New Stone Groundwater Sustainability Agency

DRAFT

Groundwater Sustainability Plan

in compliance with the

Sustainable Groundwater Management Act

September 23, 2019

LIMITATION

In preparation of this Groundwater Sustainability Plan (Plan), the professional services of Provost & Pritchard Consulting Group were consistent with generally accepted engineering principles and practices in California at the time the services were performed.

Judgments leading to conclusions and recommendations were made based on the best available information but are made without a complete knowledge of subsurface geological and hydrogeological conditions. This Plan is intended to provide information from readily available published or public sources. We understand that the interpretations and recommendations are for use by the New Stone Water District Groundwater Sustainability Agency (NSWD GSA) in assisting the GSA in making decisions related to potential water supplies and groundwater management activities in light of California's new and evolving Sustainable Groundwater Management Act (SGMA) regulations. Subsurface conditions or variations cannot be known, or entirely accounted for, in spite of significant study and evaluation. Future surface water and groundwater quantity, quality, and availability cannot be known. Trends have been estimated and projected based upon past historical data and events and are used for planning purposes. It should be noted that historic trends may not be indicative of future outcomes. Historic hydrology has been used to identify averages and potential extremes that may be experienced in future years; however, it will be important for the GSA to continually evaluate all the parameters that make up the agency water budget. Additionally, the rapidly changing regulatory environment surrounding the SGMA and State regulatory agencies may render any or all recommendations invalid in the future if not implemented and necessary approvals, permits, or rights obtained in a timely manner. Information contained in this GSP should not be regarded as a guarantee that only the conditions reported and discussed are present within the NSWD GSA) or that other conditions may exist which could have a significant effect on groundwater availability.

In developing our methods, conclusions, and recommendations we have relied on information that was prepared or provided by others. We have assumed that this information is accurate and correct, unless noted. Changes in existing conditions due to time lapse, natural causes including climate change, operations in adjoining GSAs or subbasins, or future management actions taken by a GSA may deem the conclusions and recommendations inappropriate. No guarantee or warranty, expressed or implied, is made.

Plan prepared by:

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Executive Summary

On September 16, 2014, Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA) which was passed in 2014 and is codified in Section 10720 et seq. of the California Water Code. This legislation created a statutory framework for groundwater management that can be sustained during planning and implementation without causing undesirable results.

From the first edition of DWR Publication 118 in 1978, the San Joaquin River Basin, including the Madera Subbasin, has been determined to be in a state of overdraft and has been identified by the state as being "Critically Overdrafted." Since 1995, the Madera Subbasin has lost approximately 2.6 million acre-feet of water from subsurface storage through a combination of groundwater pumping and below-normal recharge driven by an extended drought and low surface water supplies. This is still small compared to the estimated storage capacity of 50 million acre-feet (af) within the subbasin (assuming 1500 feet of thickness).

While the Madera Basin is required to be sustainable, it should be noted that within the basin different areas can and should be evaluated separately. This GSP covers about 4,200 acres in the northwestern area of the basin that is adjacent to the Chowchilla Bypass covering the New Stone Water District Groundwater Sustainability Agency. The NSWD GSA is coterminous with the New Stone Water District (NSWD or District) boundary. The District is predominantly agriculture and consists of two landowners. The New Stone Water District Groundwater Sustainability Agency was created on December 22, 2016.

Water supply to meet the NSWD GSA agricultural demands comes primarily from groundwater pumping. Although the NSWD GSA does have an appropriative water right along the Chowchilla Bypass (referred to as Eastside Bypass/Chowchilla Canal in permit) of 15,700 acre-feet/year (permit number 19615), surface water is not consistently used for irrigation. The Chowchilla Bypass is a designated floodway into which water is diverted from the San Joaquin River only in relatively wet years.

Groundwater levels have been regularly monitored in three wells within or on the border of the GSA for the CASGEM program. Groundwater quality monitoring is also an important aspect of groundwater management in NSWD. Water quality analytical data returns averages of 840 μmhos/cm and 5.6 mg/L of specific conductance and nitrate, respectively, are below their respective MCLs. The GSA is included in areas monitored by National Aeronautics and Space Administration (NASA) and the USBR's San Joaquin River Restoration Project (SJRRP) land surface subsidence monitoring. Current land subsidence rates in NSWDGSA range from -0.15 to -0.45 feet per year from south to north over the years 2011 to 2017.The NSWD is also located within the East San Joaquin Water Quality Coalition (the Coalition or ESJWQC) boundary and participates in its monitoring efforts.

Water conservation has been and will continue to be an important tool in water management, as well as a key strategy in achieving sustainable groundwater management. The NSWD practices water conservation by using drip irrigation for the majority of their crops. Water is not imported into NSWD GSA, except for water from the Chowchilla Bypass during flood releases. The NSWDGSA includes natural recharge areas but does not currently have intentional recharge from constructed recharge basins. At this time, NSWD anticipates using its water right of surface water from the Chowchilla Bypass for direct recharge in the future.

NSWDGSA lies within the Poso Farm and Firebaugh NE quadrangles. The topography of the NSWDGSA is relatively flat and ranges between approximately 150 to 160 feet above msl. Within the NSWD GSA area, surface materials are comprised solely of Quaternary age deposits. For the NSWD GSA area, the NRCS has generally described soils as soil textural class fine sandy loam. There are also small pockets of loamy sand and sandy loam. The Corcoran Clay is present below the entirety of NSWD GSA. The top of the Corcoran Clay lies between 200 to 350 feet bgs under the District and is between 40 and 60 feet thick.

The aquifers in the NSWD GSA are used primarily for irrigation purposes. The vertical aquifer boundary for the NSWD GSA is the base of freshwater, which under NSWD GSA is approximately 400 to 800 feet below msl. Aquifer characteristics of importance to the NSWD GSA are mainly transmissivity, hydraulic conductivity, and storativity. NSWDGSA has specific yields of the deposits of 8.3%, 13.3% and 14.8%. Transmissivity values ranged from 22,500 to 184,400 gpd/ft with an average of 44,000 gpd/ft within the District.

On average, the District's well depths within the GSA are about 350 feet. Groundwater elevation data from about 2000 to present show an average water level between 40 and 60 feet above sea level. Due to the size of the GSA, the relative uniformity of the land, and the lack of consistent monitored data points, groundwater inflow and outflow is assumed to be equal until more data can be collected.

Groundwater storage was determined using multiple methods. Method one used the water budget analytical model or the checkbook balance method. It uses inputs from all water sources, consumptive uses, and losses to determine groundwater surplus or overdraft over a hydrologically average period. The second method used average specific yield, basin area, and average change in groundwater levels to determine change in storage over the hydrological average period. The final method used GIS mapping tools to calculate the difference in volume between contour maps for each year in the hydrological average period.

The Madera subbasin used a model method to calculate the area's water budget. Within the Madera subbasin, it was calculated that the overdraft is between 242,500 and 363,700 AF/year. In place of a model, the complete water budget including historical, current, and projected, for NSWD was created using information from the basin setting, along with data from sources such as California Irrigation Management Information System (CIMIS), National Oceanic and Atmospheric Administration (NOAA), DWR, Irrigation Training & Research Center (ITRC), etc. The period of record chosen to analyze the historical data was 2003-2012. This period was chosen because it represents 100% of the long-term calculated natural flow (1901-2016) in the San Joaquin River and it closely reflects current management practices and facilities available to the District. Also, this period includes a mix of dry, normal, and wet years. Using this method, the overdraft for the District was calculated to be about 1,600 AF/year.

Indicators for the sustainable management of groundwater include groundwater levels, groundwater storage volume, land subsidence, water quality, interconnected surface water, and seawater intrusion. For NSWDGSA, the lowering of groundwater levels and depletion of groundwater storage is considered significant and unreasonable if pumping of groundwater has caused 25 percent of wells in the District to go dry. Also, water quality degradation is considered significant and unreasonable when concentrations of contaminants, such as nitrogen and salts, have reached levels that drastically impact crop yield. For the District, land subsidence is considered significant and unreasonable when critical infrastructure, such as the Chowchilla Bypass, or distribution systems, wells, and pumps begin to fail or take critical damage. NSWDGSA does not contain interconnected surface and groundwater systems. Due to the lack of connected water systems, interconnected surface water will not be monitored or considered when making management decisions. The Madera Subbasin and NSWDGSA do not need to account for seawater intrusion since they are not located adjacent to the coast.

Monitoring is a fundamental component of a groundwater management program and is needed to measure progress of reaching measurable objectives and the goal of groundwater sustainability. New monitoring networks will be developed, and existing networks enhanced when necessary, using the Data Quality Objective (DQO) process, which follows the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). The monitoring network for the groundwater level sustainability indicator will include the three CASGEM wells located within or on the border of the GSA as well as three District wells that are not part of CASEGEM. These wells will also be used to monitor the groundwater storage and groundwater quality sustainability indicators. Also, depletion of interconnected surface water will not be monitored due to the lack of interconnected surface water systems within NSWD GSA. The GSA is approximately 80 miles from the ocean and, therefore, seawater intrusion is not feasible and will not be monitored. The monitoring network for NSWD GSA will utilize the USBR SJRRP and NASA InSAR data to continue to monitor the areas of subsidence. The GSA will develop and maintain a data management system for storing and reporting information for the implementation of this GSP.

Implementation of projects and management actions will ensure that NSWD GSA will achieve groundwater sustainability by 2040. NSWD GSA analyzed several project types and groundwater management programs during the GSP planning process, which include, Groundwater Recharge Projects, Surface Water Acquisition Projects, Water Conservation Projects, and Management Programs. NSWD GSA will aim its efforts first towards constructing a new Chowchilla Bypass turnout, new canals, and recharge basins within its boundary. If basin overdraft isn't mitigated or if sustainable thresholds are not being met after implementation of NSWD GSA and landowner projects, the management actions and other potential projects listed may be enacted, and the priority of these projects will be increased. The severity of the situation will dictate the actions taken. Priority will be given to actions and projects that can be implemented in a relatively short amount of time and have a high benefit-to-cost ratio.

The adoption of the GSP will be the official start of the Plan Implementation for NSWD. The GSA will continue its efforts to secure the necessary funding to successfully monitor and manage groundwater resources within the District in a sustainable manner. While the GSP is being reviewed by DWR, NSWD GSA will begin the implementation of both projects and management actions. It is evaluated that by 2025, the pre-existing overdraft value will have decreased by approximately 10% due to both the implementation of projects and management actions. Of that amount, approximately 75% of that change will have developed from new or existing GSP projects and 25% will come from the implementation of NSWD GSA management actions. In the year 2030 it is estimated that the implementation of both GSP projects and management actions will have decreased the amount of overdraft by an additional 30% with 50% coming from project implementation and 50% from management actions. The progress of this trend is cumulative and will continue to increase throughout the GSP's implementation until sustainability is met.

The GSA will annually report the result of basin operations including current groundwater levels, extraction volume, surface water use, total water use, groundwater storage change, and progress of GSP implementation. The GSA will also report, at least every five years and when the GSP is amended, the result of basin operations and progress in achieving sustainability including current groundwater conditions, status of projects or management actions, evaluation of undesirable results relating to measurable objectives and minimum thresholds, changes in monitoring network, summary of enforcement or legal actions, and agency coordination efforts.

1 Introduction

1.1 Purpose of Groundwater Sustainability Plan

On September 16, 2014, Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA) which was passed in 2014 and is codified in Section 10720 et seq. of the California Water Code. This legislation created a statutory framework for groundwater management that can be sustained during planning and implementation without causing undesirable results.

SGMA requires governments and water agencies of high- and medium-priority basins to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically over-drafted basins, including the Madera Subbasin that the New Stone Water District Groundwater Sustainability Agency (NSWD GSA) area is part of, the deadline for achieving sustainability is 2040.

In his signing statement, Governor Brown emphasized that "groundwater management in California is best accomplished locally." With ongoing financial and technical assistance from the Department of Water Resources (DWR), the NSWD GSA is working to achieve area-wide collaboration between neighboring water agencies and helping to achieve groundwater sustainability.

1.2 Sustainability Goal

From the first edition of DWR Publication 118 in 1978, the San Joaquin River Basin, including the Madera Subbasin, has been determined to be in a state of overdraft and has been identified by the state as being "Critically Overdrafted." Since 1995, the Madera Subbasin has lost approximately 2.6 million acre-feet of water from subsurface storage through a combination of groundwater pumping and below-normal recharge driven by an extended drought and low surface water supplies. This is still small compared to the estimated storage capacity of 50 million acre-feet (af) within the subbasin (assuming 1500 feet of thickness). Chapter 3 of this Groundwater Sustainability Plan (GSP) discusses this chronic water imbalance in more depth.

While the Madera Subbasin has lost a great deal of its stored water in recent decades, the aquifers beneath the subbasin still contain more water than the total of all the reservoirs on the watersheds above the subbasin. That extensive storage volume has long masked the effects of overdraft from year to year, providing a buffer against the extreme fluctuations in surface water supplies depending on the rain year. Water agencies in the subbasin must work together to maintain the viability of the aquifer so that buffer capacity is always available.

To that end, this GSP proposes measures to immediately reduce and eventually eliminate systematic overdraft within the NSWD GSA area. Eliminating overdraft is defined as balancing average annual groundwater withdrawals with average annual natural and artificial groundwater recharge, accounting for subsurface flows into and out of the GSA area, over a rolling range of years. The variability in surface water supplies, in contrast to the steady nature of water demands, makes it infeasible to achieve balance every year. In reality, there will be years where the GSA area gains storage and other years where the storage balance declines, but overall the average GSA area basin storage will no longer be in decline within the GSA area once this plan becomes fully effective.

