



Water Resources ♦ Flood Control ♦ Water Rights

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October 17, 2011

Ms. Barbara Evoy
Deputy Director
Division of Water Rights
PO Box 2000
Sacramento, CA 95812-2000

**Subject: Permit 21274 (Application 31426) Water Diversion and Use
Monitoring Plan**

Dear Ms. Evoy:

On behalf of Reclamation District 108 (District) we hereby submit the enclosed Water Diversion and Use Monitoring Plan (Plan) required under terms 16 and 17 of Permit 21274 (Application 31426). The District intends to conduct the work required to implement the enclosed Plan in early 2012 in order for it to be used during the 2012-2013 diversion season.

Permit 21274 was issued to the District on October 18, 2010. The permit covers diversions for rice straw decomposition, recreational, fish and wildlife enhancement and irrigation purposes within the District from November 1 through February 1 of each year. Term 16 of the permit requires the District to develop and submit a Plan, subject to approval by the Division of Water Rights (Division), identifying a methodology for determining water diverted and consumptively used and water diverted and non-consumptively used under the permit. Term 17 of the Permit requires the District to report the quantities consumptively used and non-consumptively used in the annual Progress Reports by Permittee submitted by the District. The enclosed Plan describes the methodology for both determining and reporting the quantities as required under Permit 21274.

Due to the lack of available information regarding the quantities of water necessary for consumptive and non-consumptive uses for the purposes authorized under Permit 21274, the District explored several options as described in the attached Plan. In the process of developing the Plan, the District has become aware of interest by other parties, including the California Rice Commission and University of California at Davis, in winter water use for rice straw decomposition. Because rice straw decomposition is presumed to be the major use of water under Permit 21274, the District intends to follow and possibly participate in future work by others in this regard. If at some time in the future the District determines adjustments to the methodology for determining consumptive and non-consumptive uses under Permit 21274 are appropriate or necessary, it will request modifications to the Plan in writing to the Division, in accordance with Term 16.

Please call if you have any questions.

Sincerely,
MBK ENGINEERS


Gary Kienlen

GK/
3935/BARBARAEVOY 2011-10-17

Enclosure

cc: Mr. Lewis Bair
Ms. Maya Ferry-Stafford

Reclamation District 108
Water Diversion and Use Monitoring Plan

October 2011

Introduction

Reclamation District No. 108 (District) has prepared and is submitting this Water Diversion and Use Monitoring Plan (Plan) pursuant to Term 16 of Permit 21274 (Application 31436). As further described below, the purpose of the Plan is to identify a methodology for determining water diverted and consumptively used and water diverted and non-consumptively used pursuant to Term 16 Permit 21274. In addition, this Plan provides a reporting methodology to determine the amount of water diverted and consumptively used for rice straw decomposition and irrigation, and non-consumptively used water for rice straw decomposition and for fish and wildlife enhancement and recreation.

Background

The District filed Application 31436 with the State Water Resources Control Board (State Water Board) Division of Water Rights (Division) on May 13, 2003 for appropriation of water from the Sacramento River during the season from November 1 through February 1 of each year. Permit 21274 was issued on October 18, 2011. The following table summarizes the priority, source, purpose of use, quantity of use and season authorized by Permit 21274.

Permit 21274 (Application 31436)	
Priority	May 13, 2003
Source	Sacramento River
Purpose	Irrigation, Wildlife Enhancement, Rice Straw Decomposition, and Recreation
Amount Direct Diversion	240 cfs
Maximum Quantity	36,000 af per year
Season	November 1 to February 1
Place of Use	Net of 18,000 acres within gross area of 47,057 acres within service area of RD 108.

