United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In Reply Refer To:
CRC-Grassland Bypass Project

MAR 19 2009

Ms. Pamela Creedon, Executive Officer
Central Valley Regional Water Quality Control Board
Central Valley Region
11020 Sun Center Drive, #200
Rancho Cordova, California 95670-6114

Dear Ms. Creedon:

The U.S. Fish and Wildlife Service (Service) submits these scoping comments on the proposed extension of the Grassland Bypass Project (GBP) and the associated Amendment of the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Agricultural Subsurface Drainage Discharges. In order to protect the quality of water delivered to wetland areas within the Grassland watershed, and to protect existing and future runs of anadromous fish associated with the San Joaquin River, the Service recommends that the Central Valley Regional Water Quality Control Board incorporate the following actions into requirements for the extension of the GBP:

1. Inclusion of lands north of the GBP's Drainage Project Area into the GBP that still discharge directly into the south Grasslands wetland supply channels;
2. Elimination of discharges into the Delta Mendota Canal from the drainage sumps in the Firebaugh Canal Water District owned by the U.S. Bureau of Reclamation;
3. California Environmental Quality Act/National Environmental Policy Act (CEQA/NEPA) planning that includes evaluation of alternative routes of disposal and/or storage of excess drainage flows that occur during heavy rainfall events and that have historically been discharged into the Grasslands wetland water supply channels;
4. CEQA/NEPA planning that includes evaluation of effects of GBP selenium discharges on San Joaquin River anadromous fish including the proposed San Joaquin River Restoration runs of salmonids; and,
5. Monitoring and reporting for total mercury and methyl-mercury concentrations in water and biotic tissue at all sampling locations of the GBP to establish a mass-balance of sources of mercury in this watershed.

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Our detailed comments are attached. If you have any questions or comments about this letter, please contact Ms. Kathy Wood, Mark Littlefield, or Ms. Joy Winckel of my staff at (916) 414-6600.

Sincerely,

Susan K. Moore

Susan K. Moore
Field Supervisor

Enclosure

**U.S. Fish and Wildlife Service (Service) Scoping Comments on a Proposed Amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Agricultural Subsurface Drainage Discharges**

**Background**

Grasslands Ecological Area

The Grasslands Ecological Area includes over 80,000 acres of Federal, State, and privately-managed marsh, native pasture and riparian zones, including the largest contiguous block of wetlands remaining within the Central Valley. Prior to the early 1900s, this area was part of a vast network of some 4,000,000 acres of wetlands spread throughout the Central Valley. Today that valley-wide network is down to 300,000 acres, of which the Grasslands area is a critical component. As much as 30 percent of the migratory birds that utilize the Central Valley frequent the watershed each winter. The area annually hosts hundreds of thousands of ducks, geese and waterbirds, and is recognized by the Western Hemisphere Reserve Shorebird Network as a place of international importance to wintering and migrant shorebirds. The Grasslands Ecological Area has also been designated a Wetlands of International Importance under the Ramsar Convention, the only international agreement dedicated to the worldwide protection of wetlands.

History of the GBP

During the 1950s and 1960s, farmers on the west side of the San Joaquin Basin (north of Westlands Water District) began installation of subsurface drainage systems to maintain arability of drainage-impaired agricultural lands. Drainage water collected by those systems was commingled with agricultural tailwater and other waters and discharged into sloughs and creeks of the western Grasslands area enroute to the San Joaquin River. That commingled water was also used for management of tens of thousands of acres of wetlands in the area. In light of the findings of Kesterson Reservoir environmental studies, contamination surveys were conducted in the San Joaquin River beginning in the fall of 1984. The contamination surveys revealed elevated concentrations of salts, arsenic, boron, and/or selenium in waters, sediments, food-chain organisms, fish and wildlife collected from the area (Moore *et al.* 1990).

In 1985, drainwater stopped being used as a water supply for the Grasslands' public and private wetlands. The discovery of avian developmental abnormalities at Kesterson National Wildlife Refuge, caused by selenium contamination from drainwater disposal in surface water and disposal impoundments, resulted in changes in management by wetlands managers in the Grasslands area. Between 1985 and 1996, channels in the Grassland Water District (GWD) were used to convey both drainwater and fresh water. Through an agreement between the GWD and the surrounding agricultural districts, drainage entered the southern portion of the GWD through the Agatha Canal or the Camp 13 Ditch. When one channel was carrying drainwater, the other was used to convey fresh water to the wetlands. Then the system was switched so that the wetlands along the other channel could receive fresh water deliveries. This "flip-flop" system required flushing of the channel for 24 hours, and the flushing was an inefficient use of fresh water. Use of

the "flip-flop" system was halted in 1996 with the implementation of the first GBP. With implementation of the GBP from 1996 through 2001, about 93 miles of Grasslands wetland supply channels no longer conveyed drainage from farmlands in the Grassland Drainage Area. The continued use of the San Luis Drain and implementation of the GBP requires a revised Use Agreement and additional environmental compliance.

Water Quality Objectives for the Grasslands Wetlands

In 1988 the Central Valley Regional Water Quality Control Board (CVRWQCB) adopted an amendment to the Basin Plan for regulation of agricultural subsurface drainage discharges from the Grassland Watershed of Merced and Fresno Counties. That amendment included a site-specific selenium objective for wetland water supplies in the Grasslands of 2 µg/L on a monthly mean basis. In 1990, the U.S. Environmental Protection Agency approved the 2 µg/L monthly mean selenium objective for the water delivered to wetland areas within the Grassland watershed. A revised Basin Plan amendment was adopted by the CVRWQCB in 1996, as part of a set of amendments that focused on the control of selenium-laden agriculture subsurface drainage discharges in and from the Grassland watershed. The need to reduce selenium loadings to, and concentrations in, the Grasslands wetland water supplies and downstream waters in order to protect wildlife, including threatened and endangered species, was one of the driving forces behind the CVRWQCB's adoption of the Control of Agricultural Subsurface Drainage Discharges (Grassland Amendments). The Service has previously reviewed and commented on drafts of these amendments. The Grassland Amendments were adopted May 3, 1996, by the CVRWQCB via Regional Board Resolution 96-147, and approved by the State Water Resources Control Board in State Board Resolution 96-078 and by the State Office of Administrative Law on January 10, 1997 (CVRWQCB 1998).

