WATER QUALITY

HISTORICAL CONDITIONS

Prior to Euro-American Contact (pre-1850)

As summarized in the hydrology and geomorphology sections, the Colusa Basin (i.e., the lowland area adjacent to the Sacramento River) has been greatly altered from its historical state. Prior to Anglo-American contact, the Colusa Basin likely functioned as a substantial sink for sediments and nutrients flowing from the Sacramento River and various tributaries. Therefore, the Colusa Basin likely served as a nutrient and sediment filter during high flows when flood waters would overtop banks and flow into the once vast riparian and wetland habitats adjacent to waterways. It is likely that these ecosystem processes improved downstream water quality by reducing sediment loads, nutrient concentrations, and peak flows.

Post Euro-American Contact (post-1850)

The historical data for this assessment is a compilation primarily from Environmental Impact Statements regarding the Tehama-Colusa Canal and the Glenn-Colusa Irrigation District. These sources assess surface and groundwater quality and provide data on the chemical make up and physical properties of the water samples collected. The historical data obtained in this report begin in 1952. There is limited data on pesticide analyses prior to 1977; however, pesticide information post-1980 is reported. Specific data and historical information regarding surface water and groundwater from 1952 to the mid-1980s is described below.

Surface Water

Non-rice Pesticides. Data on pesticides prior to 1980 in the Colusa Basin Drain were not readily obtainable. Therefore, the following summary of water quality data on non-rice pesticides begins in 1980. Although DDT was banned by the U.S. Environmental Protection Agency [EPA] in 1972, it was detected in fish of the Colusa Basin Drain between 1980 and 1984 at levels greater than fish from other waters of the state and was also detected in small amounts in the Colusa Basin Drain as late as 1987 (EPA 1972). Pesticide concentrations were lower in the water and sediment; however, they tended to accumulate in the tissues of the organisms living in the Colusa Basin Drain. Endrin, Dieldrin, Aldrin, Kelthane, or their breakdown products were detected in the Colusa Basin Drain (Turek 1990).

From 1980 to 1984, the following organic chemicals were detected in fish from the Colusa Basin Drain: Chlordane, Dachthal, DDT, Dieldrin, Endosulfan, alpha HCH (hexachlorocyclohexane), Nonachlor, PCB , (polychlorinated biphenyls), toxaphene, and chemical group A. Toxaphene exceeded National Academy of Sciences (NAS) guideline of 100 parts per billion (ppb) for the protection of aquatic life and their predators. Between 1980 and 1984, 3 fish were found to exceed the NAS guidelines for toxaphene. Simazine, diazinon, and endosulfan sulfate were found in 1987 (Turek 1990).

Rice Pesticides. We found little information and data on pesticide levels prior to 1977 in the Colusa Basin Drain after an extensive literature search. Between 1977 and 1982, molinate and thiobencarb applications spiked resulting in elevated concentrations in the Colusa Basin Drain and Sacramento River. Studies by the DWR indicated that fish kills, primarily carp, in the Colusa Basin Drain and Reclamation Slough between 1976 and 1983 resulted from a high concentration of molinate (Turek 1990). The DFG found thiobencarb at elevated concentrations as well (Turek 1990). High concentrations of molinate cause anemia and death in carp. In 1980 and 1981 molinate peaked at 374 µg/L in the Colusa Basin Drain. In 1982, levels peaked to 700 µg/L in the Colusa Basin Drain and 42 µg/L in the Sacramento River. In 1983 rice farmers were required to have a 4-day holding period after application of the pesticides before they could discharge, resulting in lower levels in the Colusa Basin Drain. Over the next few years the molinate holding time was extended to 14 days, resulting in very low concentrations of the pesticides reaching the Sacramento River (Turek 1990).

Bentazon use increased in the 1980s and concentrations of 16 µg/L were detected in major agricultural drains and the Sacramento River in 1985 and 1986 (Turek 1990). It was also detected in finished tap water for the City of Sacramento in 1986. Bentazon use doubled from 1987 to 1988 resulting in a peak concentration of 5.5 µg/L in the Colusa Basin Drain and 0.8 µg/L in Sacramento River (Turek 1990).

