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TO: Ken Knox – Division of Water Resources

FROM: Jim Slattery

SUBJECT: Republican River – 2004 Colorado Pumping and Surface Water Diversions

The purpose of this memorandum is to document the procedures and basic data utilized to estimate the pumping and surface water diversions in Colorado for 2004.

SURFACE WATER DIVERSIONS

In the Republican River Basin groundwater model, the Hale Ditch, the Laird Ditch, and the Pioneer Ditch are represented explicitly. The attached "Exhibit 2004 Surface Water Diversions" list the surface water diversions for these three ditches. This data was compiled from Colorado Division of Water Resources Records. This data is also provided in electronic format in the file entitled "CO Surface Water Diversions 2004.xls".

MUNICIPAL GROUNDWATER PUMPING ESTIMATES

For 2004, Colorado is using the same municipal pumping estimates as was used for the year 2000. The 2000 pumping estimates were developed by the USGS. Colorado has not refined these numbers at this time.

AGRICULTURAL GROUNDWATER PUMPING ESTIMATES

The 2004 agricultural pumping estimates were developed using the same basic procedure utilized to estimate the 1940 to 2003 values. This procedure was summarized in the report entitled "Republican River Compact Administration Ground Water Model, June 30, 2003".

The 2004 pumping estimates are summarized in the attached "Exhibit 2004 Groundwater Pumping Estimates". The detailed crop irrigation requirement calculations and background data are provided in electronic format in the file entitled "2004 Republican-CO Pump.xls".

Exhibit 2004 Surface Water Diversions

Source: State of Colorado diversion data in file "Surface Water Diversions up to WY 2004.xls"

Hale Ditch Diversions (ac-ft) (structure ID 4900512)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	0	0	0	0	0	0	0	0	0	0	0	0	0

Laird Ditch Diversions (ac-ft) (structure ID 6500510)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	0	0	0	211	362	352	417	433	413	116	0	0	2,303

Net Pioneer Ditch Diversions used in Colorado (River Headgate Diversions minus flume at Stateline) (ac-ft)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	0	0	0	0	417	369	370	376	353	186	0	0	2,071

Calculated as Total Pioneer Ditch Diversions minus Pioneer/Haigler at the Colorado/Nebraska Stateline

Total Pioneer Ditch Diversions at River Headgate in Colorado (ac-ft) (structure ID 6500520)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	0	0	0	0	1,036	1,139	1,105	1,141	920	465	0	0	5,805

Pioneer/Haigler Ditch at the Colorado/Nebraska Stateline (ac-ft)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	0	0	0	0	619	769	735	764	567	279	0	0	3,733

Exhibit 2004 Groundwater Pumping Estimates

Table 1 - Total Acres

County (or portion of County in the Republican River Basin study area)									
Item	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Irrigated Acreage by Type									
Sprinkler	10,356	153,641	1,081	5,002	62,289	12,965	31,381	260,931	537,646
Flood	1,022	11,630	401	102	5,315	9,956	5,260	1,169	34,855
Subtotal	11,378	165,271	1,482	5,104	67,604	22,921	36,641	262,100	572,501
Irrigated Acreage Reductions									
CRP	0	0	0	0	0	0	0	123	123
CREP	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0	123	123
Total	11,378	165,271	1,482	5,104	67,604	22,921	36,641	261,977	572,378

Source:

<http://www.dola.state.co.us/PropertyTax/Publications/Publisintro.htm> - Agricultural Section of Annual Report
for Kit Carson, Phillips, and Yuma Counties. Only a portion of the remaining counties are within the Republican River basin and the acreage for these counties was estimated to be the same as 2000. See Helton & Williamsen memorandum entitled "Irrigated acreage estimates - Republican River Basin in Colorado" dated October 8, 2002.

Table 2 - Acres Irrigated by Surface Water Diversions

County (or portion of County in the Republican River Basin study area)									
Year	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2004	0	1,861	0	0	0	0	0	2,902	4,763

Source:

The only counties with surface water diversions are Kit Carson and Yuma Counties. For Kit Carson and Yuma the surface water acres are estimated to be the same as the 1940 total county irrigated acreage values as described in the Helton & Williamsen memorandum entitled "Irrigated acreage estimates - Republican River Basin in Colorado" dated October 8, 2002.