In 2000, the Service and the National Marine Fisheries Service (NMFS) issued a final biological opinion to the Environmental Protection Agency (EPA) on the California Toxics Rule (CTR) (USFWS and NMFS 2000). The CTR biological opinion found with respect to selenium that, "…*the chronic aquatic life criterion for selenium proposed in the CTR [5 µg/L] does not protect listed fish and wildlife dependent on the aquatic ecosystem for development and/or foraging*." The Service and NMFS concluded, "*In aggregate, the weight of scientific evidence supporting a chronic criterion for selenium of < 2 µg/L is now overwhelming*." The Service and NMFS further found that, "*Based on data collected by the U.S. Department of Interior's National Irrigation Water Quality Program (NIWQP) from 26 study areas in 14 western states (including 5 California study areas), a 5 µg/L chronic criterion for selenium is only 50-70 percent protective (Adams et al. 1998; Seiler et al., 2003), as opposed to the 95 percent level of protection that EPA's national water quality criteria are intended to achieve (Stephan et al. 1985). The Service believes the NIWQP data suggest that on a dissolved basis a criterion of 1 µg/L would be required to achieve 95 percent protection, which is approximately equivalent to a 2 µg/L criterion on a total recoverable basis (Peterson and Nebeker 1992).*"

The available body of scientific evidence (the majority of which has been produced subsequent to the EPA's 1987 aquatic life criterion derivation for selenium) supports a chronic criterion of 2 µg/L for the protection of sensitive taxa of fish and wildlife

(USFWS and NMFS 2000). In the absence of site-specific and species-specific data regarding the sensitivity of particular species and/or populations, a criterion of at most 2 µg/L is required to assure adequate protection of threatened and endangered species of fish and wildlife. This is especially warranted considering the steep response curves for selenium (Hoffman *et al*. 1996; Lemly 1998; Skorupa 1998) and the well-demonstrated potential for selenium-facilitated pathogen susceptibility in controlled laboratory studies (Tully and Franke 1935; Whiteley and Yuill 1989; Larsen *et al.* 1997; Wang *et al.* 1997). The Service and NMFS concluded in the CTR biological opinion that selenium-induced immune dysfunctions have the potential to rapidly extirpate entire populations of fish and wildlife via epizootic events (USFWS and NMFS 2000).

Congressional Mandates for Refuge Water Supplies

Two Federal laws have been enacted that include requirements for provisions of adequate water quality to refuges. Section 3406(d) of the Central Valley Project Improvement Act (Public Law 102-575) requires firm water supplies be provided of "*suitable quality*" to maintain and improve wetland habitat on units of the National Wildlife Refuge System in the Central Valley of California, Los Banos and North Grasslands Wildlife Management Areas; and on the Grasslands Resource Conservation District. The National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57) Section 5(F) states that the Secretary of Interior shall, "*assist in the maintenance of adequate water quantity and water quality to fulfill the mission of the System and the purposes of each refuge*."

In 2001, the Bureau of Reclamation (Reclamation) and the Service entered into a Memorandum of Understanding (MOU) providing for Central Valley Project and acquired water supplies to units in the National Wildlife Refuge System in the San Joaquin Valley (USBR and Service 2001). With respect to water quality, that MOU stipulated, "*the water delivered by Reclamation to the Service pursuant to this MOU shall be of suitable quality to maintain and improve wetland habitat areas…*"

Water quality in Grasslands wetland water supplies during the existing GBP

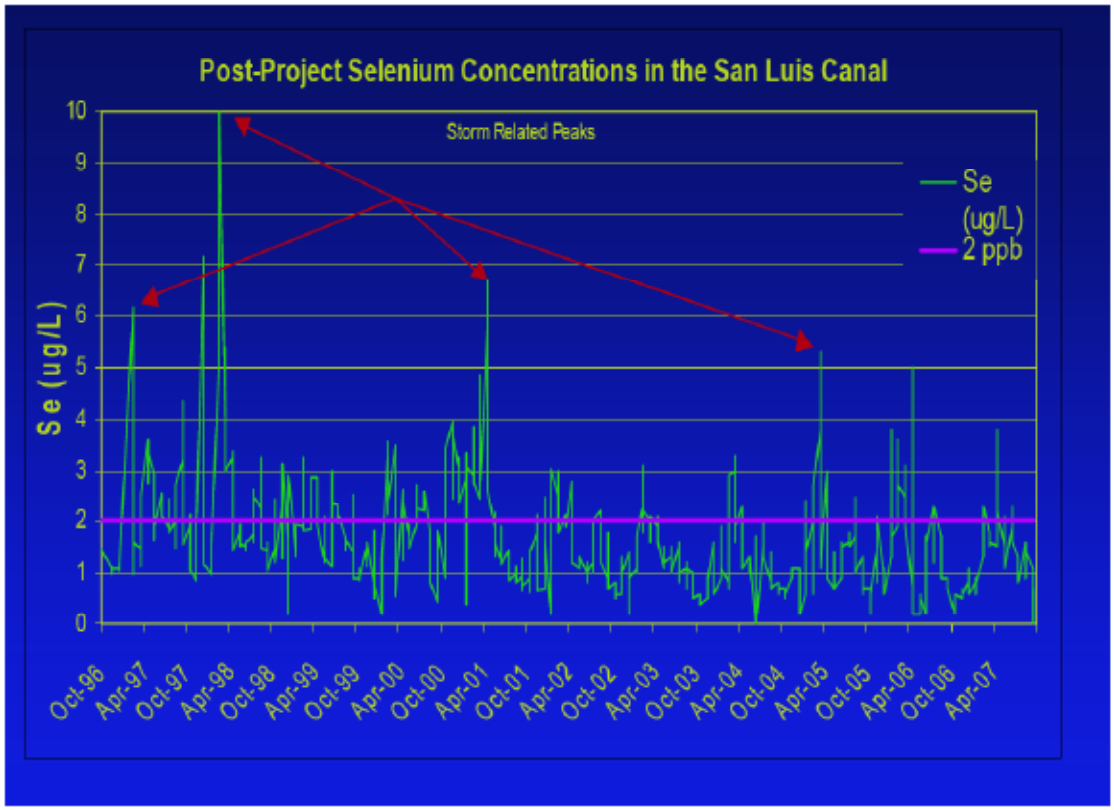
There is no question that implementation of the GBP has significantly improved water quality in the Grasslands wetland channels (with the exception of Mud Slough North where drainage is routed to the San Joaquin River), and reduced salt and selenium loading to the San Joaquin River. With respect to the Grasslands wetland channels, the Grassland Amendments, ***Basin Plan Chapter*** *IV,* IMPLEMENTATION, included the following prohibitions (CVRWQCB 1998):

"*Discharge of agricultural subsurface drainage water to Salt Slough and the identified wetland water supply channels after January 10, 1997, unless water quality objectives for selenium are being met. This prohibition is intended to ensure that discharge of agricultural subsurface drainage water does not interfere with achievement of water quality objectives for selenium in Salt Slough and the wetland water supply channels after 1/10/97. If selenium objectives are not met, the prohibition requires the elimination of agricultural subsurface drainage flows to Salt Slough and the wetland channels. This is consistent with one of the Fish and Wildlife Service's priorities regarding agricultural drainage in the Grassland area, as stated in written comments to the Regional Board in 1995, i.e., "[remove agricultural drainage flows from over 90 miles of Grassland*

*channels, including Salt Slough, so as to free them for delivery of freshwater to Refuges made available pursuant to the CVPIA" (Medlin 1995b).*"

However, exceedences of 2 µg/L selenium in water from wetland supply channels still occur, typically associated with heavy rainfall events and in the spring of each year (usually in March and/or April) as depicted in Figure 1 below, Post-Project Weekly Selenium Concentrations in the San Luis Canal (a wetland supply channel in the South Grasslands). As a result, the Grasslands wetland supply channels and Salt Slough were put back on the 2006 303(d) list of impaired water bodies for California due to non-compliance with water quality objectives and existing total maximum daily load (TMDL)s (for selenium) for those channels (SWRCB 2007).