In order to accomplish this overarching goal, this plan identifies undesirable results, which are outcomes that will be realized should the plan's strategies not be effective or not be effectively implemented. Undesirable results are marked by minimum thresholds or data points which if not met mean an undesirable result has been realized. Positive outcomes defined in this GSP will take time to achieve. The NSWD has put a plan in place to build facilities that are thought to be of sufficient size and magnitude to accomplish its goal. The NSWD GSA is also reliant upon its neighboring agencies to do the same. It is understood that it will take time to achieve the regional goals. None of the goals can be realized in a year. Many won't be fully achieved until well into the 20-year attainment period defined in the SGMA legislation. Measurable objectives have been defined to gauge progress during the intervening years and to help assure not only that the GSA is moving toward its sustainability goals, but also that the rate of progress is as planned and sufficient to meet the overall implementation schedule.

While the Madera Basin is required to be sustainable, it should be noted that within the basin different areas can and should be evaluated separately. This GSP covers about 4,200 acres in the northwestern area of the basin that is adjacent to the Chowchilla Bypass. Sustainability goals, undesirable results, minimum thresholds, and measurable objectives are all defined and discussed in detail in Section 4 of this GSP.

1.3 Coordination Agreements

Regulation Requirement:

§ 357.4. Coordination Agreements

(a) Agencies intending to develop and implement multiple Plans pursuant to Water Code Section 10727(b)(3) shall enter into a coordination agreement to ensure that the Plans are developed and implemented utilizing the same data and methodologies, and that elements of the Plans necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting.

(b) Coordination agreements shall describe the following:

(1) A point of contact with the Department.

(2) The responsibilities of each Agency for meeting the terms of the agreement, the procedures for the timely exchange of information between Agencies, and procedures for resolving conflicts between Agencies.

(3) How the Agencies have used the same data and methodologies for assumptions described in Water Code Section 10727.6 to prepare coordinated Plans, including the following:

(A) Groundwater elevation data, supported by the quality, frequency, and spatial distribution of data in the monitoring network and the monitoring objectives as described in Subarticle 4 of Article 5.

(B) A coordinated water budget for the basin, as described in Section 354.18, including groundwater extraction data, surface water supply, total water use, and change in groundwater in storage.

(C) Sustainable yield for the basin, supported by a description of the undesirable results for the basin, and an explanation of how the minimum thresholds and measureable objectives defined by each Plan relate to those undesirable results, based on information described in the basin setting.

(c) The coordination agreement shall explain how the Plans implemented together, satisfy the requirements of the Act and are in substantial compliance with this Subchapter

(d) The coordination agreement shall describe a process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations.

(e) The coordination agreement shall describe a coordinated data management system for the basin, as described in Section 352.6.

(f) Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been accepted by the Department. If an Agency forms in a basin managed by an Alternative, the Agency shall evaluate the agreement with the Alternative prepared pursuant to Section 358.2 and determine whether it satisfies the requirements of this Section.

(g) The coordination agreement shall be submitted to the Department together with the Plans for the basin and, if approved, shall become part of the Plan for each participating Agency.

(h) The Department shall evaluate a coordination agreement for compliance with the procedural and technical requirements of this Section, to ensure that the agreement is binding on all parties, and that provisions of the agreement are sufficient to address any disputes between or among parties to the agreement.

(i) Coordination agreements shall be reviewed as part of the five-year assessment, revised as necessary, dated, and signed by all parties.

The Madera Subbasin is home to seven Groundwater Sustainability Agencies (GSAs). They are Madera Irrigation District GSA, Madera County GSA, City of Madera GSA, Madera Water District GSA, Gravelly Ford Water District GSA, Root Creek Water District GSA, and New Stone Water District GSA. The Madera County GSA on behalf of all the GSAs in the subbasin applied to and received funding from the DWR for grant funds to prepare a GSP. Gravelly Ford WD and Root Creek WD were originally part of the regional GSP development until 2018 when they each decided to prepare their own GSP. New Stone WD GSA had made the decision to prepare an individual GSP when coordination began, which led to this development of this GSP. The joint GSP includes Madera Irrigation District GSA, Madera County GSA, City of Madera GSA, and Madera Water District GSA. Since three of the seven GSAs within the basin decided to prepare individual GSPs, the subbasin needs a Coordination Agreement to comply with SGMA.

The Madera County GSA developed a draft Coordination Agreement for review and distributed it to the GSAs on April 24, 2019. Since NSWD GSA planned to pursue development of its own GSP, the District edited the draft Coordination Agreement to represent regional cooperation and coordination and resubmitted the draft Coordination to the County on June 3, 2019.

1.4 Inter-basin Agreements

Regulation Requirement:

§ 357.2. Interbasin Agreements
Two or more Agencies may enter into an agreement to establish compatible sustainability goals and understanding regarding fundamental elements of the Plans of each Agency as they relate to sustainable groundwater management. Interbasin agreements may be included in the Plan to support a finding that implementation of the Plan will not adversely affect an adjacent basin's ability to implement its Plan or impede the ability to achieve its sustainability goal. Interbasin agreements should facilitate the exchange of technical information between Agencies and include a process to resolve disputes concerning the interpretation of that information. Interbasin agreements may include any information the participating Agencies deem appropriate, such as the following:

(a) General information:
(1) Identity of each basin participating in and covered by the terms of the agreement.
(2) A list of the Agencies or other public agencies or other entities with groundwater management responsibilities in each basin.
(3) A list of the Plans, Alternatives, or adjudicated areas in each basin.
(b) Technical information:
(1) An estimate of groundwater flow across basin boundaries, including consistent and coordinated data, methods and assumptions.
(2) An estimate of stream-aquifer interactions at boundaries.
(3) A common understanding of the geology and hydrology of the basins and the hydraulic connectivity as it applies to the Agency's determination of groundwater flow across basin boundaries and description of the different assumptions utilized by different Plans and how the Agencies reconciled those differences.
(4) Sustainable management criteria and a monitoring network that would confirm that no adverse impacts result from the implementation of the Plans of any party to the agreement. If minimum thresholds or measurable objectives differ substantially between basins, the agreement should specify how the Agencies will reconcile those differences and manage the basins to avoid undesirable results. The Agreement should identify the differences that the parties consider significant and include a plan and schedule to reduce uncertainties to collectively resolve those uncertainties and differences.
(c) A description of the process for identifying and resolving conflicts between Agencies that are parties to the agreement.
(d) Interbasin agreements submitted to the Department shall be posted on the Department's website.

It is understood that coordination needs to exist between the adjacent subbasins. Some initial discussions occurred with the Triangle T GSA, but the other Madera Subbasin GSAs asked that there be regional cooperation rather than discussions between the GSAs. At the request of the other Madera Subbasin GSAs, the NSWD GSA has not had any ongoing dialogue with the agencies in the Chowchilla or Delta-Mendota Subbasins.

1.5 Agency Information

Regulation Requirement:

§354.6(a) The name and mailing address of the Agency

New Stone Water District Groundwater Sustainability Agency
9500 S. De Wolf
Selma, CA 93662

Contact: Roger Skinner

1.5.1 Organization and management structure of the GSA

Regulation Requirement:

§354.6(b) The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan. **§354.6(c)** The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.

The NSWD GSA is coterminous with the New Stone Water District (NSWD or District) boundary. The District is predominantly agriculture and consists of two landowners. The NSWD GSA and the NSWD have the same general manager and rely upon consultants and contracted operational staff.

Within the Madera Subbasin and per the coordination agreement, the Basin Plan Manager is presently Jeff Lion.

The contact information is as follows:

Name: Jeff Lion
Phone: 559-834-6677
Mailing Address: P. O. Box 1350, Selma, CA 93662
Email: jlion@lionraisins.com

1.5.2 Legal Authority of the GSA

Regulation Requirement:

§354.6(d) The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the plan.

The New Stone Water District Groundwater Sustainability Agency was created on December 22, 2016.

The legislation established the Agency as a GSA under Water Code 10720 (the Sustainable Groundwater Management Act) for the portion of the Madera Subbasin that lies within the boundaries of the Agency. The legislation requires the Agency to develop and implement a GSP to achieve groundwater sustainability management within the territory of the Agency in compliance with the mandates and timelines in SGMA.

The NSWD is the only water purveyor and/or agency throughout the territory of the GSA. Accordingly, the Agency has been deemed the exclusive local agency within the designated territory endowed with powers to comply with SGMA.

The Agency's enabling act is codified in Water Code Appendix Section 143-801. The section provides that pursuant to Chapter 8 of Part 2.74 of Division 6 of the Water Code, the Agency may impose a variety of fees as it may determine to be necessary to fund its groundwater sustainability program, including but not limited to permit fees and fees on groundwater extraction and other regulated activities.

Additionally, the NSWD is a local public agency. The District was organized in 1983 under the California Water District Law, Section 34000 *et seq.* of the California Water Code (CWC) of the State of California.

Pursuant to CWC Sections 34000 *et seq.,* the District has the authority to protect and enhance the water resources available to it.

NSWD has the authority to manage the groundwater resources within its service area through CWC, Division 6, Part 2.75 (Sections 10750 et seq.) It is the primary agency responsible for its groundwater management plan, and it provides for management of the groundwater basin within its political boundary. The groundwater management plan is consistent with the provision of CWC, Sections 10750 et seq., as amended January 1, 2003.

The District boundaries encompass approximately 4,200 acres. The NSWD satisfies the definition of "local agency" which is described in the CWC 10701 (a) as any city, county district, agency, or other political subdivision of the state for the local performance of governmental or proprietary functions within limited boundaries.

1.5.3 Cost of Plan Implementation and Sources of Revenue

The cost for implementing the plan fall into a number of different categories. These consist of monitoring, facilities, planning and organizational, and purchase of surface water supplies. While the law was passed in 2014, the NSWD with its founding was intent on balancing groundwater supplies and groundwater levels and as such endeavored to acquire surface water supplies and construct facilities. The District will fund the management actions through District funds and will pursue grant funding. The following Table 1-1 Estimated Costs for Implementation Management Actions lists the potential future costs associated with the plan:

Table 1-1 Estimated Costs for Implementation Management Actions

Implementation of Projects and Management Actions	Estimated Costs Per 5-Year Period				Total 20-Year Cost
	2020 - 2025	2025 - 2030	2030 - 2035	2035 - 2040	
Bypass Turnout	$125,000	$125,000	$125,000	$125,000	$500,000
Distribution System	$375,000	$375,000	$375,000	$375,000	$1,500,000
Recharge Basins/Canal	$200,000	$200,000	$200,000	$200,000	$800,000
New wells	$500,000	$500,000	$500,000	$500,000	$2,000,000
Aquifer Storage	$750,000	$750,000	$750,000	$750,000	$3,000,000
Total Cost	$1,950,000	$1,950,000	$1,950,000	$1,950,000	$7,800,000
Average Annual Cost	$390,000	$390,000	$390,000	$390,000	

Regulation Requirement:

§354.6(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

This GSP is organized in accordance with the outline in the GSP Guidelines published by DWR.

Section 2 describes the Plan area, including geographic setting, existing water resources planning and programs, relationship of the GSP to other general plan documents within the Agency boundary, and additional GSP components.

Section 3 describes the basin setting. It includes a detailed discussion of the hydrogeologic conceptual model used to prepare the GSP, current and historical groundwater conditions, a discussion of the area groundwater budget, and a description of why there are no management areas.

Section 4 sets forth the Agency's adopted sustainability goals, addresses the mandated undesirable outcomes, defines minimum thresholds for each undesirable outcome, and sets measurable outcomes for both intermediate Plan years and for the Plan's complete implementation.

Section 5 describes the network of monitoring wells and other facilities adopted by the Agency to measure Plan outcomes and assesses the need for improvements to the network in order to provide fully representative data. Monitoring protocols and data analysis techniques are also addressed.

Section 6 lists and describes each project and management action adopted by the Agency in pursuit of sustainability. The section includes project details, required permits, anticipated benefits, project capital and operations/maintenance costs, project schedule, and required ongoing management operations.

Section 7 describes the Plan implementation process, including costs, sources of funding, an overall schedule through full implementation, description of the required data management system, methodology for annual reporting, and how progress evaluations will be made over time.

Section 8 summarizes the references and sources used to prepare and document this Plan.

2 Plan Area

Regulation Requirement:

§354.8 Each Plan shall include a description of the geographic areas covered, including the following information:

(a) One or more maps of the basin that depict the following, as applicable:

1) The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.
2) Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.
3) Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.
4) Existing land use designations and the identification of water use sector and water source type.
5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the department, as specified in section 353.2, or best available information.

The Madera Groundwater Subbasin is the southernmost subbasin within the San Joaquin Valley Basin north of the San Joaquin River (**Figure 2-1** and **Figure 2-2**). The Madera Subbasin boundary is defined in the California Department of Water Resources (DWR) Bulletin 118 as DWR Subbasin No. 5-22.06 (2006). The majority of surface water in the subbasin is supplied from the Chowchilla, Fresno, and San Joaquin Rivers. The Sierra Nevada foothills and three Groundwater Subbasins border the Madera Subbasin north of the San Joaquin River. These subbasins include the Merced, Chowchilla, and the Delta-Mendota Subbasins. The Kings Subbasin adjoins the Madera Subbasin south of the San Joaquin River. **Figure 2-2** shows the bordering subbasins and **Figure 2-3** shows the local water agencies.

Seven GSAs have formed within the 347,600-acre Madera Subbasin. The New Stone Water District Groundwater Sustainability Agency (NSWDGSA, NSWD, or GSA) contains approximately 4,182 acres in the northwestern portion of the Madera subbasin and is bounded on the east by the Chowchilla Bypass (Bypass). There is no overlap among the surrounding GSAs and there are no adjudicated areas in the groundwater basin. The Bypass along the east side of the District provides the conveyance of surface water to NSWDGSA. The Bypass is the only existing conveyance facility that could deliver surface water to District lands.

