Wyandotte Creek
GROUNDWATER SUSTAINABILITY
AGENCY

Wyandotte Creek Subbasin Advisory (WAC) Committee Correspondence

Begin forwarded message:

From: Paul Gosselin

General Plans in the Plan Area

Wyandotte Creek subbasin is subject to the Butte County General Plan 2030 and the City of Oroville General Plan. In 2018, the Camp Fire destroyed 18,000 structures in Butte County displacing over 27,000 residents. In 2020, the North Complex Fire destroyed homes in Berry Creek, Feather Falls and other areas. While the Town of Paradise, Concow, Berry Creek and other impacted areas rebuild, many residents have relocated to other parts of Butte County. The existing General Plans may not fully account for the relocation of Camp Fire survivors. A focused accounting of changes to residential land use as a result of the Camp Fire should be conducted.

Butte County General Plan 2030

The Butte County General Plan 2030 was adopted by the Butte County Board of Supervisors in October 2010. The General Plan 2030 identifies the goals, policies and actions governing land use in the unincorporated portions of Butte County. The General Plan 2030 reflects the community desire to conserve and enhance the legacy of their forebears, namely, sustainable development. To this end, the General Plan 2030 envisions and supports a Butte County in 2030 where:

- Urban development will be primarily centralized within and adjacent to the existing municipal limits and larger unincorporated communities. Urban development will have efficient, reliable public facilities and infrastructure. Employment centers and a range of services will be located near residential areas so that people spend less time in their cars. Residential communities will be walkable, bicycle facilities will be provided, and there will be access to public transit.
- Small unincorporated areas will be well-planned through community-driven planning processes so that community character is preserved and adequate public services and facilities are provided. Rural residential development will be limited and will strive to be compatible with agricultural and environmental uses, and will address wildfire risks and public services needs.
- Agriculture and open space will continue to dominate Butte County’s landscape and be an important part of the County’s culture and economy. Existing agricultural areas will be maintained and an array of agricultural services will support agriculture while providing new jobs to Butte County residents.

The General Plan 2030 includes an optional Water Resources Element in addition to the mandatory elements of Land Use, Housing, Economic Development, Agriculture, Circulation, Conservation and Open-space, Health and Safety and Public Facilities and Services. In adopting the Water Resources Element, the General Plan 2030 recognized the importance and interrelationship between land use and water resources management. The General Plan 2030 Water Resources Element has six goals:

1. Maintain and enhance water quality;
2. Ensure an abundant and sustainable water supply to support all uses in Butte County;
3. Effectively manage groundwater resources to ensure a long-term water supply for Butte County;
4. Promote water conservation as an important part of a long-term and sustainable water supply;
5. Protect water quality through effective storm water management, and;
6. Improve stream bank stability and protect riparian resources.

Key Water Resources Element policies include:

- W-P1.4 Where appropriate, new development shall be Low Impact Development (LID) that minimizes impervious area, minimizes runoff and pollution and incorporates best management practices.
- W-P2.1 The County supports solutions to ensure the sustainability of community water supplies.
- W-P2.3 Water resources shall be planned and managed in a way that relies on sound science and public participation.
- W-P2.5 The expansion of public water systems to areas identified for future development on the General Plan land use map is encouraged.
- W-P2.6 The County supports water development projects that are needed to supply local demands.
- W-P2.8 The County supports Area of Origin water rights, the existing water right priority system and the authority to make water management decisions locally to meet the county's current and future needs, thereby protecting Butte County's communities, economy and environment.
- W-P2.9 Applicants for new major development projects, as determined by the Department of Development Services, shall demonstrate adequate water supply to meet the needs of the project, including an evaluation of potential cumulative impacts to surrounding groundwater users and the environment.
- W-P3.1 The County shall continue to ensure the sustainability of groundwater resources, including groundwater levels, groundwater quality and avoidance of land subsidence, through a basin management objective program that relies on management at the local level, utilizes sound scientific data and assures compliance.
- W-P3.2 Groundwater transfers and substitution programs shall be regulated to protect the sustainability of the County's economy, communities and ecosystem, pursuant to Chapter 33 of the Butte County Code.
- W-P3.3 The County shall protect groundwater recharge and groundwater quality when considering new development projects.
- W-P4.1 Agricultural and urban water use efficiency shall be promoted.

- W-P4.2 Water conservation efforts of local Resource Conservation Districts, the Natural Resource Conservation Service and irrigation districts should be coordinated.
- W-P4.3 The County shall work with municipal and industrial water purveyors to implement water conservation policies and measures.
- W-P4.4 Opportunities to recover and utilize wastewater for beneficial purposes shall be promoted and encouraged.
- W-P4.5 The use of reclaimed wastewater for non-potable uses shall be encouraged, as well as dual plumbing that allows graywater from showers, sinks and washers to be reused for landscape irrigation in new developments.
- W-P4.6 New development projects shall adopt best management practices for water use efficiency and demonstrate specific water conservation measures.
- W-P5.2 New development projects shall identify and adequately mitigate their water quality impacts from stormwater runoff.
- W-P5.3 Pervious pavements shall be allowed and encouraged where their use will not hinder mobility.

Implementation of the Wyandotte Creek GSP will provide for sustainable groundwater management and is not anticipated to affect water supply assumptions in the General Plans.

Information on the Butte County General Plan 2030 and related documents can be found at www.buttegeneralplan.net.

City of Oroville

Permitting of New Wells

The construction, repair or destruction of wells is subject to permitting by the Butte County Division of Environmental Health pursuant to Chapter 23B of the Butte County Code, Water Wells. The chapter provides minimum procedures for the proper construction of water wells and for the proper destruction of abandoned wells in order to ensure that water obtained from wells within the County of Butte will be suitable for the purposes for which used and that wells constructed or abandoned pursuant to this chapter will not cause pollution or impairment of the quality of the groundwater within the county. An additional purpose is to reduce potential well interference problems to existing wells and potential adverse impacts to the environment which could be caused by the construction of new wells or the repair or deepening of existing wells where a permit is required. Important provisions of the chapter include:

- The construction, repair, reconstruction, deepening, abandonment and destruction of wells in Butte County must follow the standards in Bulletin 74-81 and its supplement bulletin 74-90, Water Well Standards, State of California.
- After July 25, 1996, the pumping capacity of a new well cannot be greater than fifty (50) gallons per minute per acre to reasonably serve the overlying land, including contiguous parcels of land under the same ownership as the land upon which the well is located.

- Wells can only be drilled by a person licensed to drill water wells pursuant to the provisions of Business and Professions Code section 7000 et seq. possessing a C-57 water well contractors license required by section 13750.5 of the California Water Code.
- Domestic well owners are required to insure that a new well will operate properly assuming a repeat of the groundwater conditions experienced during the period 1987 through 1994 in the area in which the new well is located.
- Well drillers reports must be filed with Butte County as well as with the Department of Water Resources.
- Notification of well permit applications are required in specific instances to adjoining landowners and/or local agencies with an adopted groundwater management plan pursuant to part 2.75 of division 6 of the California Water Code (commencing at section 10750). Landowners and/or local agencies are provided thirty (30) days to provide comments prior to permit issuance.
- Wells with a casing diameter greater than eight (8) inches are required to be drilled at specific distances away from existing wells.
- In addition to well sealing requirements specified within state well standards bulletin 74-81 and bulletin 74-90, the seal shall be extended five (5) feet into the first consolidated formation encountered below fifteen (15) feet to a maximum required sealing depth of fifty (50) feet.

Land Use Plans Outside of the Basin

The Yuba County General Plan and zoning ordinance is the only land use plan adjacent to the Wyandotte Creek subbasin. The Yuba County General Plan will not have any impact on the Wyandotte Creek GSP to achieve sustainable groundwater management. The Wyandotte Creek GSA will continue to monitor amendments to the Yuba County General Plan.

From: Duke Sherwood <duke@dukesherwoodcontracting.com>
To: Mariana Rivera-Torres <mriveratorres@cbi.org>
Sent: 3/10/2021 10:39 AM
Subject: Possible locations for groundwater recharge

Mariana,

Please find the attached list and locations of possible land owners in the Wyandotte and Wyman drainages for possible ground water recharge participants.

Thank you,
Duke Sherwood
Duke Sherwood Contracting,Inc.
P: 530-846-2710
F: 530-846-6760
C: 530-624-5642

Duke Sherwood Contracting, Inc.

General Engineering Contractor #327827
495 Stimpson Road • Oroville, CA 95965• (530) 533-2710

3-10-21

Mariana,

I have compiled a short list of possible property owners that could possibly be interested in "Artificial Groundwater Recharge". There are obviously many more locations but the following list are those that I know personally and or professionally or both. With different types of artificial recharge such as injection wells, infiltration basins, and ponds and these properties are of different sizes that may accommodate some type of recharge.

Wyandotte Creek Drainage:

The upper end, off of Alta Arosa Dr. Duke Sherwood
At the bottom end of the foothills east of Palermo/Honcut Rd. Cynthia Daley
The West side of Palermo/Honcut Rd. Pacific Coast Producers
West of Pacific Coast Producers and North of Cox Lane. Jeff Mardesich
South of Cox Lane. Bobette Vassar

Wyman Ravine Drainage:

The upper end Mooretown Rancheria, Sean Miller
South of Palermo Rd. Doug Wheeler
West of Lone Tree Rd. Jace and Susan Rash
North of Cox Lane Kyle Daley
South of Cox Lane Jim McCarten
South of Stimpson Rd. Gary Phillips, Duke Sherwood, Aaron Weinzinger

All of the parties listed would be considered part of agriculture related endeavors.

