Lehman Caves at Great Basin National Park

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photograph by Gretchen Baker, Great Basin National Park

Depletion of Surface-Water Resources at Great Basin National Park Due to Ground-Water Withdrawals in Adjacent Valleys – Can Drawdown Effects Propagate Uphill?

William P. Van Liew, P.E., Hydrologist
NPS Natural Resource Program Center
Water Resources Division
Fort Collins, CO

Presentation at NPS Water Professionals Meeting
February 13, 2008

Acknowledgements

- David Prudic, USGS

- Gretchen Baker, GRBA

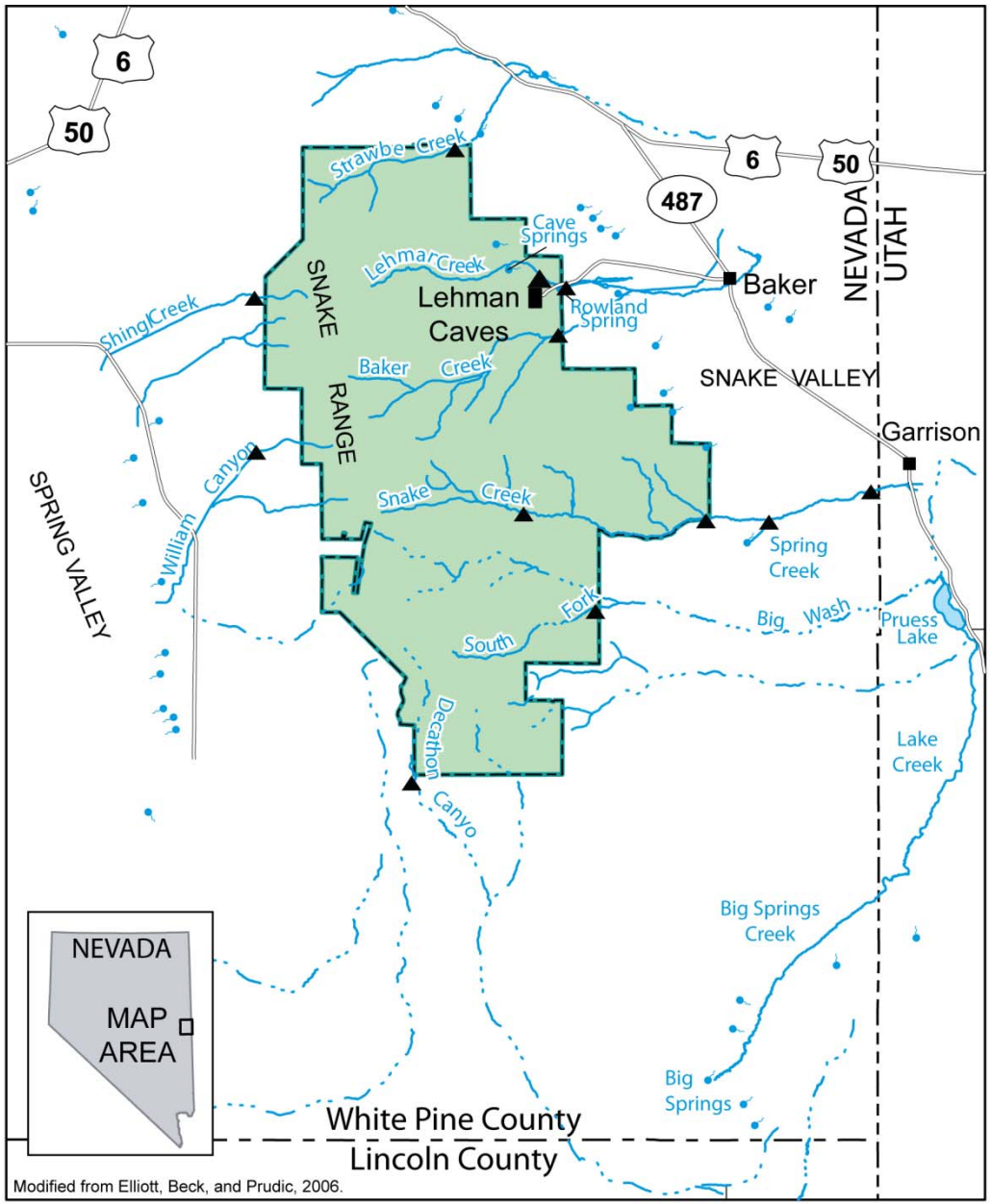
Outline of Presentation

- Description of Great Basin NP water resources
- Hydrogeologic setting
- Reasons for the concern: proposed ground-water pumping in adjacent valleys
- Generalized effects of ground-water pumping – “Capture”
- What happens when surface-water features are upgradient
- Results of USGS study; future work planned
- Conclusions

Water Resources at Great Basin National Park

- High Mountain Lakes
- Streams
  - Perennial
  - Intermittent
- Water features in caves
- Springs

Great Basin National Park



Modified from Elliott, Beck, and Prudic, 2006.

EXPLANATION

- Great Basin National Park
- USGS continual-recording streamflow gage
- Spring

0 5 MILES

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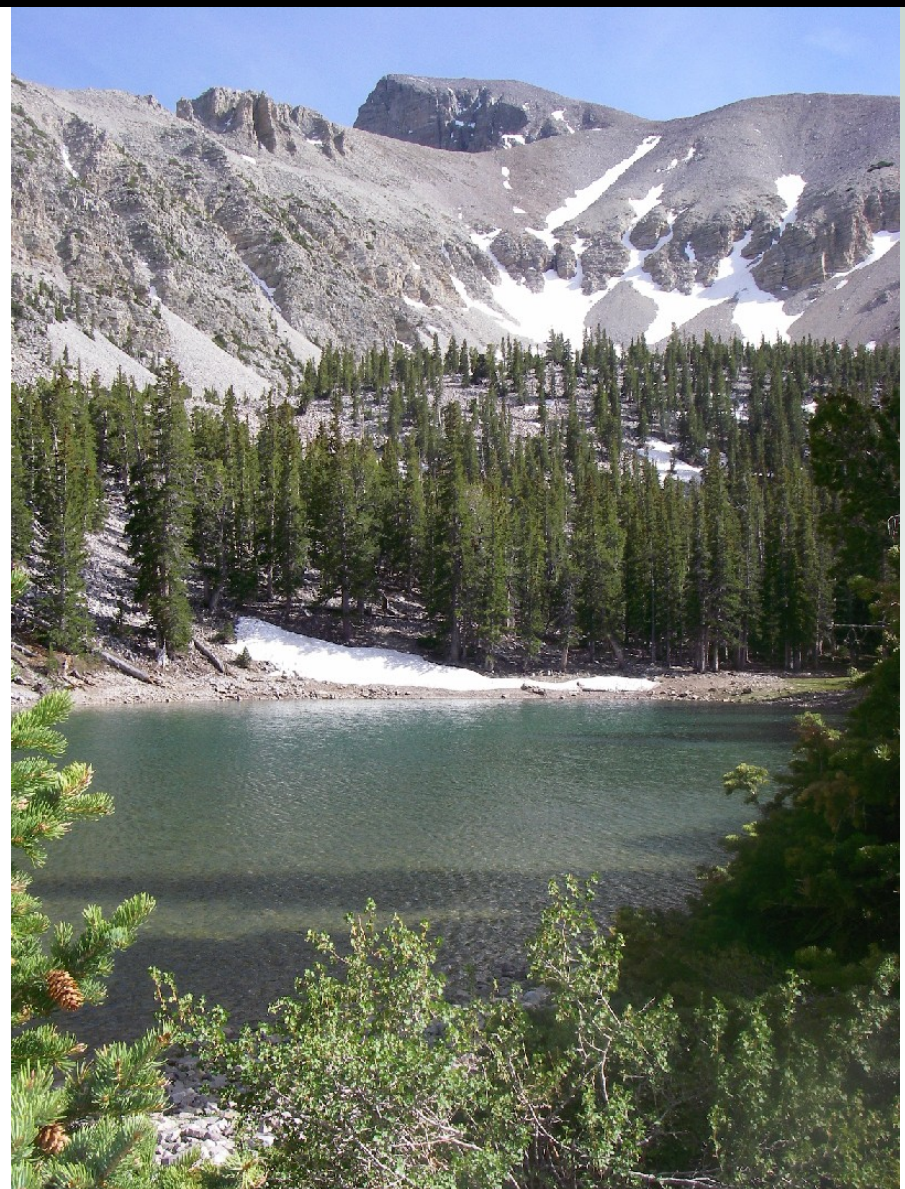
Theresa Lake and Wheeler Peak



photograph by Gretchen Baker,
Great Basin National Park

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Johnson Lake

photograph by
Gretchen Baker,
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Baker Creek

photograph by
Bill Van Liew,
NPS Water Resources
Division

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South Fork Big Wash

photograph by
Bill Van Liew,
NPS Water Resources
Division

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Cypress Room in Lehman Caves

photograph by
Gretchen Baker,
Great Basin National Park

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Stream flowing into Ice Cave

(Baker Creek drainage)

photograph by Gretchen Baker,
Great Basin National Park

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Stream flowing out of Squirrel Cave

(Snake Creek drainage)

photograph by
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Rowland Spring

photograph by
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NPS Water Resources
Division

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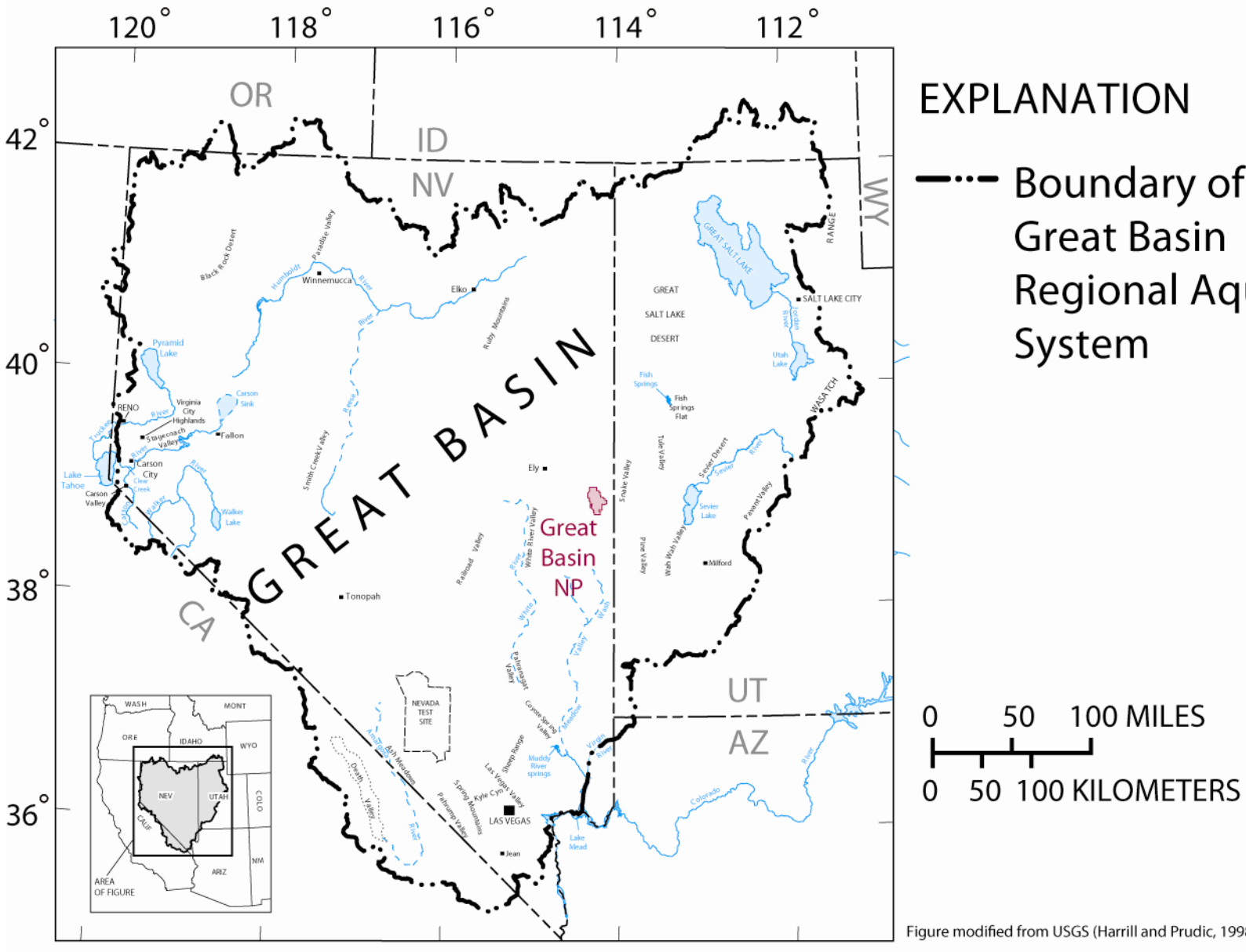
Rowland Spring Creek

photograph by
Bill Van Liew,
NPS Water Resources
Division

Overview of the Hydrogeologic Setting

- Great Basin Regional Aquifer System
- Great Salt Lake Desert Regional Ground-Water Flow System
- Upper Salt Lake Desert Flow System
- Great Basin NP Water Resources