In addition to standard terms and conditions, Permit 21274 contains several special terms. It is the intent of this Plan to address and satisfy *Terms 16 and 17* of this Permit. The Permit Terms are identified below for reference;

Term 16. Within one year of permit issuance, Permittee shall develop and submit to the Division a Diversion and Use Monitoring Plan (Plan), subject to approval by the Deputy Director of Water Rights, that includes:

- a. A methodology (including assumptions) for determining water diverted and consumptively used and non-consumptively used under this permit;*
- b. The locations of water measurement, if any.*

Term 17. The Permittee shall report annually on the Progress Report by Permittee, as determined pursuant to the approved Water Diversion and Use Monitoring Plan the following;

- a. The quantity of water diverted and consumptively used that is applied to (i) rice straw decomposition;*
- b. The quantity of water diverted and consumptively used that is applied to (ii) irrigation;*
- c. The quantity of water diverted and non-consumptively used that is applied to (iii) rice straw decomposition;*
- d. The quantity of water diverted and non-consumptively used that is applied to (iv) fish and wildlife enhancement and recreation.*

Quantity Diverted

Diversions under Permit 21274 will occur at two existing points of diversion. Both pumping plants are equipped with state of the art fish screens and totalizing flow meters. These meters will be used to measure and report the total quantities diverted under the permit.

Differentiating between Consumptive vs Non-Consumptive Uses

Water diverted under Permit 21274 will generally be used for rice straw decomposition. The practices associated with the flooding of fields for rice straw decomposition also provides benefits related to fish and wildlife enhancement, specifically habitat for local and migratory water fowl and for recreational uses such as hunting and bird watching. Irrigation uses are limited to irrigation of late season crops during November or pre-irrigation during drier years.

The requirement under Permit 21274 to differentiate between water diverted and consumptive used and water diverted and non-consumptive used is not a common requirement. In fact the District is aware of no other permit or license covering the uses and season authorized under Permit 21274 that contains this requirement. Additionally, although much information exists for determining consumptive uses by irrigated crops, there is little or no information regarding consumptive or non-consumptive uses for rice straw decomposition in published literature. Therefore, the District explored several approaches or methods for making this determination.

Water Balance Approach

In order to differentiate between the quantities diverted and consumptively used and those diverted and non-consumptively used the District first considered a simple water balance approach. Under this method the District would measure the quantity diverted from the river under Permit 21274 and the quantity returned to the river at its drainage facilities. Unfortunately, the District's drainage system receives water from sources other than tailwater resulting from its diversions and deliveries. These other sources include tailwater from lands outside of the District, rainfall runoff, and seepage into drainage canals from the high water table. Because the District has no control over these other water sources there is no direct way to determine how much water may have originated from each of these

sources. Therefore, the water balance approach is not appropriate to meet the requirements of Permit Term 16.

Consumptive Use Approach

It is understood that diversions from the Sacramento River and effective precipitation are the two primary sources of water available to meet demands within the District during the authorized season for Permit 21274. The quantity of diversions from the Sacramento River that would be characterized as consumptively used is equal to the amount of evapotranspiration (ET) minus the effective precipitation. The remaining water diverted from the river is assumed to be returned to the Sacramento River and is characterized as non-consumptively used.

Under a consumptive use approach, the quantities consumptively used for irrigation and rice straw decomposition would be determined. The quantities non-consumptively used would then be calculated as the difference between the quantity diverted under Permit 21274 and the quantity consumptively used.

The Consumptive Use approach is based on the following assumptions:

Consumptive Use (CU)	=	Water diverted that is not returned to the surface water system
Irrigation CU	=	Crop Evapotranspiration (ET _c)
Rice Straw Decomposition CU	=	Surface Evaporation (CU _{RD})
F&W Enhancement CU	=	F&W enhancement occurs over same area as rice straw decomposition; therefore, unless water is applied for F&W purposes on lands not flooded for rice straw decomposition, the CU for F&W (CU _{FW}) is the same CU from rice straw decomposition; these quantities are not additive
Non-Consumptive Use	=	Diversions - CU _{RD} - ET _c - CU _{FW}

Determining Consumptive Use

The District researched and considered several methods for determining Consumptive Uses under Permit 21274. The following section identifies the options and alternatives based on the assumptions described above in order to differentiate the quantity of water diverted from the Sacramento River pursuant to Permit 21274 that is consumptively versus non-consumptively used.

