Albuquerque Bernalillo County
Water Utility Authority

Agenda Item No. 10a

Meeting Date: October 22, 2014
Bruce Thomson, PhD., Civil Engineering Professor, UNM

TITLE: OB-14-16 - Middle Rio Grande Water Budget

ACTION: None

SUMMARY:
The challenges of meeting the water needs of the Middle Rio Grande (MRG) basin become greater each year due to the combined effects of increasing demands of water coupled with a decreased supply due to the effects of a multi-year drought and expected decrease in water supply as a result of a warming climate.

Although there is improved understanding of the water resources in the basin, there is still large uncertainty in how water is used, especially in those components of the hydrologic cycle that are difficult or impossible to measure. These include evaporation from the river and reservoirs, evapotranspiration (ET) from crops and riparian vegetation, and ground water recharge from the river, agricultural fields, and canals.

One method of understanding water resources within the basin is to develop a budget that shows water sources and sinks as well as how water moves through the basin from surface water to ground water and back. The Water Budget Task Force of the Middle Rio Grande Water Assembly prepared a water budget for the MRG watershed for three different time periods; 1975 to 1997, 2000 to 2012 and 2008 to 2012. These budgets were compiled using URGSiM which is a hydrologic model of the Rio Grande Basin developed by researchers at Sandia National Laboratories. Though it was developed to model future conditions, for this study it was simply used as an accounting tool to quantify water sources, sinks and flows during the budget periods.

The Middle Rio Grande Water Budget will be presented and discussed showing how water is used. The purpose of the presentation is to develop a better understanding of the complexity of water management and discuss future challenges and opportunities.

FISCAL IMPACT:
None.

Water Budget for the Middle Rio Grande
DRAFT

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Introduction & Objectives

- The Middle Rio Grande Water Assembly (MRGWA) prepared a water budget for the Middle Rio Grande (MRG) to support Regional Water Plan (www.waterassembly.org)
  - Published in 1999
  - El Grupo Technico let by Frank Titus Ph.D.
- Renewed interest in water planning gave the Assembly incentive to update the plan.
- Frank Titus was again asked to lead the effort. Leadership subsequently assumed by Bruce Thomson

- Objective of this presentation is to describe process & preliminary conclusions.
  - Note: This report is still in DRAFT FINAL form. Comments & suggestions are welcome

What is A Water Budget?
(Water Balance)

- A quantitative analysis that shows:
  - All sources of water to a basin (i.e. control volume)
  - All sinks of water from the basin
  - How water moves through the basin
- A basin is in balance when the sources and sinks of water are equal
  - What time period should be used for determining balance (see following comments about averaging)?

Justification for Update of Water Budget

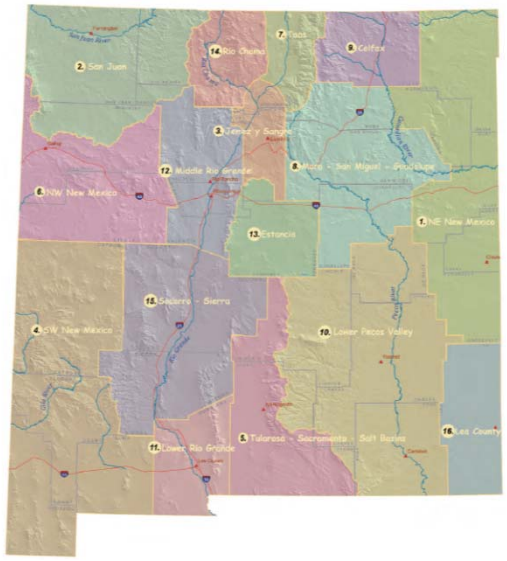
- Important changes since 1999:
  - Surface water diversion by ABCWUA beginning 12/08
  - Extended drought
  - Population growth
  - Conservation efforts
  - MRGCD metering
  - More data available (both quantity & quality)
  - Better quantitative accounting for hydrology – URGSiM
  - ISC update of Regional & State Water Plans

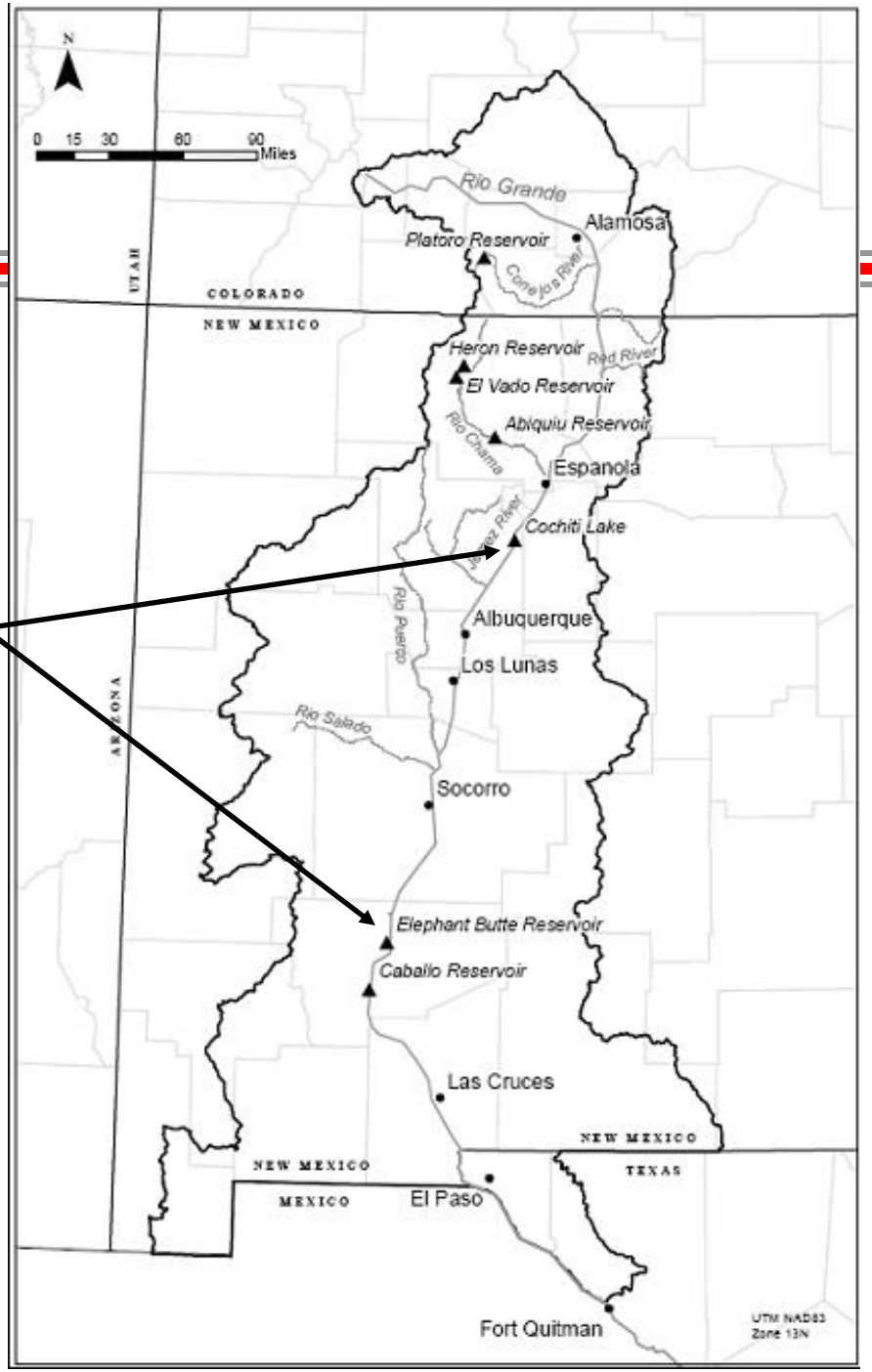
2 Notable Previous Water Budgets

- MRGWA (1999)
  - Volunteer effort
  - Based on 25 year period of record, 1972-1997
- S.S. Papodopolus & Associates (SSPA, 2004)
  - Culmination of multi-year study for NM Interstate Stream Commission
  - Included consideration of statistical variability
  - Based on 50 year period of record, 1950-1999

Boundaries of Water Budgets

- MRGWA – Cochiti to El. Butte Dam
  - Focus on 3 county planning region
- SSPA – Otowi Gage to El. Butte Dam
- This study – Cochiti to El. Butte Dam
- Budgets don't coincide with Regional Plan boundaries

