

# Dry- and Wet-Season Sampling for Federally Listed Large Branchiopods



**DRY-SEASON SAMPLING  
FOR  
FEDERALLY-LISTED LARGE BRANCHIOPODS  
AT THE  
CONNECTION SLOUGH AREA  
OF THE  
2-GATES PROJECT**



*Prepared for:* **MOSAIC ASSOCIATES, LLC**  
647 Tennent Avenue, Suite 102  
Pinole, CA 94564  
*Contact:* Judy Bendix  
(510) 964-0394

*Prepared by:* **HELM BIOLOGICAL CONSULTING, LLC**  
2273 Nolen Drive  
Lincoln, CA 95648  
*Contact:* Brent Helm  
(916) 543-7397

**February 2009**



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“I certify that the information in this survey report and attached exhibits fully and accurately represent my work.”

Todd F. Wood    Signature     Date 2-13-09



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**DRY-SEASON SAMPLING  
FOR  
FEDERALLY-LISTED LARGE BRANCHIOPODS  
AT THE  
CONNECTION SLOUGH AREA  
OF THE  
2-GATES PROJECT**

**INTRODUCTION**

Helm Biological Consulting, LLC was contracted by Mosaic Associates, LLC to conduct dry-season sampling for large branchiopods (fairy shrimp, tadpole shrimp, and clam shrimp) that are listed as threatened or endangered under the federal Endangered Species Act (e.g., vernal pool fairy shrimp [*Branchinecta lynchi*] and vernal pool tadpole shrimp [*Lepidurus packardii*]) at the Connection Slough Area of the 2-Gates Project .

The Connection Slough Area of the 2-Gates Project is located west of McDonald Island, north of Mildred Island, and southeast of Connection Slough, San Joaquin County, California. Additionally, the Connection Slough Study Area is located in an unsectionalized portion off the Bouldin Island U.S. Geological Survey 7.5 Minute Topographical Quadrangle Map (center coordinates in North American Datum 1983 Universal Transverse Mercator Zone 10 North: Easting 596109.7 and Northing 4252148.6) (Figure 1).

The 2-Gate Project consists of a fish protection plan intended to reduce the take of Delta smelt and other listed fish species, in compliance with the federal and state Endangered Species Acts. Entrainment of Delta smelt at the State Water Project (SWP) and Central Valley Project (CVP) export pumps would be reduced by the installation and operation of two operable gates in the central Delta. The project would also increase the certainty of water supply, and improve water quality. The 2-Gate Project is a five-year pilot project that is fully removable once installed.

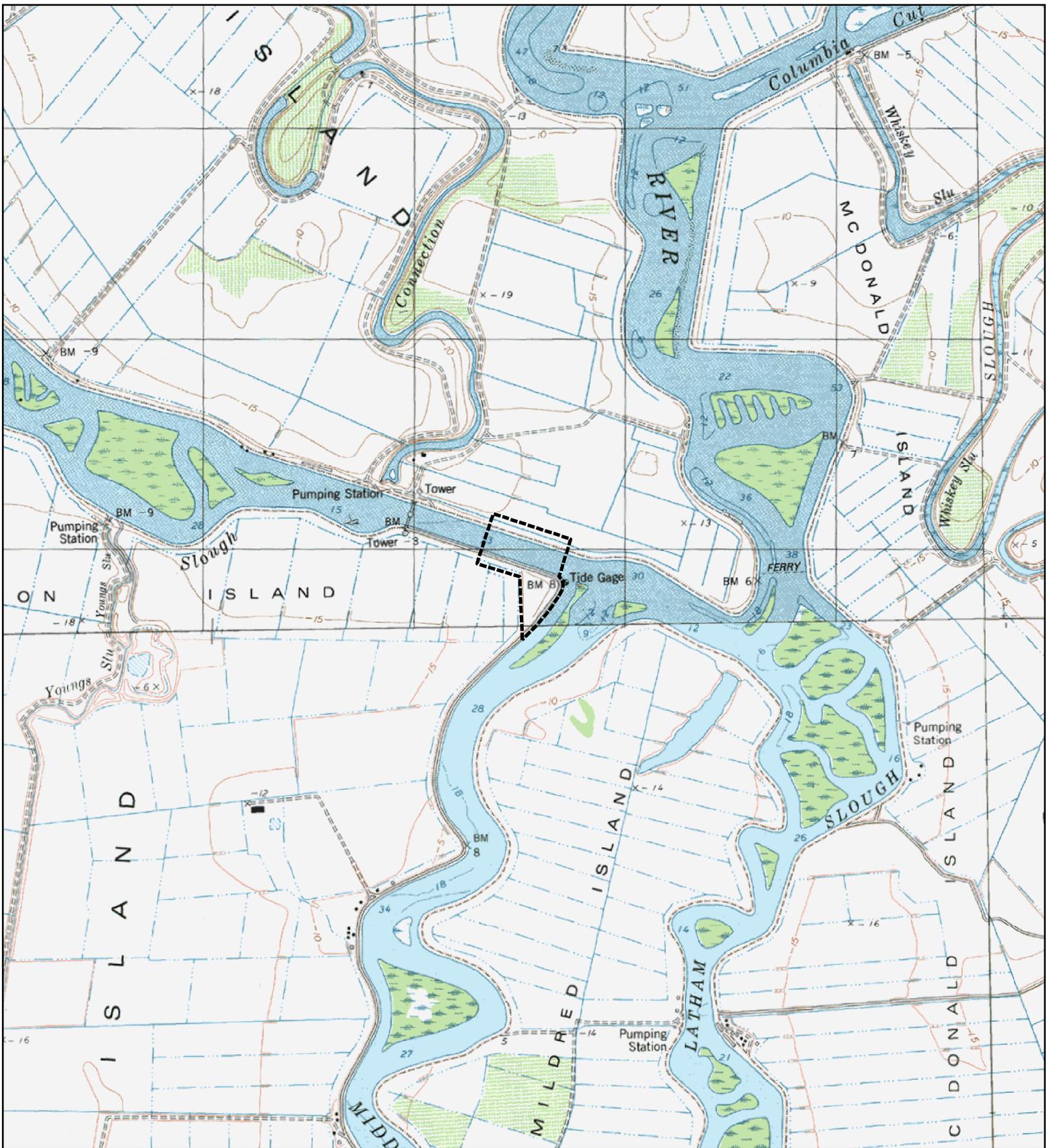
Two gates would be installed in two separate locations, one on Old River and the other on Connection Slough. A wetland delineation has been conducted by Mosaic Associates,



