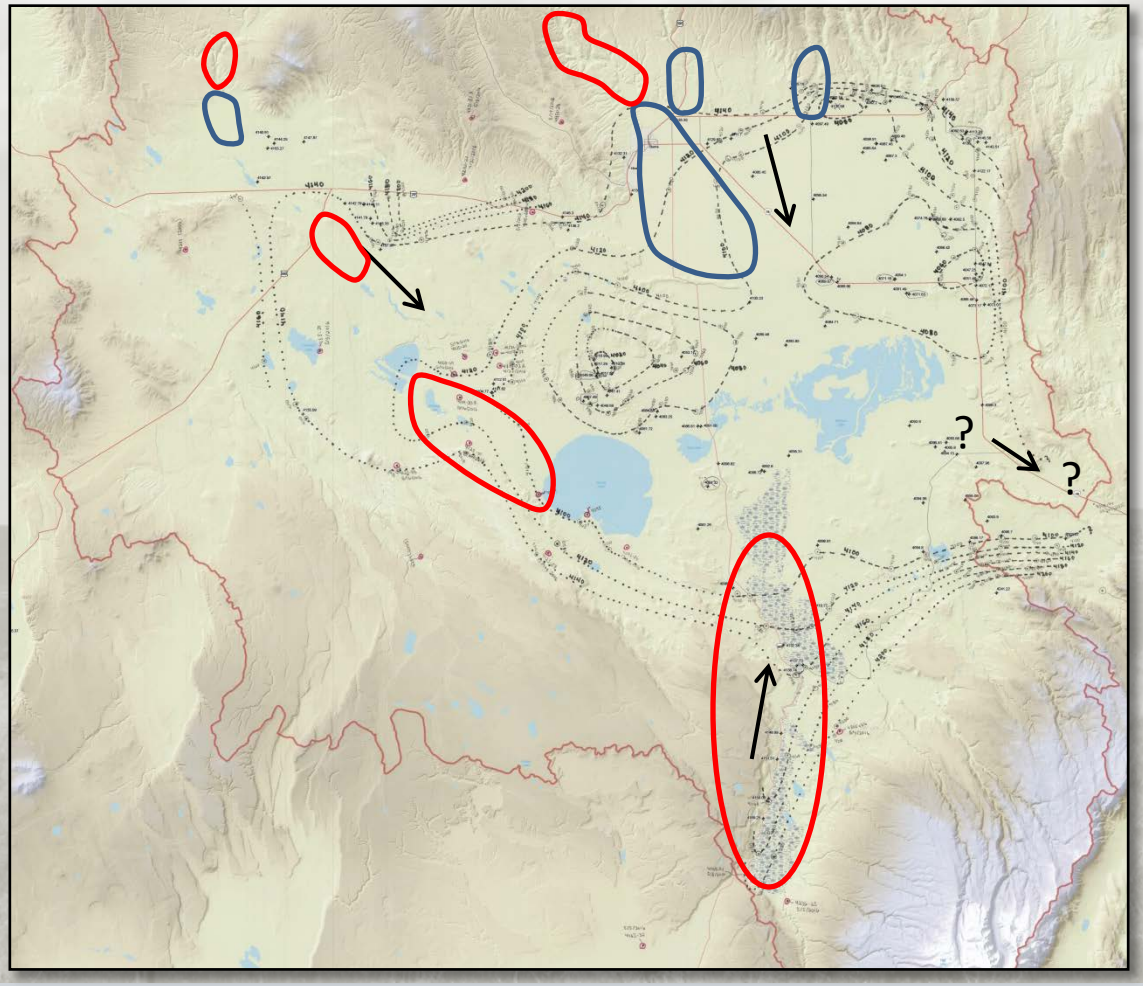
First Impressions: GW Recharge, Discharge, & Flow



Very Preliminary…Subject to Likely Change…Do Not Quote or Cite

Very Preliminary Groundwater Levels

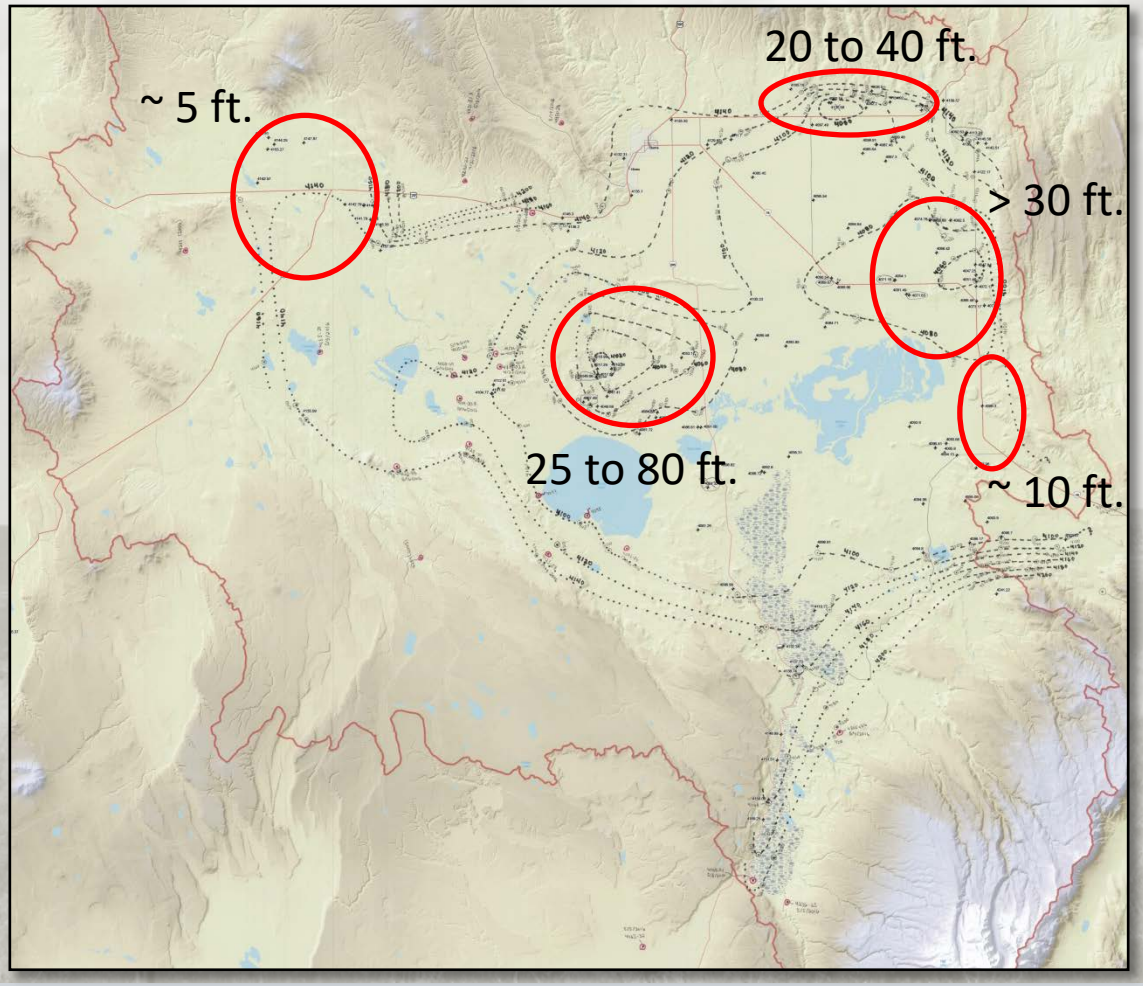
First Impressions: GW Recharge, Discharge, & Flow



