Improving California Central Valley Watersheds: Diazinon Reduction in the Feather and Sacramento Rivers

REPORTING WATERSHED IMPROVEMENT (SP 12) – Reporting Watershed Improvement Based on Impairment Removal (Option 1)

Executive Summary – Water quality in nine watersheds within the Lower Sacramento Basin in California's Central Valley has been improved using the watershed approach to control pesticide pollution. In the early 1990's state and federal natural resource agencies identified elevated levels of the pesticide diazinon in the Sacramento and Feather Rivers and linked diazinon to observed aquatic toxicity. The California Central Valley Regional Water Quality Control Board (CVRWQCB) added four river segments to California's 1994 Clean Water Act (CWA) Section 303(d) List of Impaired Waters (303(d) List) due to aquatic toxicity caused by diazinon. By 2002, CVRWQCB had identified diazinon impairments in eleven Sacramento and Feather River waterways covering 196 river miles.

Community, business, education, research, and regulatory activities resulted in the reduction of diazinon concentrations in the Sacramento and Feather River systems. A diverse group of stakeholders, motivated by the basic need for clean water and impending regulation, developed a variety of tools to reduce the use of diazinon and control polluted runoff from reaching waterways. Their combined efforts resulted in the removal of 79 river miles from the 303(d) List for diazinon impairments by 2010.

The success of the watershed approach in reducing diazinon impairments in Central Valley water bodies is a model for future water quality restoration efforts. Continuing watershed-based pollution control activities can successfully address ongoing water quality challenges in the Lower Sacramento Basin by combining community-based watershed activities with regulation. Persistent water quality problems in the Central Valley include the remaining 117 diazinon-impaired river miles, the replacement of diazinon with pyrethroid pesticides (highly toxic in the aquatic environment), and thousands of river miles that have other pesticide, nutrient, metals and toxicity water quality impairments in the Central Valley. Lessons learned from these efforts focus future actions and strengthen partnerships that continue to work toward improving water quality in the Central Valley and beyond.

Watershed Information

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C. Project Title: Improving California Central Valley Watersheds – Diazinon in the Feather and Sacramento Rivers

D. Number of Watersheds Improved
   1. Natomas Main Drainage Canal – Sacramento River (180201610402)
   2. Lake Greenhaven – Sacramento River (180201630701)
   3. Packer Lake – Sacramento River (180201041203)
   4. Clark Slough – Feather River (180201590503)
   5. Ellis Lake – Feather River (180201590502)
   6. Oregon Gulch – Feather River (180201590202)
   7. McGriff Lakes – Sutter Basin (180201041102)
   8. Gilsizer Slough – Snake River (180201590400)
   9. Wilson Creek – North Honcut Creek (180201590107)

Description of 2002 Baseline Condition

The Central Valley Regional Water Quality Control Board (CVRWQCB) included eleven river and stream segments within the Lower Sacramento Basin in its 2002 303(d) List of Impaired Water Bodies (303(d) List) due to elevated levels of diazinon causing impairments of the aquatic life freshwater habitat designated use (beneficial use), see Map 1.[1] State and federal agencies identified elevated levels of diazinon and resulting aquatic toxicity in the early 1990's which resulted in the addition of four waterways (Sacramento River from Knights Landing to the Delta, Lower Feather River from Oroville Dam to Sacramento River, Sacramento Slough and Sutter Bypass) to the 1994 303(d) List.

CVRWQCB identified more than one hundred water bodies in the Central Valley covering approximately 1344 miles and 142,292 acres as impaired for various pollutants in its 2002 303(d) List.[2] In addition to diazinon, substances such as chlorpyrifos, mercury, copper, Group A pesticides (aldrin, endrin, heptachlor, heptachlor epoxide, hexachlorecyclohexane [including lindane], endosulfan, and toxaphene), carbofuran, malathion, methyl parathion, molinate, asinphos-methyl, and toxicity occurrences of unknown origin contributed to water quality impairments in the diazinon-impaired segments within the Sacramento and Feather River systems.

Sources of diazinon include agricultural and urban nonpoint source runoff as well as stormwater point source discharges. Diazinon is applied to orchards growing plums, peaches, and almonds to control destructive pests such as spider mites, boring insects, and aphids. The

[1] http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/2002reg5303dlist.pdf
[2] http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/2002reg5303dlist.pdf

land cover surrounding the impaired segments is largely agricultural, including substantial orchard areas. Both river systems receive runoff from agricultural and urban areas, see Map 2.

The list below includes river segments within the Lower Sacramento Basin on the 2002 303(d) List[3] for diazinon impairments, the watersheds that contribute runoff to the impaired river segments, and the other pollutants contributing to 2002 water quality impairments for each diazinon-impaired segment. The watersheds are United States Geological Survey 12-digit hydrologic units (USGS 12-digit HUCs[4]), the smallest watersheds mapped by USGS.

A. **Sacramento River** from Knights Landing to the Delta 2002 water quality impairments included diazinon, mercury, and unknown toxicity from agricultural and resource extraction sources.

1. Sacramento River Knights Landing to the Delta (16 miles)
    - Packer Lake – Sacramento River (180201041203)
    - McGriff Lakes – Sutter Basin (180201041102)
    - Knights Landing Ridge Cut (180201630301)
    - Pleasant Grove Creek Canal – Cross Canal (180201610303)
    - Natomas Main Drainage Canal – Sacramento River (180201610402)
    - Tule Canal – Toe Drain (180201630302)
    - Lake Greenhaven – Sacramento River (180201630701)
2. Arcade Creek (9.9 miles, tributary to American River, tributary Sacramento River)
    - Arcade Creek (180201110302)
    - Lower American River (180201110202)
3. Chicken Ranch Slough (8 miles, tributary to American River, tributary Sacramento River)
    - Lower American River (180201110202)
4. Strong Ranch Slough (6.4 miles, tributary to American River, tributary Sacramento River)
    - Lower American River (180201110202)
5. Colusa Basin Drain (49 miles)
    - Colusa Drain (180201040400)
    - Powell Slough – Colusa Trough (180201040807)
    - Sycamore Slough (180201040900)
    - Clarks Ditch – Colusa Basin Drainage Canal (180201041003)
    - Dunnigan Creek – Colusa Basin Drainage Canal (180201041006)
    - Willow Spring Creek – Colusa Basin Drainage Canal (180201041007)
    - Smith Creek – Colusa Basin Drainage Canal (180201041008)
6. Sacramento Slough (1.3 miles)
    - McGriff Lakes – Sutter Basin (180201041102)

B. **Feather River** from Lake Oroville to Sacramento River 2002 water quality impairments included diazinon, mercury, Group A pesticides, and unknown toxicity.

