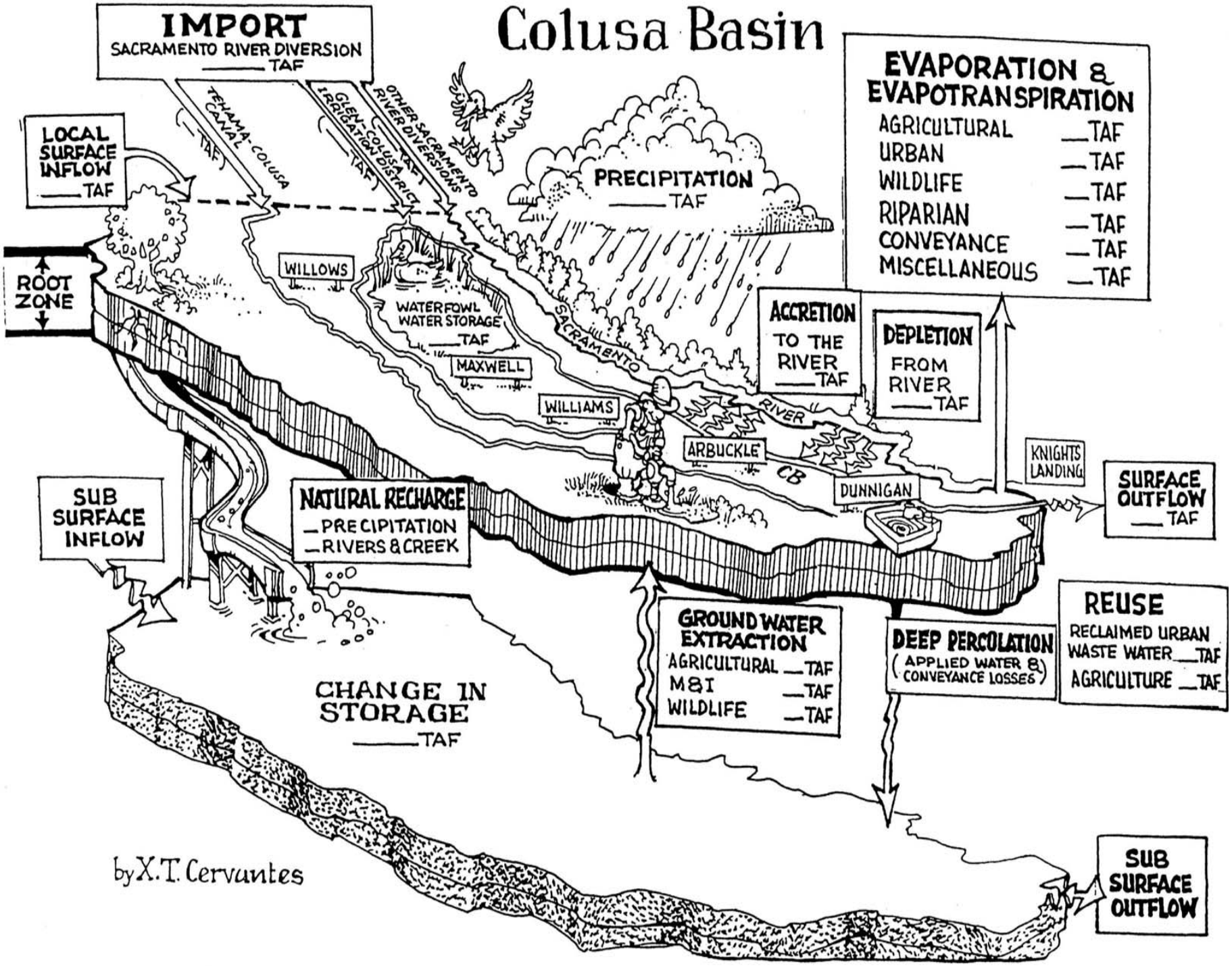
Northern District Water Balance Process

October 8, 2004

Overview

- Process and Parameters
- Demand Calculation Methodologies
- Supplies – Data and estimates
- Water Balance
  - Depletions
  - Deep Percolation
  - Outflow

Colusa Basin



Water Balance Parameters

- **TOTAL SUPPLY = WATER USE**
- **CUAW** (Consumptive Use of Applied Water)
- Agricultural Evapotranspiration of Applied Water (ETAW)
- Environmental ETAW
- Municipal and Industrial
  - Single Family Interior Use
  - Single Family Exterior Use
  - Multi Family Interior Use
  - Multi Family Exterior Use
  - Commercial Uses
  - Urban Landscaping
  - Etc.
- **CUAW by RE-USE**
- Agricultural CUAW met by RE-USE
- Environmental CUAW met by RE-USE
- Urban CUAW met by RE-USE
- **IRRECOVERABLE LOSSES**
- Agricultural Conveyance System Evaporation
- Urban Conveyance System Evaporation
- Environmental Conveyance System Evaporation
- Riparian Evapotranspiration (ET)
- Miscellaneous Agricultural ET
- Drain water to a Salt Sink or Ocean
- Water to contaminated aquifer (salt water).
- **OUTFLOW**
- Conveyance System Spill and Seepage
- Agricultural, Environmental, and/or Urban Drainage
  - To other DAUs within County
  - Out of County
  - Out of Planning Area (PA) or Planning Subareas (PSA)
- Wastewater
- **DEEP PERCOLATION** – Groundwater (GW) Aquifer
- Conveyance Losses – Deep Percolation (DP)
- Agricultural – DP
- Urban – DP
- Environmental – DP
- **CHANGE IN STORAGE –** GW Aquifer
- Accretion to a Tributary – Outflow increases, when GW Aquifer is at full capacity or above.
- Depletion from a Tributary – Outflow decreases, when GW Aquifer is below full capacity.

Ag Water Use Model

- Monthly Applied Water and ETAW
  - ETAW calculated by monthly Soil Moisture Balance
    - Soil Data Input
    - Crop Data and Management
    - Precipitation data (aerial correction, infiltration curves)
  - Applied Water
    - Annual crop acreage
      - Land Use Survey
      - Projection of Land Use Survey from Ag Commissioner reports
    - Application Fractions (e.g. irrigation efficiencies)
    - Cultural Practices (leaching, frost protection, pre-irrigation, rice flood-up/flow-thru)

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California Agricultural Water Use Model

- Input ...
- Reports ...
- Calculate ETAW ...
- Calculate Ag Water Use ...
- Maintenance ...
- About this model
- Exit

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Delete | Add New ... | Print | Done

DAU County: 163 - Colusa

DWR District: Northern

Datasets		Data Years First	Data Years Last
Precipitation Station:	COLUSA 2 SSW	1949	2002
Evaporation Station:	Gerber	1959	2002
Soil Dataset:	163 Colusa	1960	2002
Crop Dataset:	Sac Valley (rest)	1960	2002
Infiltration Curve	SCS Curve No. X		

Infiltration Curve Adjustment (inches): 0.10

Precipitation Aerial Correction Factor: 1.00

Common Years: 1960 2002

Regions

Planning Area	Colusa Basin
Planning SubArea	Central Basin West
Hydrologic Region	Sacramento River
Future 1	Future 1
Future 2	Future 2

Description

Edit DAU... | Edit County... | Edit Regions... | Edit DWR Districts...