Hopefully, this list will give us a start in collecting interested parties that we could expand upon.

Thank You,

Duke

Duke

From: Peterson, Kelly
Sent: Thursday, March 11, 2021 12:54 PM
To: Peterson, Kelly <KPeterson@buttecounty.net>
Subject: SGMA Overview Joint Webinar from DWR and the State Water Resources Control Board

Good Afternoon,

On behalf of the Wyandotte Creek GSA Management Committee, I am sending you a link to a recent webinar: "Joint DWR-State Water Board General SGMA Webinar on Groundwater Sustainability Planning"https://www.youtube.com/watch?v=TeYaZB8MT3w

We encourage you to review this as it is a great overview to understand what to expect from both DWR and the SWRCB once a GSP is submitted, the role of each agency and other important information regarding SGMA and GSPs, all in just under 2 hours.

This virtual General Sustainable Groundwater Management Act (SGMA) Webinar on groundwater sustainability planning was hosted by the DWR and the State Water Resources Control Board. It includes an update on how the State is moving forward with groundwater sustainability plan (GSP) evaluations, the timeline and approach to releasing assessments for GSPs submitted to DWR by Jan. 31, 2020, and an overview of state assistance to support locals moving forward with SGMA implementation.

We hope you find it useful, please share with anyone else you think may be interested.

Thanks,

Kelly Peterson, Water Resources Scientist
Butte County Department of Water and Resource Conservation
308 Nelson Avenue
Oroville, CA 95965
Office: (530) 552-3595
https://www.buttecounty.net/waterresourceconservation/Home

*Please click **HERE** to sign up for regular email updates from our Department.*

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Oroville, CA 95965
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*Please click **HERE** to sign up for regular email updates from our Department.*

Begin forwarded message:

From: Kathy Brazil <fewzil@att.net>
Sent: Monday, March 29, 2021 10:22 AM
To: BCWater <BCWaterFrontDeskHG@buttecounty.net>
Subject: Re: Wyandotte Creek Subbasin Advisory Committee Agenda for April 1, 2021

Please share this letter with all the Wyandotte Creek GSA members.
Dear Committe;
I have not been able to attend any WCGSA recent meetings, and I still want to ask the committee to include Ruddy Creek and all its the hydrology details to be included in all discussions of the Wyandotte Creek Groundwater Sustainability Agency. It is an intermittent creek that flows through Thermalito. If your committee is not familiar with the creek, please view it's streambanks in person at 14th and Feather Ave and Biggs Ave and 16th St. It has documented flooding issues. I have sent photos and so far the maps I have received from the County do not include the streambank riparian data details of the Fish and Wildlife Agency and Army Corp of Engineer. Please send me any current discussions and information that includes the the Ruddy Creek waterway, as it flows within the Wyandotte Groundwater Basin.
I read through these Correspondence pages 1-3:
Butte County General Plan 2030
The Butte County General Plan 2030 was adopted by the Butte County Board of Supervisors in October 2010. The General Plan 2030 identifies the goals, policies and actions governing land use in the unincorporated portions of Butte County. The General Plan 2030 reflects the community desire to conserve and enhance the legacy of their forebears, namely, sustainable development. To this end, the General Plan 2030 envisions and supports a Butte County in 2030 where: • Urban development will be primarily centralized within and adjacent to the existing municipal limits and larger unincorporated communities. Urban development will have efficient, reliable public facilities and infrastructure. Employment centers and a range of services will be located near residential areas so that people spend less time in their cars. Residential communities will be walkable, bicycle facilities will be provided, and there will be access to public transit. • Small unincorporated areas will be well-planned through community-driven planning processes so that community character is preserved and adequate public services and facilities are provided. Rural residential development will be limited and will strive to be compatible with agricultural and environmental uses, and will address wildfire risks and public services needs.
• Agriculture and open space will continue to dominate Butte County's landscape and be an important part of the County's culture and economy. Existing agricultural areas will be maintained and an array of agricultural

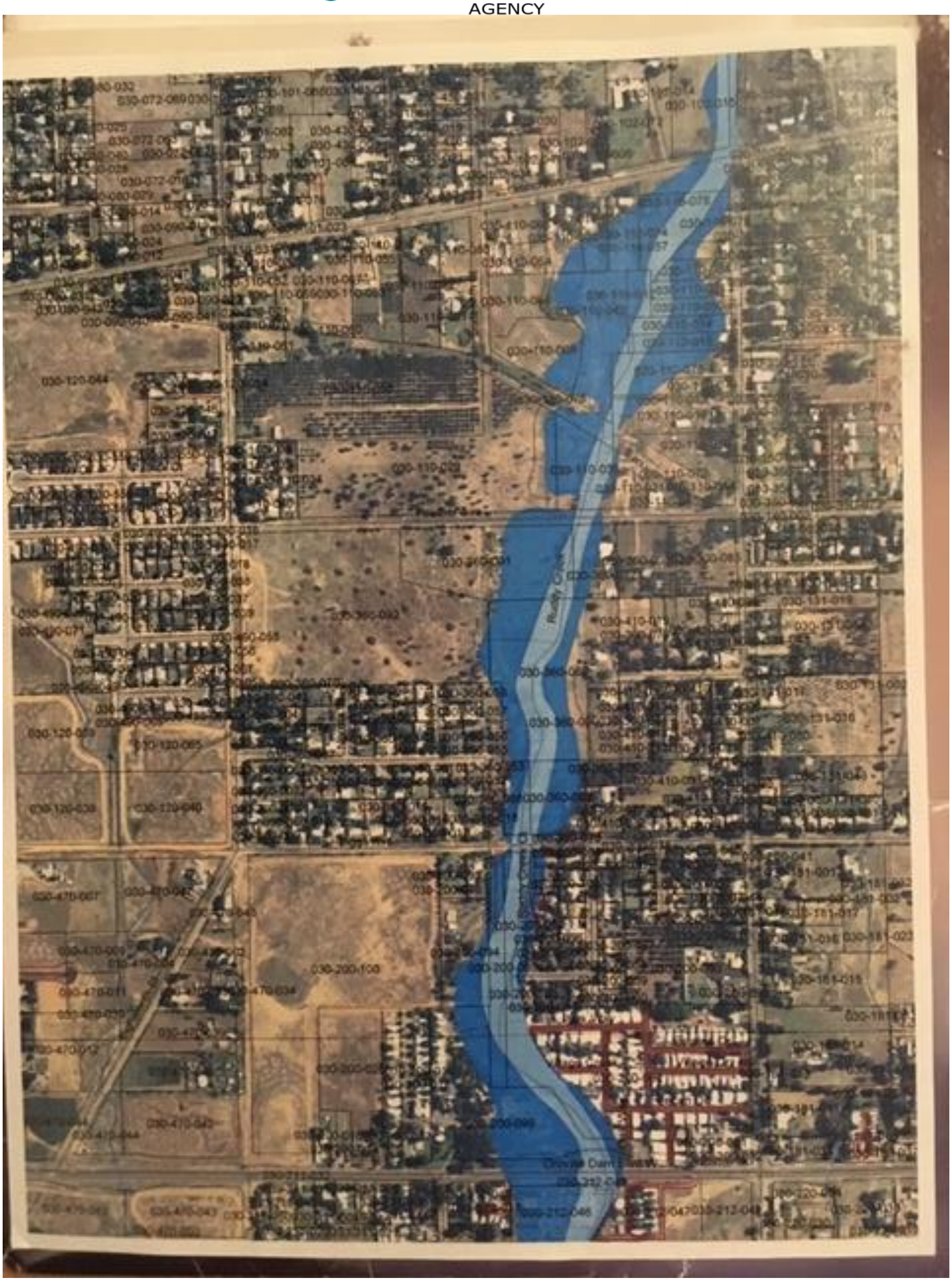
services will support agriculture while providing new jobs to Butte County residents.