1. Feather River (42 miles)

[3] http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/2002reg5303dlist.pdf
[4] http://www.ncgc.nrcs.usda.gov/products/datasets/watershed/history.html

- Oregon Gulch – Feather River (180201590202)
- Wilson Creek – North Honcut Creek (180201590107)
- Ellis Lake – Feather River (180201590502)
- Clark Slough – Feather River (180201590503)

2. Butte Slough (8.9 miles)
    - Gilsizer Slough – Snake River (180201590400)
3. Sutter Bypass (19 miles)
    - Gilsizer Slough – Snake River (180201590400)
4. Jack Slough (14 miles)
    - Jack Slough (180201590501)
5. Lower Bear River (21 miles)
    - Best Slough – Bear River (180201260502)

Evidence of Watershed Approach

A. **Area of Effort:** The Sacramento and Feather Rivers are located within the Lower Sacramento Basin drainage area, one of the upper watersheds within the greater San Francisco Bay-Delta Estuary watershed. The Sacramento Valley makes up the northern one third of the Great Central Valley which extends from Redding in the north to Bakersfield in the south and is bounded by the Coast Range to the west and the Sierra Nevada Range to the east. The Sacramento River is the largest river within the state of California by flow, length, and drainage area. The lower Feather River is the largest natural tributary to the Sacramento River flowing from Oroville dam to the confluence with Sacramento River near Marysville, see Map 2. The Sacramento River meets California's second largest river by length, the San Joaquin River, south of the City of Sacramento where they merge into the Sacramento-San Joaquin Delta (Delta). The Delta collects water from Central Valley watersheds and feeds it into the San Francisco Bay-Delta Estuary and Pacific Ocean.

B. Regulatory and Funding Agencies

1. **Central Valley Regional Water Quality Control Board 5** (CVRWQCB) is responsible for protecting water quality under the state Porter-Cologne Water Quality Control Act and the federal Clean Water Act by implementing regulatory programs and supporting watershed activities and priorities. CVRQCB used its authority to regulate diazinon sources through Basin Plan Amendments, the Irrigated Lands Regulatory Program and effluent limitations in stormwater and wastewater treatment NPDES permits.
2. **US Environmental Protection Agency** (EPA) implements environmental laws such as the CWA and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) that control water and pesticide pollution. EPA Region 9's Water Division has an active role through oversight, technical assistance and financial support for state programs under the CWA such as California's. Primary activities include review and approval for water quality standards, CWA Section 303(d) Lists of Impaired Waters, Water Quality Control Plans and Total Maximum Daily Load (TMDL).[5] The EPA Pesticide Program regulates the

[5] http://water.epa.gov/

distribution and use of pesticides in the United States under FIFRA. EPA reviews and registers pesticides for specified users, ensures appropriate labeling, and can suspend or cancel the registration of a pesticide if information shows that use poses unreasonable risks. Pesticide use can impact many environmental resources such as water, soil, and air quality.[6]

3. **California Department of Pesticide Regulation (DPR)** is authorized by California's Food and Agricultural Code to evaluate and register pesticide products before sale or use in California. These activities include, but are not limited to: a) protecting the environment from environmentally harmful pesticides by prohibiting, regulating, or ensuring proper use of those pesticides; and b) assuring consumers and users that pesticides are properly labeled and appropriate for the use designated by the label. When a pesticide impairs water quality DPR can take actions to reduce the amount of a particular pesticide that is discharged into water bodies.[7]

C. Key Stakeholders

1. **Sacramento River Watershed Program** (SRWP) is a not-for-profit corporation created in 1996 by the Sacramento Sanitation District with a multi-million dollar grant from US EPA Region 9. The SRWP is a multiple stakeholder watershed group whose mission is, "To ensure that current and potential uses of the watershed's resources are sustained, restored, and where possible, enhanced, while promoting the long-term social and economic vitality of the region." SRWP provides resources for building basin-wide efforts to improve watershed health by connecting groups and individuals concerned about the health of the Sacramento River watershed. Some of SRWP's activities include new research, monitoring and continual assessment of water quality, outreach and education about watershed issues.[8]
2. **Resource Conservation Districts (RCDs)** are state organizations that provide resources to land managers regarding soil and water management, fish and wildlife habitat restoration, farmland preservation and control of invasive plant and animal species. RCDs in the primary orchard growing counties, Butte[9], Colusa[10], Glenn[11], Sutter[12], Yuba[13] and Yolo,[14] are actively involved in watershed programs that target water quality improvement through agricultural practices.
3. **Community Alliance for Family Farms (CAFF)** is an organization of farmers and urban residents formed in 1978 in Yolo County California. Their mission is to build a movement of rural and urban people to foster family-scale agriculture that cares for the land, sustains local economies and promotes social justice.[15]

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[6] http://www.epa.gov/pesticides/about/aboutus.htm
[7] http://www.cdpr.ca.gov/dprabout.htm
[8] http://www.sacriver.org/
[9] http://www.buttecountyrcd.org/
[10] http://www.colusarcd.org/
[11] http://www.glenncountyrcd.org/
[12] http://scrcd.org/default.htm
[13] http://www.co.yuba.ca.us/ycrcd/
[14] http://yolorcd.org/
[15] http://www.caff.org/

4. **California Dried Plum Board** is composed of 22 individuals representing 1,000 growers and 22 processors under the authority of the state Secretary of Food and Agriculture. Their mission is to protect and support the health, growth, and integrity of the California Dried Plum industry through public relations, research, and education.[16]
5. **Almond Board of California** was established in 1950 to promote the best-quality product and increase the production of almonds. The Almond Board consists of ten members, five almond growers and five almond processors. The Almond Board has an Environmental Committee that provides leadership on environmental issues through research and education for almond growers.[17]
6. **Sacramento Valley Water Quality Coalition** was created in 2003, includes more than 8600 farmers and wetland managers, and maintains compliance with the state Water Code and CVRWQCB's plans and policies on behalf of its members.[18] Lands owned by SVWQC members are the source of agricultural return flows, and SVWQC members are permitted to discharge to state waters under the Coalition Group Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Order R5-2006-0053-amended).[19]
7. **Coalition for Urban Rural Environmental Stewardship (CURES)** was formed in 1997 to support educational efforts for agricultural and urban communities. Their mission is "to create and deliver science-based solutions and education to ensure that tools to control pests and grow plants are used in ways that protect people and the environment." CURES aims to foster a broad-based coalition representing stewardship interests of agricultural, environmental, crop protection and water associations, government agencies, academia and public interest groups that advance this purpose.[20]
8. **Growers** are individual land owners and operators that attend outreach meetings and work in partnership with organizations like industry groups, SRWP, and SVWA. Land owners and growers participate in pilot projects and adopt the use of BMPs in their management activities.
9. **United States Geological Survey (USGS)** National Water Quality Assessment (NAWQA) Program collects water quality data that are used to provide an understanding of water-quality conditions over time and how natural features and human activities affect those conditions.[21] USGS data identified the elevated diazinon concentrations in the Sacramento and Feather Rivers in 1992.
10. **Pesticide Registrant** – Makhteshim Agan of North America (MANA)[22] worked with US EPA to cancel the registration of diazinon for many uses and to develop label restrictions for agricultural uses.
11. **Local Governments:** The City and County of Sacramento and the cities of Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova are addressing

[16] http://www.californiadriedplums.org/FooterAboutUs/
[17] http://www.almondboard.com/AboutTheAlmondBoard/Pages/default.aspx
[18] http://www.svwqc.org/
[19] http://www.swrcb.ca.gov/centralvalley/board_decisions/adopted_orders/waivers/r5-2006-0053_24apr08_amend.pdf
[20] http://www.curesworks.org/home.asp
[21] http://water.usgs.gov/nawqa/
[22] http://www.manainc.com/

diazinon water quality problems in their collaborative Stormwater Quality Improvement Plan. Other cities are addressing diazinon controls through waste water treatment plant NPDES permits.

12. **Other stakeholders** include County Agricultural Commissioners, California Association of Pest Control Advisors, commodity and industry groups, Spray Drift Task Force, and researchers at University of California.