Great Basin Regional Aquifer System



EXPLANATION

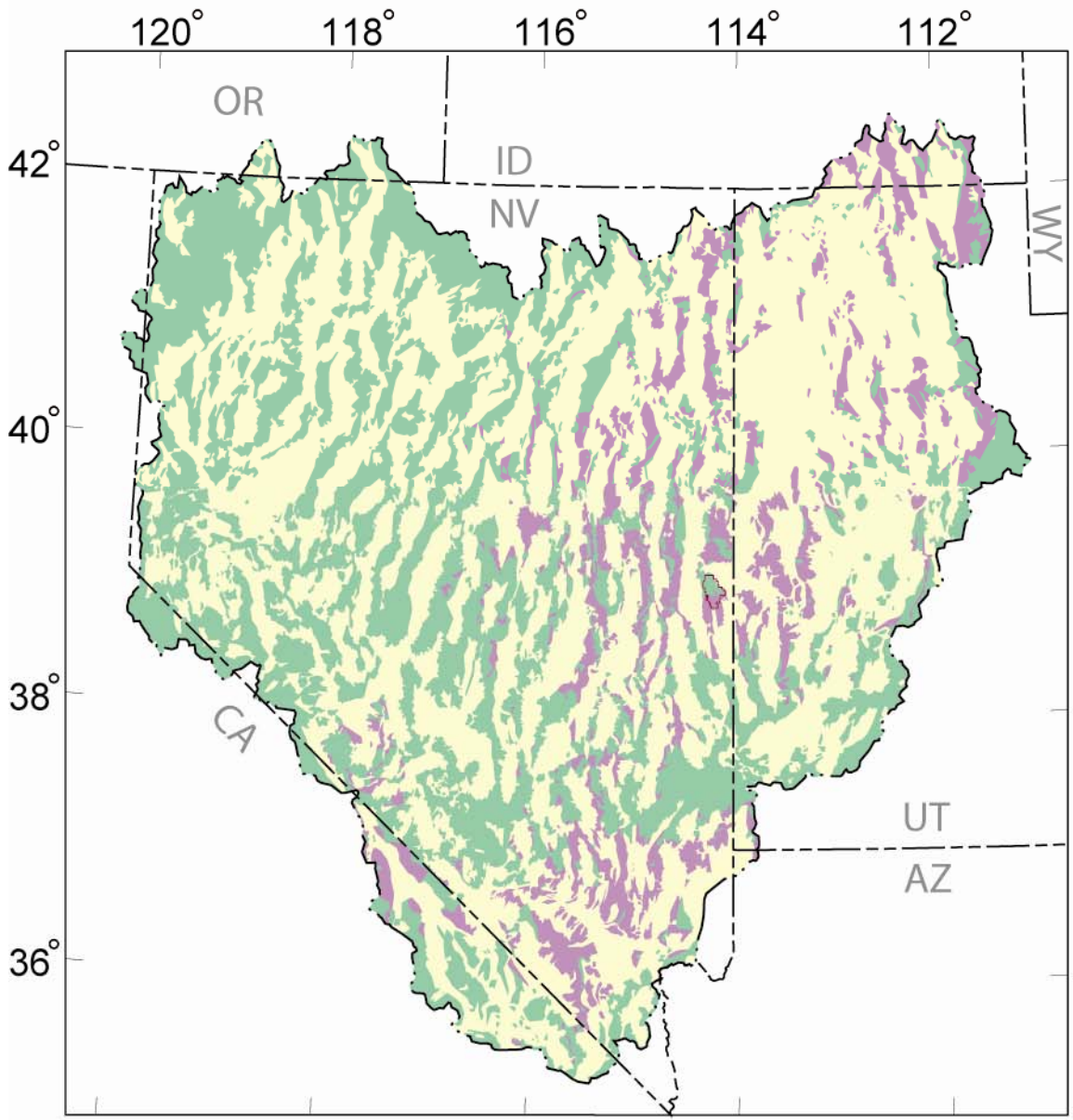
Boundary of Great Basin Regional Aquifer System

Figure modified from USGS (Harrill and Prudic, 1998).

Principal Aquifer Types

- Basin-Fill Aquifers
- Regional Carbonate-Rock Aquifer

Generalized Hydrogeologic Units



EXPLANATION

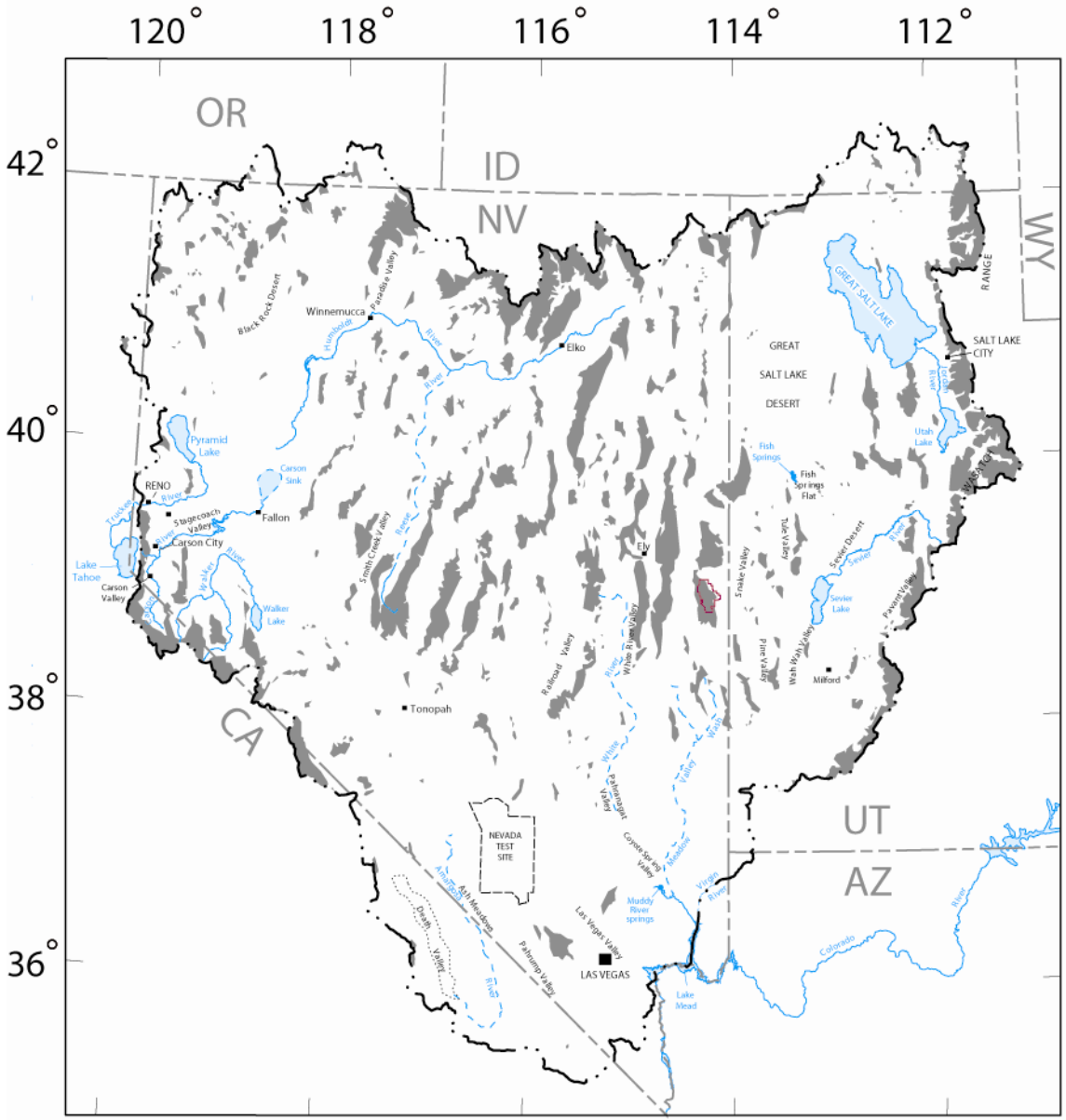
- Basin fill
- Noncarbonate consolidated rocks
- Carbonate rocks

0 50 100 MILES

0 50 100 KILOMETERS

Geology modified from USGS (Plume and Carlton, 1988).
Figure modified from USGS (Harrill and Prudic, 1998).

Source Areas of Ground-Water Recharge



EXPLANATION

Major source area for ground-water recharge

0 50 100 MILES

0 50 100 KILOMETERS

Figure modified from USGS (Harrill and Prudic, 1998).

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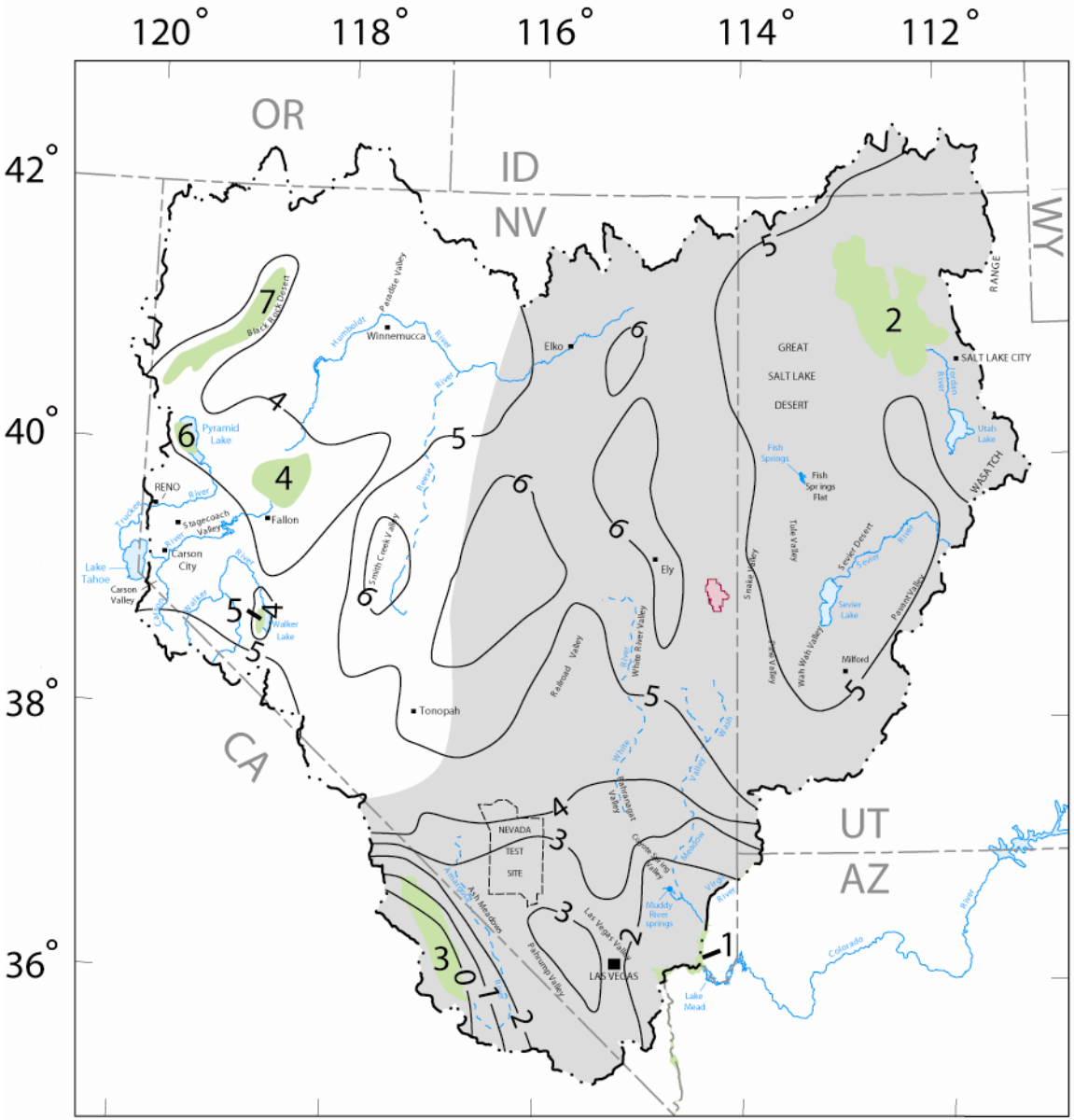
Regional Ground-Water Flow Potential



EXPLANATION

Carbonate-rock province

Regional-discharge area

–3– Line of equal regional-flow potential

0 50 100 MILES

0 50 100 KILOMETERS

Figure modified from USGS (Harrill and Prudic, 1998).

