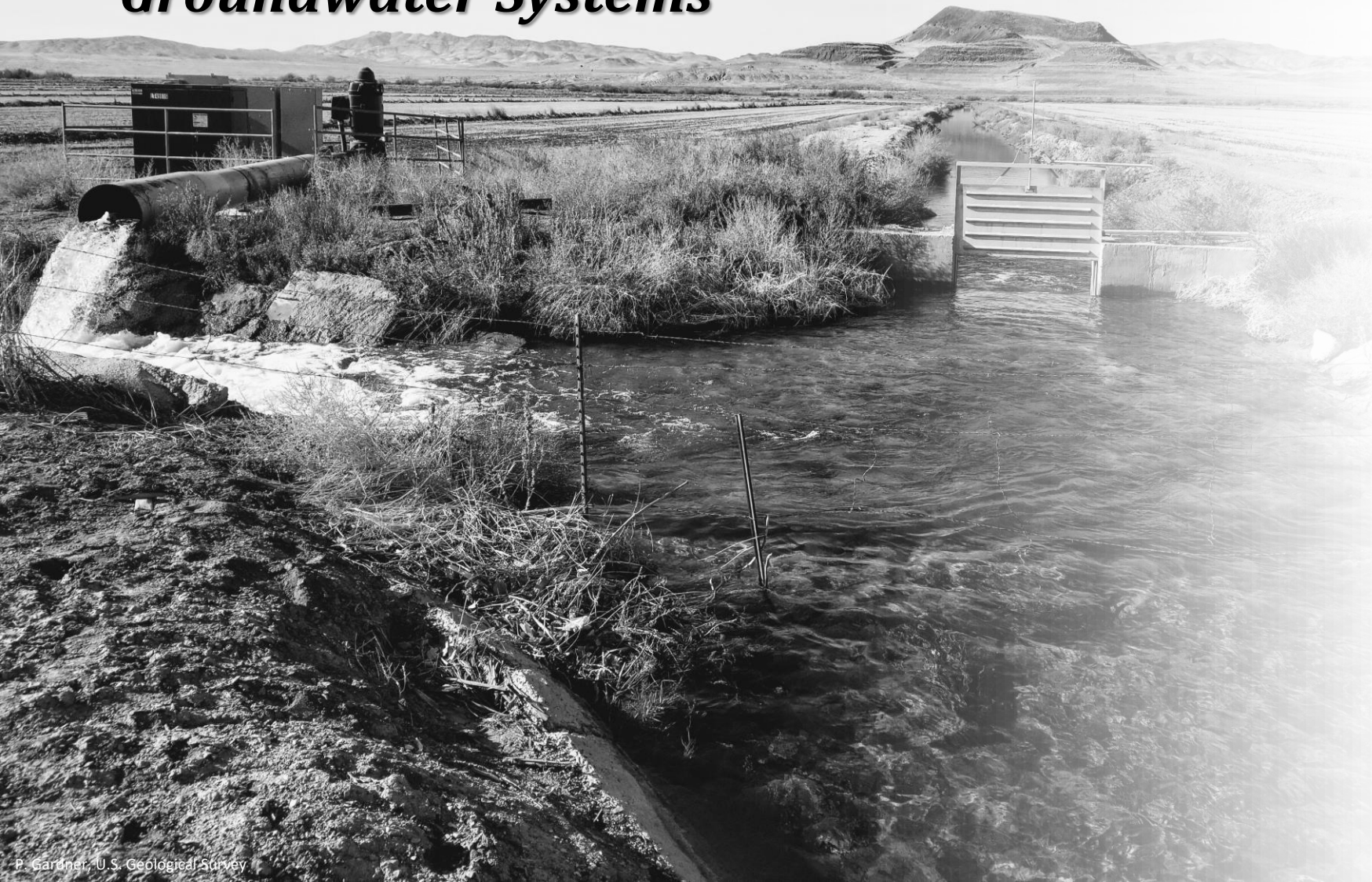
The Nevada Water Resources Initiative

Advancing the Science and Understanding of Nevada's Groundwater Systems



P. Gardner, U.S. Geological Survey

Philip Gardner

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Nevada Water Resources Association
Annual Conference
February 2, 2023

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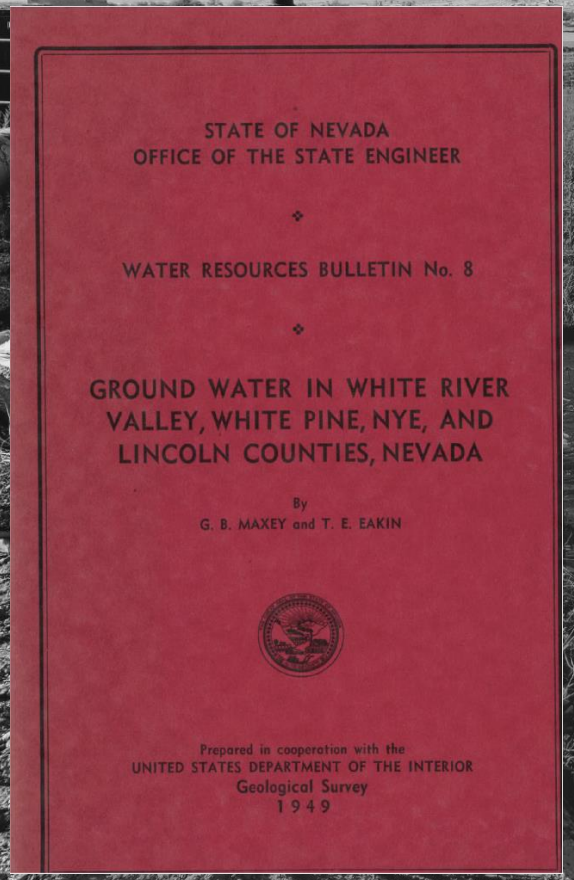
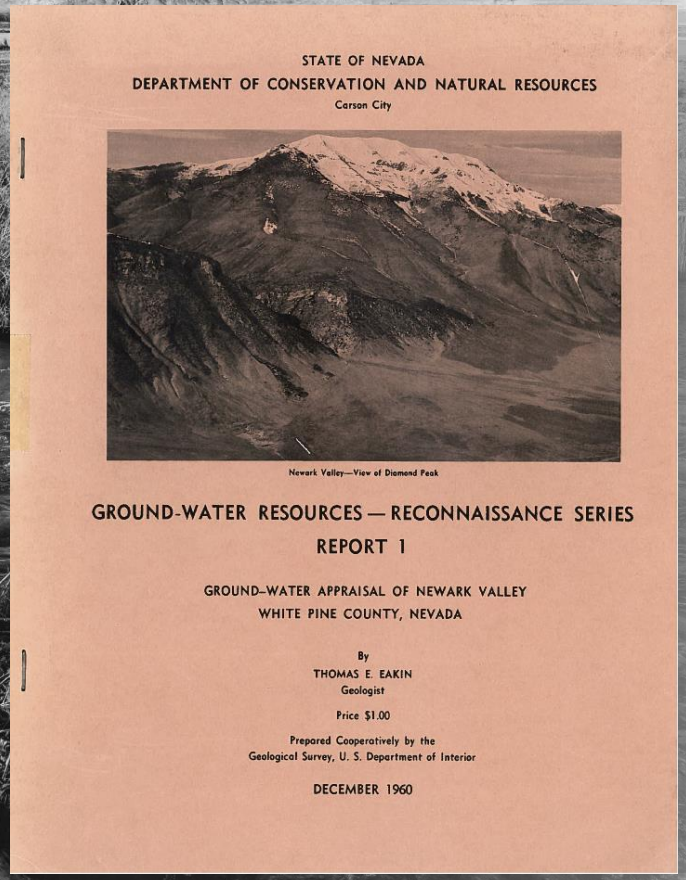
USGS science for a changing world

DRI Desert Research Institute

The Nevada Water Resources Initiative

Advancing the Science and Understanding of Nevada's Groundwater Resources





- Increased demand on water resources
- Some groundwater budgets and concepts are *incorrect*
- Some groundwater budgets and system dynamics are *uncertain*
  - Difficult to manage for conflict prevention in areas of high demand
- Groundwater budgets may be *changing with climate*
  - Native mountain vegetation consuming more, leaving less for valley recharge

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Why update flow system conceptual models and groundwater budgets?