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EVAP DATA

Evap Dataset: Adin

Year: 2002

Month	Pan Evap	Estimated?
Oct 01	0.00	☐
Nov 01	0.00	☐
Dec 01	0.00	☐
Jan 02	0.00	☐
Feb 02	0.00	☐
Mar 02	0.00	☐
Apr 02	0.00	☐
May 02	0.00	☐
Jun 02	0.00	☐
Jul 02	0.00	☐
Aug 02	0.00	☐
Sep 02	0.00	☐

Done

Print

Add New ...

Edit Stations...

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SOIL DATA

Soil Dataset: 163 Colusa

Year: 2000

Crop: Processing Tomatoes

Available Soil Moisture: 0.16 inches/inch

Effective Rooting Depth: 30.00 inches

Initial Soil Evaporation Coefficient: 15%

Soil Evaporation Layer: 6.00 inches

Soil Moisture Drawdown Override ☐

Deficit Irrigation / Soil Evaporation Override ☐

Done

Print

Add New ...

Copy Years...

Edit Datasets...

Delete Years...

Month	Management Allowable Depletion	Percent of Root Depth	Deficit Irrigation Reduction
Oct 99	0%	0%	0%
Nov 99	0%	0%	0%
Dec 99	0%	0%	0%
Jan 00	0%	0%	0%
Feb 00	0%	0%	0%
Mar 00	40%	30%	0%
Apr 00	40%	65%	0%
May 00	40%	100%	0%
Jun 00	40%	100%	0%
Jul 00	40%	100%	0%
Aug 00	40%	100%	0%
Sep 00	0%	0%	0%

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CROP DATA

Crop Dataset: Sac Valley (rest)

Year: 2000

Crop: Rice

Month	Crop Coefficient	Percent of Month
Oct 99	0.00	0%
Nov 99	0.00	0%
Dec 99	0.00	0%
Jan 00	0.00	0%
Feb 00	0.00	0%
Mar 00	0.00	0%
Apr 00	0.00	0%
May 00	0.80	83%
Jun 00	0.88	100%
Jul 00	0.99	100%
Aug 00	1.00	100%
Sep 00	0.91	83%

Done

Print

Add New ...

Copy Years...

Edit Datasets...

Edit Crop List...

Delete Years...

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Year 2000 Split Source? ☑

DAU County 163 - Colusa

Done

FARM DATA

Applied Water Input	Crop	Delete Crop	Area (Acres) Surface	Mixed	Ground	Total
	Alfalfa		1,320	356	1,013	2,689
	Almonds		21,794	3,094	2,995	27,883
	Corn		867	44	431	1,342
	Cotton		7,065	1,021	1,102	9,188
	Cucurbits		3,847	484	1,489	5,820
	Dry Beans		1,711	24	0	1,735
	Grain		4,098	458	1,832	6,388
	Grapes		566	1,340	0	1,906
	Onions & Garlic		1,536	35	84	1,655
	Other Deciduous		100	0	0	100
	Other Field		182	53	0	235
	Other Truck		235	0	50	285
	Total		144,248	12,662	14,028	170,938
	Double Crop		1,381	89	75	1,545
	Total Land Area		142,867	12,573	13,953	169,393

Add New Crop...

Print

Add New...

Copy Years...

Delete Years...

Missing Crops

Alfalfa-X
Eucalyptus

Populate Selected Crops

Notes:

Microsoft Access - [frmFarmDataInputMonthly : Form]

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Applied Water Data

Year 2000

Split Source? ☑

Done

DAU County 163 - Colusa

Crop Rice

Replicate 1st Month

Month	Surface Mix %	Application Fraction		Leaching Fraction (%)	Pre Irrigation (inches)	Frost Protection (inches)	Other ET Cultural Practices (inches)	Non ET Cultural Practices (inches)
		Surface	Ground					
Oct 99	10%	0%	0%					
Nov 99	10%	0%	0%					
Dec 99	10%	0%	0%					
Jan 00	10%	0%	0%					
Feb 00	10%	0%	0%					
Mar 00	10%	0%	0%					
Apr 00	10%	0%	0%					
May 00	10%	81%	81%					9.00
Jun 00	10%	84%	84%					2.00
Jul 00	10%	84%	84%					4.90
Aug 00	10%	84%	84%					1.90
Sep 00	10%	84%	84%					0.95

State of California, Department of Water Resources

Northern District

2000 ETAW Calculation For Almonds in Colusa County DAU 163

(inches)

	Begin of Month Soil Moisture Storage	Precip/ Infil-tration	Cult. Pract. Applied Water	Soil Moisture Storage (1)	Total Cult. Pract. Storage	ET	Initial Root Zone Storage	Unused Root Zone Storage	Soil Evapo-ration	Root Zone Storage	Minimum Root Zone Storage	End of Month Soil Moisture Storage	Initial ETAW	End of Month Cult. Pract. Storage	ETAW CP	ETAW Irr	End of Month ETAW Storage	ETAW
Oct 99	4.54	0.09	0.00	4.63	0.00	2.70	4.63	0.00	0.00	1.93	0.00	1.93	0.00	0.00	0.00	0.00	0.00	**0.00**
Nov 99	1.93	1.11	0.00	3.04	0.00	0.00	3.04	0.00	0.28	2.76	0.00	2.76	0.00	0.00	0.00	0.00	0.00	**0.00**
Dec 99	2.76	0.00	0.00	2.76	0.00	0.00	2.76	0.00	0.31	2.45	0.00	2.45	0.00	0.00	0.00	0.00	0.00	**0.00**
Jan 00	2.45	2.84	0.00	5.29	0.00	0.00	5.29	0.00	0.26	5.03	0.00	5.03	0.00	0.00	0.00	0.00	0.00	**0.00**
Feb 00	5.03	3.69	0.00	8.72	0.00	0.15	8.72	0.00	0.10	8.47	4.54	7.56	0.00	0.00	0.00	0.00	0.00	**0.00**
Mar 00	7.56	1.41	0.00	8.97	0.00	2.19	8.97	0.00	0.00	6.78	4.54	6.78	0.00	0.00	0.00	0.00	0.00	**0.00**
Apr 00	6.78	0.85	0.00	7.63	0.00	3.40	7.63	0.00	0.00	4.23	4.54	4.54	0.31	0.00	0.00	0.31	0.00	**0.31**
May 00	4.54	1.29	0.00	5.83	0.00	6.35	5.83	0.00	0.00	-0.52	4.54	4.54	5.06	0.00	0.00	5.06	0.00	**5.06**
Jun 00	4.54	0.36	0.00	4.90	0.00	7.84	4.90	0.00	0.00	-2.94	4.54	4.54	7.48	0.00	0.00	7.48	0.00	**7.48**
Jul 00	4.54	0.00	0.00	4.54	0.00	6.61	4.54	0.00	0.00	-2.07	4.54	4.54	6.61	0.00	0.00	6.61	0.00	**6.61**
Aug 00	4.54	0.00	0.00	4.54	0.00	5.88	4.54	0.00	0.00	-1.34	4.54	4.54	5.88	0.00	0.00	5.88	0.00	**5.88**
Sep 00	4.54	0.13	0.00	4.67	0.00	5.12	4.67	0.00	0.00	-0.45	4.54	4.54	4.99	0.00	0.00	4.99	0.00	**4.99**

Available Soil Moisture	0.14 in./in.
Effective Rooting Depth	54.00 in.
Initial Soil Evaporation Coefficient	15%
Soil Surface Evaporation Layer	6.00 in.

