Luhdorff & Scalmanini
Consulting Engineers

- TECHNICAL MEMORANDUM

DATE: November 19, 2025 Project No. 23-1-099

TO: Justin Jensen

FROM: Eddy Teasdale, PG/CHG; Leeah Schultz

SUBJECT: Technical Foundations for Safe Yield, Sustainable Yield, and Groundwater Demand Management in Tehama County

INTRODUCTION

Luhdorff and Scalmanini Consulting Engineers (LSCE) prepared this Technical Memorandum (TM) to support the Tehama County Flood Control and Water Conservation District (TCFCWCD or District). This TM provides a concise overview of several key technical components needed to inform groundwater management decisions in Tehama County. Major topics addressed in this TM include:

- Demand Management Concepts
  - How Representative Monitoring Sites (RMS) and Representative Monitoring Points (RMP) are used in the GSPs to track groundwater conditions and define undesirable results.
  - Recommended data requirements and durations for RMS/RMP trends, and how these compare to DWR expectations.
  - Benefits of managing groundwater extraction at smaller spatial scales to better reflect localized aquifer conditions.
  - Description of safe yield, how it is calculated, and why evaluating safe yield over longer periods (e.g., 10 years) provides a more reliable indication of sustainable yield.
  - Explanation of Thiessen polygons, how they are created, and their use in other resource allocation frameworks.
  - How combining polygons with similar characteristics can improve the effectiveness and equity of groundwater management.
- Groundwater Fees and Cost Information
  - Why fees are necessary for sustainable groundwater management and implementation of GSP actions.
  - Overview of groundwater use in Tehama County, including agricultural, domestic, and commercial sectors.

- Estimated groundwater demand by use type (e.g., AF/acre for crops, AF per household, AF used for commercial activities).
- Summary of parcel and acreage distributions (non-federal parcels, basin vs. countywide acreage, acres by crop type, number of households, number of commercial users).
- Cost comparisons for project implementation, including:
  - Cost per AF to incentivize recharge;
  - Cost per AF to construct, operate, and maintain recharge and other management projects.

Collectively, these components form the technical foundation for evaluating management strategies and supporting informed decision-making by the District.

Overview

Representative Monitoring Sites (RMS), also referred to Representative Monitoring Points (RMP) in the Corning Subbasin, serve as the backbone of groundwater level monitoring and data collection across Tehama County. These strategically selected wells form a subbasin-wide network that tracks hydrologic trends, documents aquifer responses over time, and provides the primary dataset used to evaluate progress toward achieving SGMA sustainability goals.

The RMS/RMP networks are used to evaluate each of SGMA's six sustainability indicators:

1. Chronic lowering of groundwater levels - Long-term declines in groundwater elevations that indicate persistent overdraft or insufficient recharge.
2. Reduction of groundwater storage - Decreases in total aquifer storage resulting from prolonged imbalance between pumping and recharge.
3. Degraded water quality - Declines in groundwater quality caused or exacerbated by groundwater extraction or management actions.
4. Land subsidence - Compaction of aquifer materials due to declining groundwater levels, which can damage infrastructure and reduce aquifer capacity.
5. Depletion of interconnected surface water - Reduction in groundwater discharge to streams, rivers, and wetlands, affecting ecosystems and surface-water availability.
6. Seawater intrusion - Inland migration of seawater into coastal aquifers; this indicator is not applicable in Tehama County due to its inland location.

Each sustainability indicator is evaluated using long-term trends in groundwater levels, along with supporting data collected from the RMS/RMP networks. These measurements provide the basis for determining whether groundwater conditions are stable, improving, or declining over time. The data are also used to identify undesirable results, which occur when groundwater conditions related to any of the six indicators reach levels that cause significant and unreasonable impacts within a subbasin.

Groundwater levels measured at RMS/RMP wells provide a consistent basis for determining whether the basin is operating within sustainable limits. They are essential for comparing actual conditions to established Measurable Objectives (MOs) and Minimum Thresholds (MTs) defined in each subbasin's GSP.

These thresholds mark the acceptable range of groundwater elevation and storage that prevents undesirable results and determines when Management Actions are triggered, which support decisions on groundwater extraction reductions (i.e., demand management) or fees. Groundwater levels are measured at least twice per year, typically during the spring high and fall low periods, to capture both seasonal and long-term aquifer responses.

A minimum of 10 years of somewhat consistent water level data is recommended for each RMP/RMS site, consistent with guidance from the California Department of Water Resources (DWR) (DWR, 2018). The data collected from the RMS/RMP networks establishes the foundation for monitoring and evaluating basin conditions, providing the framework for defining distinct management areas within each subbasin. By using these long-term datasets, the TCFCWCD can delineate smaller, more representative management zones that reflect localized aquifer behavior and support targeted groundwater management actions.