- Reconnaissance reports were intended as "reconnaissance"

The program of reconnaissance water-resources studies was authorized by the 1960 Legislature to be carried on by the Department of Conservation and Natural Resources, Division of Water Resources, in cooperation with the U.S. Geological Survey.

This report is the 60th report prepared by the staff of the Nevada District of the U.S. Geological Survey. These 60 reports describe the hydrology of 219 valleys.

The reconnaissance surveys make available pertinent information of great and immediate value to many State and Federal agencies, the State cooperating agency, and the public. As development takes place in any area, demands for more detailed information will arise, and studies to supply such information will be undertaken. In the meantime, these reconnaissance-type studies are timely and adequately meet the immediate needs for information on the water resources of the areas covered by the reports.

Roland D. Westergard
State Engineer

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Why update flow system conceptual models and groundwater budgets?

- Reconnaissance reports were intended as “reconnaissance”

GROUND-WATER BUDGETS

For long-term natural or near-natural conditions, ground-water inflow to and outflow from an area are about equal, assuming that climatic conditions remain reasonably constant. Thus, a ground-water budget can be used (1) to compare the estimates of natural inflow to and outflow from each valley, (2) to determine the magnitude of errors in the two estimates, provided that one or more elements are not calculated by difference, and (3) to select a value that best seems to represent both inflow and outflow, within the limits of reconnaissance accuracy. This value in turn is utilized in a following section of the report to estimate the perennial yield of each area.

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Why update flow system conceptual models and groundwater budgets?

- Reconnaissance reports were intended as “reconnaissance”
  - Many basins have been studied since the reconnaissance reports
  - Much has been learned
  - However, findings not recognized in way that would make updated budget components readily comparable to early studies

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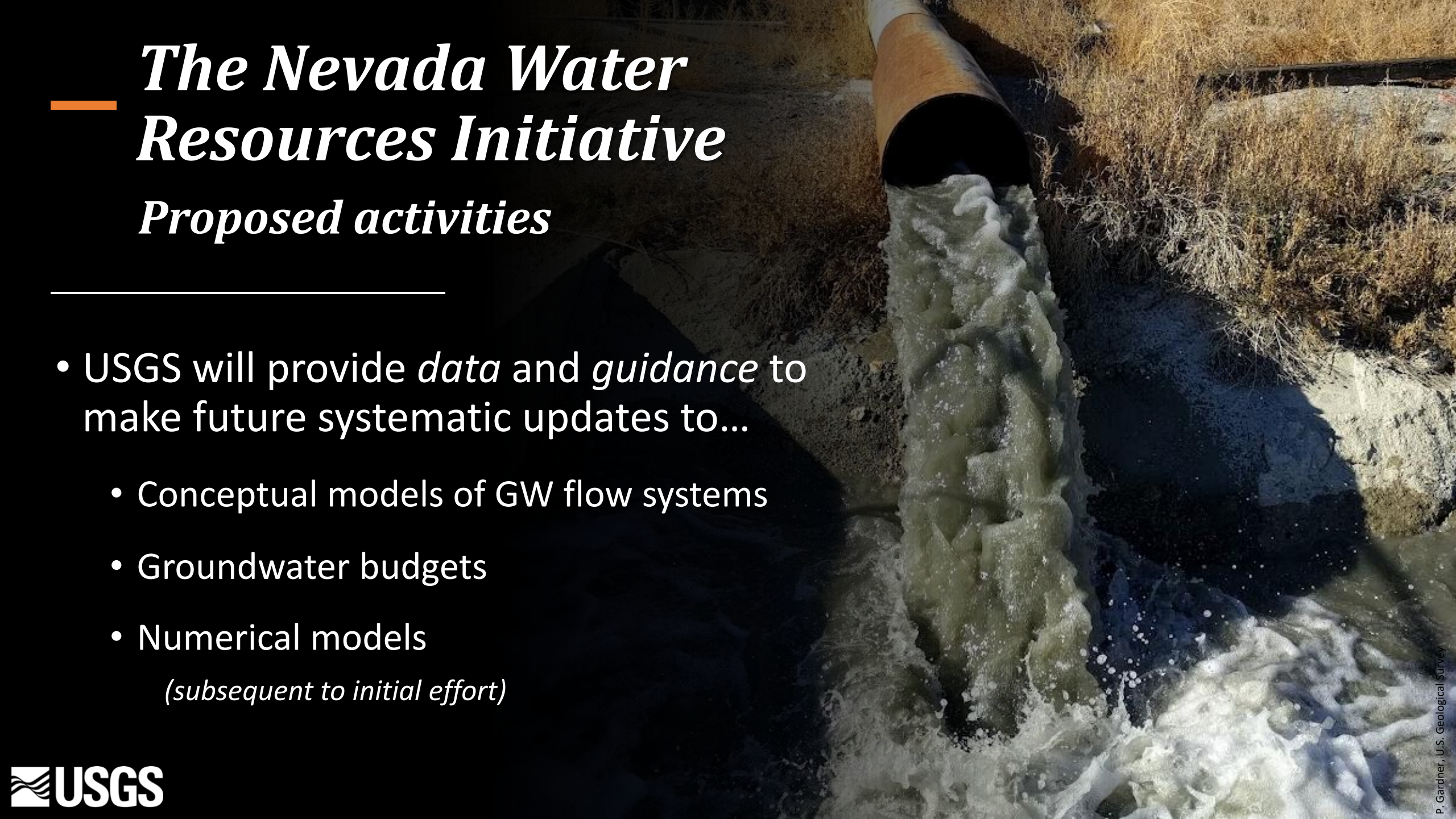
Proposed activities

- USGS will provide *data* and *guidance* to make future systematic updates to…
  - Conceptual models of GW flow systems
  - Groundwater budgets
  - Numerical models

    (subsequent to initial effort)



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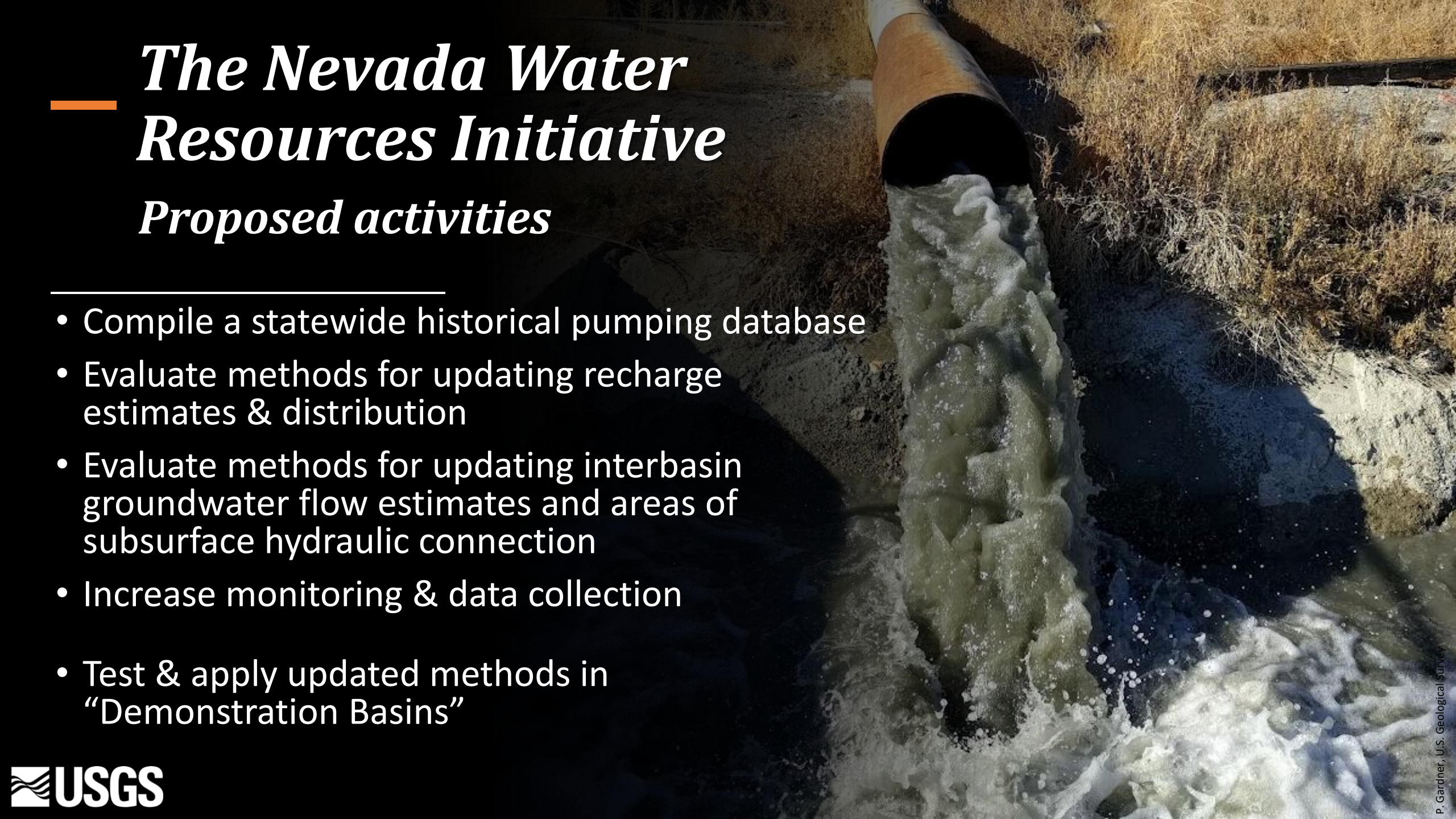
Proposed activities