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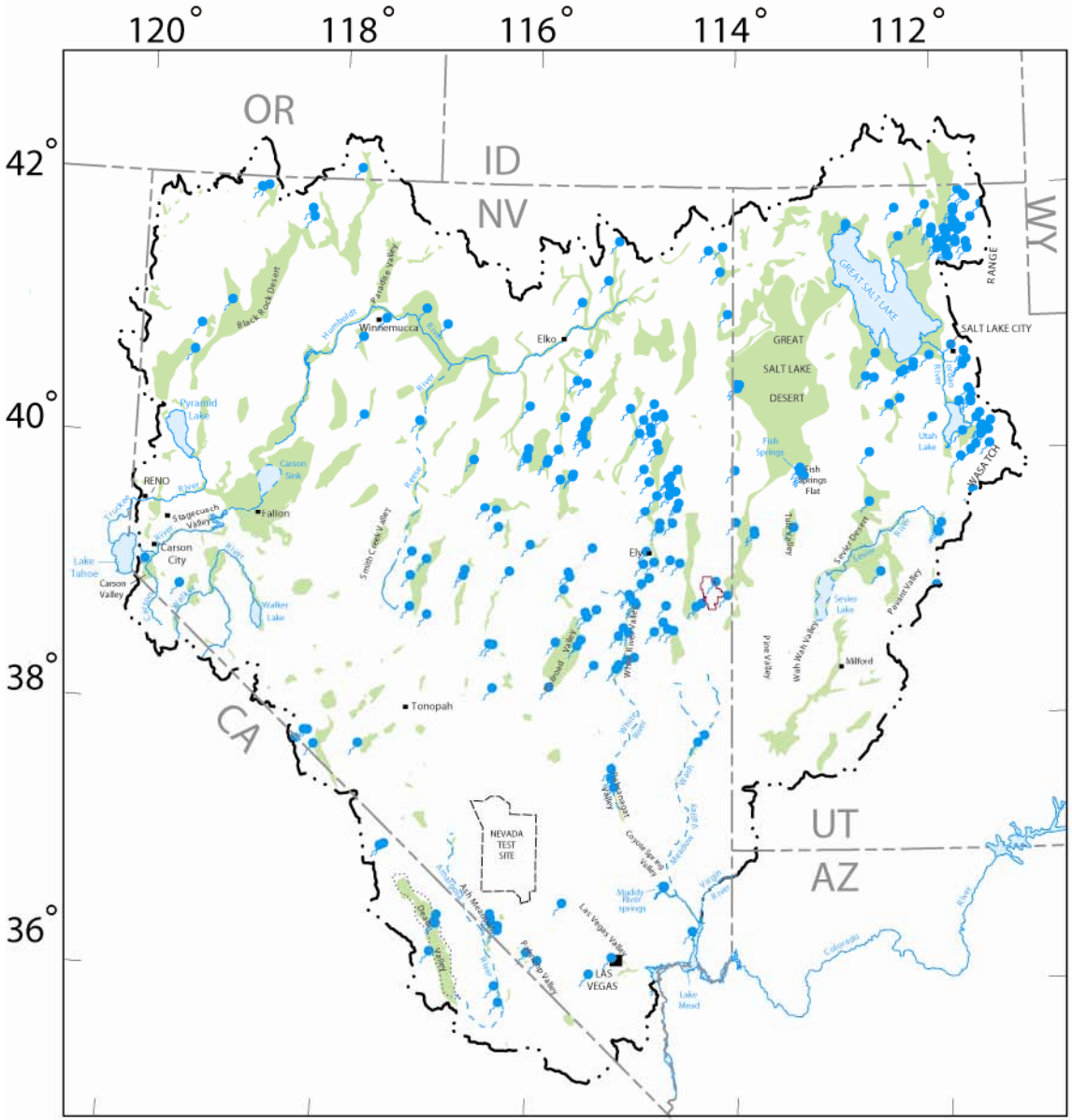
Location of Ground-Water Discharge



EXPLANATION

Area of shallow ground-water discharge by evapotranspiration

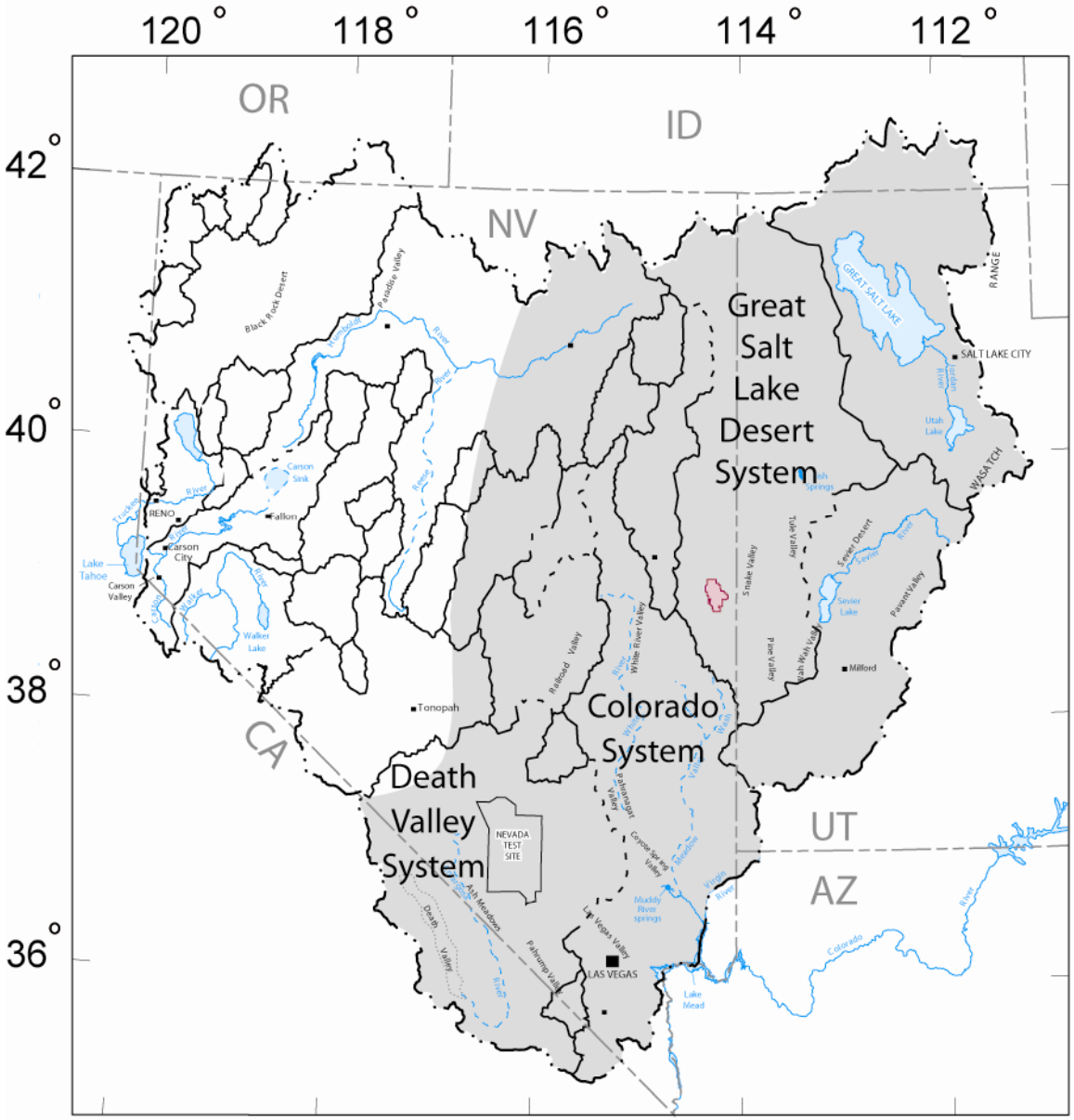
Large spring

0 50 100 MILES

0 50 100 KILOMETERS

Figure modified from USGS (Harrill and Prudic, 1998).

Major Ground-Water Flow Systems



EXPLANATION

- Boundary of major flow system
- Carbonate-rock province

0 50 100 MILES

0 50 100 KILOMETERS

Figure modified from USGS (Harrill and Prudic, 1998)

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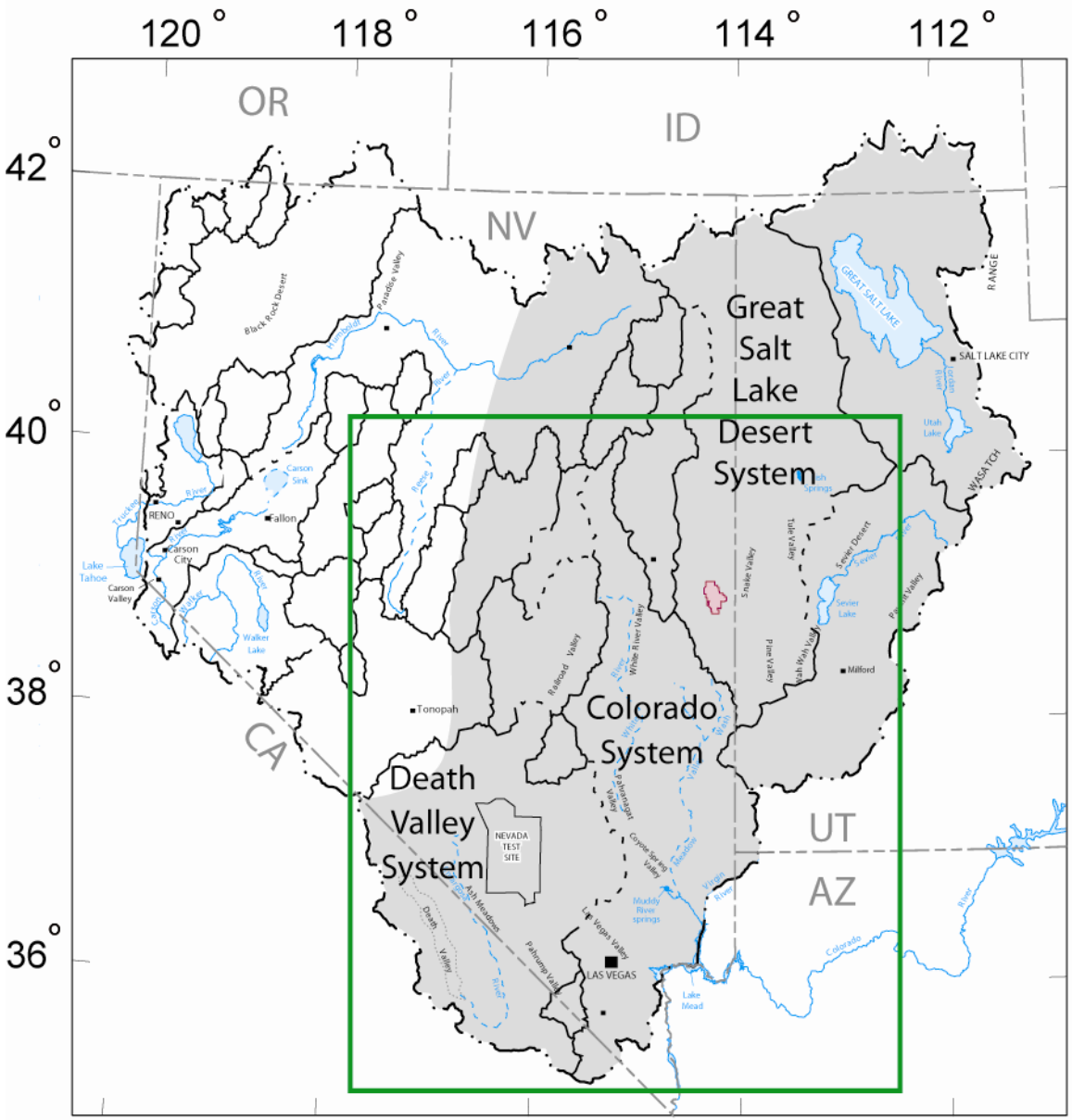
Reasons for the Concern