SEBAL

SEBAL (Surface Energy Balance Algorithm for Land) was developed by Dr. Wim Bastiaanssen of The Netherlands. SEBAL uses spectral radiances recorded by satellite-based sensors, plus ordinary meteorological data, to solve the energy balance at the earth's surface. Its primary outputs are water consumption, or ET. However, identifying the quantities ET from different sources, such as irrigation and rice straw decomposition as well as weeds, riparian vegetation, and canal water surfaces can require a significant amount of data post processing. Based on discussions with representatives of

SEBAL North America, Inc. the District determined the use of SEBAL for the purposes of determining reporting consumptive use pursuant to Terms 16 and 17 of Permit 21274 would be cost prohibitive.

CIMIS/Weather Station

The California Irrigation Management Information System (CIMIS) is a program of the Office of Water Use Efficiency (OWUE), California Department of Water Resources (DWR) that manages a network of over 120 automated weather stations in the state. CIMIS weather stations collect weather data on a minute-by-minute basis, calculate hourly and daily values and store them in the dataloggers. The data collected by the weather stations is used to calculate a reference evapotranspiration. Although in some areas alfalfa is used as the reference crop, in the Sacramento Valley ETo is the loss of water from a standardized grass surface over which the stations are sitting. Crop coefficients (Kc) are used with ETo to estimate specific crop evapotranspiration (ETc). Crop coefficients vary by crop, stage of growth of the crop, and by some cultural practices.¹

There are no CIMIS stations located within the District; however, both daily and monthly ETo data is available for the CIMIS station located at Nicolaus approximately 10 miles to the east. Crop coefficients have been developed for the major crops grown in the Sacramento Valley, including those with the District. Crop coefficients can be found in publications by CIMIS, the Irrigation and Training Research Center (ITRC) at California Polytechnic University, San Luis Obispo, and the University of California at Davis. The ITRC published a report in January 2003² that contains monthly ETo, ETc, and precipitation data for typical, wet and dry year types.

None of the published information contains crop coefficients for rice straw decomposition.

Pan Evaporation

Little or no information has been found regarding the consumptive use of water related to rice straw decomposition. In general practice once the rice field is harvested the rice straw is chopped and turned into the soil. The field is then flooded to accelerate the decomposition process. Once flooded the field is essentially nothing more than an open water body. Therefore, it is reasonable to assume that evaporation from the water surface is the consumptive use for rice straw decomposition. Evaporation pans are used in many areas for determining surface evaporation. Research of existing data found no evaporation pan data in the vicinity of RD 108. These pans are relatively inexpensive and easy to install and maintain. Manufacturers' specifications for placement, operation and maintenance of evaporation pans must be followed to assure the pans provide accurate data.

¹ The University of California Cooperative Extension has prepared two leaflets on crop coefficients: [Leaflet #21427](#) - "Using Reference Evapotranspiration (ETo) and Crop Coefficients to Estimate Crop Evapotranspiration (ETc) for Agronomic Crops, Grasses, and Vegetable Crops" and [Leaflet #21428](#) - "Using Reference Evapotranspiration (ETo) and Crop Coefficients to Estimate Crop Evapotranspiration (ETc) for Trees and Vines". These crop coefficients are designed for use with CIMIS ETo information.

² California Crop and Soil Evaporation for Water Balances and Irrigation Scheduling/Design January 2003, ITRC Report 03-001

Methodology for Determining Water Consumptively and Non-Consumptively Used

As identified above the terms contained in Permit 21274 require the District to develop a methodology for determining water diverted and consumptively used and non-consumptively used. The methodology must include any assumptions and identify locations of any measurements. In addition, the methodology must allow the District to report the quantities of water diverted and consumptively used for rice straw decomposition and the quantities diverted and non-consumptively used for rice straw decomposition and for fish and wildlife enhancement and recreation.