Very Preliminary…Subject to Likely Change…Do Not Quote or Cite

Very Preliminary Groundwater Levels

First Impressions: Areas of GW Level Decline Since 1969



Very Preliminary…Subject to Likely Change…Do Not Quote or Cite

Harney Basin GW Study

Visit My Table

- **Water Level Stuff**
  - Maps (GW flow, GW Recharge, GW Discharge)
  - Graphs (GW Trends – Seasonal & Long-Term)
  - On-Line Well & GW Level Mapper
  - Equipment

- **Geologic Hydraulic Properties**
  - Permeability
  - Storage
  - Field Tests & Analyses

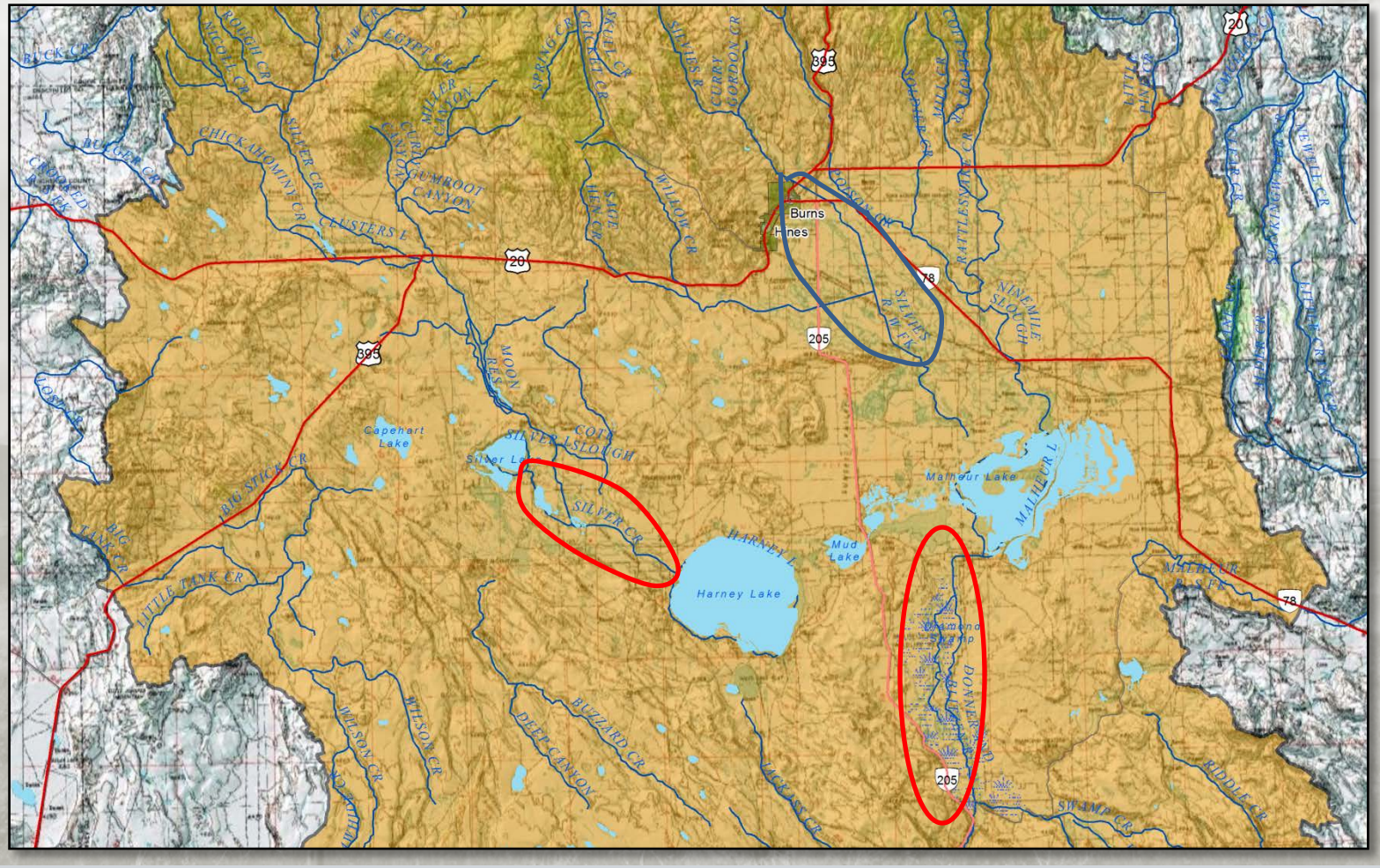
- **Determining GW Pumping (domestic, municipal, stock, …)**