- Compile a statewide historical pumping database
- Evaluate methods for updating recharge estimates & distribution
- Evaluate methods for updating interbasin groundwater flow estimates and areas of subsurface hydraulic connection
- Increase monitoring & data collection
- Test & apply updated methods in “Demonstration Basins”



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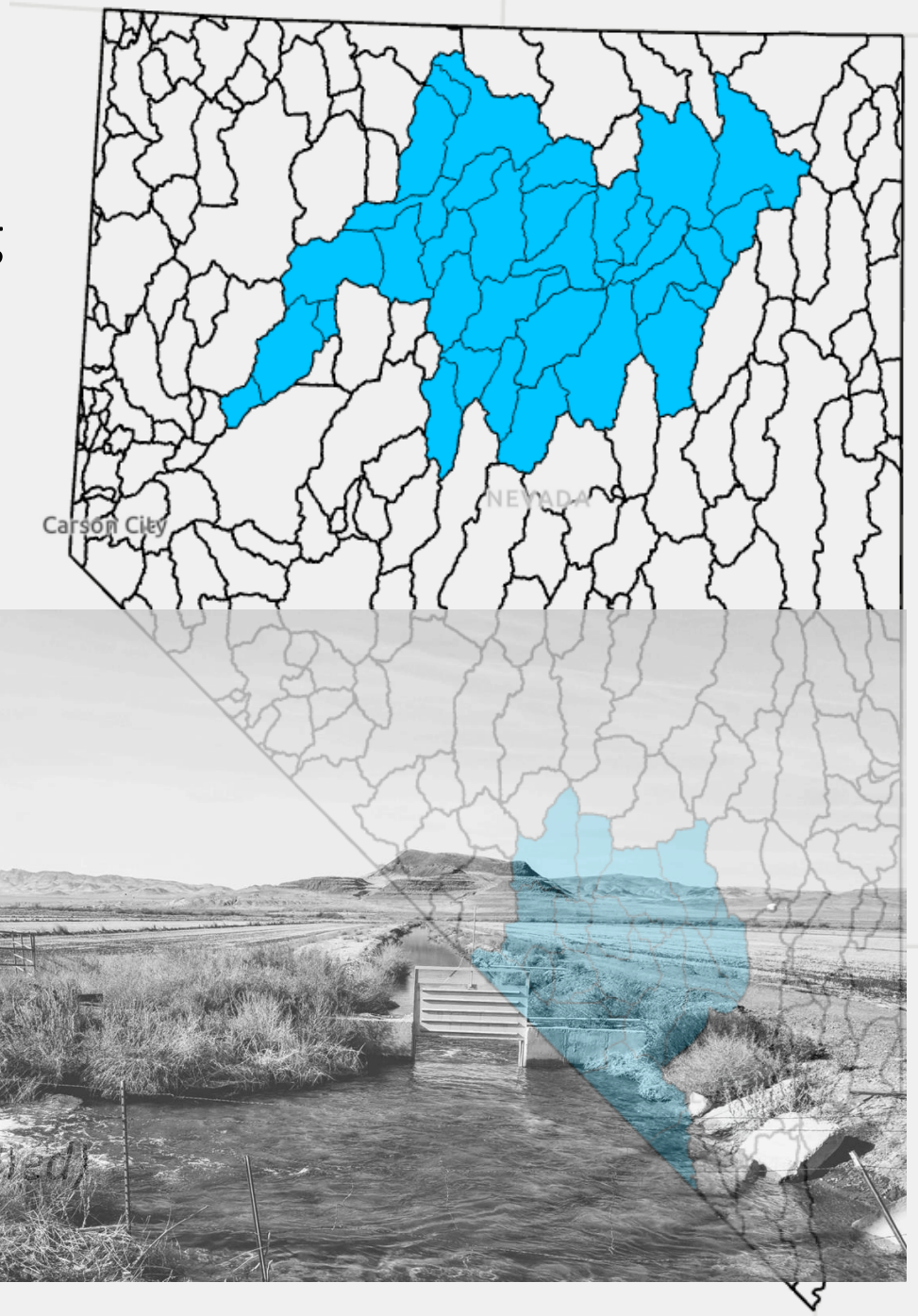
Pumping Inventory & Database

- Comprehensive database – Historical Pumping
  - Municipal
  - Domestic
  - Industrial-Commercial
  - Mining
  - Geothermal
- Agricultural - *DRI*
- A very big task
- *…we have a head start*
  - *Death Valley Regional Flow System*
  - *Humboldt River Region Flow System*
  - *Others partially complete (e.g. Carson River Watershed)*



