

# **Senate Bill 06-193 Underground Water Storage Study**

**South Platte Task Force Presentation  
July 27, 2007**

**Andy Moore, P.E., CWCB  
Dr. Gordon McCurry, CDM**

# Presentation Outline

- **Study purpose and background**
- **Study regions and subregions**
- **Evaluation criteria**
- **Technical findings**
- **Conclusions and recommendations**

# SB06-193 Study - Background

- **CWCB to conduct study of potential underground storage areas in South Platte and Arkansas River Basins**
- **Evaluation based on following considerations:**
  - hydrogeologic characteristics
  - environmental factors
  - implementation issues
- **CGS Statewide Assessment of Artificial Recharge (Topper et al., 2004) used as starting point**
- **Legislation passed in spring 2006; final report to General Assembly by March 1, 2007**

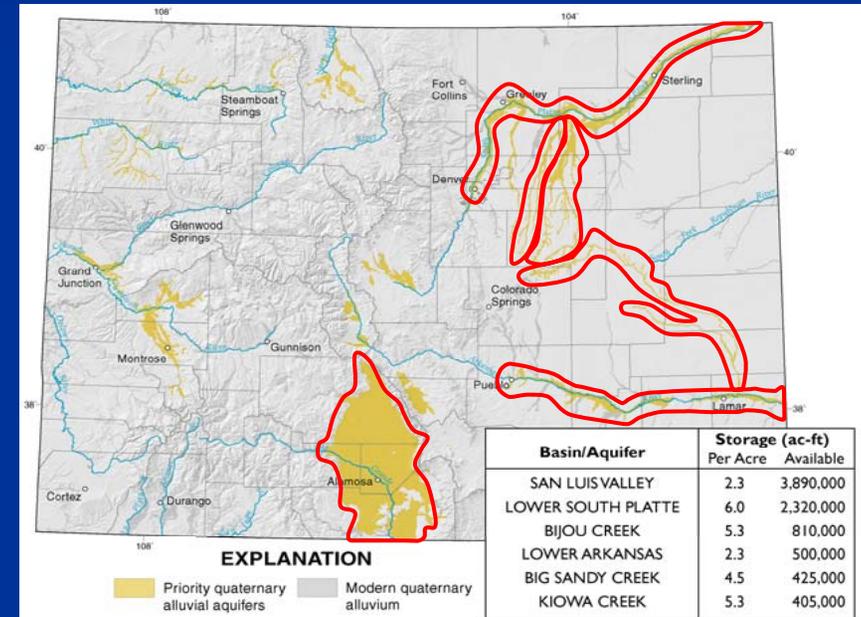
# Sources of Information

- **South Platte Decision Support System**
- **Division of Water Resources**
- **CGS studies (GW Atlas & Statewide Artificial Recharge Assessment)**
- **IBCC Basin Roundtables (South Platte, Metro, and Arkansas groundwater subcommittees)**
- **USGS**
- **Colorado State University**
- **Experts from both basins**

