Regional- Scale Groundwater Recharge

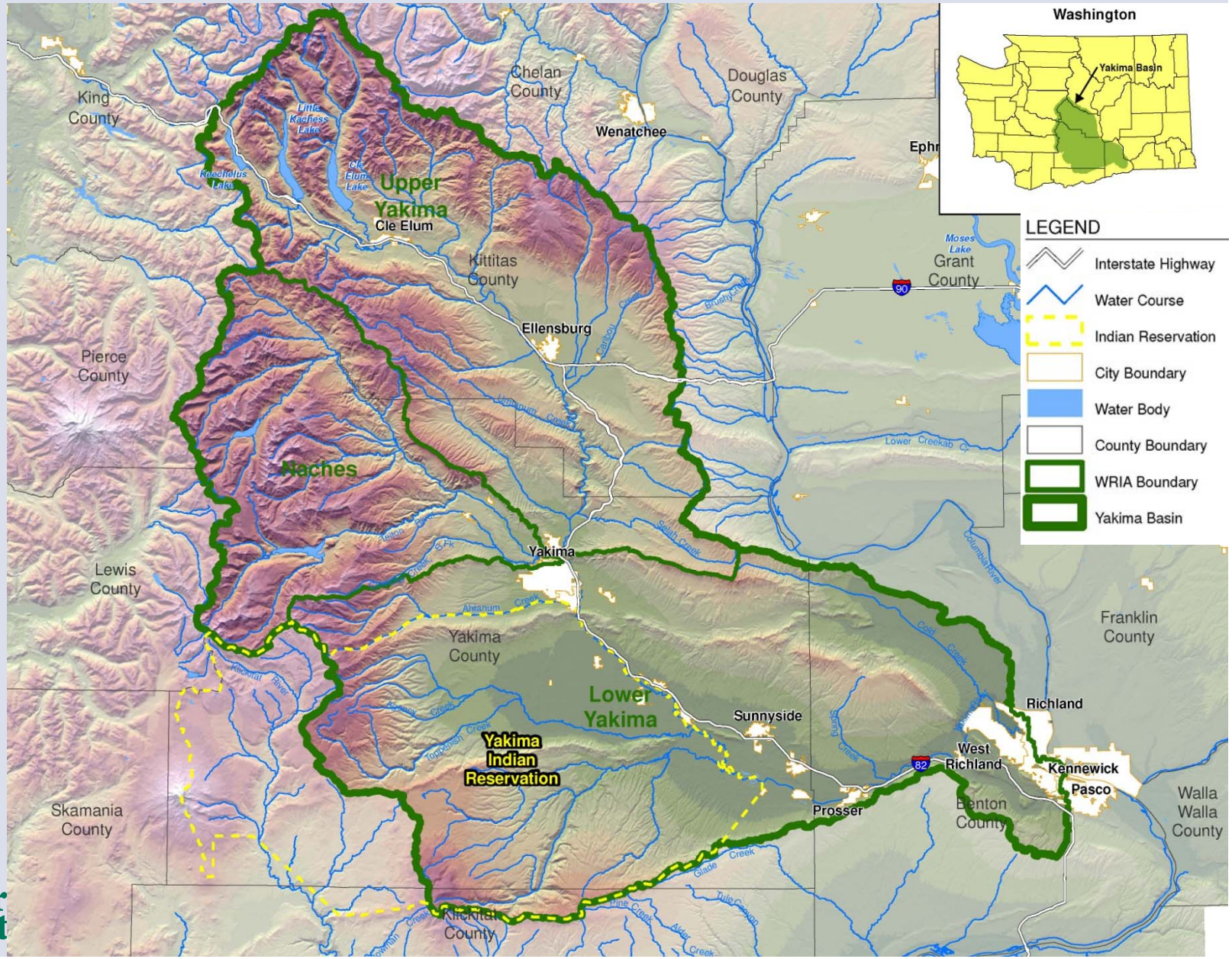
Yakima River Basin

AWWA Pacific Northwest Annual Meeting
Tacoma, Washington.

March 12, 2010

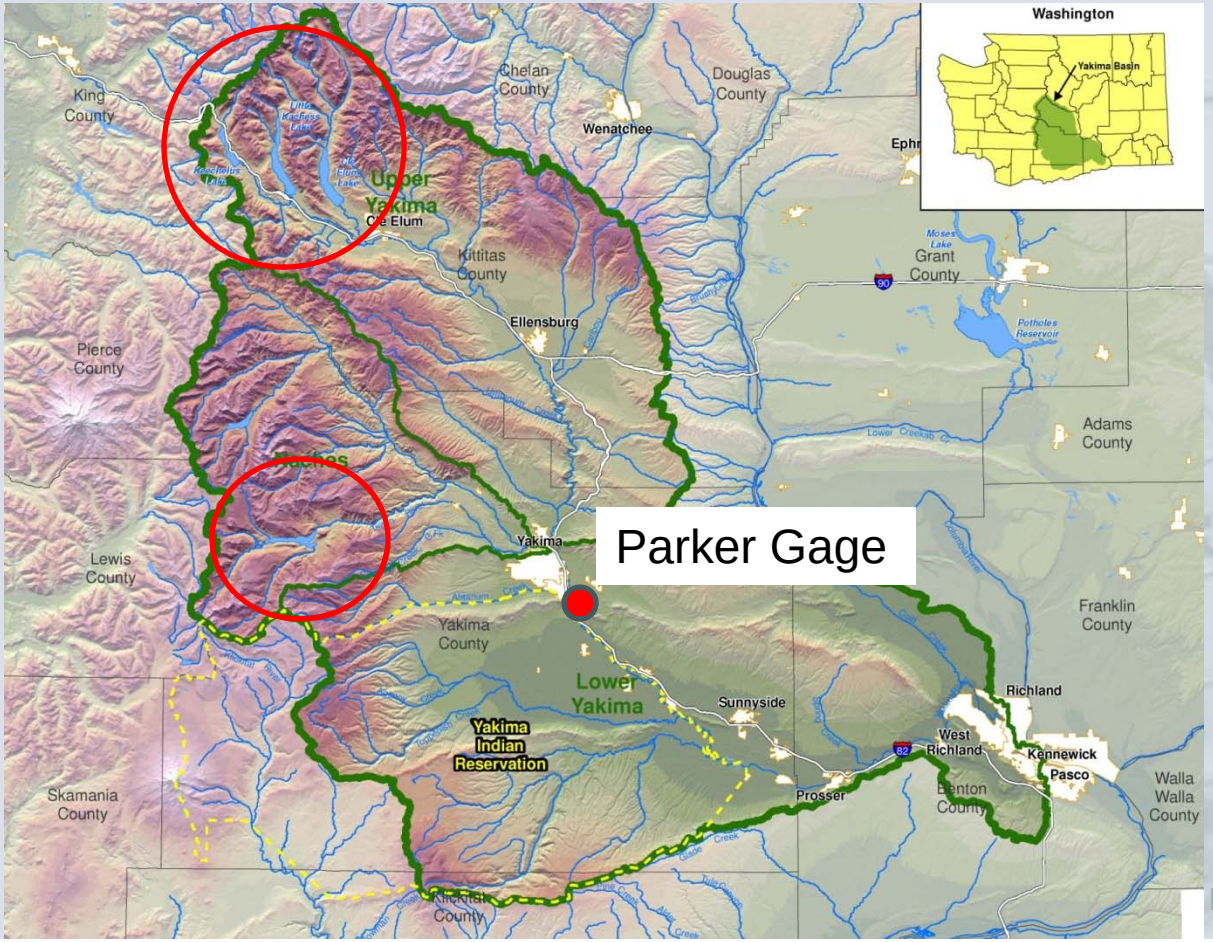
Bob Anderson
Golder Associates Inc.
Redmond, WA

Yakima River Basin, Washington



Yakima Basin

- Surface storage drives the economy and ecology
- USBOR manages reservoir releases to fulfill water rights. Key management location is the Parker Gage