The land immediately surrounding the NSWD is unincorporated County land. To the south, the county land is in the Madera subbasin, and to the north, the county land is in the Chowchilla subbasin. There are no federal, state, or tribal lands within the NSWD area.

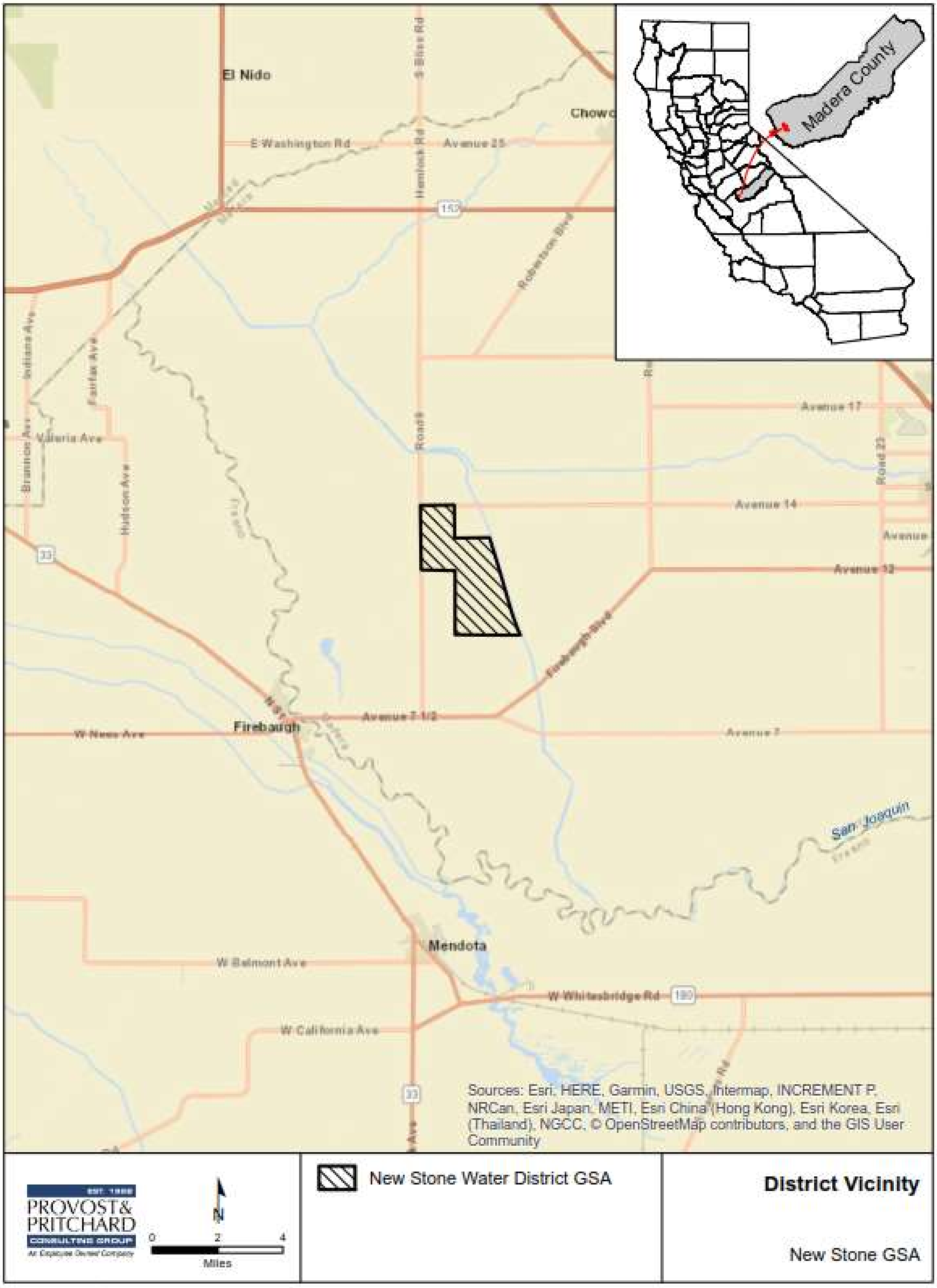

Figure 2-1 District Map

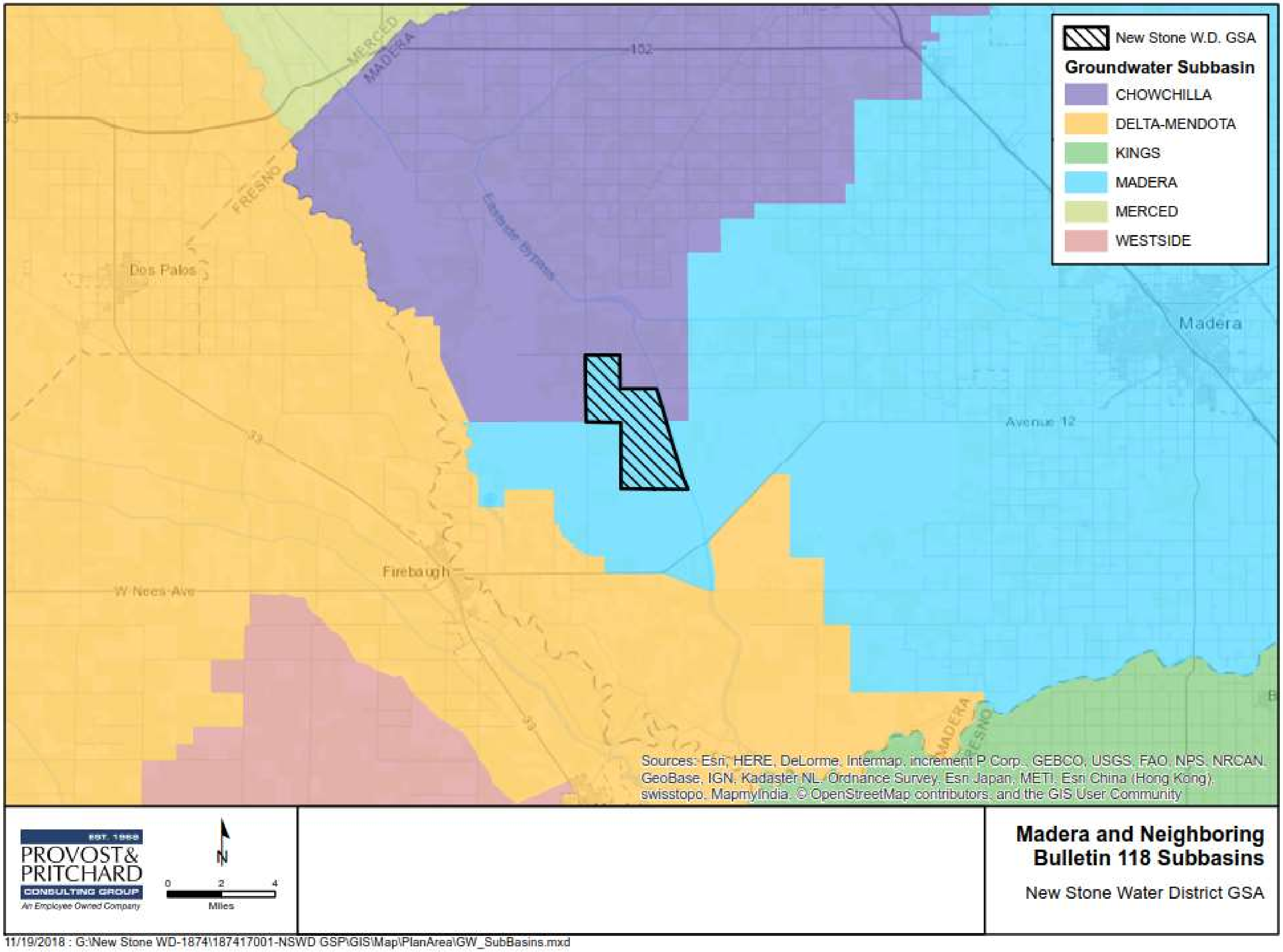

Figure 2-2 Madera and Neighboring Subbasins

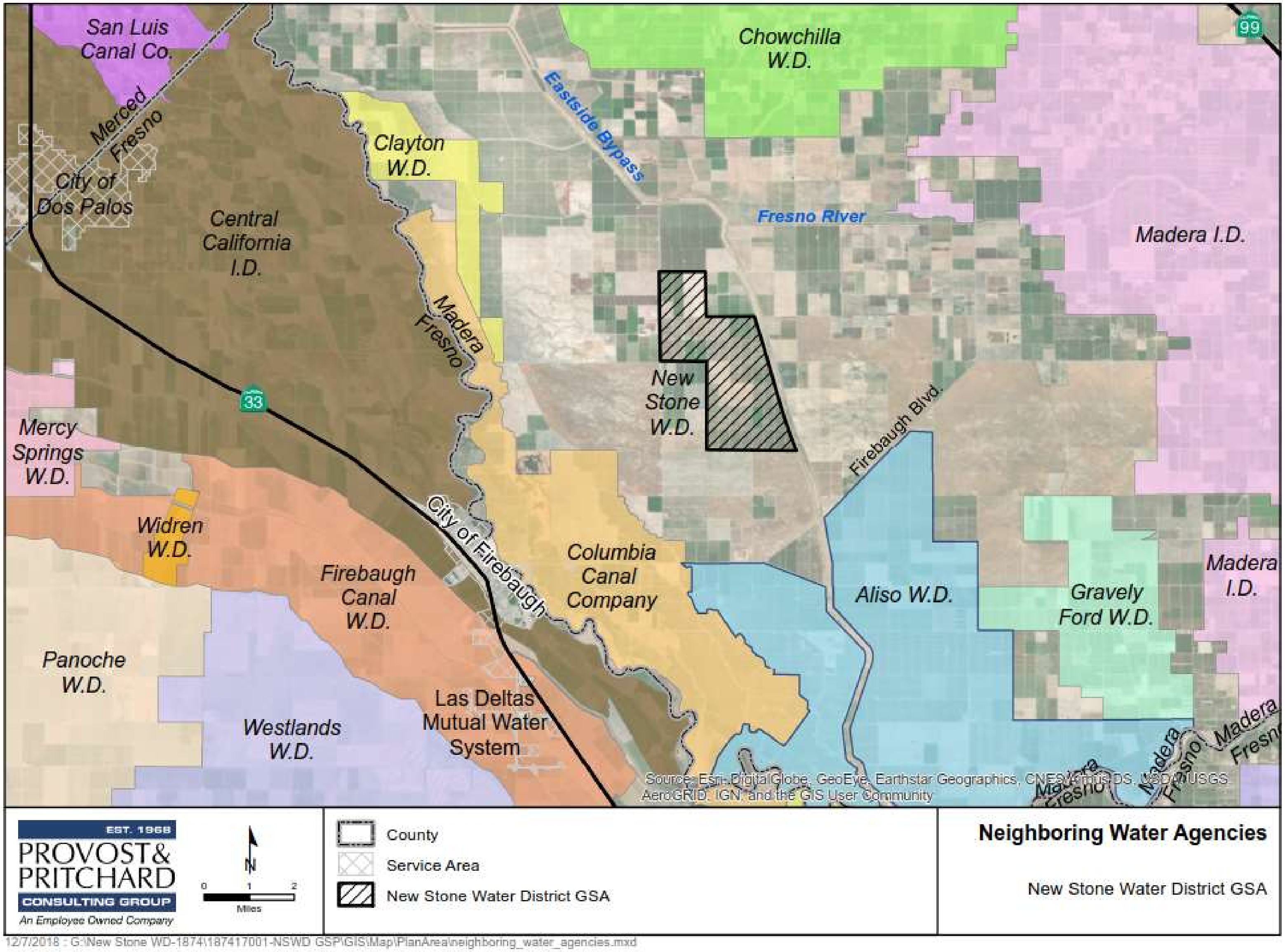

Figure 2-3 Neighboring Water Agencies

General land use in Madera County was last surveyed by DWR in 2011. The County General Plan (**Figure 2-4**) and zoned districts within the NSWD can be observed on the County interactive map available from:

https://countymadera.maps.arcgis.com/apps/webappviewer/index.html?id=d955f25b15ed4e4e9a7ac4ecad0edd2a

Land Use. The land within NSWD is exclusively used for agriculture. The Madera County Agricultural Commissioner provides annual data for cropping within the County, which was used for understanding the plantings in the District. Previously, cropping and the associated water use were estimated by using the DWR land use data; however, the DWR data source is not available on an annual basis. Of the approximate 4,182 acres of the NSWDGSA, the area primarily consists of grape vines (about 3,145 acres) with some areas of alfalfa (about 626 acres) and corn (about 231 acres) as well.

The evapotranspiration (ET) for each crop in the District, along with irrigation method (drip and surface irrigation), can be estimated for each month. Based on the crop type and acreage, as well as the ET, the estimated agricultural demand for the year 2016 is included in **Table 2-1**.