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LLC, and a single 0.5 acre seasonal wetland feature within the Connection Slough Area was assessed as potential to support the vernal pool fairy shrimp and vernal pool tadpole shrimp.

This report discusses the methods and results of the dry-season sampling for the presence of federally-listed large branchiopod at the Connection Slough Area of the 2-Gates Project.



Property Center Coordinates in NAD 1983 UTM Zone 10 N  
 Easting 629442.5 Northing 4207129.5

1:24,000  
 1 inch equals 2,000 feet

 Study Area



Prepared By:  
 Date: 10-1-08



**HELM**  
 BIOLOGICAL CONSULTING, LLC.  
 2273 Nolen Drive, Lincoln, CA 95648

**Figure 1. Connection Slough Area of the 2-Gate Project Location**

(Source: U.S. Geological Survey Bouldin Island 7.5 minute Topographical Quadrangle Map)



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## METHODS

Mr. Todd Wood conducted dry-season sampling on October 29, 2008 as authorized by the U.S. Fish and Wildlife Service (USFWS) (Appendix A). Sampling was conducted under permit TE-795930-5 of Section 10(a)(1)(A) of the federal Endangered Species Act, 16 U.S.C. 1531 *et seq.*, and its implementing regulations. Methods generally followed USFWS's Interim Survey Guidelines to Permittees for Recovery Permits under Section 10(a)(1)(A) of the Endangered Species Act for the Listed Vernal Pool Branchiopods (1996) and are described below.

Dry-season sampling involved the collection of 20 sub-samples of soil, mainly from the lowest topographic areas within the basin considered potential habitat for federally-listed large branchiopods by Mosaic and Associates, LLC. Soil samples were placed in liter size plastic freezer bags and marked with the project name, basin number, and date. The soil was then transported to Helm Biological Consulting's, LLC laboratory for processing and analysis.

In the laboratory, a brine solution was prepared by mixing table salt (NaCl) with lukewarm tap water in a large container. The collected soil material was placed in the brine solution. The soil material was then gently worked by hand to breakdown any persistent soil structure. The organic material rising to the top of the brine solution was skimmed off and placed in a 710-micron diameter pore-size sieve stacked atop a 75-micron diameter pore-size sieve. The soil material was processed through the top sieve by flushing it with lukewarm tap water while gently rubbing it with a soft-bristle brush. The soil retained from the 75-micron diameter pore size sieve was then removed and thinly ( $\approx 1.0$  mm) spread into plastic petri dishes.

The contents of each petri dish were examined under a 10 to 252-power zoom binocular microscope. A minimum of 0.5-hour was spent searching the contents of each petri dish for large branchiopod cysts (embryonic eggs). Helm Biological Consulting's, LLC large branchiopod cyst reference collection and scanning electron micrographs of cysts (Hill and Shepard 1998, Mura 1991, and Gilchrist 1978) were used to identify and compare any cysts observed within the soil samples.



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## RESULTS

Visual examinations of the soil collected from the basin on site did not reveal any evidence of federally-listed large branchiopods (e.g., cysts or carapaces of *Lepidurus* sp.) (Exhibit A). The soils supported only evidence of insects exoskeletons (mainly ants) and flatworm cysts (microturbellaria).

Representative photographs of the basins on site are in Appendix B.



**Legend**

-  Study Area
-  Coastal and Valley Freshwater Marsh
-  Seasonal Wetland
-  Ruderal Herbaceous
-  Agricultural
-  Open Water



Mapscale: 1:2,100 (1 inch = 175 feet)



Exhibit A. Habitats on the Connection Slough Study Area.  
 Basemap Source: CASIL 2005.

Mosaic Associates LLC  
 647 Tennent Ave., Suite 102  
 Pinole, CA 94564  
 Ph: (510) 964-0394 Fax: (510) 964-0396



## LITERATURE CITED

Gilchrist, B. M. 1978. Scanning electron microscope studies of the egg shell in some Anostraca (Crustacea: Branchiopoda). *Cell Tiss. Res.* 193: 337-351.