- Rapid population growth in Las Vegas and associated increased water use
- The recent drought
- Nevada's use of the Colorado River water has reached its full entitlement; so now in-state water resources are being pursued more aggressively

Location of Closeup Map



EXPLANATION

- Boundary of major flow system
- Carbonate-rock province

0 50 100 MILES

0 50 100 KILOMETERS

Figure modified from USGS (Harrill and Prudic, 1998)

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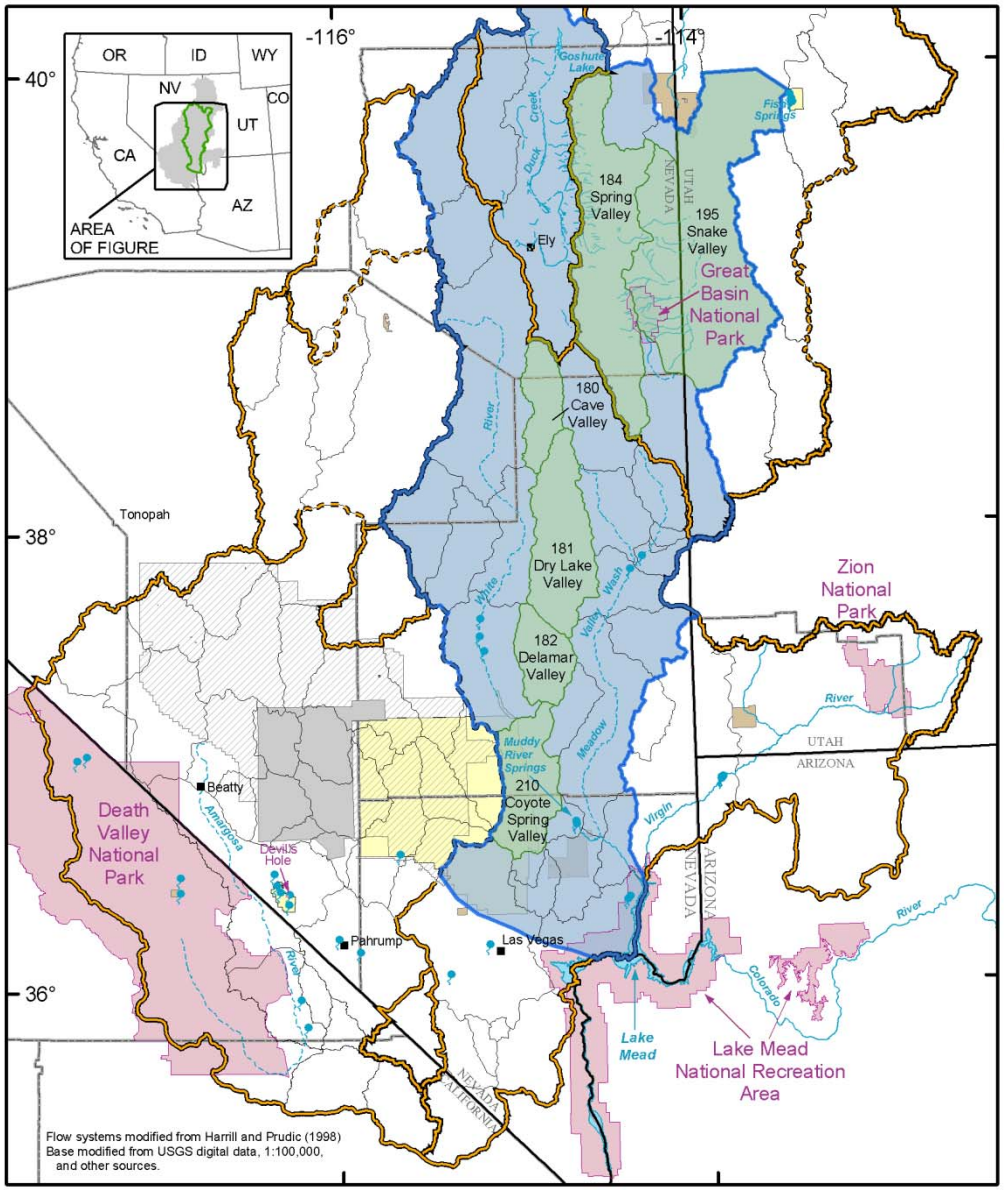
Area of the CLWP Ground-Water Development EIS



EXPLANATION

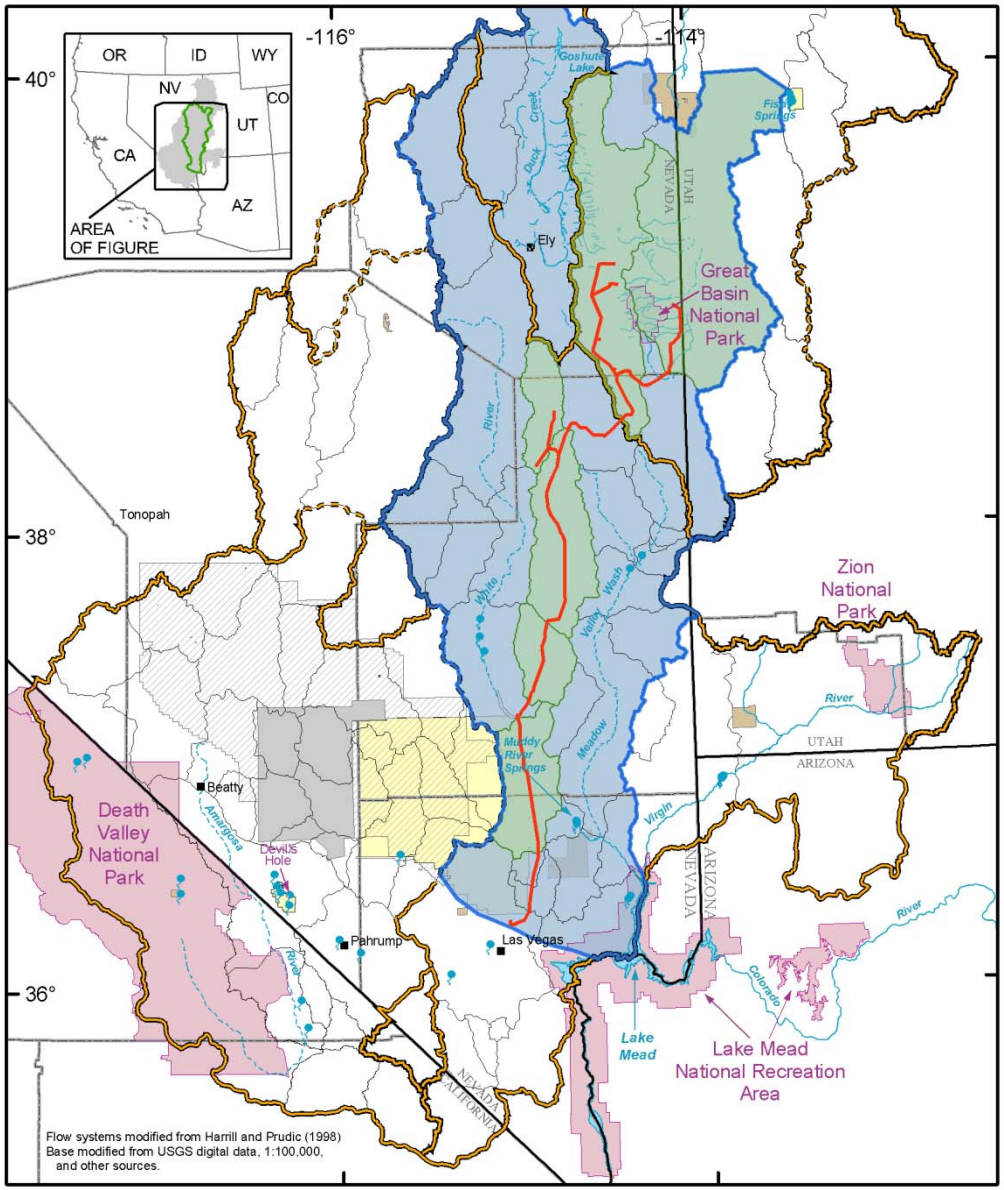
- Boundary of major flow system -- Dashed where uncertain
- Hydrographic Basins
- CLWP EIS Project Basins
- CLWP EIS Study Area

N

0 20 40

Miles

Route of the Proposed Water-Supply Pipeline



EXPLANATION

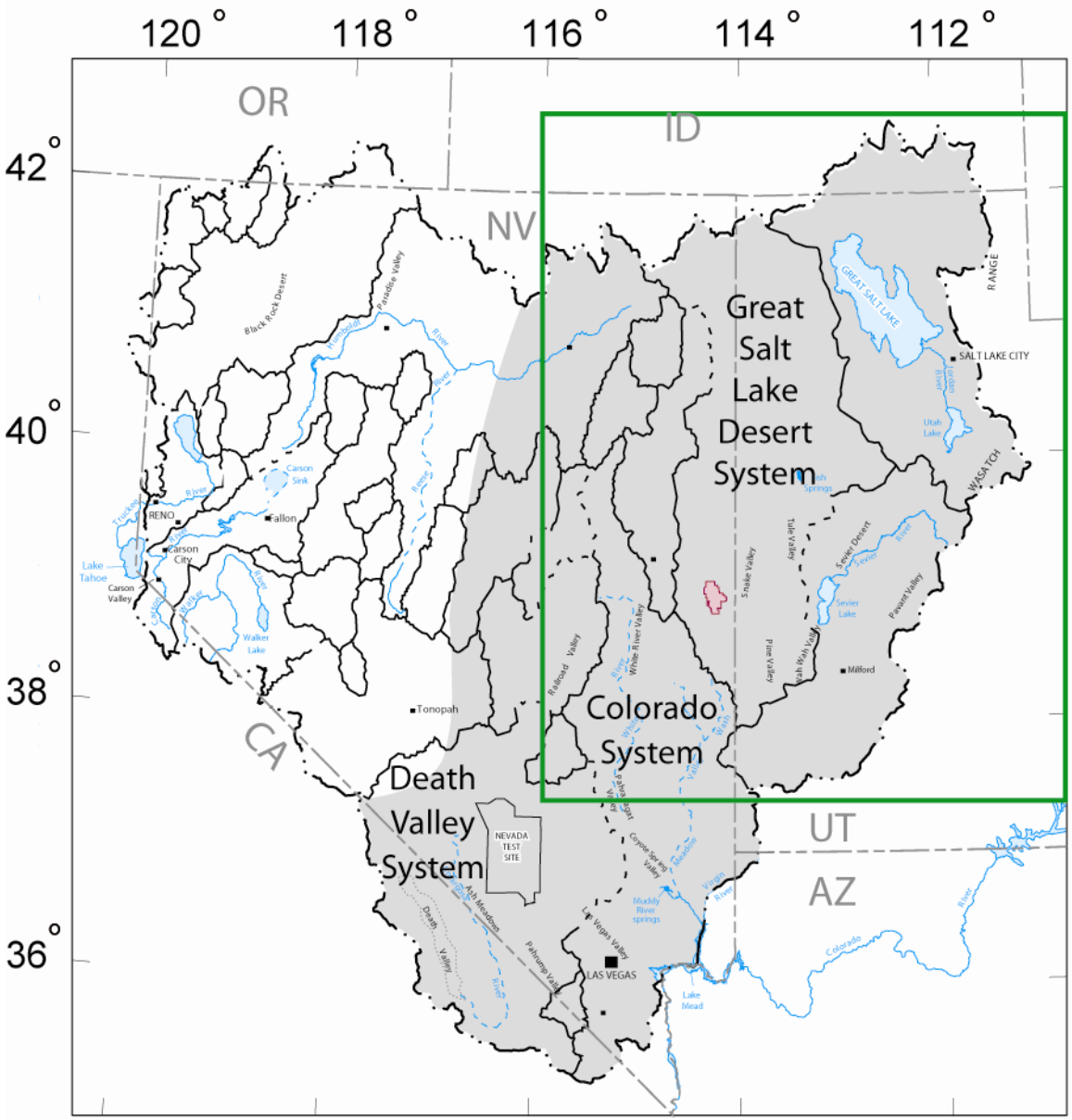
- Boundary of major flow system -- Dashed where uncertain
- Hydrographic Basins
- CLWP EIS Project Basins
- CLWP EIS Study Area
- Proposed pipeline alignment