**Figure 1. Weekly Selenium Concentrations in the San Luis Canal, 1996 – 2007 from Chilcott and Schnagl, 2008**




<u>Selenium in biota from the Grasslands wetland channels</u>

Two recent studies have documented selenium levels in biota from the Grasslands wetland supply channels (Beckon *et al.* 2007; Paveglio and Kilbride 2007). In the first study, the Service's Sacramento Fish and Wildlife Office, Environmental Contaminants Division, conducted a field investigation of sediment, aquatic invertebrates, bird eggs and fish from wetlands in the Grasslands area and analyzed these constituents for selenium from five areas that receive water from different or mixed water sources (Beckon *et al.*

2007). Sediments are thought to serve as an important reservoir of selenium contributing to long-term cycling of selenium in aquatic ecosystems long after influx of selenium has been stopped. The authors concluded that selenium concentrations in sediments and invertebrates are likely due to a continuing influx of selenium contamination that has not been fully abated in the area. The study's findings included:

- *"Of the 62 avian eggs sampled, 6.5 percent exceeded the threshold of concern for avian eggs (6 µg/g dw,). Those four eggs ranged from 6.0 to 6.9 µg/g.*
- *Of the 74 whole body fish samples collected 27 (36.5 percent) exceeded the threshold of concern for selenium in warmwater fish (4 µg/g selenium). All 12 samples of striped bass (Morone saxatilis, all of them juveniles: 11 from Gadwall Canal at Santa Cruz Gun Club, and one from Camp 13 Ditch at Checkpoint 4) exceeded the threshold of concern for selenium in warmwater fish.*
- *Thirty-two samples of invertebrates were collected in the South Grasslands. Thirteen of these (40.6 percent, Figure 5) reached or exceeded the threshold of concern for invertebrates as diet for birds (3 µg/g dietary selenium). The most effective invertebrate bioaccumulators of selenium were European freshwater snails (Physa) and Siberian shrimp (Exopalaemon modestus). The latter is a recently introduced species that evidently bioaccumulates selenium more effectively than other aquatic invertebrates in the area, such as red crayfish, that it seems to be replacing."*

In the second study, the Service's Division of Natural Resources, Branch of Refuge Biology, Vancouver, WA, conducted follow-up collections during 2005 to determine selenium concentrations in aquatic birds after long-term use (20 years) of predominately freshwater for wetland management in the Grasslands (Paveglio and Kilbride 2007). The authors found the following, *"Selenium concentrations were higher for birds from the South Grasslands during 2005, which historically received more undiluted drainage water compared with the North Grasslands. Liver selenium concentrations for black-necked stilts from the South Grasslands were within ranges associated with the first incidence of reproductive impairment. Shovelers, coots, and black-necked stilts from the South Grasslands during 2005 were found to be significantly above the background level (at a 95% confidence level)…"* The authors reported selenium concentrations in livers from northern shovelers collected in the south Grasslands (8.5 – 11 µg/g dry weight) that were comparable to levels associated with significantly reduced disease resistance and increased mortality in a controlled field experiment on mallard ducks (Hansen and Whiteley 1990; Whiteley and Yuill 1991). Paveglio and Kilbride concluded that selenium cycling within Grasslands wetlands likely is attributable to three factors: 1) historic use of agricultural drainage resulting in a reservoir of selenium in wetlands and supply channel sediments; 2) storm-water inflows; and, 3) unregulated inflows of subsurface drainage directly into wetlands or indirectly into their supply channels.

**Specific Comments and Recommendations**

1. **<u>Sources of selenium in the Grasslands wetland supply channels: lands outside the GBP's Drainage Project Area</u>**

The prohibition of agricultural subsurface drainage to Salt Slough and the Grasslands wetland supply channels resulted in the diversion of most of the drainage to Mud Slough (North) via a portion of the San Luis Drain. However, as was noted in a Regional Board Report reviewing selenium concentrations in wetland water supply channels in the Grassland Watershed (Chilcott 2000), "*Two areas have been identified where agricultural subsurface drainage can enter wetland water supply canals from farmland not contained in the DPA. One area is west of the wetland water supply channels and historically drained into the Almond Drive Drain which entered South Grassland Water District at Almond Drive. A second area is a triangle-shaped area of approximately 7,000 acres south of the Poso Drain (also known as the Rice Drain) and north of the DPA which historically drained into the Poso Drain which enters South GWD from the east (Figure 4).*" Figure 2 below is a copy of the map from Chilcott (2000) that identifies areas where agricultural drainage still enters the wetland water supply canals.

The GBP EIS/EIR in 2001 (USBR and San Luis and Delta Mendota Water Authority, 2001) noted that the proposed action may include the addition of approximately 1,100 acres of farmland to the GBP's Drainage Project Area (DPA), found immediately adjacent to the DPA, south of the San Luis Drain and east of the Grassland Bypass Channel, that currently drain to wetland channels, in the area identified Chilcott (2000) as the Poso Rice Drain Area. The 1,100 acres proposed for inclusion in the GBP EIS/EIR of 2001 is shown in Figure 3. To date, however, these additional acres have not been incorporated into the GBP.

Figure 4 is a subset of a map of the San Joaquin Valley Drainage Authority, Westside San Joaquin River Watershed Coalition that focuses on the Grasslands Area. From that map, it appears that the lands identified in Chilcott 2000 that still discharge directly to the south Grasslands wetland channels fall within Central California Irrigation District (See Figure 4 below).

***Recommendation***
Because these discharges contribute to exceedences of the adopted selenium objective of 2 µg/L, lands that discharge drainage to the wetland supply channels should be required to cease these discharges and participate in the GBP if an extension is granted.