D. **Watershed Plans**

1. The ***SRWP Sacramento and Feather Rivers OP Pesticide Management Plan: Identification and Evaluation of Pesticide Management Practices (2001)*** describes pesticide management activities that may be useful in reducing diazinon runoff including pest management strategies, application technology, and application-site actions (hedge rows, buffer strips, etc…). The main purpose of this document is to support the development of a strategic plan that addresses aquatic toxicity in the Sacramento and Feather Rivers attributable to diazinon.[23]
2. The ***Water Quality Plan for Sacramento and San Joaquin Rivers Amendments (2003, 2007)*** establish water quality objectives for diazinon and chlorpyrifos, determine total maximum daily load limits, and develop an implementation plan designed to meet objectives by 2008.
    - 2003 Basin Plan Amendment[24]
    - 2007 Basin Plan Amendment[25]
    - TMDL and Implementation Plan[26]
3. ***Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley (2006)*** was written by SVWQC and approved by CVRWQCB in 2006; monitoring began in 2006. The management plan is a coordinated monitoring program to track water quality. The SVWQC is responsible for implementing management practices in addition to activities such as outreach and compliance, development of monitoring and reporting plans, monitoring surface waters, evaluating the effectiveness of management practices, refining management practices where necessary, and protecting waters of the state against pollution and nuisance. [27]
4. ***Stormwater Quality Improvement Plan (2010)*** is an effort to control stormwater quality and protect local waterways by coordinating local government actions. This plan describes the stormwater pollution prevention actions, including diazinon monitoring and responses to toxicity incidences, to be implemented jointly or individually by members of the Sacramento Stormwater Partnership. The partnership includes the County of Sacramento and the Cities of Sacramento, Citrus Heights, Elk Grove, Folsom, Galt and Rancho Cordova.[28]

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[23] http://www.sacriver.org/documents/2001/opfg_d4_Task6_20010118.pdf

[24] http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/sacramento_feather_op_pesticide/2003_amendment/index.shtml

[25] http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/sacramento_feather_op_pesticide/2007_amendment/index.shtml

[26] http://www.swrcb.ca.gov/centralvalley/board_decisions/adopted_orders/resolutions/r5-2007-0034.pdf

[27] SVWQC (2006) Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley.

[28] http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/sacramento/r5-2010-0017_2009sqip.pdf

5. ***Monitoring Reports – Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley*** – Annual Monitoring Reports submitted by SVWQC (2006 – 2008).[29]
6. ***Sacramento Valley Water Quality Coalition Water Quality Management Plan (2009)*** is a document required by the CVRWQCB ILRP to address exceedances of water quality objectives. It addresses registered pesticides, toxicity in water and sediment, pathogens, trace metals salinity, dissolved oxygen, pH, and site specific management activities.[30]

E. Restoration Work

1. **Water Quality Community Investment.** Building a watershed community investment in protecting Sacramento Valley water laid the foundation for progress. Watershed groups develop partnerships and identify water quality problems, shared goals, and priorities for short term and long term actions. The stakeholders discussed in this watershed improvement report have a demonstrated interest in protecting and improving water quality while continuing to fulfill their individual missions. The reduction of organophosphate (OP) pesticide application and concentration in the Sacramento and Feather Rivers is the watershed approach in action.

   Organizing and employing the surging interest in improving and protecting water quality is the collective success of the Sacramento Valley watershed movement. One illustrative example is provided by the Sacramento River Watershed Program (SRWP). SRWP used grant funds from US EPA Region 9 to develop partnerships with stakeholders interested in protecting water quality including agriculture, industry groups, academic researchers, urban and rural residents, and government organizations. These partnerships were used to address the diazinon water quality problem in the Sacramento and Feather River systems by establishing the SRWP OP Pesticide Focus Group (now the Ag Issues Workgroup), which developed the Sacramento and Feather Rivers OP Pesticide Management Plan. Other critical activities include collaborative operation of monitoring programs, researching BMP effectiveness, and developing analytical pesticide modeling tools.

2. **Education and Outreach:** Education and outreach activities targeting the reduction of diazinon and OP pesticides began in the late 1990's and continue today.

   - The Almond Board's Pest Management Alliance and University of California Davis published the ***Seasonal Guide to Environmentally Responsible Pest Management Practices in Almonds***[31] based on research done by CDPR, CAFF, and the Almond Board that evaluated five years of pest management

[29] http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/region_5/2008/ref2871.zip
[30] http://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/monitoring/management_plans/2008_management_plans/svwqc/svwqc_mgt_plan_jan262009.pdf
[31] http://anrcatalog.ucdavis.edu/pdf/21619.pdf

practices and techniques designed to minimize run-off of pesticides into surface waters. The Almond Board also developed 2 newsletters in 1999 about dormant spray run-off issues and sent them to 6000 almond growers with funding received from the National Foundation for Integrated Pest Management Education.[32]

- The California Dried Plum Board's Integrated Prune Farming Practices Program (IPFP) conducted 113 educational meetings between 1999 and 2004 about their research in reducing pesticide application using pest monitoring protocols and pesticide treatment thresholds for an audience of approximately 3800 individuals interested in dried plum production. In addition, thirteen newsletters explaining their research results were published and distributed to 1,114 prune growers and 500 related industry members.[33]
- SRWP funded CURES to develop and perform extensive outreach and education activities. Between 2000 and 2001 CURES made presentations to a collective audience of 2000 individuals made up of growers and crop advisors explaining water quality problems caused by diazinon, current regulatory framework, and pesticide management options. CURES expanded their educational message to a wider audience by obtaining coverage in local news media and trade publications.[34]
- *Promotion of Farming BMPs and Calibration Technology to Mitigate OP Pesticide Runoff in Sacramento River Watershed*, was a 3-year $308,000, CALFED funded outreach and education project. Activities included education meetings for farmers and pest control advisors, dissemination of technical information, and field days at BMP demonstration plots.
  - Products include three BMP booklets, Orchard Practices for Protecting Surface Water,[35] Diazinon Insecticides,[36] Orchard Air Blast Sprayers, Mixing and Loading Tips and Techniques,[37] that provide descriptions of specific BMPS, their cost, and technical difficulty.
  - A survey of grower practices was conducted to determine the effectiveness of outreach programs on orchard runoff and awareness of BMPs.
  - A continuation of this work occurs under SWRCB-funded Pesticide Research and Investigation of Source and Mitigation Program (PRISM) program to update BMP publications, orchard site assessments, and continuing education.
- The SWQC facilitates outreach and education meetings for members, growers, and pest control advisors. Between 2005 and 2008, SWQC and their partners conducted 30 outreach and education meetings that focused the impact of pesticides on local waterways, best management practices, dormant spray regulations, and the Diazinon TMDL. SWQC surveys orchard growers

[32] SVWQC (2006) Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley.
[33] SVWQC (2006) Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley.
[34] SVWQC (2006) Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley.
[35] http://www.curesworks.org/publications/orchPrac.asp
[36] http://www.curesworks.org/publications/diazinon.asp
[37] http://www.curesworks.org/publications/orchAirBlast.asp

that use diazinon regarding awareness of diazinon label requirements and use of best management practices as a measure of program effectiveness.[38]

3. **BMP Implementation – Nonpoint Source Projects:** The CVRWQCB awarded California Nonpoint Source Program (CWA Section 319) funds to implement BMPs called for in the watershed plans. In the mid-1990's nonpoint source grants supported projects to improve sediment control and pesticide runoff from agricultural lands in the Feather River watershed. Techniques such as cover crops, riparian buffers, filter strips, hedge rows, and vegetated swales and waterways were researched and implemented to manage on-site runoff and reduce pesticide loadings to waterways in various locations in the Sacramento, Feather, and San Joaquin River watersheds.[39, 40] Grant funds also supported integrated pest management (IPM) studies by UC Davis and commodity groups which led to decreased application in orchards in the Sacramento River watershed through pest monitoring.