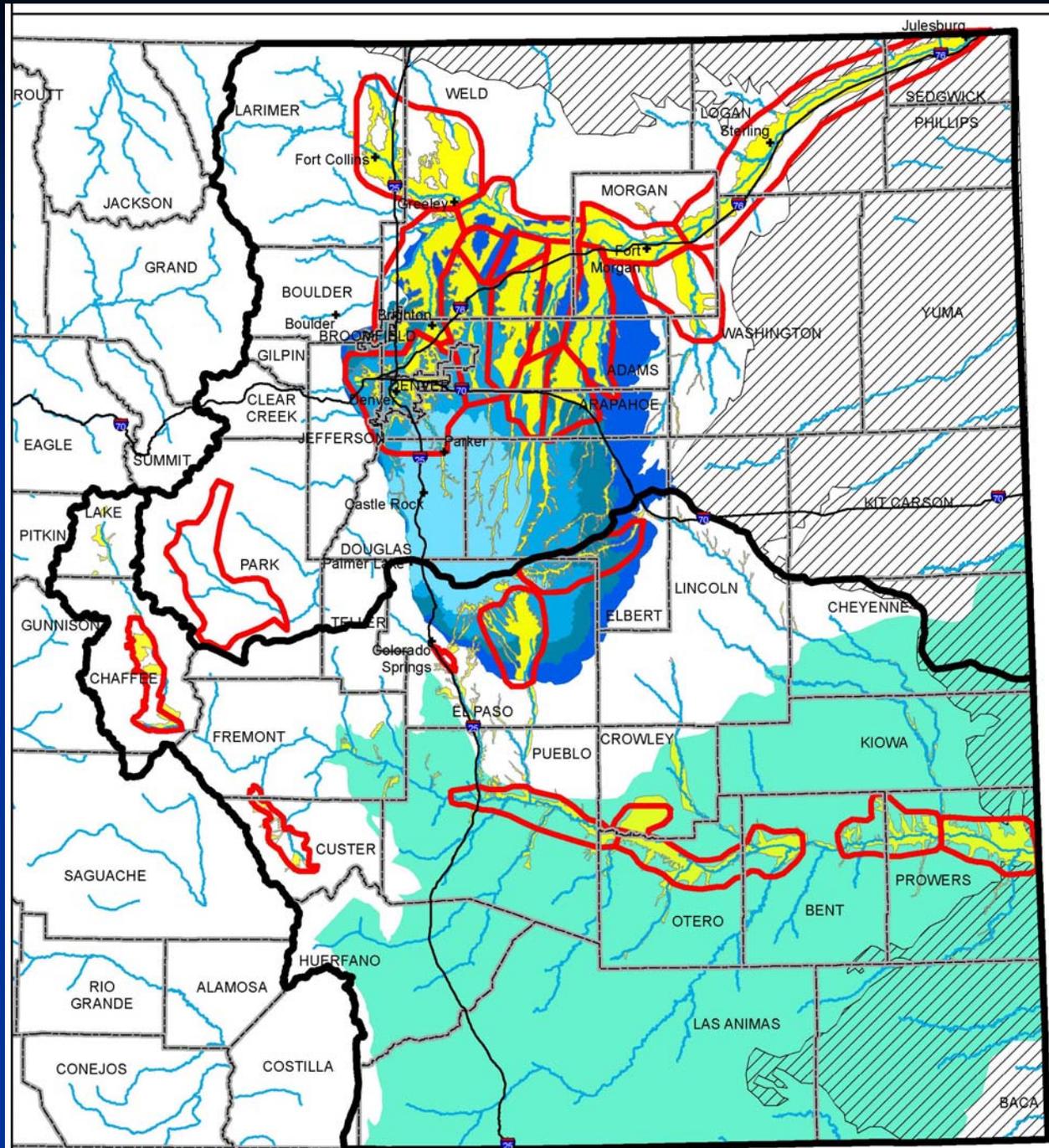


# Scale of SB06-193 Study

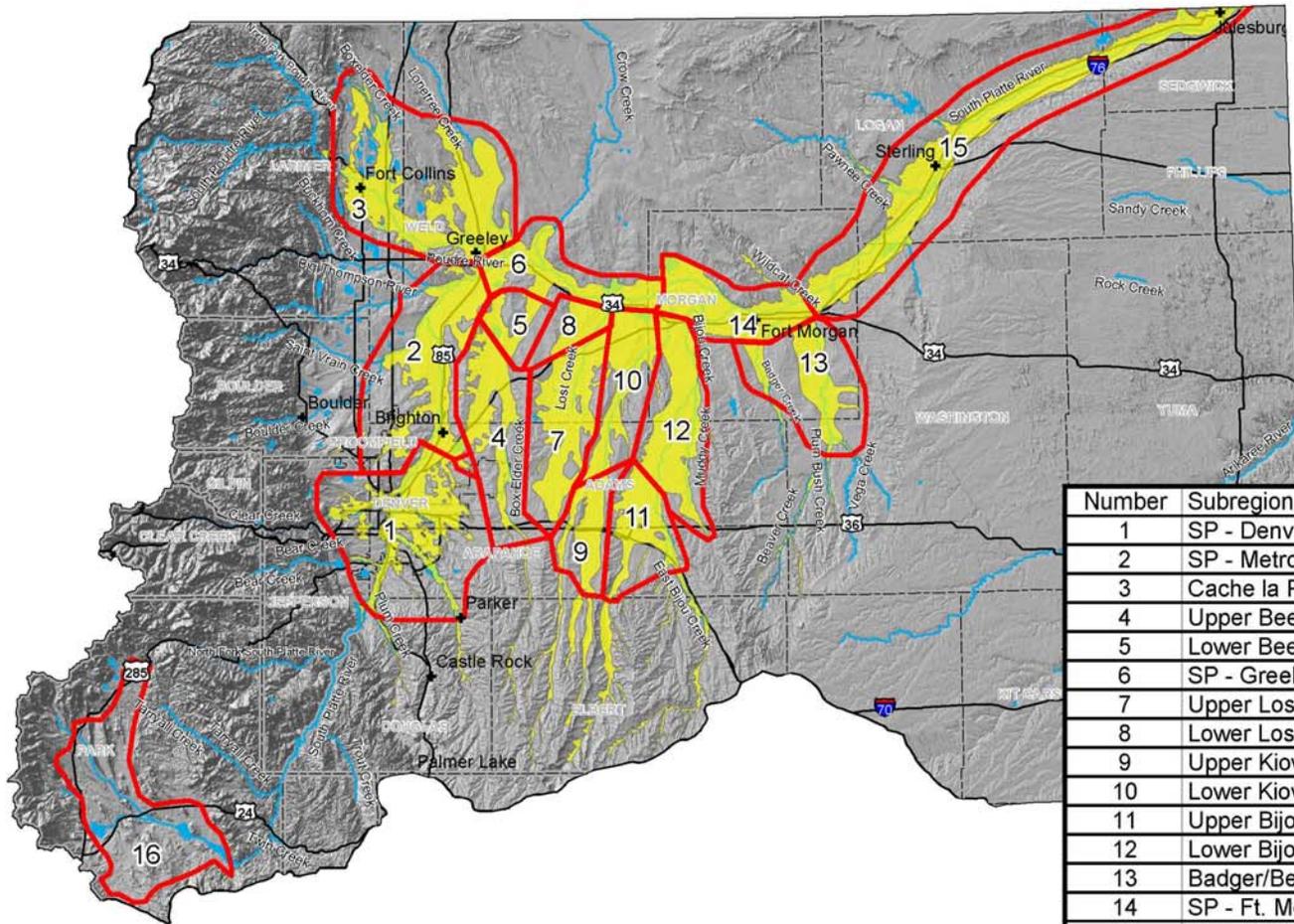
- CGS 2004 study was regional (> 80 - 100 sq. mi.)
- SB 06-193 study is subregional (10 - 50 sq. mi. for alluvial)
- Four aquifer regions examined:
  - South Platte alluvial
  - Arkansas alluvial
  - Denver Basin bedrock
  - Dakota/Ogallala bedrock
- Study regions are divided into 44 subregions for evaluation purposes



# Overview of Study Regions and Subregions

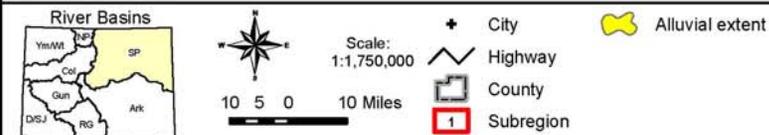


# SB06-193 Underground Water Storage Study South Platte River Basin Alluvial Aquifer Subregions



Number	Subregion
1	SP - Denver Metro
2	SP - Metro to Greeley
3	Cache la Poudre
4	Upper Beebe/Box Elder
5	Lower Beebe/Box Elder
6	SP - Greeley to Ft. Morgan
7	Upper Lost Creek
8	Lower Lost Creek
9	Upper Kiowa Creek
10	Lower Kiowa Creek
11	Upper Bijou Creek
12	Lower Bijou Creek
13	Badger/Beaver Creek
14	SP - Ft. Morgan
15	SP - Balzac to State Line
16	SP - South Park

Source: CDM 2006e



**Colorado Water  
Conservation Board**



Prepared by: **CDM**

**Figure 4**

# Denver Basin Bedrock Aquifer Subregions

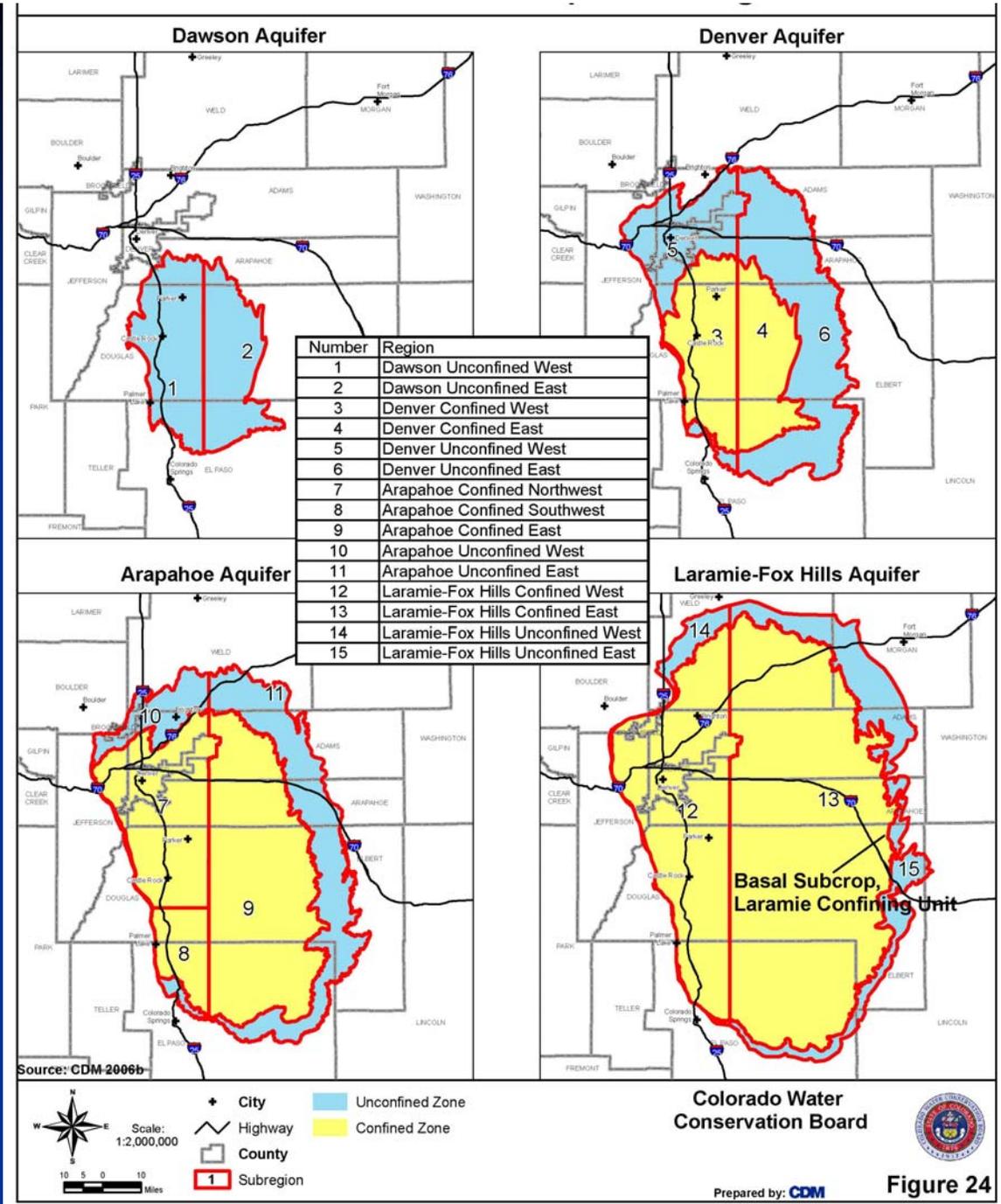


Figure 24

# Evaluation Criteria

## Hydrogeologic considerations

- Available storage capacity
- Hydrogeologic suitability
- Residence time

## Environmental considerations

- Water quality
- Habitat concerns
- Waterlogging and nonbeneficial consumptive use