Table 3 - Acres Irrigated by Groundwater Pumping

County (or portion of County in the Republican River Basin study area)									
Year	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2004	11,378	163,410	1,482	5,104	67,604	22,921	36,641	259,075	567,615

Calculated as Total Irrigated Acres minus Surface Water Irrigated Acres (Table 1 minus Table 2)

Table 4 - Efficiency Factors for Estimating Pumping In Colorado

Year	Percent of CIR Met by Pumping (%)	Sprinkler Irrigation			Flood/Gated Pipe/Furrow Irrigation		
		Maximum Farm Efficiency (%)	Pumping Lost to Spray (%)	Pumping to Deep Percolation (%)	Maximum Farm Efficiency (%)	Net Surface Water Runoff (%)	Pumping to Deep Percolation (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2004	75%	80%	3%	17%	65%	5%	30%

Source:

- (2) Data from "150 Well Water Right Change Study" (See report "Republican River Compact Administration Ground Water Model June 30, 2003")
- (3) Estimated
- (4) Estimated
- (5) Calculated as 100% - Column(3) - Column(4)
- (6) Estimated
- (7) Initial surface water runoff is estimated to be 10%. Estimated that 5% deep percolates back into aquifer after it leaves the end of the field and 5% returns to the stream or is consumed.
- (8) Calculated as 100% - Column(6) - Column(7)

Table 6 - Percent of Irrigated Land Served by Sprinkler Irrigation

County (or portion of County in the Republican River Basin study area)									
Year	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma	Weighted Average Using Acres in Table 3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2004	91.0%	93.0%	72.9%	98.0%	92.1%	98.0%	85.6%	99.6%	95.6%

Source:

<http://www.dola.state.co.us/PropertyTax/Publications/Publisintro.htm> - Agricultural Section of Annual Report
Since the majority of Logan and Sedgwick Counties serve lands that are located in the South Platte Basin, the percentage was based on discussions with staff of the County Assessor Office in the respective counties in 2000.

Exhibit 2004 Groundwater Pumping Estimates

Table 7 - Crop Irrigation Requirement (units of inches)

County (or portion of County in the Republican River Basin study area)									
Year	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma	Weighted Average Using Acres in Table 3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2004	15.87	21.05	20.68	19.28	17.17	18.45	21.76	16.42	18.30

Sources:

Potential consumptive use estimated using the Hargreaves equation calibrated to the Penman-Monteith equation.

Effective rainfall estimated using procedure outlined in TR-21.

Crop mix from NASS data was used to weight the CIR for each county.

See memorandum by Helton & Williamsen entitled "Crop Consumptive Use Requirements - Republican River Basin in Colorado" dated November 19, 2002.

Table 8 - Gain in Soil Moisture from Winter and Spring Precipitation (units of inches)

County (or portion of County in the Republican River Basin study area)									
Year	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2004	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Source:

1) "Republican River Basin Water Management Study - Working Paper - Farm Water Management", Steven J. Vandas, United States Bureau of Reclamation, March 1983

2) As a check on reasonableness

Average Monthly Precipitation for Yuma County in April and May = 4.8 inches

Average Monthly Consumptive Water Requirement for Corn Grain in Yuma County in April and May = 1.2 inches

Which results in $4.8" - 1.2" = 3.6"$ of precipitation that becomes surface water runoff, deep percolation, soil evaporation, or a gain to soil moisture storage.

Table 9 - Net Crop Irrigation Requirement (units in inches)

County (or portion of County in the Republican River Basin study area)									
Year	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma	Weighted Average Using Acres in Table 3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2004	13.87	19.05	18.68	17.28	15.17	16.45	19.76	14.42	16.30

Sources:

Calculated as Table 7 minus Table 8

Table 10 - Irrigation Groundwater Pumping (acre-feet)

County (or portion of County in the Republican River Basin study area)									
Year	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2004	12,584	247,153	2,298	6,923	81,596	29,596	58,434	292,163	730,748

For each county pumping is calculated as

Gw Irrig Acres (Table 3) x % CIR Met (Table 4, column 2) x Net CIR/12 (Table 9)

multiplied by the quantity of

Pct Land Served by Sprinkler (Table 6) / Sprinkler Efficiency (Table 4, column 3) +

Pct Land Served by Flood (100 - Table 6) / Flood Efficiency (Table 4, column 6)

Table 11 - Recharge From Groundwater Pumping in Colorado (acre-feet)

County (or portion of County in the Republican River Basin study area)									
Year	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2004	2,317	44,740	484	1,199	14,884	5,126	11,237	49,855	129,842

For each county recharge is calculated as

Sprinkler Pump x Recharge Sprinkler + Flood Pumping x Rech Flood

Which is equal to

Gw Irrig Acres (Table 3) x % CIR Met (Table 4, column 2) x Net CIR/12 (Table 9)

multiplied by the quantity of

Rech Sprinkler (Table 4, column 5) x Pct Land Sprinkler (Table 5) / Sprinkler Eff (Table 4, column 3) +

Rech Flood (Table 4, column 8) x Pct Land Served by Flood (100 - Table 5) / Flood Eff (Table 4, column 6)