Harney Basin GW Study

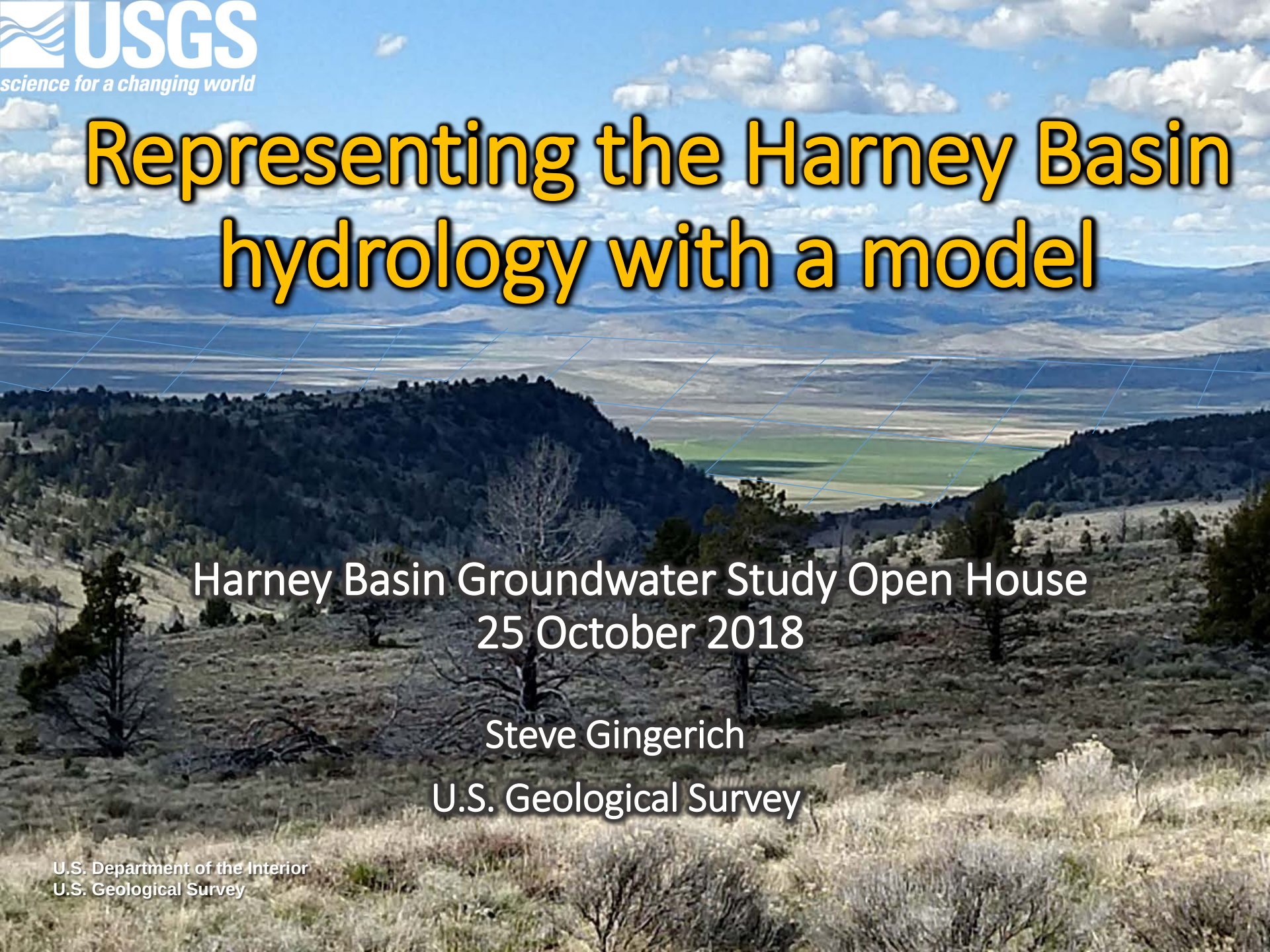
Questions & Thank You

Very Preliminary Groundwater Levels

First Impressions



Very Preliminary…Subject to Likely Change…Do Not Quote or Cite


USGS
science for a changing world
Representing the Harney Basin hydrology with a model
Harney Basin Groundwater Study Open House
25 October 2018
Steve Gingerich
U.S. Geological Survey
U.S. Department of the Interior
U.S. Geological Survey

Science everywhere!!!!

- Grew up in a rural town in southcentral Pennsylvania

Photo: Bloomberg

- Learned geology the hard way where everything is covered with plants

PennState College of Earth and Mineral Sciences

- Spent 25 years at the USGS working on island hydrology in Honolulu

UNIVERSITY of HAWAI'I MĀNOA

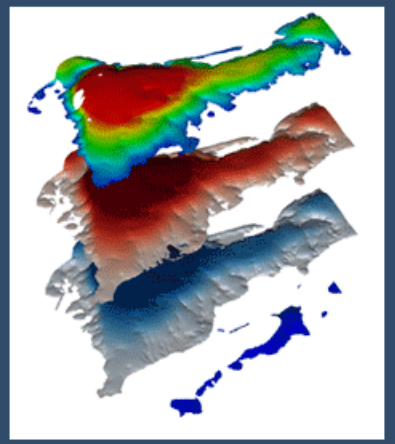
- Studies in Hawai'i, Guam, Samoa, Marshall Islands, Northern Mariana Islands, Diego Garcia, Japan…
- In Oregon since 2015