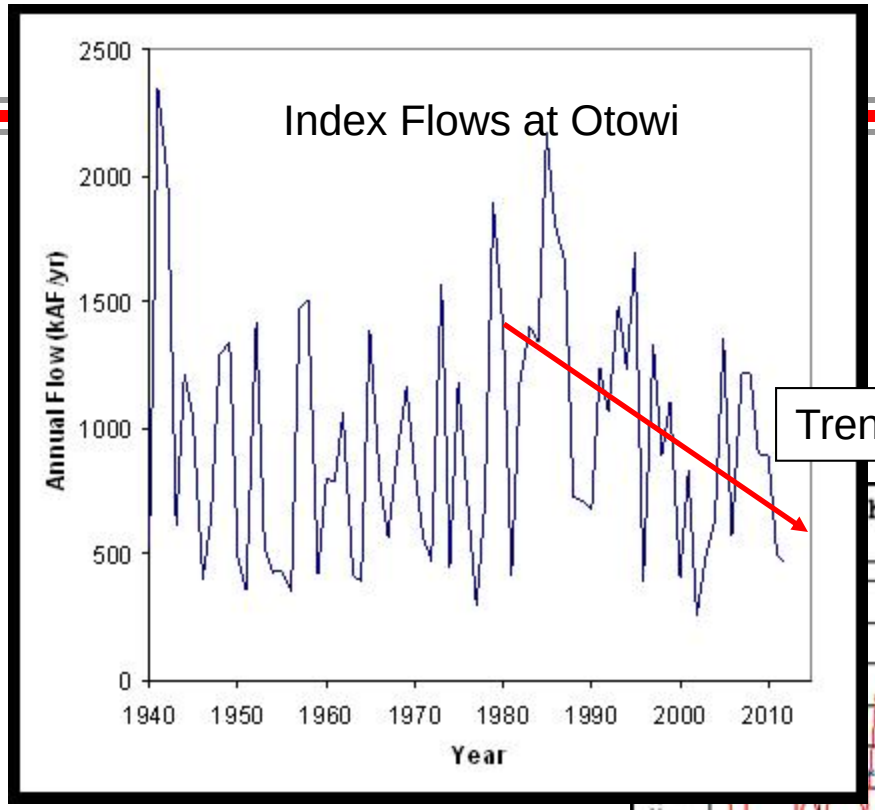




The Problem With Averaging - 1

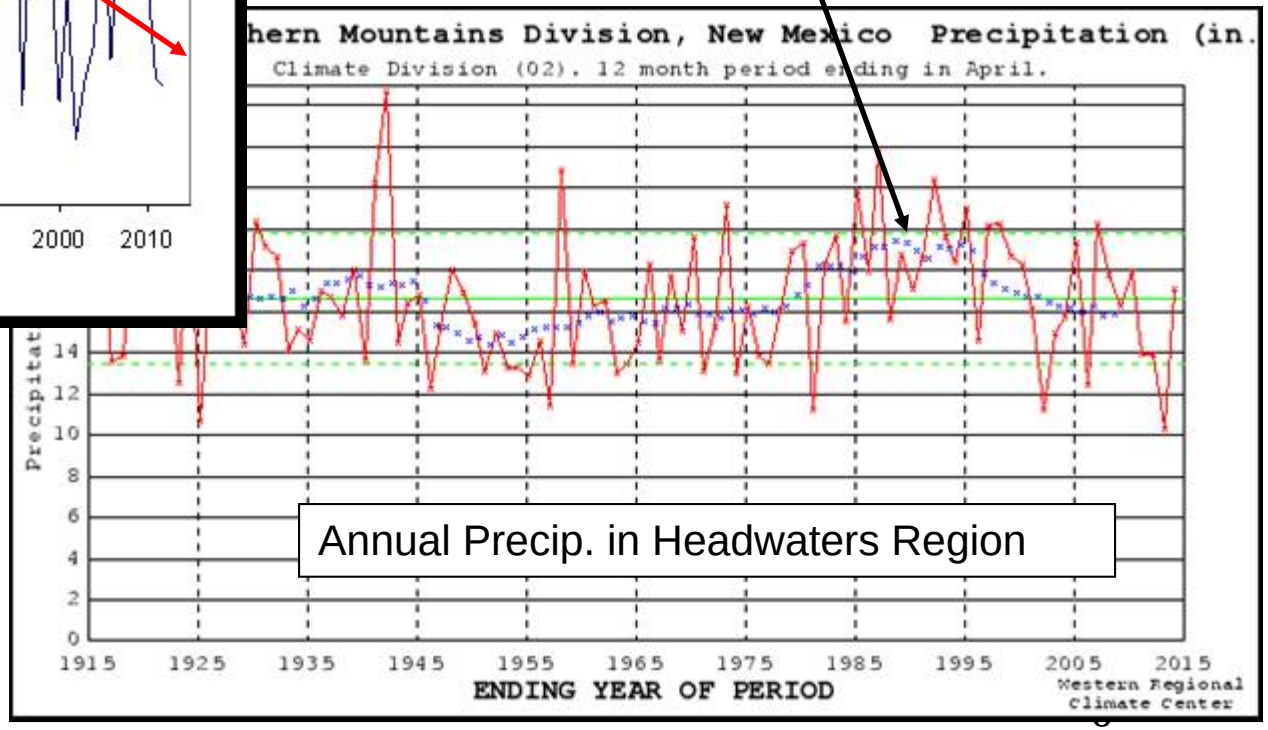
- There is no such thing as an “average year” hence obvious strategy is to average over period of years
- Previous budgets were based on averaging over long period of record. MRGWA – 25 yrs, SSPA – 50 yrs
- Problem with this approach:
  - How many years represent an appropriate average?
  - Difficult to identify long term trends from long term average
  - Difficult to capture changes in use or management such as SJC diversion, new reservoir (i.e. Cochiti) new management strategies (i.e. conservation)
  - Different response times for surface water & ground water
    - Ground water pumping may not affect surface water for decades

The Problem With Averaging - 2



Trend?

5-yr rolling average



Annual Precip. in Headwaters Region

The Problem With Averaging – 3

(Highly stochastic system)

Location	Period of Record[1]	Average Annual Flow (kAF/yr)	Q_{10}[2] (kAF/yr)	Q_{10}/Q_{avg}
Rio Grande near Cerro, NM	1949-2011	325.4	106	0.33
Rio Chama near Chamita, NM	1971-2011	413.2	214	0.52
Rio Grande at Otowi Bridge, NM[3]	1940-2012	951.0	410.8	0.43
Rio Grande at Albuquerque, NM	1974-2011	944.9	436.5	0.46
Rio Grande below Elephant Butte Dam, NM	1917-2011	718.5	422	0.59

[1]Period of record used in this analysis.

[2]Q_{10} is annual low flow that has a 10% chance of occurrence.

[3]Flows at Otowi Bridge are the Rio Grande Compact Index Flows (i.e. doesn't include SJC water)

Tributary	Drainage Area (mi^2)	$Q_{average}$ (kAF/yr)	Q_{10} (kAF/yr)[1]	Period of Record
Conejos River, CO	821	66.7	48	1953-2011[2]
Costillo Creek, CO	200	11.2	0.4	1966-2011
Red River, NM	185	56.7	33.7	1979-2011
Embudo Cr, NM	305	59.5	19.6	1924-2011
Rio Chama, NM	3,159	413.2	214	1971-2011
Galisteo Creek, NM	670	7.4	2	1942-1970
Jemez River, NM	1,038	43.1	13.9	1944-2011
SWRP - Albuq., NM[3]		59.6		2002-2011
Rio Puerco, NM	6,057	28.9	8.5	1941-2011
Rio Salado, NM[1]	1,394	10	0.9	1948-1984

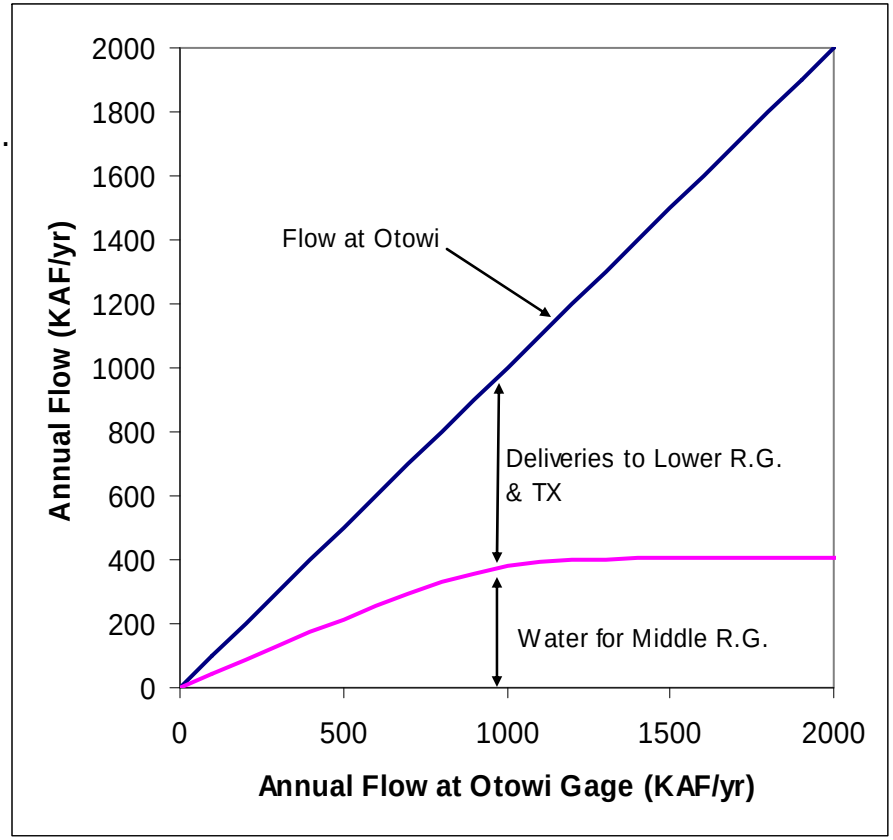
[1]Q_{10} is annual low flow that has a 10% chance of occurrence.