The General Plan 2030 includes an optional Water Resources Element in addition to the mandatory elements of Land Use, Housing, Economic Development, Agriculture, Circulation, Conservation and Open-space, Health and Safety and Public Facilities and Services. In adopting 3/26/21 2 the Water Resources Element, the General Plan 2030 recognized the importance and interrelationship between land use and water resources management. The General Plan 2030 Water Resources Element has six goals: 1. Maintain and enhance water quality; 2. Ensure an abundant and sustainable water supply to support all uses in Butte County; 3. Effectively manage groundwater resources to ensure a long-term water supply for Butte County; 4. Promote water conservation as an important part of a long-term and sustainable water supply; 5. Protect water quality through effective storm water management, and; 6. Improve stream bank stability and protect riparian resources. Key Water Resources Element policies include: ➢ W-P1.4 Where appropriate, new development shall be Low Impact Development (LID) that minimizes impervious area, minimizes runoff and pollution and incorporates best management practices. ➢ W-P2.1 The County supports solutions to ensure the sustainability of community water supplies. ➢ W-P2.3 Water resources shall be planned and managed in a way that relies on sound science and public participation. ➢ W-P2.5 The expansion of public water systems to areas identified for future development on the General Plan land use map is encouraged. ➢ W-P2.6 The County supports water development projects that are needed to supply local demands. ➢ W-P2.8 The County supports Area of Origin water rights, the existing water right priority system and the authority to make water management decisions locally to meet the county's current and future needs, thereby protecting Butte County's communities, economy and environment. ➢ W-P2.9 Applicants for new major development projects, as determined by the Department of Development Services, shall demonstrate adequate water supply to meet the needs of the project, including an evaluation of potential cumulative impacts to surrounding groundwater users and the environment. ➢ W-P3.1 The County shall continue to ensure the sustainability of groundwater resources, including groundwater levels, groundwater quality and avoidance of land subsidence, through a basin management objective program that relies on management at the local level, utilizes sound scientific data and assures compliance. ➢ W-P3.2 Groundwater transfers and substitution programs shall be regulated to protect the sustainability of the County's economy, communities and ecosystem, pursuant to Chapter 33 of the Butte County Code. ➢ W-P3.3 The County shall protect groundwater recharge and groundwater quality when considering new development projects. ➢ W-P4.1 Agricultural and urban water use efficiency shall be promoted. 3/26/21 3 ➢ W-P4.2 Water conservation efforts of local Resource Conservation Districts, the Natural Resource Conservation Service and irrigation districts should be coordinated. ➢ W-P4.3 The County shall work with municipal and industrial water purveyors to implement water conservation policies and measures. ➢ W-P4.4 Opportunities to recover and utilize wastewater for beneficial purposes shall be promoted and encouraged. ➢ W-P4.5 The use of reclaimed wastewater for non-potable uses shall be encouraged, as well as dual plumbing that allows graywater from showers, sinks and washers to be reused for landscape irrigation in new developments. ➢ W-P4.6 New development projects shall adopt best management practices for water use efficiency and demonstrate specific water conservation measures. ➢ W-P5.2 New development projects shall identify and adequately mitigate their water quality impacts from stormwater runoff. ➢ W-P5.3 Pervious pavements shall be allowed and encouraged where their use will not hinder mobility. Implementation of the Wyandotte Creek GSP will provide for sustainable groundwater management and is not anticipated to affect water supply assumptions in the General Plans. Information on the Butte County General Plan 2030 and related documents can be found at www.buttegeneralplan.net.

I question why the wording says an "optional Water Resources Element"? Water is not an optional issue. How is this Wyandotte Creek GSA committee assuring that water is a :required resource element"? See #6 highlighted above, this directly addresses Ruddy Creek and it's habitat and riparian streambanks. I look forward to hearing that the watershed of the live and viable Ruddy Creek stream is included in all related discussions of the Wyandotte Creek Groundwater Sustainability Basin committee.

Kathy Brazil

On Monday, March 29, 2021, 08:59:22 AM PDT, Wyandotte Creek Groundwater Sustainability Agency <bcwater@buttecounty.net> wrote:



February 5, 2021

Dear Reader:

We are pleased to provide a strong endorsement for the enclosed report, ***20-Year Land and Water Use Change in Butte County (1999-2019)***, which was recently prepared by Land IQ for the Agricultural Groundwater Users of Butte County ("AGUBC"), a 501(c)(6) organization that represents 56,273 acres of land in Butte County.

Groundwater in Butte County, and particularly in the Vina Subbasin, is essential for life and growth – for the food we eat, the families we raise, and the regional economy it supports. **In this report, Land IQ's analysis of land and water use changes and trends in Butte County over the past twenty years provides regional stakeholders with accurate, factual data.** This data will contribute to a better understanding of the baseline condition in Butte County, particularly as we move toward implementation of the Sustainable Groundwater Management Act ("SGMA") in the years to come.

Several **key findings** from the following report:

- Today, **agriculture in Butte County uses roughly 17% less groundwater than in 1999**.
- The decrease is the result of:
    - A **significant reduction of overall irrigated acreage**.
    - An increase in walnuts which commonly replaced peaches, prunes, and almonds, most of which have higher water demand.
    - **New orchards being installed with modern and more efficient irrigation systems**.
- As more efficient irrigation systems are installed on agricultural land and water conservation practices are implemented, **it should be expected that applied water use will continue to decrease**.

A team of soil scientists, agronomists, ecologists and environmental scientists from Land IQ used advanced data and mapping systems to develop this report. **Land IQ currently works for more than 12 Groundwater Sustainability Agencies**, **various irrigation districts, multiple environmental groups**, 7 crop commodity organizations, up to 8 urban water agencies, and various other private and public entities related to accurate water resources management within and at the interfaces of environmental, urban, and agricultural land uses.

Butte County is in a unique and enviable position. SGMA will require more from all of us and there is still room for improvement, but this report clearly illustrates that **local farms in Butte County can be proud of how they've continuously improved the management of this critically important groundwater resource** over the years.

Lee Heringer
President, Butte County Farm Bureau

Mark Pierce
President, North Valley Ag Services

Richard P. Smith
President & CEO, Tri Counties Bank

Nadine F. Bailey
Chief Operations Officer, Family Water Alliance

Maureen Kirk
Former Supervisor, Butte County

Steve Lambert
Former Supervisor, Butte County

PRAISE FOR THE LAND IQ REPORT

“Agricultural water use has decreased significantly as farms continue to become more water efficient. That’s one of the primary agricultural trends in Butte County, according to this important study that looks at land and water use changes over the past 20 years.”

Lee Heringer, President, Butte County Farm Bureau Board of Directors

“It is essential that data inform decisions regarding future water use in Butte County. The report of Land IQ demonstrates the trend of more water for urban and environmental use over the past 20 years, while water efficiency in agriculture continues to improve. Ultimately, making sure this precious resource is appropriately allocated to support production of food should be critical to all Butte County residents.”

Dave Daley, PhD, Professor Emeritus, Farm Administrator Chico State Farm, Chair of the California Cattle Council, and Past President of California Cattlemen Association

“Agriculture is the number one industry in California. Our farmers feed the world. This report by Land IQ is an opportunity for us to better understand what our farmers have done and are trying to tell us and trust them to make good choices about water that ultimately determines what’s on our dinner plate.”

Jamie Johansson, President, California Farm Bureau Federation

“Land IQ’s report is exactly what we needed. This 20-year snapshot of agricultural land and water use in Butte County will be a tremendously useful tool to support future decision making.”

Rick Smith, President and CEO, Tri Counties Bank

“A most informative report concerning agricultural water usage over the past 20 years. It’s eye opening, you see that urban and environmental water use has greatly increased. Land IQ’s data is needed for information in future decision making involving our most precious resource.”

Walter Stile, W.L. Stile & Son LLC

"This study illustrates important trends in Butte County agricultural use over the past 20 years that cannot be ignored as we work to protect our water for generations to come.”

Steven Koehnen, C.F. Koehnen & Sons

“This report commissioned by the Agricultural Ground Water Users of Butte County brings us one step closer to what the farmers have been saying all along - let’s use factual information to secure our groundwater for future generations.”

Colleen Cecil, Executive Director, Butte County Farm Bureau

“Many thanks to The Agricultural Groundwaters Users of Butte County for commissioning the study preformed by Land IQ on groundwater usage in Butte County. The study outlines historical groundwater usage in Butte County using science and facts as the guideline. This is information water users in Butte County have been seeking since the 1980’s. It will be very helpful in making informed decisions about future water usage in Butte County.”

Les Heringer, Manager, M&T Chico Ranch

“Great report. This 20-year look at agricultural land use and water use trends in Butte County is exactly what we need to help support future decision making.”

Greg Sohnrey, Sohnrey Family Foods

“Thank you, Agriculture Groundwater Users of Butte County, for collaborating with Land IQ to provide a document that is a data based, factual overview of Butte County's agricultural land and water use to share with both farmers and the general public. It is enlightening!”

Joanne Parsley, Parsley Farms

20-Year Land and Water Use Change in Butte County and the Vina Subbasin (1999-2019)

Prepared For:

Agricultural Groundwater Users of Butte County

Prepared By:

LAND IQ

Reviewed By:

Allan Fulton, M.S., UC Irrigation and Water Resources Advisor, Emeritus

JANUARY 28, 2021

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SUMMARY

INTRODUCTION

Quantifying land and water use by agricultural, environmental, and urban sectors and how it is expected to change over time is an important component of Groundwater Sustainability Plans (GSP) developed by Groundwater Sustainability Agencies (GSA) (e.g. Vina) in Butte County as well as overall water resource management practices. This report describes the methodology and results of an analysis that compared agricultural, environmental, and urban land use change and associated changes in water use at the beginning and end of a 20-year period from 1999 to 2019. The information contained within this report primarily focuses on agricultural land and water use change over this period, however results are also provided for environmental and urban land uses.

METHODS

Agricultural water use is dependent on crop type, crop acreage, rainfall, irrigation methods, and associated irrigation efficiencies. Applied water was determined from annual estimates of crop consumptive use, crop acreage for each year, irrigation efficiency of irrigation methods used on each crop, and precipitation data were used. The spatial land use dataset from California Department of Water Resources (DWR) was used for crop acreage. The spatial accuracy of the field-by-field historical mapping database is over 97.6% for all crops (California Department of Water Resources, 2019). Any misclassified crops (2.4% in 2016 metadata) are usually of similar type (e.g. almonds confused for peaches). As such, in the rare occurrence of a misclassification, the water use will be similar. Therefore, estimates of water use should be highly accurate when calculating consumptive use based on spatial mapping.

Crop consumptive use values developed by local University of California Cooperative Extension researchers and California Polytechnic State University Irrigation Training and Research Center (Cal Poly ITRC) were used for crop evapotranspiration (ET). Irrigation efficiency values were assigned to each irrigation method assumed for crops, as developed by local University of California Cooperative Extension researchers. Growing season precipitation data was summarized from Butte County weather stations. Applied water of Butte County agricultural crops was estimated for each year from available DWR spatial mapping in 1999 and 2004 representing a historical period and from DWR spatial mapping from 2014, 2016, 2018, and 2019, representing current conditions. The two time periods were developed to address change over the past approximately 20 years. All quantified changes are relative to historical conditions.