USGS

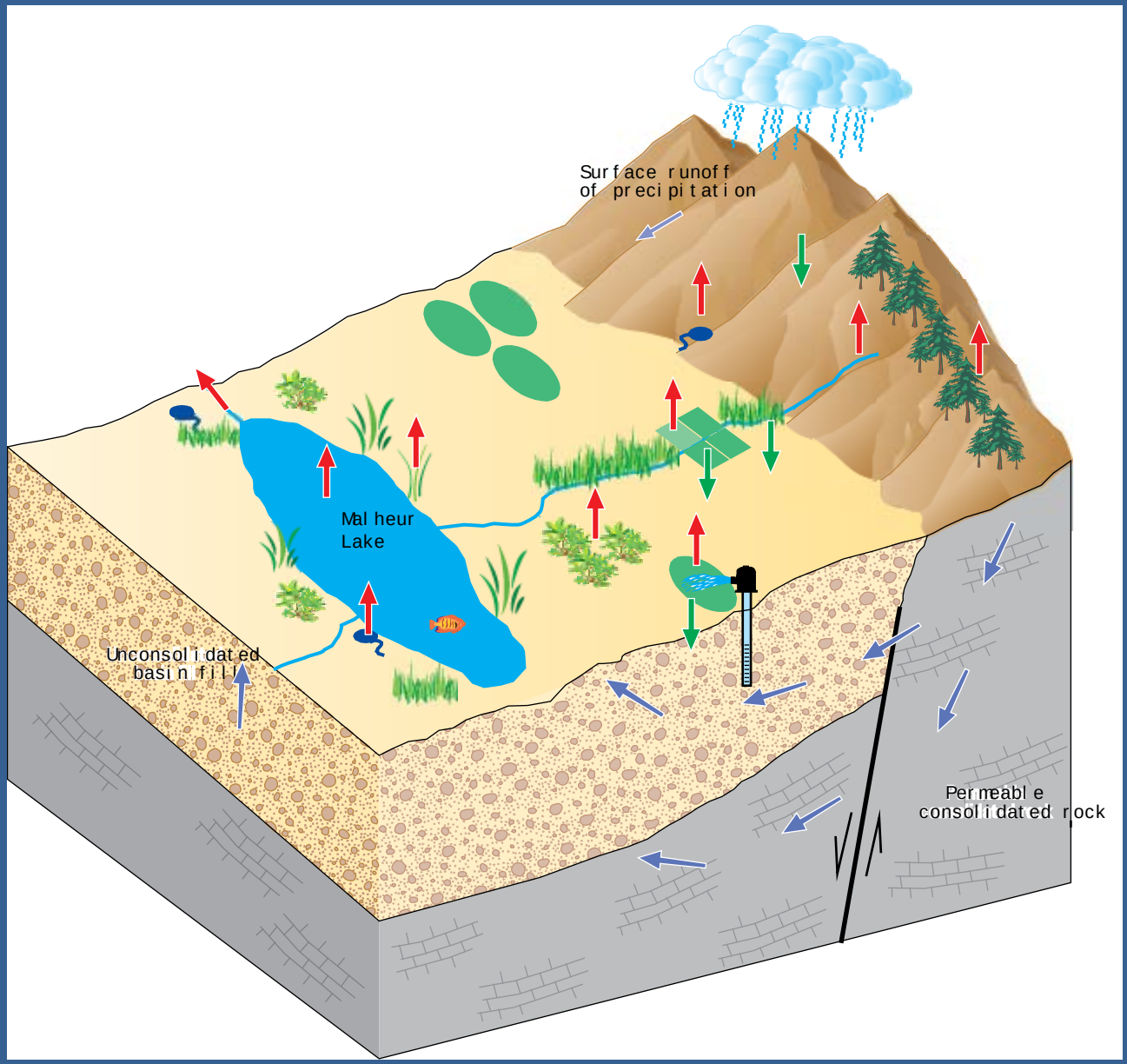
Phase 2 of Harney Basin study

- Need to synthesize the groundwater-flow system into a numerical, physically based model
- Common method to understand complex physical processes using equations that describe the physics of the process
- Numerical modeling used in many applications: aerodynamics of planes, weather forecasting, smoke-plume drift, mining, heating, etc.
- Used to test systems that can't be built in a laboratory

MODFLOW is the USGS's modular hydrologic model. MODFLOW is considered an international standard for simulating and predicting groundwater conditions and groundwater/surface-water interactions.