## Implementation considerations

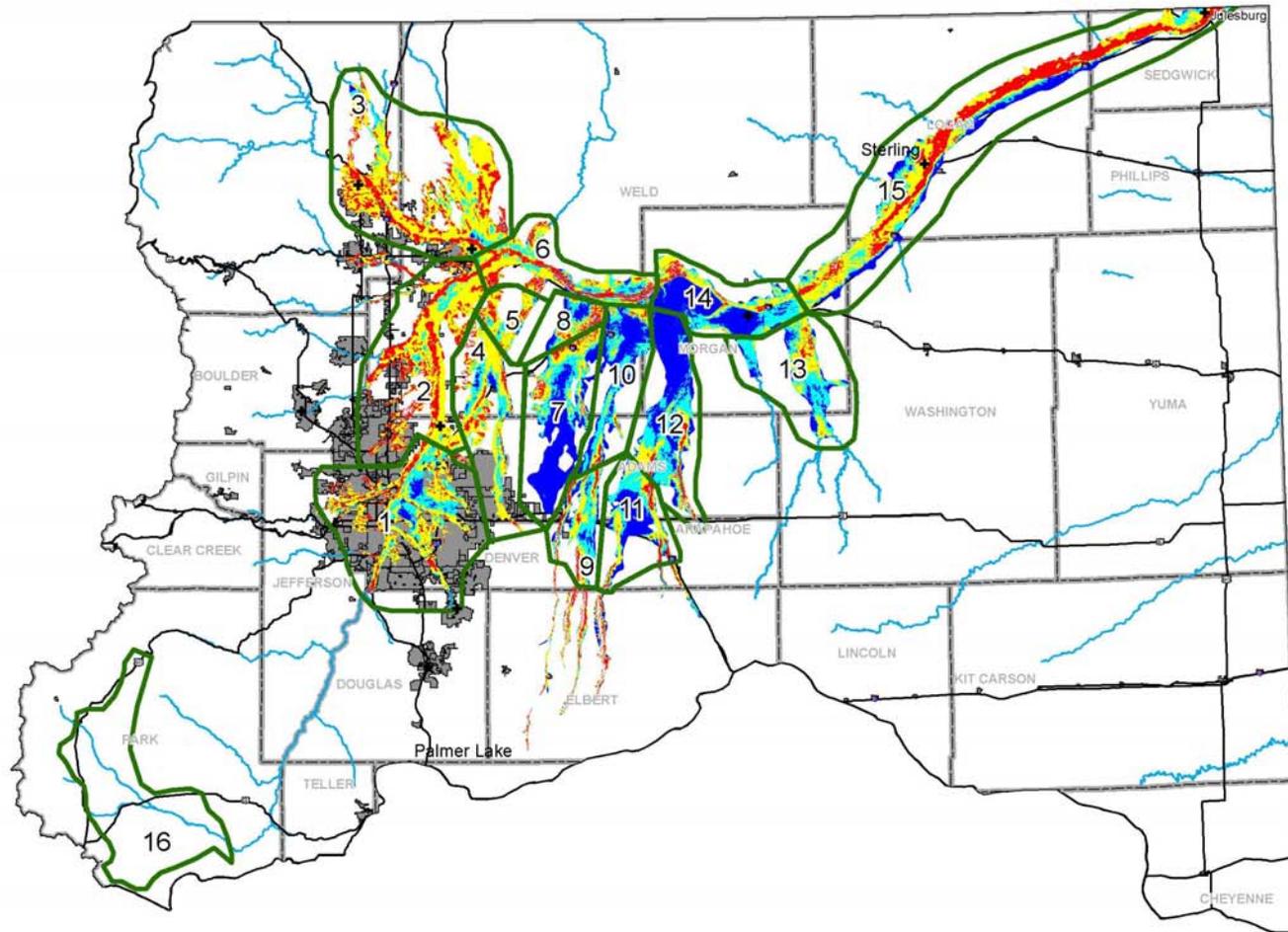
- Land ownership and land use
- Existing infrastructure
- Proximity to areas with demand
- Implementation costs

# Issues Not Considered in Study

- Available water supply and water rights
- Scale of potential projects
- Potential legal issues
- Water treatment requirements
- Local stakeholder interest
- Other site-specific issues