RESULTS AND CONCLUSIONS

The results and conclusions presented here are based on the analysis inputs used in this study, which may differ from other water use studies. Inputs that might differ between studies include acreages and methods for calculating water use. Acreage data may differ because of sources for the data and how those acreages were derived, and their public availability. Water use for various land uses may differ because of assumptions about crop water use, irrigation methods used for each crop, and irrigation efficiency.

BUTTE COUNTY LAND AND WATER USE

Results and conclusions of this study conducted over a 20-year time frame include:

- Agricultural land use has decreased by 12,366 acres or 5%.

- Estimated annual applied agricultural irrigation water has decreased by approximately 166,884 acre-feet or 17%.

- The greater decrease in agricultural water use compared to the small decrease in land use indicates that agricultural water use has become more efficient and/or that the crop distribution has shifted towards crops that use less water.

- Urban land use has increased by 3,580 acres from 43,707 to 47,287 acres or 8%.

- Environmental land use acreage has increased in the past 20 years. Managed wetlands replaced 5,474 acres of agricultural land and native lands replaced 5,153 acres of agricultural land. In addition, 1,799 acres of agricultural land was converted to urban and/or restoration/conservation use.

- Due to acreage changes and installation of modern and more efficient irrigations systems, applied water decreased in high acreage crops such as almonds (10%), rice (18%), peaches (50%), prunes (41%), alfalfa (80%) and pasture (76%). Alternatively, applied water estimates to walnuts increased by 81% almost entirely due to increased acreage.

- The decrease in applied water is the result of:
  - the increase in walnuts (26,645 acres) which likely replaced crops such as alfalfa and pasture, both of which have higher water demand and are irrigated with less efficient systems;
  - new orchards being installed with more efficient irrigation systems and management practices; and
  - much of the alfalfa acreage (a higher water user) being converted to other crops or agricultural land, which has a lower water use.

VINA SUBBASIN LAND AND WATER USE

Results and conclusions of this study conducted over a 20-year time frame include:

- While 4,486 acres of previously undeveloped agricultural land came into production, 7,254 acres of farmland were removed from production. The result was a net decrease in agricultural land use of 2,768 acres or 3.4%

- Estimated applied agricultural irrigation water has decreased by 29,004 ac-ft or 9%.
- Applied water increased by 72% in walnuts due to expansion of acreage and decreased by 13% in almonds (primarily due to improved irrigation efficiency) and 28% in rice (due to conversion to other crops). Other major crops that decreased in acreage and estimated applied water included alfalfa, pasture, peaches, and prunes.
- Urban land use within the Vina Subbasin increased by 2,550 acres from 16,848 to 19,398 acres.

GENERAL RESULTS AND CONCLUSIONS

- No quantitative estimates of changes in consumptive use were developed for the increases in urban or managed wetland areas, however the increase in these specific urban and environmental acreage footprints are expected to increase total water use.
- Although smaller in acreage, conversions of previously irrigated agricultural land to non-irrigated or flooded conservation or native areas (excluding managed wetlands) are expected to reduce water use in these areas.
- This analysis compared 5-year averages of applied water from the beginning and end of the study period as a more representative assessment of the actual conditions than individual year to year comparisons. Comparing applied water estimates of individual years skew the overall trends in applied water. The main reason for this in Butte County is that rice acreage, which accounts for a major portion of applied water (nearly 50% on average), fluctuates considerably from year to year. A significant area of rice land can be fallowed in some years because of water shortages.
- As more efficient irrigation systems and management practices are adopted on agricultural land, it should be expected that applied water use will continue to decrease as evidenced by the results of this 20-year analysis.

INTRODUCTION

Quantifying water use by the agricultural, environmental, and urban sectors and how it is expected to change over time is an important component of the Groundwater Sustainability Plan (GSP) developed by various subbasins in Butte County, as mandated by the Sustainable Groundwater Management Act (SGMA). Agriculture is a major water user in Butte County, and as such, quantifying it should be based on the best available data and use standard agronomic methods.

The purpose of this report is to describe the methodologies and results of an agricultural water use analysis that compared water use at the beginning and end of a 20-year period beginning with 1999 and ending in 2019 in Butte County and in the Vina Subbasin.

METHODS

Water use is dependent on crop type, crop acreage, precipitation, and irrigation practices and their associated efficiencies. Therefore, quantification methodologies must include each of these important components; omitting one or more of these will result in erroneous estimates of water use. In this section, the methods for obtaining and using these data and their sources are described.

CROP CONSUMPTIVE USE DEFINITIONS

Crop consumptive use, or evapotranspiration (ET) varies by crop and climate. It is a measure of the water that is used or transpired by both a crop and the soil in which it grows during the growing season. The water consumed by a crop is not the same as the water applied to a crop. The following definitions are useful for understanding the information in this report:

Crop consumptive use/evapotranspiration - The amount of water transpired during plant growth plus what evaporates from the soil surface and foliage in the cropped area.

Crop water requirement – The amount of water required by a crop to grow optimally minus precipitation. Some of the crop consumptive use is supplied by precipitation; therefore, the water required to supply the crop's water needs must take this into account.

Irrigation requirement, or applied water – The amount of water applied to a crop during the growing season assumed to meet the full demand of the crop. This amount is more than the crop ET and more than the crop water requirement because it must take irrigation efficiency into account. Irrigation systems are not 100% efficient, i.e. more water must be applied than is needed to compensate for non-uniform water application and supply crop water requirement. Irrigation efficiency depends on irrigation type and system management. Typically, but not always, pressurized irrigation systems (such as sprinkler, drip, and micro-sprinkler) have higher potential efficiencies than non-pressurized systems (surface methods such as flood, furrow and border check).

CROP CONSUMPTIVE USE DATA

Crop consumptive use values for California have been developed and maintained by the Irrigation Training and Research Center (ITRC) at California Polytechnic State University (Cal Poly). Using this resource, crop consumptive use can be found for all the major crops grown in different regions of California. The regions are delineated using the California Irrigation Management Information System (CIMIS) zones. These zones represent broad climatological conditions. For example, the agricultural area of Butte County largely falls in CIMIS Zone 12.

While ITRC ET values are good estimates of crop specific consumptive use, locally developed values should be used when possible. Therefore, where possible, ET values for permanent crops and pasture, including alfalfa, were sourced from those developed and published by UCCE specific to Butte County.

Consumptive use values for each Butte County crop used in this analysis are provided (Table 1). Some crops were grouped into crop categories because of their small acreage or because of the categories used in crop acreage land use databases. Although a component of applied water, frost protection is not included in this analysis because it is negligible compared to the overall applied water during a year. It is most often applied to almonds (a portion of the overall irrigated crop footprint) and much less often to walnuts and other fruit and nut crops. Also, it does not occur every year and the irrigation system usually runs for 3 to 6 hours for 1 to 2 frost events when it does occur. In comparison, an irrigation system on almonds usually runs for 12 to 24 hours each set and can comprise about 10 to 20 irrigation events per year depending on the system. In addition, a portion of frost applied water is stored in the soil profile and consumptively used by the almond crop in the early spring.

Table 1. Crop Consumptive Use in Butte County

Crop	Consumptive Use	
	(in/yr)	(ft/yr)
Almonds	48.9	4.1
Apples	41.0	3.4
Apricots	41.0	3.4
Misc. Deciduous	38.7	3.2
Grapes (wine)	41.2	3.4
Kiwi fruit	48.0	4.0
Mandarins	35.3	2.9
Olives (oil)	32.6	2.7
Orange	35.3	2.9
Peach	40.5	3.4
Pecan	38.7	3.2
Persimmons	38.7	3.2
Pistachio	42.5	3.5
Plum	41.0	3.4
Prunes	43.2	3.6
Walnuts	41.7	3.5
Beans (dry)	28.4	2.4
Alfalfa	53.3	4.4
Pasture (irrigated)	54.3	4.5
Rice	42.5	3.5
Wheat	28.4	2.4
Safflower	28.9	2.4
Misc. field and specialty crops	30.0	2.5
Young perennials	27.9	2.3

Note: See reference for Fulton et al. 2017. Young perennials = average ET of almond, peach, pistachio and prune 3rd leaf and walnut 2nd leaf

PRECIPITATION

As described above, growing season precipitation is subtracted from crop consumptive use values to determine crop water requirement from applied irrigation. Growing season precipitation data was collected from the Western Region Climate Center, which summarizes weather station data throughout California. Four weather stations were selected that are representative of the agricultural growing area. Monthly precipitation averages for March through September for each location were converted to effective precipitation using the Bureau of Reclamation method reviewed in Ali and Mabarak (2017). Monthly averages were summed to find an average growing season precipitation value (Table 2).