N

0 20 40

Miles

Location of Closeup Map



EXPLANATION

- Boundary of major flow system
- Carbonate-rock province

0 50 100 MILES

0 50 100 KILOMETERS

Figure modified from USGS (Harrill and Prudic, 1998)

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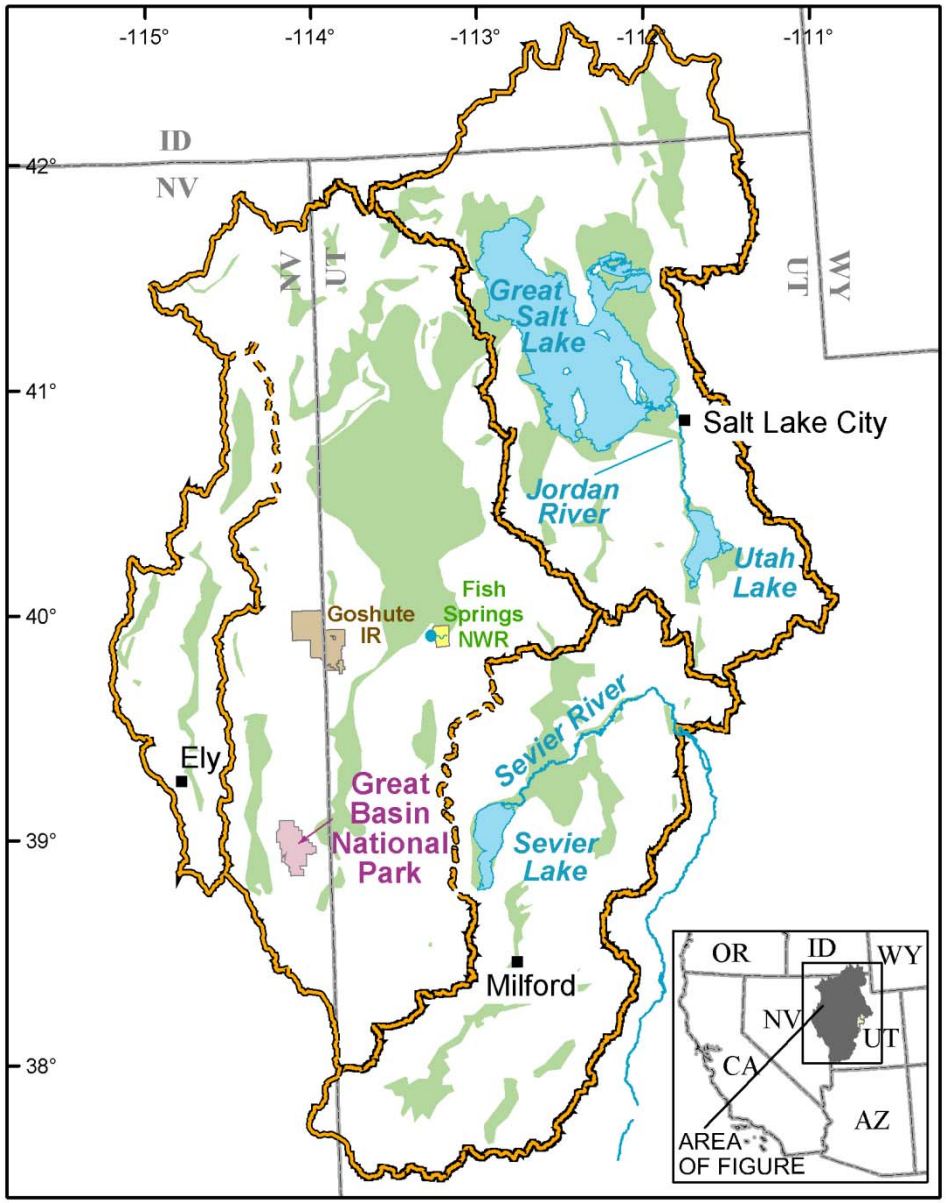
Great Salt Lake Desert Flow System



EXPLANATION

- Boundary of major flow system -- Dashed where uncertain
- Perennial Streams
- Spring
- Area of shallow ground-water discharge by evapotranspiration

N

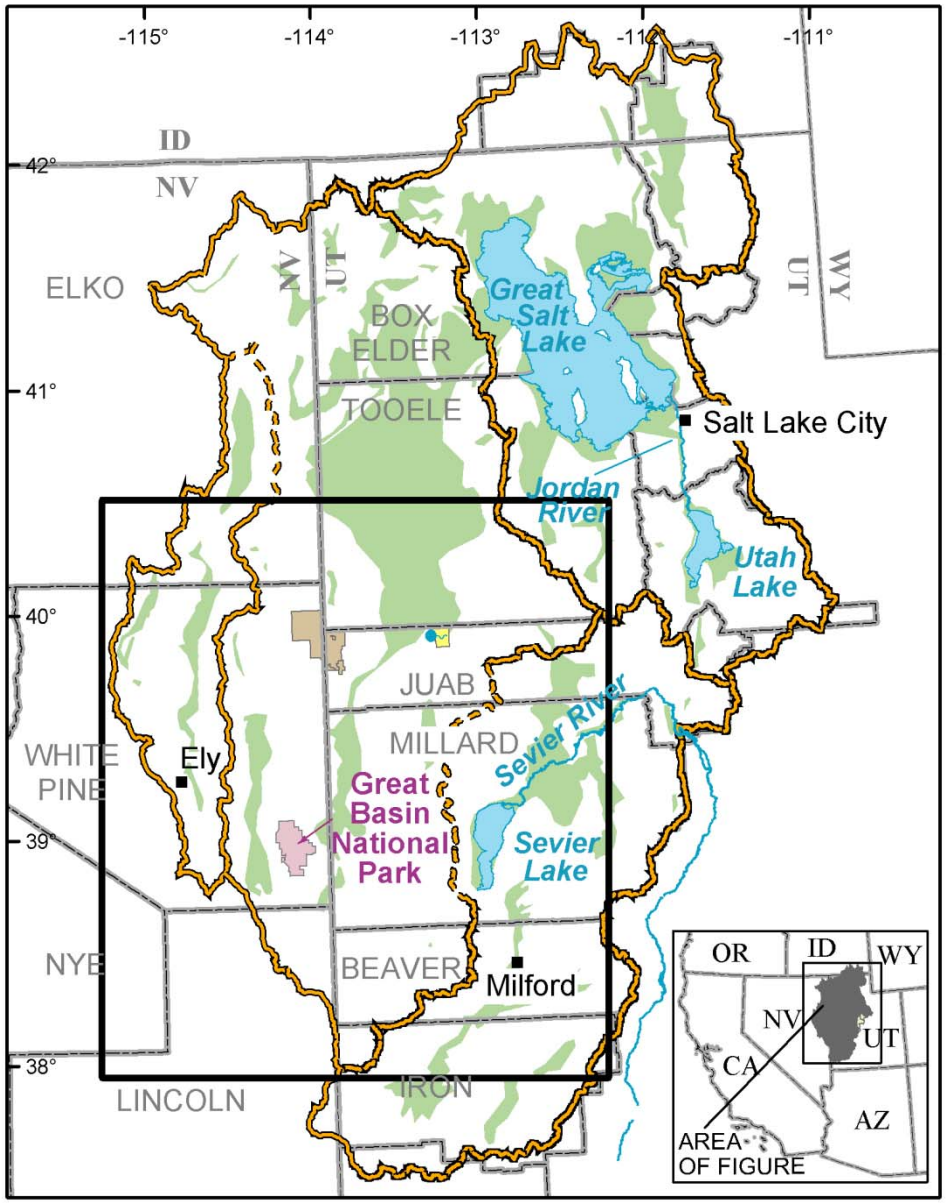
0 50 100

Miles

Flow systems modified from Harrill and Prudic (1998).

Base modified from USGS digital data, 1:100,000, and other sources.

Location of Closeup Map



EXPLANATION

- Boundary of major flow system -- Dashed where uncertain
- Perennial Streams
- Spring
- Area of shallow ground-water discharge by evapotranspiration

N

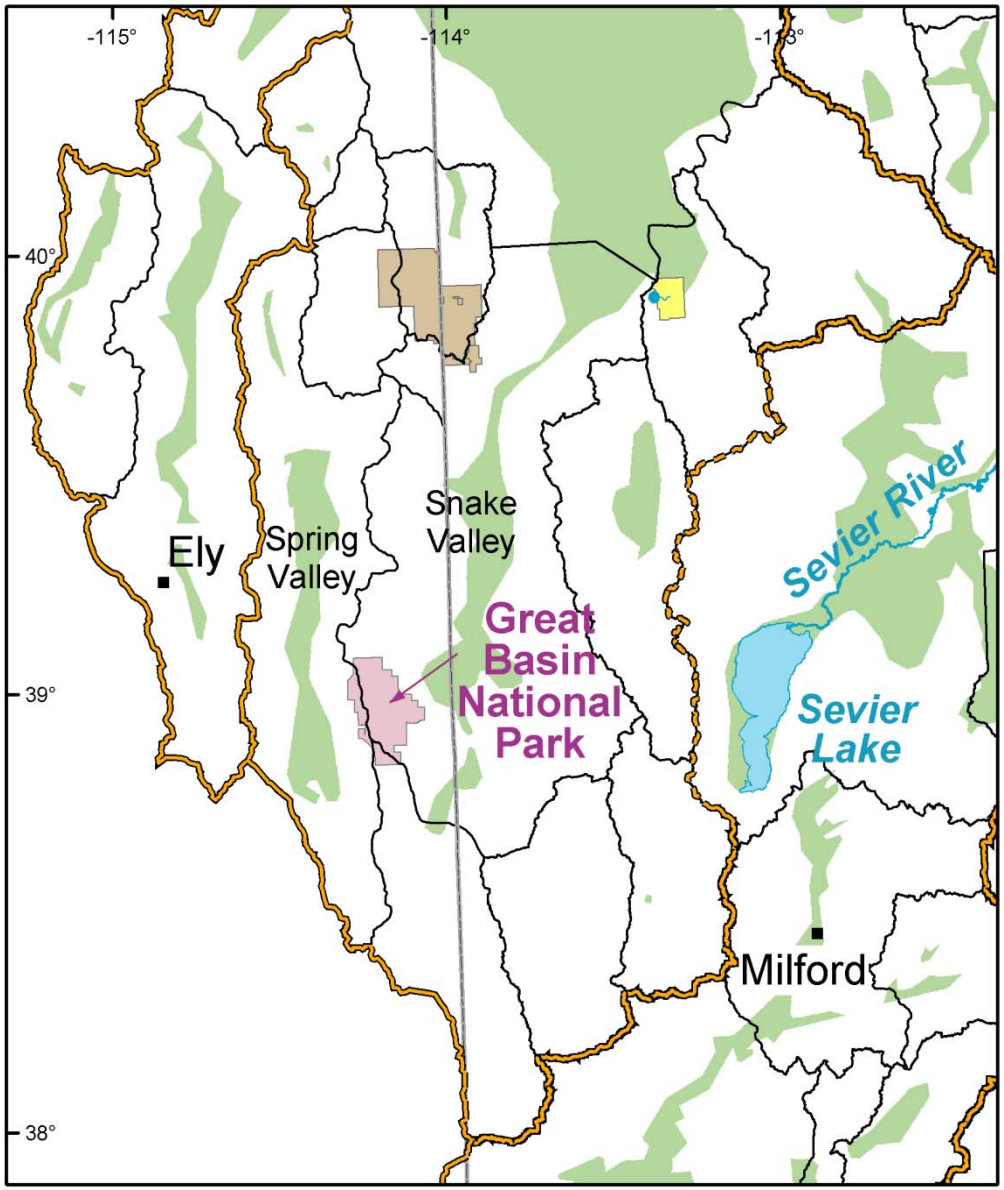
0 50 100

Miles

Flow systems modified from Harrill and Prudic (1998).

Base modified from USGS digital data, 1:100,000, and other sources.