[2]Data from CO Dept. of Water Resources CONPLACO gage

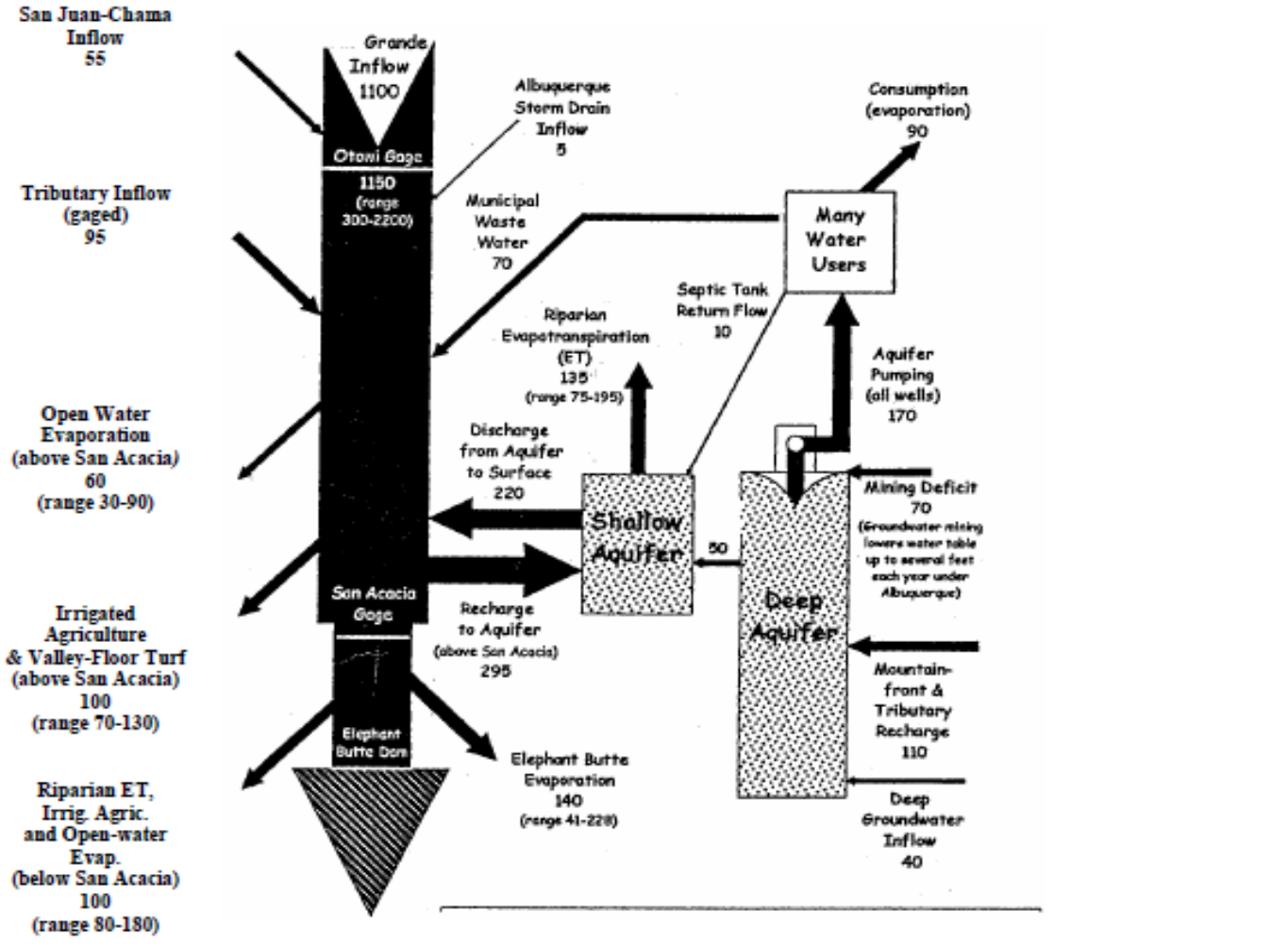
[3]Southside Water Reclamation Plant, Albuquerque, NM

Rio Grande Compact
(1938)

- Establishes water allocations among CO, NM, TX
- Deliveries to Southern NM & TX depend on native flows at Otowi Gage (index flows)
  - Difference between Q_{Otowi} and $Q_{El.\ Butte}$ is water available to Middle Rio Grande