**Figure 2. From Chilcott 2000**

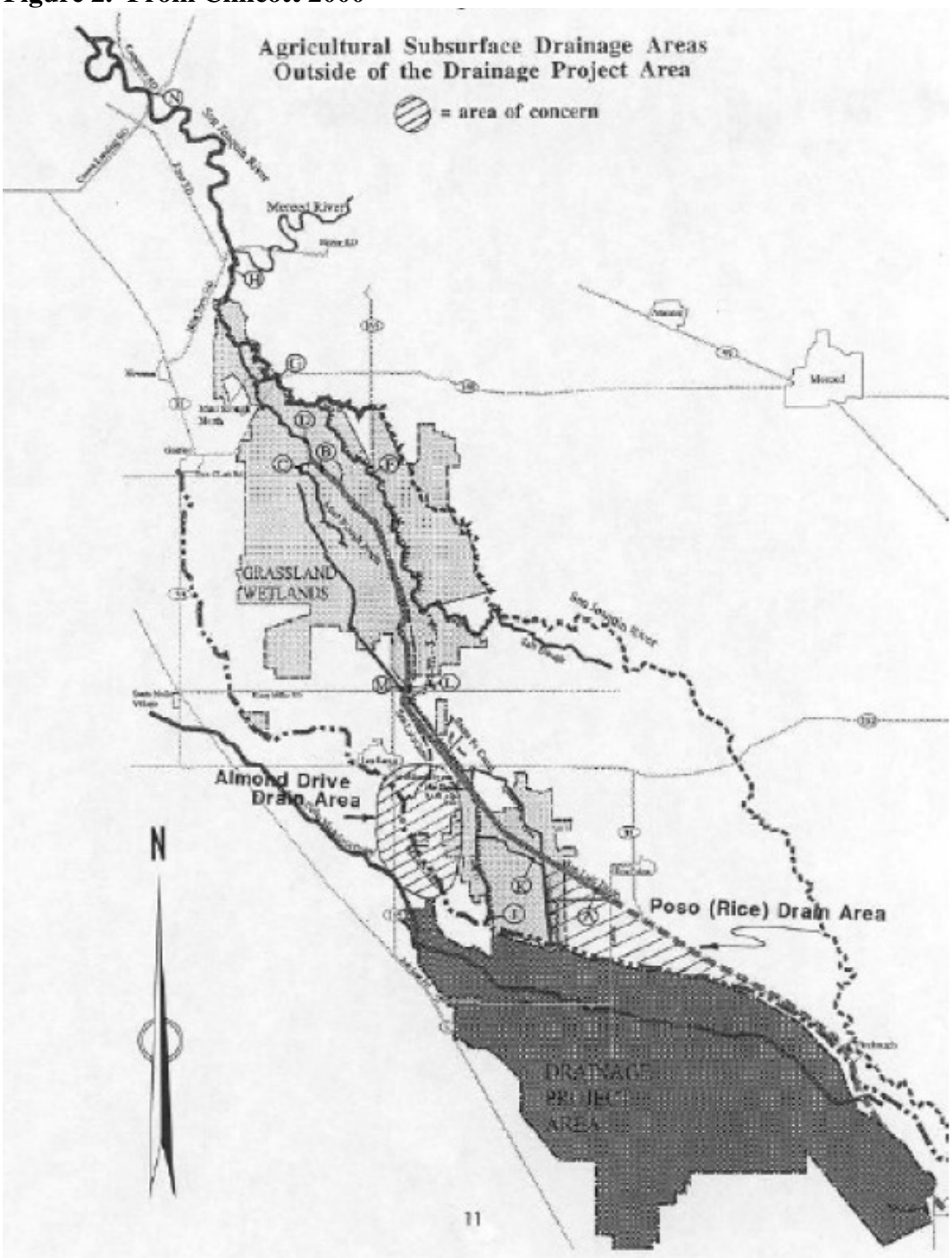


**Figure 3. GBP Project Area Map including Proposed 1,100 Acres Additional Lands to be added to the DPA (from Reclamation and San Luis and Delta Mendota Water Authority, 2001)**

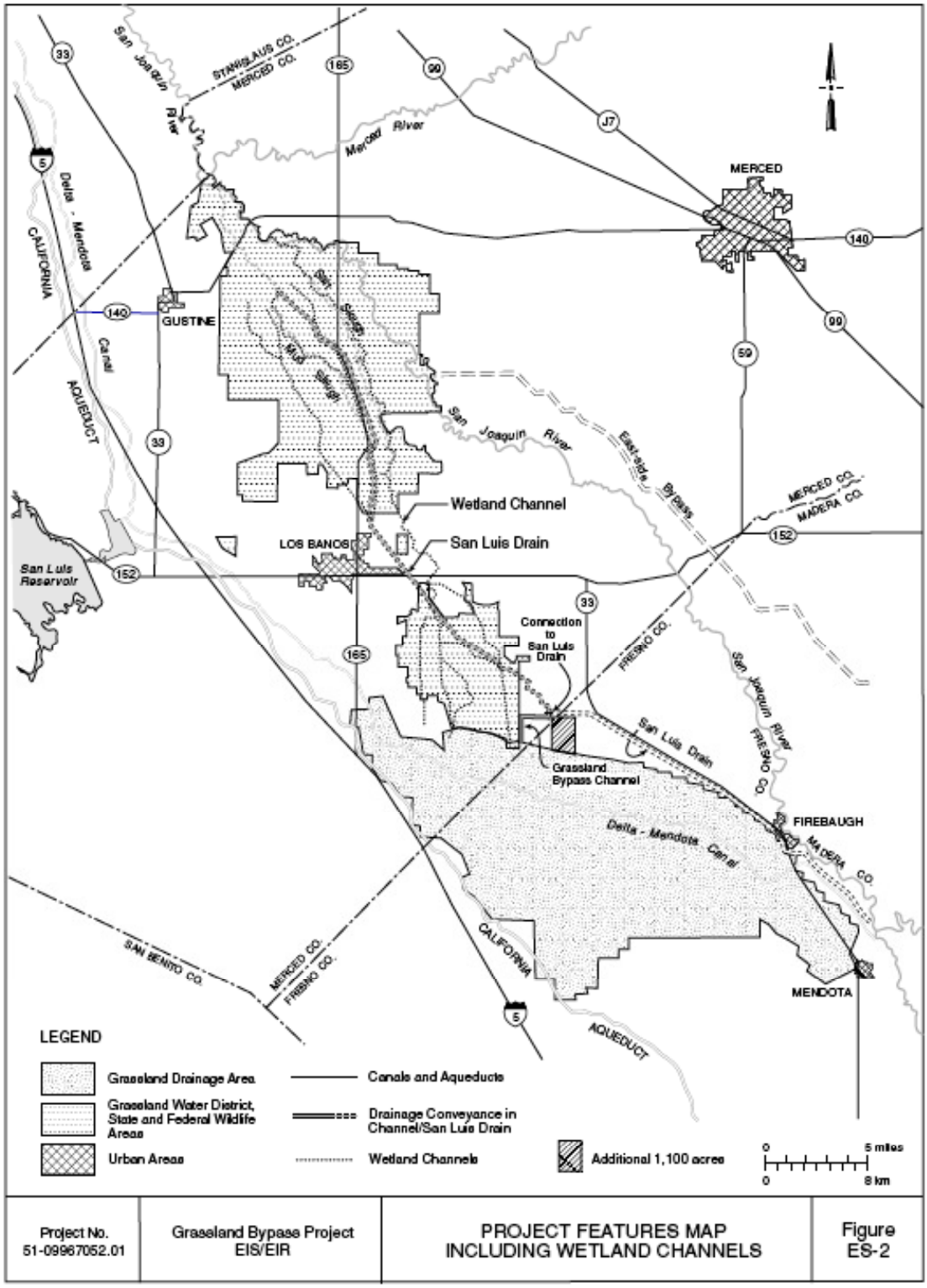
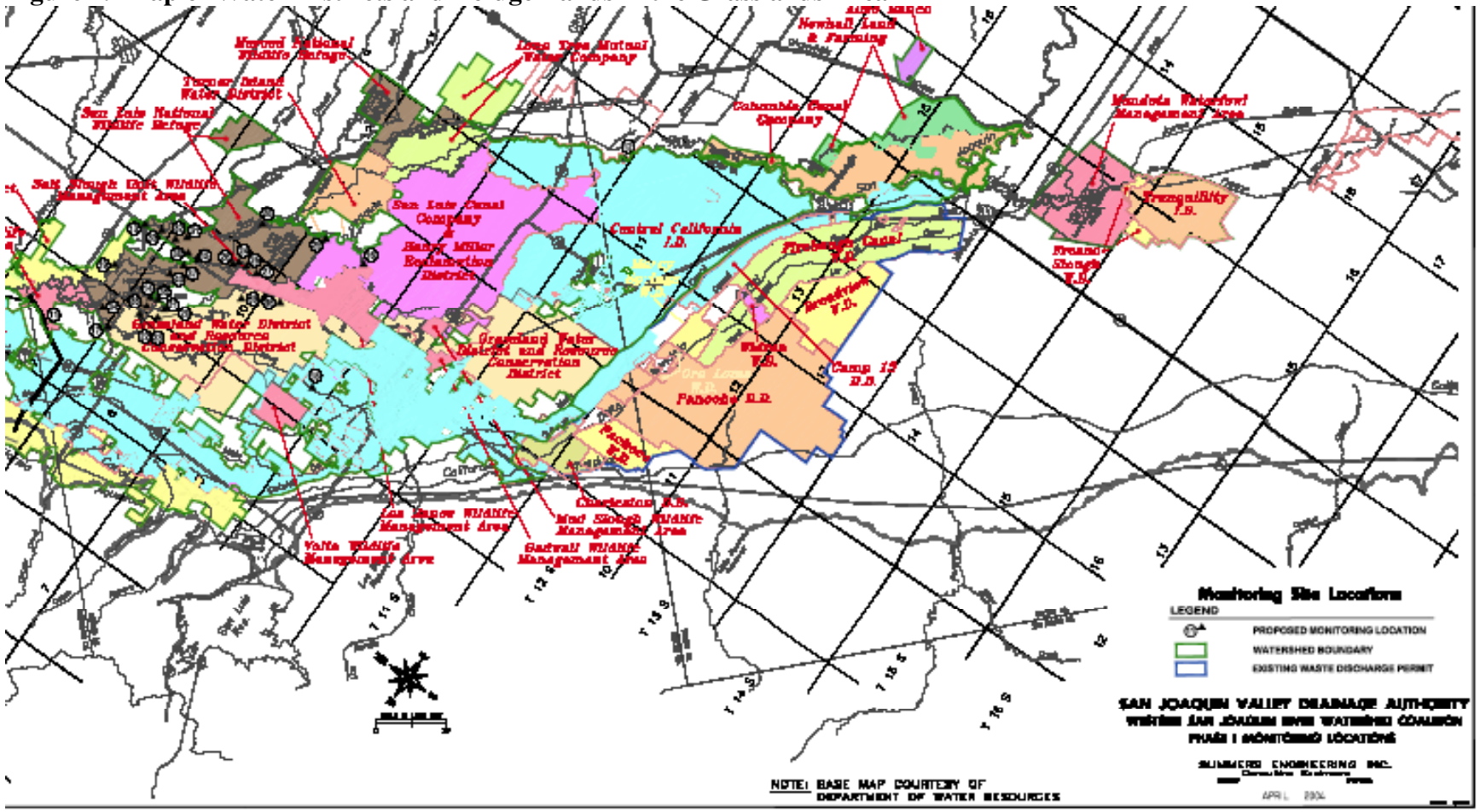