Benefits of Smaller Management Areas

Managing groundwater extraction at smaller, localized scales provides a more accurate and representative understanding of actual aquifer conditions. When management areas are refined geographically, monitoring networks can capture changes in groundwater levels, gradients and storage with greater precision. This higher-resolution understanding allows targeted areas experiencing stress, such as declining water levels, reduced well performance or diminished stream flow to be identified and addresses earlier and more effectively.

Working at a smaller scale also increases the effectiveness of corrective actions. Practices such as pumping reductions, recharge enhancement, or land-use modifications have a more direct and measurable influence on local groundwater conditions when applied within a defined, localized area. As a result, the relationship between management actions and aquifer response becomes clearer, improving both accountability and planning.

In contrast, managing groundwater extraction across broad or basin-wide areas can obscure localized problems. Aggregated conditions may appear stable even when certain zones are experiencing significant declines in groundwater elevations or other early indicators of undesirable results. This masking effect can delay necessary responses, increasing the likelihood that more severe or irreversible impacts will occur before intervention.

By delineating smaller management units, groundwater behavior can be assessed with greater precision, improving the estimation of both safe yield and sustainable yield within each subbasin. This enhanced resolution supports more reliable planning, equitable allocation of pumping, and more responsive management throughout the region.

Safe Yield and Sustainable Yield

Safe yield refers to the maximum quantity of groundwater that can be continuously withdrawn from an aquifer without causing adverse effects on the basin’s overall condition or producing undesirable results. For the purposes of Tehama County’s Groundwater DMP, safe yield is calculated as the average pumping rate plus or minus the average change in groundwater storage, calculated using 10-year rolling averages ending with the most recent water year. This long-term averaging ensures the estimate captures both wet and dry hydrologic cycles, avoiding skewed results from short-term fluctuations.

Sustainable yield, as defined under SGMA, represents a broader and more regulatory-focused concept. SGMA defines sustainable yield as *"the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually without causing an undesirable result."* While safe yield is used within the DMP to determine how much groundwater can be pumped under prevailing conditions, sustainable yield establishes the long-term, basin-wide limit required to maintain overall sustainability. Under Tehama County's demand management framework, sustainable yield will be updated every five years, reflecting new data, improved monitoring, and updated groundwater conditions.

In practice, using longer datasets improves the accuracy and reliability of both metrics—safe yield (shorter-term operational guidance) and sustainable yield (long-term regulatory guidance). Together, they describe how much groundwater can be withdrawn. In contrast, Thiessen polygons describe where management applies. These polygons provide the spatial structure necessary to assign, track, and manage groundwater use across localized areas, ensuring that pumping and recharge decisions reflect actual aquifer behavior on the ground.

Thiessen Polygons

Thiessen polygons are a standard spatial analysis tool used to distribute point-based data evenly across a defined area. For the purpose of Groundwater Demand Management, these polygons represent the specific areas by which groundwater resources are managed. Each polygon is generated using the Thiessen method around a single RMP/RMS.

Each Thiessen polygon is formed by drawing perpendicular bisectors between neighboring RMP/RMS wells so that every location within a polygon is closest to its central monitoring well. This process partitions the subbasin into non-overlapping zones of influence, with groundwater conditions within each zone assumed to reflect the measurements recorded at its corresponding RMP/RMS. This method provides a consistent spatial framework for interpreting monitoring data and applying management actions based on representative local conditions (TCFCWCD 2022c).

Beyond groundwater management, Thiessen polygons are widely used in environmental and resource planning disciplines to define areas of influence around specific data points. Common applications include:

- Environmental Monitoring
  - Estimate rainfall distribution by dividing regions based on proximity to individual weather stations.
  - Representing spatial influence zones for air quality or climate monitoring sensors
- Emergency Services and Public Safety
  - define service areas for fire stations, ambulance providers, or police response zones and ensure efficient coverage and minimize response times
- Agricultural and Environmental research

  - Mapping the effective coverage of irrigation systems or distribution uniformity across fields
  - Studying the spatial distribution of pests and plant diseases.
- Hydrologic and Water Resources Modeling
  - delineate zones of equal influence around recharge areas, monitoring wells or stream gauges
  - Supporting water budget calculations, by assigning land areas to the nearest hydrologic measurement point(s)
- Mining and Geological Assessments
  - Defining influence zones around exploratory drill holes to estimate ore body boundaries or resource grade distributions
  - Supporting block modeling and geostatistical analyses by partitioning the area according to proximity to sampling locations

These applications demonstrate how Thiessen polygons serve as a versatile tool for converting point-based measurements into meaningful spatial units for analysis, planning, and management.