   Following these activities, CWA Section 319 grant funds supported resident-based watershed monitoring and stewardship activities in multiple watersheds. From 1998 to 2003, nonpoint source grants funded education and outreach regarding pesticide use and aquatic toxicity, urban gardening, nurseries, and diazinon use in urban areas.

   Specific CWA section 319 grant projects that addressed diazinon pollution are listed below.

   - Community Alliance for Family Farms (CAFF) was awarded $991,000 in 2004 to implement their '*Environmentally Responsible Management Practices for Tree Crops in the Feather River Basin'* project. CAFF conducted intensive outreach and demonstration of environmentally beneficial crop practices to peach, prune, walnut and almond growers and PCAs in Sutter and Yuba counties. This project demonstrated water quality protection practices on 839 acres, including 352 acres of cover crops that can reseed and will ensure changes in the ground management practices of 19 project growers. BMPs are anticipated to significantly reduce pesticide loading to lower Feather River and Sutter Bypass.
   - California Dried Plum Board was awarded $350,000 in 2001 to implement best management practices developed by a Sacramento River Watershed Program workgroup and described in the *Water Quality Management Strategy*

[38] SWQC (2006 – 2008) Annual Reports: Diazinon Runoff Management Plan for Orchard Growers in Sacramento Valley.
[39] Zalom FG, Oliver W, Wallender WW, et al. Monitoring and mitigating offsite movement of dormant spray pesticides from California orchards. Acta Hort. 2002. 592:35. Found here: http://www.actahort.org/members/showpdf?booknrarnr=592_102
[40] Klassen, PN, Bret BL, Ehn RC, et al. Stakeholder Development of Agricultural Management Practices in Orchards to Reduce Pesticides in Surface Waters Following Dormant Applications in Winter. Total Maximum Daily Load (TMDL) Environmental Regulations: Proceedings of the March 11-13, 2002 Conference, (Fort Worth, Texas, USA) 701P0102. 2002. Pp 168-172.

for Diazinon in the Sacramento and Feather Rivers. BMPs include pest management strategies, alternate chemical application methods and runoff reduction techniques like vegetated buffer strips and short term sprinkler irrigation following pesticide application. Participating growers saved approximately 90,468 pounds of pesticides from being applied to orchards and subsequently moving into aquatic systems over a five year period.

4. **BMP Implementation and Research:**
   - Sutter County RCD was awarded $905,000 in 2005 from California Proposition 50 bond funds (Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002) to assist with implementation of the Feather River TMDL. Activities include evaluating and tracking grower participation and field level BMP implementation to control the amounts of diazinon, pyrethroid, and other pesticides transported into the lower Feather River watershed. BMP effectiveness was assessed by monitoring data from two field sites, calculating load reductions, and extrapolating to the lower Feather River watershed.
   - The Yolo County RCD received a $783,000 grant from the SWRCB's PRISM Program funded by the California Proposition 13 Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Bond Act of 2000 to measure and model the water quality benefits of vegetated agricultural drainage ditches. [41] Results showed that vegetated ditches were twice as efficient at removing 50% of the initial pesticide concentration (including diazinon and permethrin) when compared to unvegetated ditches.[42]
   - Colusa County RCD in conjunction with CAFF and Audubon society is currently working with almond growers on a demonstration project to reduce sediment and pesticide runoff from almond orchards with funding provided by SWRCB. Measures of sediment and diazinon loads will be taken up and downstream before and after storm events to test effectiveness of BMPs (cover crops, hedgerows, vegetated swales).
   - SWQCs analyzed the impact of SmartSprayer technology, orchard floor vegetation, and vegetated filter strips on reducing loadings of diazinon and chlorpyrifos to waterways.
   - SRWP evaluated the impact of diazinon label changes to water quality and developed models to forecast spatial and temporal mass loadings of OP pollutants in the watershed.
5. **Integrated Pest Management Implementation and Research**
   - CDPR, CAFF, and the Almond Board conducted a five year evaluation of pest management practices and techniques to minimize run-off of pesticides into

[41] Yolo County RCD (March 31, 2008) Water Quality Benefits of Vegetated Agricultural Drainage Ditches as a Viable Management Practice. Final Report to SWRCB's PRISM Grant Program. Grant Agreement Number 04-070-555-1.

[42] Denton, D.L., M.T. Moore, C.M. Cooper, J. Wyrsinsk, W.M. Williams, J.L. Miller, K. Reece, D. Crane, P. Robbins. (2008) Mitigation of Permethrin in Irrigation Runoff by Vegetated Agricultural Drainage Ditches in California. ASC Symposium Series. Chapter 19 Synthetic Pyrethroids, p. 417-427. http://pubs.acs.org/doi/abs/10.1021/bk-2008-0991.ch019

surface waters between 1993 and 2003. Almond growers reduced their dormant applications of pesticides by 77% between 1991 and 2000 according to CDPR Pesticide Use Reports.[43]

- The Almond Board was involved in financing $900,000 for new and continuing research and development of integrated pest management techniques that allow growers to reduce their reliance on higher risk pesticides.[44] CDPR identified almonds as one of the crops having significantly reduced diazinon application, approximately 49% compared with previous years, and a reduction of more than 1.5 million pounds of almond orchard pesticides between 2000 and 2001.[45]
- Between 1999 and 2004, the California Dried Plum Board's Integrated Prune Farming Practices Program (IPFP) examined reducing pesticide application by pest monitoring protocols and treatment thresholds. The IPFP project included 45 industry and 13 University of California participants and land donations for research plots from 37 growers. Approximately 111,928 pounds of pesticides were saved by growers participating in this project over a six year period.[46]

6. **Basin Plan Amendments (2003, 2007):** The CVRQCB adopted numeric water quality objectives for diazinon, total maximum daily load (TMDL) limits for the Sacramento and Feather Rivers, and a program to implement the TMDL[47] in 2003. A 2007 basin plan amendment adjusted diazinon objectives, added numeric objectives for a similar pesticide, chlorpyrifos, and adjusted the TMDL to address the additive toxicity of diazinon when present with chlorpyrifos.[48]

7. **Total Maximum Daily Load (TMDL) implementation:** Beginning in 2003, the TMDL for diazinon and chlorpyrifos was implemented through the CVRWQCB Irrigated Lands Program and a Conditional Waiver of Waste Discharge Requirements held by the Sacramento Water Quality Coalition (SWQC). A Conditional Waiver of Waste Discharge Requirements is a permit regulating discharge of pollutants into waterways as long as conditions are met, including meeting water quality standards, TMDL limits, and performing monitoring and reporting activities. The conditional waiver requires SWQC to create a monitoring and reporting plan, monitor surface waters, implement management practices, evaluate effectiveness of management practices, refine management practices where necessary, and protect waters of the state against pollution and nuisance.