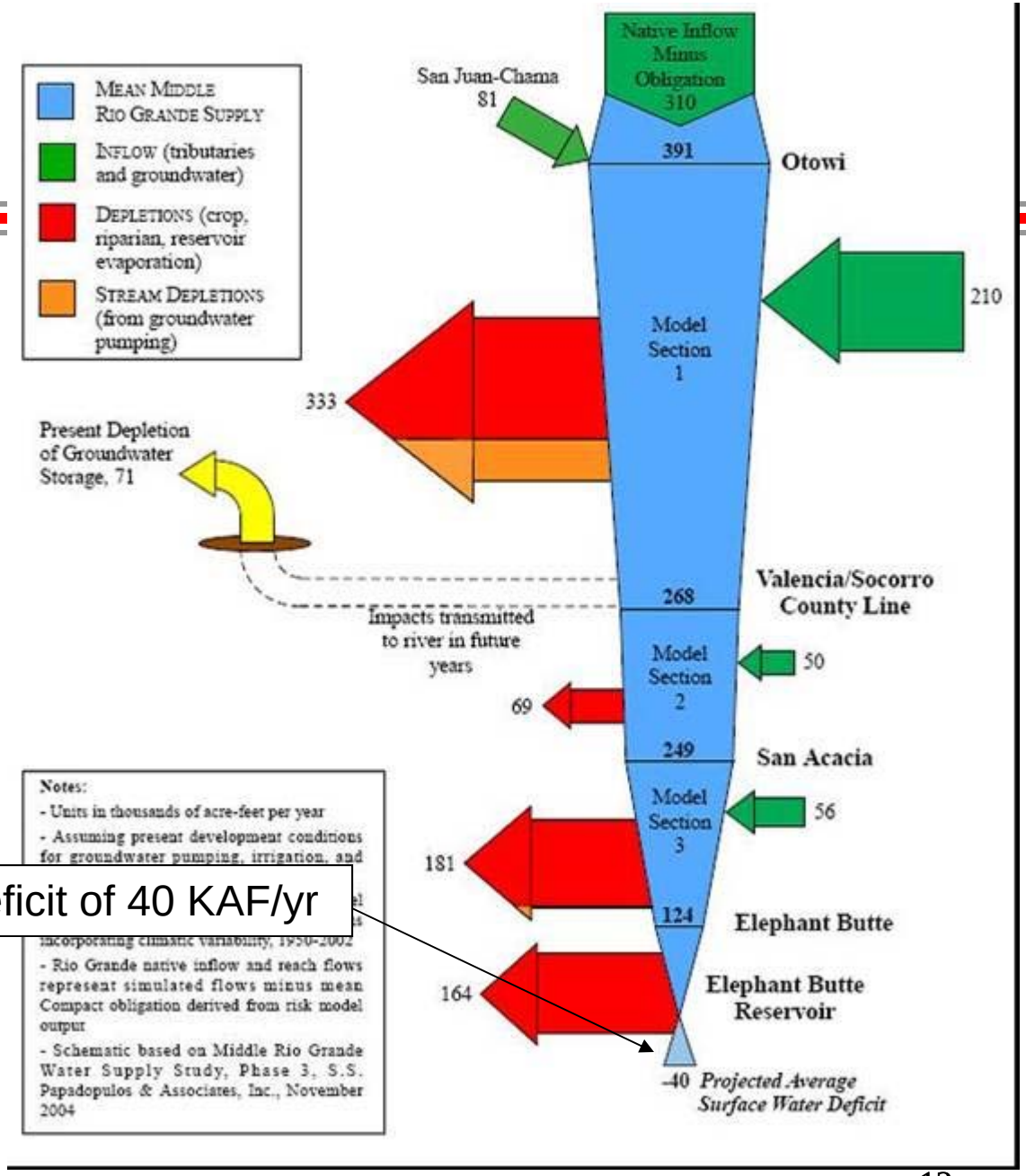


MRGWA Water Budget – Wiring Diagram



SSPA Water Budget by Proportional Flows

- Budget for avg. conditions in 2000



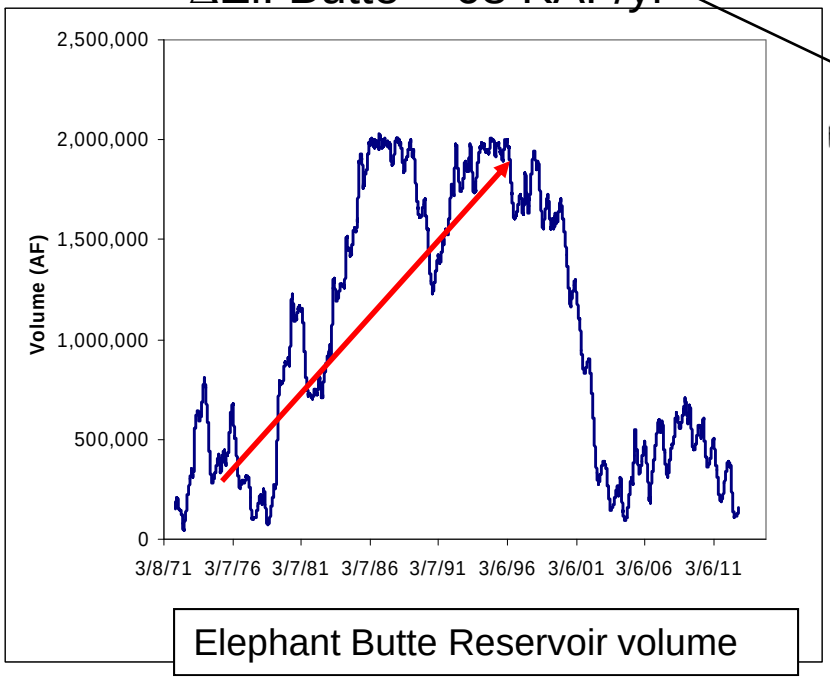
Annual deficit of 40 KAF/yr

MRGWA 2014 Water Budget Update

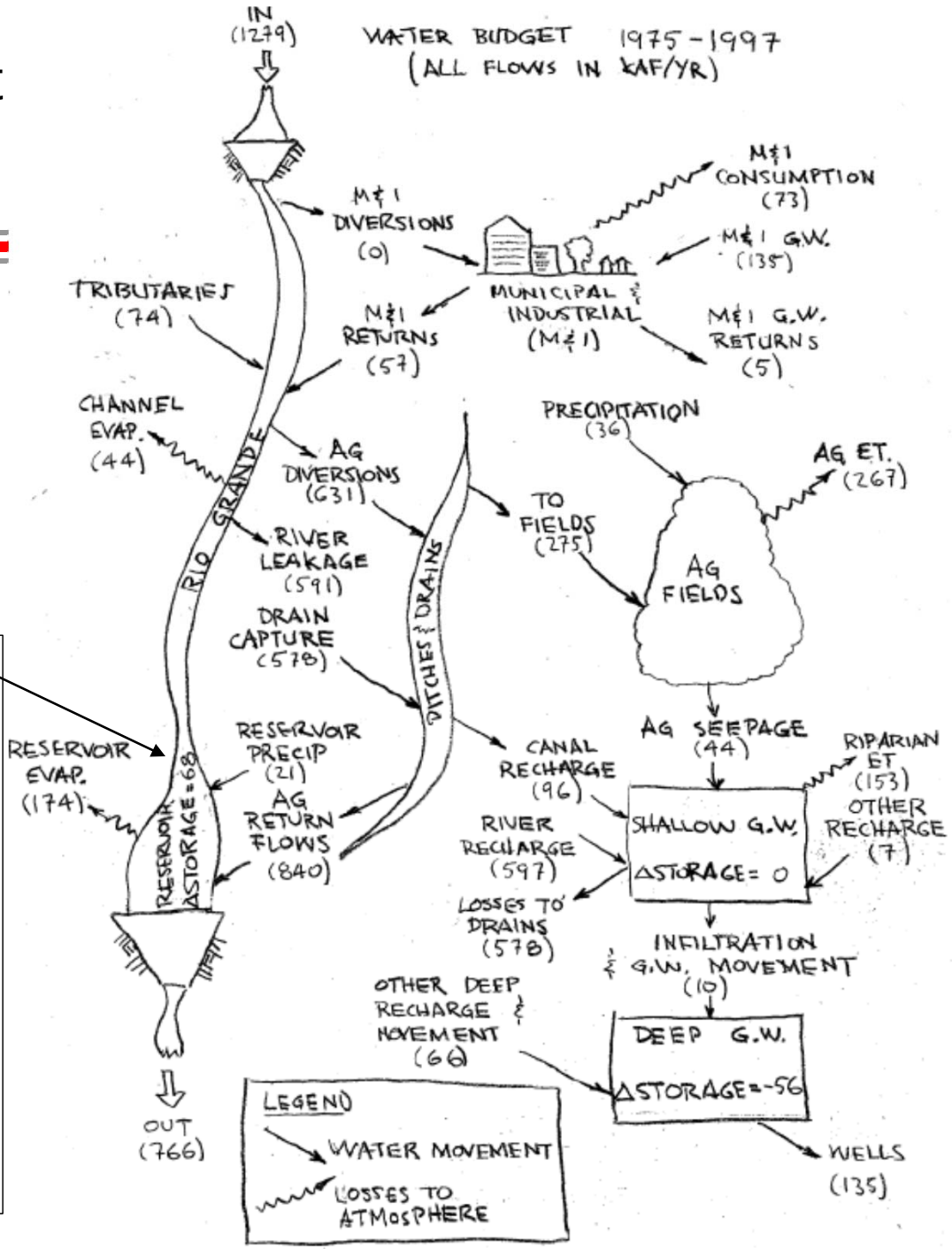
- Used URGSiM (USBOR 2013, Appendix E) – System dynamics model developed by SNL, especially Jesse Roach (now at Tetra Tech)
  - Used in this study for monthly accounting – not forecasting
  - Updated to include hydrologic information through 2012
  - Allows calculation of flows that are difficult/impossible to measure including: ET, ground water recharge, evaporation
- Considered 3 time frames:
  - 1975-1997 – similar to MRGWA (1999) budget
  - 2000-2012 –period that more closely resembles “average” precipitation & flows
  - 2008-2012 – includes changes due to: 1) ABCWUA SJC diversion, 2) record drought

MRGWA 2014 Water Budget (1975-1997 Data)

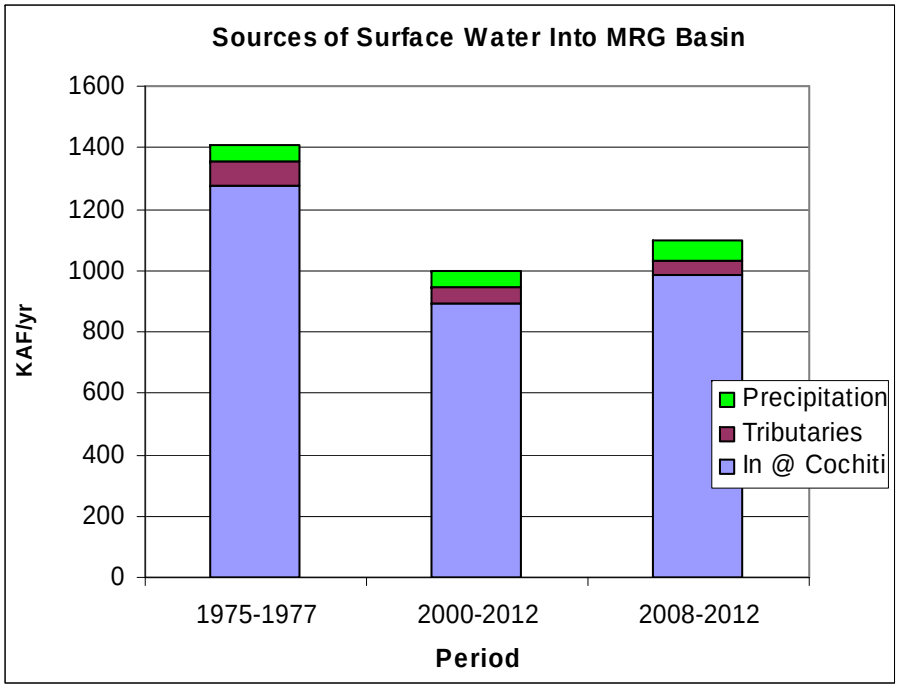
- Comparison to 1999 budget:
- Q_{in} = 1,279 KAF/yr vs 1,100
- Q_{out} = 766 KAF/yr vs 792
- Improved spatial resolution
- Ann. increase of 12 KAF/yr
  - ΔEl. Butte = 68 KAF/yr