In the context of Tehama County's Groundwater DMP, Thiessen polygons form the foundation for defining and combining areas with similar groundwater characteristics. Polygons with similar attributes, such as comparable groundwater elevations, change in storage or safe yield values, are combined to create what is referred to as a Combined Safe Yield Area (CSYA). Grouping polygons in this way allows for more effective management by:

- Simplifying monitoring and data collection within zones that share similar hydrogeologic behavior
- More efficiently identifying problem areas experiencing groundwater declines
- Calculating sustainable yield by averaging safe yield across multiple, similar polygons
- Identifying more stable areas that may require less intensive management intervention

The TCFCWCD proposes two Management Actions (Mas) that will be triggered when groundwater levels in a CSYA fall below the MOs.

Management Actions and Triggers

Management Action 1 – Establishes an escalating framework to reduce groundwater use when water levels decline below MOs, with the intention of preventing undesirable results. This MA1 introduces a series of pumping reductions and associated administrative fees based on how significantly groundwater elevations deviate from MOs within a CSYA.

The process is triggered when 50% or more of RMS/RMPs in a CSYA show declines below their MO levels for two consecutive years. There are four progressive tiers of management response based on the percentage of decline:

- Tier 1: A decline exceeding 20% of the annual range (Spring measurement minus Fall measurement) results in a 10% reduction in the target assumed maximum pump rate (AF/acre).
- Tier 2: A decline exceeding 40% of the annual range results in a 20% reduction.

- Tier 3: A decline exceeding 80% of the annual range results in a 40% reduction.
- Tier 4: A decline exceeding 100% of the annual range results in an 80% reduction.

At each tier, any pumping above the reduced target rate incurs increased administrative fees. As groundwater conditions improve, management restrictions are relaxed in reverse order. If water levels rise to a higher tier for two consecutive years, the corresponding reduction is lessened. After the groundwater levels remain above the MO for two consecutive years, all pumping restrictions are lifted.

Management Action 2 – Designed to work in coordination with MA 1 to prevent groundwater extraction above the sustainable yield from producing undesirable results or causing water levels to remain below MTs.

The action is triggered under two conditions:

I. If, over any two-year period, groundwater levels in any RMP/RMS fall below the MT for that site, the entire CSYA containing that RMP/RMS becomes restricted to its average safe yield.
II. If undesirable results occur at any time within the CSYA, that area will also be restricted to its average safe yield regardless of MTs.

The average safe yield becomes the calculated sustainable yield for the CSYA and is determined using a standardized method:

1. Each Thiessen Polygon within the CSYA is assigned a total safe yield (acre-feet).
2. The total safe yield is divided by the total irrigated acreage to obtain acre-feet per acre (AF/acre).
3. The safe yield for all polygons within the CSYA is averaged to produce a single calculated sustainable yield (AF/acre) that is representative of the entire management area.
4. This sustainable yield value will be recalculated every five years beginning January 1, 2031.

Once this MA2 is in effect, all groundwater extractors are limited to the calculated sustainable yield for their combined irrigated acreage. This applies to all contiguous parcels under the same ownership served by one or more extraction facilities. If a property spans multiple CSYAs, the most restrictive yield value applies. Extraction volumes may be determined by reported data or by assumed use rates.

MA2 remains in place until all three of the following conditions are satisfied:

1. No existing undesirable results are present within the CSYA.
2. Groundwater levels in all RMS/RMPs within the CSYA remain above MTs for at least two consecutive years.
3. Conditions requiring Step 1 of Management Action Number 1 are no longer met.

Within 180 days of the DMP's adoption, the TCFCWCD Board of Directors will adopt an ordinance establishing a fine of up to $500 per acre-foot for all groundwater, whether measured or assumed, extracted in excess of the sustainable yield during an active pumping restriction.

The successful implementation of these Management Actions relies on a stable and equitable funding mechanism. To support monitoring, enforcement, and incentive-based programs, the TCFCWCD has established a fee structure designed to sustain the administrative and operational functions of the DMP.

Fees

Fees are an essential and practical component of achieving sustainable groundwater management in Tehama County. They provide a stable and predictable source of funding that enables the TCFCWCD to meet its legal, technical and administrative obligations under SGMA. Fee revenue supports the continuation of grant-funded programs, support day-to-day operations needs, and provides the resources necessary to the County to implement, administer, and enforce demand management actions across the subbasins.

Collected fees are used to support several critical program areas. They incentivize water users to extract less groundwater by tying costs to water use, thereby deterring over-pumping when groundwater levels decline. Fees also fund and sustain demand management programs that directly reduce groundwater pumping through voluntary measures, such as crop conversion, irrigation efficiency improvements, and fallowing programs.

In addition, fees are necessary to cover GSA administrative and operational expenses, including groundwater monitoring, reporting, and staffing. They also fund technical studies, modeling, and research needed to refine safe yield and sustainable yield calculations, as well as project design, construction, and maintenance for recharge and conservation projects. Lastly, fees further support public education and enforcement, ensuring transparency, compliance, and informed participation from all groundwater users.