# SB06-193 Underground Water Storage Study South Platte River Basin Depth to Water Table



Source: CDM 2006b



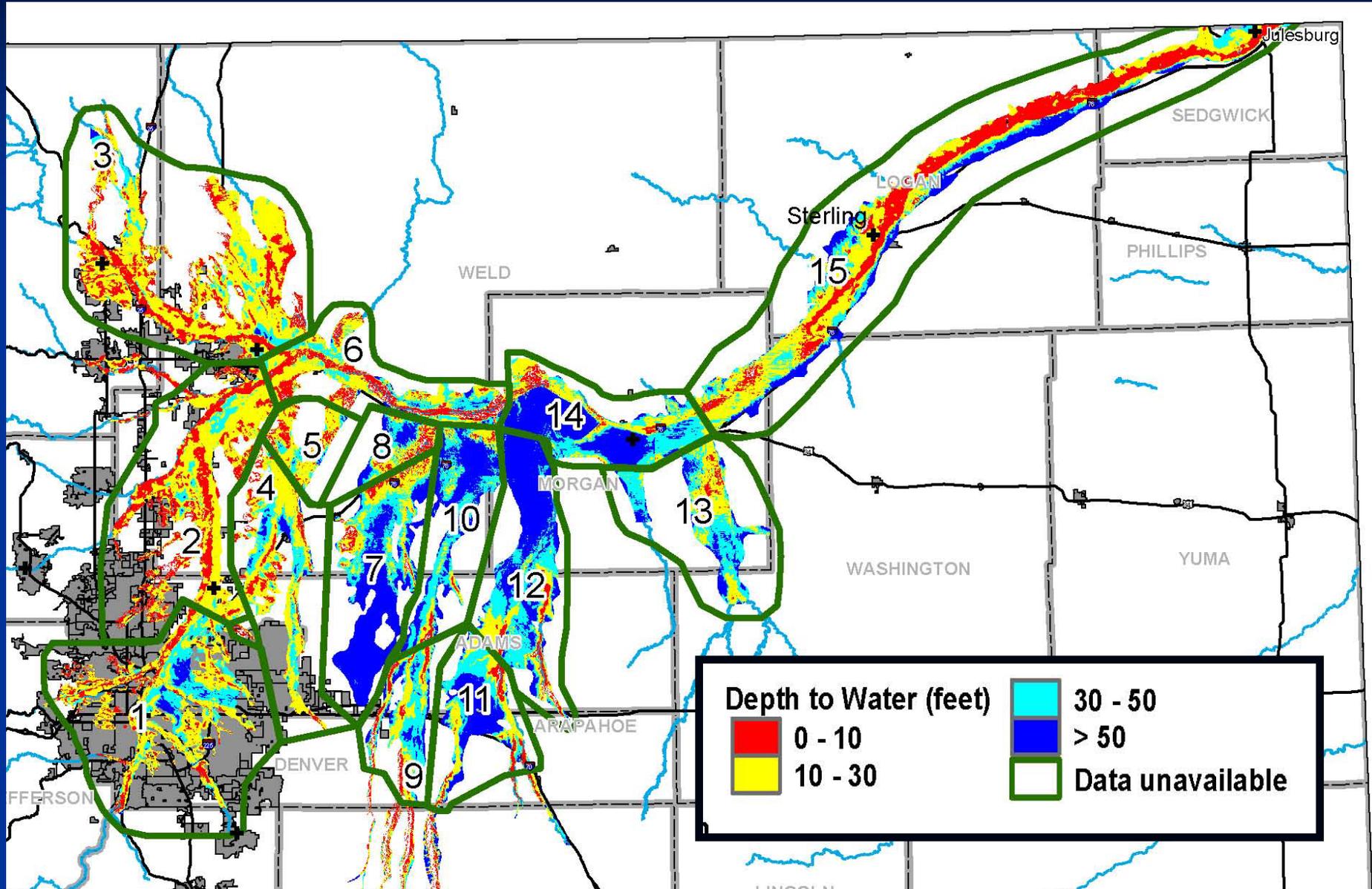
**Colorado Water  
Conservation Board**



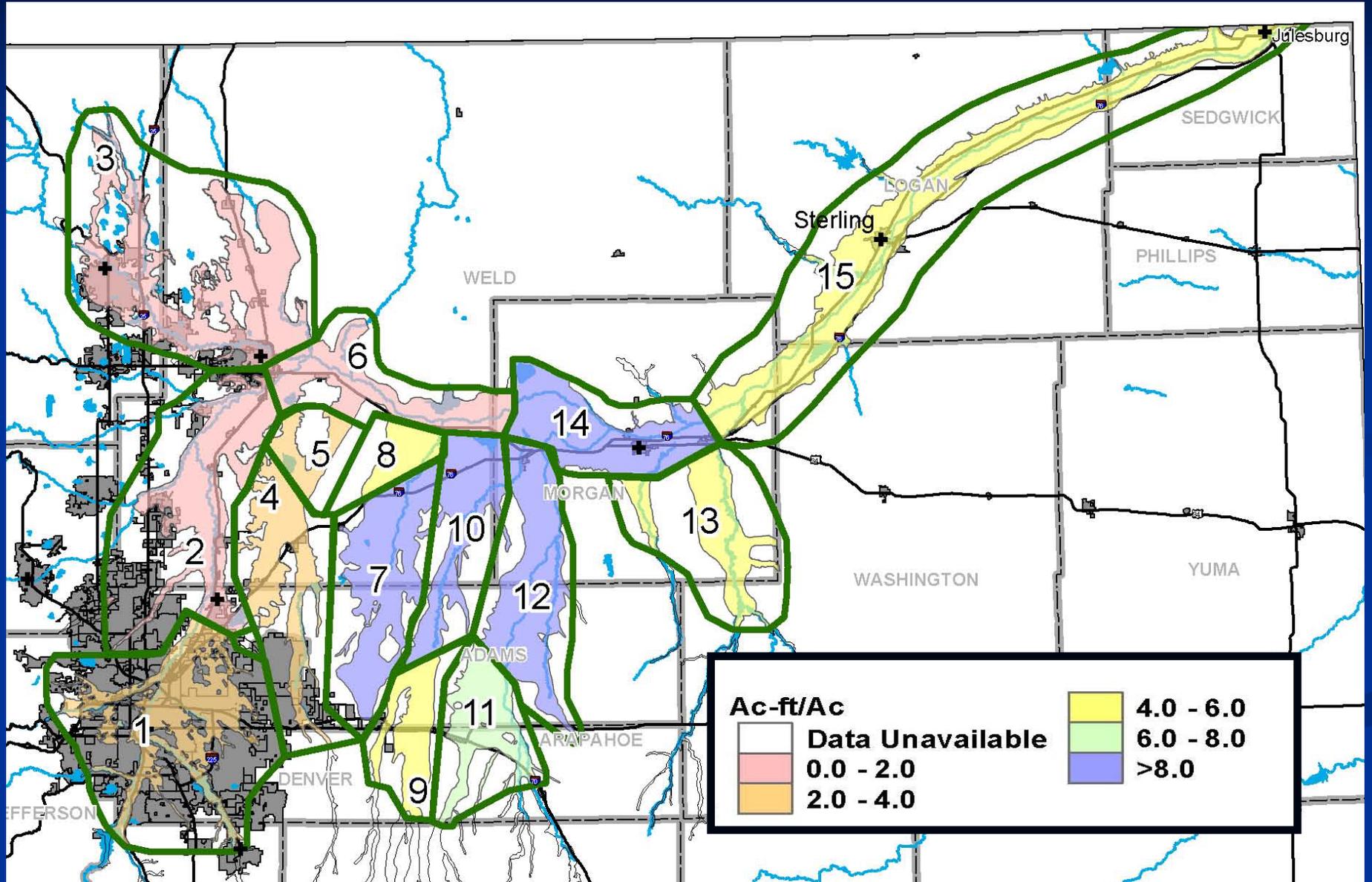
Prepared by: **CDM**

**Figure 5**

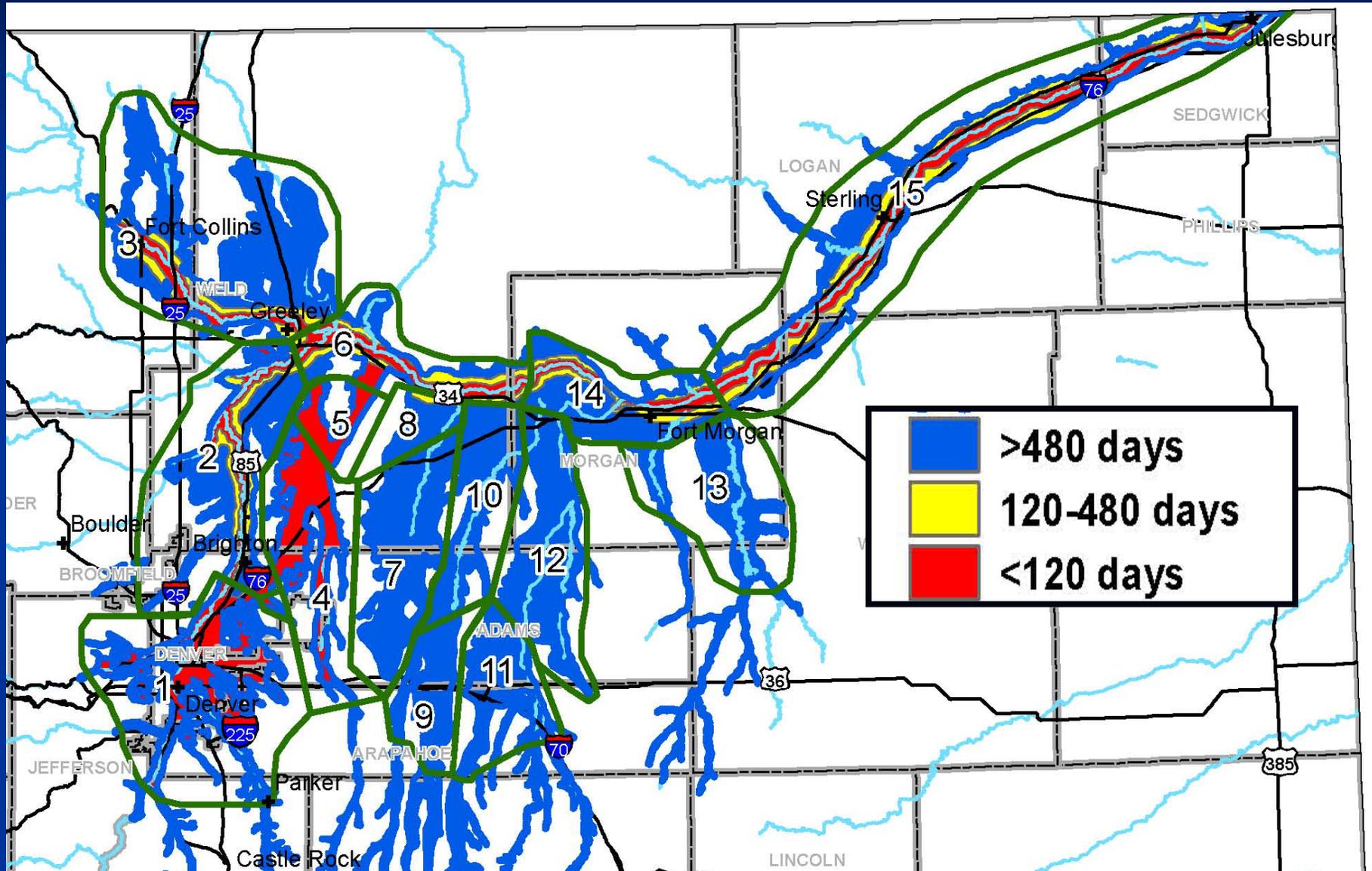
# Depth to Ground Water – South Platte



# Available Aquifer Storage Capacity

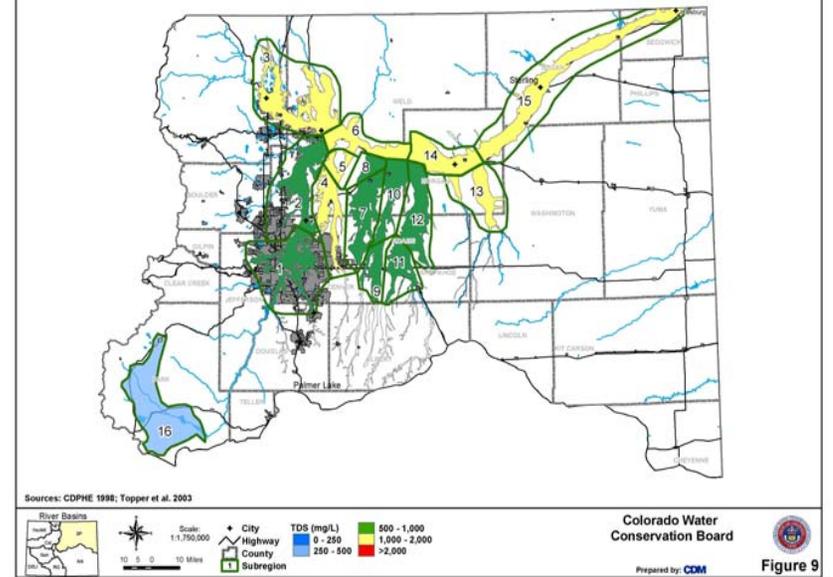


# Aquifer Residence Time – South Platte

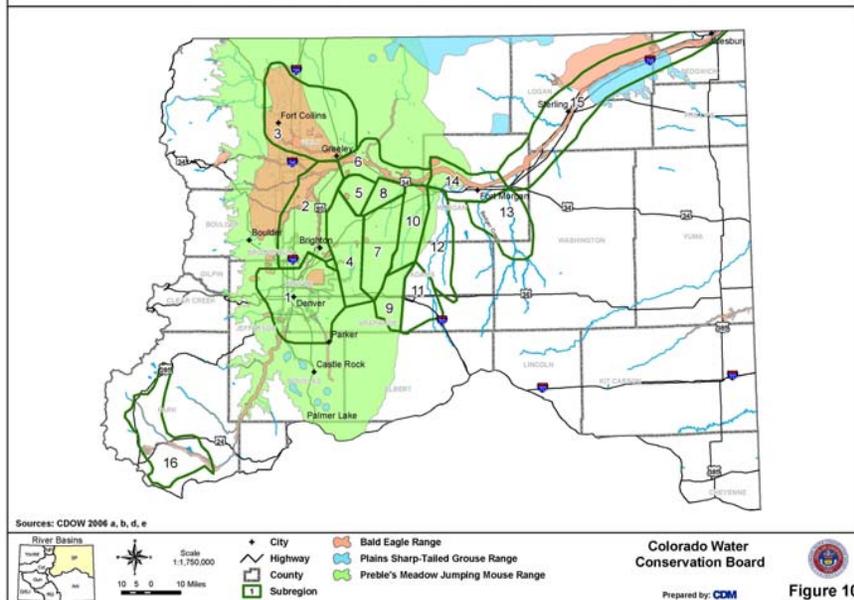


# Aquifer Water Quality

SB06-193 Underground Water Storage Study  
South Platte River Basin Alluvial Aquifer TDS Values

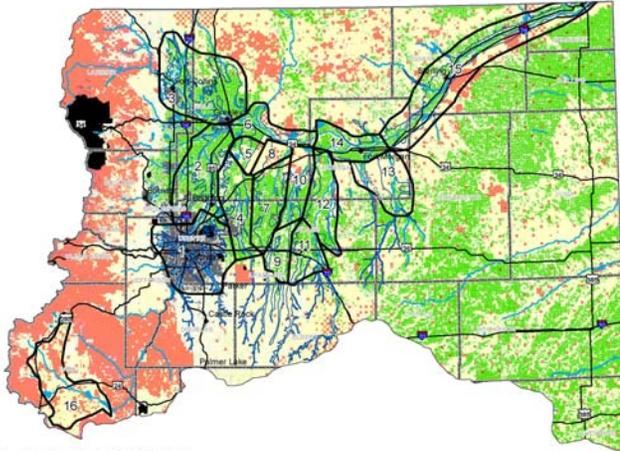


SB06-193 Underground Water Storage Study  
South Platte River Basin Potential Habitat Concerns



# Potential Habitat Concerns

SB06-193 Underground Water Storage Study  