Hill, R. E., and W. D. Shepard. 1998. Observation on the identification of California anostracan cysts. *Hydrobiologia* 359: 113-123.

Mura, G. 1991. SEM morphology of resting eggs in the species of the genus *Branchinecta* from North America. *J. Crust. Biol.* 11: 432-436.

U. S. Fish and Wildlife Service. 1996. Interim Survey Guidelines to Permittees for Recovery Permits under Section 10 (a)(1)(A) of the Endangered Species Act for the Listed Vernal Pool Branchiopods. 11 pp.



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## APPENDIX A. USFWS AUTHORIZATION LETTER

**From:** David\_Kelly@fws.gov

**To:** bhelm69485@aol.com

**Cc:** Susan\_P\_Jones@fws.gov; Mary\_Hammer@fws.gov

**Subject:** Authorization to conduct wet and dry season VPb surveys at Connection Slough in San Joaquin County

**Date:** Thu, 16 Oct 2008 2:40 pm

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By this electronic mail message and in response to your recent request (October 1, 2008, fax), Mr. Brent Helm (TE-795930-5) is authorized to conduct:

Dry-season survey and follow-up wet season survey of vernal pool branchiopods (including *Branchinecta* spp.) per the conditions of his Recover Permit, under the Endangered Species Act and the Interim Survey Guidelines to Permittees for Recovery Permits under Section 10(a)(1)(A) of the Endangered Species Act for the Listed Vernal Pool Branchiopods (USFWS; April 19, 1996) at the Connection Slough area of the 2-Gate Project in San Joaquin County.

Please remember to have all biologists carry a copy of their permit while doing the work, and to follow the terms and conditions of the permit and the survey protocol, including the reporting requirements. In your report, please include which surveys were authorized, the names of all persons involved the surveys, their recovery permit numbers, and the date of this authorization, to help ensure that we correctly record the fulfillment of the reporting requirement under this authorization. Please let us know if the surveys are not performed as authorized, or if they are done by a different permittee under a separate authorization.

Please keep in mind that the Service can authorize surveys that establish presence, but not surveys where the purpose is to determine absence when there is a reason to believe that the species can be present even when they are not detected. Such reasons would include species characteristics that make it hard to detect, habitat suitability, and proximity to known occurrences of the species. Therefore, if additional information becomes available to us that indicate that listed crustaceans are likely to be present at the project site, the Service may determine that the species are present even if your surveys have failed to detect individuals or cysts. Please keep in mind; all soil samples collected for dry-season sampling must be collected during the dry season. The dry season is defined generally as that time between April 15th and until the first qualifying rain event on or before October 15th, defined as a frontal precipitation of more than one half of an inch for 24 hours.

Please send separate copies of the report(s) to the San Joaquin Valley Branch (Attn. Mary Hammer) and David Kelly (of this office) at the time of any formal or informal consultation under section 7 of the Endangered Species Act with the Fish and Wildlife Service.

Please reference track number 84120-2009-TA-0051 in future correspondence concerning this sampling.  
Thank you.

David Lee Kelly  
Fish and Wildlife Biologist  
Recovery Branch  
US Fish and Wildlife Service  
2800 Cottage Way  
Sacramento, CA 95825  
Ph. (916) 414-6492



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## APPENDIX B. REPRESENTATIVE PHOTOGRAPH

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Large Branchiopod Dry-Season Sampling  
Connection Slough Area of the 2-Gates Project

Ph: (916) 543-7397  
Fax: (916) 543-7398



2-Gates Project – The seasonal wetland found on site photograph taken facing northwest.



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April 20, 2009

Mr. David Lee Kelly  
Recovery Branch  
U.S. Fish and Wildlife Service  
2800 Cottage Way, W-2605  
Sacramento, CA 95825-1846

RE: RESULTS OF THE 2008/2009 WET-SEASON SAMPLING FOR  
FEDERALLY-LISTED LARGE BRANCHIOPODS AT THE CONNECTION  
SLOUGH AREA OF THE 2-GATES PROJECT.

Dear Mr. Kelly:

Wet-season sampling was conducted at the Connection Slough Area of the 2-Gates Project during the 2008/2009 wet-season (Figure 1). Sampling was conducted by Dr. Brent Helm and Mr. Todd Wood under permit TE-795930-5 of Section 10(a)(1)(A) of the federal Endangered Species Act, 16 U.S.C. 1531 *et seq.*, and its implementing regulations. Site visits were conducted on November 14, 2008; December 24, 2008; January 8 and 30, 2009; February 18, 2009; and March 5, 2009 after all major storm events of the 2008/2009 wet-season. The site supports one ½ acre basin on the south side of Connection Slough which never had ponded water during any of the wet-season visits (Exhibit A). Similar results were obtained from dry-season sampling conducted by Helm Biological Consulting, LLC in 2008 (only ant exoskeletons and microturbellaria cysts were observed), indicating a more xeric environment. In conclusion, the basin on site is not considered potential habitat for federally-listed large branchiopods based on our observations during the 2008/2009 wet-season and the results of 2008 dry-season sampling.

This letter constitutes our 90-day report, as per our section 10(a)(1)(A) permit requirements, for wet-season sampling efforts at the Connection Slough Area of the 2-Gates Project.