The revenue generated through groundwater management fees directly supports the development and implementation of projects and incentive programs that advance sustainability objectives. These investments enable the design, construction, and maintenance of infrastructure and management projects that improve recharge, enhance water use efficiency, and offset groundwater extraction throughout Tehama County.

Surface and Groundwater Projects

The cost of implementing and maintaining groundwater and surface water projects in Tehama County varies widely depending on the type, scale, and infrastructure requirements of each project. As noted by project collaborators, surface water connection projects can range from approximately $40 to $1,200 per acre-foot (AF) during the first year of implementation (P. Dhaliwal, personal communication, 2025). These costs typically decrease in subsequent years as initial capital investments (such as the installation of pumps, pipes, filtration systems, and other conveyance infrastructure) are distributed over the project's operational lifespan.

Groundwater-focused projects exhibit similar variability, with estimated costs ranging from about $60 to $1,435 and averaging around $400 per acre-foot, including capital investments, though these figures also decline over time. However, as highlighted by technical staff, these estimates generally represent construction and installation costs only and do not account for water acquisition or delivery costs (W. Anderson, personal communication, 2025).

Comparable recharge efforts in other regions demonstrate similar long-term investment patterns. For example, the Fresno Irrigation District's recharge pond program estimates cost to recharge (through ponds) to be about $42 per acre-foot (2005–2025) (E. Teasdale, personal communication, 2025).

Overall, project implementation costs for groundwater, surface water and recharge programs across the region vary widely depending on project type, scale, infrastructure needs, and permitting requirements. Initial first-year implementation costs generally range from approximately $40 per acre-foot for low-cost recharge or incentive-based programs to as high as $1,435 per acre-foot for more capital-intensive projects, such as construction of recharge basins, or complex conveyance improvements. These cost differences reflect the substantial variation in design, construction, operational complexity, and long-term maintenance requirements associated with different project categories.

Incentive Mechanisms

The TCFCWCD has also identified several options for incentivized demand management that encourage voluntary reductions in groundwater use while supporting agricultural and economic productivity.

Common incentive-based activities include:

- Fallowing, or the reduction of total irrigated acreage, through conversion to non-irrigated uses such as grazing, dryland cropping, or recharge basins.
- Crop diversification, where growers transition to lower-water-use crops
- Delayed replanting, a temporary reduction approach that delays the replanting of orchards or other crops, creating a period in which irrigation is not required.
- Irrigation efficiency improvements, including the adoption of advanced irrigation systems, soil-moisture monitoring, evapotranspiration (ET) scheduling, and other technologies that reduce water demand.
- Substitution of surface water for groundwater, promoting the use of available surface supplies before groundwater extraction.
- Soil improvement practices, such as applying organic or inorganic amendments that improve soil moisture retention and reduce irrigation requirements.

Two primary mechanisms can be used to support these activities:

1. Direct incentive funding, where a set amount is added to the base GSA fee and used to fund voluntary conservation programs. Program budgets and participation criteria would be approved by the Board of Directors, with field verification by District staff or contractors.
2. Fee avoidance, where users who voluntarily implement water-saving practices receive reduced groundwater management fees. This method aligns well with the goals of demand management, as participants both reduce their groundwater use and benefit financially from lower per-acre-foot costs associated with compliance under SGMA.

Because the TCFCWCD is likely to implement assumptive use fees (i.e., fees based on estimated groundwater use rather than mandatory metering), many reductions in groundwater demand such as such as fallowing, crop switching, crop diversification, or delayed replanting can be readily quantified using standard water use assumptions. These practices lend themselves well to an assumptive framework because the associated reduction in groundwater demand can be calculated without installing meters.

In contract, activities such as irrigation efficiency improvements or surface water substitution may require voluntary metering or other verification methods if water users wish to receive credit for reductions below the standard assumed groundwater volume to verify reductions below the assumed groundwater volume.

This incentive-based structure gives groundwater users the flexibility to choose the actions that best align with their operations, while still ensuring that the District can demonstrate real measurable progress toward achieving long-term groundwater sustainability.

Groundwater Uses in Tehama County

Agricultural irrigation represents the largest single use of groundwater across all Tehama County subbasins, where the cultivation of diverse crop types accounts for the majority of total extraction. In 2024, the Corning Subbasin exhibited the highest proportion of agricultural groundwater use at 97%, followed closely by the Red Bluff and Los Molinos Subbasins at 93% each, the Antelope Subbasin at 91%, and the Bowman Subbasin at 57% (TCFCWCD and CSGSA 2025a, 2025b, 2025c, 2025d, 2025e). While domestic and municipal uses play a critical role in supplying households and small communities, their overall contribution to total groundwater demand is considerably smaller compared to agricultural use. Additionally, tribal and public water systems similarly rely heavily on groundwater for their drinking water supply (TCFCWCD and CSGSA 2021; TCFCWCD 2022a, 2022b, 2022c, 2022d).