Based on the above discussion the District intends to use a consumptive use approach utilizing the crop ET method based on CIMIS for determining consumptive and non-consumptive use for water diverted and applied for irrigation. For water diverted and applied for rice straw decomposition and fish and wildlife enhancement and recreation the pan evaporation approach will be used. The assumptions and methods to be utilized are described below.

Assumptions

Diversions, consumptive use is generally considered to be the evapotranspiration of the crops (ETc) of being grown.

Consumptive Use (CU) = Water diverted under Permit 21274 that is not returned to the surface water system

Irrigation CU = Crop Evapotranspiration (ETc)

Rice Straw Decomposition CU = Surface Evaporation (CU_{RD})

F&W Enhancement CU = F&W enhancement and recreational uses occur over same area as rice straw decomposition; therefore, unless water is applied for F&W purposes on lands not flooded for rice straw decomposition, the CU for F&W (CU_{FW}) is the same CU from rice straw decomposition; these quantities are not additive

Non-Consumptive Use = Diversions - CU_{RD} - ETc - CU_{FW}

Quantity Diverted

Diversions under Permit 21274 will be measured utilizing totalizing flow meters the District's Wilkins Slough and Emery Poundstone Pumping Plants located as follows:

Pumping Plant	Coordinates ¹	40-acre Subdivision	Section, Township, Range
Wilkins Slough	N2,130,572 feet E6,610,675 feet	SW ¼ of SE ¼	Sec 35, T14N, R1E, MDB&M
Emery Poundstone	N2,105,148 feet E6,608,242 feet	SW ¼ of SW ¼	Sec 26 T13N, R1E, MDB&M

¹ Reference to California Coordinate System of 1983, Zone 2

Quantities Consumptively Used

Irrigation

The quantity of water diverted and consumptively used for irrigation will be calculated based on the ET of the crops irrigated under the Permit. The ETc will be calculated monthly based on the reference ET ETo published for the CIMIS station located at Nicolaus and monthly crop coefficients based on the ITRC Report for the crops grown and hydrologic conditions.

Rice Straw Decomposition

The District will install and maintain an evaporation pan within the District to measure the rate of surface evaporation. The evaporation pan will be located at a site yet to be determined. The evaporation pan installed in accordance with the manufacturers specifications and generally recognized practices. The measured surface evaporation data will be adjusted to account for precipitation during the permit season. The quantity of water diverted and consumptively use for rice straw decomposition will be calculated by multiplying the acreage flooded for rice straw decomposition each month by the adjusted pan evaporation for the month.

Quantities Non-Consumptively Used

As identified in the assumptions above, the quantity of water diverted and non-consumptively used under Permit 21274 will be calculated as the difference between the quantity diverted under the permit and the quantities consumptively used.

Irrigation

Irrigation uses during the season covered under Permit 21274 are typically limited to irrigation of late season crops in drier years during November. Deliveries to the fields in which these types of crops are grown are measured by the District. Therefore, the quantity diverted and non-consumptively used that is applied for irrigation will be calculated as the measured quantity delivered to fields for irrigation minus the quantity determined to be consumptively used as calculated above.

Rice Straw Decomposition

The quantity diverted and non-consumptively used that is applied for rice straw decomposition will be calculated as the difference between the quantity diverted under Permit 21274, less the quantity measured and delivered for irrigation purposes, minus the quantity consumptively used for rice straw decomposition as calculated above.

Fish and Wildlife Enhancement and Recreation

As identified in the assumptions above, fish and wildlife enhancement and recreational uses generally occur simultaneously rice straw decomposition. That is these uses occur on the same lands, at the same time, and with the same water. Therefore, the water diverted and non-consumptively used that is applied for these purposes is accounted for under quantities that would be reported as non-consumptively used for rice straw decomposition. In the event that water would be diverted and applied solely for these purposes in areas not utilizing water for rice straw decomposition, the quantity

consumptively and non-consumptively used will be determined using the same methodology as for rice straw decomposition.

Reporting

As required under Term 17 of Permit 21274, the quantities of water diverted and consumptively and non-consumptively used as determined under the methods described above will be reported annually in the Progress Report by Permittee.