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Yakima Basin Issues

- Instream flows
  - Target flows mandated by Congress, instream target flows.
- Irrigation demand
  - Over 2 million acre-feet of Irrigation Entitlements
  - Non-Proratable [Senior] vs Proratable [Junior] entitlements
  - Proratable water users did not receive all of their entitlement in 1992, 1993, 1994, 2001, and 2005
- Municipal demand
  - By 2050 municipal demand may grow to 82,000 AF/Yr
- Other Demand (residential & agricultural)
  - Other groundwater users in hydraulic continuity with Yakima River

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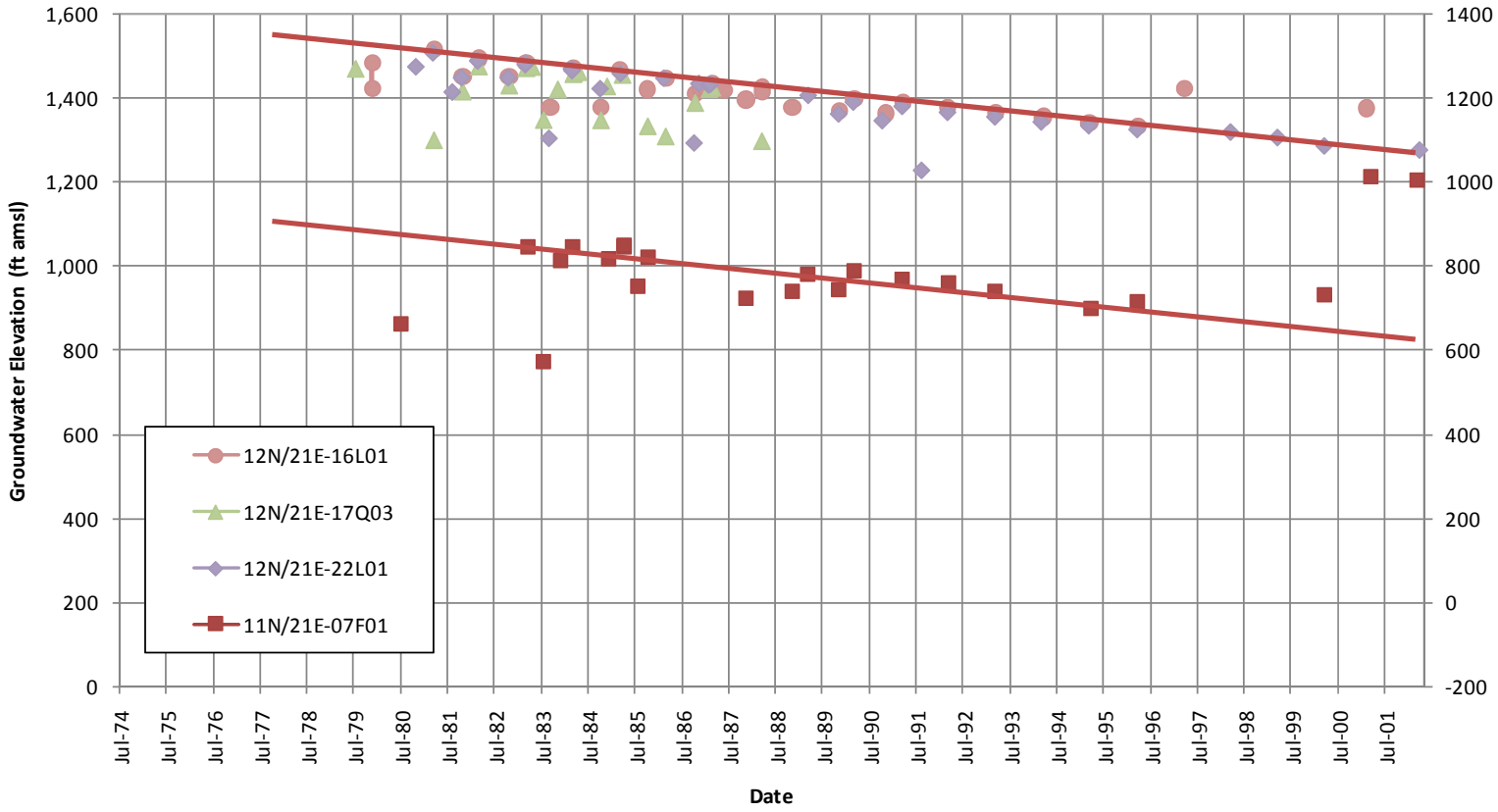
Groundwater levels declining



Golder Associates	Title: Roza Wells - Wanapum		Drawn: XXX
			Checked: YYY
	Project Name: Project Name	Project No.: xxx-xxxxx	Reviewed: ZZZ
	Client Name: Client Name	Date: April 7, 2009	FIGURE 4

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Yakima Basin Storage Options

- Surface Storage
  - Black Rock Reservoir
  - Wymer Reservoir

Artists rendition of Black Rock reservoir (USBOR, 2007)

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Yakima Basin Storage Options

- USBOR Alternatives under NEPA
  - Black Rock Reservoir
  - Wymer Reservoir
- Additional "State Alternatives" under SEPA
  - Enhanced Conservation
  - Enhanced surface storage
  - Market based allocation
  - Aquifer storage
    - ***Municipal ASR***
    - ***Surface Infiltration***
    - ***Regional ASR***

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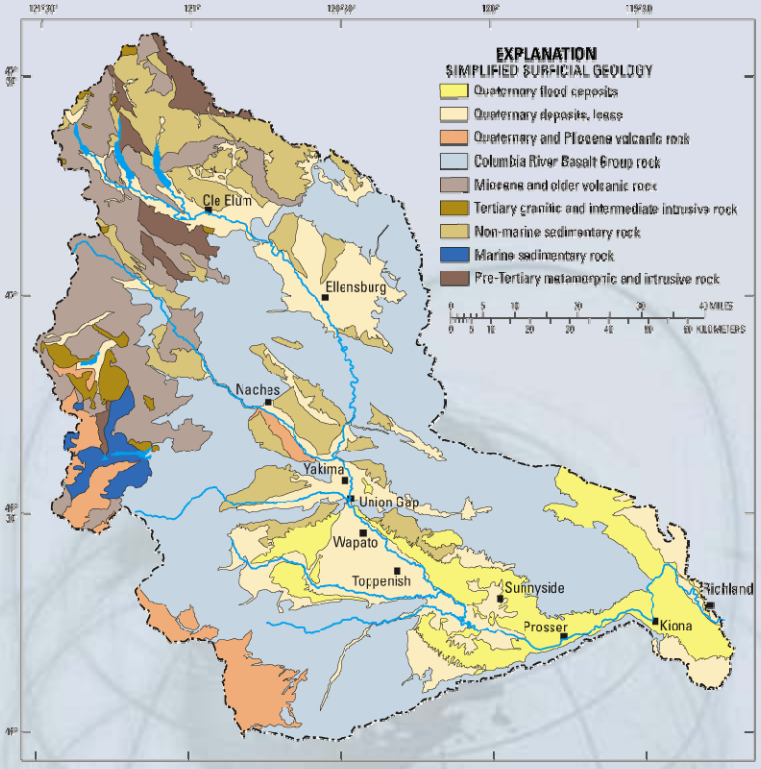
Overview

- Aquifer Storage
  - Surface recharge in alluvium
  - Municipal ASR in clastic formations
  - Large scale ASR in Basalts