Commercial and industrial uses, including agricultural processors and small businesses, depend on groundwater for processing, manufacturing, and service operations (TCFCWCD and CSGSA 2021). Additionally, environmental and habitat uses are recognized as vital beneficiaries of groundwater. Groundwater helps maintain baseflow in creeks, preserve wetlands, and support groundwater-dependent ecosystems (GDEs), including riparian vegetation and wildlife habitats (TCFCWCD 2022b, 2022c).

Groundwater provides both direct and indirect benefits to a wide range of property owners and users throughout Tehama County. For agricultural landowners and farmers, reliable groundwater access sustains a variety of crops, maintaining property values and regional agricultural income (TCFCWCD and CSGSA 2021). Residential and rural property owners, particularly those outside municipal service areas, also depend on private wells for safe and affordable drinking water.

Commercial and industrial property owners benefit from dependable groundwater supplies that support food processing, manufacturing, and other local economic activities. The general public, including disadvantaged communities (DACs), tribal groups, and environmental organizations, also benefits from sustainable groundwater management, which protects both human and ecological water needs (TCFCWCD 2022a).

Finally, groundwater contributes to recreational opportunities and the overall health of native plant and animal species through its role in sustaining GDEs and riparian ecosystems (TCFCWCD and CSGSA 2021).

Applied Water Use in Tehama County

Table 1 presentes the assumed water used associated with for agricultural crops, as well as typical domestic and commercial demands. The methodology and data sources used to develop these assumptions are described in the following section.

Table 1. Assumed Volume per Use Type (AF/acre/yr)	
Use Type	Applied Water Use
Grain (wheat, barley, oats, hay, misc.)	1.6
Rice (wild, flooded, upland)	4.7
Safflower	2.1
Other Field Crops (flax, hops, sorghum, sudan, castor beans, sunflower, millet, sugarcane)	3.3
Alfalfa	3.7
Pasture (mixed, native, Bermuda, fescue, clover, rye, Klein grass, misc. grasses)	4.4
Cucurbits (melons, squash, cucumbers, watermelon)	1.8
Truck Crops (artichokes, asparagus, green beans, carrots, celery, lettuce, peas, spinach, bush berries, strawberries, peppers, broccoli, cabbage, cauliflower)	2.4
Almonds & pistachios	3.6
Other Deciduous (apples, apricots, walnuts, cherries, peaches, nectarines, pears, plums, prunes, figs, kiwis)	3.3
Citrus & subtropical (grapefruit, lemons, oranges, dates, avocados, olives, jojoba)	2.6
Vineyard (table grapes, wine grapes, raisins)	2.4
Domestic Well and Urban Use Factors	**AF/Connection/ Year**
Domestic Well (household)	0.75
Urban Residential (household)	0.5
Commercial	3.64

Source: DWR 2020; US Census Bureau 2020

Agricultural Usage

Applied water use for Tehama County's agricultural sector was estimated using the most recent data from the DWR Land and Water Use Data for Water Years 2016–2020. This dataset provides applied water values, expressed in acre-feet per acre, for individual crop types across the region. These values were used to estimate assumed groundwater volumes for agricultural use by calculating the net irrigation water required to produce each crop. The calculation incorporates multiple factors, including soil and crop characteristics, precipitation, and crop evapotranspiration. It divides the result by the mean seasonal irrigation system application efficiency to determine the final applied water volume (DWR 2020).

Crop acreage within Tehama County was calculated through a GIS analysis using the most recent LandIQ land use dataset provided by the DWR (LandIQ, 2023). This analysis identified a total of 117,321 acres of active cropland across the County, not including approximately 20,979 acres of Young Perennials, Urban, Idle and Unclassified Fallowed land for a total of 138,300 acres. Acreage totals for individual crop types are summarized in **Table 2**.

Table 2. Acreage per Crop Type

Crop Type	Acreage (2023)
Grain and Hay Crops (wheat, barley, oats, hay, misc.)	8,203.85
Rice (wild, flooded, upland)	94.05
Field Crops (flax, hops, sorghum, sudan, hybrid sorghum/sudan, castor beans, dry beans, sugar beets, sunflower, millet, sugarcane, safflower)	1,529.01
Pasture (alfalfa and alfalfa mixtures, mixed pasture, native pasture, Bermuda grass, fescue, clover, rye grass, Klein grass, turf farms, misc. grasses)	23,984.11
Truck Crops (melons, squash, cucumbers, watermelon, artichokes, asparagus, green beans, carrots, celery, lettuce/leafy greens, peas, spinach, bush berries, blueberries, strawberries, peppers, broccoli, cabbage, cauliflower, greenhouse, potatoes, sweet potatoes)	517.22
Deciduous Fruits and Nuts (almonds, pistachios, apples, apricots, walnuts, cherries, peaches, nectarines, pears, plums, prunes, figs, kiwis, mixed deciduous, pomegranates)	64,143.17
Citrus & subtropical (grapefruit, lemons, oranges, dates, avocados, olives, jojoba, eucalyptus, mixed subtropical fruits)	18,596.23
Vineyard (table grapes, wine grapes, raisin grapes)	253.43