**Figure 4. Map of Water Districts and Refuge Lands in the Grasslands Area**



## 2. Sources of selenium in the Grasslands wetland supply channels: Delta Mendota Canal sumps and check drains

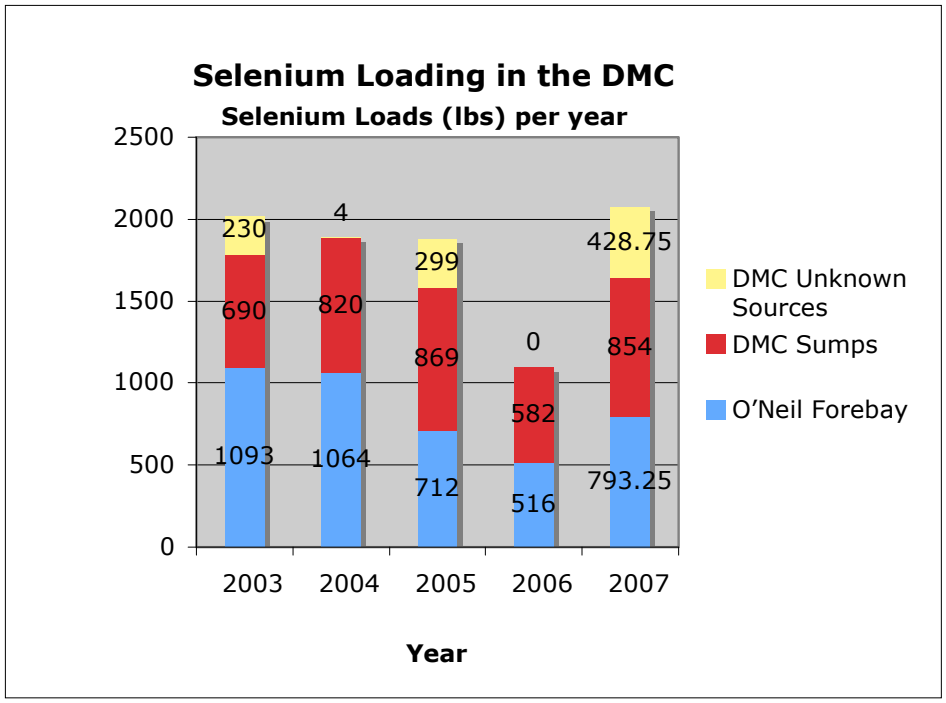
Another source of selenium in the Grasslands wetland supply channels has been identified to be supply water in the Delta Mendota Canal (DMC) (Eppinger and Chilcott, 2002). The major source of supply water to the Grasslands wetland channels and to the agricultural lands of the Grassland Drainage Area is the DMC, via Mendota Pool and the Central California Irrigation District Main Canal. Sources of selenium to the DMC include: groundwater pumping into Mendota Pool, recycling of San Joaquin River drainage into the federal pumps in the south Delta, flood flow and sediment loading from the Panoche and Silver Creek watersheds, and discharge from DMC subsurface drains and six shallow groundwater sumps (DMC sumps) owned by Reclamation and operated by the San Luis and DMC Water Authority in the Firebaugh Canal Water District (Pierson *et al.* 1987; Chilcott 2000; USBR 2008).