If you need additional information, please call us at (916) 543-7397. Thank you for your time and consideration in this matter.

Sincerely,



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*Brent Helm*

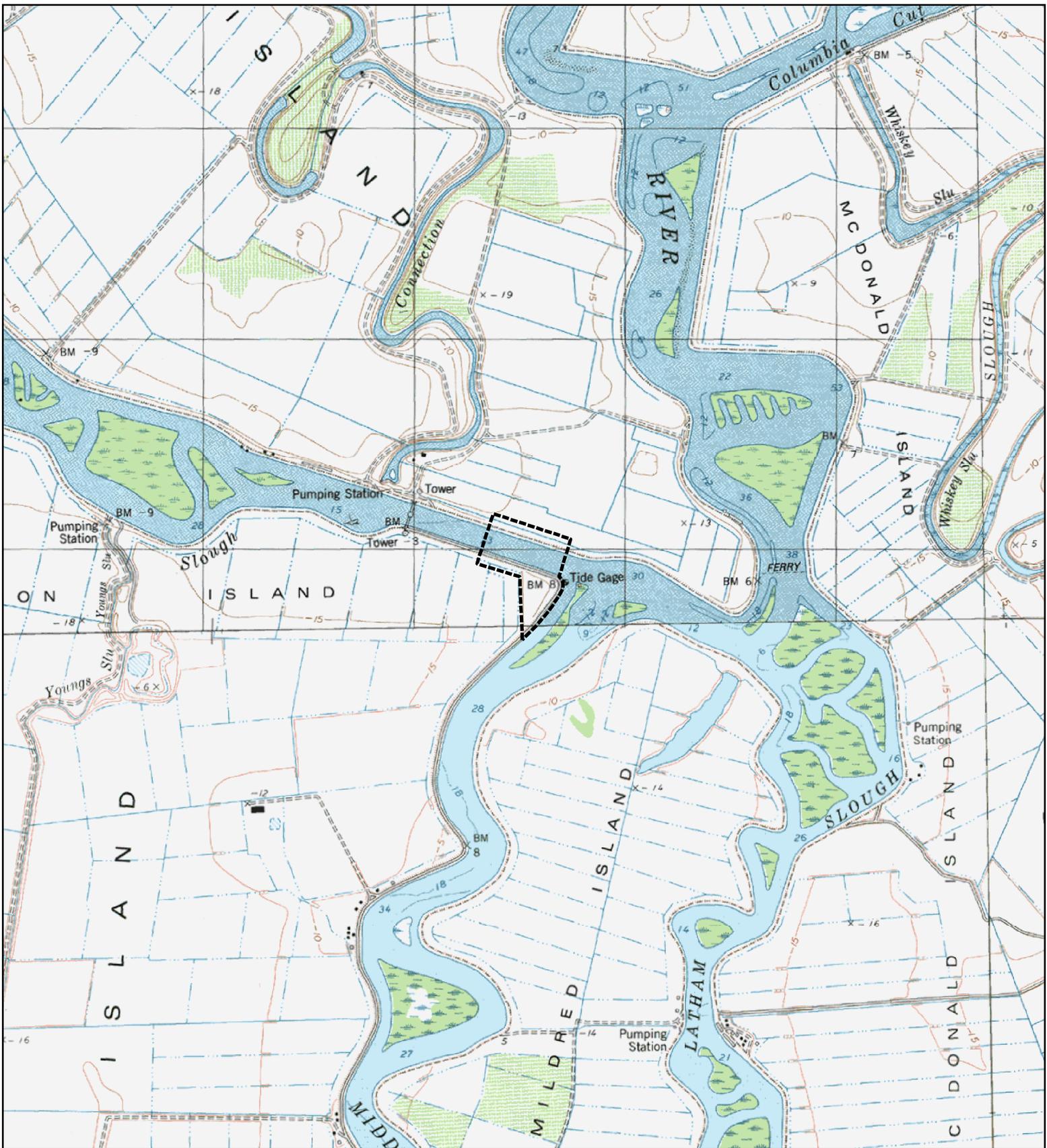
Brent Helm, Ph.D.  
Senior Ecologist

and

*Todd Wood*

Todd Wood  
Wetland Ecologist

CC: Judy Bendix of Mosaic Associates, LLC



Property Center Coordinates in NAD 1983 UTM Zone 10 N  
 Easting 629442.5 Northing 4207129.5

1:24,000  
 1 inch equals 2,000 feet

 Study Area



Prepared By:  
 Date: 10-1-08



**HELM**  
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 2273 Nolen Drive, Lincoln, CA 95648

**Figure 1. Connection Slough Area of the 2-Gate Project Location**

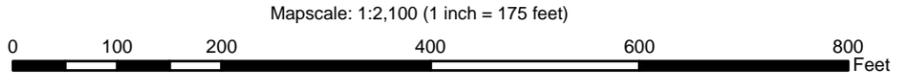
(Source: U.S. Geological Survey Bouldin Island 7.5 minute Topographical Quadrangle Map)



**Legend**

-  Study Area
-  Coastal and Valley Freshwater Marsh
-  Seasonal Wetland
-  Ruderal Herbaceous
-  Agricultural
-  Open Water

Exhibit A. Habitats on the Connection Slough Study Area.  
 Basemap Source: CASIL 2005.