Source: DWR 2023

Domestic (Household) Usage

The average household water use was determined using data from the City of Red Bluff 2020 Urban Water Management Plan (UWMP) (Red Bluff 2022), which reports an average daily water use of 253 gallons per capita per day. This rate is considered representative of domestic water use across the Red Bluff, Los Molinos, Antelope, and Bowman subbasins. Using the most recent 2020 Census block household data and 2023 American Community Survey data from the US Census Bureau, Tehama County was found to contain 24,934 households with an average of 2.6 persons per household (USCB, 2020, 2023b). When applied to the UWMP daily use rate, this equates to an estimated 18,370.5 acre-feet of water per year used by households Countywide (**Table 1**).

To express this demand on a per-parcel basis, average domestic groundwater use can be estimated as follows:

- Total households: 24,934
- Total domestic groundwater use: 18,370.5 AFY
- Estimated domestic use per household (or domestic parcel):

$$\frac{18{,}370.5 \text{ AFY}}{24{,}934 \text{ households}} \approx 0.74 \text{ AF per parcel per year}$$

Thus, a typical domestic well parcel in Tehama County is estimated to use approximately 0.7 to 0.8 acre-feet per year, depending on household size and local water-use practices.

Commercial Usage

Annual commercial water use in Tehama County will be estimated using a multi-step approach designed to develop a representative water use factor for the commercial sector. The primary method involves obtaining five years of historical commercial water use data from nearby urban water suppliers, including the cities of Corning and Red Bluff, which are considered reasonable analogs for commercial use patterns within Tehama County. This data will be supplemented with information from each city's UWMP, where available, to provide additional context on commercial demand characteristics.

Commercial water use patterns will be evaluated across both urban areas to identify consistent usage ranges and inform the development of a final estimated commercial water use factor (AF/Year) applicable to Tehama County. The cities have been contacted, and data requests are currently pending (**Table 3**).

Table 3. Non-Federal Parcel Distribution in Tehama County

Water Agency	5-Year Avg. Annual Use Per Commercial Account	Estimated Avg. Annual Use Per Commercial Account	Estimated Number of Commercial Accounts	Notes
City of Corning	846,883 gallons	2.6 AFY	270	Using 2020-2024 Commercial Water Use Data
City of Red Bluff	339,394 gallons	1.04 AFY	649	Using 2020-2024 Commercial Water Use Data
Average		**1.82 AFY**		Using 2020-2024 Commercial Water Use Data

Source: City of Corning; City of Red Bluff

The average commercial water use in the City of Corning is approximately 2.6 AFY per commercial account. For Red Bluff, the average commercial water use is approximately 1.04 AFY per commercial account.

Alternatively, the commercial category could be subdivided into industry-specific subclasses (e.g., restaurants, retail, personal care services, and light industrial users). However, this approach would require extensive additional data collection and would introduce analytical complexity that is unlikely to provide proportional benefit for the purposes of this DMP. Water use varies significantly by business type due to the diversity of operational needs, and these differences also vary across agencies depending on how their utility billing categories are structured. In some cases, additional data manipulation may be required to align inconsistent billing classifications or consumption categories, further complicating analysis. **Table 4** summarizes key points regarding water usage by different business types.

Table 4. Commercial Water Use by Business Type

Business Type	Water Use Description
Office Buildings	Restrooms, heating and cooling, and landscaping are the areas that consume the most water in office buildings.
Restaurants	Restrooms and kitchen use are the highest water uses.
Healthcare Facilities	Hospitals and other health care facilities have the highest water use, with cooling equipment, plumbing fixtures, landscaping, and medical equipment being the primary uses.
Retail Sales Stores	Water is used for sanitation, maintenance, and aesthetic appeal, with specific uses including toilet flushing, air-conditioning, washing floors, and lawn watering.
Government and Military Facilities	Water use encompasses both domestic and commercial activities, with specific uses varying according to the facility's function.
Educational Institutions	Water is used for sanitation, maintenance, and aesthetic appeal, with specific uses including toilet flushing, air-conditioning, and washing floors.
Resorts and Hotels	Water is used for sanitation, maintenance, and aesthetic appeal, with specific uses including toilet flushing, air-conditioning, and lawn watering.
Car Washes and Laundries	Water is used for daily operations, sanitation and maintenance.
Business Parks	Water is used for sanitation, maintenance, and aesthetic appeal, with specific uses including toilet flushing, air-conditioning, and lawn watering.

Although understanding water-use patterns by individual business type can be valuable for certain planning efforts, it is not the most practical basis for developing a representative commercial water-use factor for this DMP. Business-type-specific factors would likely require annual updates based on the most recent 12-month billing period (e.g., July through June), increasing both workload and uncertainty. For these reasons, LSCE recommends using the average annual water use per commercial connection as the primary basis for estimating groundwater demand for the commercial sector.