2000 ETAW = 2.5 AF/ac

2000 Potential ET = 3.4 AF/ac

2000 EP = 0.9 AF/ac

Soil Moisture Drawdown Override ☐

Deficit Irrigation / Soil Evaporation Override ☐

Precipitation Station: COLUSA 2 SSW

Evaporation Station: Gerber

Soil Dataset: 163 Colusa

Crop Dataset: Sac Valley (rest)

Infiltration Curve Name: SCS Curve No. X

	Deep Perc. (excl. leach & irrig. appl.)	Deficit Irrig. Reduct.Factor	MAD	Percent Rooting Depth
Oct 99	0.00	0%	40%	100%
Nov 99	0.00	0%	0%	0%
Dec 99	0.00	0%	0%	0%
Jan 00	0.00	0%	0%	0%
Feb 00	0.91	0%	40%	100%
Mar 00	0.00	0%	40%	100%
Apr 00	0.00	0%	40%	100%
May 00	0.00	0%	40%	100%
Jun 00	0.00	0%	40%	100%
Jul 00	0.00	0%	40%	100%
Aug 00	0.00	0%	40%	100%
Sep 00	0.00	0%	40%	100%

Monthly Ag Water Use DAU County

District Crops

	Area (Acres)			Unit ETAW	ETAW (Acre-feet)			Consumed Fraction			Unit Applied Water (feet)			Applied Water (Acre-feet)			Unit ET	ET (Acre-feet)			Unit EP	EP (Acre-feet)		
	SW	GW	Total		SW	GW	Total	SW	GW	Tot	SW	GW	Tot	SW	GW	Total	ET	SW	GW	Total		SW	GW	Total
2000 Water Year																								
163 - Colusa																								
Prunes																								
Dec 99	223	0	223	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Jan 00	223	0	223	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Feb 00	223	0	223	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Mar 00	223	0	223	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.1	14	0	14	0.1	14	0	14
Apr 00	223	0	223	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.2	49	0	49	0.2	49	0	49
May 00	223	0	223	0.1	27	0	27	0.79	0.00	0.79	0.2	0.0	0.2	34	0	34	0.4	98	0	98	0.3	71	0	71
Jun 00	223	0	223	0.5	122	0	122	0.78	0.00	0.78	0.7	0.0	0.7	156	0	156	0.6	128	0	128	0.0	6	0	6
Jul 00	223	0	223	0.5	120	0	120	0.78	0.00	0.78	0.7	0.0	0.7	153	0	153	0.5	120	0	120	0.0	0	0	0
Aug 00	223	0	223	0.5	112	0	112	0.78	0.00	0.78	0.6	0.0	0.6	144	0	144	0.5	112	0	112	0.0	0	0	0
Sep 00	223	0	223	0.5	107	0	107	0.78	0.00	0.78	0.6	0.0	0.6	138	0	138	0.5	110	0	110	0.0	3	0	3
Total	223	0	223	2.3	515	0	515	0.78	0.00	0.78	3.0	0.0	3.0	660	0	660	3.2	710	0	710	0.9	195	0	195
Rice																								
Oct 99	88,432	3,335	91,767	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Nov 99	88,432	3,335	91,767	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Dec 99	88,432	3,335	91,767	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Jan 00	88,432	3,335	91,767	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Feb 00	88,432	3,335	91,767	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Mar 00	88,432	3,335	91,767	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Apr 00	88,432	3,335	91,767	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
May 00	88,432	3,335	91,767	0.5	45,100	1,701	46,801	0.37	0.36	0.37	1.4	1.4	1.4	123,557	4,660	128,217	0.5	45,100	1,701	46,801	0.0	0	0	0
Jun 00	88,432	3,335	91,767	0.8	67,801	2,557	70,358	0.71	0.71	0.71	1.1	1.1	1.1	95,454	3,600	99,054	0.8	67,801	2,557	70,358	0.0	0	0	0
Jul 00	88,432	3,335	91,767	0.7	64,334	2,426	66,760	0.57	0.57	0.57	1.3	1.3	1.3	112,698	4,250	116,948	0.7	64,334	2,426	66,760	0.0	0	0	0
Aug 00	88,432	3,335	91,767	0.6	57,039	2,151	59,190	0.71	0.71	0.71	0.9	0.9	0.9	80,411	3,033	83,444	0.7	59,400	2,240	61,640	0.0	2,361	89	2,450
Sep 00	88,432	3,335	91,767	0.3	27,264	1,028	28,292	0.69	0.69	0.69	0.4	0.4	0.4	39,458	1,488	40,946	0.5	43,845	1,653	45,498	0.2	16,581	625	17,206
Total	88,432	3,335	91,767	3.0	261,538	9,863	271,401	0.58	0.58	0.58	5.1	5.1	5.1	451,578	17,031	468,609	3.2	280,480	10,577	291,057	0.2	18,942	714	19,656
Safflower																								
Oct 99	163	253	416	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Nov 99	163	253	416	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Dec 99	163	253	416	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Jan 00	163	253	416	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Feb 00	163	253	416	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Mar 00	163	253	416	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
Apr 00	163	253	416	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0
May 00	163	253	416	0.1	17	27	44	0.66	0.72	0.70	0.2	0.1	0.2	26	37	63	0.4	58	89	147	0.2	41	62	103
Jun 00	163	253	416	0.2	28	44	72	0.67	0.73	0.71	0.3	0.2	0.2	42	60	102	0.6	92	143	235	0.4	64	99	163
Jul 00	163	253	416	0.4	64	99	163	0.68	0.73	0.71	0.6	0.5	0.6	94	135	229	0.6	98	152	250	0.2	34	53	87
Aug 00	163	253	416	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.3	56	87	143	0.3	56	87	143
Sep 00	163	253	416	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0

Urban Water Use

- Develop Representative Per-capita Water Use by Class
  - Residential, Industrial, Commercial, Landscape
- Determine Interior / Exterior Use
- Evaluate Sewerage vs. Septic
- Calculate
  - Landscape Depletion (ETAW0
  - Landscape Deep Percolation
  - Septic Deep Percolation
- Balance components