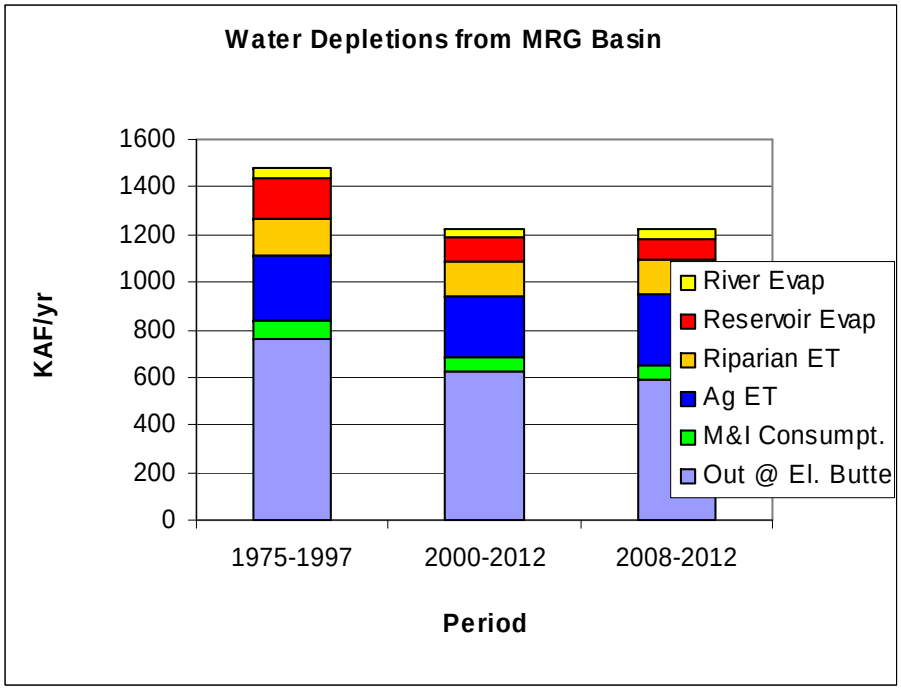


Elephant Butte Reservoir volume



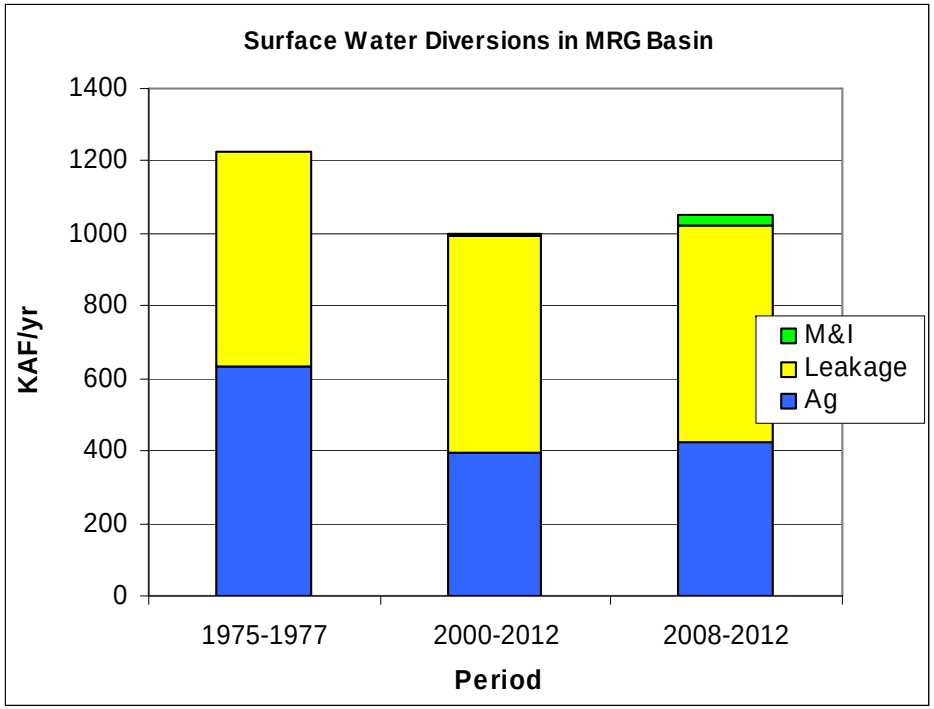
Changes Over 3 Budget Periods - 1

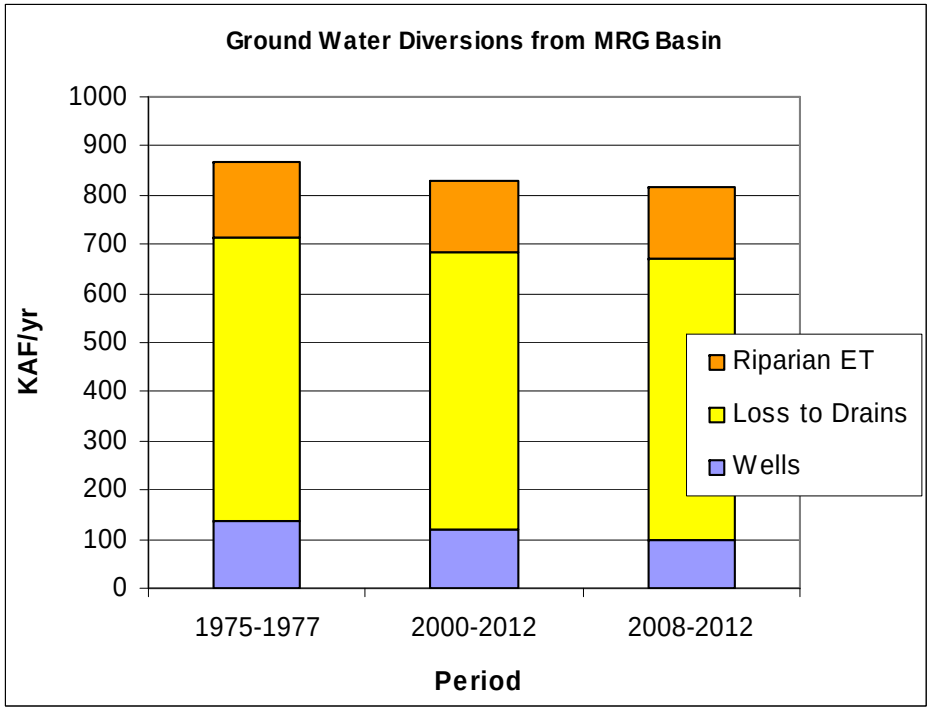




- Importance of river flow as source of supply
- Decreased inflows since 2000 due to drought
- Decreased outflows since 2000 due to reduced Compact deliveries

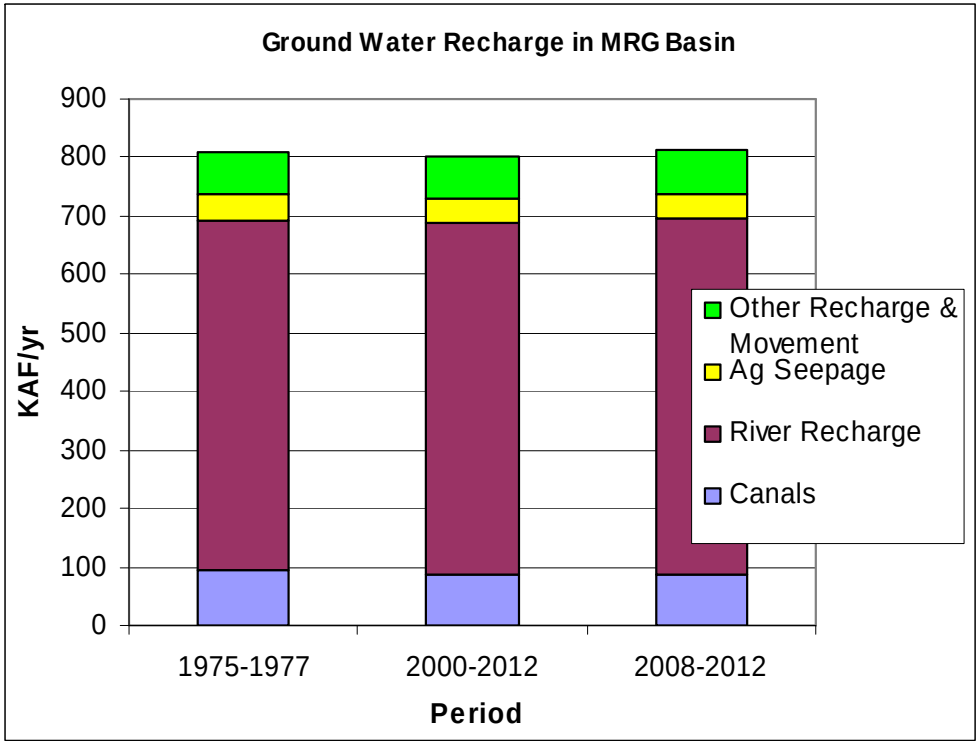
Changes Over 3 Budget Periods - 2





- Surface water diversion by ABCWUA began 12/08
- Decreased ground water pumping by ABCWUA