South Platte River Basin Land Use and Ownership



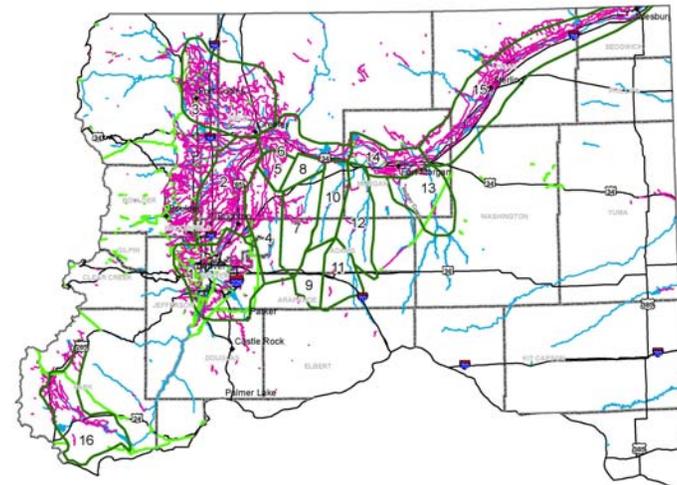
Sources: USGS National Land Cover Dataset 2001; US BLM 2002



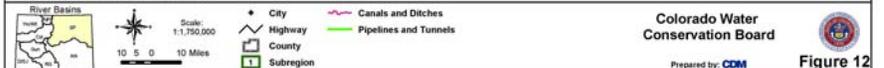
# Land Use and Ownership

# Existing Infrastructure

SB06-193 Underground Water Storage Study  
South Platte River Basin Existing Infrastructure

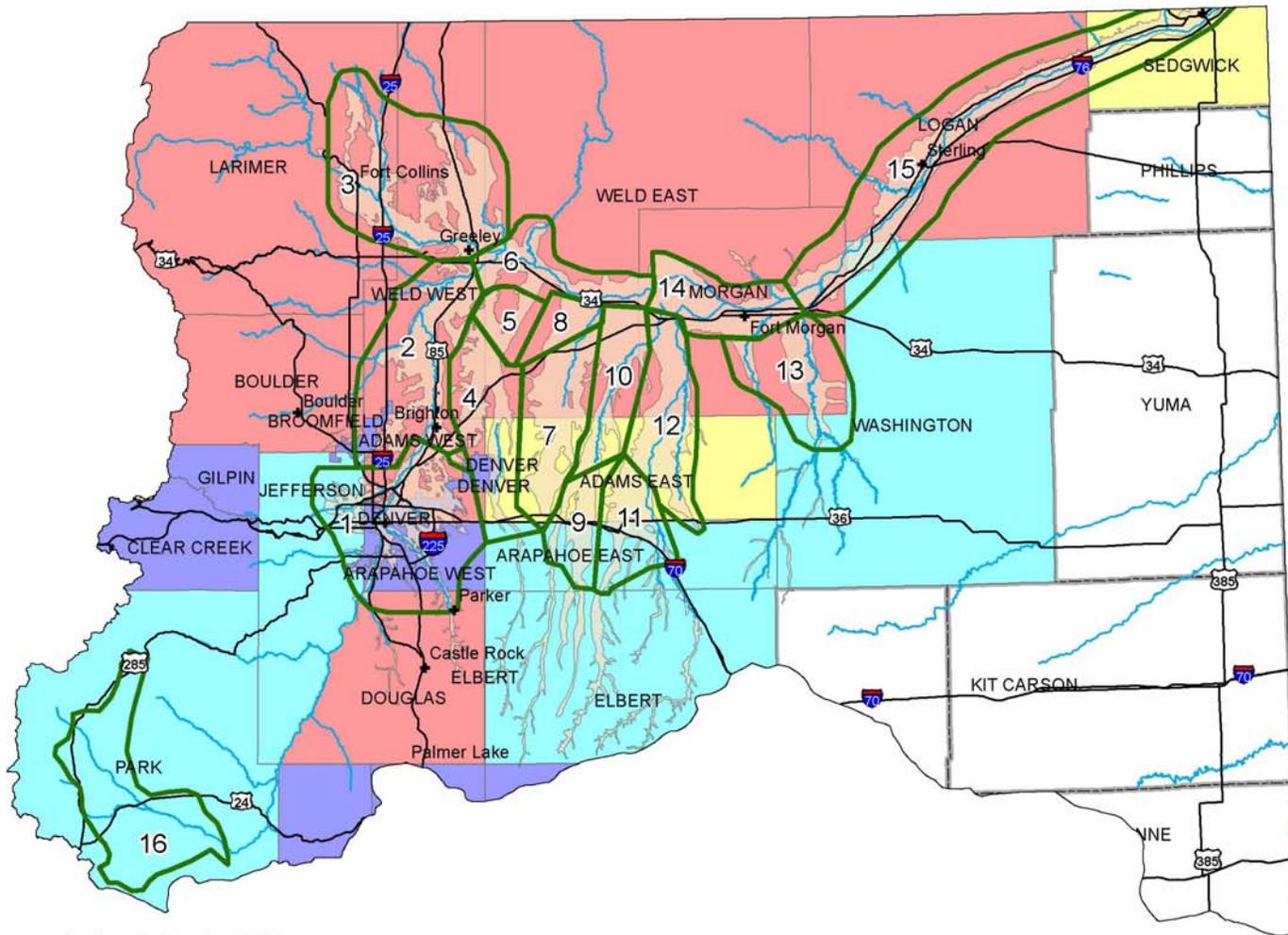


Sources: Colorado DWR; USGS 2006 NHD

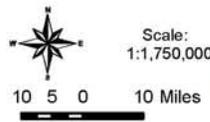


# SB06-193 Underground Water Storage Study

## South Platte River Basin Projected Unmet Demand in 2030



Unmet demands represent both agricultural and M&I uses.  
Sources: CDM 2004; SPDSS 2001



- City
- Highway
- Subregion
- Alluvial extent

- Projected 2030 Unmet Demands by County (ac-ft/yr)
- Data Unavailable
  - 0 - 1,000
  - 1,000 - 5,000
  - 5,000 - 10,000
  - >10,000