Mercury. Mercury is a trace metal that occurs naturally in the environment. It can be toxic to humans and other organisms even at low concentrations. In California, mercury can be found throughout many watersheds due to both natural occurrence and human influences redistributing it through activities such as mining or use of fossil fuels (Gassel et al. 2005). In the environment, mercury cycles through soil, water, and organisms. The Sacramento River Basin has mercury from both natural geologic deposits and as a legacy from mercury and gold mining in the Sierra Nevada and Coast ranges. Mercury is currently considered the most serious water quality problem in the Sacramento River, some tributaries of the Sacramento River, and downstream locations including the San Francisco Bay (Domagalski 1998).

Regulatory agencies have implemented maximum concentrations of mercury to protect aquatic life and human health. The EPA National Recommended Ambient Water Quality Criteria for Freshwater Aquatic Life Protection recommended 4-day average concentration for total mercury is 770 ng/L (Marshack 2003). The California Toxics Rule Inland Surfacewater 30-day average for human health drinking water sources (consumption of water and of aquatic organisms like fish) is 50 ug/L. (Marshack 2003, Domagalski et al. 2000, EPA 1999)

Depending on environmental conditions, mercury in aquatic systems may be transformed into methylmercury. Methylmercury is more able to bioaccumulate than elemental mercury in fish and other organisms. Either elemental or methylmercury may be present in water, sediment and aquatic biota. For example, more than 95% of the mercury found in fish occurs as methylmercury (Domagalski et al. 2000). Bioaccumulation and biomagnification increase the concentration of mercury found in organisms along the food chain; the higher on the food chain, the higher the amount of mercury in the organism. Consumption of fish is the major route of human exposure to methylmercury.

Dissolved mercury analyses showed that no mercury was detected within the Colusa Basin Drain in Colusa County. However, in 1974 0.9 µg/l of mercury was detected north of Colusa County at a site within the drainage area of the Colusa Basin Drain (USGS 1975). The precise location of sample collection is not known.

Trihalomethanes (THMs). During the 1980s, trihalomethanes (THMs) were detected in the City of Sacramento's drinking water (Turek 1990). No concentrations were reported by the author. The source for this drinking water was at the time primarily surfacewater from the Sacramento River. THMs are considered a water treatment disinfection by-product and are formed by the chlorination of organic material and some are considered carcinogenic. A study carried out in 1987 by DWR indicated that the Colusa Basin Drain had a higher THM formation potential than the Sacramento River, and the river had a higher potential for THM formation below the Colusa Basin Drain outfall than upstream. This finding suggested that agricultural drainage waters were in part increasing the THM formation potential of the river.

Analysis of data presented in Bay Delta and Tributaries [BDAT] Project site (BDAT 2008) presents limited data on THMs. Specifically, data on the THMs chloroform, dibromochloromethane (DBCM) and bromodichloromethane (BDCM) collected at the Colusa Basin Drain between 1993 and 2001 indicate that the concentration of these THMs has decreased over time. For example, the concentration of DBCM was 17 ug/L in 1994 and dropped to non-detect in 2001. The concentration of these THMs at no time exceeded the drinking water maximum contaminant level for total THMs of 100 ug/L.

Conventional Water Quality Parameters (dissolved oxygen, pH, turbidity, conductivity, trace elements). DWR studies from 1952 to 1964 provide data on conventional water quality parameters for the Colusa Basin Drain (DWR 1964). The sampling locations in the Colusa Basin Drain extended from Highway 20 to Knights Landing. Over a period of 9 years the lower area of the Colusa Basin Drain mostly met standards of Class I water, only 2 of 63 collected samples exceeded standards. This classification of the water likely uses the USDA Agricultural Handbook #60 qualitative standard for irrigation water. In particular, Class I water is suitable for irrigation under most circumstances with equivalent total dissolved solids (TDS) less than approximately 175 mg/L.