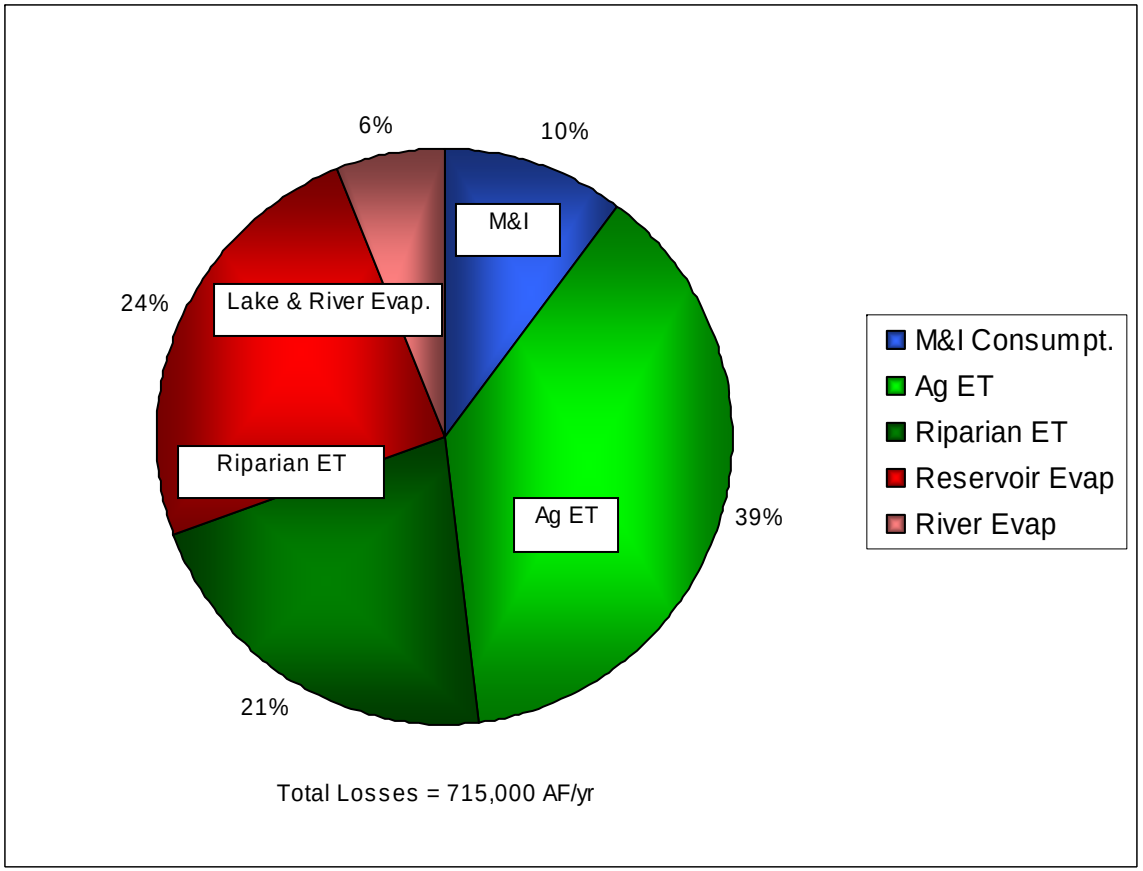
Changes Over 3 Budget Periods - 3



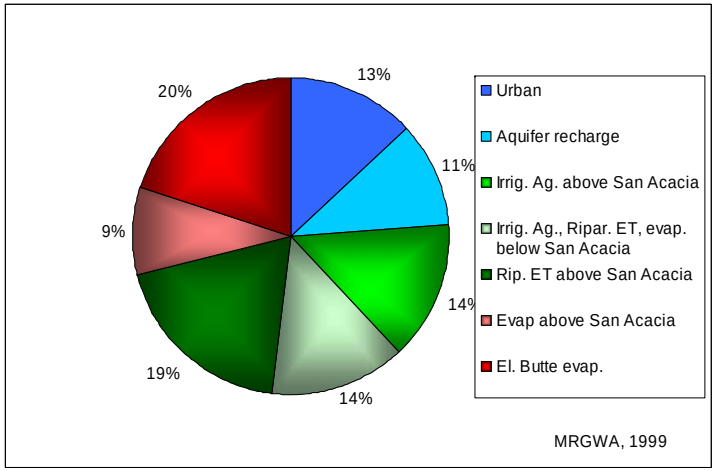
- Little change in ground water recharge