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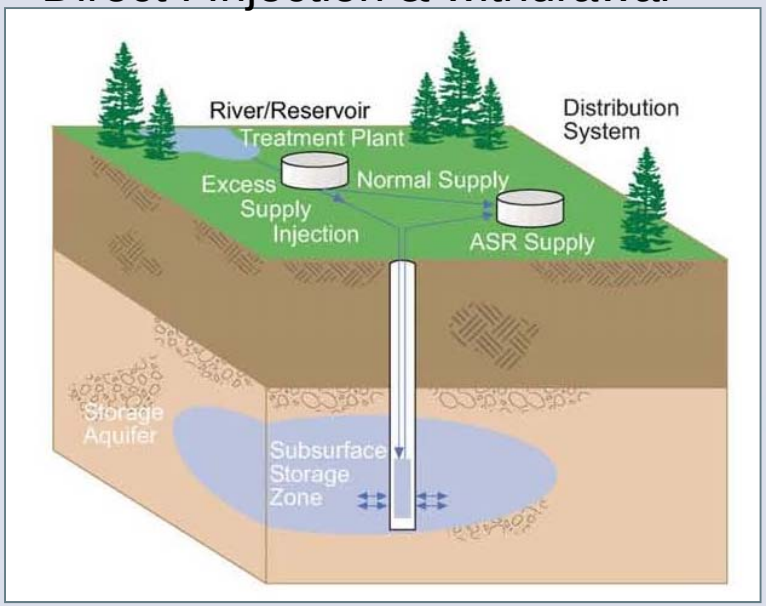
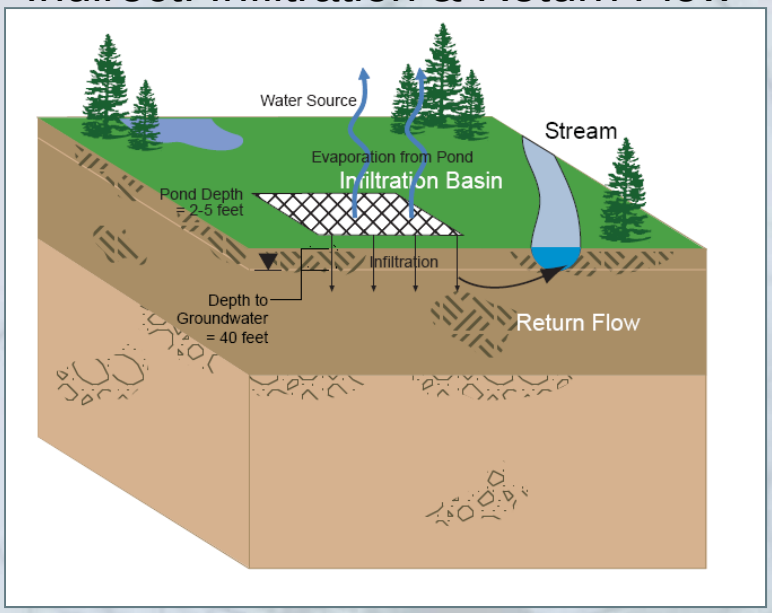
Aquifer Storage Concept

- Divert and store water underground when it is available
- Recover water (directly or indirectly) during storage control to benefit streamflows

Direct : Injection & withdrawal



Indirect: Infiltration & Return Flow



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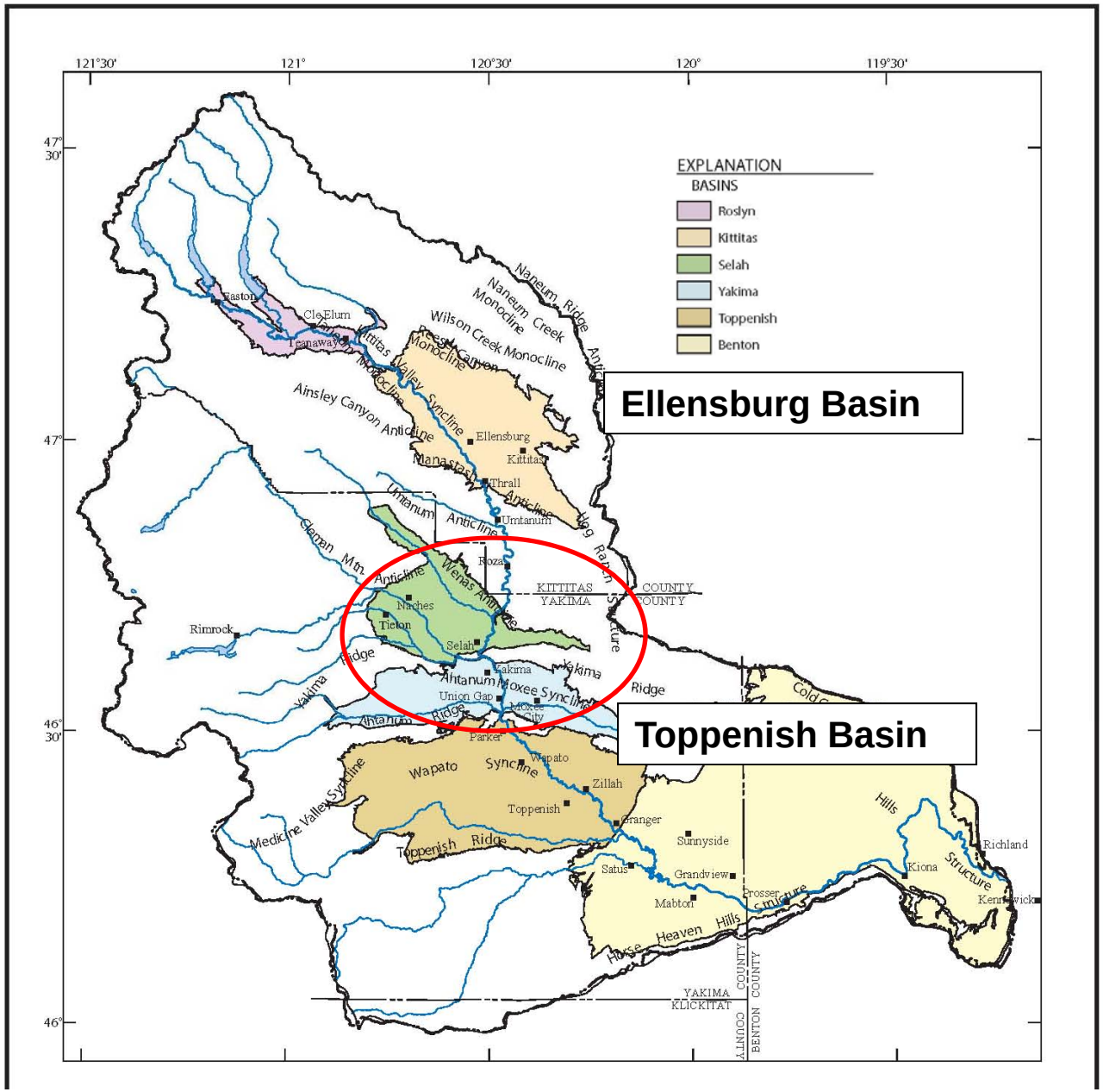
ASR Evaluations



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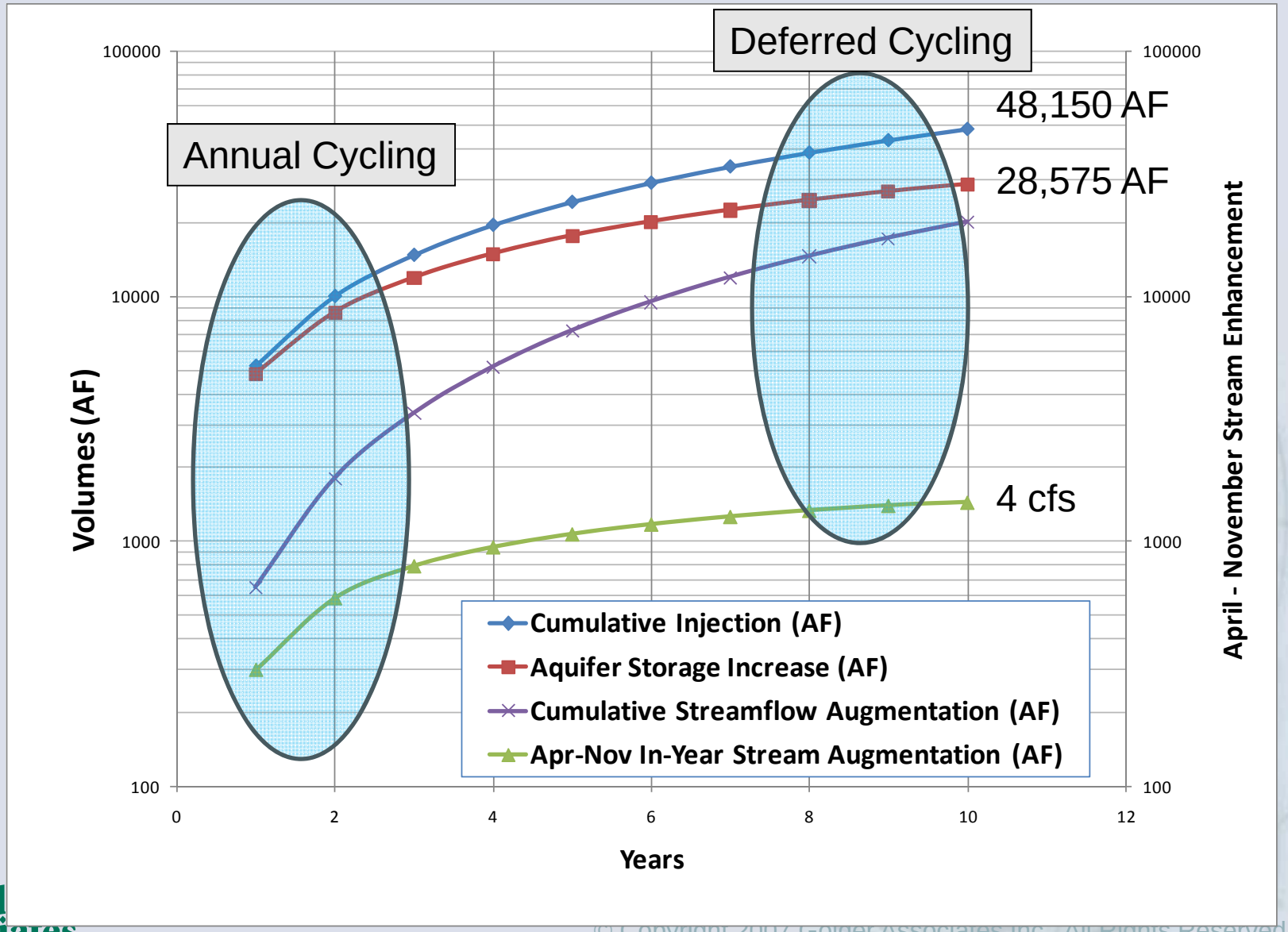
Municipal ASR