To support this evaluation, commercial business counts in Tehama County were compiled using the most recent County Business Patterns dataset from the U.S. Census Bureau (USCB, 2023). Relevant commercial and institutional sectors were identified by filtering North American Industry Classification System (NAICS) codes associated with businesses that typically use water as part of their operations. These sectors included Newspaper Publishers; Radio and Television Broadcasting; Libraries and Archives; Offices of Real Estate Agents and Brokers; Monetary Authorities and Central Banks; Personal Care Services (e.g., hair and nail salons); Automotive Repair and Maintenance; Food and Beverage Manufacturing; Retail Trade; Ambulatory Health Care Services; Hospitals; Nursing and Residential Care Facilities; Food and Beverage Retailers; Restaurants and Other Eating Places; Religious, Grantmaking, Civic, Professional, and Similar Organizations; Educational Services; and Golf Courses and Country Clubs. Applying these filters resulted in the identification of approximately 956 commercial establishments within Tehama County.

Parcels Subject to the DMP

To identify the number of State of California, federal, and non-federal parcels within each of the five managed groundwater subbasins, a GIS analysis was conducted using multiple spatial datasets. The analysis incorporated the California Land Ownership shapefile from CAL FIRE (CAL FIRE, 2019), the Bulletin 118 Groundwater Basins shapefile from DWR (DWR, 2019), and Tehama County parcel data provided by the Tehama County Transportation Commission (TCTC, 2024). These datasets were overlaid to quantify the total number of federal, state and non-federal parcels and their corresponding acreage, within each subbasin. The total numbers of parcels and their acreages corresponding to each subbasin are shown in **Table 4**.

Within the five managed subbasins, the raw GIS analysis identified 36,430 non-federal parcels (including 236 State-owned parcels) and 237 federal parcels. However, because some parcels extend across more than one subbasin boundary, they are counted once in each subbasin they intersect. This boundary overlap results in a slightly higher aggregated parcel total when summing across all subbasins (36,745 non-federal parcels, 258 State parcels, and 271 federal parcels) reflecting double-counting and, in some instances, triple-counting of parcels located in multiple subbasins. The same effect is observed in the acreage totals, where the raw summed acreage across subbasins is 744,664 acres, compared to the tabulated total acreage of 712,593 acres.

To determine how many parcels within each subbasin may be subject to groundwater management fees, the total parcel count (which includes both federal and non-federal parcels, with State parcels included in the non-federal category) was adjusted by subtracting all State and federal parcels. This calculation isolates the number of parcels subject to fees.

Table 4. Parcel Distribution of Relevant Subbasins in Tehama County				
Location	**Total Number of Parcels**	**Number of Federal Parcels**	**Number of State Parcels**	**Number of Parcels Applicable to Fees**
Antelope Subbasin	3,643	34	18	3,591
Bowman Subbasin	6,247	21	10	6,216
Corning Subbasin	7,963	59	57	7,847
Los Molinos Subbasin	2,821	33	134	2,654
Red Bluff Subbasin	16,342	124	39	16,179

Source: CalFire 2025; DWR 2019; Tehama County GIS Department 2024

Table 4. Acreage Distribution of Relevant Subbasins in Tehama County				
Location	**Total Number of acres**	**Number of Federal Acres**	**Number of State Acres**	**Number of Acres Applicable to Fees**
Antelope Subbasin	24,343	2,245	448	21,650
Bowman Subbasin	128,240	1,369	921	125,950
Corning Subbasin	171,076	9,141	2,238	159,697
Los Molinos Subbasin	102,828	4,747	22,841	75,240
Red Bluff Subbasin	286,106	12,216	1,401	272,489

Source: CalFire 2025; DWR 2019; Tehama County GIS Department 2024

REFERENCES

California Department of Water Resources (DWR). 2018. *Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development*. California Department of Water Resources. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Climate-Change-Guidance_Final_ay_19.pdf. Accessed November 13, 2025.

California Department of Water Resources (DWR). 2020. *Agricultural Water-Use Data, 2016-2020* [Dataset]. Sacramento: California Natural Resources Agency. Available at: https://data.cnra.ca.gov/dataset/agricultural-water-use-data-2016-2020.

City of Red Bluff. 2022. 2020 Urban Water Management Plan. Prepared by Carollo Engineers. Available at: https://cms5.revize.com/revize/redbluff/2020_UWMP_CERTIFIED.pdf. Accessed November 13, 2025.

CAL FIRE. (2019). *California Multi-Source Land Ownership* [Dataset]. State of California and Department of Forestry and Fire Protection. https://gis.data.ca.gov/search?categories=%252Fcategories%252Fboundaries%2520and%2520ownership.