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[43] SVWQC (2006) Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley.
[44] SVWQC (2006) Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley.
[45] CDPR (2002) Summary of Pesticide Use Reporting Data 2002 Indexed by Commodity, California Department of Pesticide Regulation, 478 pp. http://www.cdpr.ca.gov/docs/pur/purmain.htm
[46] SVWQC (2006) Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley.
[47] http://oaspub.epa.gov/tmdl/waters_list.tmdl_report?p_tmdl_id=34921
[48] http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/sacramento_feather_op_pesticide/2007_amendment/index.shtml

8. **Urban Product Registration Cancellation.** US EPA issued cancellation orders in 2004 that terminated the registration and sale of pesticides containing diazinon for indoor use, non-agricultural outdoor use (lawns and gardens) and application to certain agricultural crops (alfalfa, bananas, dried beans, peas, coffee, and others) and agricultural land covers (pasture, rangeland, orchard).[49]

9. **Federal Label Changes.** In 2003, US EPA worked with the company holding the diazinon registration, Makhteshim Agan of North America (MANA), to develop a special label for products containing diazinon. Labels include dormant spray restrictions such as 10-foot wide vegetated buffer strips between orchards and waterways, ground-only application of diazinon pesticide, restricting diazinon application to the dormant season, provision of water quality fact sheets to pesticide handlers and operators, and specific spray instructions when waterways are downwind of pesticide application.

10. **Dormant Spray Regulations.** California Department of Pesticide Regulation (DPR) adopted diazinon dormant spray regulations in 2006 restricting spray applications of pesticides containing diazinon during the dormant season. These regulations prohibit application of diazinon within 48 hours of a forecasted storm or when soil at the application site is already saturated with water. The regulations provide limited conditions under which diazinon can be applied, such as using dormant oil, application to a hydrologically isolated site, or holding runoff from fields that receive diazinon and chlorpyrifos treatments for 72 hours before releasing into waterways.[50]

11. **Stormwater and NPDES** permits were amended to include diazinon and chlorpyrifos monitoring and in some instances effluent restrictions were established at the level of water quality objectives. Smaller cities such as Auburn, Anderson, Shasta Lake, Stillwater, Live Oak, and Yuba City have diazinon effluent limitations in their wastewater treatment plant NPDES permits. Similarly, monitoring is required by the combined stormwater permit for Sacramento City and County and the cities of Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova.

Evidence of Impairment Removal

A. Watershed-wide improvement is documented in nine watersheds surrounding the Sacramento River, Feather River, Sacramento Slough, and Sutter Bypass within the Lower Sacramento Basin. Water quality improved as a result of activities using a watershed approach to reduce diazinon levels in impaired water bodies.

According to US EPA's watershed improvement performance measure,[51] "Improved means that one or more of the impairment causes indentified in 2002 are removed for

[49] http://www.epa.gov/fedrgstr/EPA-PEST/2002/December/Day-09/p31013.htm
[50] http://www.cdpr.ca.gov/docs/emon/dormspray/dormant_fact.pdf
[51] US EPA Strategic Plan. http://www.epa.gov/ocfo/plan/plan.htm

at least 40 percent of the impaired water bodies or impaired miles/acres."[52] Impairment removal refers to removing, or delisting, a waterbody from the state 303(d) List. Table 1 shows the individual watersheds containing 2002 diazinon-impaired river segments and 2010 river segments delisted for diazinon[53] within the Lower Sacramento River drainage basin.[54] Map 3 shows the location of 2010 diazinon-impaired and improved (delisted) waterbodies and the individual watersheds they flow through. As Table 1 and Map 3 show, nine of these watersheds meet the 40 per cent requirement for demonstrating an improvement in water quality.

The broader Lower Sacramento Basin also shows an overall water quality improvement due to the reduction of diazinon levels. Table 1 shows that approximately 48% of the river miles listed as diazinon-impaired in 2002 within the Lower Sacramento Basin have been removed from the CWA Section 303(d) Impaired Water Bodies List for diazinon impairments. Map 3 shows the relationship between the diazinon-impaired and delisted waterbodies, small watersheds, and the Lower Sacramento Basin.

B. Evidence demonstrating diazinon water quality improvements, including monitoring data, are synthesized into fact sheets produced by the CVRWQCB and can be found at the links provided below.

1. Lower Feather River – Oroville Dam to Sacramento River
   http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/01204.shtml#4172
2. Sacramento River from Knights Landing to the Delta
   http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/01144.shtml#4158
3. Sacramento Slough
   http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/01203.shtml#6776

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[52] http://www.epa.gov/region9/water/watershed/docs/SP-12_Guidance_12-05-08.pdf

[53] Sutter Bypass and Sacramento Slough were delisted from the 303(d) List of Impaired water bodies for diazinon impairments in 2006. Sacramento River from Knights Landing to the Delta and the Lower Feather River have been recommended for delisting by the CVRWQCB and are awaiting final adoption from the State Water Resources Control Board and approval by USEPA.

[54] Two data sources were used to estimate the 40% river miles for this report. The first is the 2002 CVRWCB 303(d)/305(b) Integrated Report which lists estimated river miles and acres of each evaluated water body. The second data source, the one used in Table 1, contains data from two geographic information systems (GIS) databases, the National Hydrography Dataset (http://nhd.usgs.gov/) and the USGS 12-digit HUCs (http://www.ncgc.nrcs.usda.gov/products/datasets/watershed/). Use of GIS data is required to calculate the water quality improved river miles within each 12-digit HUC, a requirement of the watershed improvement performance metric guidance. The 2002 303(d)/305(b) Integrated Report river mile estimates cannot be imported into a GIS program for measurement or analysis. We noted in the report when each data set was used. Regardless of which data set is used, 40% or more of the diazinon-impaired river miles were delisted in 2010 within the Lower Sacramento Basin. Using the 303d List estimates, approximately 79 river miles were delisted for diazinon in 2010 out of 196 river miles impaired in 2002, or 40.3% of the 2002 diazinon-impaired river miles. Table 1 shows that 48% of the 2002 diazinon-impaired river miles were delisted in 2010.

4. Sutter Bypass
   http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/01214.shtml#4657

C. Diazinon concentrations in the Feather and Sacramento River systems have successfully been reduced, however water quality impairments persist in the Lower Sacramento Basin and Great Central Valley. There are thousands of river miles and hundreds of thousands of acres of aquatic resources in the Central Valley with water quality impairments from metals, low dissolved oxygen, nutrients, industrial compounds, and pesticides that negatively impact designated uses (swimming, fishing, agriculture, warm and cold freshwater habitat, spawning habitat, wildlife habitat, etc.).[55] In addition, there is evidence that a group of pesticides, pyrethroids, are highly toxic to aquatic invertebrates[56] and they have replaced diazinon in the urban market.[57] Water quality criteria (objectives) do not yet exist for any of the commonly used pyrethroid compounds.

The partnerships and tools developed to address diazinon pollution in the Central Valley will continue to work toward reducing impairments and can be employed to address many remaining water quality challenges. The alliance between water quality advocacy groups, the agricultural industry, and regulatory agencies established through common efforts to reduce diazinon is a solid foundation from which to focus future efforts. Immediate next steps include removal of the remaining diazinon-impaired waterways from the 303(d) List, removing similar OP impairments caused by chlorpyrifos, and addressing replacement pesticide problems. Progress is already being made as the CVRWQCB works to adopt a Pesticide TMDL for the Central Valley that includes establishing numeric water quality criteria for additional pesticides including some pyrethroid compounds.[58] The ground level collaboration between growers, water quality advocates, and government organizations illustrated in this water quality improvement story is the reason California continues to be a national leader in natural resource protection.