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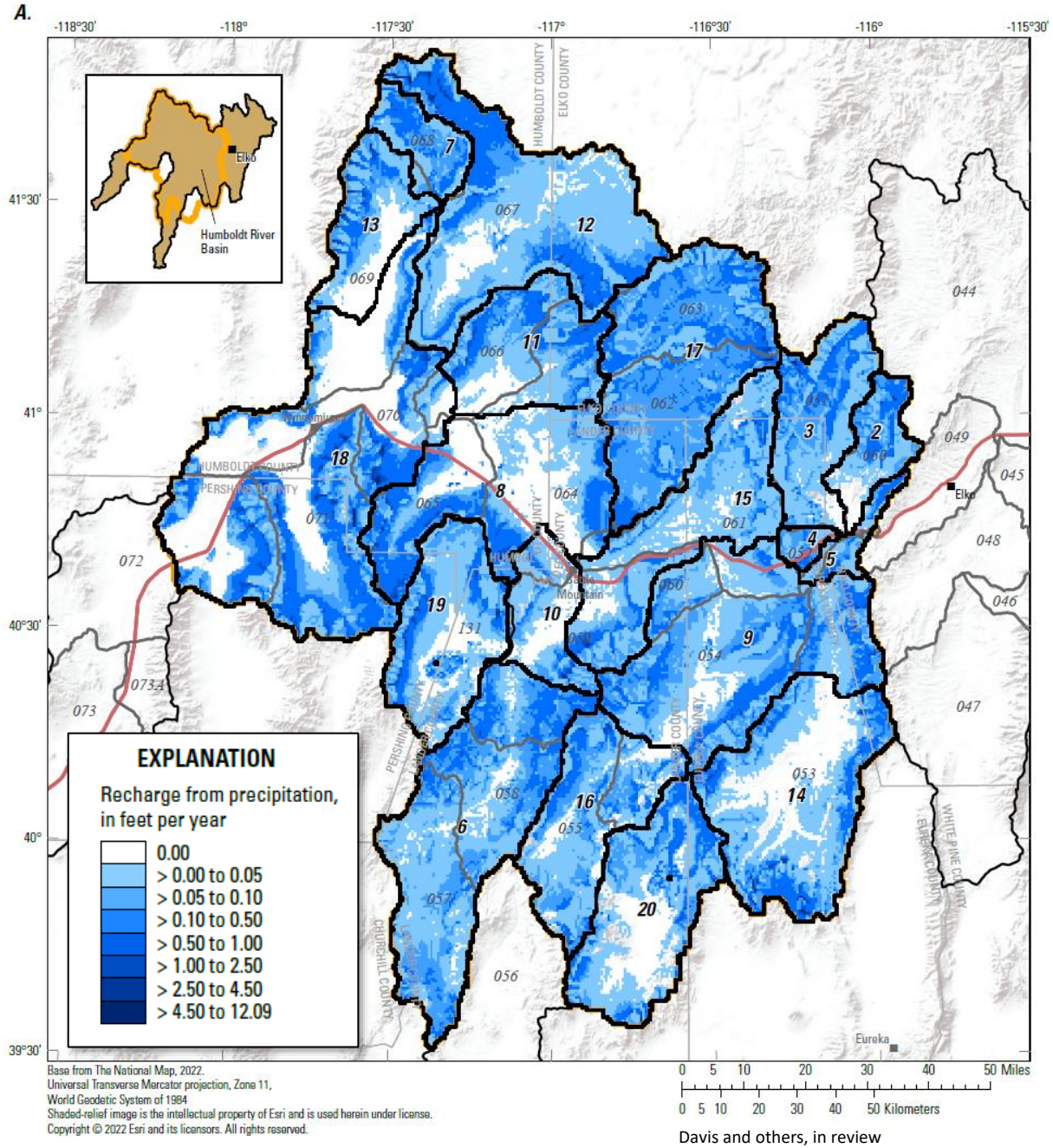
Recharge Evaluation

- Going beyond Maxey-Eakin
  - Often good for volume
  - Unrealistic for distribution
- Distribution tied to conceptual models
- *Necessary for numerical models*
- New methods exist - evaluate methods
  - Water Yield from instrumented watersheds
  - Modified Maxey-Eakin
  - Water Balance Models (PRMS)*
  - Land Surface Models (WLDAS)*
  - Chemical and Isotopic methods
    - Chloride mass balance
    - Tritium Peak

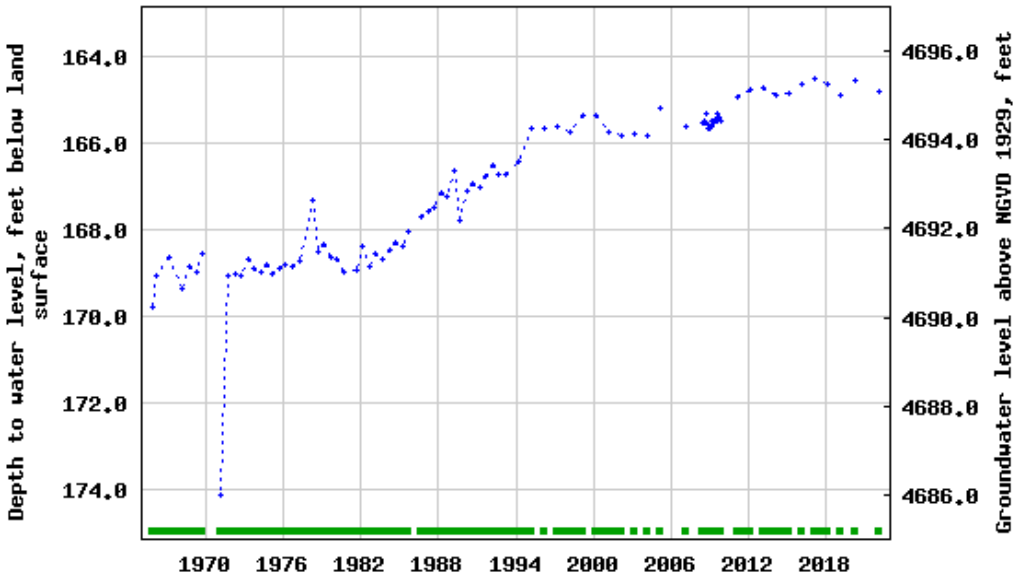


Davis and others, in review

*PRMS, Precipitation Runoff Modeling System; WLDAS, Western Lands Data Assimilation System

Recharge – Different Processes in Different Terrains

- Diffuse recharge potential example



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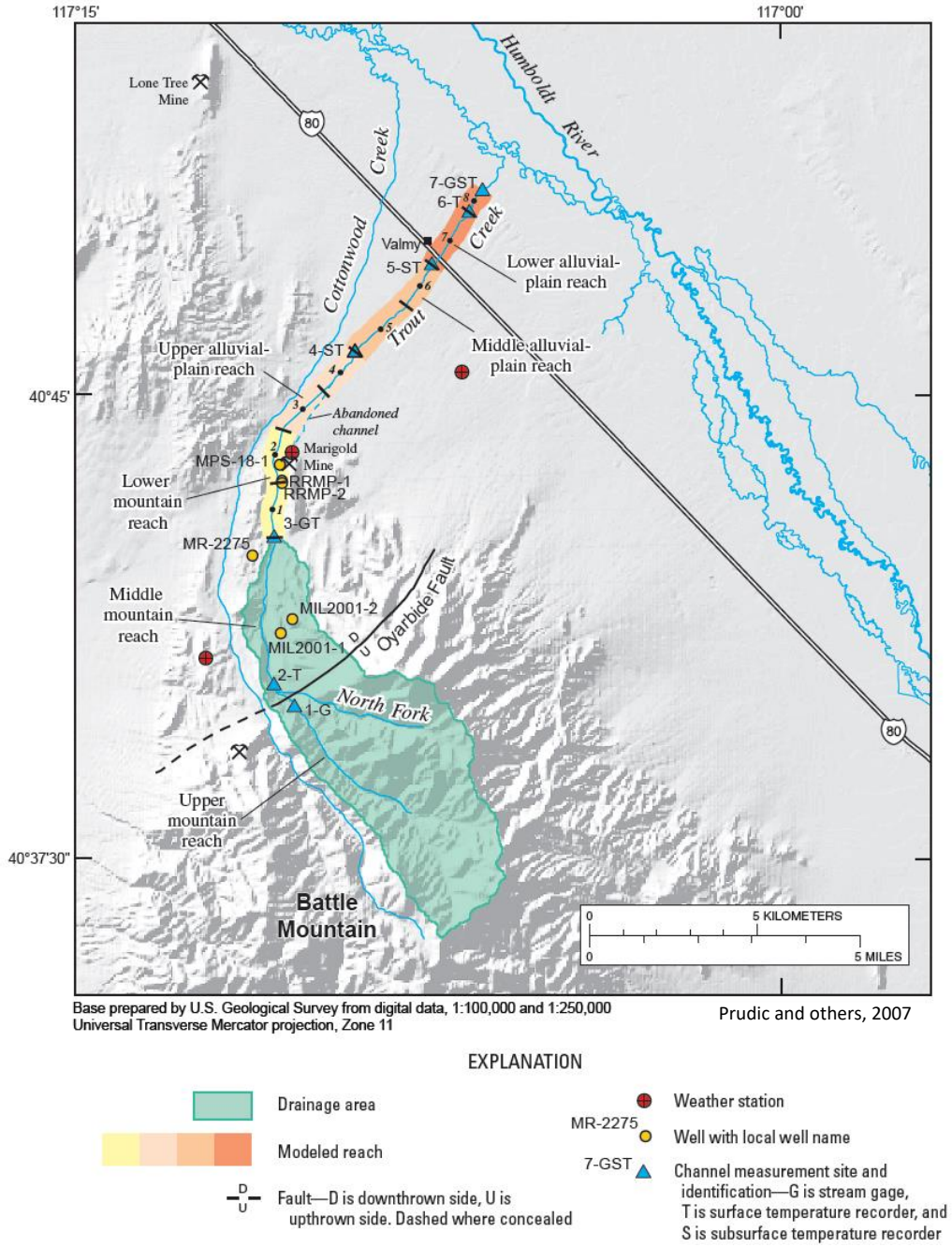
Recharge – Different Processes in Different Terrains