Municipal, Industrial and Rural Residential Water Balance Calculations

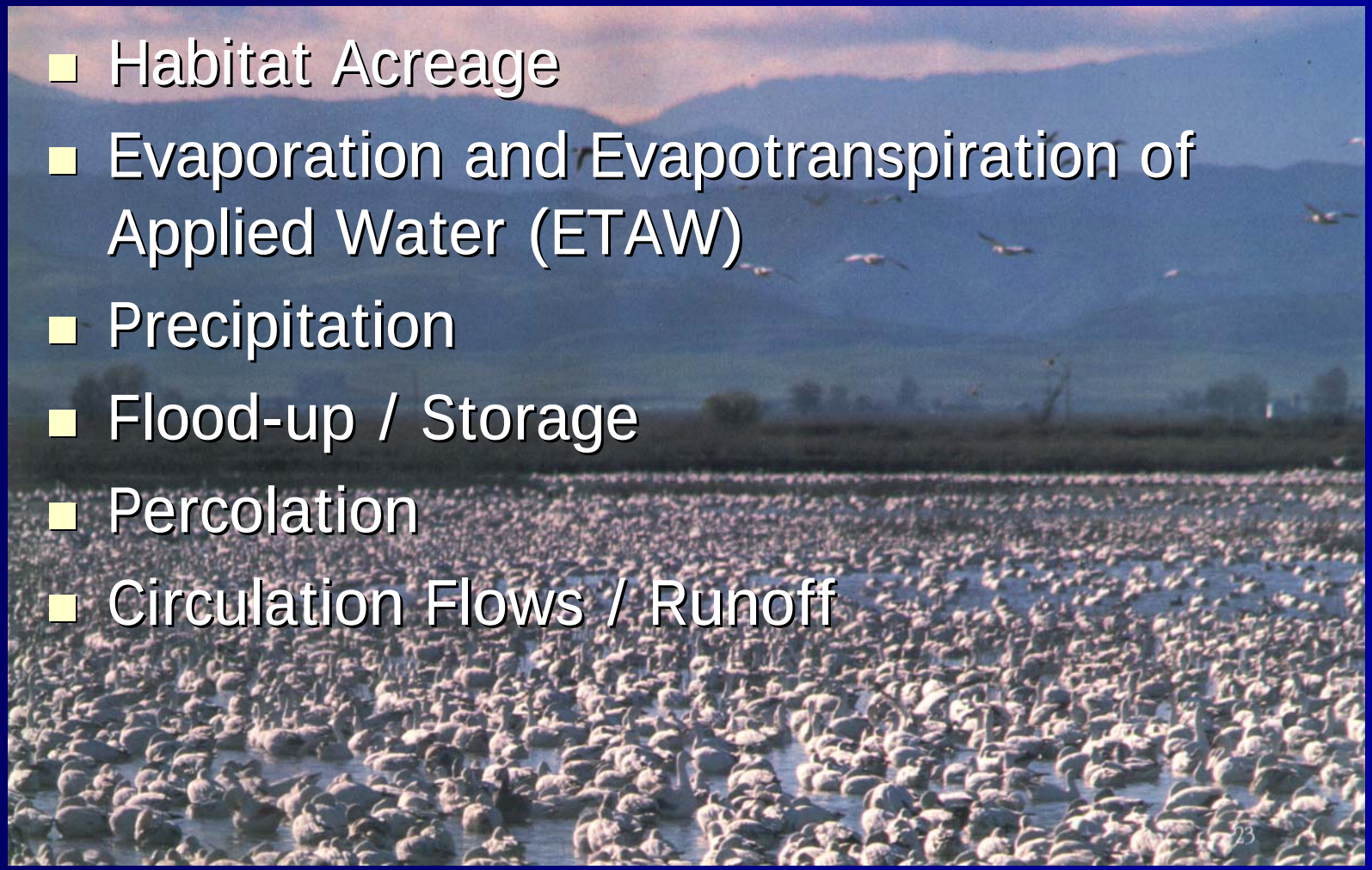
Year: 2000
DAU: 163
County: Colusa

					Comments
User Group	**2000 SUMMARY**				
Population	10625				
Groundwater Production	1,529.92 mg	4,686 af			
Surface Water Production	0.00 mg	0 af			
Single Family Residential Use	950.69 mg	2,909 af	62.1%	SFR WU Factor	
Multi-Family Residental Use	0.01 mg	0 af	0.0%	MFR WU Factor	
Commercial Use	54.38 mg	166 af	3.6%	Com. WU Factor	
Industrial Use	499.20 mg	1,532 af	32.6%	Ind. WU Factor	
Landscape Use	25.65 mg	79 af	1.7%	Lan. WU Factor	
Energy Production	0.00 mg	0 af	0.0%	En. WU Factor	
Urban Per-Capita Water Use	393 gpcd	0.441 afpca			
Indoor Per-Capita Water Use Estimate	179 gpcd	0.202 afpca			
Single Family Residential Use - Interior	406.95 mg	1,249 af			
Multi-Family Residental Use - Interior	0.00 mg	0 af			
Sewerage	526.07 mg	1,614 af			
Evaporation Pond	20.36 mg	62 af			
Deep Percolation Pond	245.80 mg	754 af			
Total Sewerage & Septic	697.72 mg	2,141 af			
Septic System - Deep Percolation	171.65 mg	527 af			
Outdoor Depletion	744.81 mg	2,278 af			
Outdoor Deep Percolation - Groundwater	87.39 mg	267 af			
Outdoor Deep Percolation - Surface Water	0.00 mg	0 af			
Total Deep Percolation - Groundwater	504.84 mg	1,548 af			
Total Deep Percolation - Surface Water	0.00 mg	0 af			
User Group	**2000 PUBLIC WATER SUPPLY SUMMARY**				
User Group	**2000 SELF-PRODUCED WATER SUPPLY SUMMARY**				
User Group	**Arbuckle**				
User Group	**Williams**				
User Group	**Maxwell**				
User Group	**Rural Self-Supplied**				
User Group	**INDUSTRIAL USE**				
User Group	**GOLF COURSES**				

Managed Wetland Water Use

- Habitat Types
  - Upland
  - Permanent Ponds
  - Seasonally Flooded Marsh
  - Summer Water
  - Watergrass Production
  - Rice