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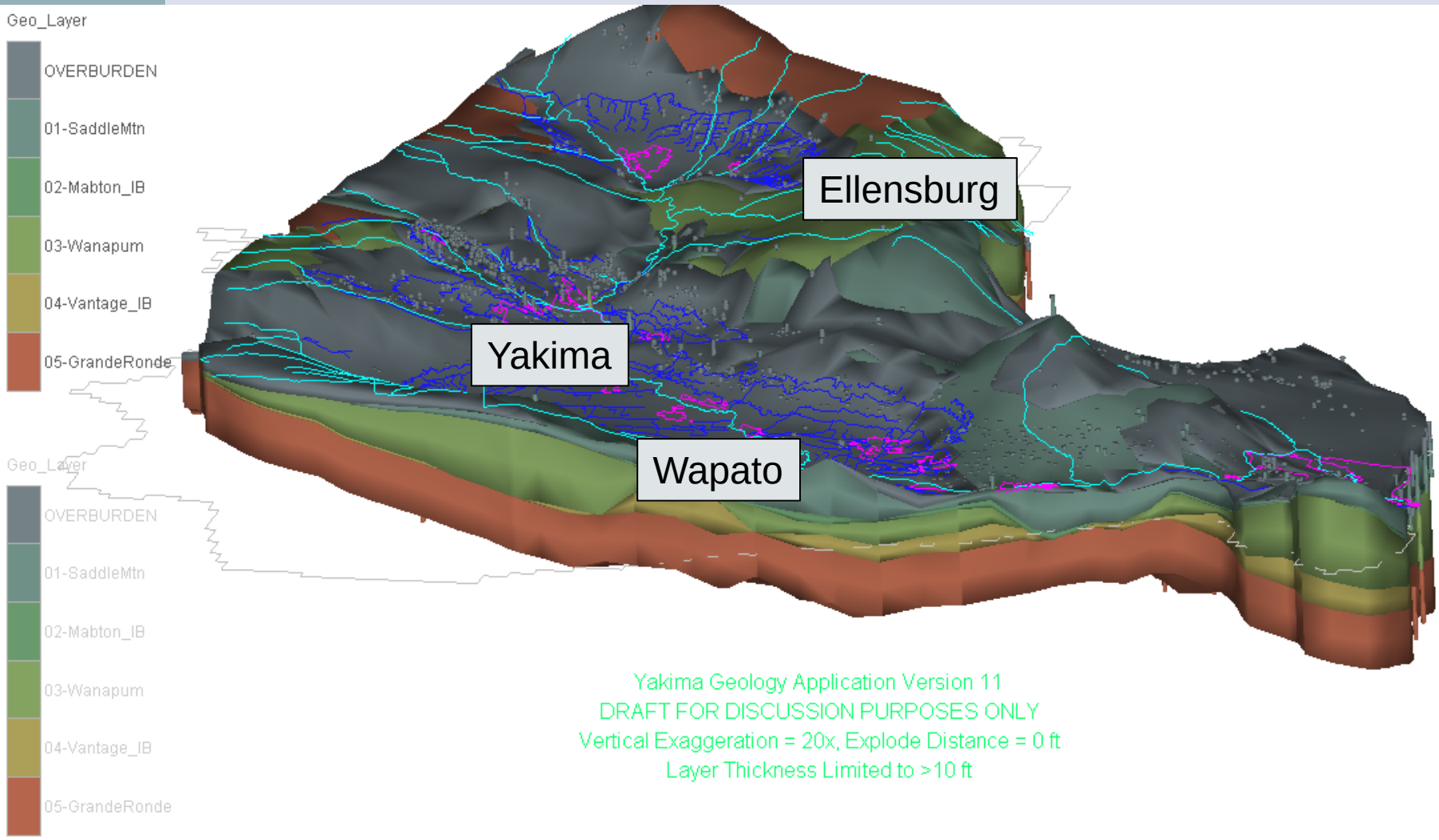
Regional ASR



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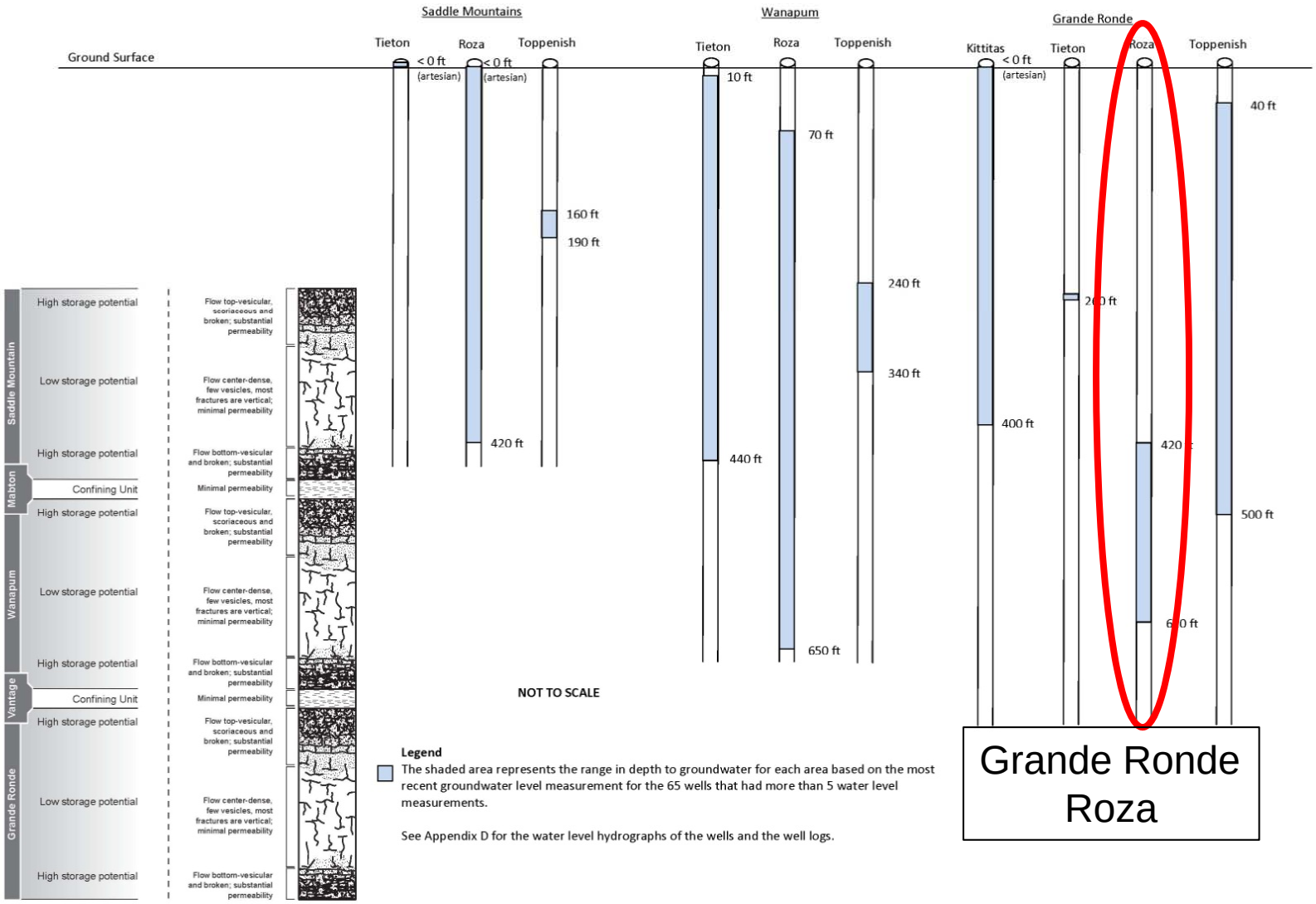
Basalt Water-Levels