**Colorado Water Conservation Board**

Prepared by: **CDM**



**Figure 13**

# Evaluation Criteria & Scoring Measures

Evaluation Criteria	Criteria Description	Scoring Measures									
		High			Medium				Low		
		10	9	8	7	6	5	4	3	2	1
<u>Hydrogeologic considerations</u>											
1. Aquifer storage capacity	Available capacity for recharge	> 2 AF/Ac			0.25 - 2 AF/Ac				< 0.25 AF/Ac		
2. Hydrogeologic suitability	Potential rate of aquifer recharge;	> 250 ft/day			50 - 250 ft/day				< 50 ft/day		
• Unconfined aquifers	- Estimated from aquifer K values	> 900 ft <sup>2</sup> /day			300 – 900 ft <sup>2</sup> /day				< 300 ft <sup>2</sup> /day		
• Confined aquifers	- Estimated from aquifer T values										
3. Residence time	Duration recharged water is in aquifer	> 1 year			4 months – 1 year				< 4 months		
• Unconfined aquifers	Subcrop proximity to alluvial aquifers	> 3 miles			1 – 3 miles				< 1 mile		
• Confined aquifers											
<u>Environmental considerations</u>											
4. Water quality	Aquifer water quality with respect to State standards, soil leaching potential	No standards exceeded; minimal leaching potential			Limited areas where standards exceeded; minor leaching pot.				Large areas where standards exceeded; strong leaching pot.		
5. Habitat concerns	Presence of threatened and endangered species habitat; effect on wetlands	Minor area of T&E habitat; no effect on wetlands			Some T&E habitat; some wetlands affected				Much T&E habitat; wetlands affected		
6. Waterlogging and non-beneficial use	Potential to create high water table & increased ET by phreatophytes	Low concerns for waterlogging effects			Medium concerns for waterlogging effects				High concerns for waterlogging effects		
<u>Implementation considerations</u>											
7. Land ownership and land use considerations	Proportion of area with accessible public land, multiple jurisdictions	Many areas of public and non-urban land			Some areas of public and non-urban land				Mostly private and/or urban land		
8. Existing infrastructure	Proximity of infrastructure (pipelines, ditches, etc.) and available capacity	Suitable infrastructure < 5 miles from area			Suitable infrastructure 5-20 miles from area				Suitable infrastructure >20 miles from area		
9. Proximity to areas with demand	Recharge areas nearby to areas of projected unmet demand in 2030	Near areas with demands > 10,000 AF/yr			Near areas with demands of 5,000 – 10,000 AF/yr				Near areas with demands < 5,000 AF/yr		
10. Implementation costs	Relative land costs for construction	Low cost			Medium cost				High cost		
• Unconfined aquifers	Depth to aquifer and proximity to existing high capacity wells	< 250 ft; many wells in area			250 - 1,000 ft; few wells in area				> 1000 ft; no wells in area		
• Confined aquifers											

# Scoring Table

## South Platte Alluvial Region

		Evaluation Criteria (Weighting Factor in bold)										Overall Score
		Storage Availability	Hydrogeo. Suitability	Residence Time	Water Quality	Habitat Concerns	Nonbeneficial Use	Land Ownership/Use	Existing Infrastructure	Proximity to Demand	Costs	
Area No.	Subregion	<b>2</b>	<b>1.5</b>	<b>1</b>	<b>0.5</b>	<b>0.5</b>	<b>0.5</b>	<b>0.5</b>	<b>1</b>	<b>2</b>	<b>0.5</b>	
8	Lower Lost Creek	9	8	9	6	6	7	7	4	8	9	77
7	Upper Lost Creek	10	8	10	5	6	9	6	5	6	8	76
10	Lower Kiowa Creek	10	8	9	5	6	8	7	2	7	8	74
14	SP - Ft. Morgan Area	9	7	4	3	6	8	6	9	8	8	73
5	Lower Beebe/Box Elder Ck	7	8	8	3	5	4	7	10	8	5	72
1	SP - Denver Metro	8	9	4	5	4	7	1	9	9	3	71
12	Lower Bijou Creek	10	6	8	5	10	8	6	1	7	8	71
15	SP - Balzac to State Line	8	9	3	3	3	6	7	10	7	8	70
4	Upper Beebe/Box Elder Ck	8	9	6	4	5	5	6	10	6	4	70
13	Badger/Beaver Creek	8	7	7	4	10	7	8	1	7	9	68
6	SP - Greeley to Ft. Morgan	6	8	5	3	3	6	6	9	9	4	67
2	SP - Metro to Greeley	7	8	5	4	3	5	4	9	8	4	66
3	Poudre River	7	9	4	4	3	4	4	9	8	4	66
9	Upper Kiowa Creek	9	8	10	6	6	7	7	3	3	8	66
11	Upper Bijou Creek	9	6	10	6	10	7	7	1	3	8	63
16	SP - South Park	7	8	7	7	10	6	8	6	2	8	63

Note: Rankings based on scoring measures in Table 5

Ranking is on a 1-to-10 scale with 10 being the highest score

'SP' denotes areas along the mainstem of the South Platte River

# Scoring Summary

## South Platte Alluvial Region

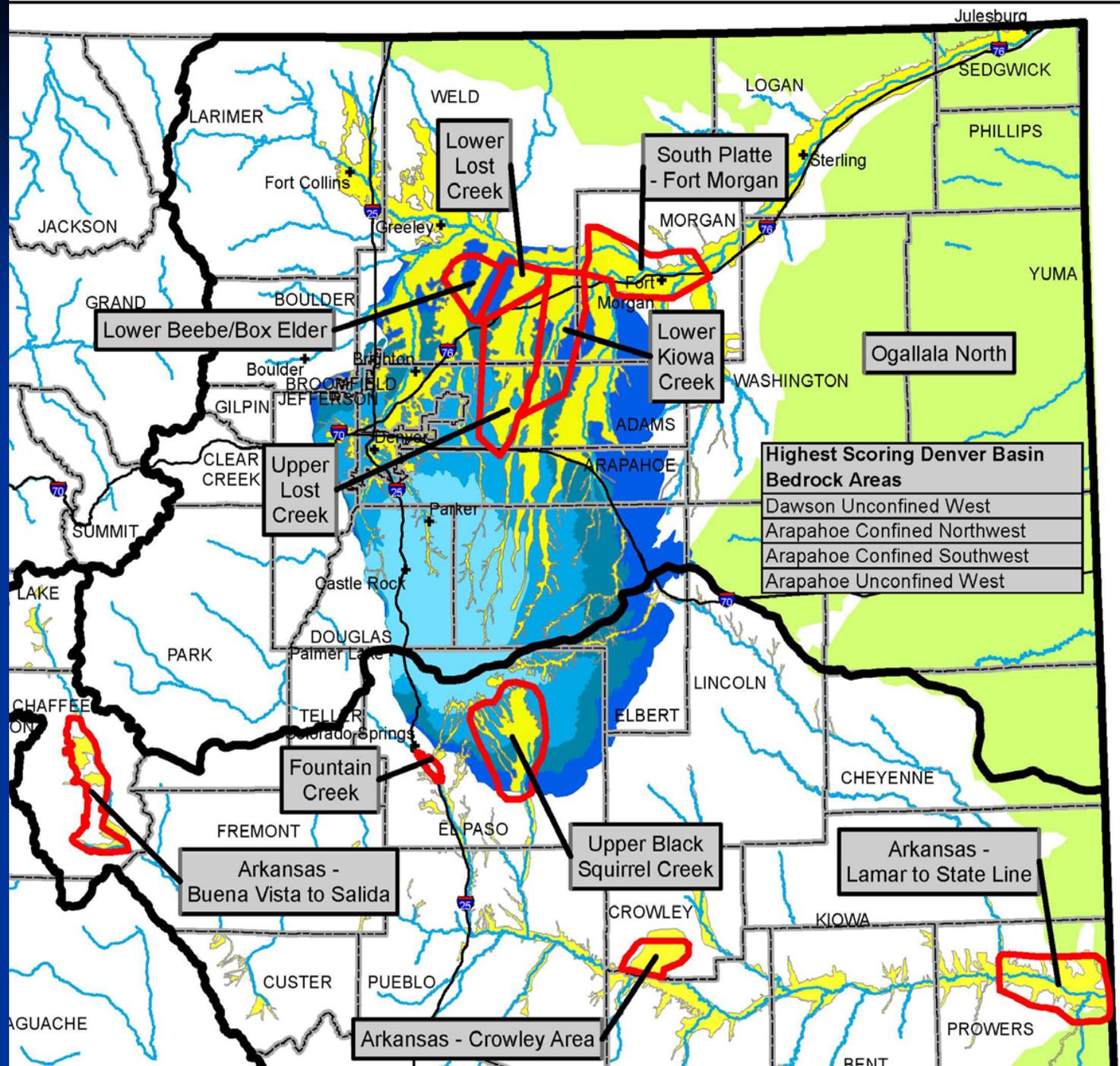
Area No.	Subregion	Overall Score
8	Lower Lost Creek	77
7	Upper Lost Creek	76
10	Lower Kiowa Creek	74
14	SP - Ft. Morgan Area	73
5	Lower Beebe/Box Elder Ck	72
1	SP - Denver Metro	71
12	Lower Bijou Creek	71
15	SP - Balzac to State Line	70
4	Upper Beebe/Box Elder Ck	70
13	Badger/Beaver Creek	68
6	SP - Greeley to Ft. Morgan	67
2	SP - Metro to Greeley	66
3	Poudre River	66
9	Upper Kiowa Creek	66
11	Upper Bijou Creek	63
16	SP - South Park	63