Managed Wetland Water Use

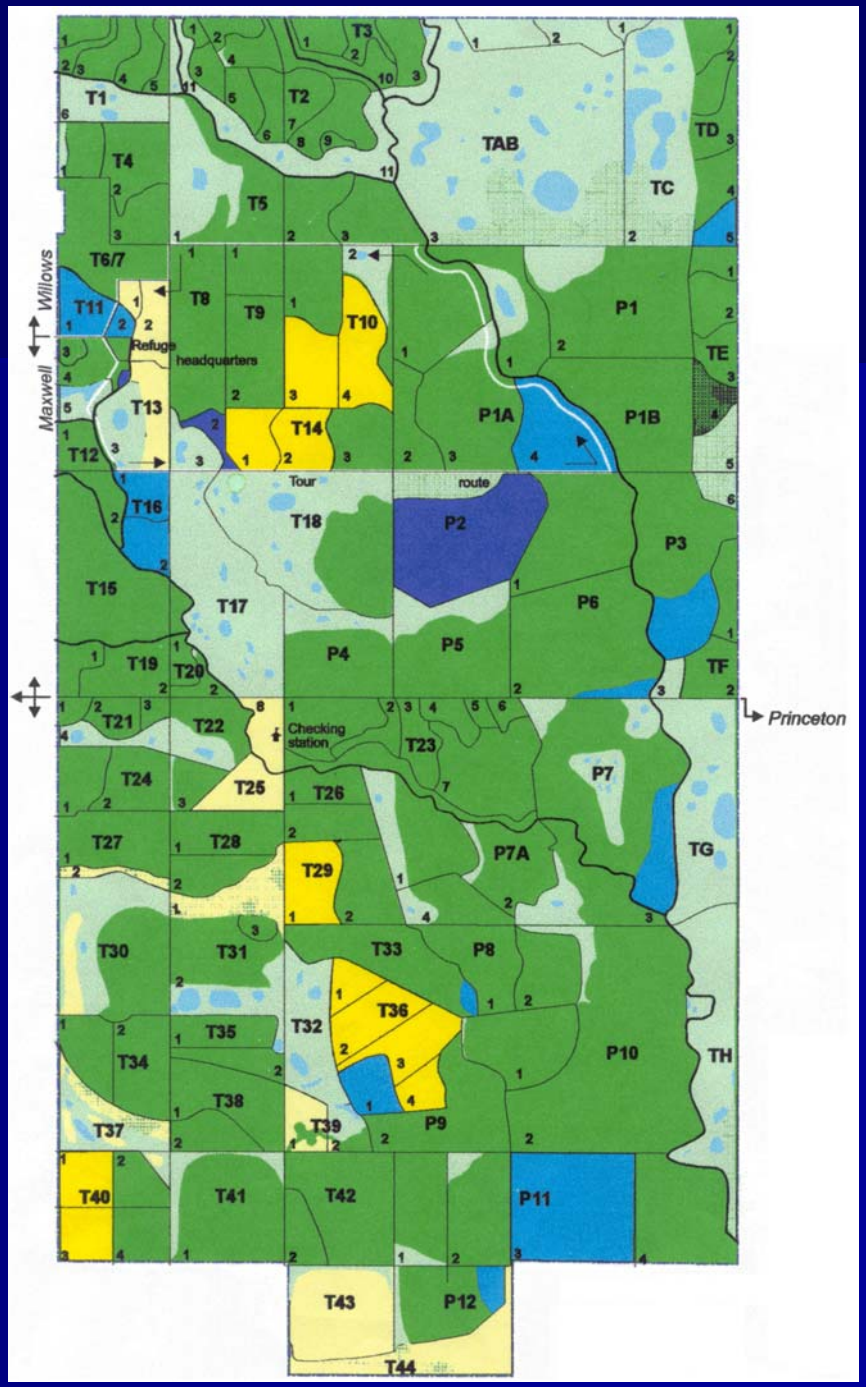


- Habitat Acreage
- Evaporation and Evapotranspiration of Applied Water (ETAW)
- Precipitation
- Flood-up / Storage
- Percolation
- Circulation Flows / Runoff

Sacramento NWR

1998 - 99 HABITAT MANAGEMENT PLAN

- *Permanent Pond*
- *Summer Water*
- *Seasonal Flooded Marsh*
- *Watergrass Production*
- *Alkali Meadow*
- *Non-native Grassland*
- *Vernal Pool*
- *Riparian Scrub*



Habitat Area: **Sacramento National Wildlife Refuge**
Water Year: **2000**

INPUT DATA SHEET

All data input data are highlighted in green.

	O	N	D	J	F	M	A	M	J	J	A	S	
Pan Evap or Cimis Eto (inches)	5.41	1.9	2.51	1.72	1.4	4.3	5.76	9.21	10.5	8.82	8.06	7.88	Gerber Pan
Effective Precipitation (inches)	0.25	1.82	0	3.01	4	1	0.8	1.06	0.5	0	0	0.32	Willows 6 W

Habitat Type	Flood-up/ Drawdown Date	Monthly Calender of Flood-up, Drawdown, and Irrigation												Acreage	Habitat Water Depth	Soil Saturation Depth	Irrigation Depth	Irrigation Efficiency	Habitat Coefficients												Soil Percolation Rate	Circulation Rate	Closed System (Y or N)										
		O	N	D	J	F	M	A	M	J	J	A	S	Ac	in				O	N	D	J	F	M	A	M	J	J	A	S	in/day	CFS/AC	O	N	D	J	F	M	A	M	J	J	A	S
Permanent Ponds	All Year	M	M	M	M	M	M	M	M	M	M	D		168	24	3			0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.78	0.05	0.01			Y	Y	Y							
Permanent Ponds	All Year	M	M	M	M	M	M	M	M	M	M	M	M	64	24	3			0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.05	0.01			Y	Y	Y							
																																			Y	Y	Y							
Seasonal Marsh	Aug - Mar	M	M	M	M	M	D					F	M	1630	12	3			0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.44			0.44	0.88	0.05	0.005			Y	Y	Y							
Seasonal Marsh	Sep												F	9	12	3														0.88	0.05	0.005			Y	Y	Y							
Seasonal Marsh	Sep - Feb	M	M	M	M	D							F	1630	12	3			0.88	0.88	0.88	0.88	0.88	0.44						0.88	0.05	0.005			Y	Y	Y							
Seasonal Marsh	Sep - Mar	M	M	M	M	M	D						F	1630	12	3			0.88	0.88	0.88	0.88	0.88	0.88	0.44					0.88	0.05	0.005			Y	Y	Y							
Seasonal Marsh	Oct - Mar	F	M	M	M	M	D							1630	12	3			0.88	0.88	0.88	0.88	0.88	0.88	0.44						0.05	0.005			Y	Y	Y							
Watergrass	Sep - Apr	M	M	M	M	M	M	D			I		F	255	12	3	6	0.8	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.44	0.96	0.48		0.88	0.05	0.005			Y	Y	Y							
Watergrass	Sep - Apr									I			F	44	12	3	6	0.8									0.96	0.48		0.88	0.05	0.005			Y	Y	Y							
Watergrass	Sep - Apr	M	M	M	M	M	D			I		F	M	256	12	3	6	0.8	0.88	0.88	0.88	0.88	0.88	0.88	0.44		0.96	0.48	0.5	0.88	0.05	0.005			Y	Y	Y							
Summer Water	Oct - Jul	F	M	M	M	M	M	M	M	M	D			275	12	3			0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.44		0.05	0.01			Y	Y	Y							
Summer Water	Jul -1/2 Apr	M	M	M	M	M	M	D						18	12	3			0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.44					0.05	0.01			Y	Y	Y							
Summer Water	Jul -1/2 Apr	M	M	M	M	M	M	D			F	M	M	49	12	3			0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.44		0.88	0.88	0.88	0.05	0.01			Y	Y	Y							
														7658																															

FOOTNOTES

F FLOOD-UP
D DRAWDOWN
M MAINTAIN FLOODED FIELD
I IRRIGATION
C CROPPED

Closed System Used to account for no outflow and/or no supply
Habitat Coefficients Coefficients convert Evaporative Index (Pan Evaporation or CIMIS Eto) to representative crop/habitat ET
Circulation Rate This accounts for habitat flows used to control waterfowl disease. A typical value could be 1cfs/20acres, or .05 cfs/ac.
Soil Percolation Rate This is the average soil percolation rate by habitat in terms of inches per day.