Table 2. Growing Season Effective Precipitation in Agricultural Areas of Butte County

Weather Station	Growing Season Effective Precipitation	
	(in)	(ft)
Chico Exp Station	5.90	0.49
Oroville (046521)	5.77	0.48
Oroville Ranger Station	5.10	0.43
Gridley	4.49	0.37
AVERAGE	**5.32**	**0.44**

IRRIGATION EFFICIENCY

Reasonable estimates of irrigation efficiency are required to convert crop water requirement to irrigation requirement. Because irrigation methods are less than 100% efficient, growers must apply more water than the crop requires to meet crop water needs. Irrigation methods and efficiencies for the Sacramento Valley are shown in Table 3 (Fulton, 2020). Irrigation methods were assigned to crops, as shown in Table 4, based on local agronomic conditions, commonalities, and knowledge. Pressurized systems such as drip, micro-sprinklers, and to a lesser extent solid set sprinklers are typically used on nut crops (e.g. minisprinklers are commonly used in walnut orchards), whereas sprinklers are used on some stone fruits and citrus and surface systems are more common on field crops. As an indication towards the future, some growers are now installing sub-surface drip systems, which have even higher potential irrigation efficiencies, on permanent crops.

Table 3. Butte County Irrigation Methods and Efficiency

Irrigation Type	Irrigation Method	Efficiency Range (%)	Average Efficiency (%)
Mini/micro	Drip	80-95	88
	Micro	80-90	85
	Mini	75-90	83
	Solid set	70-90	80
Sprinkler	Solid set	70-85	78
	Hand move	65-85	75
Surface	Conventional furrow	45-65	55
	Conventional furrow with tailwater return	60-80	70
	Basin flood	60-75	68
	Precision level basin flood	60-80	70

Table 4. Butte County Irrigation Methods and Irrigation Efficiencies by Crop

Crop	Irrigation Method	Irrigation Efficiency (%)
Almonds	Micro/drip	86.5
Apples	Micro/drip	86.5
Apricots	Flood	68.0
Misc. deciduous	Micro/drip	86.5
Grapes (wine)	Micro/drip	86.5
Kiwi fruit	sprinkler	78.0
Mandarins	sprinkler	78.0
Olives (oil)	surface	68.0
Orange	Micro/drip	86.5
Peach	surface furrow	55.0
Pecan	sprinkler	78.0
Persimmons	sprinkler	78.0
Pistachio	Micro/drip	86.5
Plum	surface	68.0
Prunes	basin flood	68.0
Walnuts	Micro/drip/solid set	86.5
Beans (dry)	sprinkler	78.0
Alfalfa	basin flood	68.0
Pasture (irrig)	basin flood	68.0
Rice	Precision level basin flood	70.0
Wheat	surface	68.0
Safflower	surface	68.0
Misc. field and specialty crops	surface	68.0
Young perennials	Micro/drip	68.0

CROP ACREAGE

Changes in crop distribution and corresponding changes in irrigation methods and irrigation efficiency represent the largest influences on total agricultural water use. For this analysis, the spatial databases of land use from California Department of Water Resources (DWR) from 1999 through 2016, and from Land IQ for 2018 and 2019 were used to compute total crop water use. (Land IQ performs the land use mapping and develops the datasets for DWR. Datasets from 2018 and 2019 have been completed but are not available to the public yet. Accuracies are 97.6% or greater.) The main purposes of these spatial databases are to comply with the statewide requirements of land use of the Sustainable Groundwater Management Act (SGMA), estimate crop water use for water budgeting, overall water management activities, water transfer planning, and various other purposes.

DEPARTMENT OF WATER RESOURCES LAND USE DATA

California DWR has historically mapped crop acreage in all California counties. Because of staffing, budget and time constraints, county crop maps were not updated every year. For this reason, data from 2000 through 2003 crop years were not available for Butte County, however the bookend years for this timeframe (1999 and 2004) were available. Prior to 2014, this database was developed through ground survey where DWR staff visually inspected accessible fields in the county.

In 2014, a statewide spatial land use database was developed using remotely sensed image analysis approaches. Every field that is at least 2 acres (and sometimes less) was mapped. Non-cropped and non-irrigated areas (roads, berms, etc.) are excluded in this spatial database. Therefore, this represents the true irrigated area of every homogeneous cropped field. An automated analytical process based on known cropped fields is used to identify crops (calibration), and where there is uncertainty, fields are confirmed with ground surveys. Some of this ground truthing data is used to calibrate the analytical algorithm, while different data is held back and used to validate accuracy of the spatial mapping results. The spatial map database was updated every other year from 2014 to 2018 and now every year.

An analysis of land use polygons that transitioned from agricultural to non-agricultural land uses was conducted on polygons at least 10 acres in area.

Accuracy has been determined on the DWR dataset. Currently, 2016 dataset accuracy values are publicly available (California Department of Water Resource, 2019). Example accuracies for major Butte County crops in the 2016 DWR dataset are as follows:

- Almonds 99.8%
- Kiwi fruit 100.0%
- Olives 100.0%
- Peaches/nectarines 99.1%
- Mixed pasture 98.6%
- Plums, Prunes and Apricots 99.0%
- Rice 99.7%
- Walnuts 99.2%
- Young perennials 97.0%

OTHER LAND USE DATA - BUTTE COUNTY CROP REPORTS

California's Agricultural Commissioners in produce annual crop reports for each county that document crop acreage and value. Butte County crop reports were available for every year from 1999 to 2019; however, the 2000 crop report was less detailed than reports in other years.

Butte County develops their crop database from pesticide use permits. When growers want to apply pesticides, they must obtain a permit from the county that specifies what crop they are growing, what parcel it is grown on, how many acres will be treated, and what pesticides will be used. Each year, when a grower requests a new permit for a field that is already in the permitting system, the information is updated as necessary (if crop type and/or acreage changes) by county staff. For pasture and other areas where pesticides are not applied, the County cannot rely on these permits for crop acreage data. The County sources pasture acreage information from University of California Cooperative Extension livestock farm advisors, and information on organic acreage, which might not be registered through pesticide use permits, from California Department of Food and Agriculture (CDFA) (L. Mendoza, Butte County Agriculture Commissioner, 2020 pers. comm.). No accuracy assessments are performed on this data, and the data is tabular rather than spatial. Also, the reliability and accuracy of the data are dependent on the grower reporting them. For this analysis, Butte County records are not useful for the Vina Subbasin because they are not spatially referenced and could therefore not be attributed to a specific area of the county.

RESULTS

The annual applied water results can be evaluated in several ways. One way is to compare annual water use from one year to the annual water use of another year. Another, more appropriate way is to use multi-year averages. Results for the Butte County and Vina Subbasin water use change analyses are provided below.

BUTTE COUNTY

CHANGE IN AGRICULTURAL LAND USE FROM 1999 TO 2019

Agricultural land use decreased by 12,366 acres from 1999 to 2019 (Figure 1). While 15,472 acres of undeveloped land was converted to agriculture, 27,838 acres of farmland was removed from production. In general, agricultural land use increased in the following areas:

- West of Durham bordering the Sacramento River;
- South and east of Oroville and Gridley; and
- Southwest corner of Butte County.

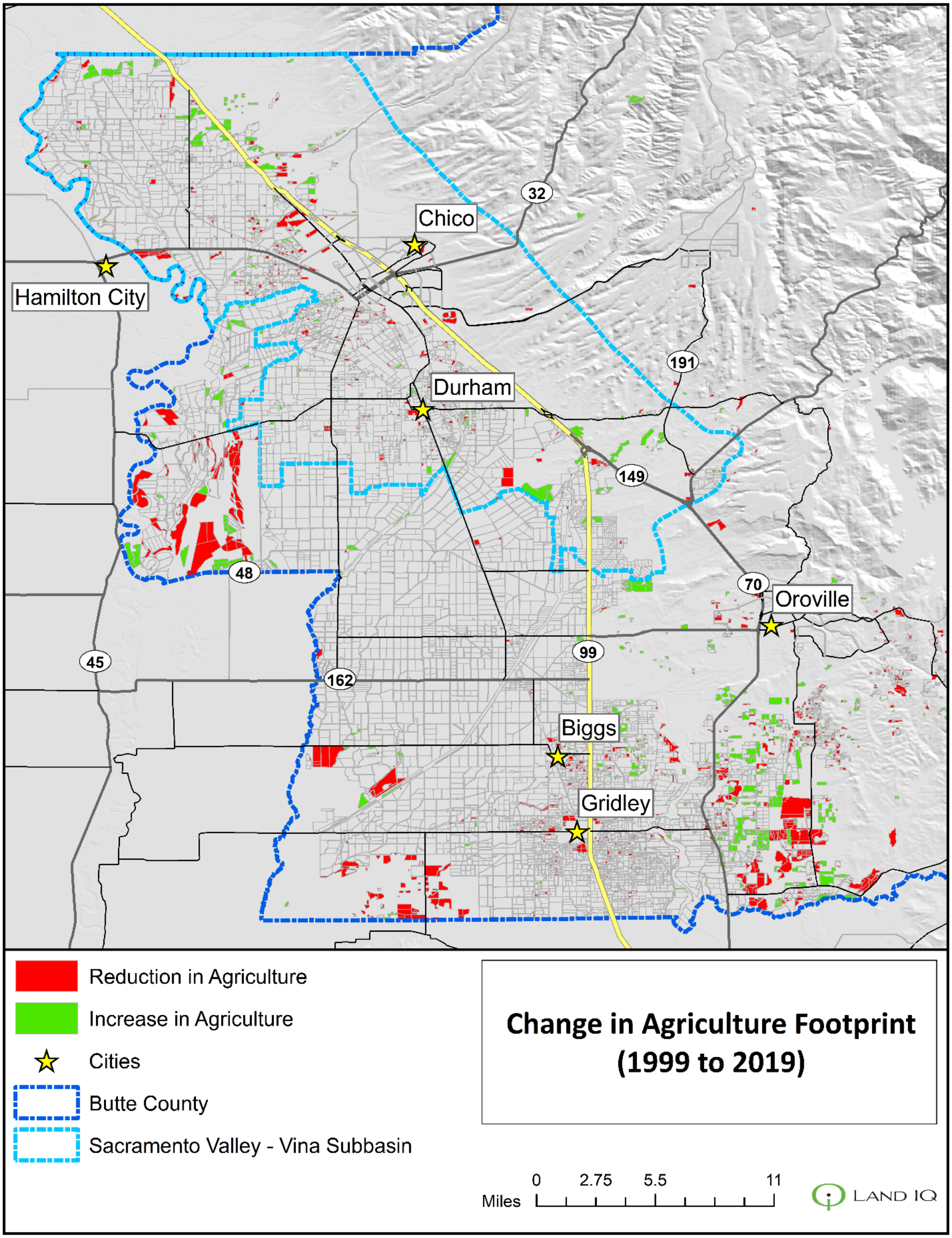

Figure 1. Change in Butte County agricultural land use from 1999 to 2019

Most of the decrease in agricultural acreage was the result of the following:

- Agriculture (frequently rice) to conservation/managed wetland (example below)
- Agriculture to urban (example below)
- Pasture to native (essentially termination of irrigation)

Rice to Managed Wetlands (1998 (closest available image year to 1999) to 2019).