# Scoring Summary

## Arkansas & Denver Basin Regions

<b>Arkansas Alluvial</b>			<b>Bedrock Regions</b>		
Area No.	Subregion	Overall Score	Area No.	Subregion	Overall Score
6	Upper Black Squirrel Creek	71	1	Dawson Unconfined West	74
2	Ark - Crowley Area	69	7	Arapahoe Confined Northwest	72
5	Ark - Lamar to State Line	68	17	Ogallala - North	70
10	Ark - Buena Vista to Salida	65	8	Arapahoe Confined Southwest	68
8	Fountain Creek	65	10	Arapahoe Unconfined West	67
3	Ark - Apishapa to John Martin	63	18	Ogallala - South	67
4	Ark - John Martin to Lamar	62	2	Dawson Unconfined East	64
1	Ark - Pueblo to Apishapa	61	12	LFH Confined West	62
9	Wet Mountain Valley	59	3	Denver Confined West	62
7	Upper Big Sandy Creek	57	14	LFH Unconfined West	61
			9	Arapahoe Confined East	55
			5	Denver Unconfined West	52
			13	LFH Confined East	52
			11	Arapahoe Unconfined East	51
			4	Denver Confined East	48
			6	Denver Unconfined East	47
			15	LFH Unconfined East	47
			16	Dakota-Cheyenne	41

# Highest Scoring Areas in Study



# Conclusions & Recommendations

- **Many potential areas exist for underground water storage in both basins**
- **Further investigation warranted in areas where there is stakeholder interest and potential water supply**
- **Site- and project-specific factors affect the feasibility of a given project and must be considered**

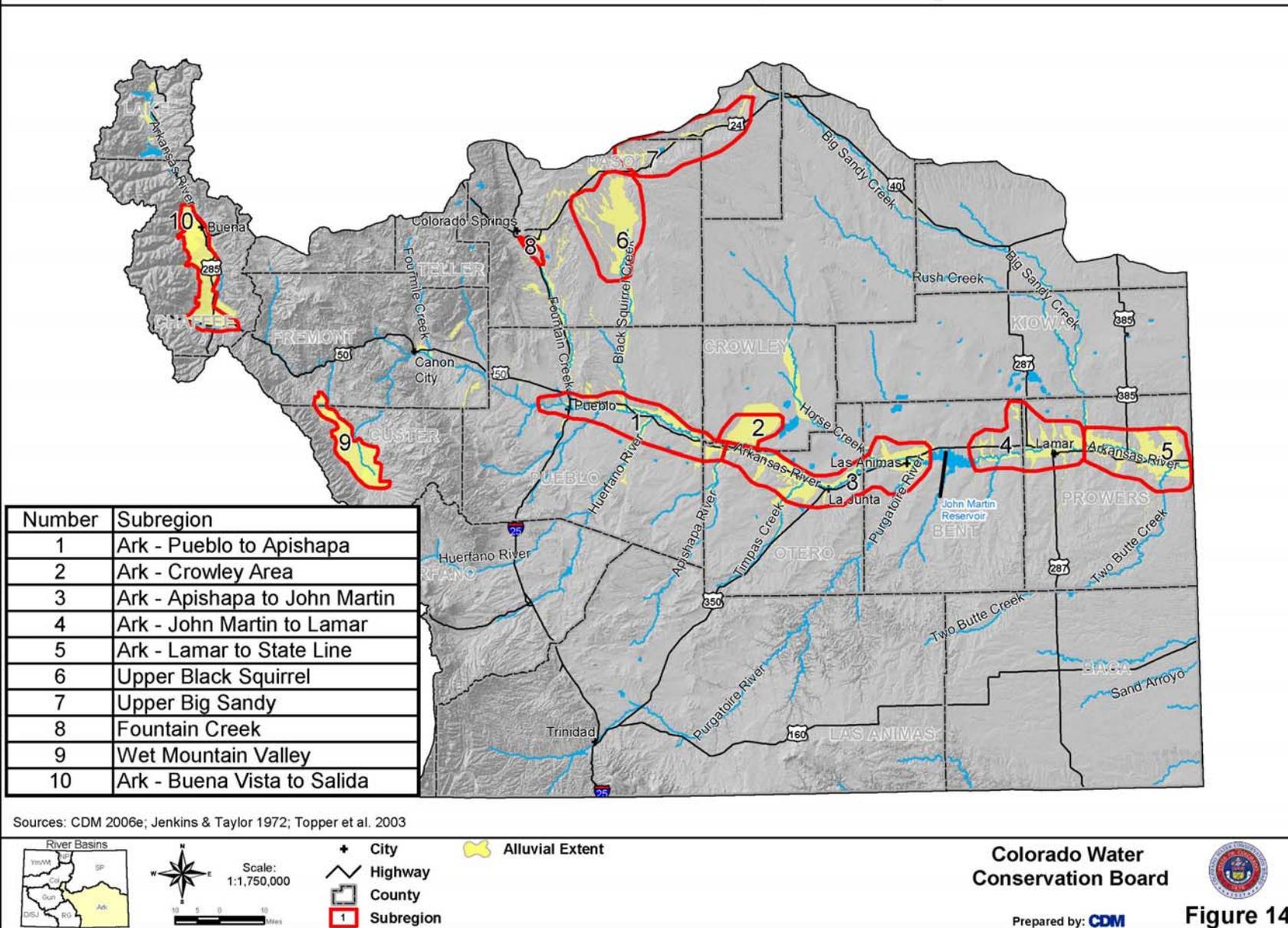
# What's Next?

- **SR 07-007 Underground Water Banking Strategies**
- **HJR 07-1017 and upcoming conference on groundwater management policy (Sept. 27-28, 2007)**
- **Other ongoing efforts include groundwater evaluations: SPDSS, SWSI, IBCC roundtables and WSRA (SB 06-179)**
- **Avenues for funding projects include CWCB Construction Fund, Severance Tax Fund, loans and WSRA**

## For more information:

- Full report available at CWCB web site:
  - [cwc.state.co.us](http://cwc.state.co.us)
- Contact Andy Moore at CWCB
  - [andy.moore@state.co.us](mailto:andy.moore@state.co.us)
  - 303-866-3533