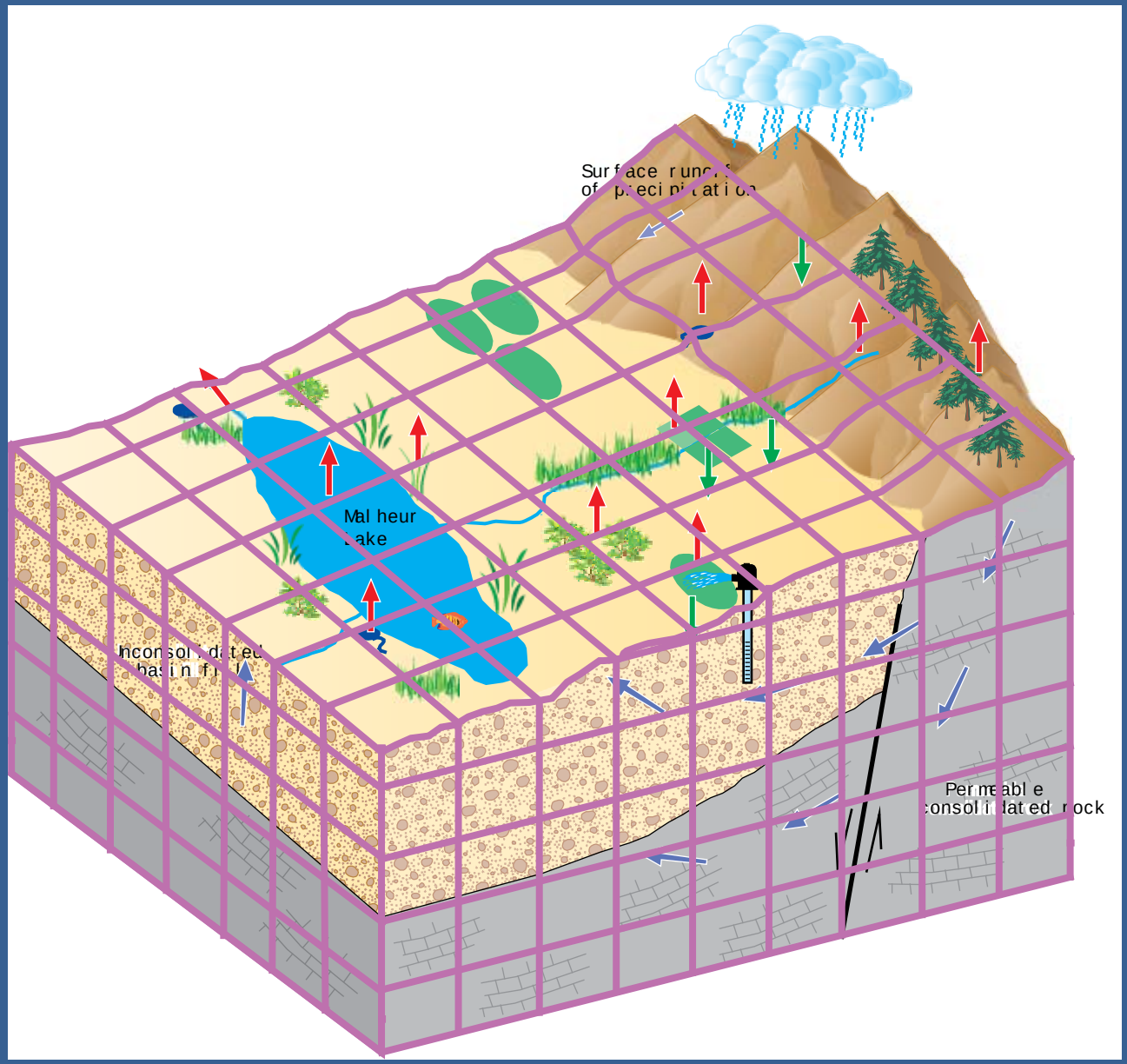


USGS

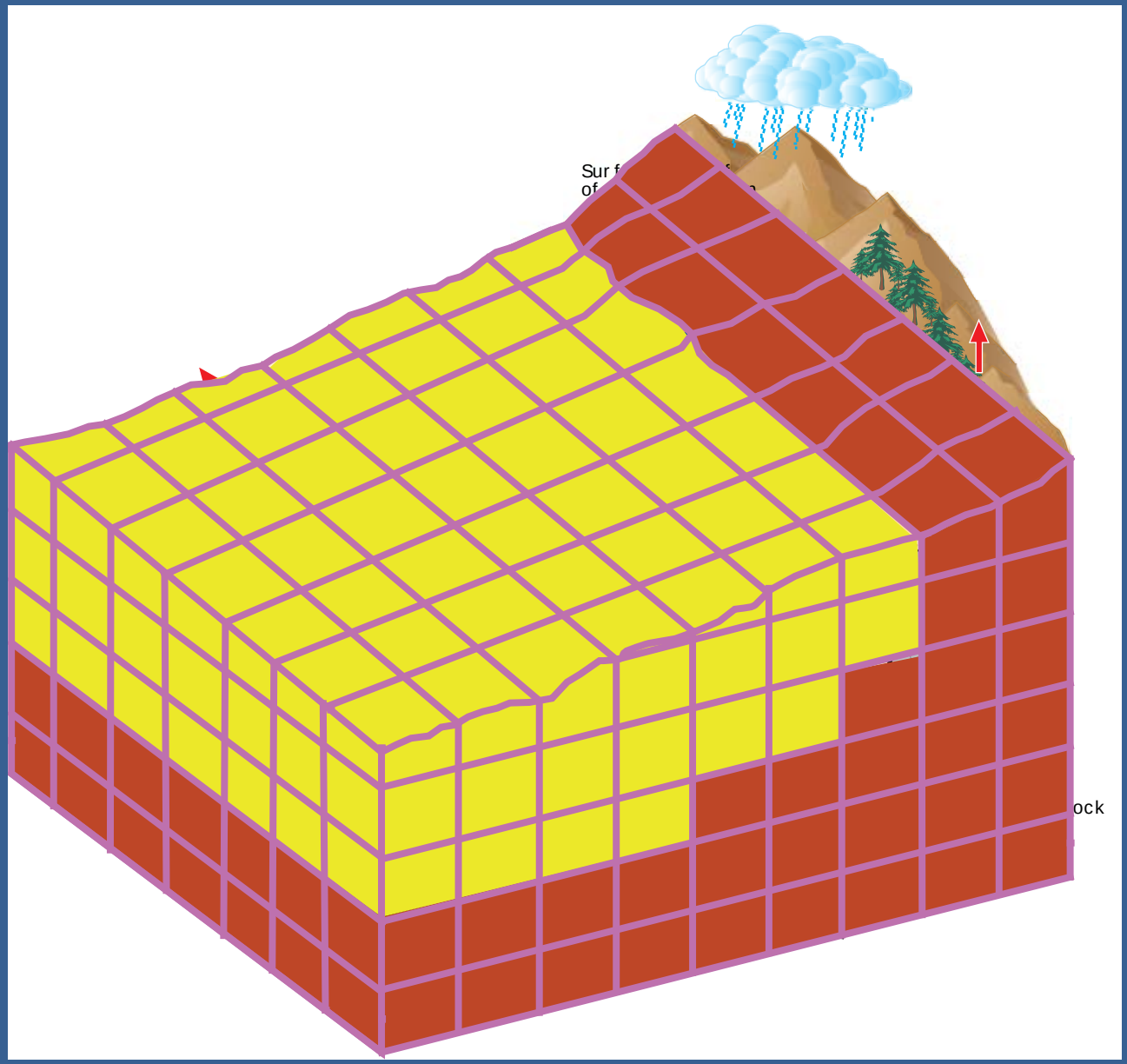


USGS

Modified from Masbruch and others (2010)