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Supplemental Information on Wet-Season Surveys for Large Branchiopods Provided by Brent Helm, Ph.D., Helm Biological Consulting, Inc., August 5, 2009

According to U.C Davis Statewide Integrated Pest Management Program daily weather report for Tracy, California, a total of 6.81 inches of precipitation fell during the months of November 1, 2008 through March 31, 2009. A summary of the rainfall per site visit is provided below.

- Our first site visit was conducted on November 14, 2008. A total of 0.51 inch of rainfall had occurred during that month prior to sampling.
- Our second sit visit was conducted on December 24, 2008 after a several back-to-back storm events generated 0.76 inch of rainfall. To date 1.65 inches of precipitation had occurred.
- Site visit number three was conducted on January 8, 2009. Between this survey date and the prior survey date only 0.47 inch of rain had occurred. At this date 2.12 inches of rain had been recorded.
- The fourth survey date occurred on January 30, 2009 five days after a fairly large storm event occurred that resulted in 1.77 inches of precipitation. Combined rainfall recorded to date was 3.89 inches.
- Our fifth site visit occurred, on February 18, 2009, one day after 14 days of back - to-back storm events accumulated 2.25 inches of rain. A total of 6.14 inches of rain had been recorded to date.
- Our last site visit occurred on March 5, 2009 one day after a storm event produced 0.44 inch of rain. To date 6.64 inches of precipitation had occurred.

No ponding or soil saturation was observed within the basin during any of the site visits conducted during the wet-season. The basin on site was delineated as a seasonal wetland by Mosaic Associates. Many seasonal wetlands derive there hydrology from high ground water tables or precipitation that saturates the soil, but may never actually pond water. The far majority of habitats that support or potentially could support federally-listed large branchiopods would pond for short durations, after 4 inches of rainfall was received during the winter months (when evaporation and transpiration are at a minimum). Perhaps the seasonal wetland on site never ponds water, or very irregularly pond water during above annual rainfall years, and instead that plants are supported by a high ground water table that is known to occur in the delta.

Given the following:

1. No evidence of federally-listed large branchiopods, nor other crustaceans were observed in the basin during dry-season sampling.

2. No ponding nor soil saturation was observed during the wet-season.
3. The historic habitats on site (i.e., tidal tule marsh) and current habitats on site (i.e., agricultural crops consisting of sun flowers, corn, etc.) are not known to support large branchiopods.

The conclusion is that the basin does not offer habitat for aquatic species, especially those species that are dependent on a minimum of 1 to 2 inches of ponding depth at a duration of two or more weeks, such as the vernal pool fairy shrimp (*Branchinecta lynchi*).



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**Daily weather report for TRACY.A** (CIMIS #167, Tracy)

More about TRACY.A: [Station description](#); More data: [Daily](#) ;

Time Period: November 1, 2008 to April 1, 2009, retrieved on August 7, 2009

Note: All data were retrieved from station TRACY.A. See [retrieval table](#).