## SB06-193 Underground Water Storage Study Arkansas River Basin Alluvial Aquifer Subregions

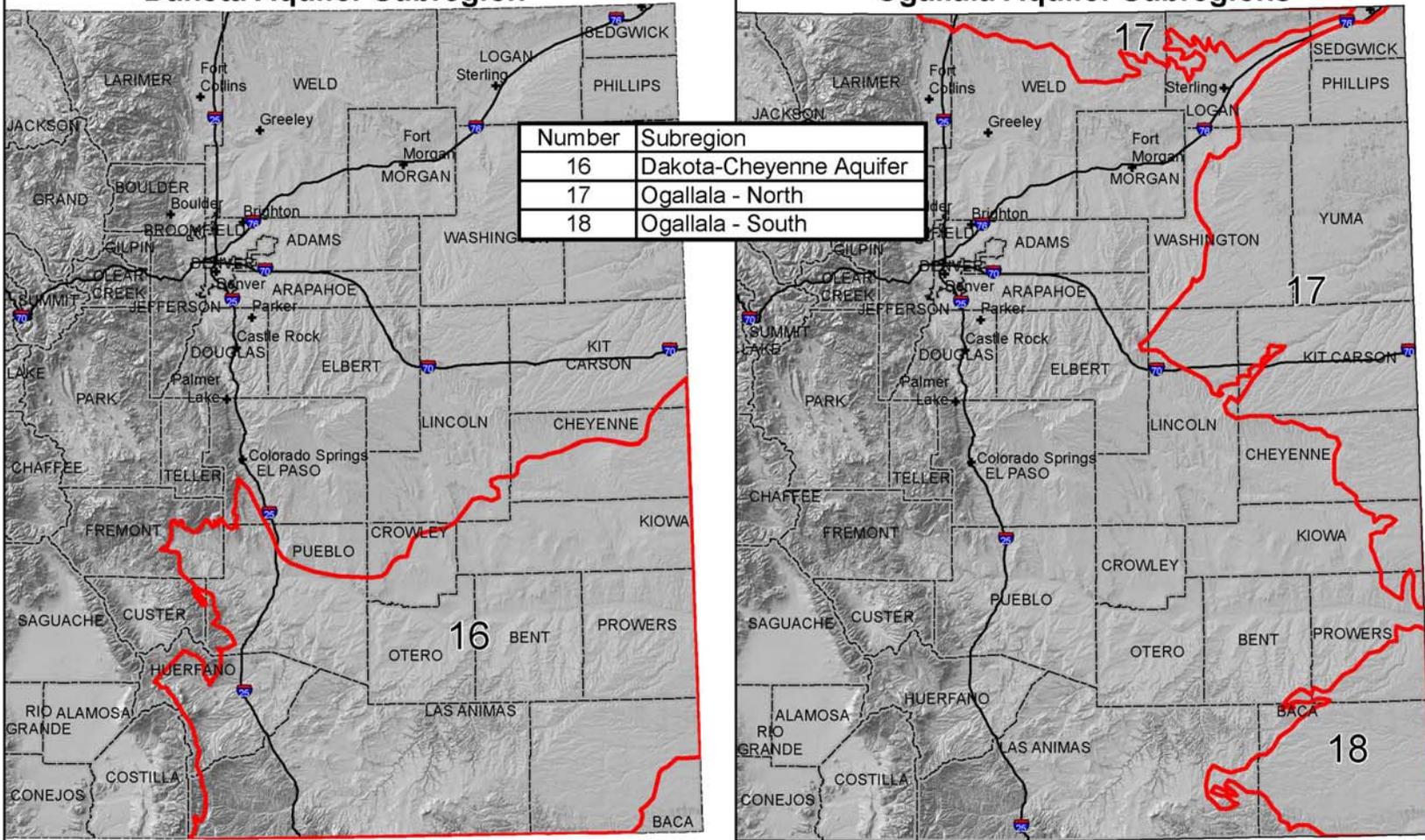


# SB06-193 Underground Water Storage Study

## Dakota and Ogallala Bedrock Aquifer Subregions

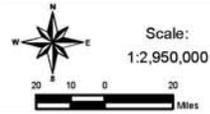
### Dakota Aquifer Subregion

### Ogallala Aquifer Subregions



Northern extent of the Dakota aquifer is drawn where depth to top of formation becomes greater than 2,000 feet.  
Source: Robson and Banta 1987

Source: Topper et al. 2003



- + City
- Highway
- County
- 16 Subregion

Colorado Water Conservation Board

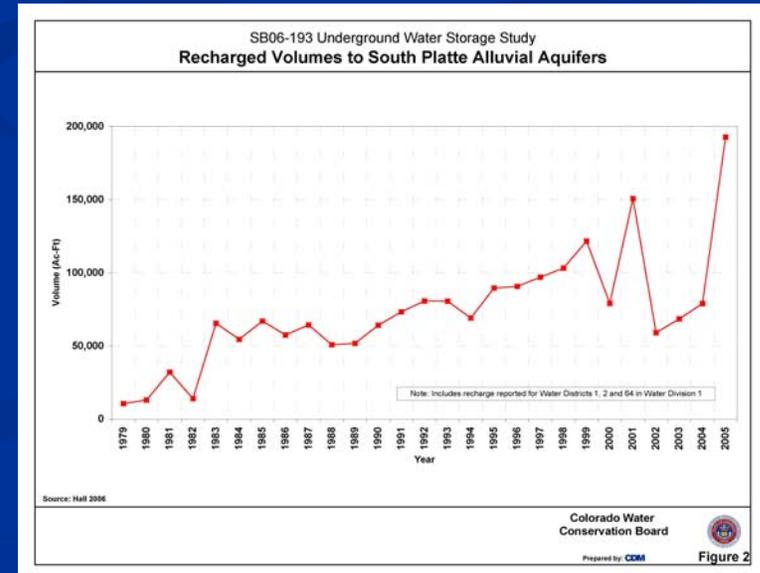


Prepared by: CDM

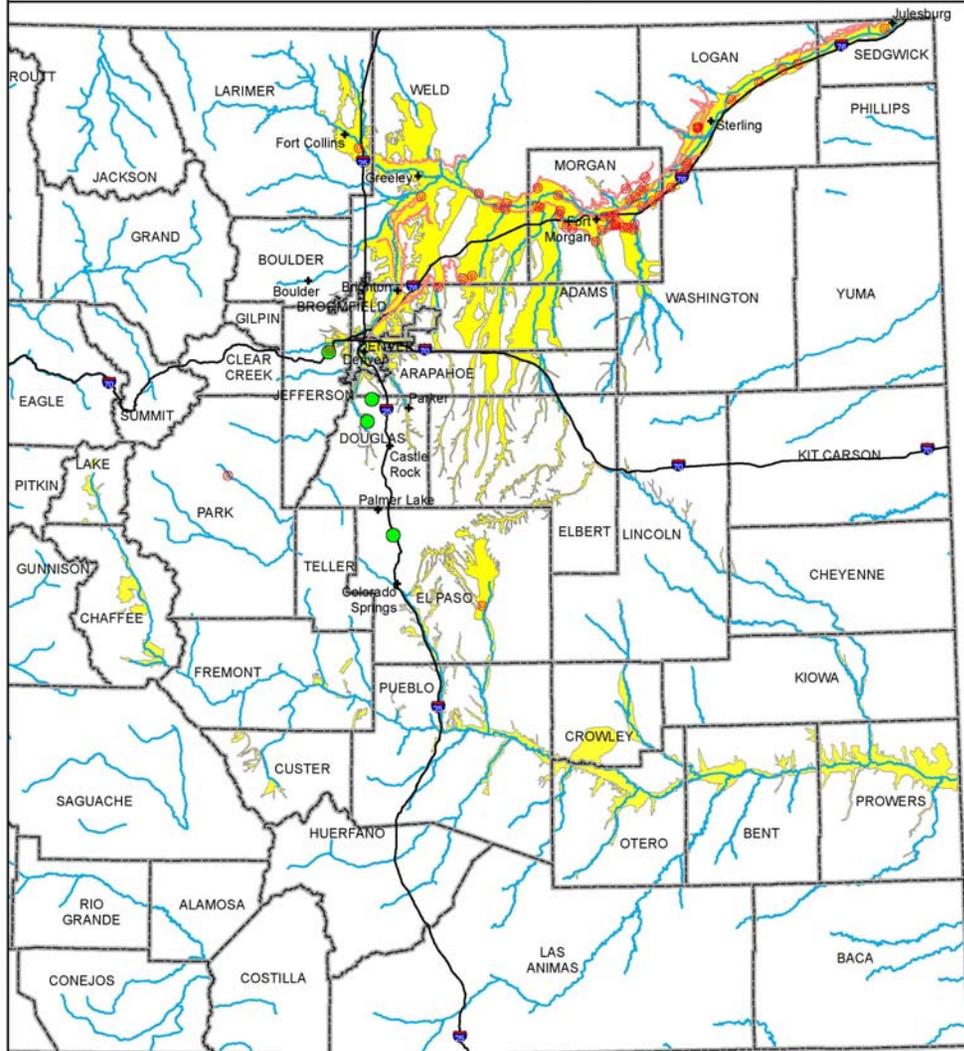
Figure 35

# Current Recharge Projects

- South Platte recharge for augmentation
  - Over 190,000 acre-feet recharged in 2005
  - Since 1979, a cumulative total of about 2 million acre-feet have been recharged
- Denver Basin recharge projects
  - Centennial WSD
  - Castle Pines North
  - Consolidated Mutual Water Co.
  - Colorado Springs Utilities



## SB06 - 193 Underground Water Storage Location of Artificial Recharge Projects in the Study Area



Sources: Brand 2005; Cherokee Metropolitan District 2005; Sanchez 2007; Topper et al. 2004; Welton 2006

<p>Scale: 1:2,100,000</p> <p>0 5 10 Miles</p>	City	Bedrock Active Recharge Sites
	Highway	Alluvial Recharge Ditch System
	County	Alluvial Active Recharge Sites
	Alluvial Extent	

**Colorado Water Conservation Board**

Prepared by: **CDM** **Figure 3**