USGS



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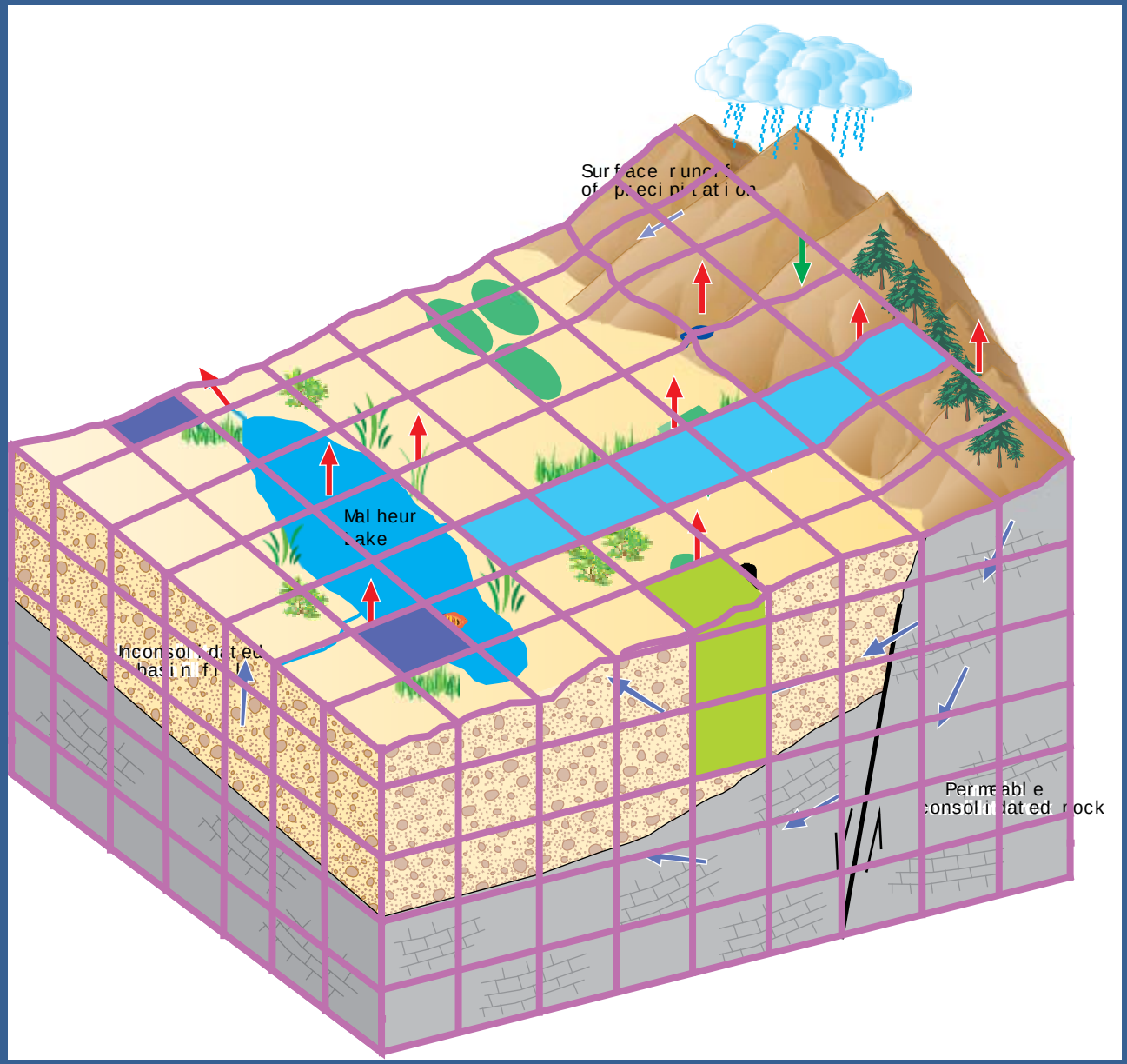
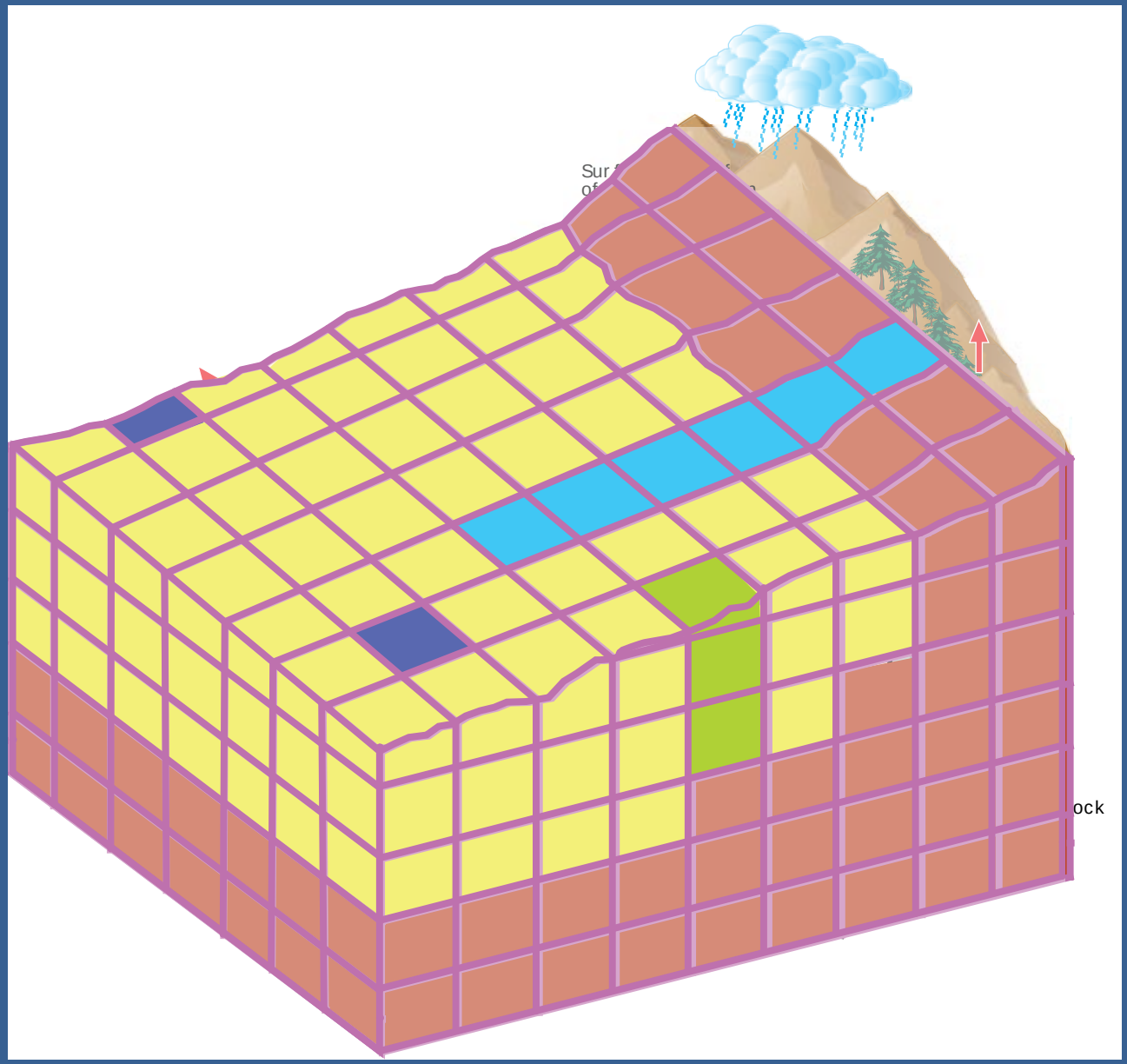
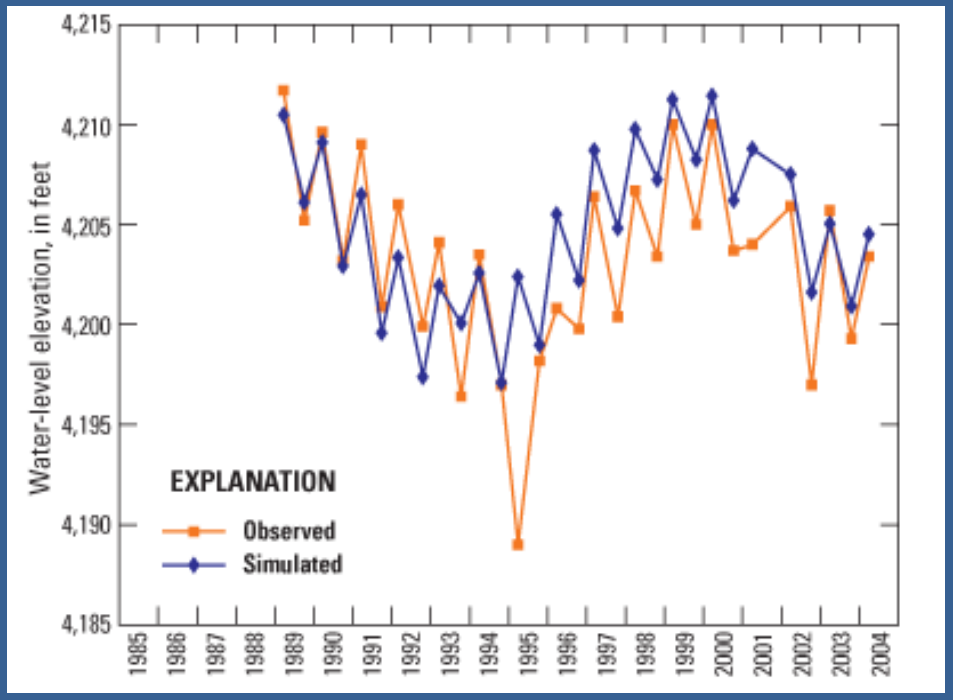