Table 2-1 Estimated Monthly Agricultural Demand (2016)

Alfalfa				Corn				Grapes			
Month	Acres	ET (Feet)	Estimated Demand (AF)	Month	Acres	ET (Feet)	Estimated Demand (AF)	Month	Acres	ET (Feet)	Estimated Demand (AF)
January	626	0.08	50	January	231	0.00	0	January	3145	0.00	0
February	626	0.19	120	February	231	0.00	0	February	3145	0.00	0
March	626	0.34	210	March	231	0.00	0	March	3145	0.00	0
April	626	0.48	299	April	231	0.00	0	April	3145	0.08	264
May	626	0.62	388	May	231	0.10	24	May	3145	0.40	1243
June	626	0.64	401	June	231	0.42	98	June	3145	0.48	1522
July	626	0.67	422	July	231	0.84	193	July	3145	0.45	1400
August	626	0.63	394	August	231	0.66	152	August	3145	0.27	864
September	626	0.50	310	September	231	0.31	72	September	3145	0.12	390
October	626	0.35	217	October	231	0.00	0	October	3145	0.02	74
November	626	0.13	82	November	231	0.00	0	November	3145	0.00	0
December	626	0.09	57	December	231	0.00	0	December	3145	0.00	0
Total for 2016		**4.71**	**2949**	**Total for 2016**		**2.33**	**538**	**Total for 2016**		**1.83**	**5758**

Water Source. Water supply to meet the NSWDGSA agricultural demands comes primarily from groundwater pumping. Although the NSWDGSA does have an appropriative water right along the Chowchilla Bypass (referred to as Eastside Bypass/Chowchilla Canal in permit) of 15,700 acre-feet/year (permit number 19615), surface water is not consistently used for irrigation. The Chowchilla Bypass is a designated floodway into which water is diverted from the San Joaquin River only in relatively wet years. The District formerly used Bypass water to irrigate crops; however, when a drip system was installed, the water could no longer be used. As a result, part of the District's canal conveyance system adjacent to the Bypass was backfilled to make more room for grape vines.

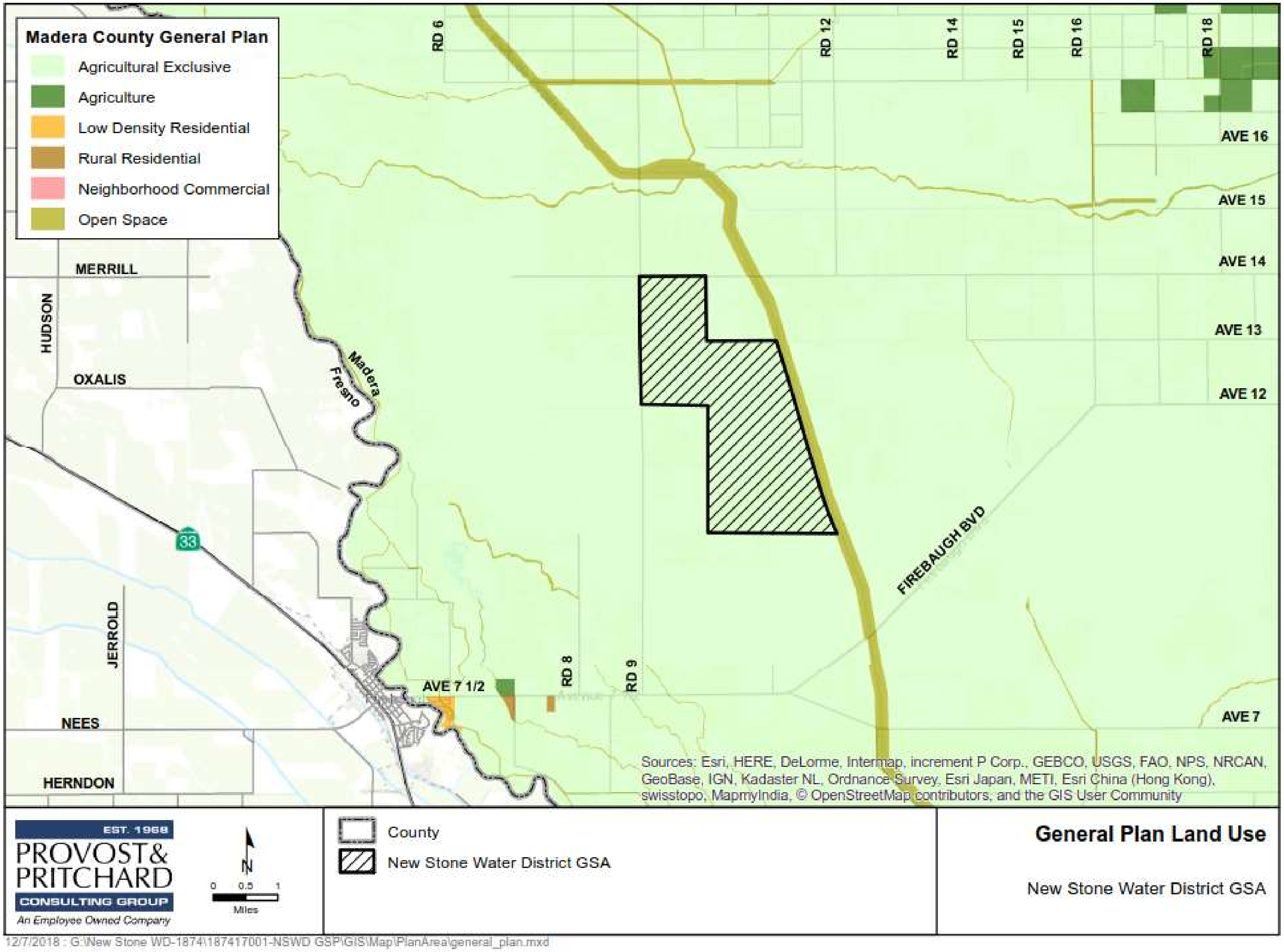

Figure 2-4 County General Plan Land Use

Figure 2-5 shows well density in the NSWD area. There are an estimated 31 active wells in the District area. The map is based on a well canvas that was performed in 2007. This is considered the best available data and includes known well locations for individual landowners as well as state wells. Well logs from the DWR, if available, have been reviewed to determine the construction of the well. However, this has not been able to be determined. A discussion of groundwater well pumping is included in Section 3.1.8.3.

2.1 Summary of Jurisdictional Areas and Other Features

Regulation Requirement:

§354.8(b) A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.

Groundwater Basin Boundaries

The Madera Subbasin is a large groundwater subbasin located within the southern part of the San Joaquin Valley Basin, in the Central Valley of California. The groundwater basin boundary is defined in the DWR Bulletin 118 as DWR Basin No. 5-22.06. The groundwater basin covers 614 square miles (394,000 acres). DWR estimated the amount of stored groundwater as of 1995 for the entire San Joaquin Valley Basin at about 12.6 million AF to a depth of 300 feet (DWR, Bulletin 118). They also state in Bulletin 118 that the amount of stored groundwater in this subbasin as of 1961 was 24 million AF to a depth of <1000 feet.

Groundwater Management Plan Area

The NSWD does not have a Groundwater Management Plan, but the District is covered in the Madera Regional Groundwater Management Plan under Madera County that was adopted in December 2014. The NSWD is identified in **Figure 2-2**. The District is in the southwest portion of Madera County at the approximate center of the San Joaquin Valley. The area is not specifically described in the Plan and is surrounded by County area; therefore, there are no immediately adjacent water agencies (**Figure 2-3**).

2.2 Water Resources Monitoring and Management Programs

2.2.1 Monitoring and Management Programs

Regulation Requirement:

§354.8(c) Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.

Groundwater Level Monitoring

The California State Groundwater Elevation Monitoring (CASGEM) program was created by SBx7 6, Groundwater Monitoring, a part of the 2009 Comprehensive Water Package. Groundwater levels have been regularly monitored in three wells within or on the border of the GSA for the CASGEM program. These wells have state well IDs 11S14E36R001, 11S15E30A001, and 11S15E31J001. Water depths have been measured in these wells by the U.S. Bureau of Reclamation (USBR) on a bi-annual basis since the late 1950s or early 1960s. Well logs and construction information are not available for these wells. Several other nearby wells not in the GSA are also monitored for the CASGEM program.

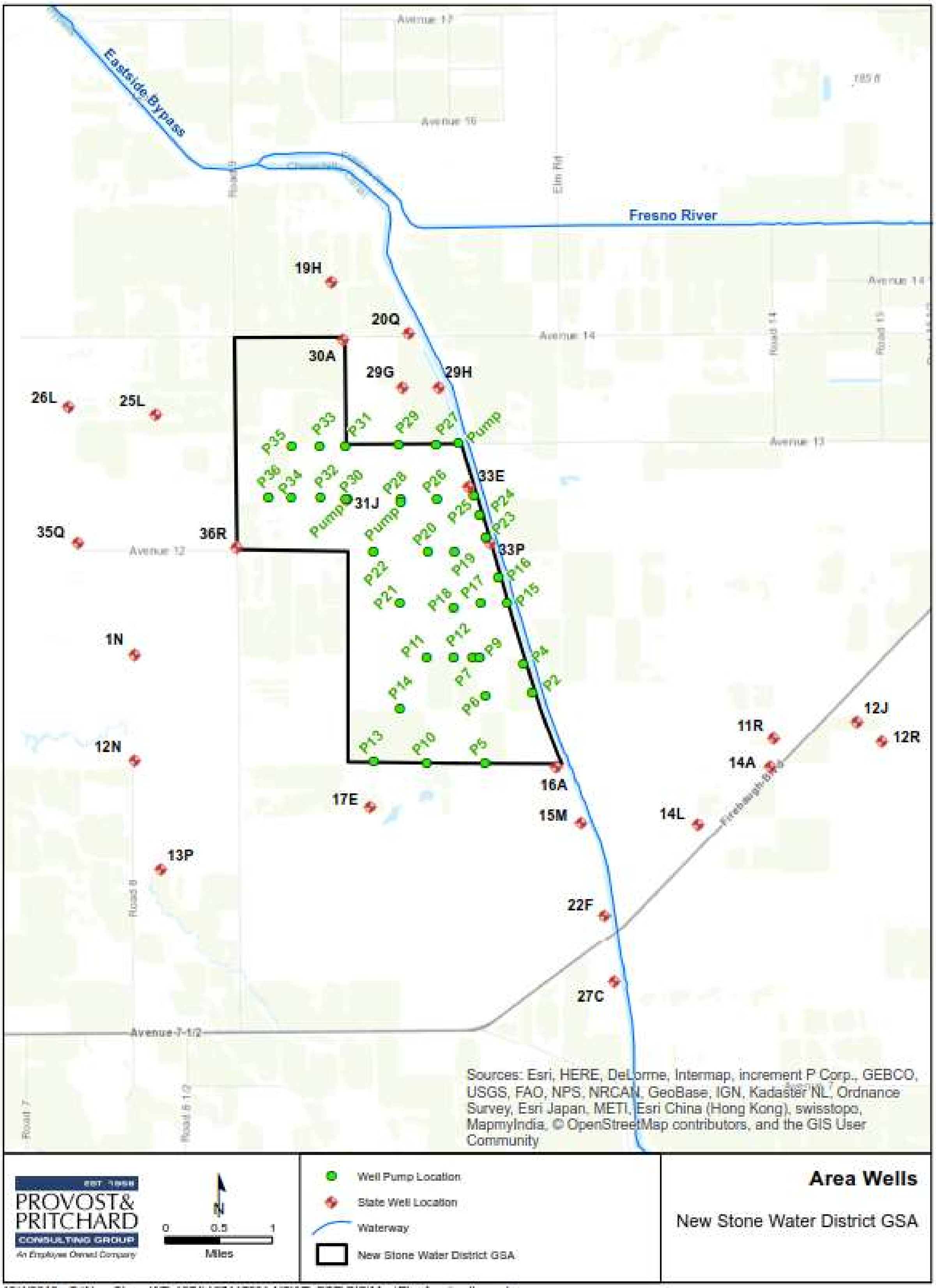

Figure 2-5 Wells 2018

Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect of groundwater management in NSWD. Monitoring groundwater quality serves the following purposes:

1. Spatially characterize water quality according to soil types, soil salinity, geology, surface water quality, and land use;
2. Establish a baseline for future monitoring;
3. Compare constituent levels at a specific well over time (i.e., years and decades);
4. Determine the extent of groundwater quality problems in specific areas;
5. Identify groundwater quality protection and enhancement needs;
6. Determine water treatment needs;
7. Identify impacts of recharge and surface water use on water quality;
8. Identify suitable crop types that are compatible with the water characteristics; and
9. Monitor the migration of contaminant plumes.

A discussion on groundwater quality in the NSWDGSA is in Section 3.2.5 – Groundwater Quality. Several agencies are involved in the monitoring and mitigation of groundwater quality in the surrounding area. These agencies include the County of Madera, State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCB), United States Geological Survey (USGS), and California Department of Toxic Substances Control (DTSC). Data from these sources indicate that common constituents of concern in NSWDGSA and the region are nitrate and total dissolved solids (TDS). Data available within and near the GSA show that levels of these constituents are generally below respective regulatory levels for drinking water (see Section 3.2.5 for details). Contaminant plumes are not known within the GSA.

Land Surface Subsidence Monitoring

The GSA is included in areas monitored by National Aeronautics and Space Administration (NASA) and the USBR's San Joaquin River Restoration Project (SJRRP). Data from these sources show that subsidence has been occurring at significant rates within and surrounding the GSA. The monitoring network for NSWDGSA will include the USBR SJRRP and NASA InSAR data to continue to monitor the areas of subsidence. If data from these sources becomes unavailable in the future, a new monitoring network will be established to monitor land subsidence.

Surface Water Monitoring

The only surface water feature in NSWDGSA is the Chowchilla Bypass (Bypass), which is located along the eastern edge of the NSWDGSA. The Bypass is a designated floodway into which water is diverted from the San Joaquin River only in relatively wet years.

<u>Imported Surface Water</u>. NSWD does not import any surface water into the area.

Irrigated Lands Regulatory Program

The NSWD is located within the East San Joaquin Water Quality Coalition (the Coalition or ESJWQC) boundary. The Coalition is a group of agricultural interests and growers formed to represent all "dischargers" who own or operate irrigated lands east of the San Joaquin River within Madera, Merced, Stanislaus, Tuolumne and Mariposa Counties and portions of Calaveras County. The ESJWQC has been approved by the Executive Officer of the Central Valley Regional Water Quality Control Board to serve as a third-party group to conduct water quality monitoring and reporting on behalf of its enrolled grower members to meet requirements of the Irrigated Lands Regulatory Program (ILRP). In fulfillment of required reports and monitoring, the ESJWQC completed a Groundwater Assessment Report which evaluated readily available groundwater quality data and assessed areas within the Coalition boundary with increased potential to influence groundwater quality.