The Upper Great Salt Lake Desert Flow System



EXPLANATION

- Boundary of major flow system -- Dashed where uncertain
- Hydrographic Basins
- Area of shallow ground-water discharge by evapotranspiration

N

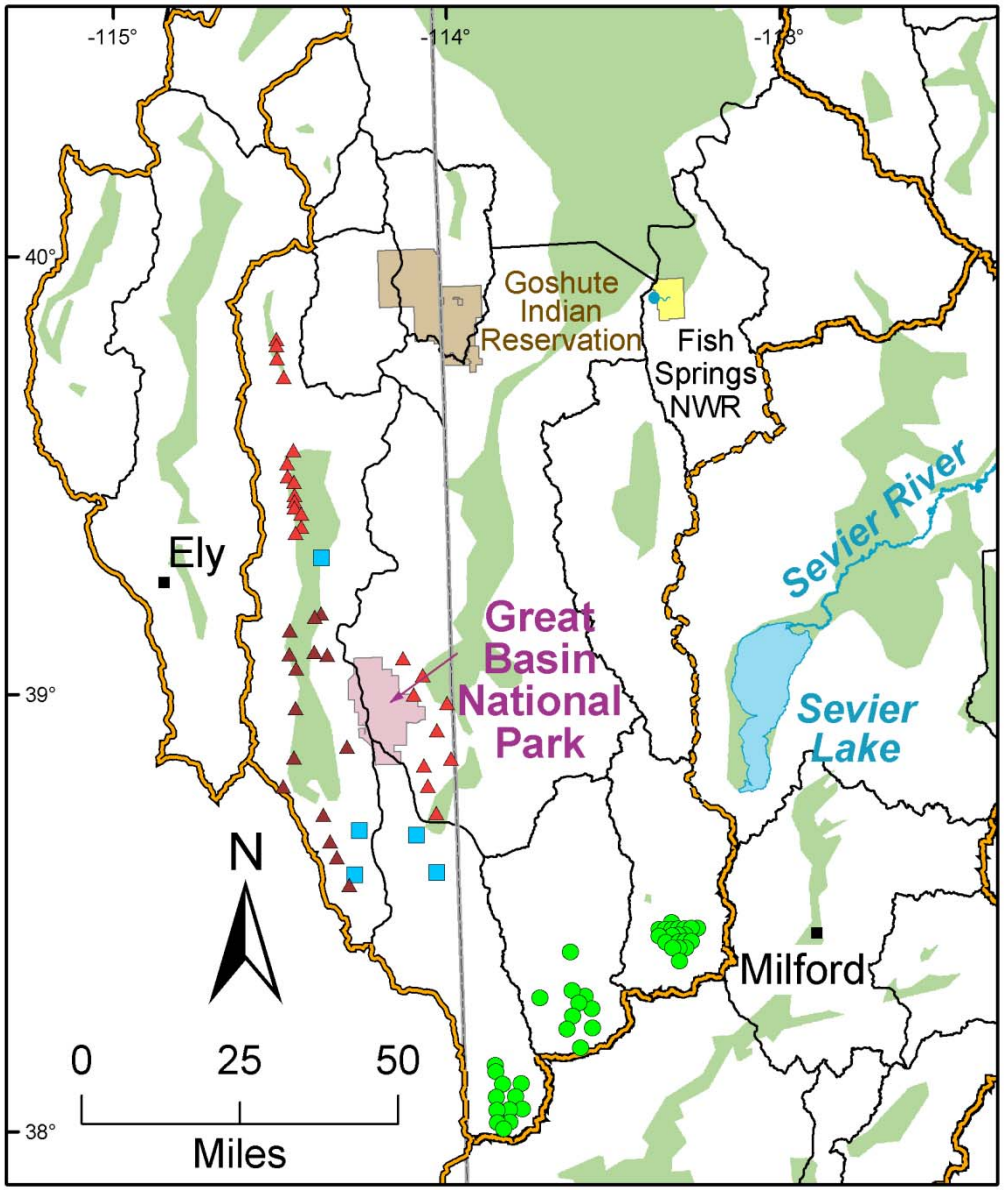
0 25 50

Miles

Flow systems modified from Harrill and Prudic (1998).

Base modified from USGS digital data, 1:100,000, and other sources.

Selected Ground-Water-Right Applications



EXPLANATION

- Boundary of major flow system -- Dashed where uncertain
- Area of shallow ground-water discharge by evapotranspiration
- Hydrographic Basins

Central Iron County Water District

- Pending applications

Vidler Water Company

- Pending applications

Southern Nevada Water Authority

- Existing permits
- Pending applications

Flow systems modified from Harrill and Prudic (1998). Base modified from USGS digital data, 1:100,000, and other sources.

When a well is pumped, the water comes from:

- Aquifer storage --- (*early time*)
- "Capture" --- (*late time*)
  - Induced increased recharge (*usually not, in the desert*)
  - Induced decreased discharge

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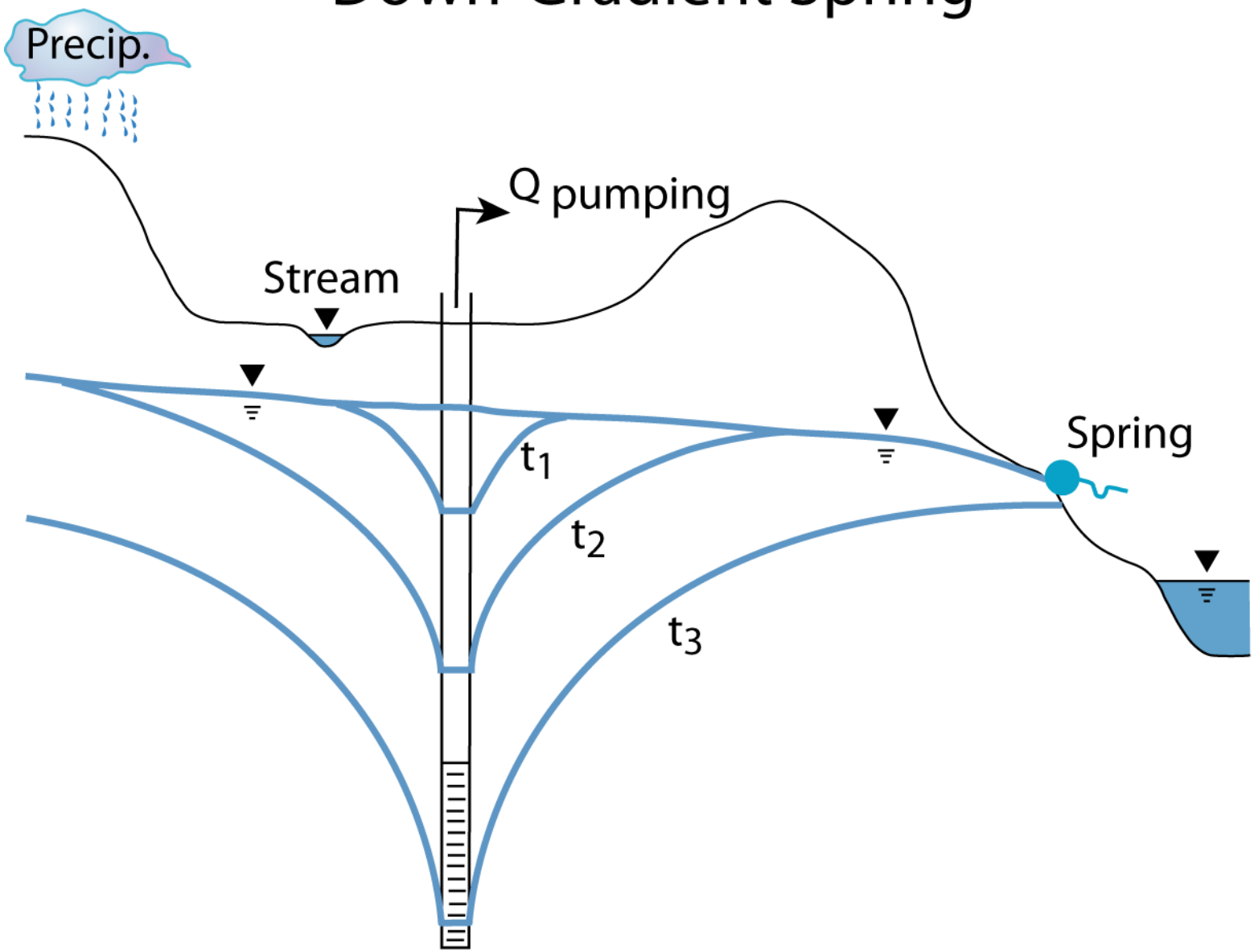
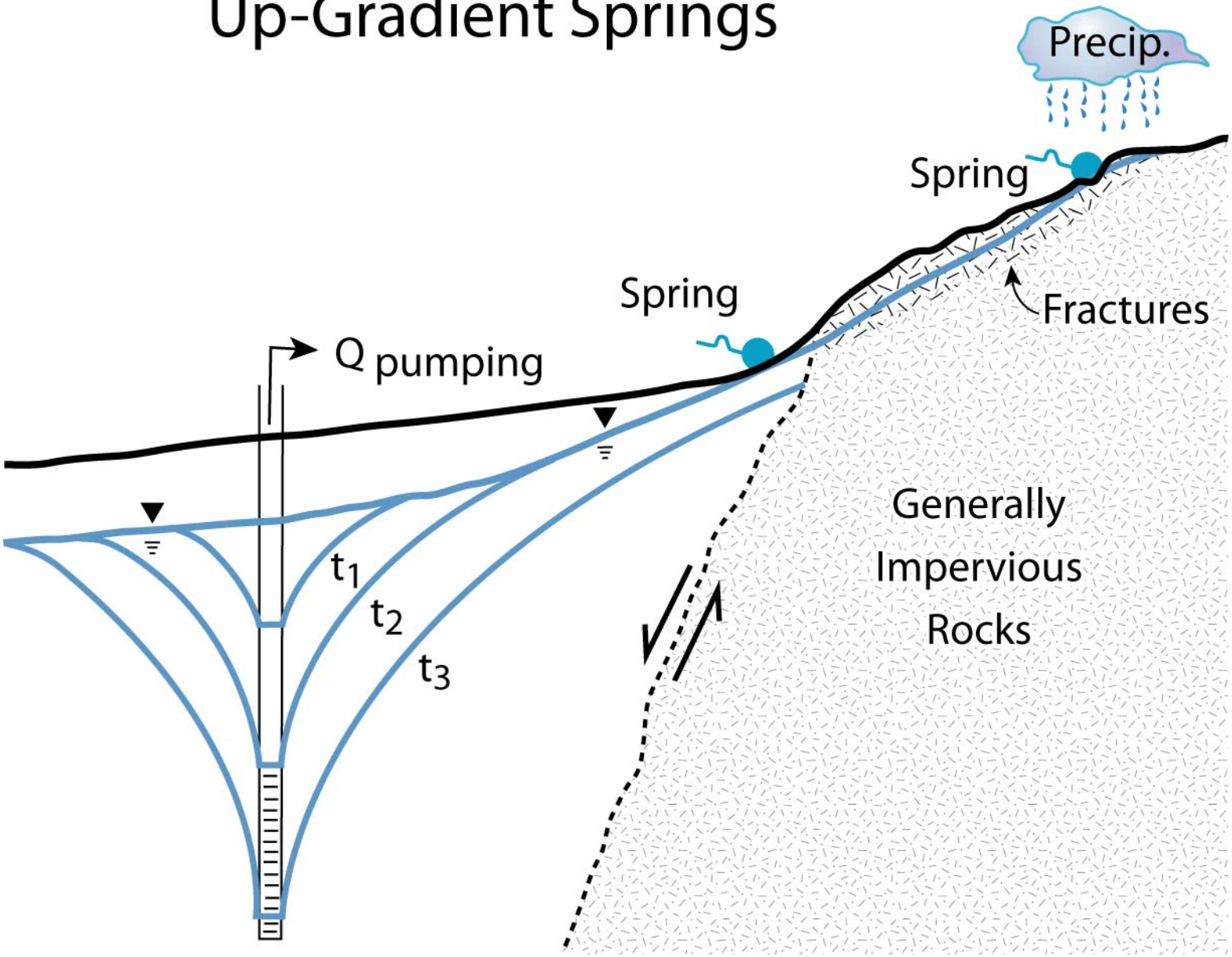
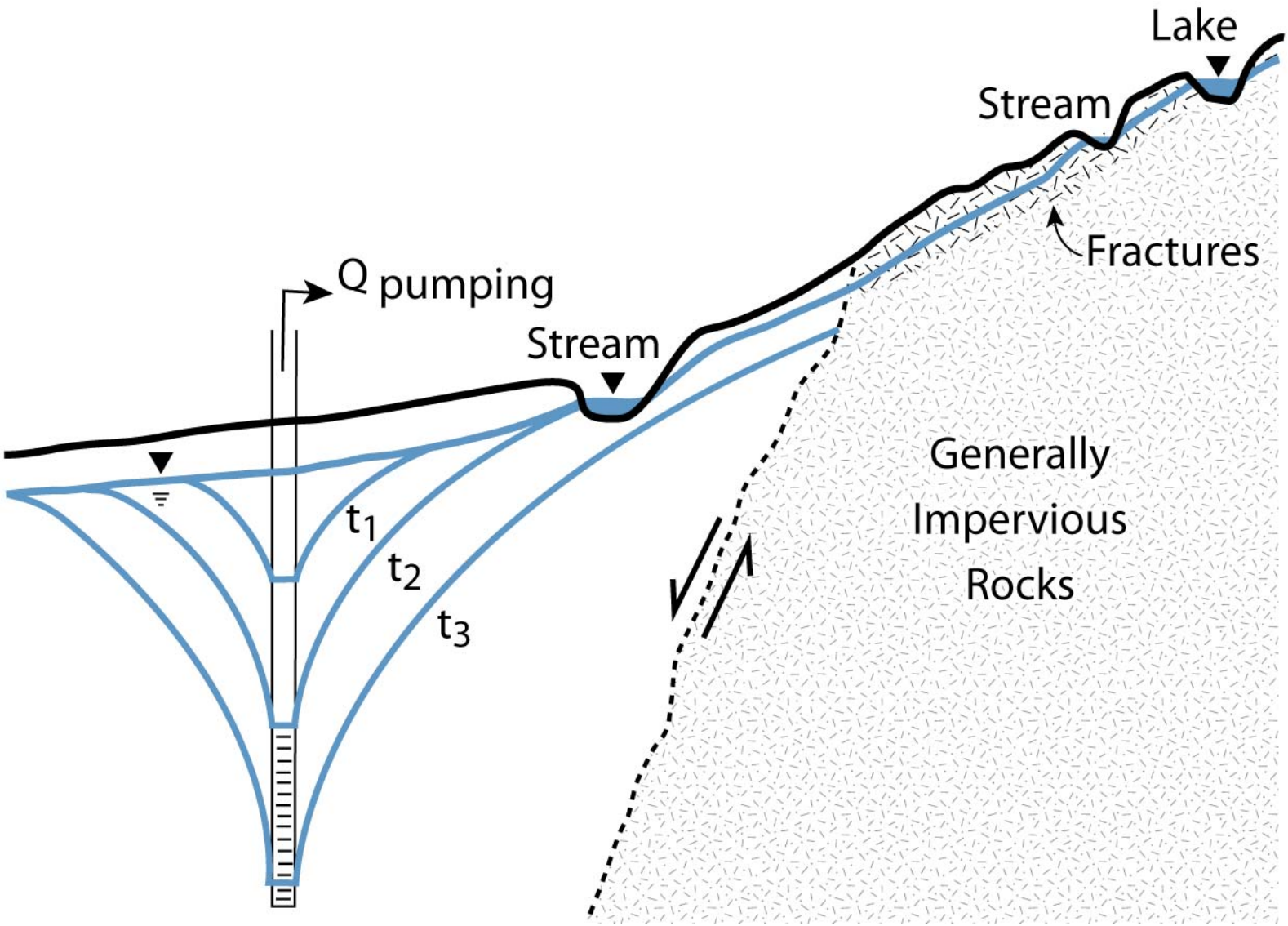
Schematic Cross-Sectional View: Down-Gradient Spring