In the 1950s Reclamation installed check drains and the DMC sumps between Mileposts 99 and 110, parallel to the DMC, to collect small quantities of seepage water or surface runoff to prevent accumulation and possible damage to the canal bank or adjacent lands. Water collected in the subsurface drains is discharged into the DMC by the sumps through six drainage inlet structures. Although flow from Reclamation's DMC sumps is relatively small (the cumulative volume of drainage from the six DMC sumps averages 3.3 acre-feet per day and 110 acre-feet per month from USBR 2008), selenium concentrations in discharged water have ranged from 57 - 2,100 µg/L between 1985 and 2000 (USBR April 2002). Reclamation monitoring data up to 1994 revealed water discharged from sump "K" exceeded California's hazardous waste threshold for selenium in water (1,000 µg/L) in one or more months sampled annually. Since 2003, selenium in water from DMC sump "K" was at or exceeded this State Hazardous Waste threshold for selenium on two separate dates (May 20, 2003 and April 26, 2006: source USBR 2008).

Regional Board staff indicated a close correlation between selenium in DMC and Central California Irrigation District's Main Canal source water and selenium in wetland supply channels, during the non-flood water years of 1999 and 2000 (Eppinger and Chilcott 2002). This report noted that when the source water had elevated selenium concentrations (above 2 µg/L) a corresponding increase in selenium concentration was noted in the wetland water supply channels.

Since 2002, Reclamation has monitored the DMC sumps for selenium on a weekly basis. Reclamation water quality monitoring data from various points along the DMC from 2003 to 2007 indicate that between O'Neil Forebay and the Mendota Pool, from 582 to 1,283 pounds of selenium have been added to the DMC supply water annually (see Figure 5. below). Depending on the year, from 67 to 100% of that added load downstream of O'Neil Forebay is from the DMC sumps and the remainder of the added load is from unaccounted sources (e.g., DMC check drains) (USBR 2008).

**Figure 5.**




1. Selenium loads from Unknown Sources were calculated by subtracting the selenium loads from the DMC sumps and at O'Neil Forebay from the selenium loads at the DMC Terminus (MP-116.48 at Bass Ave). In the case of 2006, the input from Unknown Sources was a negative number, and therefore assumed to be zero.

2. For the month of September 2007 a monthly selenium load was not available for O'Neil Forebay. For the purposes of this analysis, a monthly load was calculated as the average of the monthly selenium loads at this location from September for the years 2003-2006.

As part of the San Luis Drainage Feature Re-evaluation planning effort, Reclamation proposed the building of a DMC Drain to intercept groundwater at the DMC sumps and convey it to the GBP's reuse area for reuse, treatment and disposal of approximately 1,100 AF/year. The DMC Drain was envisioned to consist of two pipelines. The upstream pipeline would convey drainwater 300 feet from Sump A over the DMC and into the adjoining reuse area. The other 39,700 feet of buried pipeline would collect drainwater from the other five sumps and convey it along the southwestern side of the canal to the southeastern corner of the reuse area (USBR 2006).

***Recommendation***

Because selenium loading in the DMC supply water can affect water quality in the Grasslands wetland supply channels, the Service recommends that drainage discharges into the DMC be eliminated as a requirement of the GBP Extension. Drainage discharges from the DMC sumps could be routed to the reuse area, and treatment and disposal facilities of the GBP as was proposed in the San Luis Drainage Feature Re-evaluation Final EIS (USBR May 2006).

## 3. Sources of selenium in the Grasslands wetland supply channels: heavy rainfall events

Tile-drained farmlands in the GBP's DPA southwest of the Grasslands wetland supply channels have proven to be susceptible to flooding during winter storm events from the Panoche/Silver Creek watershed in the Coast Range. These flood flows [40,000 acre-feet during 2-week periods associated with these storm events (San Luis and Delta Mendota Water Authority 1997)] have been characterized by high selenium levels and loads. For example, selenium concentrations in flood waters from the Panoche/Silver Creek watershed ranged from 4 to 155µg/L during a February 1998 storm event (Chilcott 2000). Presser and Luoma (2006) estimated the cumulative selenium load from Panoche Creek during the *El Nino* Water Year of 1998 to be 8,045 pounds. Such flood flows have overwhelmed the GBP resulting in the diversion of selenium-contaminated water into the Grasslands supply channels.

Since 1996, there also have been infrequent, short-term instances where agricultural drainage flows within the GBP have been diverted to Grasslands wetland supply channels during winter storm events. Since 1995, such events occurred in water years 1995, 1997, 1998 and 2005 and have resulted in significant spikes in selenium concentrations in the Grasslands wetland supply channels and selenium loading into the San Joaquin River (Presser and Luoma 2006, Grassland Area Farmers 2005).

The most recent rainfall event in 2005 was described in a report submitted to Reclamation and the CVRWQCB (Grassland Area Farmers 2005). As a result of heavy rainfall drainage flows that normally would have been routed into the San Luis Drain were rerouted into the Agatha Canal in the south Grasslands. During the 2005 rainfall event, selenium concentrations in water from Agatha Canal were elevated over 2 µg/L for several weeks as denoted in Table 1 below.

**Table 1. Flood Flows into Agatha Canal, 2005**

| Date | Flow (AF) | Selenium (µg/L) | Selenium (pounds) |
|---|---|---|---|
| 2/16/2005 | 7 | 3.5 | 0.1 |
| 2/17/2005 | 75 | 4.5 | 0.9 |
| 2/18/2005 | 50 | 3.5 | 0.5 |
| 2/19/2005 | 44 | 26.5 | 3.1 |
| 2/20/2005 | 40 | 39.9 | 4.3 |
| 2/21/2005 | 40 | 43.8 | 4.7 |
| 2/22/2005 | 14 | 3.7 | 0.1 |
| 2/23/2005 | 0 | 44.4 | 0 |
| 2/24/2005 | N/A | 24.8 | N/A |
| 2/25/2005 | N/A | 24.2 | N/A |
| 2/26/2005 | N/A | 16.6 | N/A |
| 2/27/2005 | N/A | 14.8 | N/A |
| 2/28/2005 | N/A | 9.27 | N/A |
| 3/1/2005 | N/A | 5.1 | N/A |
| 3/2/2005 | N/A | 2.83 | N/A |

Selenium bioaccumulates rapidly in aquatic organisms and a single pulse of selenium (>10 µg/L) into aquatic ecosystems could have lasting ramifications, including elevated selenium concentrations in aquatic food webs (Besser *et al.* 1993; Graham *et al.* 1992; Maier *et al*. 1998; Nassos *et al.* 1980; Hamilton 2004). Besser *et al*. (1993) reported that within 24-hours waterborne treatment levels of 100 µg /L selenium in the form of selenite and selenate bioaccumulated to greater than 40 µg/g in algae and 8-15 µg/g in daphnids (both extremely dangerous levels of food web selenium for higher trophic level consumers). Graham *et al.* (1992) also documented rapid bioaccumulation from waterborne spikes of selenium and much slower elimination of that selenium from the food web. Based on standard acute toxicity testing, Nassos *et al.* 1980 concluded that, "*… organisms can concentrate Se several hundred times the level in the water within a period of 24 h*." Maier *et al*. (1998) documented that a brief pulse of selenium of about 10 µg/L in a Sierra Nevada stream for less than 11 days (selenium was 10.9 µg/L at 3 hrs post-treatment and at < 1 µg/L when next measured 11 days post-treatment) resulted in elevated invertebrate selenium concentrations of > 4 µg/g (composite invertebrate samples collected before fertilization of the treatment area contained 1.67 µg/g selenium (dry weight)). Maier *et al.* found that the invertebrate food web was still contaminated at > 4 µg/g 12 months after selenium treatment when the monitoring ended even though water concentrations were < 1 µg/L.