The Coalition has collected surface water quality data since 2004 and more recently began collecting groundwater quality data as part of a long-term trend monitoring program. This information is summarized annually and submitted to the CVRWQCB in compliance with requirements of the ILRP.

GSP Monitoring and Management Plans

The NSWDGSA will be responsible for collecting data or using existing programs to monitor the various groundwater conditions. The monitoring network and its goals are described in detail in Chapters 4 and 5 of the Plan.

2.2.2 Impacts to Operational Flexibility

Regulation Requirement:

§354.8(d) A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.

The development of relationships between NSWD, various regulatory agencies, and other local water agencies is an important part of an effective groundwater sustainability plan. The District is in the Madera groundwater subbasin, which extends beyond many political boundaries and includes other municipalities, irrigation districts, water districts, private water companies, and private water users. This emphasizes the importance of inter-agency cooperation, and the District has historically made efforts to work conjunctively with many other GSAs.

Several existing water management constraints impact operational flexibility and water operations. These programs are described below for each program and possible measures to adapt to them.

Contaminant Plumes

As noted above, water quality data indicate that common constituents of concern in NSWDGSA and the region are nitrate and TDS and that concentrations of these constituents are generally below respective regulatory levels for drinking water. A review of the DTSC and SWRCB online databases, EnviroStor and GeoTracker, show no active contaminated sites within 4 miles of the GSA. The USGS from 2005 to 2006 performed their Groundwater Ambient Monitoring and Assessment (GAMA) program which undertook investigation to characterize the groundwater condition in the Southeast San Joaquin Valley (Burton et al, 2012). There are no known contaminant plumes in the area currently; however, should one be discovered or created, the monitoring and management of the plume may impact the operational flexibility of this plan in the following ways:

1. New wells may not be installed in specific areas because they may capture contaminated water or cause a plume to migrate.
2. Some existing wells may not be utilized, and may either be abandoned or placed on standby.
3. Groundwater recharge basins may not be constructed in specific areas because they may cause a plume to migrate.

4. Wellhead treatment may be required at some wells, thus increasing the cost to produce water. These wells are often put on stand-by and only used to help meet peak demands.

Flood Control Operational Limitations

New Stone Water District is situated next to the Bypass that carries flood flows. The District has rights to use some of the flood water. However, its current system is undersized and cannot distribute the permitted volume. Plans to upgrade the system are being considered so that the full water right can be used soon. No other flood control operations currently exist in the District.

San Joaquin River Restoration Program

In 2006, after an 18-year court session, the Friant Central Valley Project (CVP) contractors entered into the San Joaquin River Restoration (SJRR) settlement agreement. The agreement increases flows to the River to benefit fisheries resulting in a significant reduction in water deliveries to the Friant contractors.

The San Joaquin River Restoration Program (SJRRP) is currently in the development phase. The SJRRP Revised Framework for Implementation (SJRRP, 2015) estimates full restoration flows will begin between 2025 and 2029. Restoration water supply impacts to the Friant contractors were estimated by Provost & Pritchard (2009) including a water delivery impact to Merced ID as a reduction of about 27,500 AF annually. However, the impacts are not expected to be fully realized until 2025 or later. In a critically dry year, it is not required that restoration flows be left in the River.

Several mitigation programs were established as part of the restoration settlement intended to partially reduce the water supply impacts from the river restoration program, and include the following:

1. <u>Recirculated Water</u>: Some restoration flows could be recaptured in the Lower San Joaquin River or Delta for use by the Friant contractors. These waters will either be sold, exchanged for other water supplies, or, when feasible, delivered directly back to some Friant contractors.
2. <u>Part 3 Water (formerly Title 3 or T3 water)</u>: Part 3 water is generated from the facilities and programs built to increase groundwater recharge and recovery using the $50 million authorized as part of Title 3 of the San Joaquin River Restoration Act.
3. <u>16(b) Water (also known as $10 water)</u>: This program allows the impacted parties to buy floodwater at $10/AF to the extent they have been impacted. This is less than the cost of purchasing other floodwaters from the San Joaquin River.
4. <u>Unreleased Restoration Flows</u>: Designated restoration flows that are not used will be sold to the Friant contractors, who can use them directly for irrigation or domestic use. Restoration flows may not be used for a variety of reasons, including operational limitations, flood control releases, facility maintenance and construction, etc.

The Friant contractors have no control over the implementation of the SJRRP; however, they can use the mitigation programs as much as feasible. These programs will only partially compensate for the water losses, so Friant contractors may attempt to develop new water supplies through water transfers, recharge, recycling, reuse, and conservation to make up for the reduced water deliveries. The construction of new storage projects, including the Temperance Flat reservoir on the Upper San Joaquin River, can help to mitigate the impacts of the river restoration and restore some operational flexibility.

2.2.3 Conjunctive Use Programs

Regulation Requirement:

§354.8(e) A description of conjunctive use programs in the basin.

Conjunctive use is the coordinated and planned management of both surface and groundwater resources to maximize efficient use. Conjunctive use is a strategy to improve water supply reliability and environmental conditions, reduce groundwater overdraft and land subsidence, and protect water quality.

It includes balancing the use of surface water when it is available with the use of groundwater in order to sustainably meet the needs of beneficial users. Conjunctive use also includes cyclic storage where groundwater is recharged during wet years using surplus surface water to offset the groundwater pumped during dry periods. This strategy should also include a robust monitoring program to help prevent negative impacts and verify the quantity of water in storage.

The NSWD does not have a current conjunctive use program since they rely primarily on groundwater. Although they have a right to the water from the Bypass when it flows, the District's system is undersized to handle the full amount of water for which they have a right. It should be noted that the Madera and Chowchilla subbasins are used conjunctively, meaning that groundwater and surface water are used collectively for municipal and agricultural purposes. The groundwater basin can be viewed as a storage reservoir during wet years, less groundwater pumping is required, and recharge is practiced so that excess surface water supplies can be added to below-ground storage. In dry years, less surface water is available, more groundwater is pumped to meet demands, and groundwater levels decline. Because of this variable use, it is expected that water levels will rise and fall, but in a balanced groundwater basin those levels will be relatively stable over a longer period (P&P, 2014).

2.3 Relation to General Plans

2.3.1 Summary of General Plans/Other Land Use Plans

Regulation Requirement:

§354.8(f) A plain language description of the land use elements or topic categories of applicable general plans that include the following: 1) A summary of general plans and other land use plans governing the basin.

Land use planning activities in unincorporated areas of Madera County are performed by the Madera County Planning Department and overseen by the Madera County Planning Commission. NSWD does not have land use planning authority; therefore, regional and local land use planning activities will remain with the appropriate agencies. However, when appropriate, NSWD will comment on proposed land use plans that may impact the local groundwater quantity or quality.

California Government Code (§65350-65362) requires that each county and city in the state develop and adopt a general plan. The General Plan consists of a statement of development policies and includes diagrams and text setting forth objectives, principles, standards, and plan proposals. It is a comprehensive long-term plan for the physical development of the county or city. In this sense, it is a "blueprint" for development.

The General Plan must contain seven state-mandated elements. It may also contain any other elements that the legislative body of the county or city wishes to adopt. The seven mandated elements are: Land Use, Open Space, Conservation, Housing, Circulation, Noise, and Safety. The General Plan may be adopted in any form deemed appropriate or convenient by the legislative body of the county or city, including the combining of elements. The General Plan document materials for Madera County can be accessed by element at the following web page:

https://www.maderacounty.com/government/community-economic-development-department/divisions/planning-division/planning-forms-and-documents/-folder-269

The General Plan Policy Document for Madera County was adopted October 24, 1995. Other elements and updates or amendments have been added since then.

2.3.2 Impact of the Madera General Plan on Water Demands

Regulation Requirement:

§354.8(f) (2) A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects.

The countywide General Plan consists of two documents: *Background Report* and the *Policy Document*. In addition, the adopted Housing Element addresses housing issues on a countywide basis. The Background Report inventories and analyzes existing conditions and trends in Madera County. It provides the formal supporting documentation for general plan policy, addressing ten subject areas: land use; population; economic conditions and fiscal considerations; transportation and circulation; public facilities; public services; recreational and cultural resources; natural resources; safety; and noise.

The County General Plan was adopted prior to the development of the GSA and the Sustainable Groundwater Management Act (SGMA); however, updates have been made since then and land use in the District area may change. The land use plan makes assumptions for urban development, and this GSP uses the same land use change assumptions identified in the general plans for forecasting the anticipated water budget, described later in this GSP.

2.3.3 Impact of GSP on Land Use Plan Assumptions

Regulation Requirement:

§354.8(f) (3) A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.

Several County General Plan sections that cover water supply are summarized below. As noted, the Plan was developed prior to the development of the GSP.

The Public Facilities and Services, Section 3 of the Madera County General Plan, discuss various topics including water supply and delivery in Section 3.C. The primary goal in this Section is to ensure the availability of an adequate (i.e., sustainable) and safe water supply and the maintenance of high-quality water in water bodies and aquifers used as sources of domestic and agricultural water supply. The relevant policies for domestic supply (some of which are also agriculture water supply policies) are listed below:

- PF Policy 3.C.1 - The County shall approve new development only if an adequate water supply to serve such development is demonstrated.
- PF Policy 3.C.3 - The County shall limit development in areas identified as having severe water table depression to uses that do not have high water usage or to uses served by a surface water supply.
- PF Policy 3.C.7 - The County shall promote the use of reclaimed wastewater to offset the demand for new water supplies.
- PF Policy 3.C.8 - The County shall support opportunities for groundwater users in problem areas to convert to surface water supplies.
- PF Policy 3.C.9 - The County shall promote the use of surface water for agricultural use to reduce groundwater table reductions.

This Plan aims to support the assumptions and policies made in the Madera County General Plan by encouraging surface water use whenever available and planning for the use of recharge facilities.

2.3.4 Permitting New or Replacement Wells

Regulation Requirement:

§354.8(f) (4) A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.

The Madera County Community and Economic Development, Environmental Health Division permits new or replacement wells. They adhere to state requirements for the construction of new or replacement wells in addition to requiring that all new or replacement wells must be equipped with a flow meter and a sounding tube. The County Water Well Program details can be reviewed, and applications obtained online at:

https://www.maderacounty.com/government/community-economic-development-department/divisions/environmental-health/water-well-program

2.3.5 Land Use Plans Outside the Basin

Regulation Requirement:

§354.8(f) (5) To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.

The County General Plan was amended in 2008 to include a Dairy Element (2008). Key issues to siting a new diary would include potential impacts to groundwater and surface water quality from the diary effluent. Chapter 3 of the Dairy Element discusses goals, policies, and programs for new and existing dairies, which include buffer zones between developed or development areas, avoiding flood zones and wetlands, as well as high groundwater areas, etc. The County requires submittal of technical reports for new or expanding dairy operations for review and approval to insure that environmental and other concerns are met or mitigated.

Plan Developments
No plan developments are anticipated in the NSWDGSA area.

2.4 Additional GSP Components

Regulation Requirement:

§354.8(g) A description of any of the additional Plan elements included in the Water Code Section 10727.4 that the Agency determines to be appropriate.

2.4.1 Saline Water Intrusion

Saline (or brackish) water intrusion is the induced migration of saline water into a freshwater aquifer system. Saline water intrusion is typically observed in coastal aquifers where over pumping of the freshwater aquifer causes salt water from the ocean to encroach inland, contaminating the fresh water aquifer. The distance of the GSA area from the Pacific Ocean negates the possibility of saltwater intrusion from the ocean into the freshwater aquifer.

However, groundwater with naturally occurring elevated concentrations of salts exist at larger depths in the local aquifers. The base of freshwater, or the depth at which elevated specific conductance is encountered, has been characterized as the boundary where the concentration of specific conductance is over 3,000 μS/cm (Page, 1973). The base of freshwater varies throughout the GSP area and is discussed in detail in Section 3.1 – Hydrogeologic Conceptual Model. As wells are drilled deeper, pumping can cause upcoming (i.e., upward vertical migration) of saline water thus increasing salinity in the freshwater aquifer.

2.4.2 Wellhead Protection

A Wellhead Protection Area (WHPA) is defined by the Safe Drinking Water Act Amendment of 1986 as "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield." The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WHPAs can vary in size and shape depending on subsurface geologic conditions, the direction of groundwater flow, pumping rates, and aquifer characteristics.

The Federal Wellhead Protection Program was established by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the program is to protect groundwater sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. The program is based on the concept that the development and application of land use controls, usually applied at the local level, and other preventative measures can protect groundwater.

Under the Act, States are required to develop an EPA-approved Wellhead Protection Program. To date, California has no state-mandated program, but instead relies on local agencies to plan and implement programs. Wellhead Protection Programs are not regulatory in nature, nor do they address specific sources. They are designed to focus on the management of the resource rather than control a limited set of activities or contaminant sources.

Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the wellhead. A well is also the direct supply source to the customer, and such contaminants entering the well could then be pumped out and discharged directly into the distribution system. Therefore, essential to any wellhead protection program are proper well design, construction, and site grading to prevent intrusion of contaminants into the well from surface sources.

Wellhead protection is performed primarily during design and can include requiring annular seals at the well surface, providing adequate drainage around wells, constructing wells at high locations, and avoiding well locations that may be subject to nearby contaminated flows. Wellhead protection is required for potable water supplies and is not generally required, but is still recommended, for agricultural wells.