Schematic Cross-Sectional View: Up-Gradient Springs



Schematic Cross-Sectional View: Up-Gradient Streams and Lakes



Factors that Influence Timing and Magnitude of Capture

- Distance
- Pumping Rate
- Aquifer Properties

USGS Final Report Published

Elliott, P.E., Beck, D.A., and Prudic, D.E., 2006

"Characterization of Surface-Water Resources in the Great Basin National Park Area and Their Susceptibility to Ground-Water Withdrawals in Adjacent Valleys, White Pine County, Nevada"

USGS SRI 2006-5099, 157 p.

Criteria Used to Delineate Areas of Susceptible Surface Waters

- Surface-water feature must by hydraulically continuous with ground-water beneath it; and
- Ground water beneath the surface-water feature must be hydraulically continuous with the aquifer in the adjacent valley.

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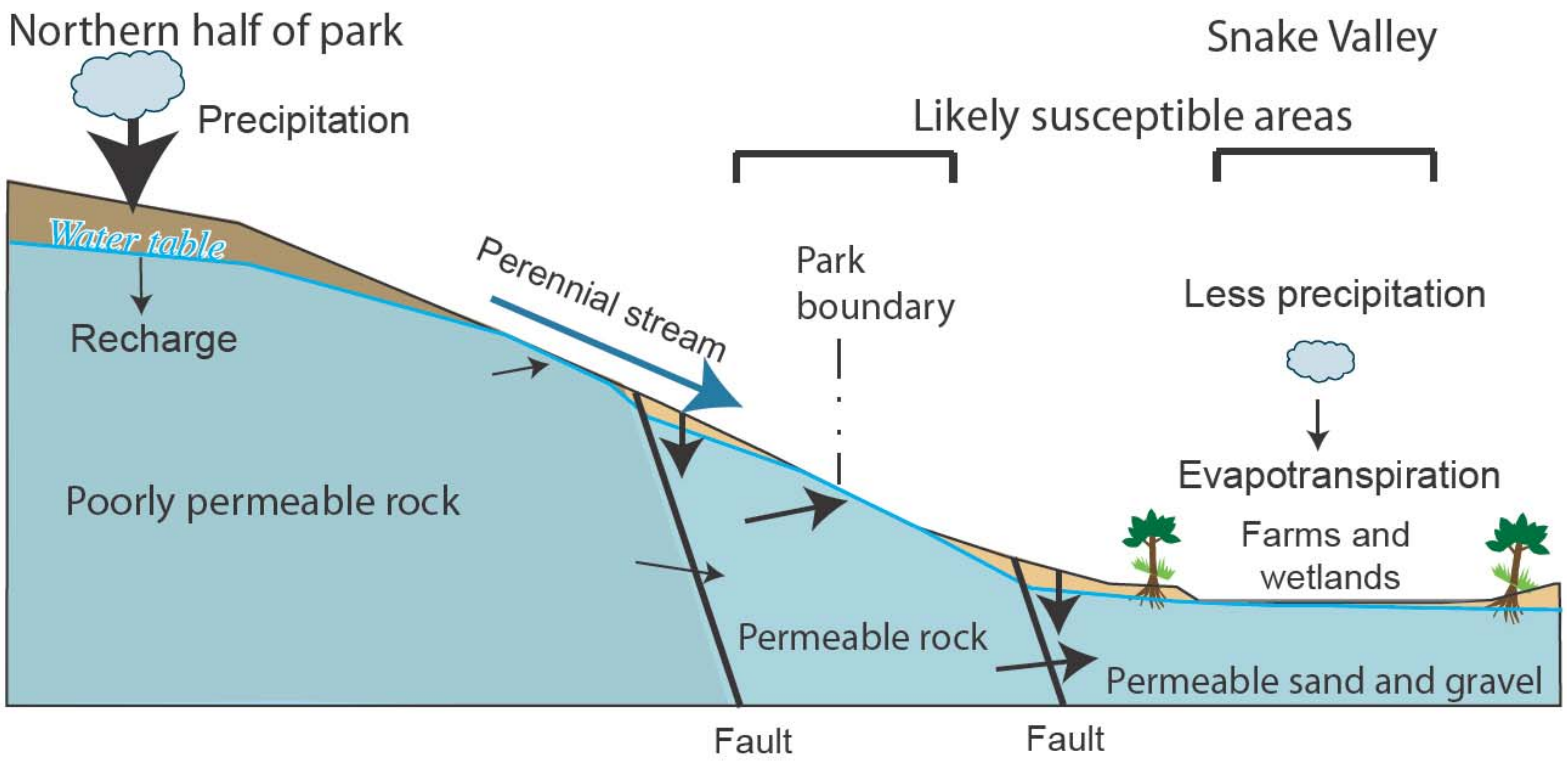
Northern half of the park

(modified from David Prudic, USGS)



EXPERIENCE
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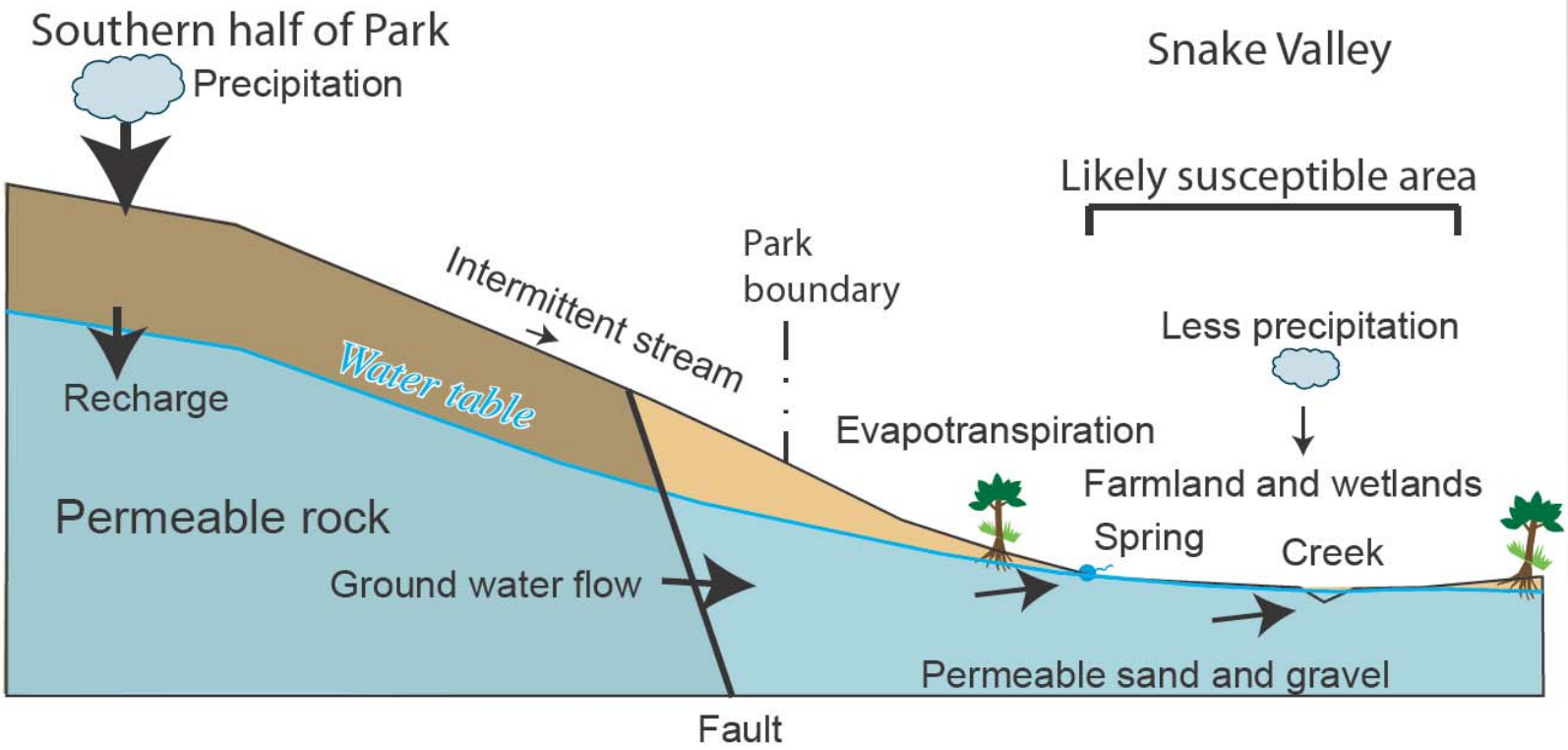
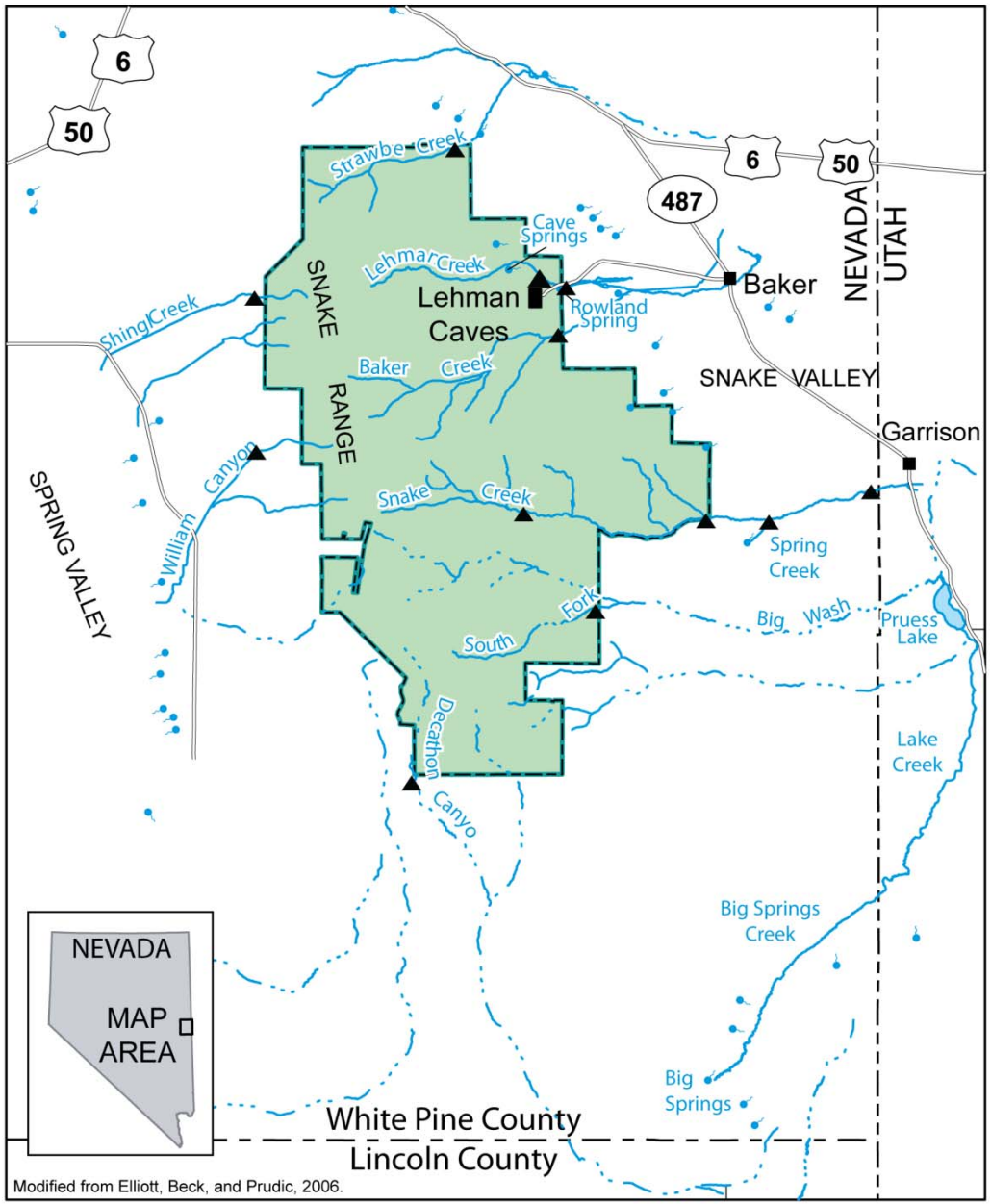
Southern half of the park