Distribution of Water Losses from MRG Basin 1975-1997

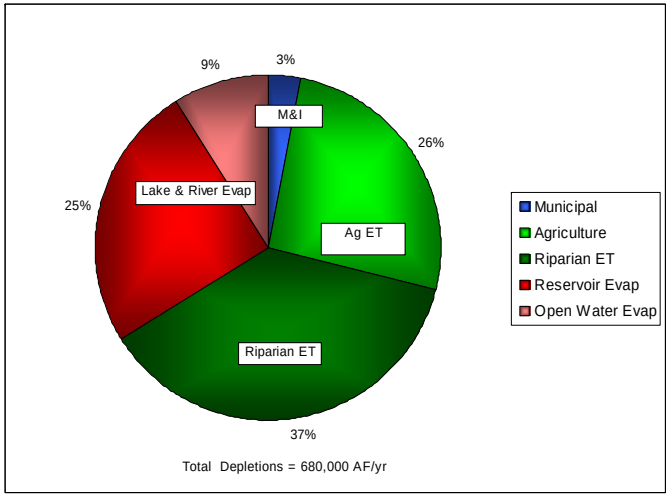
MRGWA Depletions 1975-1997



MRGWA Depletions 1972-1997

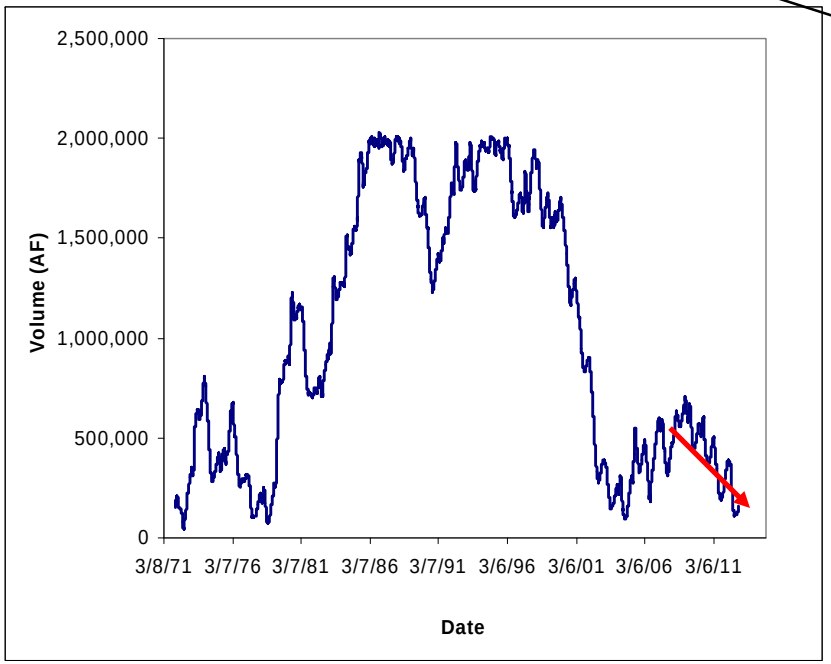


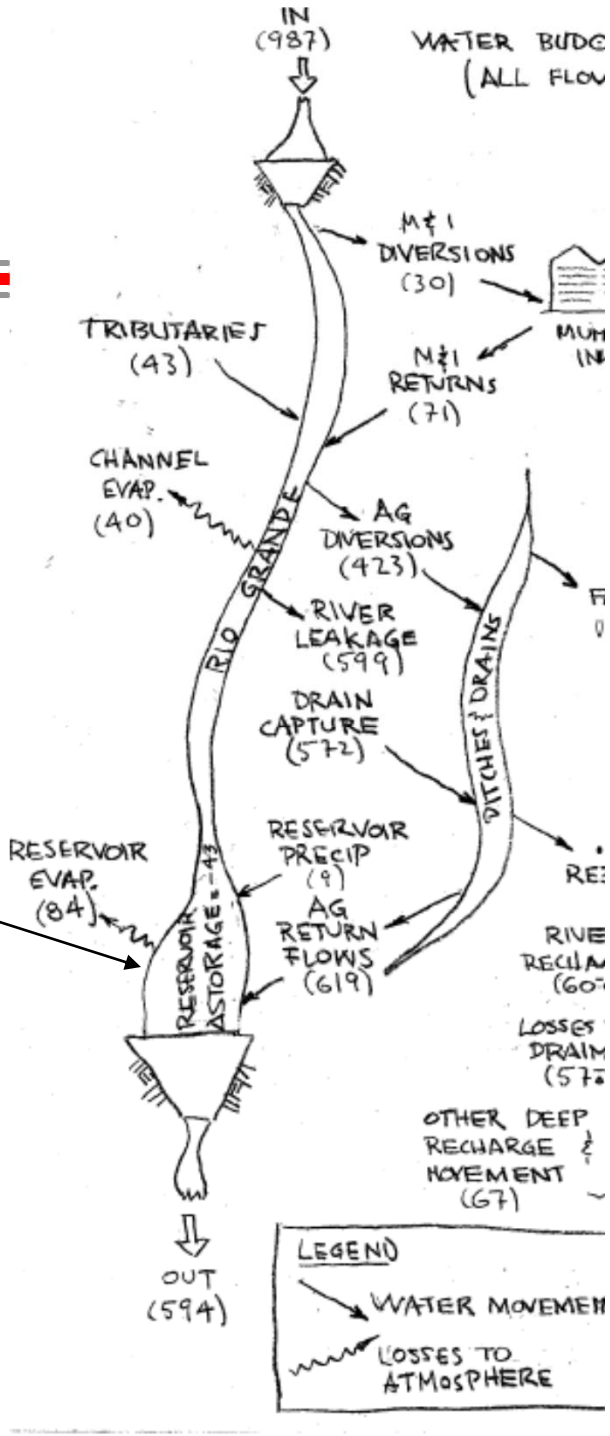
SSPA Distribution for 2000



2008-2012 Details: The River

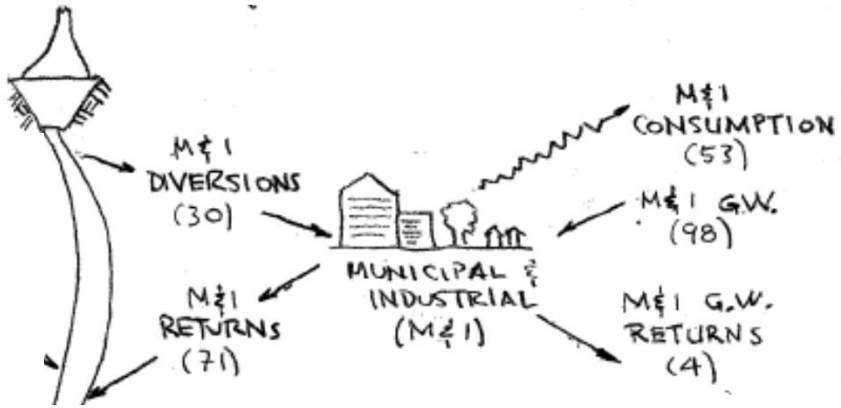
- Diminished inflows & outflows
- Large open water evap. losses (124 KAF/yr)
- Large diversions for ag (423 KAF/yr)
- Large river leakage (599 KAF/yr), mainly to drains
- El. Butte lost ~200 KAF during this period
  - ΔEl. Butte = -48 KAF/yr

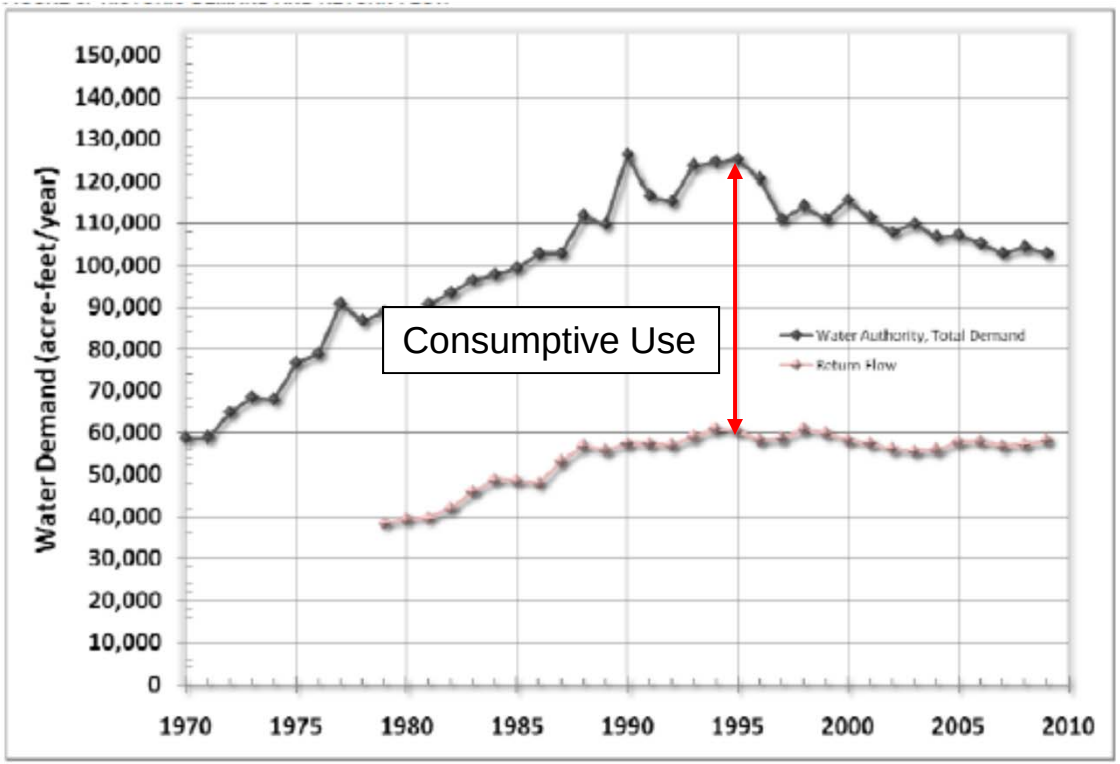




2008-2012 Details: Municipal & Industrial Use

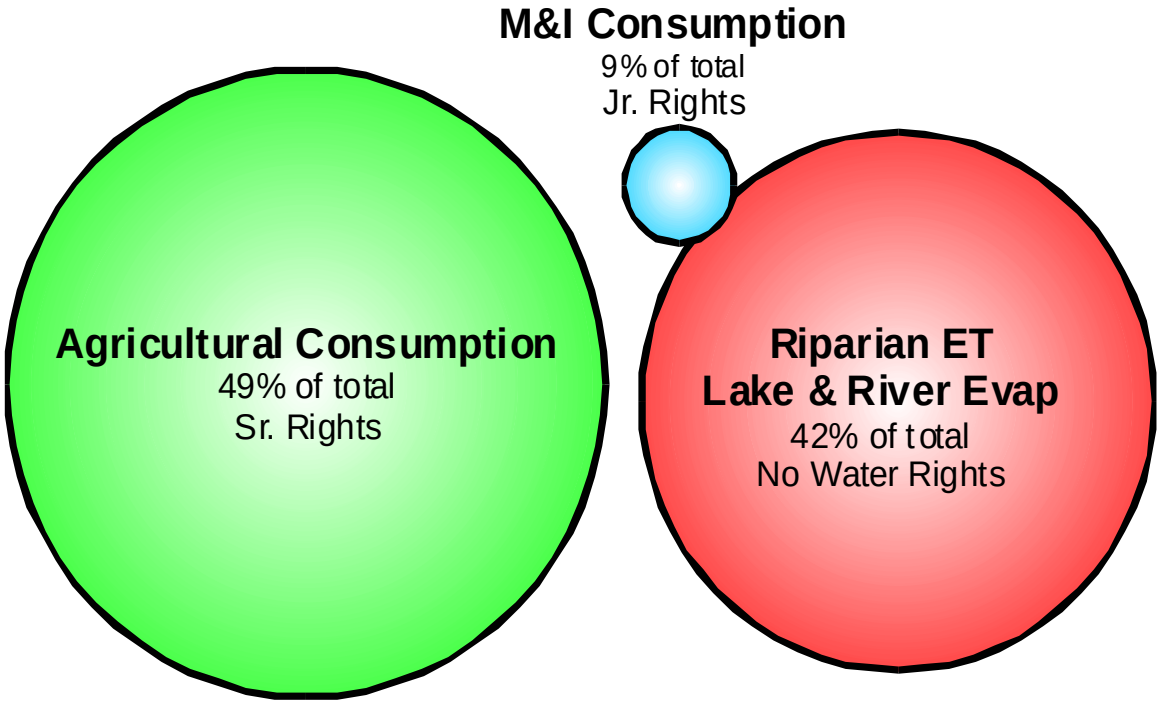
- Urban conservation has been remarkably successful
  - ABCWUA reduced use ~20 KAF/yr





What Does It All Mean?