Tree Crops to Urban (1998 (closest available image year to 1999) to 2019)

Most of the increase in agricultural land was the result of the following:

- Native to pasture
- Native to misc. grain and hay (likely non-irrigated, rain-fed)
- Native to tree crops
- Native to rice

The land use accounting for the highest increase of converted agricultural land was managed wetlands (5,474 acres). Of those acres, most of the crop land that was converted was formerly rice, accounting for 3,424 acres or 63%. The land use accounting for the second highest gain of converted agricultural land was native (5,153 acres). Additional acres of rice and other crops were converted to urban and restoration or conservation land use (1,799 acres). Land area previously cropped but not evaluated for specific current land use totaled 13,306 acres, because each field polygon was less than 10-acres. It should be assumed that the 13,306 acres of small fields converted from agriculture to urban and environmental land uses correlates with larger land uses that were verified as conversions to urban or environmental land uses. A complete list of crops and their net increase (new agriculture) or decrease (retired agriculture) in acreage between 1999 and 2019 is provided in Appendix A.

CHANGE IN URBAN LAND USE FROM 1998 TO 2019

Urban land use in Butte County was compared between 1998 and 2019 (imagery for spatial analysis was not available for 1998). The net increase in urban land use was 3,580 acres from 43,707 to 47,287 acres. Most urban expansion occurred around the cities of Chico, Oroville, and to a lesser extent, Gridley (Figure 2).

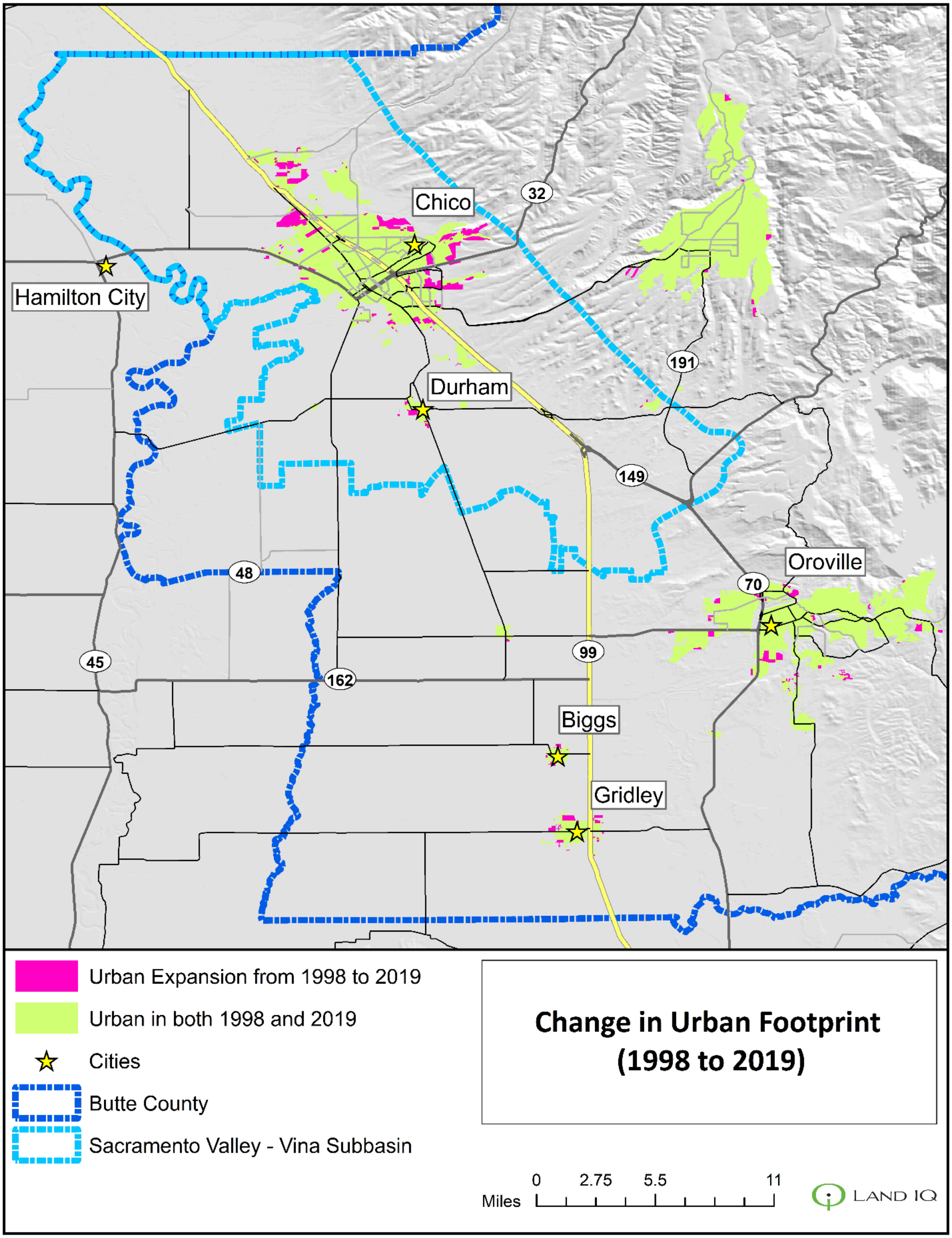

Figure 2. Change in Butte County urban land use from 1998 to 2019

SINGLE YEAR TO YEAR COMPARISONS OF APPLIED WATER

It is difficult to draw meaningful results from two single year comparisons for at least two reasons. First, Butte County has a high acreage of rice, which is an annual crop that can fluctuate considerably in acreage from year to year. Though a small portion of Butte County rice acreage has been replaced by permanent crops such as walnuts, most of the rice ground lies fallow and remains part of the long- term rice growing area. However, it is temporarily fallowed (and is not converted to other crops) as part of a management response to drought conditions and water shortages.

DWR rice mapping is highly accurate (99.7%) and shows that rice acreage fluctuated from about 82,098 acres to 101,240 acres between 2014 and 2016. This swing in acreage was likely because of lower planting in 2014, a drought year when less land was planted in-lieu of water shortages, and much more land was planted in 2016 when water was more plentiful. Second, seasonal weather influences how much water is applied to crops and changes from year to year. Therefore, crop ET is usually expressed as a seasonal average, and not based on one year's data.

Therefore, choosing any two years to compare applied water would generate different results. If 2016 were compared to 2018, when rice decreased from 101,240 acres to 78,504 acres, rice acreage, and therefore applied water, was decreasing significantly. This latter comparison results in a difference of 448,017 to 347,402 ac-ft of applied water.

Comparing applied water for all crops between the crop years 1999 and 2019, total applied water decreased from 1,006,089 ac-ft in 1999 to 827,819 ac-ft in 2019 – a reduction of 178,270 ac-ft, or 18%. The year-to-year comparisons are not reflective of overall trends in increases or decreases in how much water growers are applying to crops in Butte County over time because they are heavily influenced by fluctuations in weather and annually fluctuating acreage of rice, which accounts for a major portion of applied water (Figure 3).