Irrigation Irrigation on watergrass is typically applied in June and July to encourage gowth and seed production for waterfowl forage.

Sacramento National Wildlife Refuge
Water Year 2000 Summary

Habitat Type	Flood-up/ Drawdown Date	Acreage	Habitat Coefficient	Unit ET	ET Volume	Precip. Volume	Flood-up Volume		Percolation		Circulation		Habitat Irrigation	Applied Water	ETAW	Unit Applied Water	Unit ETAW
							Habitat Water Depth	Flood-up Volume	Soil Percolation Rate	Volume	Circulation Rate	Volume					
		Ac		In	AF	AF	in	AF	in/day	AF	cfsAc	AF	AF	AF	AF	AF/AC	AF/AC
Permanent Ponds	All Year	168			753	178		0		220		712	0	1304	642	7.8	3.8
Permanent Ponds	All Year	64			288	68		0		96		347	0	652	246	10.2	3.8
Seasonal Marsh	Aug - Mar	1630			4721	1733		2038		1477		1972	0	6827	3656	4.2	2.2
Seasonal Marsh	Sep	9			5	9		11		1		3	0	20	5	2.2	0.6
Seasonal Marsh	Sep - Feb	1630			2744	1733		2038		1055		1471	0	5633	1932	3.5	1.2
Seasonal Marsh	Sep - Mar	1630			3344	1733		2038		1266		1471	0	5633	2423	3.5	1.5
Seasonal Marsh	Oct - Mar	1630			2403	1733		2038		1055		986	0	4039	1525	2.5	0.9
Watergrass	Sep - Apr	255			965	272		319		231		308	159	1299	788	5.1	3.1
Watergrass	Sep - Apr	44			78	48		55		6		13	28	161	75	3.7	1.7
Watergrass	Sep - Apr	256			916	272		320		231		310	160	1446	761	5.6	3.0
Summer Water	Oct - Jul	275			1120	292		344		324		999	0	2182	937	7.9	3.4
Summer Water	Jul -1/2 Apr	18			37	20		0		12		33	0	50	25	2.8	1.4
Summer Water	Jul -1/2 Apr	49			188	50		61		54		178	0	392	157	8.0	3.2
Total		7658			17562	8141		9262		6028		8803		29638	13172	3.9	1.7

Summary	AW	ETAW
Oct	8,731	2,852
Nov	3,321	0
Dec	0	1,396
Jan	0	0
Feb	0	0
Mar	722	1,497
Apr	541	1,376
May	660	769
Jun	1,146	792
Jul	687	543
Aug	3,896	802
Sep	9,934	3,145
Total	29638	13172

Supply	GCID Canals	GCID Drains	Total
Oct	6648	1034	7682
Nov	3808	954	4762
Dec	0	0	0
Jan	0	0	0
Feb	0	0	0
Mar	240	0	240
Apr	720	0	720
May	502	0	502
Jun	618	0	618
Jul	638	0	638
Aug	2454	364	2818
Sep	5533	876	6409
Total	21161	3228	24389

Supply	AF	Reuse	s/g ratio
Estimated Total Water Supply	**24,389**		
Reuse of Total Water Supply	5,249	17.71%	
Groundwater			
Feather River			
Butte Creek			
Rice Drainage			
Colusa Basin Drain			
Sacramento River - Riparian			
Sacramento River - CVP	24,389		
Local Creek			

Fall (Oct-Mar) AW	12,774
Season (Apr-Sep) AW	16,864
Fall (Oct-Mar) ETAW	5,745
Season (Apr-Sep) ETAW	7,427

Northern District Water Budgets

- Inflow-Outflow Analysis
  - By DAU/County subarea
- Develop Land Use/Water Source Data
- Collect Diversion Data
- Develop Water Demands
  - Ag Water Use
  - Urban Water Use
  - Managed Wetland Water Use

Detailed Water Balance
2000 Actual Year Scenario
Colusa Basin

		GLE 163	COL 163	YOL 163	GLE 164	COL 164	YOL 164	TOTAL
	Local Surface Water	3.0 TAF	3.0 TAF	3.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	9.0 TAF
S	**State Water Project**	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF
U	**Central Valley Project / Sacramento River**	503.5 TAF	636.4 TAF	13.8 TAF	14.7 TAF	161.2 TAF	99.3 TAF	1,428.9 TAF
P	**Other Federal**	2.1 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	2.1 TAF
P	**Ground Water**	272.6 TAF	86.0 TAF	81.8 TAF	25.6 TAF	92.1 TAF	3.7 TAF	561.8 TAF
L	**Sub-Total (Prime Supply)**	781.2 TAF	725.4 TAF	98.6 TAF	40.3 TAF	253.3 TAF	103.0 TAF	2,001.8 TAF
Y	Inflow Drain Water	19.2 TAF	239.1 TAF	86.1 TAF	0.0 TAF	30.9 TAF	29.2 TAF	404.5 TAF
	Carry-over Drainage Reuse	8.8 TAF	54.7 TAF	4.0 TAF	0.2 TAF	7.5 TAF	0.0 TAF	75.2 TAF
	Reclaimed Waste Water	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF
	Total Supply	809.2 TAF	1,019.2 TAF	188.7 TAF	40.5 TAF	291.7 TAF	132.2 TAF	2,481.5 TAF
	Evapotranspiration of Applied Water							
	Agricultural: ETAW	432.2 TAF	459.3 TAF	93.8 TAF	21.1 TAF	184.4 TAF	77.6 TAF	1,268.4 TAF
D	Wildlife Refuge	10.5 TAF	13.9 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	24.4 TAF
E	Municipal & Industrial	2.0 TAF	2.3 TAF	0.0 TAF	0.0 TAF	1.0 TAF	0.0 TAF	5.3 TAF
P	Fall Flood / Private Wetland: Rice Drainage	2.6 TAF	12.9 TAF	1.6 TAF	0.1 TAF	2.5 TAF	0.0 TAF	19.7 TAF
L	Fall Flood / Private Wetland: Supply	16.9 TAF	19.5 TAF	0.1 TAF	0.3 TAF	2.8 TAF	3.1 TAF	42.7 TAF
E	**Other Consumptive Losses**							
T	Conveyance System Evaportation: Supply	2.5 TAF	3.2 TAF	0.1 TAF	0.1 TAF	0.8 TAF	0.5 TAF	7.2 TAF
I	Riparian ET: Supply	13.2 TAF	10.4 TAF	2.0 TAF	0.7 TAF	3.4 TAF	1.5 TAF	31.2 TAF
O	Miscellaneous Agricultural ET	6.9 TAF	7.4 TAF	1.3 TAF	0.3 TAF	3.1 TAF	1.3 TAF	20.3 TAF
N	Miscellaneous Wildlife Refuge ET	0.2 TAF	0.5 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.7 TAF
	Miscellaneous Fall Flood / Private Wetland ET	1.0 TAF	1.2 TAF	0.0 TAF	0.0 TAF	0.1 TAF	0.1 TAF	2.4 TAF
	Total Depletion	488.0 TAF	530.6 TAF	98.9 TAF	22.6 TAF	198.1 TAF	84.1 TAF	1,422.3 TAF
P	**Percolation of Applied Water**							
E	Conveyance System Percolation	76.3 TAF	102.3 TAF	0.7 TAF	1.3 TAF	22.6 TAF	9.4 TAF	212.6 TAF
R	Agricultural Percolation (Surface water)	23.4 TAF	33.3 TAF	2.4 TAF	0.1 TAF	11.2 TAF	6.3 TAF	76.7 TAF
C	Wildlife Refuge Percolation	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF
O	Fall Flood / Private Wetland Perc.: Supply	2.6 TAF	2.8 TAF	0.0 TAF	0.0 TAF	0.2 TAF	0.3 TAF	5.9 TAF
L	Fall Flood / Private Wetland Perc.: Rice Drainage	0.5 TAF	4.9 TAF	0.0 TAF	0.0 TAF	1.0 TAF	0.5 TAF	6.9 TAF
A	***Subtotal***	102.8 TAF	143.3 TAF	3.1 TAF	1.4 TAF	35.0 TAF	16.5 TAF	302.1 TAF
T	Percentage of subtotal (Deep Percolation)	36.0 TAF	35.8 TAF	0.9 TAF	0.7 TAF	8.8 TAF	4.1 TAF	86.3 TAF
I	Groundwater Percolation (Agricultural)	34.3 TAF	10.3 TAF	7.0 TAF	1.9 TAF	19.6 TAF	0.1 TAF	73.2 TAF
O	M & I Percolation (Septic & Outdoor Deep Percolation)	3.0 TAF	1.5 TAF	0.0 TAF	0.0 TAF	0.4 TAF	0.0 TAF	4.9 TAF
N	**Total Deep Percolation**	73.3 TAF	47.6 TAF	7.9 TAF	2.6 TAF	28.8 TAF	4.2 TAF	164.4 TAF
	Conveyance System Spill and Seepage	15.9 TAF	31.9 TAF	0.2 TAF	0.4 TAF	4.8 TAF	3.0 TAF	56.2 TAF
O	**Agricultural & Enviornmental Drainage**							
U	To Other DAUs within County	0.0 TAF	28.4 TAF	35.0 TAF	14.7 TAF	0.0 TAF	6.8 TAF	84.9 TAF
T	To Same DAU, Out of County	223.2 TAF	53.2 TAF	0.0 TAF	0.0 TAF	26.7 TAF	0.0 TAF	303.1 TAF
F	To Other DAU, Out of County	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	25.8 TAF	0.0 TAF	25.8 TAF
L	Out of PA, Outflow to Ocean, or Outflow to Salt Sink	0.0 TAF	272.8 TAF	42.7 TAF	0.0 TAF	0.0 TAF	34.1 TAF	349.6 TAF
O	**Wastewater**	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF	0.0 TAF
W	**Total Outflow**	239.1 TAF	386.3 TAF	77.9 TAF	15.1 TAF	57.3 TAF	43.9 TAF	819.6 TAF
	Drainage Carry-over to Next Water Year	8.8 TAF	54.7 TAF	4.0 TAF	0.2 TAF	7.5 TAF	0.0 TAF	75.2 TAF