D. Photos and graphics *(maps located at the end of this document and are also available as separate files as high quality pdfs.)*

1. Map 1: 2002 Baseline Condition – Sacramento River Basin Waterbodies with Diazinon Water Quality Impairments
2. Map 2: Lower Sacramento River Basin
3. Map 3: Diazinon improvements in the Sacramento and Feather River Systems

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[55] http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml and http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr.pdf

[56] Donald P. Weston and Michael J. Lydy (2010). Urban and Agricultural Sources of Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California *Environ. Sci. Technol.*, **2010**, *44* (5), pp 1833–1840

[57] Pesticides of Interest for Urban Surface Water Quality – Urban Pesticides Use Trends Annual Report (2008). http://www.up3project.org/documents/UP3UseTrendsReport2008.pdf

[58] http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/pest_bpa_status_jul2010.pdf

4. Table 1: Watersheds improved through reduction of diazinon-impaired river miles

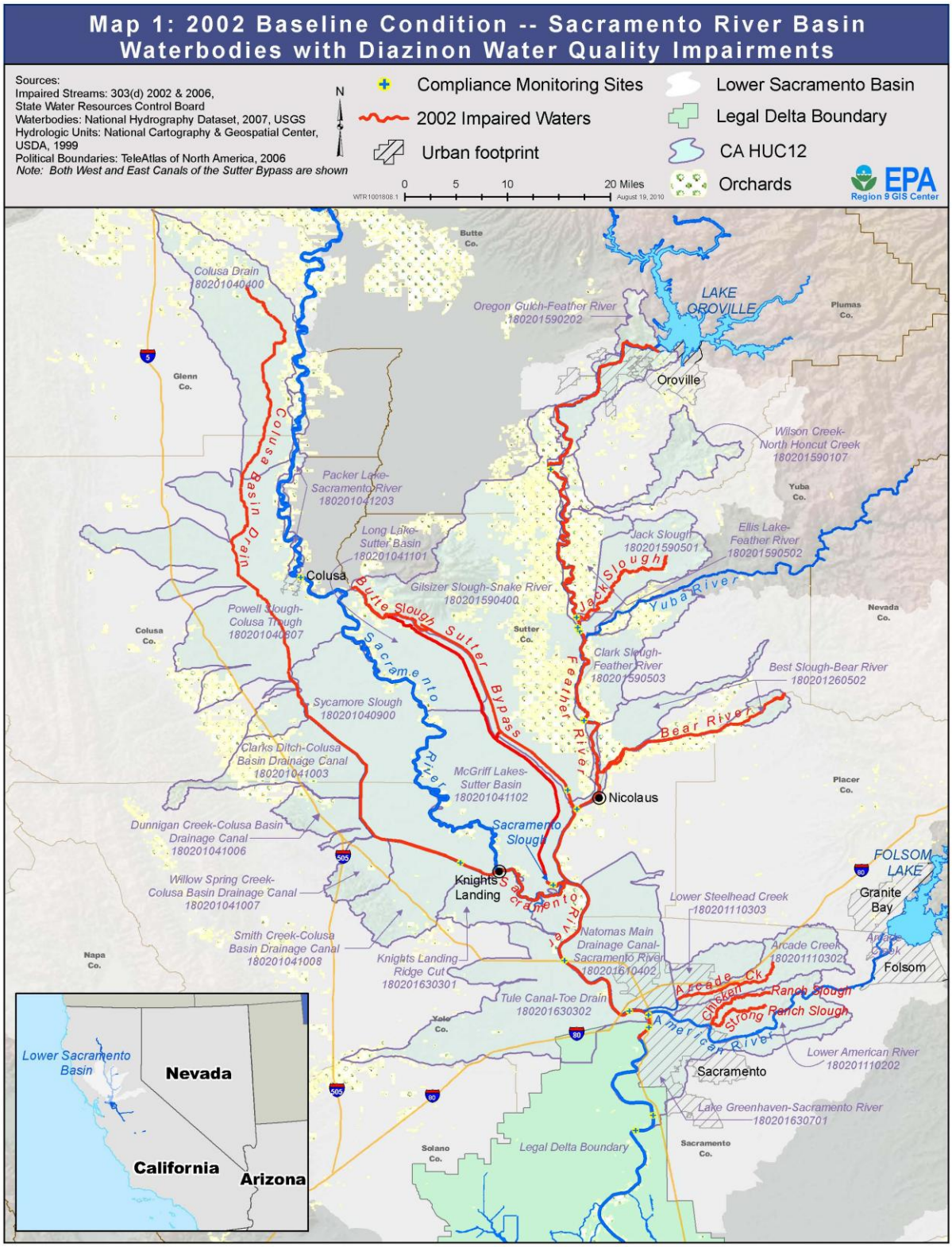
Table 1 "Watersheds improved through reduction of diazinon-impaired river miles"