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Well Capacity

- Predicted build-up from 2,500 gpm injection based on reported short term specific capacity tests on 36 wells:
  - Maximum : >1,000 ft
  - Average : 473 ft
  - Median : 171 ft
  - Minimum : <20 ft

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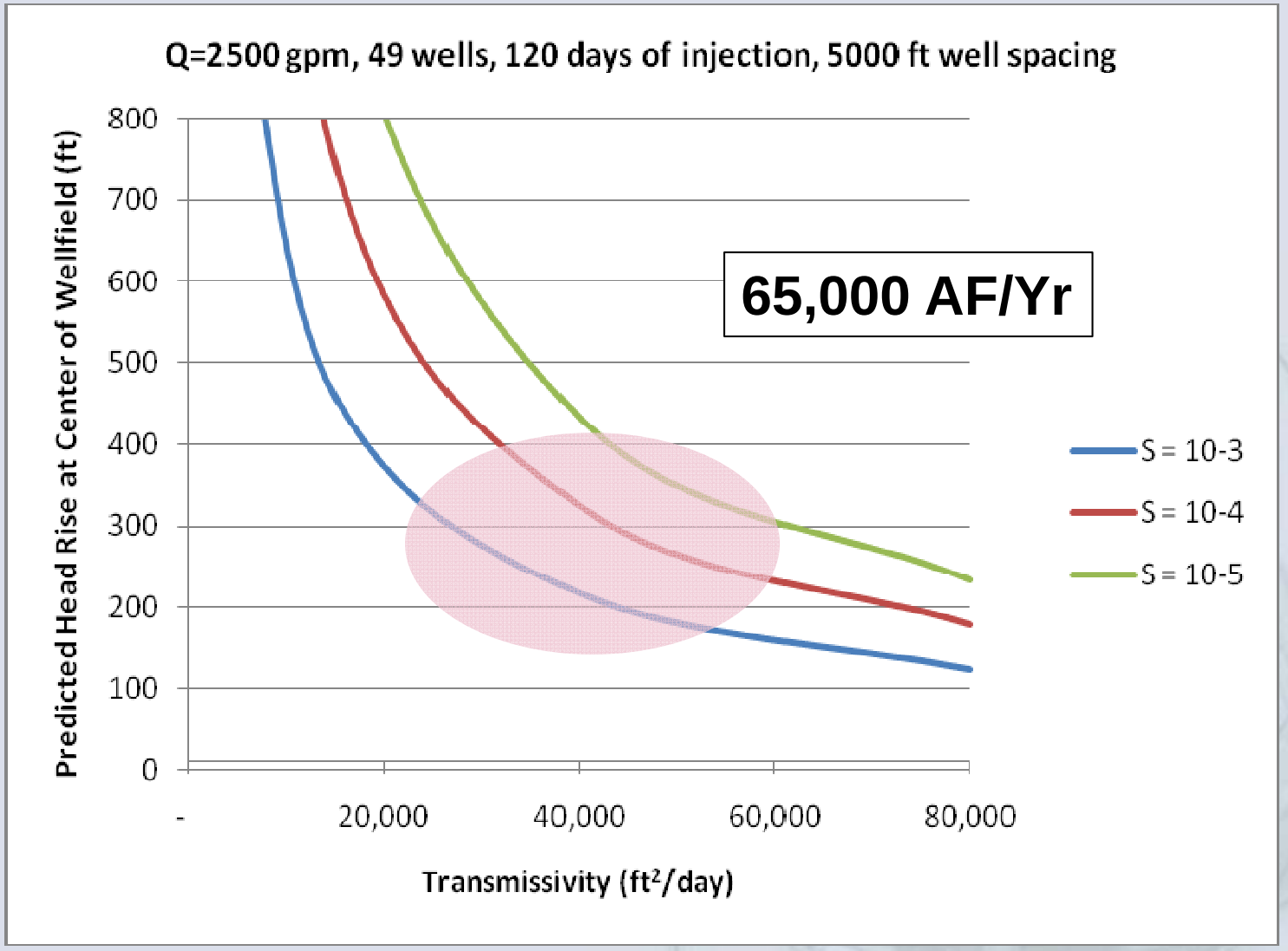
Conceptual Wellfield Design



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Regional ASR

- Deep Basalt Reservoirs
  - >60,000 AF/yr per well field
  - Replace/enhance agricultural diversions
- Complex/costly infrastructure and operations
  - Water treatment
  - Conveyance
  - O&M (power, well fields)

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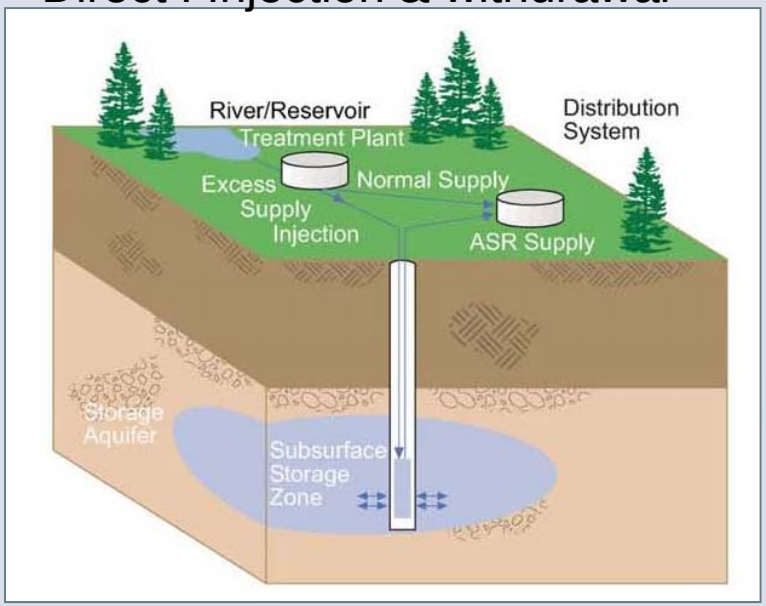
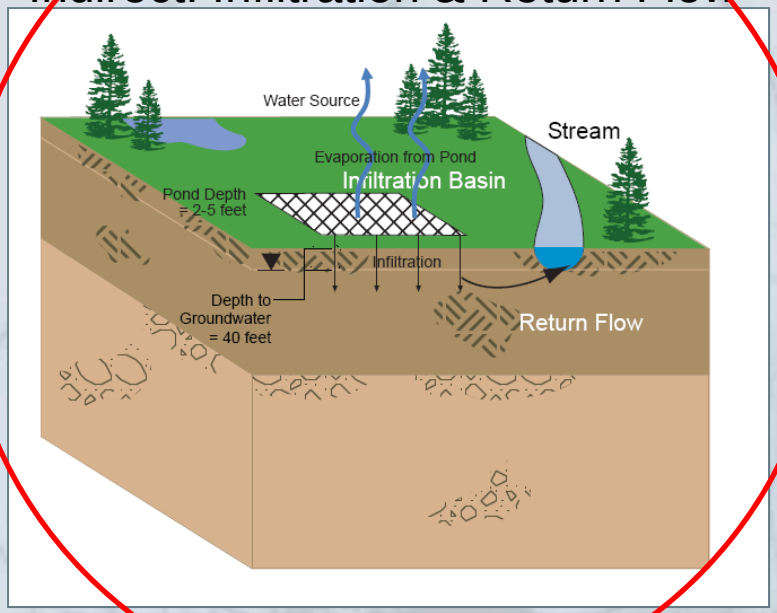
Aquifer Recharge Concept