- Focused recharge beneath an intermittent stream

B. Trout Creek on piedmont alluvial plain below Marigold Mine; view is to north

J.L. WOOD, U.S. GEOLOGICAL SURVEY



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Recharge – Different Processes in Different Terrains

- Rapid mountain block recharge to karst

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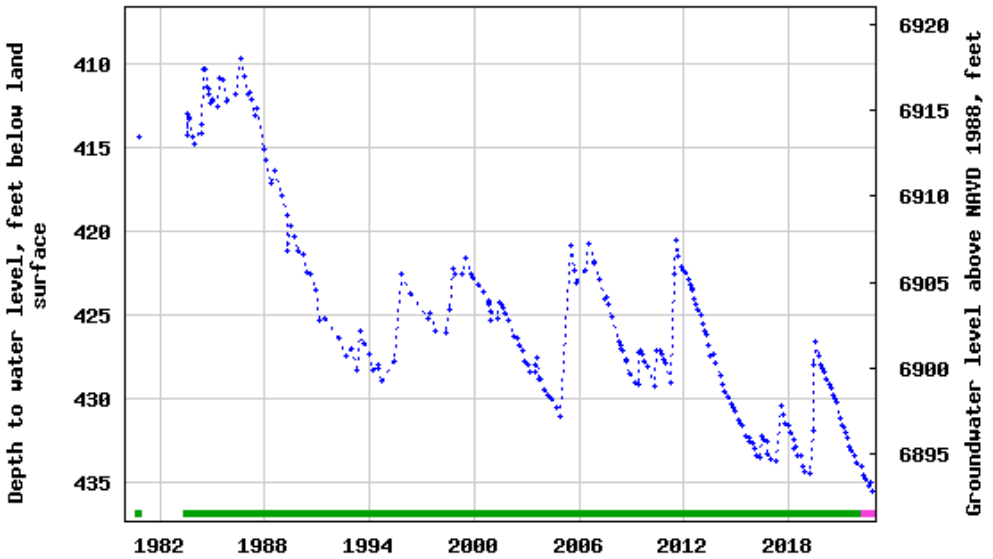

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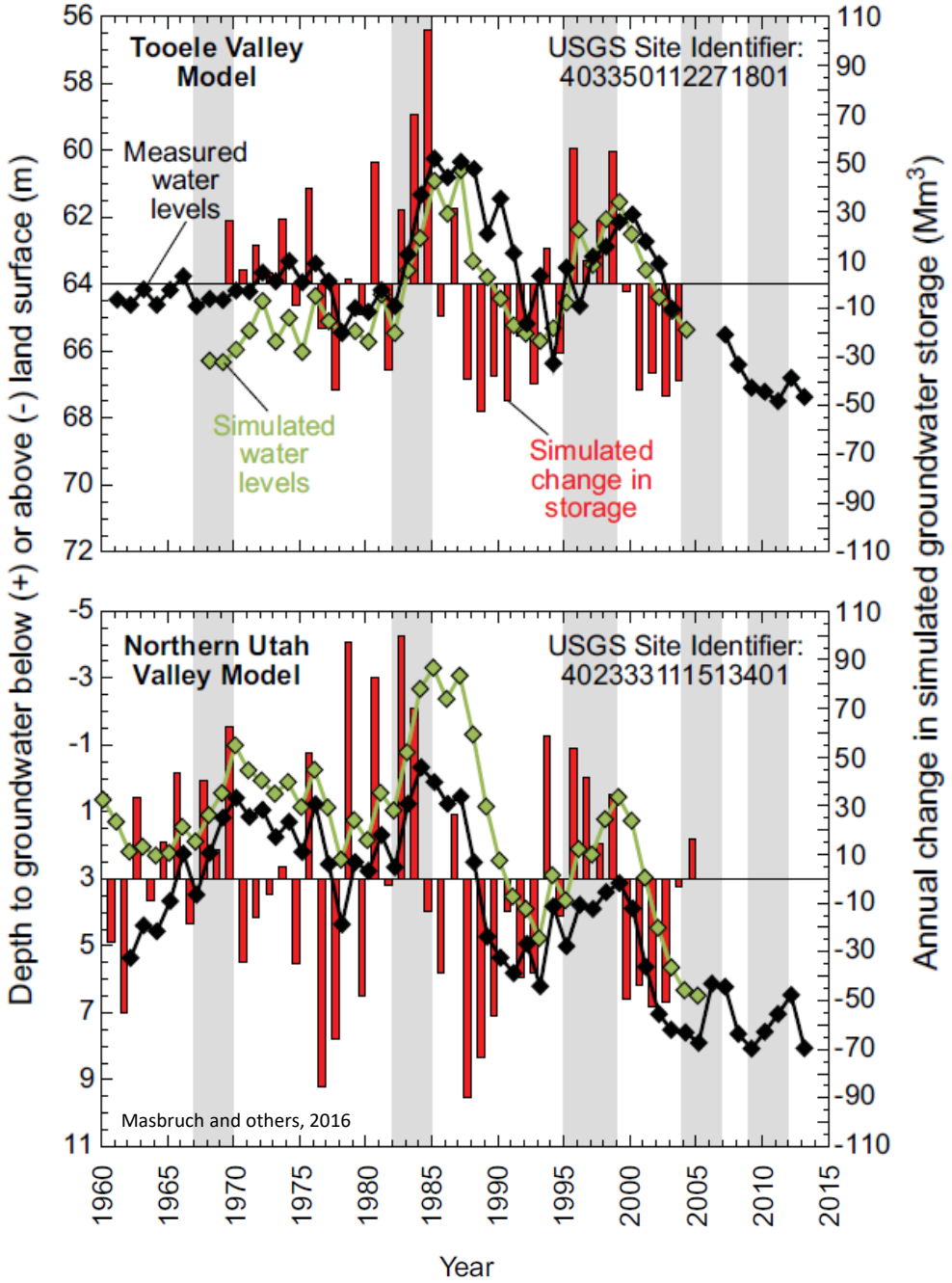
Recharge – Variable in Time

- Significant recharge is intermittent
- In the Great Basin, most recharge occurs during decadal multi-year wet periods
- Study of three Northern Utah basins found that most valley aquifer storage sustained by five such events from 1960 to 2015
- Climate related implications on recharge
  - Change in frequency of events
  - Change in intensity of events