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DATE	OBS TIME	PRECIP AMOUNT & TYPE	AIR TEMPERATURE		WIND	ET <sub>o</sub>	SOL RAD	SOIL T		RELATIVE HUMIDITY	BULB TEMP	PAN EVAP
			MAX	MIN				MAX	MIN			
MM DD YYYY	HH:MM	(IN)	MAX	MIN	DD SS	(IN)	(LY)	(F)	(F)	(F)	(F)	(IN)
11-01-2008	23:59	0.39	65	57	NW 4	0.01	49	62	62	91.0	63.3	
11-02-2008	23:59	0.06	69	52	W 4	0.06	238	63	62	91.5	57.3	
11-03-2008	23:59	0.03	66	48	SE 6	0.05	128	62	61	89.3	49.9	
11-04-2008	23:59	0.00	63	47	W 8	0.10	302	61	59	79.6	42.3	
11-05-2008	23:59	0.00	62	43	NW 5	0.09	281	59	58	73.7	45.1	
11-06-2008	23:59	0.00	66	44	W 4	0.09	323	59	58	79.2	49.5	
11-07-2008	23:59	0.00	70	42	SW 3	0.08	324	59	57	89.5	50.2	
11-08-2008	23:59	0.03	67	42	W 6	0.05	154	59	57	87.2	57.8	
11-09-2008	23:59	0.00	66	51	SW 11	0.12	305	58	57	74.1	38.4	
11-10-2008	23:59	0.00	65	40	W 4	0.08	268	58	57	86.9	50.3	
11-11-2008	23:59	0.00	64	41	NW 5	0.07	211	58	56	84.8	59.8	
11-12-2008	23:59	0.00	70	47	N 3	0.08	297	59	57	86.9	56.0	
11-13-2008	23:59	0.00	76	46	W 5	0.11	301	60	57	92.1	43.5	
11-14-2008	23:59	0.00	74	55	W 5	0.11	302	60	59	61.3	36.1	
11-15-2008	23:59	0.00	74	46	SW 3	0.09	295	60	58	72.1	41.7	
11-16-2008	23:59	0.00	76	43	SW 2	0.07	273	59	57	82.8	45.6	
11-17-2008	23:59	0.00	76	46	SW 3	0.08	282	59	56	88.1	48.0	
11-18-2008	23:59	0.00	74	44	SW 2	0.08	281	59	56	85.6	45.5	
11-19-2008	23:59	0.00	67	40	W 4	0.07	263	58	56	92.5	51.8	
11-20-2008	23:59	0.00	68	52	W 7	0.09	277	59	57	80.8	54.5	
11-21-2008	23:59	0.00	64	37	W 5	0.10	289	58	55	64.3	32.3	
11-22-2008	23:59	0.00	68	34	SW 3	0.07	275	56	54	77.7	35.5	
11-23-2008	23:59	0.00	65	36	SW 2	0.06	261	55	53	90.1	51.1	
11-24-2008	23:59	0.00	63	39	NW 4	0.06	200	55	53	87.8	47.0	
11-25-2008	23:59	0.00	62	41	W 3	0.03	109	56	54	81.4	58.2	
11-26-2008	23:59	0.29	56	50	W 2	0.01	47	57	55	90.8	69.6	
11-27-2008	23:59	0.00	63	44	NW 4	0.05	200	57	56	91.8	69.6	
11-28-2008	23:59	0.01	59	40	NW 3	0.02	111	57	55	92.8	66.5	
11-29-2008	23:59	0.00	61	37	SE 3	0.05	241	55	54	92.8	69.1	
11-30-2008	23:59	0.02	59	39	W 2	0.02	133	55	54	93.0	79.9	
12-01-2008	23:59	0.02	50	36	NW 2	0.01	77	55	53	93.3	92.8	
12-02-2008	23:59	0.00	58	37	SE 5	0.02	95	55	54	93.9	83.7	
12-03-2008	23:59	0.01	56	33	NW 3	0.02	127	54	52	93.8	74.5	
12-04-2008	23:59	0.00	58	35	SW 3	0.03	125	55	53	91.6	59.7	
12-05-2008	23:59	0.01	57	35	NW 3	0.03	167	53	52	93.5	68.3	
12-06-2008	23:59	0.00	46	39	S 4	0.01	74	53	52	93.4	86.5	
12-07-2008	23:59	0.00	44	39	SE 3	0.01	70	53	52	93.2	84.4	
12-08-2008	23:59	0.01	45	30	NW 4	0.00	44	52	50	93.7	74.6	
12-09-2008	23:59	0.00	49	26	NW 3	0.02	157	50	49	92.1	76.1	
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12-11-2008	23:59	0.01	54	29	N 3	0.04	217	49	47	87.7	57.9	
12-12-2008	23:59	0.00	64	31	NW 4	0.05	209	51	48	93.6	42.0	
12-13-2008	23:59	0.00	55	43	W 13	0.10	206	51	49	74.8	32.6	
12-14-2008	23:59	0.16	49	31	SE 9	0.04	99	50	48	87.0	60.6	
12-15-2008	23:59	0.19	52	33	SE 7	0.05	202	50	49	89.8	57.5	
12-16-2008	23:59	0.06	43	33	NW 5	0.01	74	49	48	90.1	80.4	
12-17-2008	23:59	0.00	51	32	W 7	0.06	251	48	46	77.4	32.0	
12-18-2008	23:59	0.00	50	26	SE 6	0.05	177	48	46	85.2	57.3	
12-19-2008	23:59	0.02	50	38	SE 5	0.02	85	49	48	88.0	72.2	
12-20-2008	23:59	0.00	50	33	NW 4	0.05	216	48	47	83.5	50.5	
12-21-2008	23:59	0.13	49	35	SE 6	0.01	56	49	47	88.1	75.5	
12-22-2008	23:59	0.07	55	41	W 8	0.06	216	49	48	85.3	55.2	
12-23-2008	23:59	0.00	53	38	E 6	0.04	170	50	48	83.0	55.5	
12-24-2008	23:59	0.13	52	44	SE 10	0.03	62	50	49	85.4	66.2	
12-25-2008	23:59	0.28	53	42	W 13	0.08	187	50	48	85.8	44.3	
12-26-2008	23:59	0.00	51	31	W 6	0.07	249	48	47	77.4	38.7	
12-27-2008	23:59	0.00	54	30	SE 3	0.05	223	48	46	82.7	42.3	
12-28-2008	23:59	0.00	59	34	SE 3	0.05	233	49	47	89.2	50.1	
12-29-2008	23:59	0.00	62	38	SW 3	0.05	231	49	47	91.1	55.9	
12-30-2008	23:59	0.00	55	36	NW 4	0.04	200	50	49	92.8	68.6	
12-31-2008	23:59	0.01	43	36	SE 3	0.01	71	49	48	93.7	92.8	
01-01-2009	23:59	0.00	46	41	SE 4	0.01	56	50	49	92.9	80.4	
01-02-2009	23:59	0.10	51	42	SE 7	0.01	82	50	50	91.0	81.7	
01-03-2009	23:59	0.00	52	37	NW 8	0.07	251	50	48	87.5	36.8	
01-04-2009	23:59	0.00	49	32	W 5	0.06	253	48	47	81.0	40.4	
01-05-2009	23:59	0.07	46	36	SE 5	0.01	57	48	47	91.6	76.4	
01-06-2009	23:59	0.00	53	35	SE 4	0.04	186	50	48	92.5	69.7	
01-07-2009	23:59	0.01	47	34	E 3	0.01	81	49	48	93.6	81.5	
01-08-2009	23:59	0.00	54	41	NW 6	0.03	146	50	49	89.6	73.6	
01-09-2009	23:59	0.00	57	32	W 4	0.07	266	50	48	85.4	38.5	