Direct : Injection & withdrawal



Indirect: Infiltration & Return Flow



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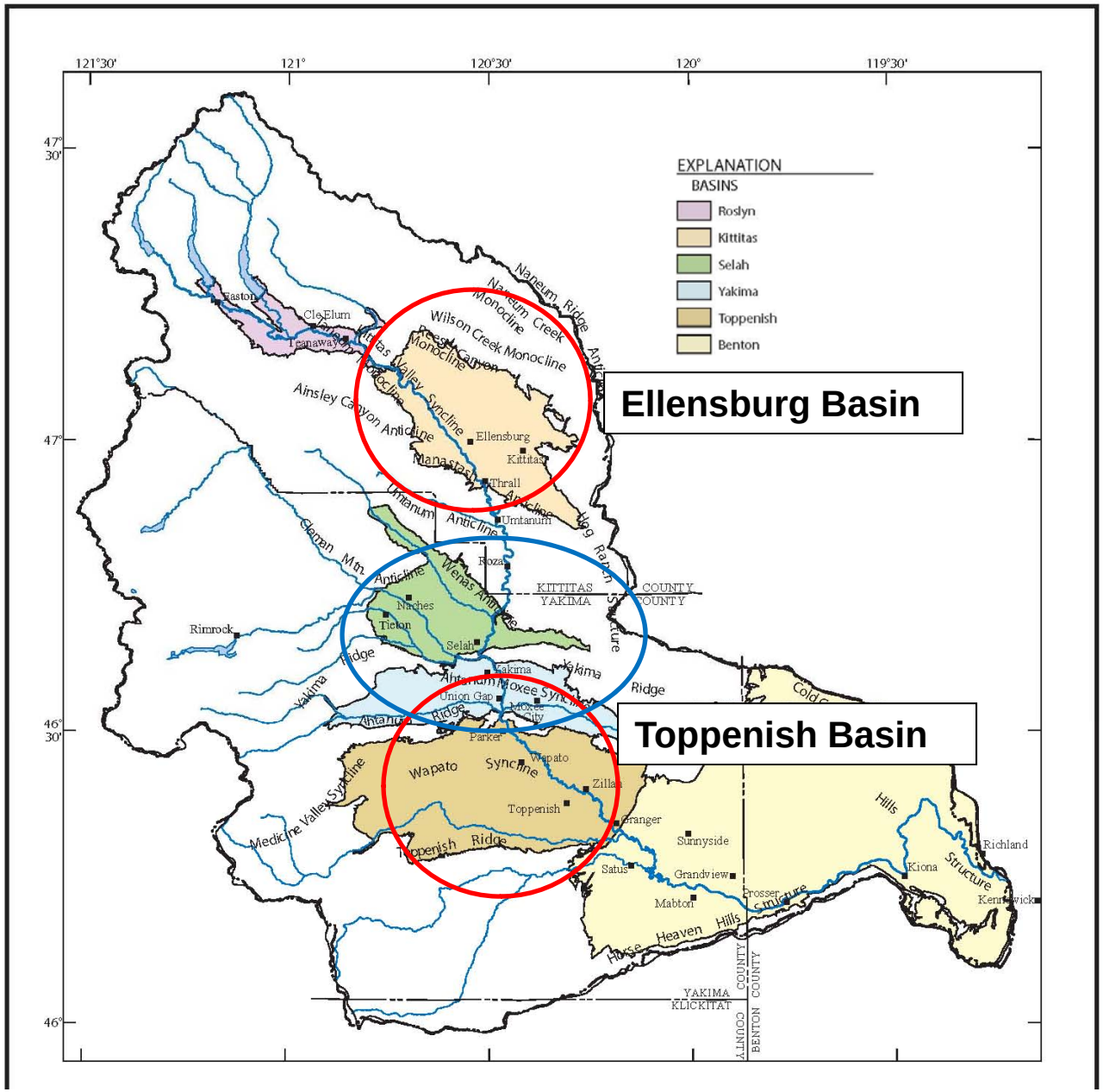
Surface Infiltration Evaluation



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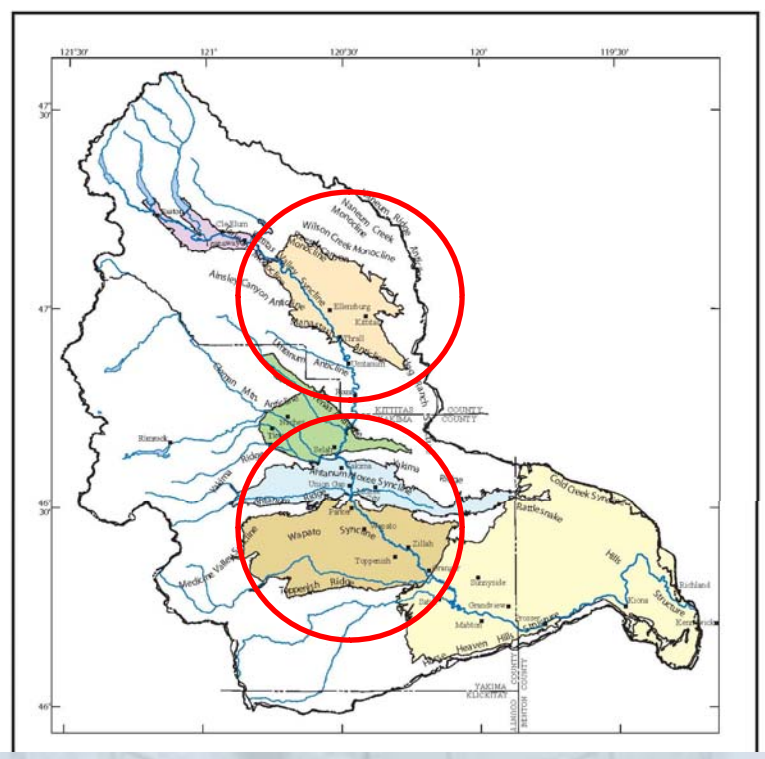
Surface Infiltration Evaluation

- Infiltration basins
  - "Engineered" for desired return flow profile
- Spreading
  - "Holistic" recovery of shallow groundwater system



Key evaluation criteria :

Return flow to streams
Delay of "storage control"

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Infiltration Basins

Conceptual Design and empirical predictions of infiltration capacity

10,000 AF/Mo @ 20 to 60 AF/Acre/Mo = 200 to 500 acres

Central Arizona Project Facilities

Location	Size (Acres)	Peak Volumes (AF/Mo)	Total Capacity (AF/Acre/Mo)
Agua Fria	100	5,000	50
Avra Valley	10.8	850	79
Hieroglyph	38	2,800	73
Santa Cruz	30	3,977	132
Pima Mine	14	2,000	142

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Calculating Return Flow - SDF

- Stream Depletion Factor (SDF)

$$sdf = \frac{x^2 S}{T}$$

x = effective distance from the infiltration basin to the surface water source (ft)

S = specific yield (dimensionless)

T = transmissivity (ft^2/day)