The MRG Water Problem As A Venn Diagram

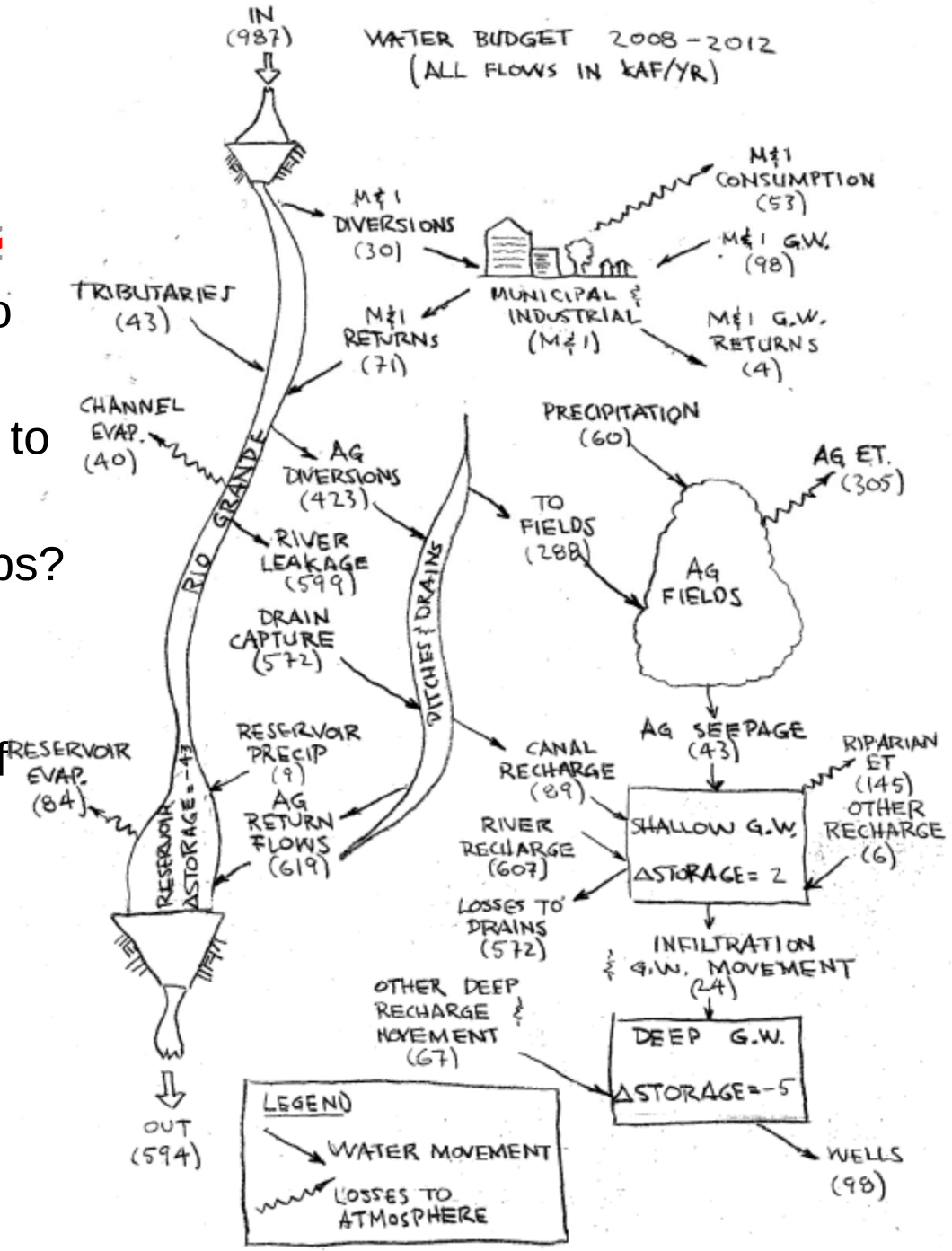


Diameters are proportional to % depletion

The interests of Middle Rio Grande Basin water users largely do not overlap.

The Grand Challenge: 3 Questions

- What changes can be made to bring basin into balance?
  - What knobs can be turned to change consumptive use?
- Who has authority to turn knobs?
- What are the incentives to change water use?
  - What are consequences of not changing?

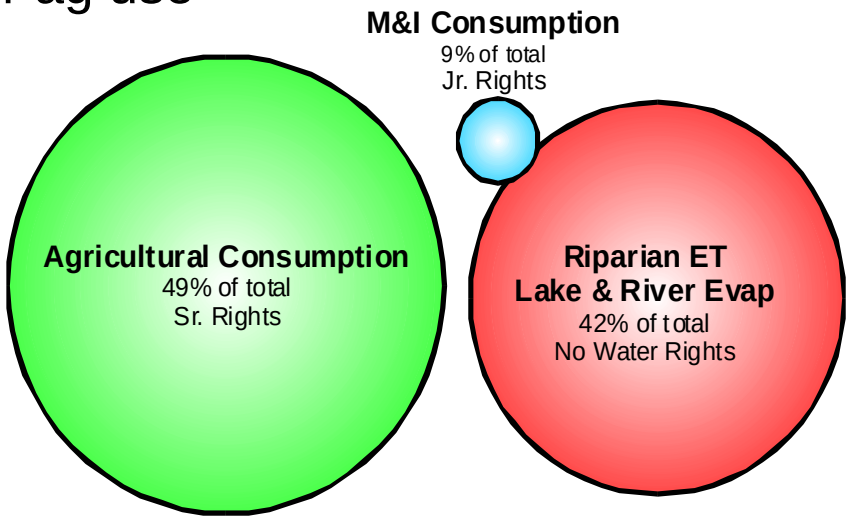


Question 1: What knobs can be turned?

- Objective is to bring basin into balance
  - Must distinguish between changes within basin and changes to entire basin
- Changes within basin don't affect overall balance:
  - Water reuse
  - Stormwater capture
- Changes to basin:
  - Ag & urban conservation
  - Reduced lake/river evaporation & riparian ET
  - New sources – cloud seeding, interbasin transfers, deep brackish water

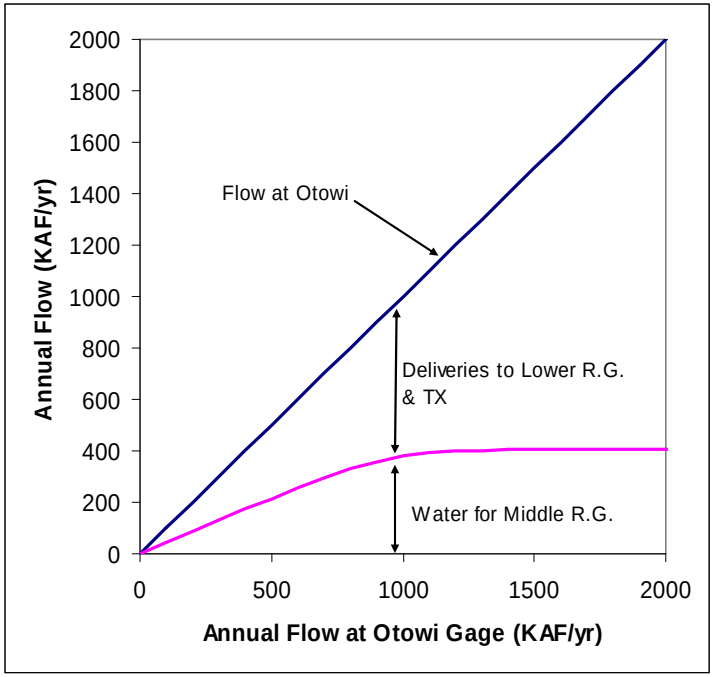
Question 2: Who has authority to turn knobs?

- Feds - Primarily BOR, USACE, USFWS
  - Manage reservoirs & Bosque del Apache
  - Implement Endangered Species Act
- State – Primarily State Engineer, Interstate Stream Commission
  - Administer water rights – Active Water Resources Mgt.
  - Compliance with Rio Grande Compact
- Local agencies – MRGCD, ABCWUA, Rio Rancho, etc.
  - Utilities have considerable influence over urban use
  - MRGCD has limited influence over ag use
- Owners of water rights
  - Pueblos
  - Ag owners
  - Domestic well owners



Question 3: What are incentives to bring basin into balance?

- Water supply for future generations
  - "What have future generations ever done for me?"
- Why not keep pumping ground water?
  - Cost & quality
  - Subsidence
- $$$$$$
  - Buy/sell water rights – Water Markets
  - Settle with Pueblos
- Compliance with Rio Grande Compact
  - Why not let the courts take over?



Concluding Thoughts

- Water budget hasn't changed much in past 15 years within resolution of the calculations
  - Biggest uncertainties are in ET losses
  - Remarkable success for urban conservation
  - Basin is still out of balance ~40-50 KAF/yr
- Effects of drought principally manifested as reduced river flow
  - Consumptive uses have changed little
- Wiring diagram shows complexity of system
- Water budget exercise raises 3 questions:
  - How can we bring basin into balance?
  - Who can make changes?
  - What are incentives for balancing basin?

MRGWA Water Budget Task Force Members

- Bruce Thomson (Chair) – UNM
- Jesse Roach – SNL/TetraTech
- Dagmar Llewellyn – USBOR
- Dave Jordan – Intera
- Nabil Shafike – NM ISC
- Elaine Hebard – MRGWA

- With input from John Fleck (Abq. Journal), Howard Passell (SNL), John Stomp (ABCWUA)