01-10-2009	23:59	0.00	61	26	SW	2	0.05	259	48	46	92.6	45.1
01-11-2009	23:59	0.00	63	27	SW	3	0.07	265	48	45	88.0	29.6
01-12-2009	23:59	0.00	73	32	W	3	0.07	264	49	46	86.8	35.1
01-13-2009	23:59	0.00	68	31	SW	3	0.06	261	49	47	93.8	39.4
01-14-2009	23:59	0.00	66	32	SW	2	0.06	270	48	46	87.9	40.8
01-15-2009	23:59	0.00	68	33	SW	2	0.06	262	48	46	87.3	37.7
01-16-2009	23:59	0.00	69	33	SE	3	0.07	258	48	46	90.2	34.2
01-17-2009	23:59	0.00	68	31	SW	3	0.07	262	49	46	88.4	35.2
01-18-2009	23:59	0.00	66	35	W	3	0.07	261	49	47	88.6	37.7
01-19-2009	23:59	0.00	67	32	SW	2	0.07	278	48	46	79.1	35.5
01-20-2009	23:59	0.00	66	34	NW	4	0.08	277	49	46	84.4	31.3
01-21-2009	23:59	0.39	57	40	W	2	0.02	65	49	48	89.5	48.4
01-22-2009	23:59	1.06	52	48	NW	3	0.00	47	50	49	92.6	89.4
01-23-2009	23:59	0.28	55	50	NW	2	0.01	60	52	50	92.9	87.1
01-24-2009	23:59	0.02	62	47	W	7	0.07	258	53	52	93.1	62.6
01-25-2009	23:59	0.02	58	40	W	10	0.10	298	52	51	81.8	48.4
01-26-2009	23:59	0.00	55	38	W	7	0.08	301	51	50	84.2	44.8
01-27-2009	23:59	0.00	56	32	W	5	0.08	305	50	48	70.4	28.7
01-28-2009	23:59	0.00	60	29	W	5	0.08	300	49	46	83.4	37.1
01-29-2009	23:59	0.00	62	33	W	4	0.08	308	49	48	89.5	41.6
01-30-2009	23:59	0.00	65	31	W	2	0.07	292	49	47	92.0	42.7
01-31-2009	23:59	0.00	69	35	W	4	0.08	307	50	47	88.3	33.8
02-01-2009	23:59	0.00	65	36	W	5	0.10	320	50	48	87.6	28.1
02-02-2009	23:59	0.00	63	31	SW	3	0.07	297	50	47	87.0	53.0
02-03-2009	23:59	0.00	65	36	SW	3	0.07	296	50	47	92.0	54.6
02-04-2009	23:59	0.00	62	38	NW	3	0.05	226	51	48	91.6	56.1
02-05-2009	23:59	0.31	60	47	SE	7	0.05	174	52	50	88.5	56.0
02-06-2009	23:59	0.72	55	48	SE	5	0.02	99	53	52	91.7	81.0
02-07-2009	23:59	0.00	61	45	W	6	0.09	327	53	52	92.3	48.9
02-08-2009	23:59	0.04	59	39	SW	6	0.07	232	53	51	89.8	55.7
02-09-2009	23:59	0.00	54	40	W	8	0.09	300	52	50	75.1	36.2
02-10-2009	23:59	0.06	55	33	SE	5	0.08	312	51	49	82.8	35.3
02-11-2009	23:59	0.05	56	40	SE	6	0.04	175	51	50	85.7	57.1
02-12-2009	23:59	0.02	53	40	SE	4	0.05	222	52	50	90.4	57.0
02-13-2009	23:59	0.16	54	40	SE	5	0.06	231	52	50	83.7	50.7
02-14-2009	23:59	0.00	56	39	SE	7	0.08	271	52	50	85.0	56.1
02-15-2009	23:59	0.10	53	44	SE	13	0.07	131	52	51	89.4	61.5
02-16-2009	23:59	0.28	56	44	SE	9	0.05	148	52	51	83.5	57.0
02-17-2009	23:59	0.50	54	41	SE	9	0.05	177	52	50	89.6	66.8
02-18-2009	23:59	0.01	59	33	W	4	0.07	316	52	49	92.3	56.5
02-19-2009	23:59	0.00	61	40	W	3	0.08	361	52	50	91.3	62.7
02-20-2009	23:59	0.00	62	38	NW	4	0.09	325	52	50	89.6	52.0
02-21-2009	23:59	0.01	61	37	SE	4	0.05	199	52	50	89.4	62.9
02-22-2009	23:59	0.02	60	54	SE	11	0.04	66	54	52	88.4	67.0
02-23-2009	23:59	0.02	66	54	SE	7	0.06	209	56	54	89.6	55.6
02-24-2009	23:59	0.00	63	45	NW	4	0.08	283	55	54	90.5	53.1
02-25-2009	23:59	0.00	64	46	W	5	0.09	313	56	54	81.7	51.4
02-26-2009	23:59	0.01	64	46	W	6	0.09	317	56	55	91.3	52.8
02-27-2009	23:59	0.00	60	35	NW	4	0.11	399	55	53	88.8	50.5
02-28-2009	23:59	0.00	61	39	W	3	0.05	199	55	53	88.3	62.9
03-01-2009	23:59	0.03	62	52	SE	8	0.03	41	55	54	88.8	64.4
03-02-2009	23:59	0.02	67	50	S	7	0.09	257	57	55	82.4	51.6
03-03-2009	23:59	0.18	62	47	S	6	0.08	250	56	55	83.9	57.1
03-04-2009	23:59	0.21	56	36	S	4	0.06	250	55	53	87.5	57.6
03-05-2009	23:59	0.00	56	36	W	4	0.06	281	54	52	90.1	59.6
03-06-2009	23:59	0.00	58	43	W	7	0.08	257	53	52	80.7	55.1
03-07-2009	23:59	0.00	61	39	W	5	0.12	447	54	51	81.9	40.9
03-08-2009	23:59	0.00	63	34	W	5	0.13	454	54	51	87.0	41.6
03-09-2009	23:59	0.00	55	37	W	7	0.13	470	53	51	69.9	32.5
03-10-2009	23:59	0.00	57	31	NW	5	0.12	473	52	50	83.6	32.9
03-11-2009	23:59	0.00	61	31	SW	3	0.11	425	52	49	81.0	33.0
03-12-2009	23:59	0.00	67	36	W	6	0.15	467	54	50	79.2	33.2
03-13-2009	23:59	0.00	69	35	NW	4	0.13	475	55	51	87.4	47.8
03-14-2009	23:59	0.00	57	38	W	11	0.15	435	54	52	81.0	52.7
03-15-2009	23:59	0.00	66	44	W	6	0.09	303	55	52	78.1	51.1
03-16-2009	23:59	0.00	67	48	W	5	0.10	342	57	54	83.5	54.8
03-17-2009	23:59	0.00	68	44	NW	5	0.13	432	58	55	91.8	52.3
03-18-2009	23:59	0.00	71	45	W	5	0.14	449	58	56	83.9	41.2
03-19-2009	23:59	0.00	76	47	SW	4	0.16	480	60	56	83.0	38.8
03-20-2009	23:59	0.00	73	41	W	5	0.16	492	60	56	86.1	49.3
03-21-2009	23:59	0.03	65	45	W	7	0.09	265	59	57	76.8	55.6
03-22-2009	23:59	0.14	57	40	W	10	0.15	428	57	54	80.0	35.6
03-23-2009	23:59	0.00	61	38	W	9	0.18	521	54	52	60.3	25.6
03-24-2009	23:59	0.00	69	43	W	7	0.18	515	57	53	67.6	33.2
03-25-2009	23:59	0.00	72	40	W	7	0.18	475	58	54	80.6	29.7
03-26-2009	23:59	0.00	75	52	W	10	0.22	515	59	56	70.9	30.8
03-27-2009	23:59	0.00	75	51	NW	7	0.21	531	61	57	58.6	25.7
03-28-2009	23:59	0.00	79	41	NW	6	0.20	526	61	57	78.4	33.1
03-29-2009	23:59	0.00	65	51	NW	13	0.26	549	60	56	69.3	16.4
03-30-2009	23:59	0.00	67	43	NW	9	0.22	548	58	54	51.1	22.7
03-31-2009	23:59	0.00	74	37	W	7	0.22	528	58	54	65.7	26.0
04-01-2009	23:59	0.00	76	54	W	11	0.25	539	60	57	54.9	27.2