Furthermore, the USBR reported in an EIS the levels of dissolved oxygen (DO), pH, turbidity, electrical conductivity (EC), TDS, and trace elements including Ca, Mg, K, Na, CO_3, etc., between 1962-1971 (Bureau of Reclamation 1975). Throughout this sampling period at Highway 20, the DO held constant ranging from 8.4-10.2 mg/L with the peak in 1970, and pH remained fairly constant with values ranging from 7.7-8.2. Turbidity was only measured from 1969-1971 and had a decreasing trend of 181 NTU (Nephelometric Turbidity Units) to 121 NTU. EC ranged from 612 µmhos/cm to a peak of 807 µmhos/cm in 1967. TDS was measured starting in 1965 and ranged from 386-495 mg/L with a peak in 1967. Most trace elements held fairly constant; however, Na had a decreasing trend falling from 102 mg/L to 76 mg/L. Samples from Knights Landing took place from 1967-1971. Data are similar to those taken at Highway 20 with fairly steady values. However, the only difference is an increasing trend of DO: levels increased from 8.8-11.0mg /l from 1968-1971. The Sacramento River above the Colusa Basin Drain and below Knights Landing were also sampled from 1962-1971 and reported in the impact statement. DO and pH held constant between the 2 sampling regions. Average turbidity was lower below Knights Landing with values averaging 34 NTU, EC was also lower with values averaging 175 µmhos/cm, TDS was not measured and Na was higher with averaging values of 11 mg/L. Boron was measured in both regions and was detected at no more than 0.1 mg/L. No data was available on nitrogen or phosphorus values. The results of this study indicate suggest that the water is of good quality throughout, and the input of the Colusa Basin Drain at Knight's landing did not significantly impact water quality. Increased sodium values do suggest a slight increase in salts, possibly due to leaching from cultivated land upstream of the drain.

Reports regarding the Tehama-Colusa Canal Project present that TDS increase in return flows to the Sacramento River, which includes collector drains such as the Colusa Basin Drain (USBR 1972). The Colusa Basin Drain also accepts drain water and irrigation run off from the Glenn Colusa Irrigation District. According to the Return Flow Water Quality Appraisal by Low et al. (1974) compiled for the calendar year of 1973, the water quality parameters (EC, TDS, turbidity and Suspended Solids [SS]) were typical of irrigated waters. Flow weighted averages of EC in the Colusa Basin Drain was 402 µmhos/cm, TDS was 220 mg/L, turbidity was 31 NTU, and SS was 36 mg/L. These values are averages of samples taken during the April-October irrigation season.

Groundwater

Data on groundwater analysis from 1969 to 1971 from various wells within Colusa County was taken from near Williams and Maxwell (USBR 1975). Average pH held fairly constant between Maxwell and Williams but EC was higher in Maxwell at 1050 µmhos/cm and 792 µmhos/cm in Williams. TDS and sodium (Na) levels were also slightly higher in Maxwell with respective values of 630 mg/L and 134 mg/L. Williams had average TDS of 444 mg/L and Na of 92 mg/L. Sulfate (SO_4) levels were also higher in Maxwell, 142 mg/L; but NO_3 levels were higher in Williams with an average of 7.8mg/L.

Chemical analysis of the groundwater within the Tehama-Colusa Canal Service Area is available for the years 1974 and 1977 (USGS 1975 and 1977). Groundwater was sampled from wells throughout the service area and included regions near the Colusa Basin Drain. Analytes measured in the 1975 report were sampled from August-October in 1974 and include dissolved silica, Al, Fe, Mn, Ca, Mg, Na, K, bicarbonate, alkalinity, sulfate, Cl, F, N (nitrate and nitrite), P, dissolved solids, hardness, specific conductance (SC), pH, temperature, As and B. Dissolved constituents sampled and analyzed were ammonium, Cd, Cr, Co, organic C, Pb, Li, Hg, Mo, Ni, Se, Sr, V, and Zi. The SC of samples within the range of the Colusa Basin Drain in Colusa County varied from 257-1710 µmhos. Dissolved Boron ranged from 0-2900 µg/l within the same area.

The 1977 USGS document states that the groundwater from over 200 well samples was suitable for most agricultural and domestic uses. Typical for the area, dissolved solids ranged from 150-1000 mg/L and there were negligible levels of toxic or phytotoxic compounds. However, it was found that near the city of Arbuckle and Williams there were relatively high concentrations of B, Cl, Na, and dissolved solids. According to the report it was assumed that the sources of these compounds were saline springs and seeps.