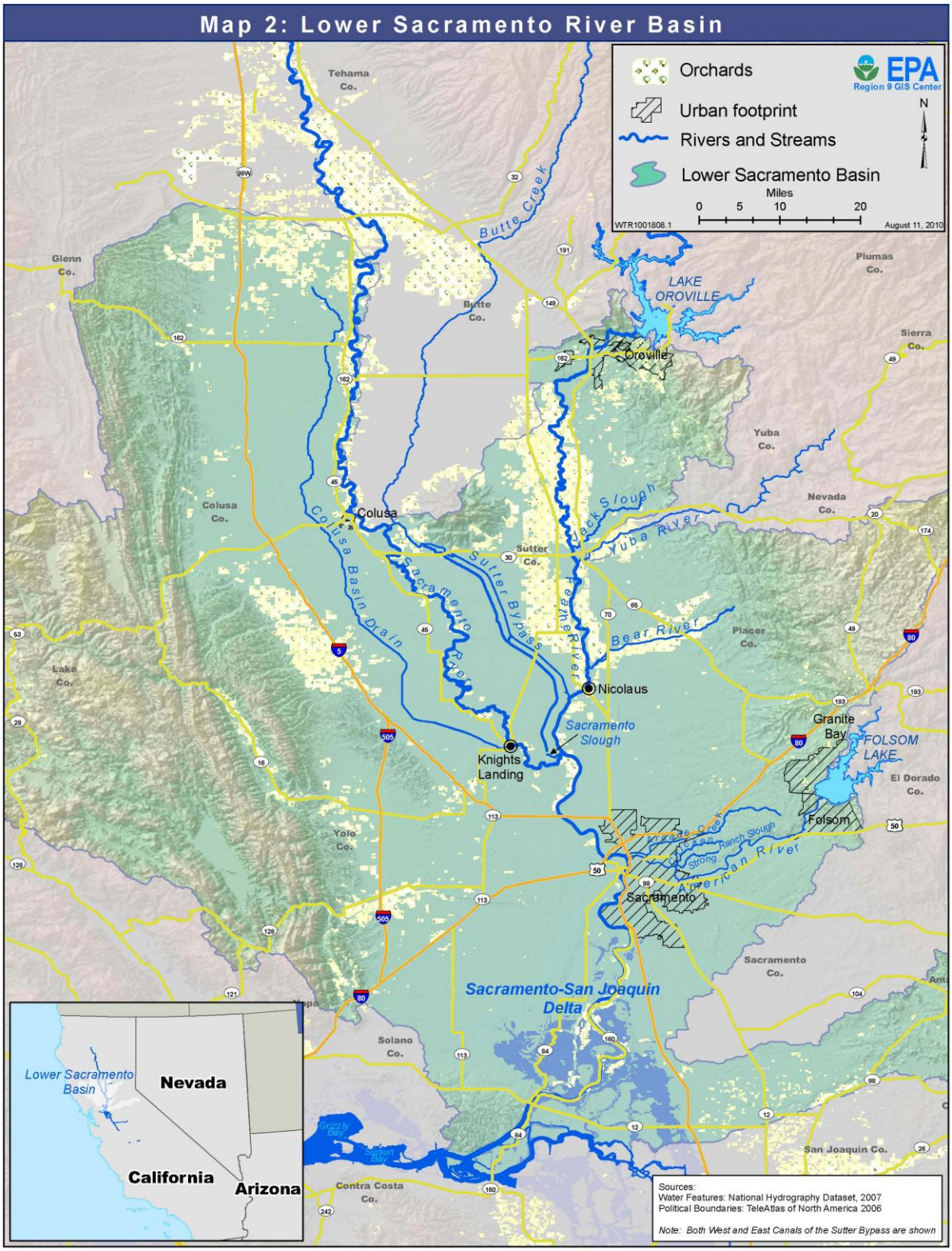
HUC 12 Name	Water Body Name	2002 River Miles Diazinon Impaired	2010 River Miles Delisted for Diazinon	Percent Impairment Removal
Arcade Creek	Arcade Creek	9.9	0	0
Best Slough – Bear River	Lower Feather River	0.07	0.07	
	Lower Bear River	19.32	0	0.4
Clark Slough – Feather River	Lower Feather River	28.37	28.37	
	Lower Bear River	0.14	0	
	Sutter Bypass	0.89	0.89	99.5
Clarks Ditch – Colusa Basin Drainage Canal	Colusa Basin Drain	20	0	0
Colusa Drain	Colusa Basin Drain	21.8	0	0
Ellis Lake – Feather River	Lower Feather River	17.39	17.39	100
Gilsizer Slough – Snake River	Butte Slough	10.38	0	
	Sutter Bypass	21.73	21.73	68
Jack Slough	Lower Feather River	0.03	0.03	
	Jack Slough	14.81	0	0
Knights Landing Ridge Cut	Sacramento River*	0.13	0.13	
	Colusa Basin Drain	0.59	0	18

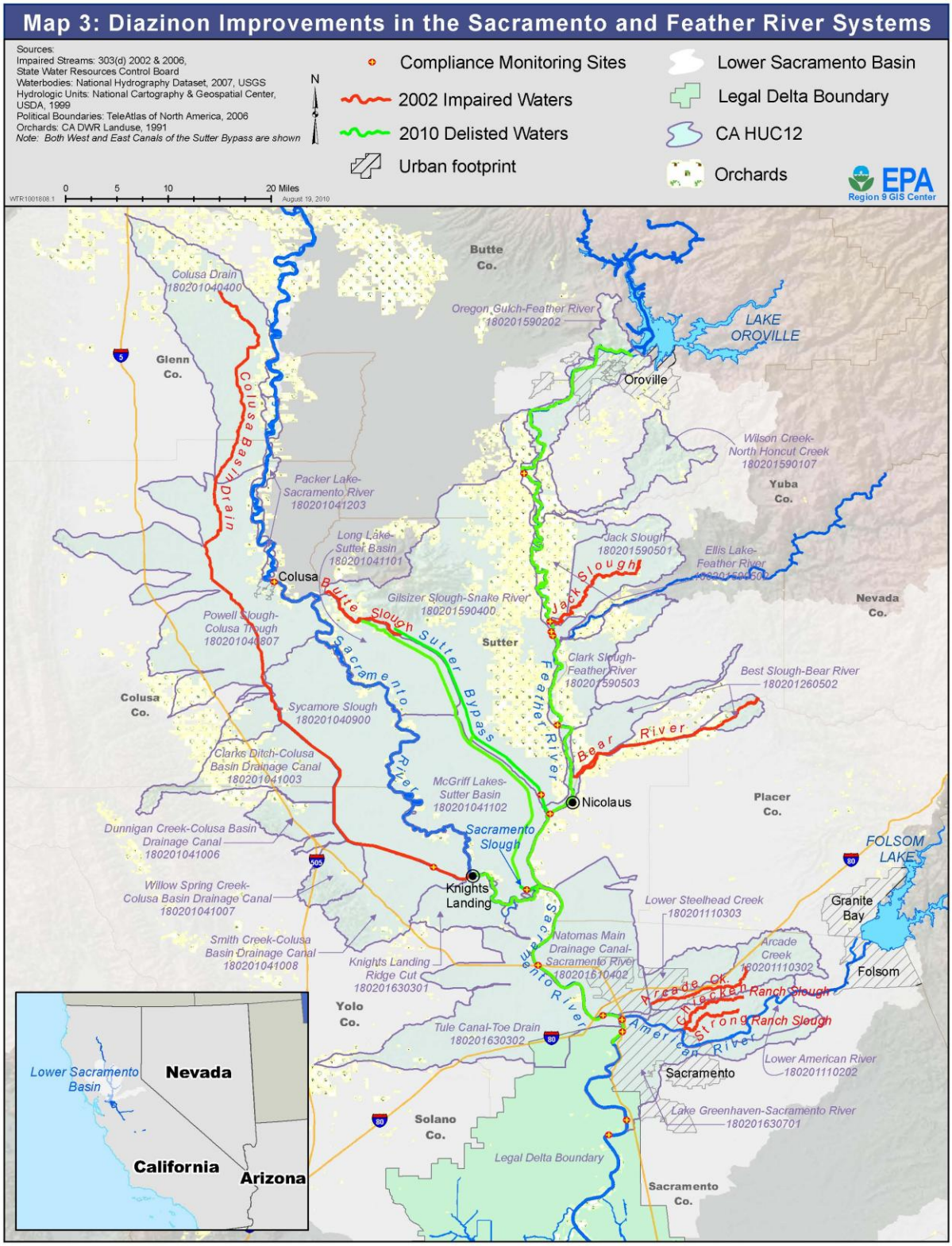
HUC 12 Name	Water Body Name	2002 River Miles Diazinon Impaired	2010 River Miles Delisted for Diazinon	Percent Impairment Removal
Lake Greenhaven – Sacramento River	Sacramento River	2.65	2.65	100
Lower American River	Strong Ranch Slough	6.42	0	
	Chicken Ranch Slough	8.02	0	0
McGriff Lakes – Sutter Basin	Sacramento River	0.05	0.05	
	Sutter Bypass	0.11	0.11	
	Sacramento Slough	1.6	1.6	100
Natomas Main Drainage Canal – Sac River	Lower Feather River	0.03	0.03	
	Sacramento River	19.17	19.17	100
Oregon Gulch – Feather River	Lower Feather River	28.46	28.46	100
Packer Lake – Sacramento River	Colusa Basin Drain	0.05	0.05	
	Sacramento Slough	0.06	0.06	
	Sacramento River	8.71	8.71	100
Powell slough – Colusa Trough	Colusa Basin Drain	26.72	0	0
Smith Creek – Colusa Basin Drainage Canal	Colusa Basin Drain	5.14	0	0
Sycamore Slough	Colusa Basin Drain	21.48	0	0
Tule Canal – Toe Drain	Sacramento River	1.8	1.8	0

HUC 12 Name	Water Body Name	2002 River Miles Diazinon Impaired	2010 River Miles Delisted for Diazinon	Percent Impairment Removal
Willow Spring Creek – Colusa Basin Drainage Canal	Colusa Basin Drain	0.49	0	0
Wilson Creek – North Honcut Creek	Lower Feather River	0.48	0.48	100
Total		**277.6**	**133.73**	**48**

Sources: 303(d) 2002 and 2006 GIS datasets, State Water Resources Control Board; National Hydrography Dataset, 2007, USGS; Watershed Boundary Dataset, 1999, National Cartography and Geospatial Center, USDA.