USGS

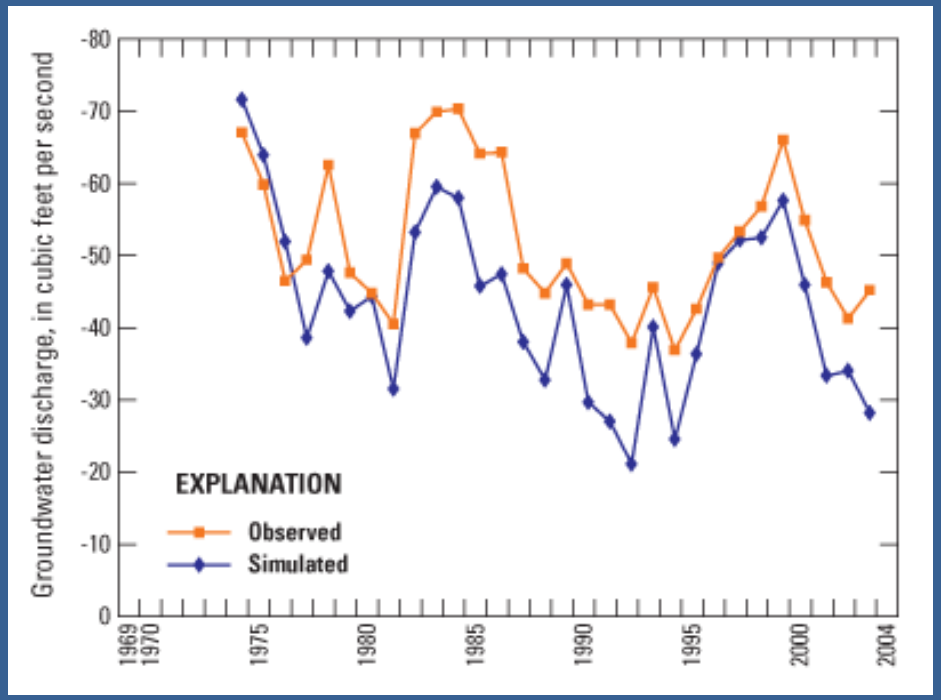


USGS

Match model to measured hydrologic data "Calibration"



Water levels



Stream and river discharge

USGS

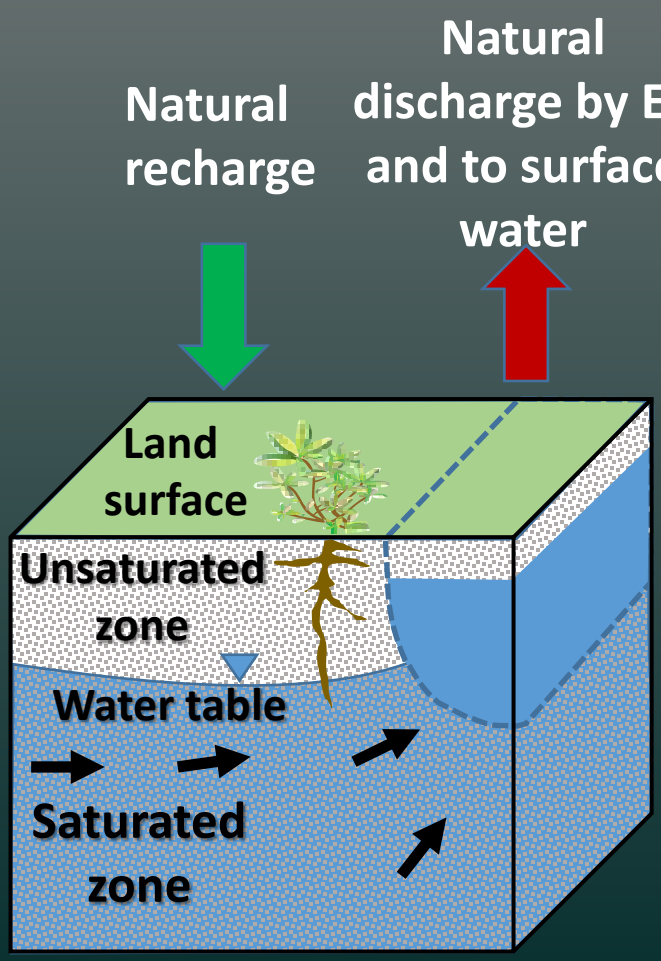
Gannett and others, 2012

Some benefits of a groundwater model

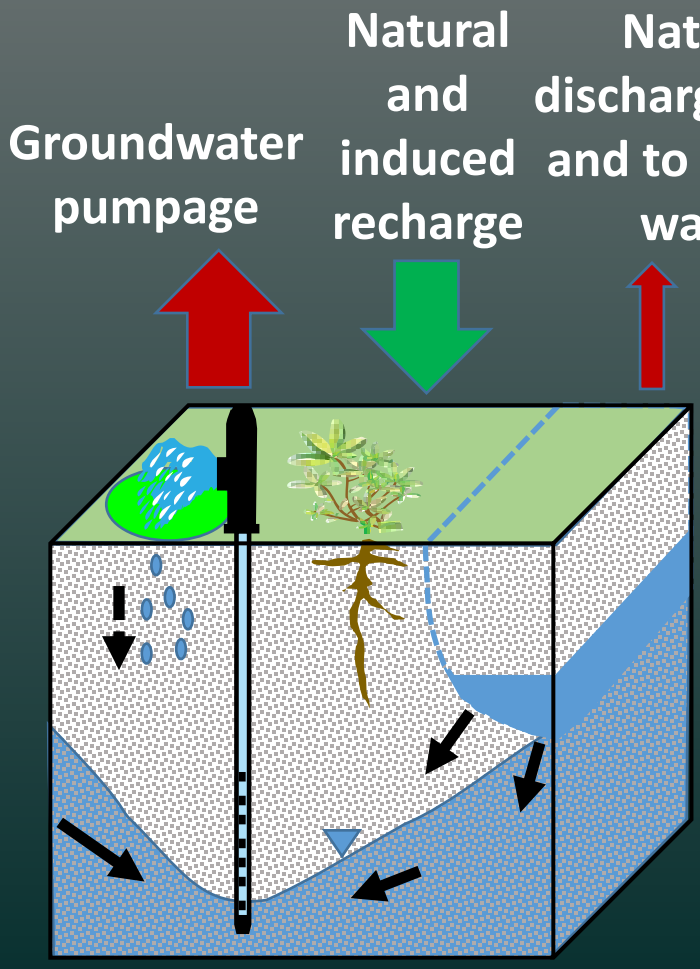
- Synthesize understanding of the flow system into a numerical, physically based groundwater-flow model in 3-D
- Test our understanding of flow system and aquifer framework
- Investigate effects of new wells on existing wells
- Investigate how well pumping effects streamflow
- Help understand groundwater-flow paths and travel times