The following 5 documents were reviewed and no relevant information was found:

- Battling the River – a History of Reclamation District 108 (Bayse 2003)
- Colusa Basin Study: Environmental Appraisal (USBR 1974)
- Colusa Basin Investigation (DWR 1964)
- Return Flow Water Quality Appraisal, Glenn-Colusa Irrigation District, Calendar Year 1973 (Low et. al 1974)
- Water Quality Data of the Sacramento River, California: May 1972 to April 1973 (USGS 1974)

EXISTING CONDITIONS

Background

This section covers the time period from the mid-1980s to 2007. As summarized in the hydrology section, irrigation water is supplied to the Colusa Basin Watershed primarily by a variety of water suppliers who pump from the Sacramento River. These include, but are not limited, to the Glenn-Colusa Irrigation District, Tehama Colusa Canal Authority, RD108, Princeton Codora Glenn Irrigation District, and the Princeton Irrigation. This water is considered of excellent quality (CH2MHill 2003). Impacts to water quality are thought to occur in the upper watershed from erosion and subsequent downstream sedimentation (CH2MHill 2003). The above geomorphology section provides a summary of the existing information regarding potential sources of erosion in the Colusa Basin Watershed. In contrast, water quality in the valley and lower watershed is influenced by agricultural field drainage and reuse of irrigation water. Both drainage and reuse cause increases in salt and sediment loading and in some cases, pesticide and fertilizer impacts. Municipal wastewater treatment plant discharge and stormwater discharge from Willows, Williams, Maxwell, Dunnigan, and Colusa also contribute to degradation of water quality. The Arbuckle Public Utilities District is not listed by the Regional Water Quality Control Board [RWQCB] as holding a National Pollutant Discharge Elimination System permit for discharge of municipal wastewater. Therefore the quality of water discharged from the wastewater treatment plant and its impacts, if any, to surface water quality in the Colusa Basin are not known.

Surfacewater

Non-rice Pesticides. The organophosphate pesticide Diazinon is a pollutant that is of particular concern in the Colusa Basin Drain. Between 1994 and 2006, of the 118 samples collected by various programs from the Colusa Basin Drain, 30 samples, or approximately 25%, exceeded the DFG threshold of 0.05 ug/L (RWQCB 2007).

In 2002, the Colusa Basin Drain was listed as impaired by the State Water Resources Control Board [SWRCB] as required by Section 303(d) of the Federal Clean Water Act Rationale for 303(d) listing was as a result of the presence of several constituents potentially from agricultural sources. The Colusa Basin Drain was listed for the following insecticides and herbicides: Azinphos-methyl, Carbofuran, Diazinon, Malathion, Methyl Parathion, Molinate, Group A pesticides, and unknown toxicity, while Jack Slough was listed for Diazinon (Larry Walker & Associates 2005, RWQCB 2007). An "unknown toxicity" designation is given to a sample or as rationale for listing if toxicity is noted and attempts using EPA Toxicity Identification Evaluations [TIEs] procedures do not identify a causative agent(s). As a result of these 303(d) listings, Total Maximum Daily Loads [TMDLs] are being developed for the listed constituents that are currently assigned a low to medium priority (Jones & Stokes 2006).

In 2002, the Sacramento Valley Water Quality Coalition [Coalition] formed to comply with the RWQCB's Conditional Waiver for Irrigated Lands, often referred to as the "Ag Waiver" or Irrigated Lands Regulatory Program [ILRP]. Since 2005, the Coalition has executed a water quality Monitoring and Reporting Program Plan. The ILRP requires the implementation of management plans to mitigate water quality problems in specific areas in sub-watersheds where water quality monitoring reveals exceedences that are attributed to irrigated agricultural practices. The Coalition monitors water quality at the following locations in and around the Colusa Basin:

- Colusa Basin Drain above Knights Landing
- Freshwater Creek at Gibson Road
- Logan Creek at 4 Mile-Excelsior Road
- Lurline Creek at Interstate 5
- Walker Creek at County Road 48
- Colusa Basin Drain near Maxwell Road

The Coalition makes a variety of water column and sediment measurements including the following analytes:

- <u>General Chemistry</u>: pH, Conductivity, DO, Temperature, Color, Hardness, Turbidity, TDS, Total Suspended Solids, Total Organic Carbon
- <u>Pathogen Indicators</u>: *E. Coli* bacteria
- *Water Column and Sediment Toxicity*: Ceriodaphnia, 96 hour acute; Pimephales, 96 hour acute; Selenastrum, 96 hour short-term chronic; Cell Growth; Hyalella 10 day short-term chronic
- <u>Pesticides</u>: Carbamate, Organochlorine, Organophosphorus, Pyrethroid, and Chlorinate Herbicides
- <u>Trace Elements</u>: Arsenic, Boron, Cadmium, Copper, Lead, Nickel, Selenium, Zinc
- <u>Nutrients</u>: Total Kjeldahl Nitrogen, Phosphorus, Soluble Orthophosphate, Nitrate as N, Nitrite as N, Ammonia as N

The Coalition recently reported results from sampling in 2007 (Larry Walker & Associates 2007).

Complete mortality was observed in toxicity tests conducted with Ceriodaphnia on samples collected in December 2006 at Colusa Basin Drain above Knight's Landing. Use of TIE indicated that a metabolically activated pesticide (which includes organophosphate pesticides such as Diazinon and Chlorpyrifos) was a significant cause of toxicity. No organophosphate, organochlorine, triazine, or pyrethroid pesticides were detected in the sample, but a low concentration (0.26 µg/L) of Diuron, a pre-emergent herbicide, was detected (Larry Walker & Associates 2007). Follow-up samples collected at the Colusa Basin Drain and did not cause any

Ceriodaphnia toxicity, indicating the toxicity was not persistent at the site 6 days after the original samples were collected. No specific cause of the toxicity was determined.

In 2007, the Coalition reported 2 detections of the insecticide Diazinon (0.0088 to 0.0475 µg/L) and one each of the herbicide Simazine (0.0595 ug/L) and the insecticide Dimethoate (0.0352 µg/L) in the Colusa Basin Drain at Knights Landing in February and March 2007. Both reported detections of Diazinon were below the Colusa Basin Plan water quality goal of 0.05 µg/L (RWQCB 1998). No applicable water quality objective currently exists for Dimethoate. The detection of Simizine was below the drinking water Maximum Contaminant Level [MCL] of 4 µg/L (Marshack 2003).

The detection of trace concentrations of a variety of pesticides in the Colusa Basin Watershed is not unexpected given the intensity and history of production agriculture in the area. The concentration of some of these pesticides are in excess of regulatory limits, and a variety of regulatory programs, such as the Irrigated Lands Program and 303(d) listing, are in place to address this issue. In general, in spite of detected water quality impacts from the presence of these pesticides, the surface water quality in the Colusa Basin Watershed is adequate to support existing uses which are predominantly agricultural. The quality of surface water in the Sacramento River appears to be largely unaffected by the presence of pesticides and as a result is of high quality.

Legacy Pesticides. The USGS National Water Quality Assessment [NAWQA] data also suggest that Dichlorodiphenyldichloroethylene concentrations in the Colusa Basin Drain were 2-100 times higher in biota than other sample sites in the Sacramento River watershed (Domagalski et al. 2000). Although DDE was detected in the Knights Landing Ridge Cut and Willow Slough Bypass, only 3 of 12 samples reported detectable levels in 2005 (Larry Walker & Associates 2005). Monitoring results presented by Larry Walker & Associates in 2004-2005 indicate that water quality of the Colusa Basin Drain is similar to water found currently in the Willow Slough Bypass (Larry Walker & Associates 2005).

Rice Pesticides. Some of the major pesticides that have been historically used on rice are Molinate, Thiobencarb, and Carbofuran. Rice farming requires that fields be flooded with water throughout the growing season. Molinate and Thiobencarb are applied to control aquatic grasses and weeds, whereas Carbofuran was applied to control insects. During the late 1970s, the levels of rice pesticides in the Colusa Basin Drain were sometimes toxic to fish such as carp as a result of the presence of Molinate. In addition, the concentration of some of these pesticides, particularly Thiobencarb, caused taste and odor problems at the cities of Sacramento and West Sacramento in the late 1970s and early 1980s due to interactions with chemicals at the water treatment plant.