Another field example of an effect of a selenium pulse in water was noted at the Tulare Lake Drainage District's flow-thru compensation wetland in the southern San Joaquin Valley. Although the water supplied to the wetland was generally managed to keep its selenium content at or below about 2- 3 µg/L, a pulse of 23 µg/L was documented on March 29, 1995, (Tulare Lake Drainage District 1996). Three months later (June 20, 1995), and without any additional selenium pulses, 16 avian eggs sampled at the site contained from 3.4 to 6.2 µg/g selenium and averaged 4.75 µg/g selenium (Tulare Lake Drainage District 1996) which exceeds the embryotoxic risk threshold reported in Skorupa (1998). In June 1995, 12% of sampled eggs exceeded 6 µg/g selenium which very plausibly may have been linked to the late March pulse of 23 µg/L selenium that passed through the system. In 1996, a year without any selenium pulses 16 avian eggs sampled in June at the same site contained from 2.2 to 4.1 µg/g and averaged 3.00 µg/g selenium (Tulare Lake Drainage District 1997). Twelve of the 16 eggs collected in 1995 contained more selenium than the maximum egg selenium from 1996. The average selenium value in 1995 was statistically significantly higher than in 1996 based on a two-sample nonparametric medians test (Skorupa pers. comm. 2009).

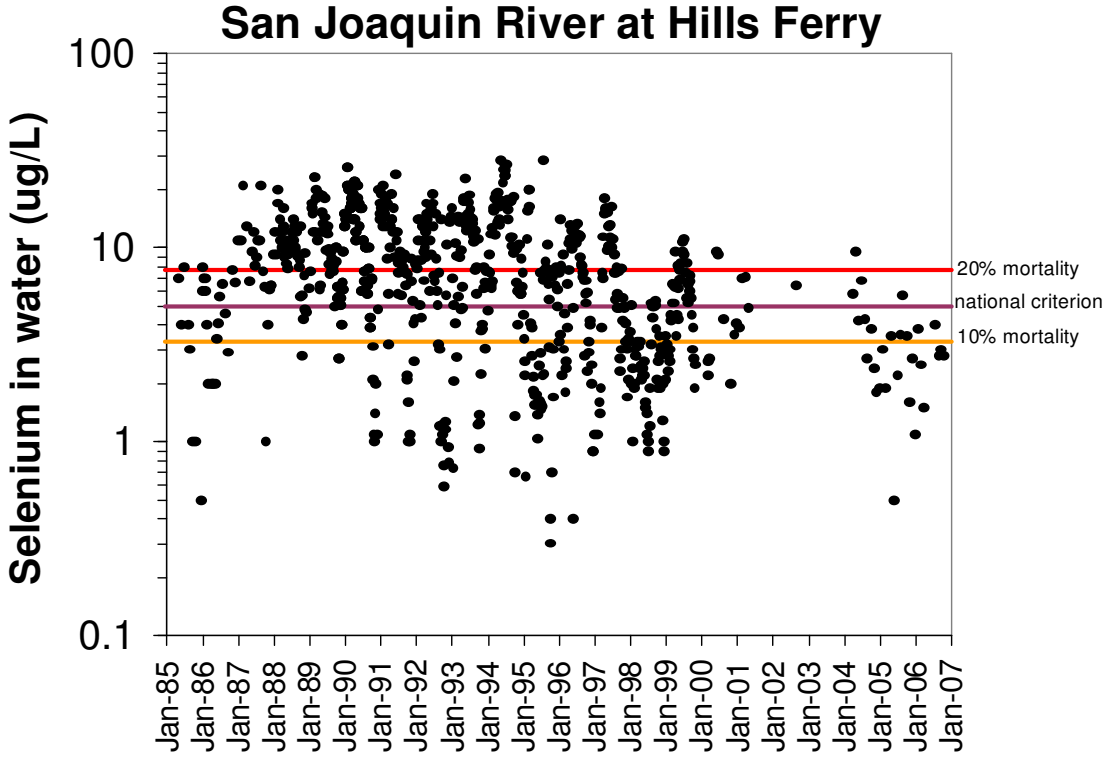
***Recommendation***

California Environmental Quality Act/National Environmental Policy Act (CEQA/NEPA) planning for the GBP Extension and associated Basin Plan Amendment should include an evaluation of alternative routes of disposal and/or storage of excess drainage flows that occur during heavy rainfall events and that have historically been discharged into the Grasslands wetland supply channels.

## 4. Effects of GBP selenium discharges on Anadromous Fish Including San Joaquin River Restoration Program's Goal to Restore Salmonids

In an analysis of the effects of San Luis Unit selenium contamination on federally listed species, Beckon and Maurer (2008) found that seepage and flood flows carrying agricultural drainwater from the San Luis Unit into the San Joaquin River may impact Chinook salmon and steelhead and could impair efforts to restore them to upstream reaches of this river. Central Valley Chinook salmon and steelhead are among the most sensitive of fish and wildlife to selenium exposure. They are especially vulnerable during juvenile life stages when they migrate and rear in selenium-contaminated Central Valley rivers and the San Francisco Bay/Delta estuary. Rivers and sloughs that carry agricultural drainwater, concentrations of selenium in invertebrates, small (prey) fish, and larger predatory fish commonly reach levels that could kill a substantial portion of young salmon (Beckon *et al*. 2008) if the salmon, on their downstream migration, are exposed to those selenium-laden food items for long enough for the salmon themselves to bioaccumulate selenium to toxic levels. Based on existing water quality data for selenium in specific reaches of the San Joaquin River, Beckon and Maurer (2008) concluded that there remains a substantial ongoing risk to migrating juvenile Chinook salmon and steelhead in the San Joaquin River, as shown in Figure 6 below.

**Figure 6. Selenium concentrations measured in the San Joaquin River at Hills Ferry (data from the Central Valley Regional Water Quality Control Board)**



The San Joaquin River Restoration Program (SJRRP) is a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of Merced River, ensure irrigation supplies to Friant Water users, and restore a self-sustaining Chinook salmon fishery in the river. The SJRRP will implement the San Joaquin River litigation Settlement (Settlement), filed in Federal Court in September 2006 (SJRRP 2007). The SJRRP includes a Restoration Goal to, "*To restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish*." A Draft SJRRP Environmental Impact Statement/Environmental Impact Report (Draft Program EIS/R) is scheduled for release in Spring 2009. The Final Program EIS/R is scheduled for release in July 2009 (SJRRP 2008). The Settlement calls for interim flows to begin in the fall of 2009 and full restoration flows to begin no later than January 2014. Additionally, salmon are to be reintroduced no later than December 31, 2012, in the upper reaches of the San Joaquin River (SJRRP 2007). Senators Boxer and Feinstein introduced Federal legislation on January 6, 2009, that limits direct Federal spending on Settlement implementation to $88 million during the first 10 years. Together with $200 million committed by the State of California and other highly reliable funding, including pre-existing fees paid by water users, there is at least $380-390 million available for implementing the settlement over the next 10 years (source: Central Valley Business Times, January 6, 2008, http://www.centralvalleybusinesstimes.com/stories/001/?ID=10787). The Senate passed this legislation in a special session held on January 11, 2009, (source: http://thomas.loc.gov/cgi-bin/query/z?c111:S.22:)

***Recommendation***
The CEQA/NEPA planning for the GBP Extension and associated Basin Plan Amendment should include an evaluation of effects of GBP selenium discharges on anadromous fish including the proposed San Joaquin River Restoration runs of Chinook salmon and steelhead.