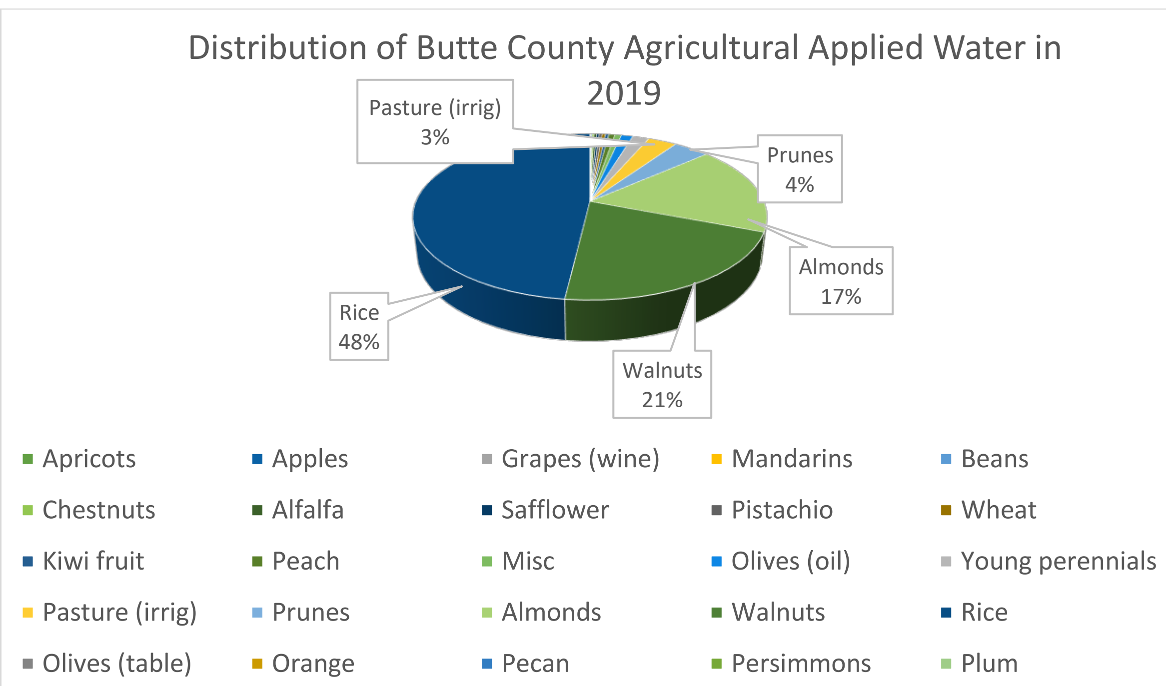

Figure 3. Estimated applied water in 2019.

MULTI-YEAR AVERAGE COMPARISONS OF APPLIED WATER

A more representative approach is to compare multi-year averages of applied water. Land use data from 1999 and 2004 was used to represent the historical period of 1999-2004, because data was only available for those two years. Land use data from 2014, 2016, 2018 and 2019 was used to represent the current period of 2014-2019 (Data for 2015 and 2017 was not available). Water use was calculated for each of these years using the respective land use data, then averaged for each period. Using this approach resulted in annual applied water decreasing from 983,462 to 816,578 ac-ft, a decrease of about 166,884 ac-ft or 17% (Table 5) from the historical 5-year period to the current 5-year period. Comparing these multi-year averages, applied water increased by 81% in walnuts and decreased by 10% in almonds and 18% in rice (Figure 4). Other major crops that decreased in acreage and estimated applied water include alfalfa, pasture, peaches, and prunes.

The decrease in applied water is because of at least two reasons. First, the decrease in almonds, peaches and prunes from 1999 to 2019 was 15,692 acres, not accounting for young orchards (under 2 years).The overall increase in walnuts from 1999 to 2019 was 26,765 acres, and assuming some of this change was almonds converted to walnuts, this change represents a decrease in water use because walnuts use less water than almonds (Fulton, 2020) (Table 1). Conversion from peach and prune to walnuts likely caused little change in water use because crop water consumption for these three crops is very similar. The most likely reason the conversion from peach and prune to walnut would result in decreased water use would be if the irrigation method changed from a less efficient flood or furrow system to a more efficient drip, microsprinkler, or solid set sprinkler system. Second, conversion from flood or furrow irrigated crops such as alfalfa, pasture, or miscellaneous row crops or orchard removal and replanting is an opportunity for growers to convert to more efficient irrigation systems (Table 4). These types of land use changes and corresponding irrigation improvements would have resulted in less applied water. The remaining approximately 11,072 acres added to walnuts may have been converted from native land or rice ground, which represents an increase in water use, or from other crops such as alfalfa and pasture, which would likely represent a decrease in water use either because of lower consumptive use by walnuts and more efficient irrigation systems installed in new orchards.

Table 5. 5-year Average Applied Water in Butte County Using DWR Land Use Data.

Crop	1999-2004 Average Annual Applied Water (ac-ft)	2014-2019 Average Annual Applied Water (ac-ft)	Net Change (ac-ft)
Walnuts	91,370	165,223	73,853
Wheat	105	3,913	3,808
Pistachio	1,308	2,560	1,252
Misc. Dec	1,011	1,662	650
Mandarins	549	552	3
Grapes (wine)	452	375	-77
Beans	591	507	-85
Orange	455	Included in mandarins	-455
Olives (oil)	11,828	10,990	-838
Apples	1,063	84	-979
Kiwi fruit	4,751	3,157	-1,593
Safflower	2,749	1,154	-1,595
Young perennials	15,801	12,922	-2,879
Peach	15,014	7,456	-7,558
Alfalfa	13,607	2,739	-10,868
Misc.	19,621	7,159	-12,463
Almonds	162,713	146,821	-15,892
Prunes	58,577	34,331	-24,246
Pasture (irrig)	105,918	25,762	-80,156
Rice	475,977	389,211	-86,766
TOTAL	**983,462**	**816,578**	**-166,884**

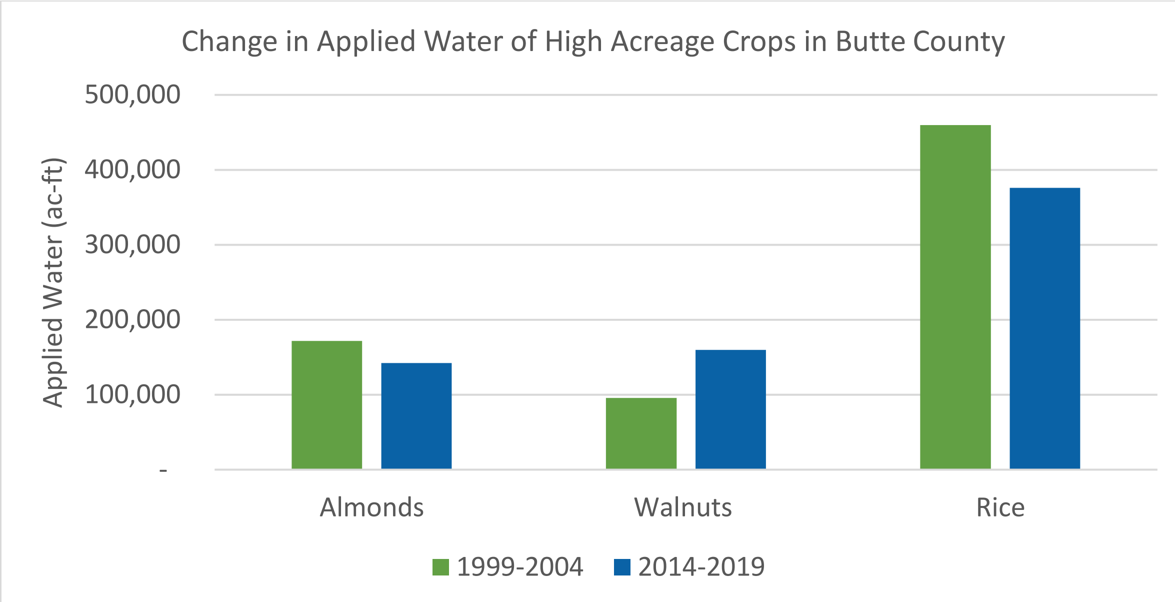

Figure 4. Almond, walnut and rice 5-year applied water averages.

VINA SUBBASIN

CHANGE IN AGRICULTURAL LAND USE FROM 1999 TO 2019

Agricultural land use decreased by 2,768 acres from 1999 to 2019 (Figure 2). While 4,486 acres of agricultural land came into production, 7,254 acres were removed from production. An analysis of land use polygons that transitioned from agricultural to non-agricultural land uses was conducted on polygons at least 10 acres in area.

CHANGE IN URBAN LAND USE FROM 1998 TO 2019

Urban land use in the Vina Subbasin was compared between 1998 and 2019. (Imagery for spatial analysis was not available for 1999.) The net increase in urban land use was 2,550 acres from 16,848 to 19,398 acres. Most urban expansion occurred around the cities of Chico and to a lesser extent Durham (Figure 3).

SINGLE YEAR TO YEAR COMPARISONS OF APPLIED WATER

Comparing applied water for all crops between the crop years 1999 and 2019, total applied water decreased from 327,590 ac-ft in 1999 to 287,750 ac-ft in 2019: a reduction of 39,840 ac-ft, or 12%. The distribution of agricultural applied water by crop in 2019 is shown in Figure 5.

As noted above, single year comparisons lack representation of conditions over multi-year comparisons. The Vina Subbasin has a lower proportion of rice compared to total crop acreage, which lessens annual fluctuations in water use; however, the impact of seasonal weather is still apparent.