Supply

- Collect data by point of diversion
- Estimate Supply from water source mapping & crop data

  Supply = Surface AW * (1- reuse) /

  (1 – Conveyance Loss)

Detailed Water Balance

2000 Actual Year Scenario

DAU: 163 Name: Willows - Arbuckle

County: Colusa

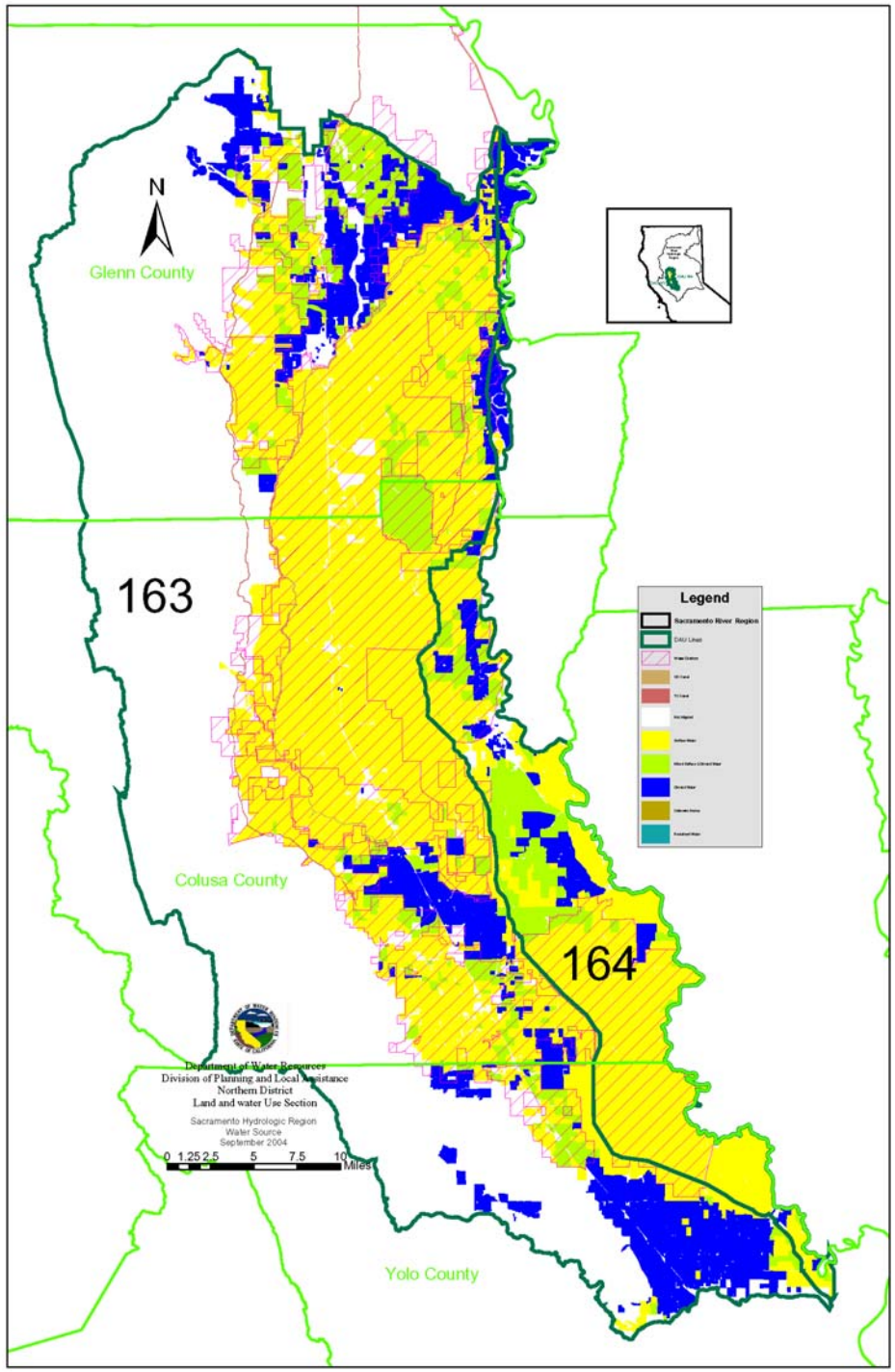
Planning Subarea: Central Basin West

Hydrologic Region: Sacramento River

WATER SUPPLY	Fall/Winter Environmental Use	Ag, M&I and Summer Enviormental Use
Local Surface Water		
Agricultural		3.0 TAF
Wildlife Refuges		
Municipal & Industrial		0.0 TAF
Fall Ag Flood / Private Wetland Management		
State Water Project		
Agricultural		
Wildlife Refuges		
Municipal & Industrial		
Fall Ag Flood / Private Wetland Management		
Central Valley Project / Sacramento River		
Agricultural		528.8 TAF
Wildlife Refuges	24.5 TAF	18.2 TAF
Municipal & Industrial		
Fall Ag Flood / Private Wetland Management	52.4 TAF	12.5 TAF
Other Federal		
Agricultural		
Wildlife Refuges		
Municipal & Industrial		
Fall Ag Flood / Private Wetland Management		
Ground Water		
Agricultural		73.1 TAF
Wildlife Refuges		
Municipal & Industrial		4.7 TAF
Fall Ag Flood / Private Wetland Management	4.5 TAF	3.7 TAF
Sub-Total (Prime Supply)	81.4 TAF	644.0 TAF
Inflow Drain Water	43.1 TAF	196.0 TAF
Carry-over Drainage Reuse	54.7 TAF	
Reclaimed Waste Water		
Total Supply	179.2 TAF	840.0 TAF

Water Source

- Surface Water
- Mixed Water Source
  - represents potential use of both sources on a particular crop
  - defined as a ratio of surface/ground water for a region (e.g., 60/40)
  - Changes from year to year
- Groundwater



Groundwater Extraction

- Utilizes the Applied Water concept

  AW = Acreage x Unit Applied Water = GW

  Where

  Acreage = GW Acreage + % of Mixed Source Acreage

  Unit AW = ETAW / Application Fraction + Cultural Practices

- Assumption:
  - Groundwater extraction for a region is the summation of the applied groundwater on individual fields

Consumptive Use

- ETAW
- Conveyance and Drainage Evap & ET
  - Relationship to Surface Supply, Applied Water, etc.

	Evapotranspiration of Applied Water		
	Agricultural: ETAW		459.3 TAF
	Pre-Irrigation		
	Cultural Practices		
D	Wildlife Refuge	6.7 TAF	7.2 TAF
E	Municipal & Industrial		0.0 TAF
P	Fall Flood / Private Wetland: Rice Drainage	7.0 TAF	5.9 TAF
L	Fall Flood / Private Wetland: Supply	9.4 TAF	10.1 TAF
E	***Other Consumptive Losses***		
T	Conveyance System Evaportation: Supply	0.4 TAF	2.8 TAF
I	Conveyance System Evap.: Rice Drainage	0.0 TAF	
O	Riparian ET: Supply	1.2 TAF	9.2 TAF
N	Riparian ET: Rice Drainage	0.0 TAF	
	Miscellaneous Agricultural ET		7.4 TAF
	Miscellaneous Wildlife Refuge ET	0.5 TAF	0.0 TAF
	Miscellaneous Fall Flood / Private Wetland ET	1.1 TAF	0.1 TAF
	Total Depletion	26.3 TAF	502.0 TAF

Adjustment Factors				