- Provides analytical link to geology & aquifer properties

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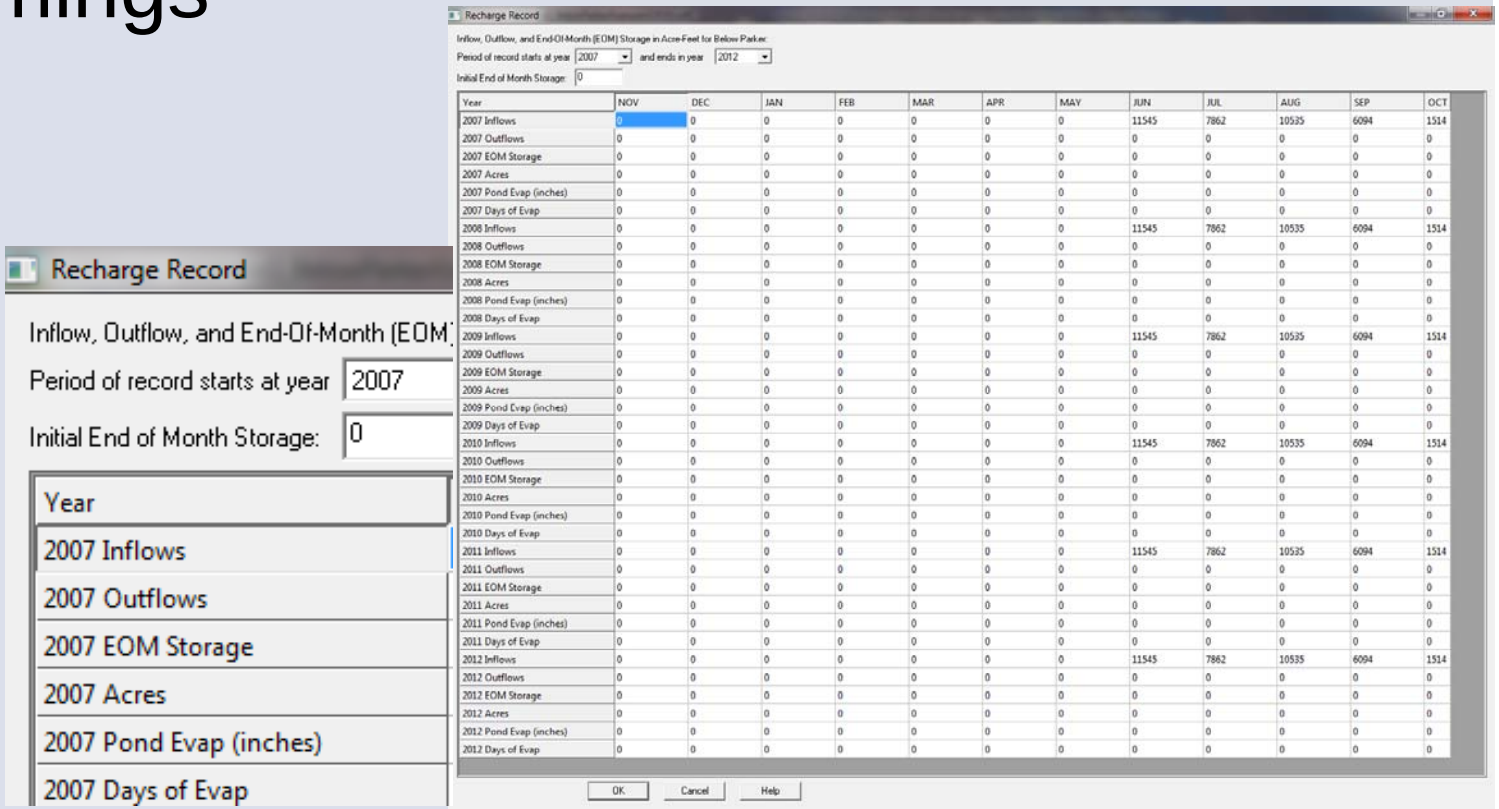
Developing Recharge Profile

- SDF View – Analytical tool to build recharge & return flow profiles for different SDF factors and recharge timings



Recharge Record

Inflow, Outflow, and End-Of-Month (EOM) Storage in Acre-Feet for Below Parker

Period of record starts at year 2007 and ends in year 2012

Initial End of Month Storage: 0

Year	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
2007 Inflows	0	0	0	0	0	0	0	11545	7862	10535	6094	1514
2007 Outflows	0	0	0	0	0	0	0	0	0	0	0	0
2007 EOM Storage	0	0	0	0	0	0	0	0	0	0	0	0
2007 Acres	0	0	0	0	0	0	0	0	0	0	0	0
2007 Pond Evap (inches)	0	0	0	0	0	0	0	0	0	0	0	0
2007 Days of Evap	0	0	0	0	0	0	0	0	0	0	0	0
2008 Inflows	0	0	0	0	0	0	0	11545	7862	10535	6094	1514
2008 Outflows	0	0	0	0	0	0	0	0	0	0	0	0
2008 EOM Storage	0	0	0	0	0	0	0	0	0	0	0	0
2008 Acres	0	0	0	0	0	0	0	0	0	0	0	0
2008 Pond Evap (inches)	0	0	0	0	0	0	0	0	0	0	0	0
2008 Days of Evap	0	0	0	0	0	0	0	0	0	0	0	0
2009 Inflows	0	0	0	0	0	0	0	11545	7862	10535	6094	1514
2009 Outflows	0	0	0	0	0	0	0	0	0	0	0	0
2009 EOM Storage	0	0	0	0	0	0	0	0	0	0	0	0
2009 Acres	0	0	0	0	0	0	0	0	0	0	0	0
2009 Pond Evap (inches)	0	0	0	0	0	0	0	0	0	0	0	0
2009 Days of Evap	0	0	0	0	0	0	0	0	0	0	0	0
2010 Inflows	0	0	0	0	0	0	0	11545	7862	10535	6094	1514
2010 Outflows	0	0	0	0	0	0	0	0	0	0	0	0
2010 EOM Storage	0	0	0	0	0	0	0	0	0	0	0	0
2010 Acres	0	0	0	0	0	0	0	0	0	0	0	0
2010 Pond Evap (inches)	0	0	0	0	0	0	0	0	0	0	0	0
2010 Days of Evap	0	0	0	0	0	0	0	0	0	0	0	0
2011 Inflows	0	0	0	0	0	0	0	11545	7862	10535	6094	1514
2011 Outflows	0	0	0	0	0	0	0	0	0	0	0	0
2011 EOM Storage	0	0	0	0	0	0	0	0	0	0	0	0
2011 Acres	0	0	0	0	0	0	0	0	0	0	0	0
2011 Pond Evap (inches)	0	0	0	0	0	0	0	0	0	0	0	0
2011 Days of Evap	0	0	0	0	0	0	0	0	0	0	0	0
2012 Inflows	0	0	0	0	0	0	0	11545	7862	10535	6094	1514
2012 Outflows	0	0	0	0	0	0	0	0	0	0	0	0
2012 EOM Storage	0	0	0	0	0	0	0	0	0	0	0	0
2012 Acres	0	0	0	0	0	0	0	0	0	0	0	0
2012 Pond Evap (inches)	0	0	0	0	0	0	0	0	0	0	0	0
2012 Days of Evap	0	0	0	0	0	0	0	0	0	0	0	0