152 records listed

Codes in columns with an asterisk (*) designate the station used to fill in missing data (for data to left of code).	Code	Data from
	1	Backup station 1
	2	Backup station 2
	A	Long-term averages

**Retrieval Table**

Stations used to fill in missing data

Time period: November 1, 2008 to April 1, 2009, retrieved on August 7, 2009 (152 days)

Variable	Data values from station	Data values from backup station 1	Data values from backup station 2	Data values from averages	Data values missing
Precipitation	152 TRACY.A	0 MATENCA.A	0 MODESTO.A	0 TRACY.C	0
Air Temperature, max/min	152 TRACY.A	0 MANTECA.A	0 MODESTO.A	0 TRACY.C	0
Soil Temperature, max/min	152 TRACY.A	0 MANTECA.A	0 MODESTO.A	0 LODI.A	0
Relative Humidity, max/min	152 TRACY.A	0 none	0 none	0 none	0
Reference Evapotranspiration	152 TRACY.A	0 none	0 none	0 none	0
Solar Radiation	152 TRACY.A	0 MANTECA.A	0 MODESTO.A	0 MANTECA.A	0
Wind Speed & Direction	152 TRACY.A	0 none	0 none	0 none	0

**Measurement details about TRACY.A variables:**

**Air temperature:** Daily max/min measured at 1.5 m (4.92 ft).

**Precipitation:** Daily total measured in a 20 cm (8 in) diameter gauge.

**Soil temperature:** Daily max/min measured at a 15 cm (6 in) depth.

**Humidity:** Daily max/min relative humidity measured at 1.5 m (4.92 ft).

**Evapotranspiration:** Calculated from CIMIS hourly values.

**Solar radiation:** Daily global radiation measured by Licor pyranometer at 2 m (6.5 ft).

**Wind speed & direction:** Daily average measured at 2 m (6.5 ft).

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