## 5. Mercury in the Grassland Watershed

In 1987, mercury was identified as a potential substance of concern in agricultural drainage water from the west side San Joaquin Valley and was assigned to the highest priority rank (Hansen and Morhardt 1987). The San Joaquin Valley Drainage Program identified mercury as a substance of concern that warrants further attention (Moore *et al.* 1990). Elevated concentrations of vanadium, chromium, and mercury have also been observed in the shallow groundwater in the San Luis Unit (Deverel *et al.* 1984 cited in USBR 2005).

Water quality sampling of the DMC sumps (along the Delta Mendota Canal in the Firebaugh Canal Water District) from 2002 through 2007 by Reclamation has documented significantly elevated concentrations of total mercury in the sump water currently being pumped into the Delta Mendota Canal. Total mercury in water from the DMC sumps has ranged from 200 ng/L to 3,000 ng/L and is currently being pumped into

the DMC upstream of Mendota Pool (USBR 2008).

Eighteen miles of Panoche Creek (from Silver Creek to Belmont Avenue) and the San Joaquin River (from Bear Creek to the Delta Boundary) are listed on the 2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments for mercury impairment (SWRCB 2007). Mercury levels in fish from the lower San Joaquin River and Mud Slough have been found to be elevated (Davis *et al.* 2000; Slotton *et al.* 2000). The principal finding of a CalFed Mercury Study in the San Joaquin Basin is that Mud Slough contributes about 50% of the methylated mercury at Vernalis (legal boundary of the Delta) but only 10% of the water volume during the non-irrigation season (September to March) (Stephenson *et. al.*, 2005).

Preliminary methyl mercury water data collected from the vicinity of the San Luis Drain was provided to the Service in a letter from Dr. Chris Foe, staff scientist of the CVRWQCB in 2005 (Foe 2005). In that letter Dr. Foe noted, "*Regional Board staff has been monitoring methyl mercury concentrations in the San Joaquin watershed for the past two years to identify sources and to characterize concentrations and loads. The highest concentrations in the Basin occur in Mud Slough downstream of the inflow from the San Luis Drain (GBP monitoring site D). Methyl mercury loads in Mud Slough are sufficiently high that they may account for 40-60 percent of the Vernalis load during non-irrigation season. Similar calculations have not been made for the irrigation season as the amount of water removed and returned to the River by water agencies and others is not known. However, Mud Slough concentrations and loads remain high suggesting that the Slough is still a significant source of River methyl mercury. The non-irrigation season loads imply that Mud Slough is responsible for about half the methyl mercury accumulating in fish in the main stem San Joaquin River in winter. The source of the methyl mercury in Mud Slough is not known.*" Table 2 summarizes the preliminary methyl mercury concentrations for the San Joaquin River at Vernalis, and for Mud Slough at site D and the San Luis Drain.

Dr. Foe concluded that, "*The results suggest that methyl mercury concentrations at all three sites are elevated and may constitute a health hazard to wildlife consuming local fish. Methyl mercury mass balance calculations have not yet been made for Mud Slough. Regional Board staff has commenced a mass balance study to better define the primary source(s) of methyl mercury in Mud Slough.*"

**Table 2. Summary of unfiltered methyl mercury concentrations (ng/L) in the Grassland Bypass portion of the San Luis Drain, Mud Slough at Site D and San Joaquin River at Vernalis (from Foe 2005).**

| Date | San Luis Drain @ Site B | Mud Slough @ Site D | San Joaquin @ Vernalis |
|---|---|---|---|
| 6/14/05 | 0.302 | 0.671 | 0.235 |
| 7/13/05 | 0.648 | 0.769 | 0.218 |
| 8/9/05 | 1.150 | 1.430 | 0.226 |
| 9/12/05 | 0.846 | 1.070 | 0.062 |

In a separate study of avian eggs at an evaporation pond in Westlands Water District, mercury was found to be elevated above toxic levels in some of the eggs collected. In 2002 the Service's Sacramento Fish and Wildlife Office, Environmental Contaminants Division, randomly sampled nine black-necked stilt eggs at the Britz-Deavenport evaporation pond. The mercury concentrations in those eggs ranged from 0.74 to 3.1 ug/g (ppm) dry weight, with a median value of 1.2 ug/g (Skorupa pers comm.; Service unpublished data). Based on data for mallards reported in Heinz (1979), the putative toxic threshold for mercury in avian eggs is 3 ug/g dry weight. In 2002, two of the nine eggs (22%) sampled at Britz-Deavenport contained $\geq$ to 3 ug/g dry weight mercury. The source of the mercury exposure was not determined.

***Recommendation***

Given the fact that some drainage sump water in the GBP DPA (i.e., DMC sumps) and the San Luis Drain is elevated in total mercury, a more comprehensive reconnaissance survey of the extent of mercury contamination in subsurface drainage in the DPA is warranted. The Service therefore recommends that if the GBP is extended, monitoring and reporting for total mercury and methyl-mercury concentrations in water and biotic tissue be required at all sampling locations of the GBP to establish a mass-balance of sources of mercury in this watershed.

## Conclusion

In order to protect the Federal, State and private wetland resources in the Grasslands Area the Service recommends that the CVRWQCB take all the actions necessary to protect the water quality that is provided to these wetlands. Specifically, with respect to the extension of the GBP and associated Basin Plan Amendment, the Service recommends the Regional Board require:

1. Inclusion of lands north of the GBP's DPA into the GBP that still discharge directly into the south Grasslands wetland supply channels;
2. Elimination of discharges into the DMC from the DMC sumps in the Firebaugh Canal Water District;
3. That CEQA/NEPA planning includes evaluation of alternative routes of disposal and/or storage of excess drainage flows which occur during heavy rainfall events and that have historically been discharged into the Grasslands wetland supply channels;
4. That CEQA/NEPA planning includes evaluation of effects of GBP selenium discharges in the San Joaquin River on anadromous fish including the proposed San Joaquin River Restoration runs of Chinook salmon and steelhead; and,
5. Monitoring and reporting for total mercury and methyl-mercury concentrations in water and biotic tissue at all sampling locations of the GBP to establish a mass-balance of sources of mercury in this watershed.

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