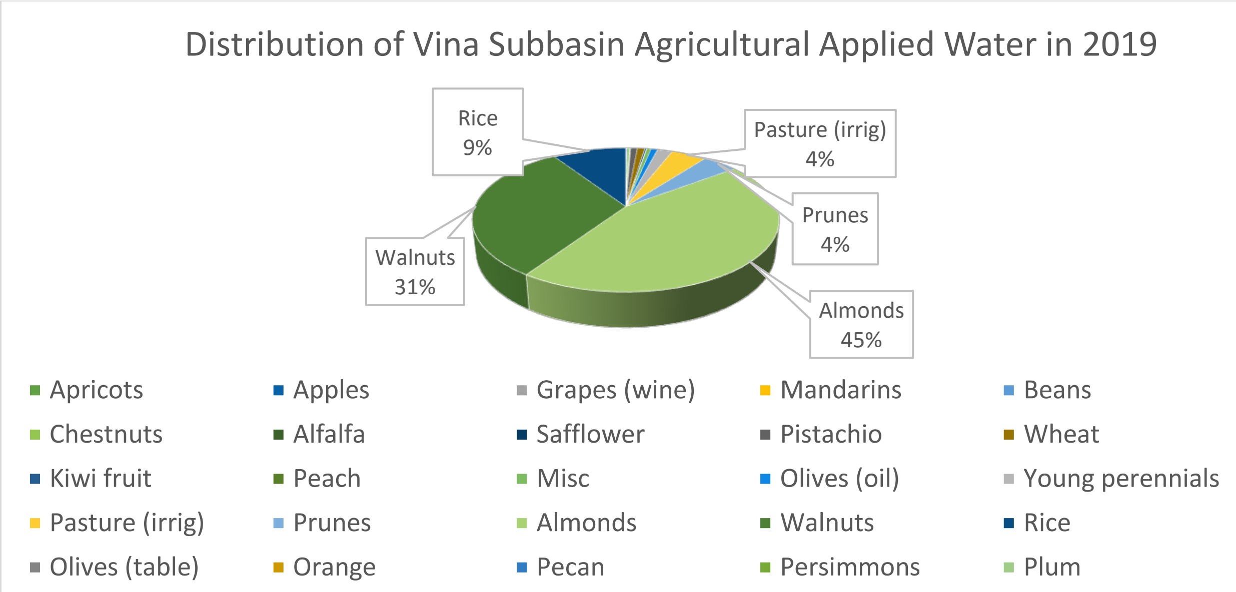

Figure 5. Distribution of applied water by crop in 2019.

MULTI-YEAR AVERAGE COMPARISONS OF APPLIED WATER

Using the same multi-year approach described above for Butte County, the comparison between historical and current periods resulted in annual applied water decreasing from 320,856 to 291,851 ac-ft, a decrease of about 29,004 ac-ft or 9% (Table 6). Applied water again increased in walnuts and decreased in almonds and in rice (Figure 6). Other major crops that decreased in acreage and estimated applied water include alfalfa, pasture, peaches, and prunes.

Table 6. 5-year Average Applied Water in Vina Subbasin Using DWR Land Use Data.

Crop	1999-2004 Average Annual Applied Water (ac-ft)	2014-2019 Average Annual Applied Water (ac-ft)	Net Change (ac-ft)
Walnuts	50,477	85,653	35,176
Wheat	73	1,972	1,899
Pistachio	1,284	2,278	994
Misc. Deciduous	238	671	433
Olives (oil)	2,043	2,457	413
Grapes (wine)	60	135	75
Mandarins	51	29	-22
Wheat	73	-	-73
Young perennials	5,127	4,883	-244
Apples	326	33	-293
Peach	528	182	-346
Beans	592	195	-397

Safflower	1,003	371	-631
Kiwi fruit	1,379	607	-772
Alfalfa	3,612	486.4	-3,127
Misc. field and specialty crops	8,444	1,765	-6,680
Prunes (and plums and apricots)	25,444	13,146	-12,298
Pasture (irrig)	21,364	8,983	-12,381
Rice	46,410	33,047	-13,363
Almonds	152,476	131,222	-21,254
TOTAL	**320,856**	**291,851**	**-29,004**

Similar to Butte County as a whole, the decrease in applied water can likely be attributed to the increase in walnut acreage and conversion from older, less efficient irrigation systems to newer, more efficient systems. Monitoring of land, crop and water use change is recommended and should be useful in making decisions about future groundwater management.

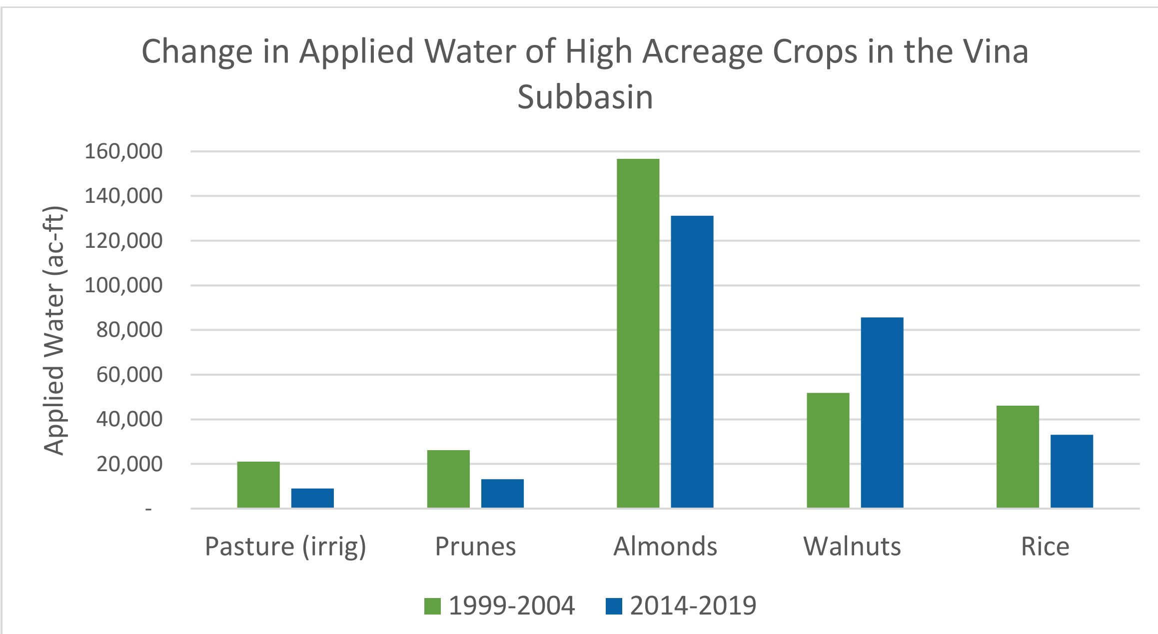

Figure 6. Change in applied water using 5-year averages.

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APPENDIX A

Table A-1. Crop Acreage Distribution in Butte County for Years Used in Water Use Analysis

Crop	1999	2004	2014	2016	2018	2019
Almonds	40,267	37,177	36,105	34,853	34,703	34,100
Apples	376	242	19	29	25	25
Chestnuts	287	342	426	503	598	539
Grapes (wine)	69	192	86	112	114	122
Kiwi fruit	1,113	971	689	708	696	677
Mandarins	153	190	164	166	180	180
Olives (oil)	3,375	3,713	3,620	3,265	3,148	3,139
Orange	141	175	-	-	-	-
Peach	3,148	2,486	1,700	1,558	1,296	1,042
Pistachio	395	336	638	673	775	775
Prunes	14,387	10,855	7,964	7,469	7,175	6,980
Walnuts	23,006	29,073	43,636	45,765	49,294	49,651
Beans	352	127	-	236	193	391
Alfalfa	3,006	1,621	502	535	453	373
Pasture (irrig)	17,709	17,616	5,765	4,769	7,873	8,475
Rice	109,077	106,039	82,091	101,231	78,477	90,005
Wheat	51	23	51	2,348	2,055	1,070
Safflower	1,619	287	303	130	396	770
Misc.	7,722	5,252	2,940	2,358	2,275	1,893
Young perennials	7,437	7,354	2,699	7,360	7,131	7,001
Total	**233,668**	**224,071**	**189,400**	**214,066**	**196,856**	**207,209**

Source: DWR 1999, 2004, 2014, 2016; Land IQ 2018, 2019

Notes: Citrus value was used for mandarin and is inclusive of orange. Plum, prune and apricot values were used for prunes. No value for beans because they are included in misc. field. Miscellaneous deciduous value used for chestnuts and includes pecan and persimmons. For 1999 and 2004, young perennial values calculated as 8% of orchard values. The large increase in wheat acreage may have been the result of differences in land use mapping between the historical and current periods.

Table A-2. Crop Acreage Distribution in the Vina Subbasin for Years Used in Water Use Analysis

Crop	1999	2004	2014	2016	2018	2019
Almonds	37,618	34,954	32,883	32,143	30,920	30,610
Apples	151	38	10	10	9	9
Chestnuts	66	82	219	180	224	222
Grapes (wine)	15	19	36	36	43	43
Kiwi fruit	331	274	131	138	135	135
Mandarins	17	15	-	-	18	18
Olives (oil)	617	608	811	736	718	718
Peach	105	93	44	39	29	28
Pistachio	387	330	630	577	686	686
Prunes	6,124	4,840	3,174	2,814	2,784	2,707
Walnuts	12,936	15,834	23,201	24,284	25,764	25,676
Beans	352	127	-	31	113	175
Alfalfa	677	551	132	86	84	29
Pasture (irrig)	3,310	3,816	663	741	2,540	2,127
Rice	10,876	10,099	8,361	8,075	7,800	6,029
Wheat	51	-	-	913	931	939
Safflower	602	93	297	74	75	75
Misc.	3,152	2,431	613	746	741	503
Young perennials	2,418	2,367	1,535	2,677	2,570	2,587
Total	**77,386**	**74,205**	**72,741**	**74,300**	**75,914**	**73,315**

Source: DWR 1999, 2004, 2014, 2016; Land IQ 2018, 2019

Notes: Citrus value was used for mandarin and is inclusive of orange. Plum, prune and apricot values were used for prunes. No value for beans because they are included in misc. field. Miscellaneous deciduous value used for chestnuts and includes pecan and persimmons. For 1999 and 2004, young perennial values calculated as 8% of orchard values. The large increase in wheat acreage may have been the result of differences in land use mapping between the historical and current periods.