0.5%	0.5%	Est. % of Total Ag Surface Water		
		Est. % of Carry-over Drainage Reuse		
1.5%	1.5%	Est. % of Total Ag Surface Water	1.0%	Est. % of Groundwater Runoff
		Est. % of Carry-over Drainage Reuse		
	1.0%	Est. % of Total Ag AW		
2.0%		Est. % of Total Refuge Surf. Water	2.0%	Est. % of Refuge Applied GW
2.0%		Est. % of Total Flood/Wetland SW	2.0%	Est. % of Flood/Wetland Applied G

Deep Percolation

- Differentiate between seepage and deep percolation
- Relationship to Applied Water, Supply, etc.

	Percolation of Applied Water							
P	Conveyance System Percolation	12.3 TAF	90.0 TAF	16.0%	16.0%	Est. % of Total Ag Surface Water		Est. % of Groundwater
E	Agricultural Percolation (Surface)		33.3 TAF		5.0%	Est. % of Local Surface Water		
R	Wildlife Refuge Percolation					Est. % of Wildlife AW		
C	Fall Flood / Private Wetland Perc.: Supply	2.8 TAF	0.0 TAF	5.0%		Est. % of Total Flood/Wetland from Supply		
O	Fall Flood / Private Wetland Perc.: Rice Drainage	4.9 TAF		5.0%		Est. % of Total Flood/Wetland from Rice Drainage		
L	***Subtotal***	20.0 TAF	123.3 TAF					
A	Percentage of subtotal	5.0 TAF	30.8 TAF	25.0%	25.0%	Est. % of Percolation as Deep Percolation		
T	Groundwater Percolation (Agricultural)							
I	(AW-ETAW) - 20% ETAW		10.3 TAF		20.0%	Est. % reduction of GW percolation		
O	M & I Percolation							
N	Septic & Outdoor Deep Percolation		0.0 TAF	→ Leach lines, Septic Tanks, Urban Irrigation.				
	Total Deep Percolation	5.0 TAF	41.1 TAF					

Outflow

- Use gage readings to calibrate outflow
- Make estimates where no data are available

	Conveyance System Spill and Seepage	3.8 TAF		28.1 TAF	1,2,3		5.0%	Est. % of Operational Spill and Seepage Contributing to Outflow				
O	*Agricultural & Enviornmental Drainage*								**Outflow Distribution**			
U	To Other DAUs within County	11.5 TAF		17.2 TAF	1	→	31.2 TAF drains to Colusa Co. DAU 1		Fall	Season		Fall Dist.	S. Dist.
T	To Same DAU, Out of County	21.6 TAF		32.1 TAF	2	→	58.5 TAF drains to Yolo Co. DAU 163.		11.8 TAF	19.4 TAF	COL164	8.00%	8.00%
F	To Other DAU, Out of County	0.0 TAF		0.0 TAF					22.2 TAF	36.3 TAF	YOL163	15.00%	15.00%
L	Out of PSA, Outflow to Ocean, or Outflow to Salt Sin	111.0 TAF		164.8 TAF	3	→	300.3 TAF drains to Sacramento Rive		0.0 TAF	0.0 TAF			
O	*Wastewater*			0.0 TAF					113.9 TAF	186.4 TAF	OUT	77.03%	76.95%
W	*Fall Storage-Spring Release*								147.9 TAF	242.1 TAF		100.03%	99.95%
	Total Outflow	147.9 TAF		242.2 TAF									
	Drainage Carry-over to Next Water Year	0.0 TAF		54.7 TAF									
	State of Balance: Balanced / Balanced	0.0 TAF		0.0 TAF									

Water Balance

- Calibrate using known outflow or estimates of outflow
- Closure term is deep percolation
- Sacramento Valley Water Balances usually take multiple iterations where drainage flows are exchanged between DAU/County subareas