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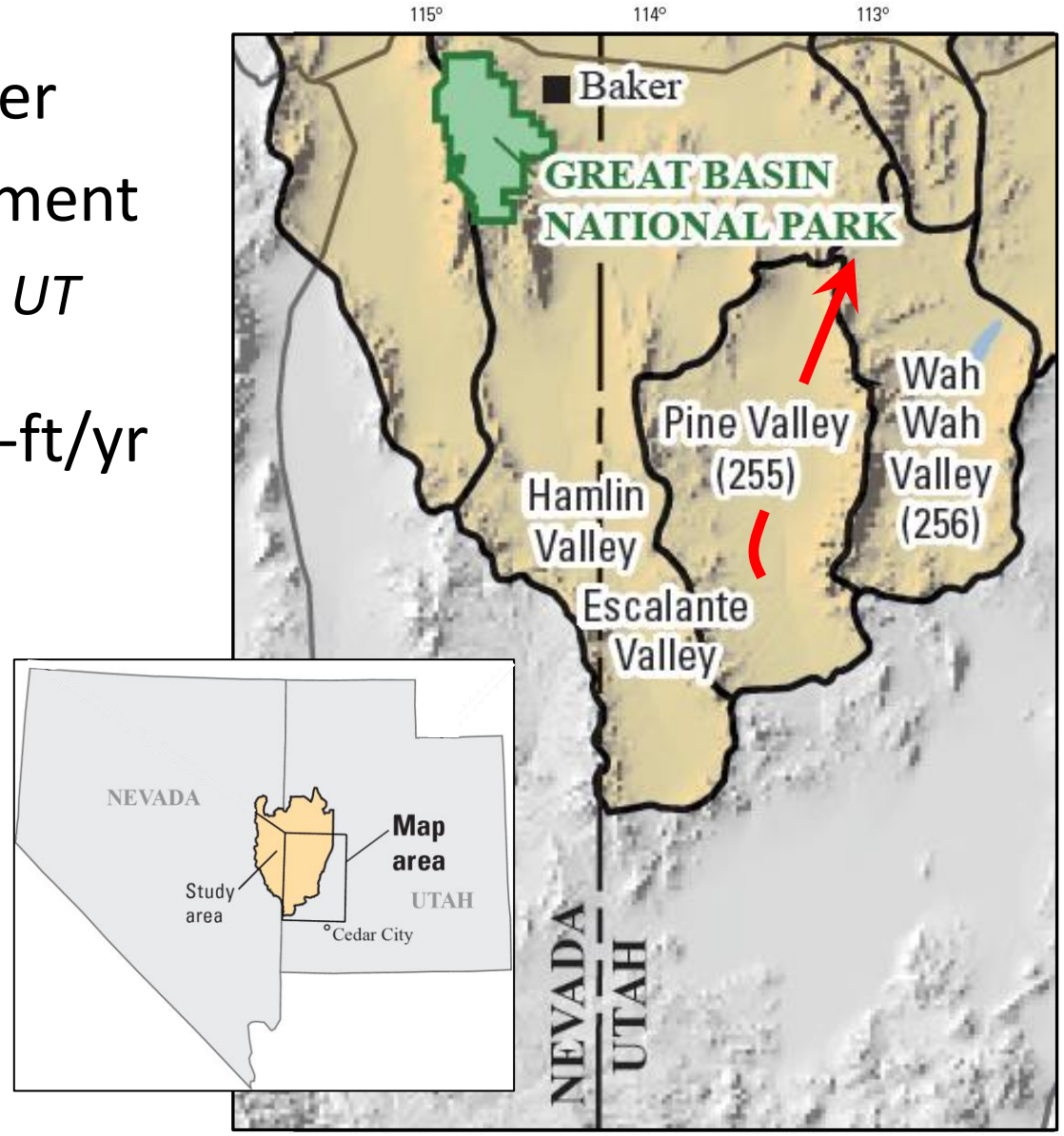
Example: Rethinking recharge in Pine Valley, UT

- Eastern Great Basin, near NV border
- Undergoing groundwater development
  - *For interbasin transfer to Cedar City, UT*
- Maxey Eakin recharge 21,000 acre-ft/yr
  - Applications → 21,000 acre-ft
  - Water rights → 15,000 acre-ft
- No valley-floor discharge
  - *Interbasin flow toward the north*



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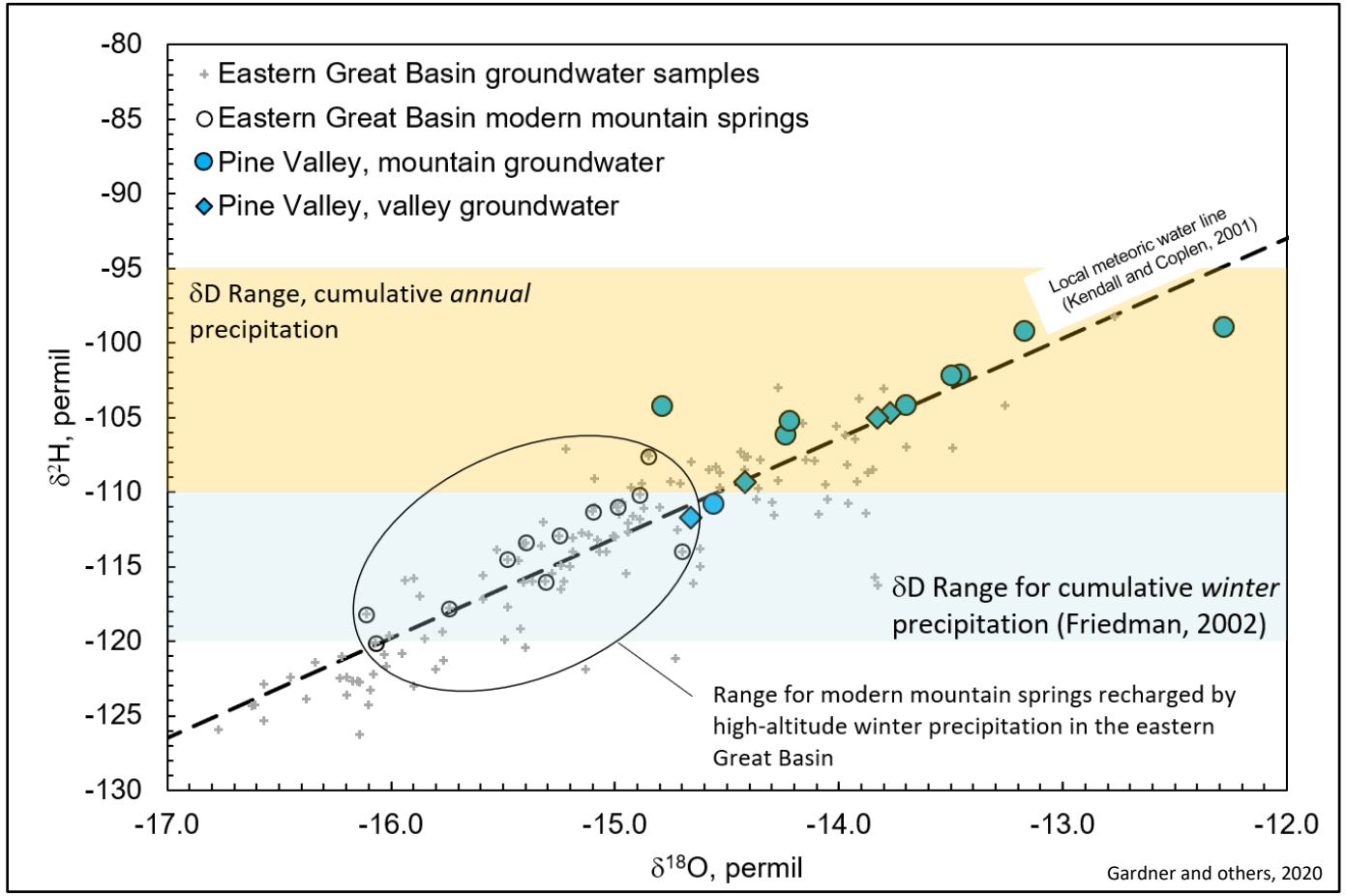
Example: Rethinking recharge in Pine Valley, UT

- Groundwater stable isotopes
- Recharge sources
  - *Winter snowmelt → light*
  - *Summer rains → heavy*
- Pine Valley groundwater dominantly sourced from summer monsoons