(modified from David Prudic, USGS)



Great Basin National Park



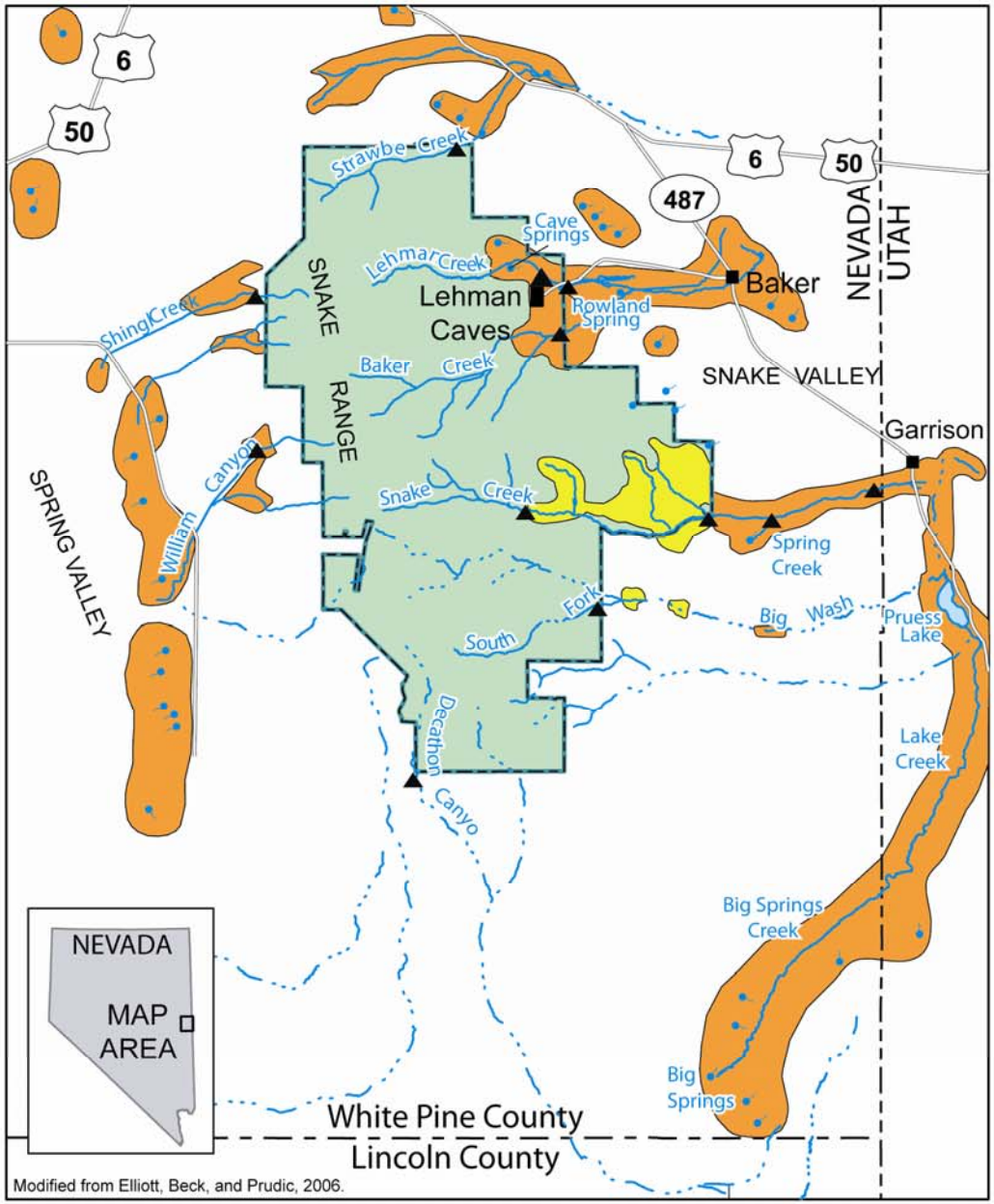
Modified from Elliott, Beck, and Prudic, 2006.

EXPLANATION

- Great Basin National Park
- USGS continual-recording streamflow gage
- Spring

0 5 MILES

Surface-Water Features Susceptible to GW Withdrawals

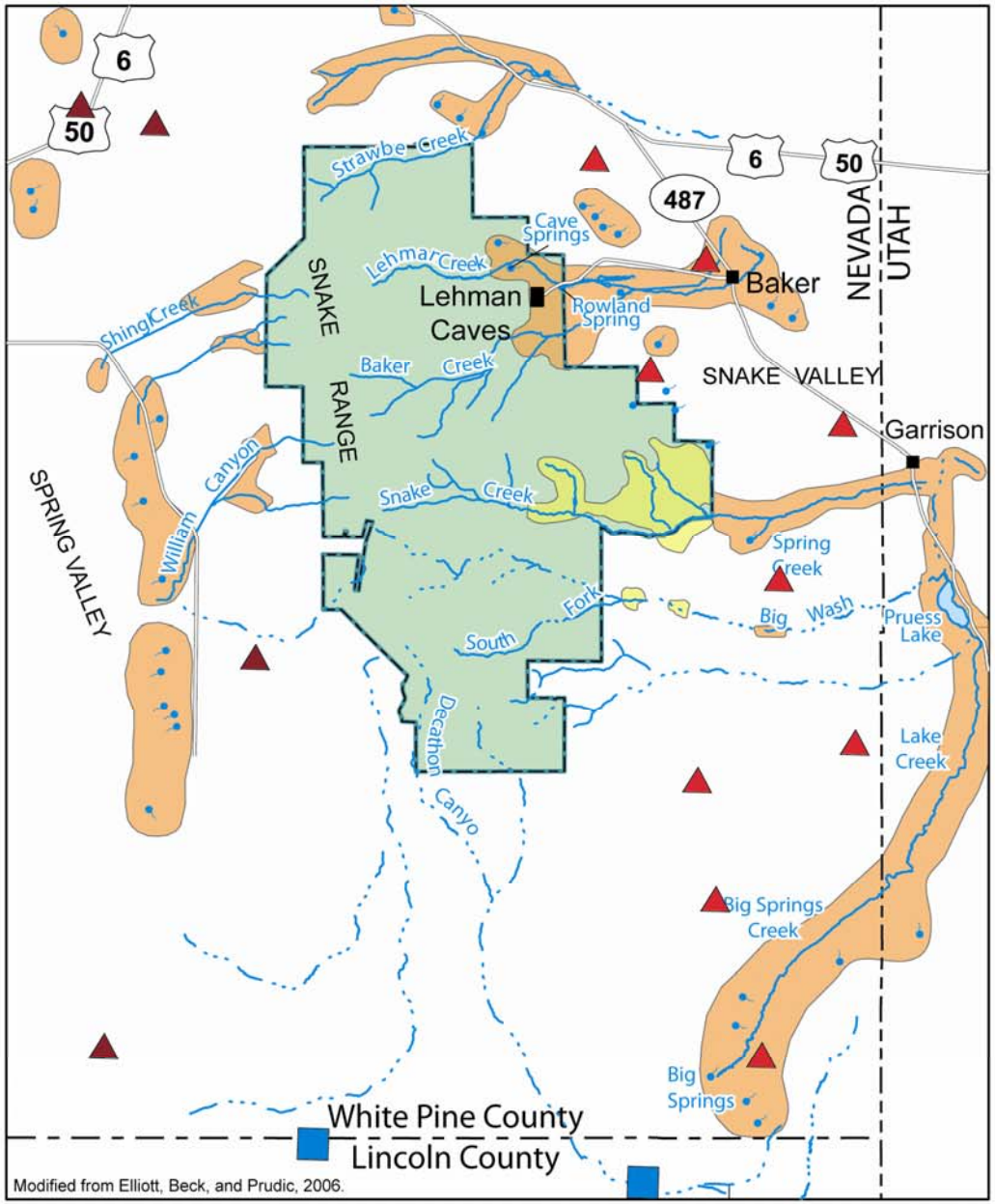


EXPLANATION

- Great Basin National Park
- USGS continual-recording streamflow gage
- Spring
- Likely susceptible to ground-water withdrawls
- Potentially susceptible to ground-water withdrawls

0 5 MILES

Ground-Water-Right Applications Near Great Basin NP



EXPLANATION

- Great Basin National Park
- Spring
- Likely susceptible to ground-water withdrawls
- Potentially susceptible to ground-water withdrawls

Vidler Water Company

- Pending applications

Southern Nevada Water Authority

- Existing permits
- Pending applications

0 5 MILES

Future Work Efforts:

New USGS/UNR study set to start

- Evaluate geologic properties of basin-fill aquifers and their connection with carbonate-rock aquifer
- Quantify site-specific properties of surface-water – ground-water interactions
- Evaluate inter-basin ground-water flow from Spring Valley to Snake Valley

CONCLUSIONS

- High mountain water resources are likely not susceptible to depletion from pumping in valleys
- Some park water resources at the mountain front in Snake Valley are likely susceptible to depletion from pumping in adjacent valleys
- Streams along the mountain front may be depleted but not dried up completely
- Springs are the most fragile of the water resources
  - Once the ground-water level is lowered below spring orifice, springs will go totally dry.
- Future work will better quantify site-specific aquifer properties and gw – sw interactions
- Hydrogeology of Lehman / Baker Creek cave system needs to be further understood

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Baker Creek

photograph by
Bill Van Liew,
NPS Water Resources
Division