OK Cancel Help

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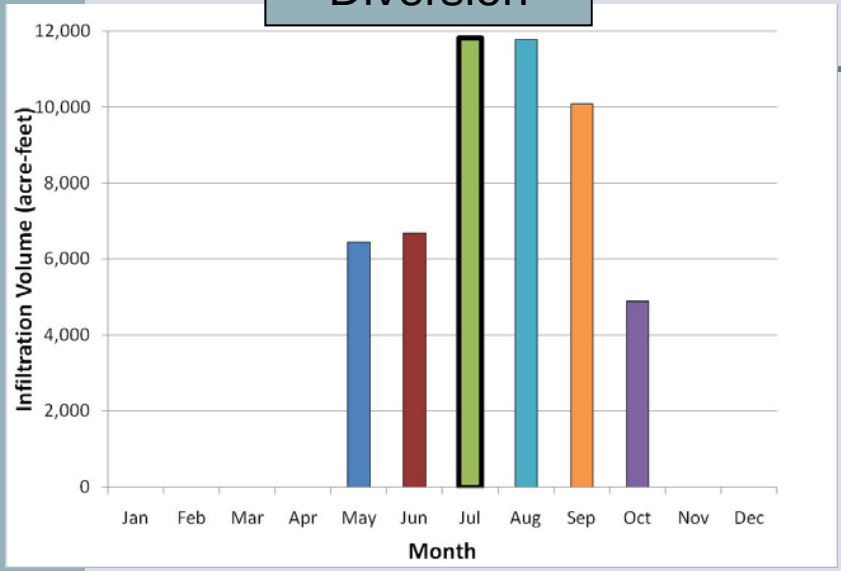
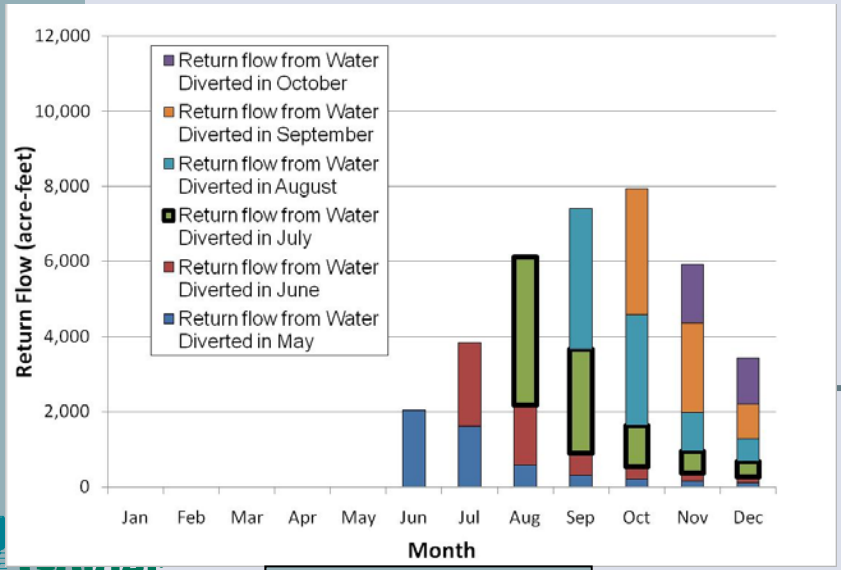
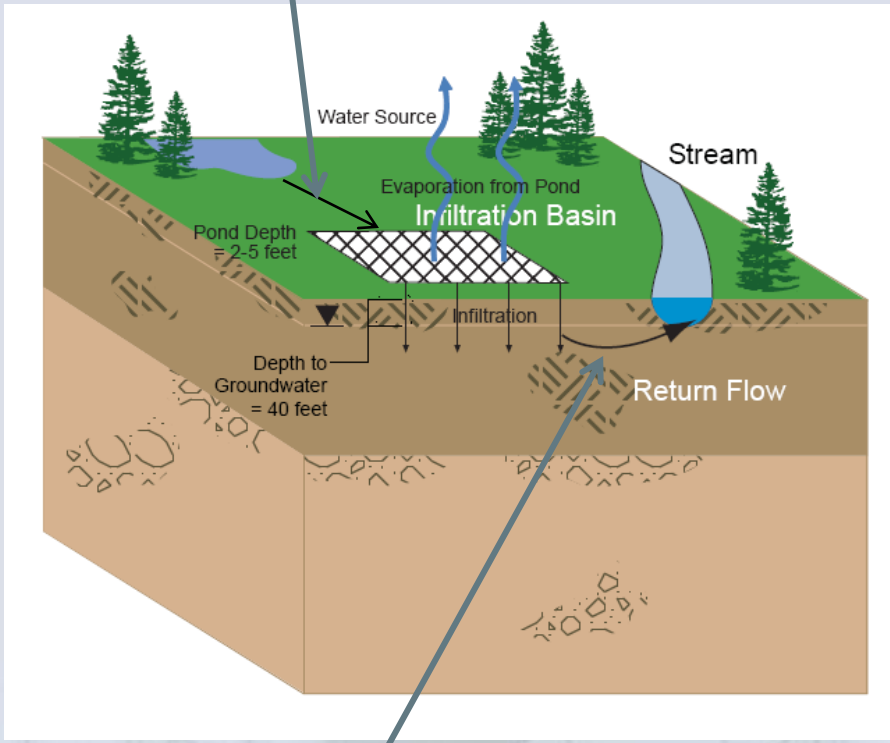
Return Flow Profiles

Diversion





Return Flow



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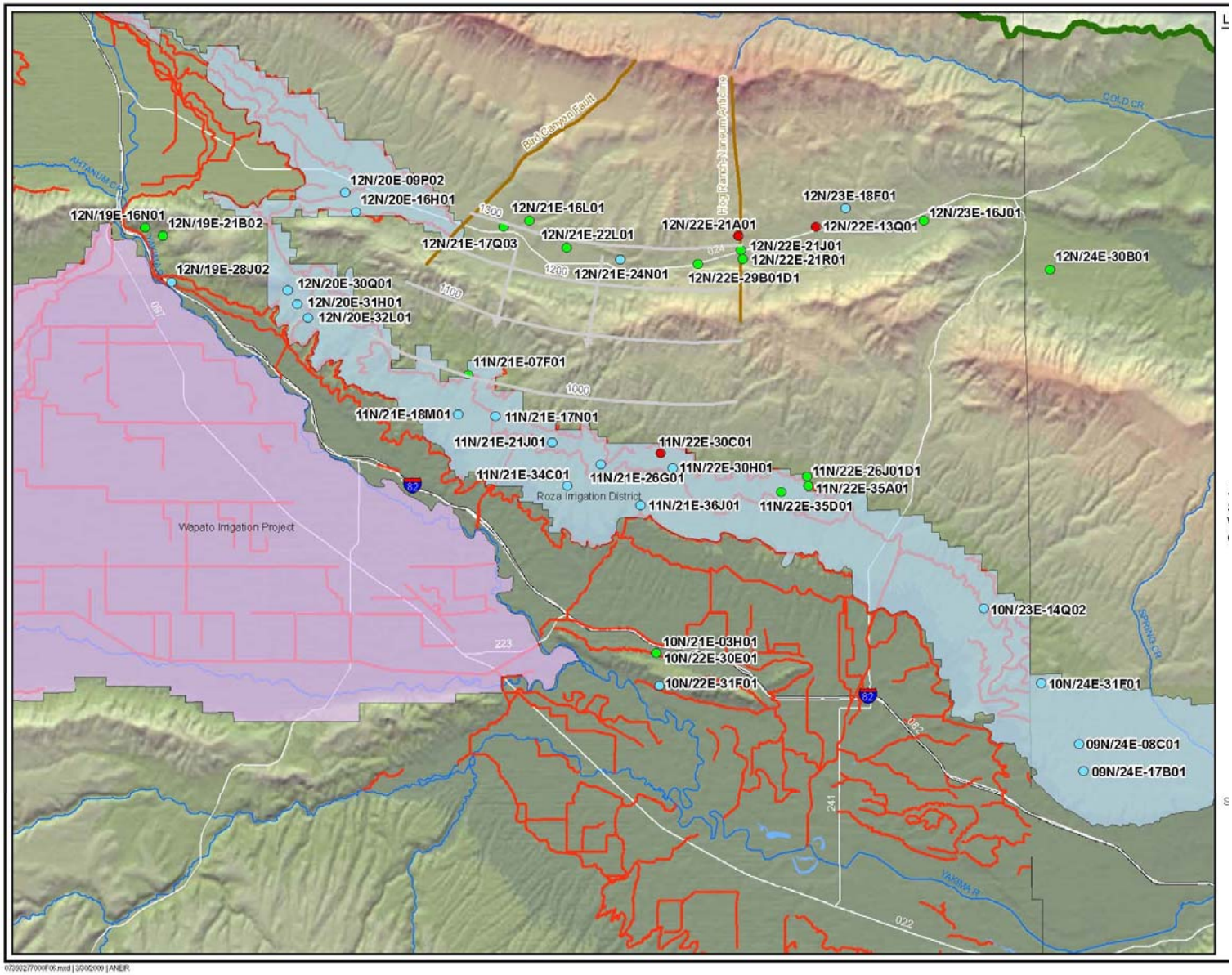
Spreading Concept



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Relative Comparisons

Option	Study Scope	Ultimate Cost	Benefit (Habitat + People)	Nexus to USBR Program
Surface Infiltration & Return Flow	High	Moderate	Moderate	High
Municipal ASR	Low	Low	Low	Low
Agricultural ASR	Moderate	High	High	High

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Thank You

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