Groundwater Storage Depletion

Predevelopment conditions



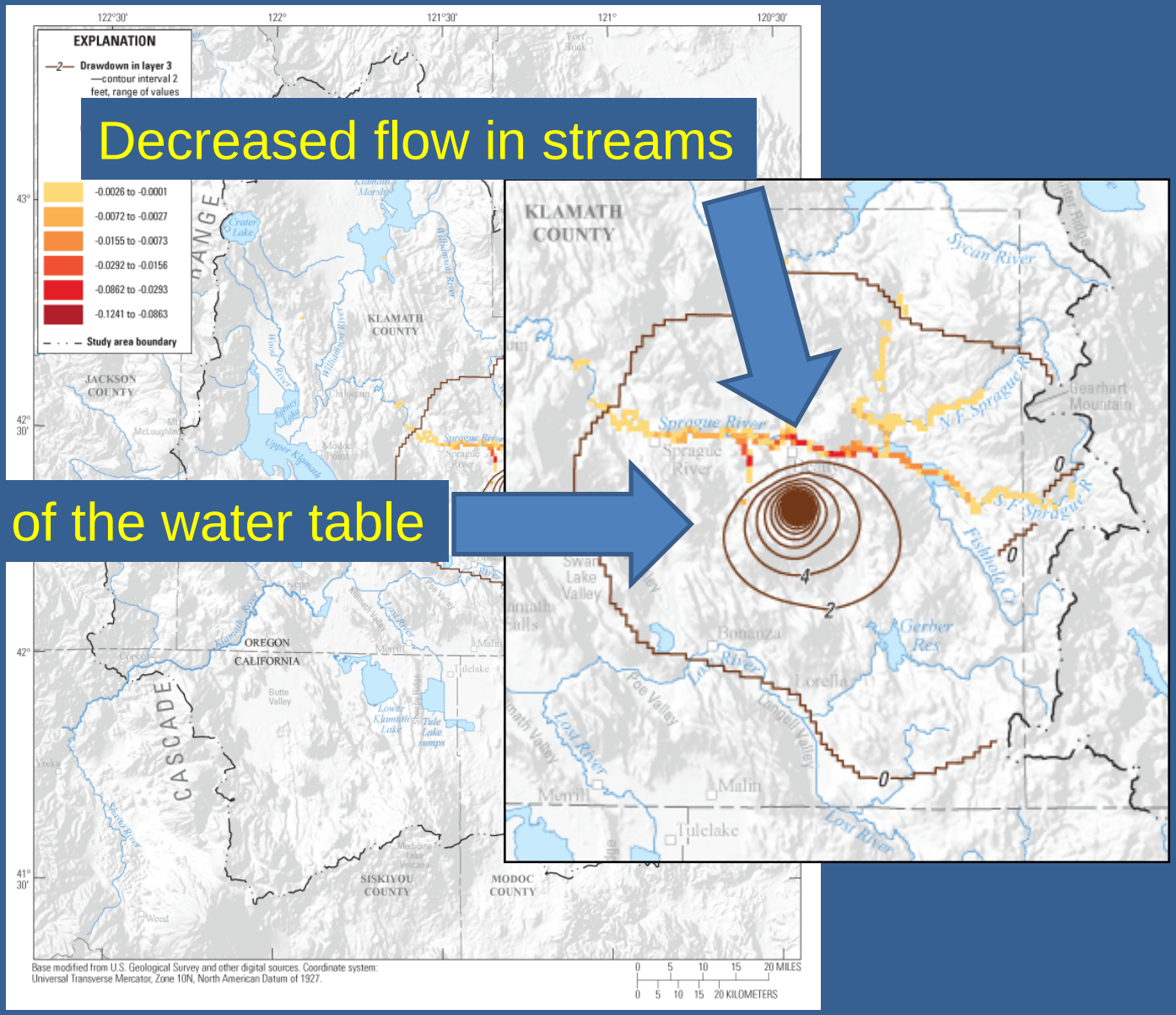
Development conditions



USGS

Test pumping scenarios with model

Example from Klamath Basin



Gannett and others, 2012

Next steps??

- Just beginning to lay out the framework of basin-scale model
- Preliminary model can be used now to guide where we might need to collect more data

USGS

OREGON WATER RESOURCES DEPARTMENT

Study Advisory Committee

Convened in July 2016

14 committee members

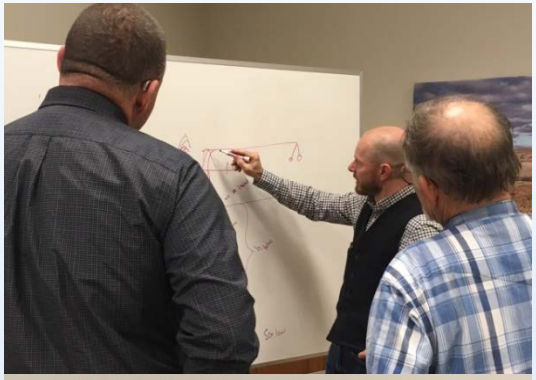
OREGON WATER RESOURCES DEPARTMENT

Study Advisory Committee

Quarterly meetings – Jan, Apr, Jul, Oct

10 meetings so far

Study Advisory Committee



Purpose:

Open exchange of ideas, information, and data – TWO WAY

From the science team to the advisory committee

From the advisory committee to the science team

OREGON WATER RESOURCES DEPARTMENT

Study Advisory Committee

Reflections??? Questions???

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