Department of Water Resources (DWR). (2019). *i08 Bulletin 118 California Groundwater Basins* [Shapefile]. Department of Water Resources. https://data.ca.gov/dataset/i08-b118-ca-groundwaterbasins.

LandIQ. (2023). *Statewide Crop Mapping – Provisional* [Shapefile]. Department of Water Resources. https://www.landiq.com/land-use-mapping.

Tehama County Flood Control and Water Conservation District (TCFCWCD) and Corning Subbasin Groundwater Sustainability Agency (CSGSA). 2021. *Corning Subbasin Groundwater Sustainability Plan*. Prepared by Luhdorff and Scalmanini Consulting Engineers. Available at: https://www.corningsubbasingsp.org/finalgsp. Accessed November 13, 2025.

Tehama County Flood Control and Water Conservation District (TCFCWCD). 2022a. *Bowman Subbasin Groundwater Sustainability Plan.* Prepared by Luhdorff and Scalmanini Consulting Engineers. Available at: https://tehamacountywater.org/gsa/groundwater-sustainability-plans-public-draft/. Accessed November 13, 2025.

Tehama County Flood Control and Water Conservation District (TCFCWCD). 2022b. *Los Molinos Subbasin Groundwater Sustainability Plan.* Prepared by Luhdorff and Scalmanini Consulting Engineers. Available at: https://tehamacountywater.org/gsa/groundwater-sustainability-plans-public-draft/. Accessed November 13, 2025.

Tehama County Flood Control and Water Conservation District (TCFCWCD). 2022c. *Red Bluff Subbasin Groundwater Sustainability Plan.* Prepared by Luhdorff and Scalmanini Consulting Engineers. Available at: https://tehamacountywater.org/gsa/groundwater-sustainability-plans-public-draft/. Accessed November 13, 2025.

Tehama County Flood Control and Water Conservation District (TCFCWCD). 2022d. *Antelope Subbasin Groundwater Sustainability Plan*. Prepared by Luhdorff and Scalmanini Consulting Engineers. Available at: https://tehamacountywater.org/gsa/groundwater-sustainability-plans-public-draft/. Accessed November 13, 2025.

Tehama County Flood Control and Water Conservation District (TCFCWCD). 2025a. *Antelope Subbasin (5-021.54) Groundwater Sustainability Plan Annual Report – Water Year 2024.* Prepared by Luhdorff and Scalmanini Consulting Engineers and Davids Engineering. April 2025.

Tehama County Flood Control and Water Conservation District Groundwater Sustainability Agency (TCFCWCD GSA). 2025b. *Bowman Subbasin (5-006.01) Groundwater Sustainability Plan Annual Report – Water Year 2024.* Prepared by Luhdorff and Scalmanini Consulting Engineers and Davids Engineering. April 2025.

Tehama County Flood Control and Water Conservation District Groundwater Sustainability Agency (TCFCWCD GSA) and Corning Sub-Basin Groundwater Sustainability Agency (CSGSA). 2025c. *Corning Subbasin (5-021.51) Groundwater Sustainability Plan Annual Report – Water Year 2024.* Prepared by Luhdorff and Scalmanini Consulting Engineers and Davids Engineering. April 2025.

Tehama County Flood Control and Water Conservation District Groundwater Sustainability Agency (TCFCWCD GSA). 2025d. *Los Molinos Subbasin (5-021.56) Groundwater Sustainability Plan Annual Report – Water Year 2024.* Prepared by Luhdorff and Scalmanini Consulting Engineers and Davids Engineering. April 2025.

Tehama County Flood Control and Water Conservation District Groundwater Sustainability Agency (TCFCWCD GSA). 2025e. *Red Bluff Subbasin (5-021.50) Groundwater Sustainability Plan Annual Report – Water Year 2024.* Prepared by Luhdorff and Scalmanini Consulting Engineers and Davids Engineering. April 2025.

Tehama County Transportation Commission (TCTC). (2024). Tehama County Parcel Data. Red Bluff, CA. Tehama County Transportation Commission. https://tehamartpa.org/gis/data/.

U.S. Census Bureau (USCB). (2020). *2020 California Census Blocks: Households* [Shapefile]. U.S. Census Bureau. Accessed November 6th, 2025.

U.S. Census Bureau (USCB). (2023a). *County Business Patterns* [Dataset]. U.S. Census Bureau. Accessed November 7th, 2025. https://data.census.gov/table?q=CBP2023.CB2300CBP&g=050XX00US06103&y=2023&codeset=naics~311:3121:44-45:445:447:51111:5151:51912:521:5312:61:621:622:623:71391:72251:8111:8121:8123:813.

U.S. Census Bureau (USCB). (2023b). *American Community Survey 1-year estimates.* Retrieved from *Census Reporter Profile page for Tehama County, CA.* http://censusreporter.org/profiles/05000US06103-tehama-county-ca/