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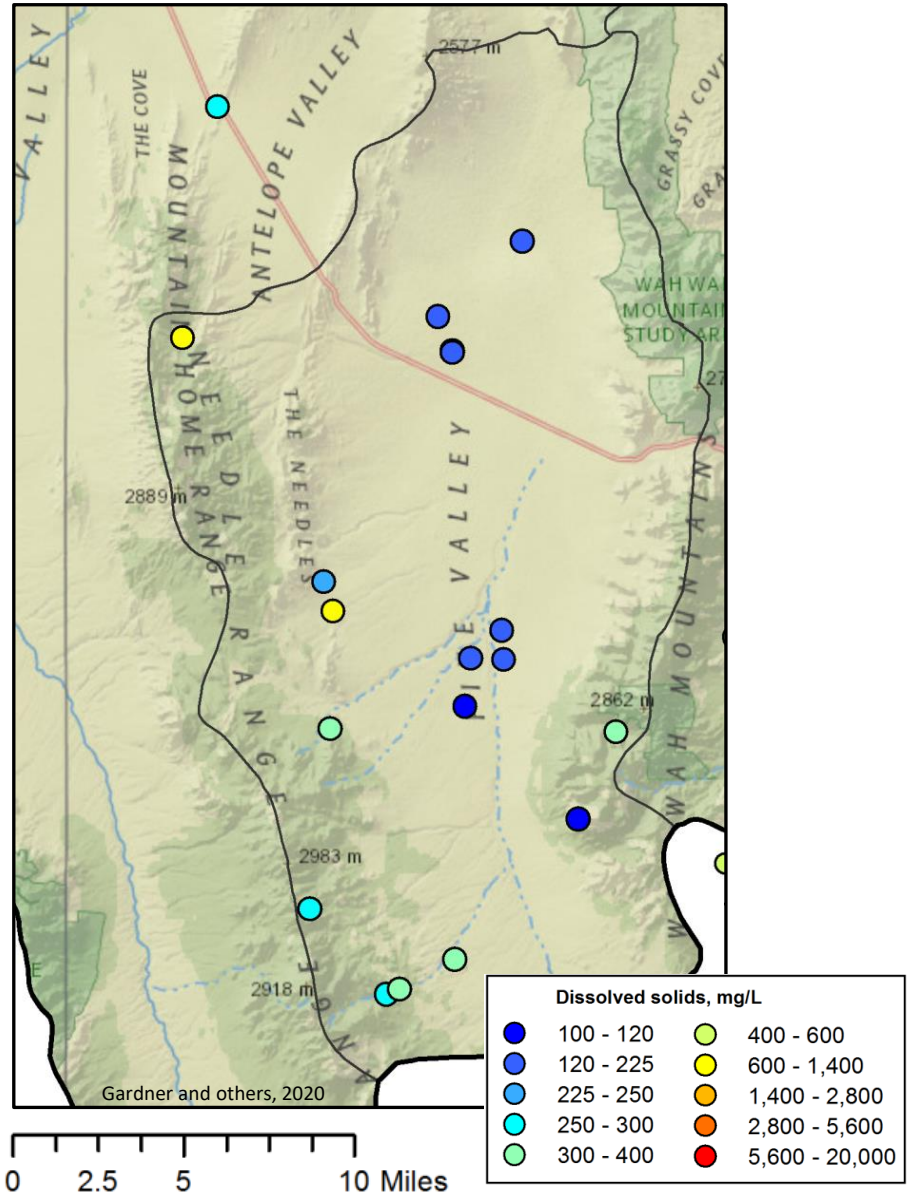
Example: Rethinking recharge in Pine Valley, UT

- Total dissolved solids

- Valley groundwater → *low*
- Mountain Groundwater → *High*

- High TDS mountain groundwater is perched
  - Discharges from perched groundwater discharge areas (GDAs)
- Valley aquifer recharged by *focused infiltration* beneath ephemeral stream channels during flood events



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Example: Rethinking recharge in Pine Valley, UT

Screenshot from Utah Division of Water Rights website

- Reexamination of recharge distribution
- Basin fill (target) aquifer recharge reduced
  - from 21,000 to 11,000 acre-ft

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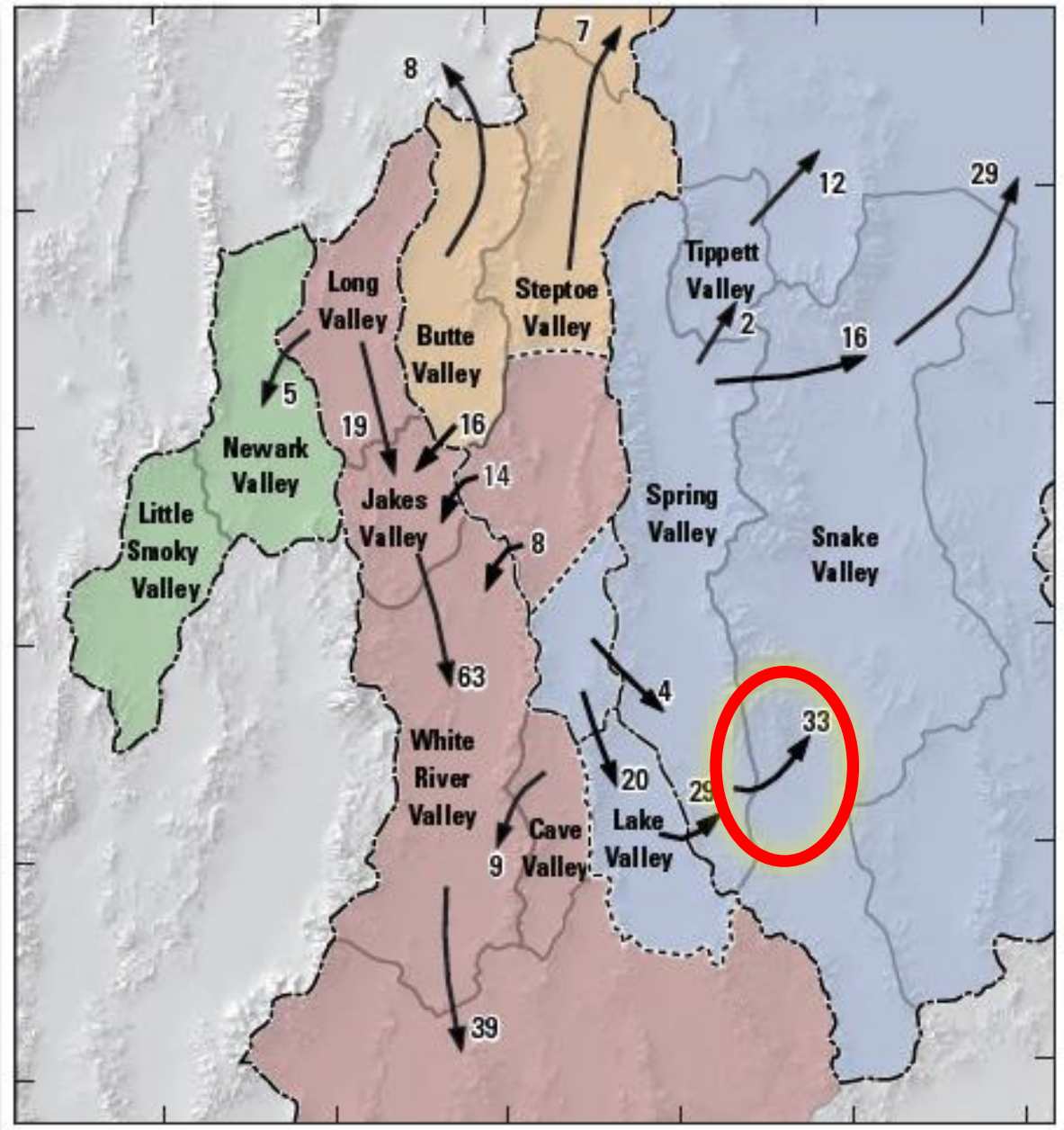
Interbasin flows

- Significant interbasin flows estimated
  - Based on imbalances between recharge and discharge
  - Sensitive to groundwater budget uncertainty
  - Biases understanding of regional groundwater flow systems
- Spring to Snake Valley example
  - 4,000 af/yr (Rush and Kazmi, 1965)
  - 8,000–12,000 af/yr by (Nichols, 2000)
  - 33,000 af/yr (Welch & others, 2007)
  - 5,600 acre-ft/yr (Halford & Plume, 2011)
  - 4,400 acre-ft/yr (Burns & Drici, 2011)
  - 6,000 – 11,000 af/yr (Prudic, 2015)



Welch and others, 2007

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Increased Hydrologic Monitoring for Four Years