Municipal and agricultural wells constructed by the member agencies are designed and constructed in accordance with DWR Bulletin 74-81 and 74-90. Also, a permit is needed from the County to construct a new well. In addition, the member agencies encourage landowners to follow the same standard for privately owned wells. DWR Bulletins 74-81 and 74-90 provide specifications pertaining to wellhead protection, including:

- Methods for sealing the well from intrusion of surface contaminants
- Covering or protecting the boring at the end of each day from potential pollution sources or vandalism
- Site grading to assure drainage is away from the wellhead

2.4.3 Migration of Contaminated Groundwater

Groundwater within the GSA Area is generally of good quality for agricultural use. However, serious water quality problems in certain areas of the subbasin exist due to high concentrations of certain constituents. Information on existing contaminant plumes is limited. However, some of the main constituents of concern in the County include nitrate, Dibromo-Chloropropane (DBCP), Ethylene-Dibromide (EDB), 1,2,3-Trichloropropane (TCP) and petroleum hydrocarbons. Contamination of groundwater can result in poor drinking water quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems. Several federal laws help protect groundwater quality.

In addition, several State of California online databases provide information and data on known groundwater contamination, planned and current corrective actions, investigations into groundwater contamination, and groundwater quality from select water supply and monitoring wells. These databases are discussed below:

California Water Resources Control Board: The State of California Water Resources Control Board (SWRCB) maintains an online database that identifies known contamination cleanup sites, known leaky underground storage tanks, and permitted underground storage tanks. The online database contains records of investigation and actions related to site cleanup activities at:
http://geotracker.waterboards.ca.gov.

The Department of Toxic Substance Control
The State of California Department of Toxic Substances Control (DTSC) provides an online database with access to detailed information on permitted hazardous waste sites, corrective action facilities, as well as existing site cleanup information. Information available through the online database includes investigation, cleanup, permitting, and/or corrective actions that are planned, being conducted, or have been completed under DTSC's oversight. The online database can be accessed at:
http://www.envirostor.dtsc.ca.gov.

Groundwater Ambient Monitoring and Assessment Program
The State Water Resources Control Board GAMA (Groundwater Ambient Monitoring and Assessment) program collects data by testing untreated raw water for naturally occurring and man-made chemicals and compiles all of the data into a publicly accessible online database. The online database can be accessed at:
http://geotracker.waterboards.ca.gov/gama/

Currently, the District is not aware of contaminant plumes in the area. The District will regularly review groundwater quality data from other sources and remain alert to the possibility of contaminated groundwater migration into NSWD.

2.4.4 Well Abandonment/Well Destruction Program

Well abandonment generally includes properly capping and locking a well that has not been used in over a year. Well destruction includes completely filling in or removing portions of a well in accordance with standard procedures. Proper well destruction and abandonment are necessary to protect groundwater resources and public safety. Improperly abandoned or destroyed wells can provide a conduit for surface or near surface contaminants to reach the groundwater. In addition, undesired mixing of water with different chemical qualities from different strata can occur in improperly destroyed wells.

The administration of a well construction, abandonment, and destruction program has been delegated to the Counties by the State legislature. Madera County requires that wells be abandoned according to State standards documented in DWR Bulletins 74-81 and 74-90. Due to staff and funding limitations, enforcement of the well abandonment policies is limited.

2.4.5 Replenishment of Groundwater Extractions

Replenishment of groundwater is an important technique in management of a groundwater supply to mitigate groundwater overdraft. Groundwater replenishment occurs naturally through rainfall and stream/river seepage and intentionally through means including deep percolation of crop and landscape irrigation, wastewater effluent percolation, and intentional recharge. The primary local water sources for groundwater replenishment include precipitation, San Joaquin River, and the Eastside Bypass.

Currently, there is no dedicated groundwater recharge activity within the GSA. For more information, refer to Section 2.2.3 - Conjunctive Use Programs or refer to Section 3.3 – Water Budget.

2.4.6 Well Construction Policies

Madera County has enacted and is responsible for enforcing a County Well Ordinance that regulates well construction. The California DWR also has well construction standards documented in DWR Bulletins 74-81 and 74-90. NSWD does not have its own well construction policies, but rather follows State and County standards.

2.4.7 Groundwater Projects

The NSWD is responsible for development and operation of recharge, storage, conservation, water recycling, and extraction projects. The GSA develops projects to help meet their water demands and will develop additional future projects to meet sustainability goals. Developing more groundwater recharge and banking projects is considered key to stabilizing groundwater levels. Chapter 6 – Project and Management Actions provides descriptions, estimated cost, and estimated yield for the main project focus. The role of the NSWDGSA is to promote cooperation and sharing of information and ideas between interested parties as well as implementing projects to assure sustainability.

The GSA will also support measures to identify funding and implement regional projects that help the region achieve groundwater sustainability. This can include recharge projects that take advantage of local areas conducive to recharge and areas where recharge provides the most benefits to the GSA.

2.4.8 Efficient Water Management Practices

Water conservation has been and will continue to be an important tool in water management, as well as a key strategy in achieving sustainable groundwater management. The NSWD practices water conservation by using drip irrigation for the majority of their crops.

Details of water conservation programs can be found in various documents including Urban Water Management Plans and USBR Water Management Plans. Efficient water management practices will include maximizing the beneficial uses of water along with recycled water use as it can replace potable water use in some instances. Future efforts will include an increased focus on elevating awareness on groundwater overdraft, land subsidence, and explaining the requirements of SGMA. Some or all these conservation efforts will be necessary to achieve groundwater sustainability.

2.4.9 Relationships with State and Federal Agencies

Several member agencies receive San Joaquin River water from the Friant Division of the Central Valley Project. The Friant Dam is owned and operated by the USBR. The USBR is also the lead agency for the San Joaquin River Restoration, which has resulted in significant delivery curtailments to Friant contractors. The member agencies communicate often with USBR staff on water deliveries, water allocations, progress on the SJRRP, and the Water Management Program for the SJRRP that is intended to help mitigate water losses to Friant contractors.

Many of the member agencies receive grants from various agencies for water related projects. Grants are obtained from the California DWR, SWRCB, USBR, and others. The member agencies work closely with these State and Federal agencies to track grant programs and administer and implement grant contracts.

2.4.10 Land Use Planning

Land use policies are documented in various reports, such as General Plans, Specific Plans, and plans for proposed developments. Updating some of these plans is a multi-year process, and not all could be fully updated concurrently with the GSP development. These plans are expected to be modified gradually over time to be consistent with the goals and objectives of this GSP. Some smaller communities have no formal land use policies or rely on County policies. These smaller communities will need to develop new policies and long-term plans as part of the SGMA process.

2.4.11 Impacts on Groundwater Dependent Ecosystems

There not any groundwater dependent ecosystems within the district. The depth of groundwater ranges from 50 to 110 feet below ground surface and there are not any interconnected surface water systems throughout NSWD.

2.5 Notice and Communication

2.5.1 Description of Beneficial Uses and Users

Regulation Requirement:

§354.10 Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:

(a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.
(b) A list of public meetings at which the Plan was discussed or considered by the Agency.
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.

Pursuant to California Water Code Section 10723.2, the NSWDGSA shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing a GSP. Engagement with groundwater users occurs in the following phases of the development and implementation of the GSP:

1. Formation of the GSA
2. Development of the Draft GSP
3. Finalization of the GSP
4. Implementation of the GSP

<u>Formation of the GSA:</u>
To form the NSWD GSA, stakeholders gathered over several months and subsequently prepared their Notification of Intent to become a GSA, dated December 13, 2016. The NSWDGSA continues to work in concert with the six GSAs in the subbasin and enter into a coordination agreement. NSWD has formed a technical advisory ad-hoc committee to develop and implement the GSP. Public workshops will be conducted to obtain input to finalize the GSP.

<u>Development of the Draft GSP:</u>
Pursuant to California Water Code Section 1073.2, the NSWDGSA shall consider the interests of the beneficial uses and users of groundwater, as well as those responsible for implementing a GSP. To this end the NSWDGSA has held public workshops and participated in workshops sponsored by the other agencies within the Subbasin that are preparing a joint GSP. The NSWD GSA is composed 100 % of agricultural users.

Once the administrative draft is of sufficient form to provide information on both the historic and future plans of the GSA, then it will be shared for review and dialogue with these various beneficiaries as well as the GSA's within the Subbasin.

Finalization of the GSP
Upon receipt of public comments by individuals and other agencies, the GSA will respond and make revisions to the draft GSP. The draft GSP was presented to the GSA on September 11, 2019 and then made available immediately thereafter.

2.5.2 Decision-Making Process

Regulation Requirement:

§354.10 (d) A communication section of the Plan that includes the following:
1) An explanation of the Agency's decision-making process.

The NSWD filed to become a GSA on December 13, 2016. They are currently working independent of other GSAs in the Madera Subbasin to develop and implement a GSP in order to comply with SGMA requirements. The DWR was notified that NSWDGSA intended to develop a GSP in a letter filed with the DWR on December 12, 2018.

The NSWDGSA continues to work in concert with the six GSAs in the basin on developing a GSP while still allowing for the development of its own GSP and entering into a coordination agreement with the other GSAs in the basin. NSWDGSA has formed a technical advisory ad-hoc committee to develop and implement the GSP. The committee will report any activity to the Board of Directors when public comments are made. Public workshops will be conducted to obtain input to finalize the GSP.

2.5.3 Public Engagement / Public Outreach Plan

Regulation Requirement:

§354.10 (d)(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.

The development of the NSWDGSP has consisted of involvement with the Madera County GSA's to be an inclusive, transparent effort requiring ongoing engagement with a variety of stakeholders to allow public input and response during various stages of development. It should be recognized that this GSA has 2 landowners. A list of public meetings can be found in **Appendix 2-C**.

The overarching goal is to inform, engage, and build stakeholder support for NSCDGSA GSP metrics and thresholds. Progress on implementation of this GSP will be presented at public meetings and through the NSWDGSA website.

2.5.4 Encouraging Active Involvement

Regulation Requirement:

§354.10 (d)

3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of population within the basin.
4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

NSWDGSA has and will continue to initiate outreach activities and produce outreach materials to encourage active engagement by all stakeholders in GSP development. This Plan will guide the Board to implement consistent and coordinated public involvement and outreach. NSWDGSA seeks to actively solicit information, feedback, and opinions from stakeholders and beneficial users to inform program implementation decisions. To meet this objective, NSWDGSA will engage with stakeholders in new and existing venues

2.6 References

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3 Basin Setting

3.1 Hydrogeologic Conceptual Model

3.1.1 Introduction

Regulation Requirement:

§354.14(a) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.

The purpose of a Hydrogeologic Conceptual Model (HCM) is to provide an easy to understand description of the general physical characteristics of the regional hydrology, land use, geology, geologic structure, water quality, principal aquifers, and principle aquitards in the basin setting. Once developed, an HCM is useful in providing the context to develop water budgets, monitoring networks, and identification of data gaps.

An HCM is not a numerical groundwater model or a water budget model. An HCM is rather a written and graphical description of the hydrologic and hydrogeologic conditions that lay the foundation for future water budget models. Refer to Section 3.3 for information on the GSA's water budget.

This HCM has been written by adhering to the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 2 (§354.14). Several topics are touched on in the HCM, including groundwater quality, groundwater flow, and groundwater budget which are discussed in greater detail in Groundwater Conditions (Section 3.2) and Water Budget (Section 3.3).

The narrative HCM description provided in this chapter is accompanied by graphical representations of the New Stone Water District Groundwater Sustainability Agency's (NSWDGSA or District) portion of the Madera Subbasin that have attempted to clearly portray the geographic setting, regional geology, basin geometry, and general water quality. This HCM has been prepared utilizing published studies and resources and will be periodically updated as data gaps are addressed, and new information becomes available.

3.1.2 Lateral Basin Boundaries

Regulation Requirement:

§354.14(b)(2) The hydrogeologic conceptual model shall be summarized in a written description that includes lateral basin boundaries, including major geologic features that significantly affect groundwater flow.

As shown in **Figure 3-1** and **Figure 3-2** , NSWDGSA is in the western portion of the Madera Groundwater Subbasin and is bounded to the north by Avenue 14 and to the west by Road 9, coincident with the southern boundary of the Chowchilla Groundwater Subbasin. To the east, the NSWDGSA is bounded by the Chowchilla Bypass. The County of Madera GSA borders NSWDGSA around the southern portion.