As a result of these problems, a management program was enacted to reduce the levels of these pesticides in streams. The plan requires that rice-field water be retained on fields for one month following pesticide application to allow concentrations in water to be reduced through mechanisms such as volatilization, biological processes, or sunlight-induced degradation. Sampling of rice pesticides during this period showed that concentrations occasionally were in excess of management objectives in agricultural streams, but always were very low in the Sacramento River (Domagalski et al. 2000).

The concentrations of Molinate and other pesticides used in rice farming measured between 1994 and 1998 in the Colusa Basin Drain or in the Sacramento River represent a significant improvement over concentrations measured in previous years (Domagalski 2000). Declining maximum Molinate concentrations found in the Colusa Basin Drain from 1993 to 2000 reflect a trend of decreasing use of Molinate over that time period (Orlando and Kuivila 2004)

As result of improved water and weed management techniques (particularly the increased rice-field retention time), the CRC reports that the total herbicide load (Molinate and Thiobencarb) carried by the Sacramento River dropped from approximately 40,000 lbs in 1982 to less than 125 lbs in 1992 (CRC 2007). The concentration of Thiobencarb in the Sacramento River has been below the secondary public health level since 1986. The concentration of rice herbicides in the Colusa Basin Drain has also declined to less than 10% of pre-1985 levels. Since 1982, the concentration of Molinate in the Colusa Basin Drain decreased from a peak of 357 ug/L in 1981 to 25 ug/L in 1995 (CRC 2007). According to the latest reports from the CRC, Carbofuran use on rice has been cancelled since 2000 and Molinate will no longer be registered after August 31, 2009 (Pers. Comm. R. Firoved 2008 based on actions by USEPA and the California Department of Pesticide Regulation (DPR)).

Mercury Monitoring. Mercury and methylmercury readily adhere to particles of sediment and organic matter. As such, mercury is transported downstream from upstream watershed sources with suspended sediment loads. Streambed sediment samples taken within the Colusa Basin Watershed have concentrations close to the typical amount of mercury present in rocks found on the earth's surface. MacCoy and Domgalski (1999) found average mercury concentrations in sediment of 0.07 μg/kg in the Sacramento River at Colusa and 0.06 μg/kg in the Colusa Basin Drain and detected mercury in aquatic biota at the same sites at concentrations of 0.1 μg/g and 0.24 μg/g, respectively.

The Central Valley RWQCB reviewed existing data on mercury monitoring in the Sacramento Valley and recently prepared a TMDL for mercury in the Delta. In characterizing the total mercury input from upstream sources to the Delta, the TMDL study calculated that between 1984 and 2003, the Colusa Basin Drain contributed 2.7% of the total mercury to the Delta. Monitoring data for 2000-2003 resulted in a calculated mercury load from the Colusa Basin Drain of 3.6% of the total mercury load to the Delta (Wood et al. 2005). A TMDL for mercury is also being considered for the entire Sacramento River Basin.

Sampling by USGS done between February 1996 and April 1998 at the Colusa Basin Drain reported median methylmercury concentrations of 0.19 ng/L (Domagalski et al. 2000; Domagalski 2001). During the same time period, the Sacramento River at Colusa had a median methylmercury concentration of 0.102 ng/L (Domagalski 2001). While there is not a water quality standard for methylmercury, Rudd suggests that a concentration at or below 0.1 ng/L is representative of water in pristine condition (Rudd 1995).

The concentration of mercury in water correlates well with the concentration of mercury adhered to suspended sediment. Domagalski and others correlated high mercury concentrations in sediment in the Colusa Basin Drain with the heavy rains and related elevated sediment loads during the winter of 1997 (Domagalski et al. 2000).

The Sacramento River Watershed Program found mercury concentrations in the Sacramento River at Colusa to be 4.4 ng/L during 1999 and 2000. Levels at the Colusa Basin Drain site were between 7.1 and 19.27 ng/L (CALFED 2003).