Pine Nut Creek


Humboldt River near Elko


Virgin Peak precip


Mud Springs wells

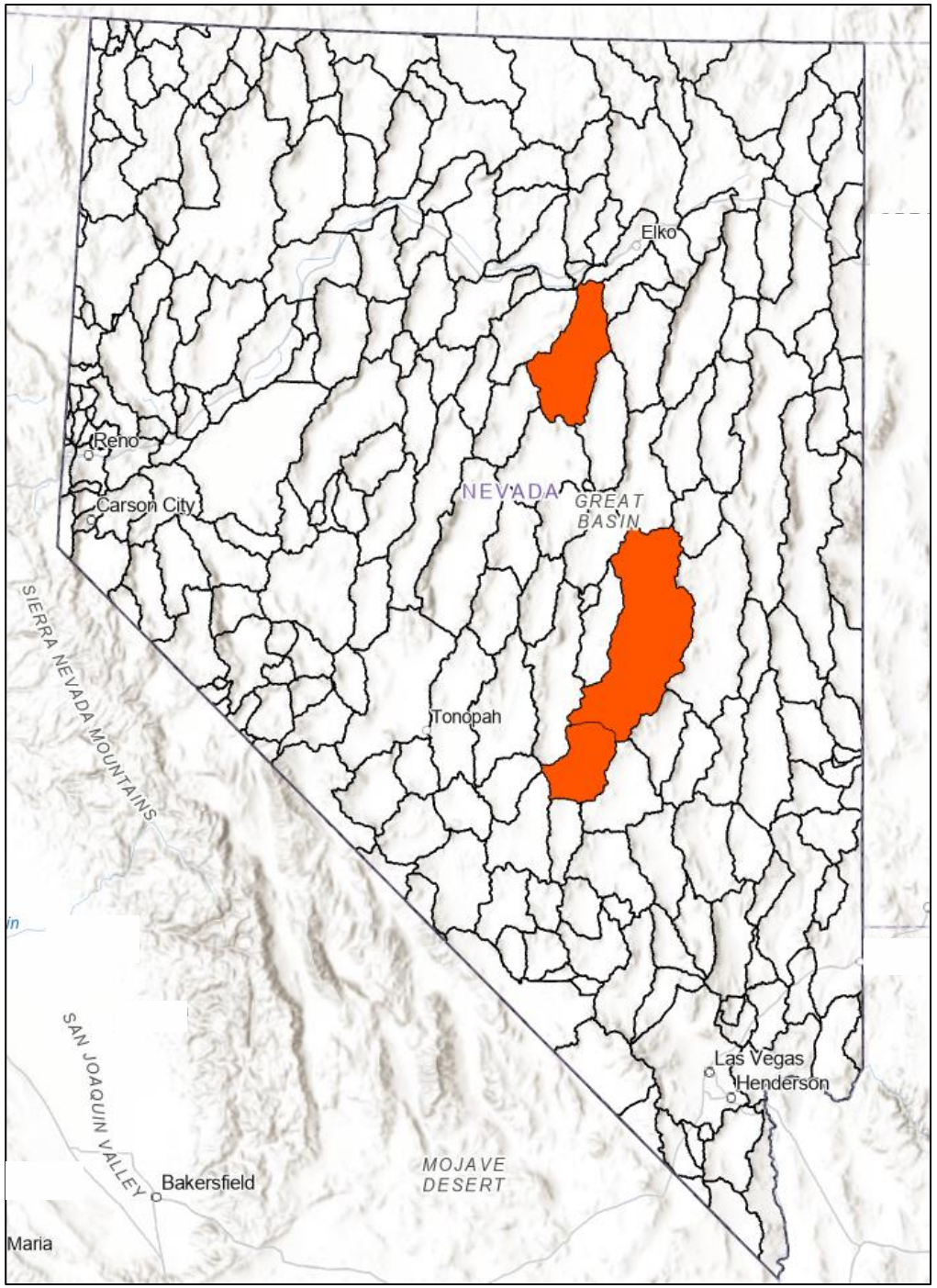

Meadow Valley Wash near Rox


Delmar Valley well

All photos by USGS NV Water Science Center Staff

Demonstration Basins

- Pine Valley
  - Reconnaissance Series Report No. 2
    (Eakin, 1960)
- Railroad Valley
  - Reconnaissance Series Report No. 60
    (Van Denburgh & Rush, 1974)
- Reevaluate conceptual models
- Focus methods evaluation
  - Recharge
  - Interbasin Flow



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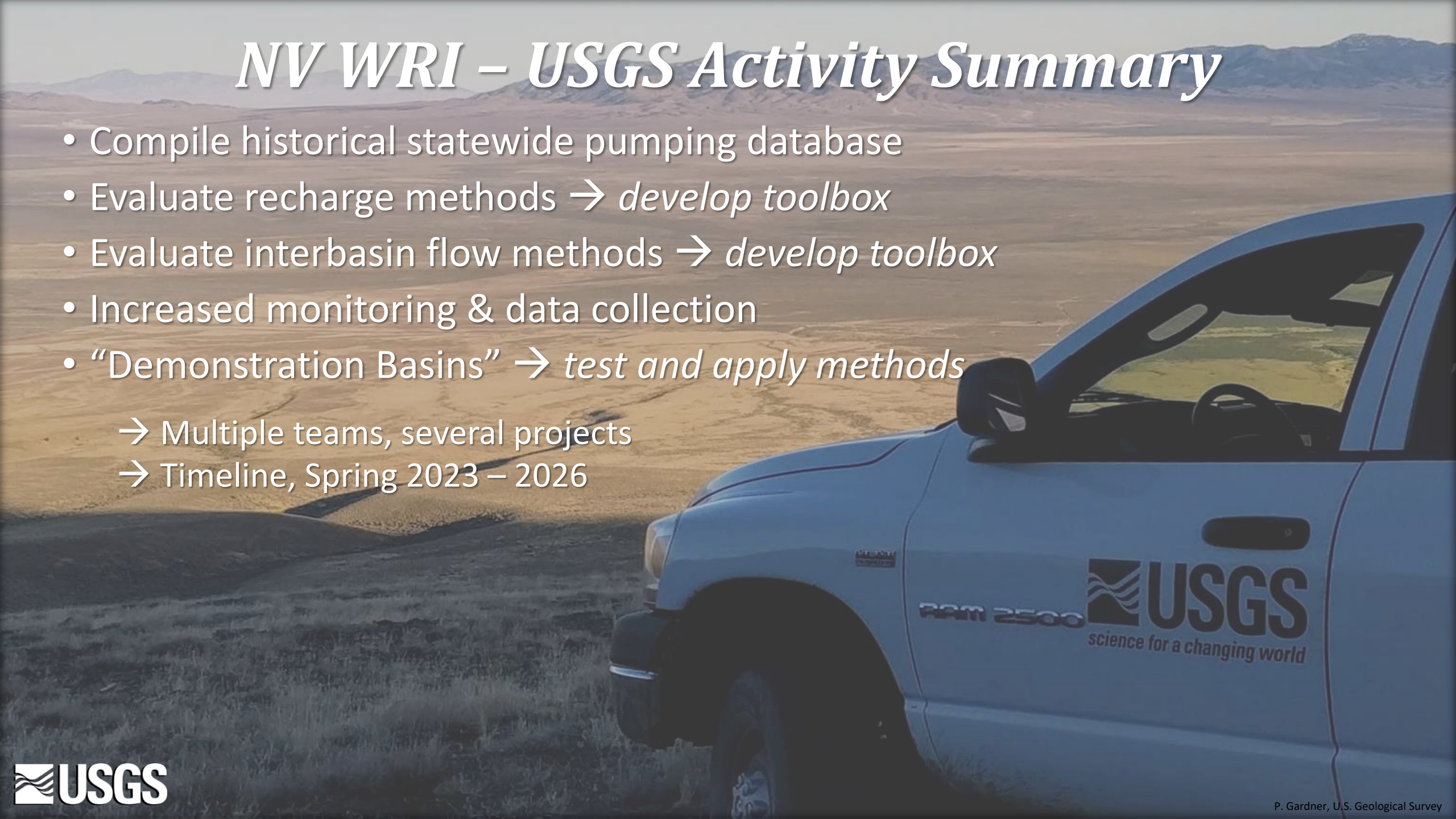
NV WRI – USGS Activity Summary

- Compile historical statewide pumping database
- Evaluate recharge methods → *develop toolbox*
- Evaluate interbasin flow methods → *develop toolbox*
- Increased monitoring & data collection
- "Demonstration Basins" → *test and apply methods*

  → Multiple teams, several projects
  → Timeline, Spring 2023 – 2026



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