The Madera Groundwater Subbasin is bordered by the Kings Groundwater Subbasin to the south and southeast, with the San Joaquin River serving as the boundary between the two. The Delta-Mendota

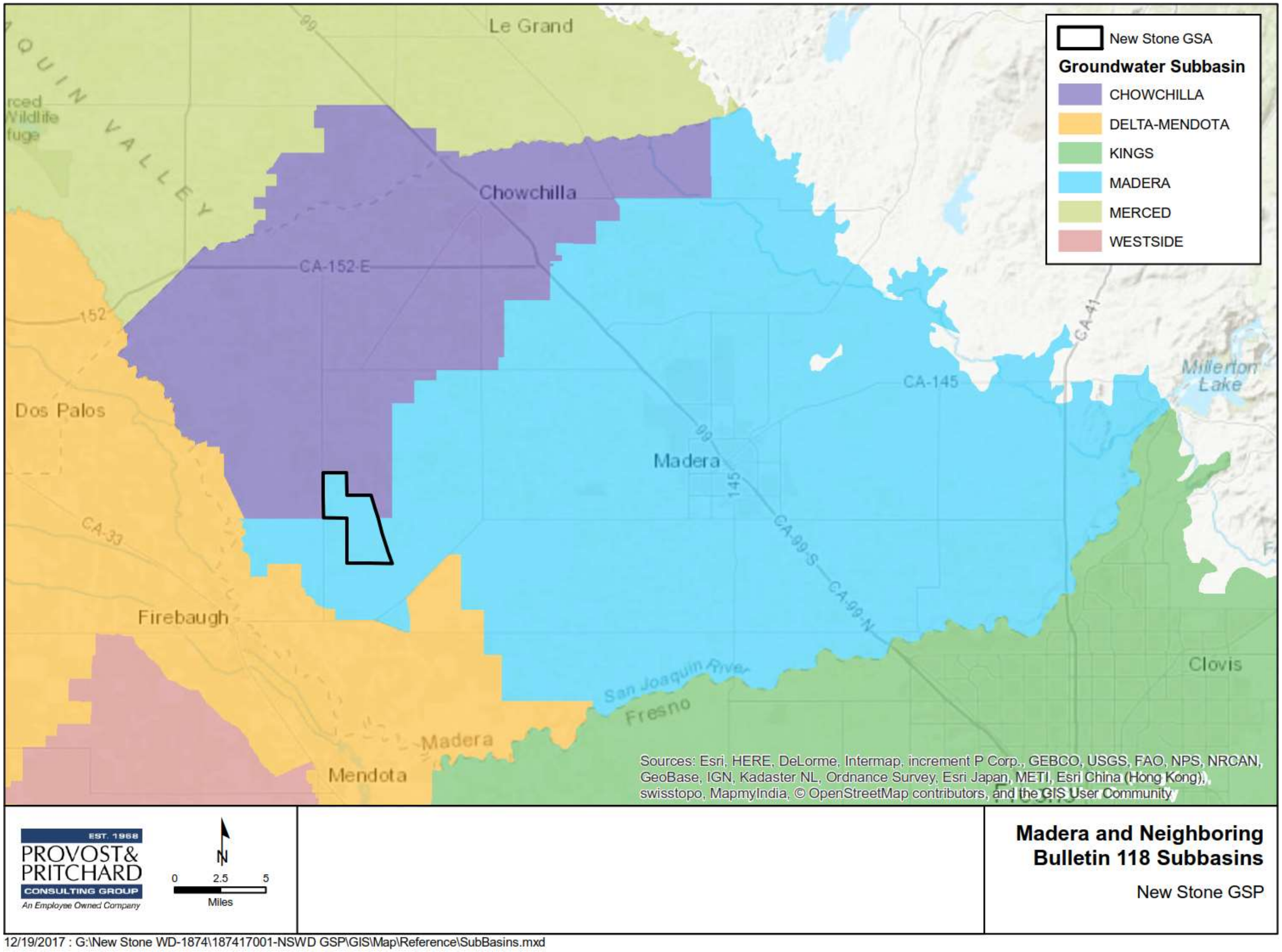

Figure 3-1 Madera and Neighboring Bulletin 118 Subbasins

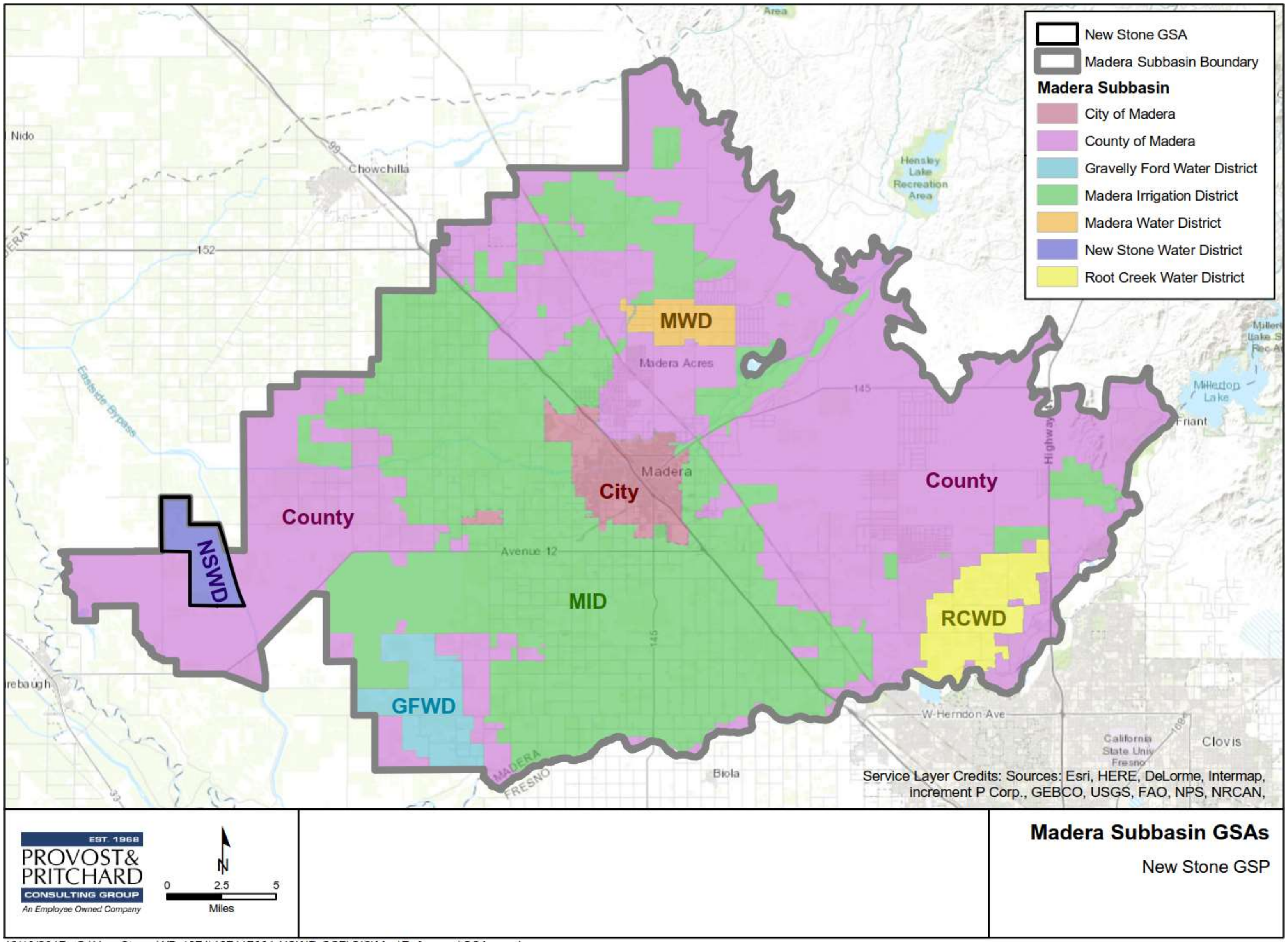

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Figure 3-2 Madera Subbasin Groundwater Sustainability Agencies

Groundwater Subbasin is located to the southwest, and the Chowchilla Groundwater Subbasin is to the northwest. The boundaries between Madera Subbasin and the adjacent subbasins primarily coincide with water agency boundaries. The foothills of the Sierra Nevada form the Madera subbasins eastern boundary (**Figure 3-1**).

The major features that affect groundwater flow in the Madera Subbasin are the San Joaquin River and the basement complex of the Sierra Nevada Mountains (i.e., bedrock). Significant amounts of seepage, termed stream depletion, occur along the San Joaquin River and cause groundwater to flow away from the recharge of the River (DWR, 2006). These river losses are gains to the area's groundwater aquifers. According to DWR (2006), groundwater flow in the Madera Subbasin is generally southwestward in the eastern portion and northwestward in the southern portion and there do not appear to be horizontal barriers to groundwater flow within the subbasin. However, the A- and E-clays are barriers to vertical flow where present.

3.1.3 Regional Geologic and Structural Setting

Regulation Requirement:

§354.14(b)(1) The hydrogeologic conceptual model shall be summarized in a written description that includes the regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.

The Madera Groundwater Subbasin lies within the San Joaquin Valley which comprises the southern portion of the Great Central Valley of California. The San Joaquin Valley is a structural trough up to 200 miles long and 70 miles wide. It is filled with up to 32,000 feet of marine and continental sediments deposited during periodic inundation by the Pacific Ocean and by erosion of the surrounding mountains, respectively. Continental deposits shed from the surrounding mountains form an alluvial wedge that thickens from the valley edges toward the axis of the structural trough. This depositional axis is slightly west of the series of rivers, lakes, sloughs, and marshes, which mark the current and historic axis of surface drainage in the San Joaquin Valley (DWR, 2006). **Figure 3-3** is a regional cross-section schematic across the San Joaquin Valley perpendicular to the trough illustrating topography and subsurface features (from Faunt, 2009).

Geologic units in the region consist of consolidated rocks and unconsolidated deposits. The consolidated rocks are comprised of a pre-Tertiary age basement complex, and marine and continental sedimentary rocks of Cretaceous (145 to 66 million years ago) and Tertiary (66 to 2.6 million years ago) age. The unconsolidated deposits are of both Tertiary and Quaternary age (2.6 million years ago to the present).

The Madera Groundwater Subbasin has been extensively studied by Mitten, LeBlanc, and Bertoldi (Mitten et al., 1970) as part of a larger study area. As shown on **Figure 3-4** the basement complex in Madera County (pTb) crops out along the eastern boundary of the 1970 Mitten study. The current basin boundary along the foothills has a long strip of basement complex mapped within the basin. The basement complex comprises a large portion of the Sierra Nevada and other regional mountain ranges that is composed of a mass of plutonic and metamorphic rocks commonly referred to as the Sierra Nevada batholith. The basement complex surface slopes gently to the southwest from the foothills to beneath the valley floor.

The U.S. Geological Survey (Mitten et al., 1970) identified the consolidated basement rock materials beneath NSWDGSA as metamorphic (schistose) and igneous (granitic) rocks that can be observed in outcrop in the foothills of the Sierra Nevada near the eastern boundary of the Madera Subbasin. Depth to basement rock in the western boundary of the Madera Subbasin, near NSWDGSA, occurs at a depth in excess of 10,000 feet (Mitten et al., 1970). Contact between the basement rocks and the overlying sediments slope steeply