Generally speaking, mercury is not a significant problem in the Colusa Basin, and the Colusa Basin Drain has not been identified as a significant source for mercury inputs to the Sacramento River. The presence and concentration of mercury in sediment and surface water in the Colusa Basin Drain appears to be consistent with the average amount of mercury in rock. The most significant sources of mercury in California are as a result of historical mining for both mercury and gold. Because the locations for mining are in either the Coast Range foothills or the Sierra Nevada, and drainages from these areas do not directly empty into the Colusa Basin Drain, significantly elevated concentrations of mercury are not found there.

Groundwater

DPR has conducted extensive investigations of groundwater quality in the Colusa Basin since 1983 (Schuette et al. 2003). Every year, up to 91 pesticides were sampled in up to 161 wells in the Colusa Basin. A total of 14 verified detections were reported over this time period, none above the drinking water MCL. Bentazon accounted for 7 (50%) of the reported detections (Schuette et al. 2003). Bentazon is currently used on dry beans. This pesticide was formerly used on rice, however, rice use of Bentazon was cancelled in approximately 1988 (Pers. Comm. R. Firoved 2008). In 2002-2003, the RWQCB took action in Colusa County as a result of minor (<100 ft^2) groundwater contamination by Simazine that was adequately addressed by soil remediation.

USGS installed and sampled 28 shallow (< 45 ft) wells in rice growing areas of the Sacramento Valley in 1997 (Dawson 2001). At least one health-related state or federal drinking-water standard (maximum contaminant or long-term health advisory level) was exceeded in 25% of the wells for Ba, B, Cd, Mo, or sulfate. At least one state or federal secondary MCL was exceeded in 79% of the wells for chloride, iron, manganese, or TDS. Nitrate and nitrite were detected, but at concentrations below primary drinking water MCLs. Eleven pesticides and one pesticide degradation product were reported in groundwater samples. Four of the detected pesticides were rice pesticides (Bentazon, Carbofuran, Molinate, and Thiobencarb). Pesticides were detected in 89% of the wells sampled, and rice pesticides were detected in 82% of the wells sampled. The most frequently detected pesticide was Bentazon, detected in 20 out of 28 wells (Dawson 2001). No pesticide concentration exceeded its respective drinking water MCL. Bentazon use was suspended in 1989 and banned by DPR in 1992. The environmental fate characteristics of Bentazon suggest that it may migrate and persist in groundwater for extended periods.

In the early 1990s, the ground-water quality in the Colusa Basin area was not entirely suitable for human or agricultural use because of the presence of elevated concentrations of boron, fluoride, chloride, nitrate, sulfate, and volatile organic chemicals ([VOCs] Domagalski 2000; Jones &

Stokes 2006). Recently (Domagalski 2000), reported analysis of samples from 31 existing domestic wells in the greater Colusa Basin Drain area. Only one sample exceeded the drinking water MCL for nitrate and one for the drinking water MCL for arsenic. One or more pesticides were detected in 9 of 31 (29%) of the wells. All detections were below applicable drinking water MCLs. VOCs were not widely detected in the shallow aquifer. However, in one well downgradient from a known point source, 8 different VOCs were detected. One of those VOCs (Trichloroethylene, measured at 5.5 µg/L) exceeded current drinking-water standards (primary MCL is 5 µg/L, Marshack 2003). Trichloromethane [TCA] was the most frequently detected volatile organic chemical (16 of 19 wells). The concentration of TCA did not exceed its MCL and its presence may be attributed to lawn irrigation using water treated by chlorination.

Groundwater quality in the Colusa Basin is generally acceptable for agricultural uses (CH2MHill 2003). With the exception of boron, no naturally occurring groundwater constituent prevents the use of groundwater for irrigation. Throughout most of the Basin, areas may exist where groundwater has salt concentrations high enough to adversely affect yields of commonly grown crops. For example, TDS values range from 120- to 1220-mg/L, averaging 391 mg/L (DWR 2006.) High EC, TDS, adjusted sodium absorption ratio [ASAR], nitrate, and manganese impairments occur near Colusa. High TDS and boron occur near Knights Landing. Localized areas have high manganese, fluoride, magnesium, sodium, iron, ASAR, chloride, TDS, ammonia, and phosphorus.