Map 1: 2002 Baseline Condition -- Sacramento River Basin
Waterbodies with Diazinon Water Quality Impairments
Sources:
Impaired Streams: 303(d) 2002 & 2006,
State Water Resources Control Board
Waterbodies: National Hydrography Dataset, 2007, USGS
Hydrologic Units: National Cartography & Geospatial Center, USDA, 1999
Political Boundaries: TeleAtlas of North America, 2006
Note: Both West and East Canals of the Sutter Bypass are shown
N
Compliance Monitoring Sites
2002 Impaired Waters
Urban footprint
Lower Sacramento Basin
Legal Delta Boundary
CA HUC12
Orchards
0 5 10 20 Miles
WTR1001808.1
August 19, 2010
EPA
Region 9 GIS Center
Colusa Drain 180201040400
Oregon Gulch-Feather River 180201590202
LAKE OROVILLE
Oroville
Butte Co.
Plumas Co.
Glenn Co.
Colusa Basin Drain
Packer Lake-Sacramento River 180201041203
Wilson Creek-North Honcut Creek 180201590107
Yuba Co.
Long Lake-Sutter Basin 180201041101
Jack Slough 180201590501
Ellis Lake-Feather River 180201590502
Jack Slough
Colusa
Gilsizer Slough-Snake River 180201590400
Yuba River
Powell Slough-Colusa Slough 180201040807
Nevada Co.
Colusa Co.
Sutter Co.
Butte Slough
Sutter Bypass
Sacramento River
Clark Slough-Feather River 180201590503
Best Slough-Bear River 180201260502
Feather River
Bear River
Sycamore Slough 180201040900
Clarks Ditch-Colusa Basin Drainage Canal 180201041003
McGriff Lakes-Sutter Basin 180201041102
Placer Co.
Nicolaus
Dunnigan Creek-Colusa Basin Drainage Canal 180201041006
Sacramento Slough
FOLSOM LAKE
Granite Bay
Knights Landing
Willow Spring Creek-Colusa Basin Drainage Canal 180201041007
Sacramento River
Lower Steelhead Creek 180201110303
Natomas Main Drainage Canal-Sacramento River 180201610402
Arcade Creek 180201110302
Smith Creek-Colusa Basin Drainage Canal 180201041008
Knights Landing Ridge Cut 180201630301
Napa Co.
Folsom
Arcade Ck
Chicken Ranch Slough
Strong Ranch Slough
Tule Canal-Toe Drain 180201630302
Yolo Co.
American River
Lower American River 180201110202
Sacramento
Lake Greenhaven-Sacramento River 180201630701
Solano Co.
Legal Delta Boundary
Sacramento Co.
Lower Sacramento Basin
Nevada
California
Arizona


Map 2: Lower Sacramento River Basin
Orchards
Urban footprint
Rivers and Streams
Lower Sacramento Basin
Miles
0 5 10 20
WTR1001808.1
August 11, 2010
EPA
Region 9 GIS Center
N
Tehama Co.
Glenn Co.
Butte Co.
Butte Creek
LAKE OROVILLE
Oroville
Plumas Co.
Sierra Co.
Yuba Co.
Nevada Co.
Colusa Co.
Colusa
Colusa Basin Drain
Sacramento River
Sutter Bypass
Sutter Co.
Jack Slough
Feather River
Yuba River
Bear River
Placer Co.
Nicolaus
Sacramento Slough
Knights Landing
Granite Bay
FOLSOM LAKE
El Dorado Co.
Folsom
Lake Co.
Yolo Co.
Arcade Creek
Strong Ranch Slough
American River
Sacramento
Sacramento Co.
Sacramento-San Joaquin Delta
Solano Co.
San Joaquin Co.
Contra Costa Co.
Lower Sacramento Basin
Nevada
California
Arizona
Sources:
Water Features: National Hydrography Dataset, 2007
Political Boundaries: TeleAtlas of North America 2006
Note: Both West and East Canals of the Sutter Bypass are shown


Map 3: Diazinon Improvements in the Sacramento and Feather River Systems
Sources:
Impaired Streams: 303(d) 2002 & 2006,
State Water Resources Control Board
Waterbodies: National Hydrography Dataset, 2007, USGS
Hydrologic Units: National Cartography & Geospatial Center, USDA, 1999
Political Boundaries: TeleAtlas of North America, 2006
Orchards: CA DWR Landuse, 1991
Note: Both West and East Canals of the Sutter Bypass are shown
N
0 5 10 20 Miles
August 19, 2010
Compliance Monitoring Sites
2002 Impaired Waters
2010 Delisted Waters
Urban footprint
Lower Sacramento Basin
Legal Delta Boundary
CA HUC12
Orchards
EPA
Region 9 GIS Center
Butte Co.
Colusa Drain 180201040400
Oregon Gulch-Feather River 180201590202
LAKE OROVILLE
Glenn Co.
Oroville
Wilson Creek-North Honcut Creek 180201590107
Yuba Co.
Packer Lake-Sacramento River 180201041203
Long Lake-Sutter Basin 180201041101
Jack Slough 180201590501
Ellis Lake-Feather River
Colusa
Gilsizer Slough-Snake River 180201590400
Nevada Co.
Powell Slough-Colusa Trough 180201040807
Sutter
Clark Slough-Feather River 180201590503
Best Slough-Bear River 180201260502
Colusa Co.
Sycamore Slough 180201040900
Clarks Ditch-Colusa Basin Drainage Canal 180201041003
McGriff Lakes-Sutter Basin 180201041102
Nicolaus
Placer Co.
Dunnigan Creek-Colusa Basin Drainage Canal 180201041006
Sacramento Slough
FOLSOM LAKE
Willow Spring Creek-Colusa Basin Drainage Canal 180201041007
Knights Landing
Lower Steelhead Creek 180201110303
Granite Bay
Smith Creek-Colusa Basin Drainage Canal 180201041008
Natomas Main Drainage Canal-Sacramento River 180201610402
Arcade Creek 180201110302
Knights Landing Ridge Cut 180201630301
Folsom
Yolo Co.
Tule Canal-Toe Drain 180201630302
Sacramento
Lower American River 180201110202
Lower Sacramento Basin
Nevada
California
Arizona
Solano Co.
Lake Greenhaven-Sacramento River 180201630701
Legal Delta Boundary
Sacramento Co.