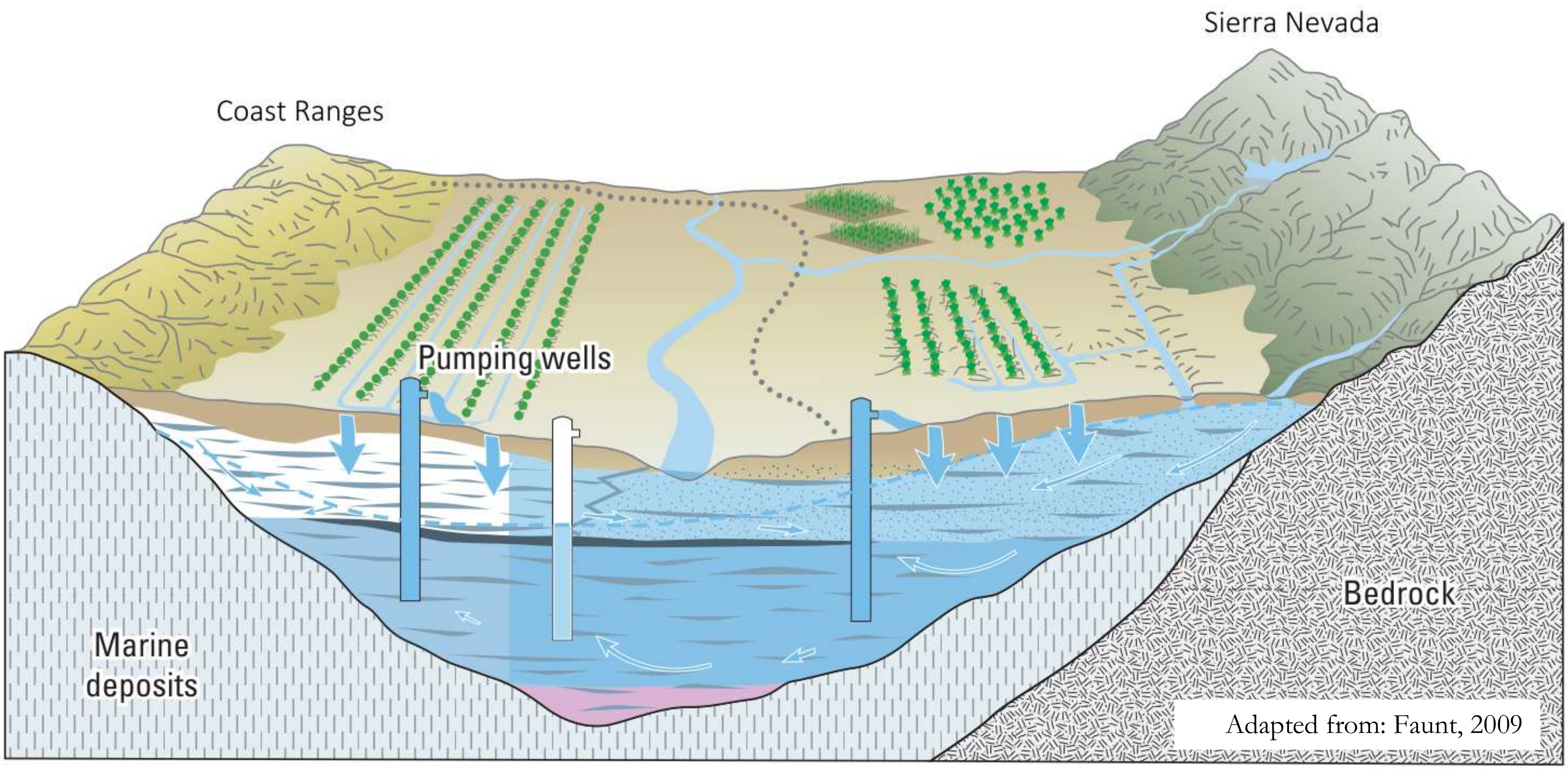

Figure 3-3 Generalized Cross-section of the San Joaquin Valley

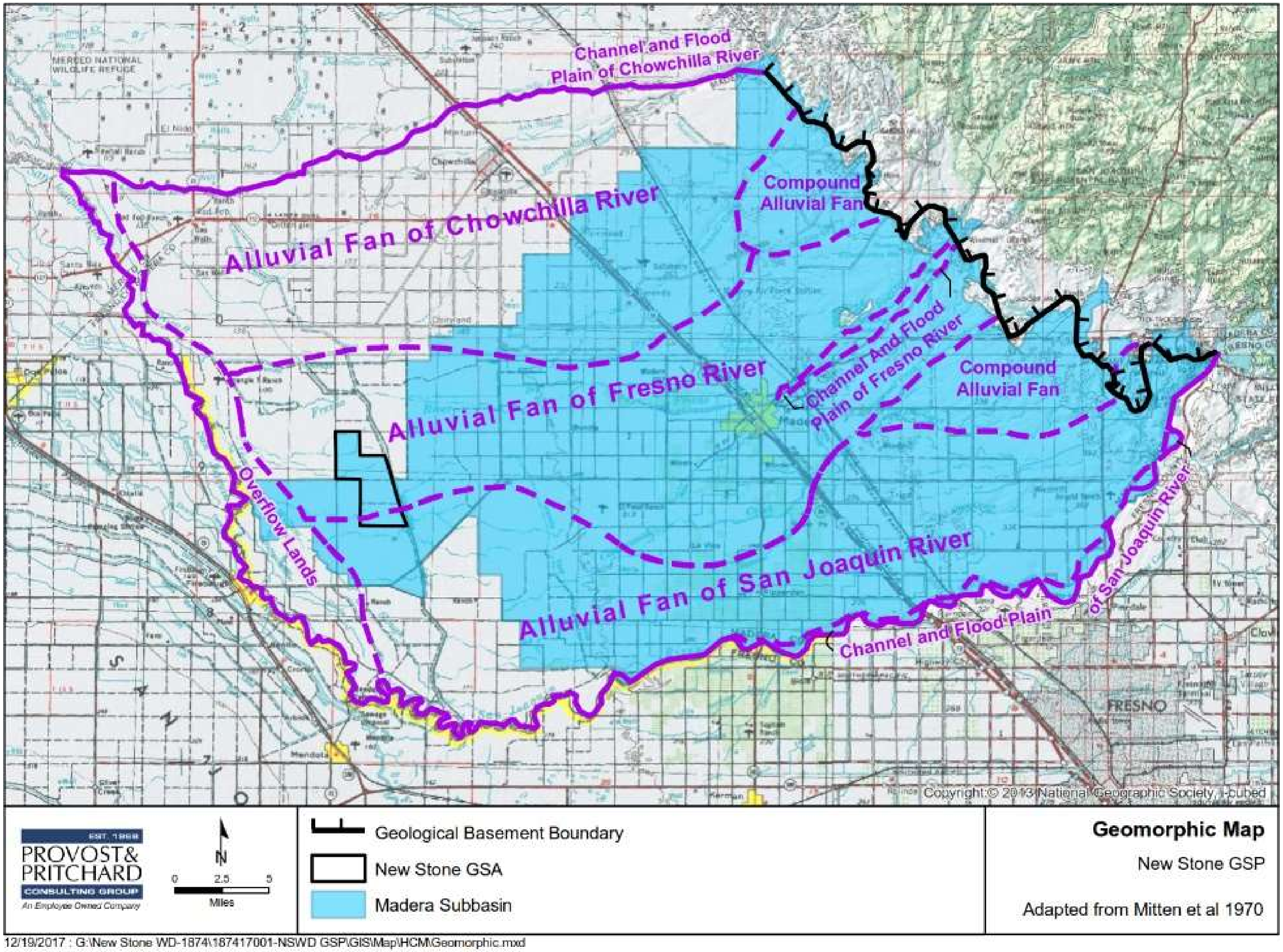

Figure 3-4 Geomorphic Features Map

southwestward from the Sierra Nevada beneath the marine rocks. Because they are largely impermeable, the rocks of the basement complex are of little importance as a source of water supply (Davis et al., 1959).

Marine sedimentary rocks, where present, overlie the crystalline basement complex. The marine rocks do not crop out in the Madera Subbasin and wedge out in the subsurface to the east where unconsolidated sediments lie directly upon the basement rocks (Mitten et al., 1970). The marine rocks generally have low yields of saline connate water which is unsuitable for most uses (Page, 1986). The base of the aquifer in the NSWDGSA area is the top of the marine rocks. The marine rocks occur at a depth of about 2,500 feet beneath NSWDGSA (as interpolated from Plate 3 of Page, 1986).

Two kinds of sedimentary deposits are present in the region of the NSWDGSA area overlying the basement complex rocks. The first is deep, marine sediments deposited on the basement described above. The second consists of continental deposits primarily formed by very large alluvial fans bordering both sides of the valley and flood basin deposits formed primarily along the axis of the valley. The fans are coalescing with distinctive deposits in the fan and interfan areas. The fans are characterized by a mass of generally coarse, permeable deposits in the upper portions of the fan, and consist largely of tongues and lenses of sand and gravel that extend to near the topographic trough of the valley. Near the trough of the valley, the fan sediments are finer grained with fewer thick and extensive permeable riverbed sands present.

The alluvial sediments are typically silty sands with a moderate permeability. The soils formed in the axis of the valley near the toe of the interfan area were formed by the Fresno River and the San Joaquin River. A few miles west of NSWDGSA are flood basin deposits (Overflow Lands described by Mitten et al., 1970). These formed fine-grained deposits and overflow lands, resulting in somewhat different soil characteristics.

Lake and marsh deposits formed in low areas that are isolated and discontinuous areas within the fan and are identified as clayey and silty sediments on driller's logs. The geologic environment in which these sediments formed is one of interfingering layers of silty sands, sands, and clays/silts. Such an environment is not conducive to the development of aerially extensive aquifers or aquicludes/aquitards. This is demonstrated by a review of the available well logs for the area. Although successions of silt, sand, clay, and gravel are noted on the logs, they do not correlate well between logs, and construction of cross-sections displaying continuous sedimentary units with laterally continuous characteristics is difficult.

A sedimentary layer of both regional and local importance is the Corcoran Clay. The lake in which the clays formed was known as Lake Corcoran or Lake Clyde. It was widely extensive, ranging from 10 to 40 miles wide and more than 200 miles long, covering much of the valley floor. The Corcoran Clay is essentially an impermeable barrier and creates a confined aquifer where it is present and has created one of the primary sources of water in the area. Groundwater flow beneath the Corcoran Clay is both from the west towards the axis of the valley and from the east also towards the axis of the valley. Regionally, groundwater flow beneath the Corcoran Clay is both from the west and east towards the axis of the valley. The Coast Range groundwater passes through sediments derived from marine source rocks and contains a higher quantity of salts and other mineral matter sometimes deleterious to crop growth. Wells drilled beneath the Corcoran Clay located in areas closer to the axis of the valley show a stronger influence from the Coast Ranges, with the water being of much lower quality. Eight wells within NSWDGSA have been completed to depths below 350 feet below ground surface (bgs) and may encounter sub-Corcoran water.

3.1.4 Topographic Information

Regulation Requirement:

§354.14(d)(1) Physical characteristics of the basin shall be represented on one or more maps that depict topographic information derived from the U.S. Geological Survey or another reliable source.

Geomorphic features of the NSWD area and surrounding areas in the Madera Groundwater Subbasin were mapped by Mitton et al. (Plate 1, 1970). As shown in **Figure 3-4**, the landscape of this area is dominated by overlapping alluvial fans of the Chowchilla, Fresno, and San Joaquin Rivers and the compound alluvial fans of the intermittent streams between the major rivers. In general terms, alluvial fans are fan or cone-shaped deposits of sediment deposited by streams. Alluvial fans are narrower at the head than at the toe, and slope with decreasing gradient from head to toe. The area east of the NSWD consists of foothills and mountains of the Sierra Nevada, which provide the source of the sediment for the alluvial fan deposits.

A topographic map of the Madera Subbasin area is presented as **Figure 3-5**. The highest points in the basin are in the east along the boundary of the of the Sierra Nevada foothills where elevations are as high as 790 feet above mean sea level (msl). The lowest elevations (approximately 140 feet above msl) are found in the western portion of the basin. Relatively steep slopes exist in the subbasin adjacent to the eastern boundary; however, the overall topography of the greater subbasin slopes gently to the southwest.

NSWDGSA lies within the Poso Farm and Firebaugh NE quadrangles, shown in **Figure 3-6**. The topography of the NSWDGSA is relatively flat and ranges between approximately 150 to 160 feet above msl.

3.1.5 Surficial Geology

Regulation Requirement:

§354.14(d)(2) Physical characteristics of the basin shall be represented on one or more maps that depict surficial geology derived from a qualified map including the locations of cross-sections required by this Section.

Within the NSWDGSA area, surface materials are comprised solely of Quaternary age deposits which have been categorized by Mitten et al. (1970) as Quaternary Older Alluvium (Qoa). The subbasin consists mostly of Quaternary Older Alluvium, Quaternary Younger Alluvium (Qya), and Flood Basin Deposits (Qb). Quaternary alluvium within the subbasin is a result of erosion of the Sierra Nevada range to the east and subsequent deposition on the valley floor. Qoa covers the largest area within the subbasin. Thin bands of Qya are located adjacent to modern day stream channels and rivers (i.e., San Joaquin River, Fresno River, and Chowchilla River, and the small intermittent creeks that drain the foothills). Large deposits of Qya formed in the southwest paths of the aforementioned rivers. The western boundary of Madera County is composed of flood basin deposits. However, only a minor portion of the Madera Subbasin is located within an area that includes flood basin deposits. Also shown on **Figure 3-7** are several minor subsurface geologic features of significance including Ione Formations (Ti) and Terrace Deposits (Qt)

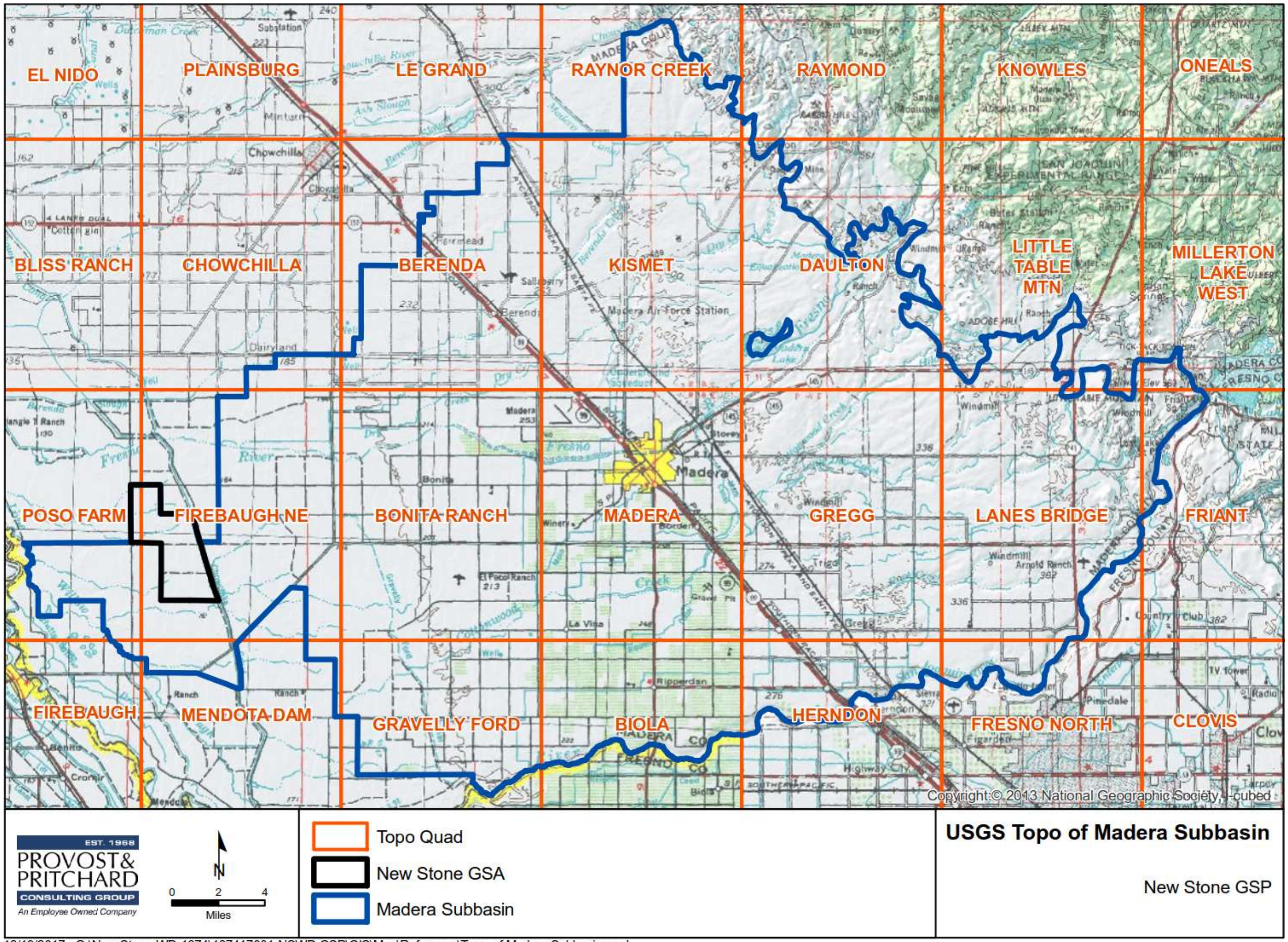

Figure 3-5 Madera Subbasin Topography

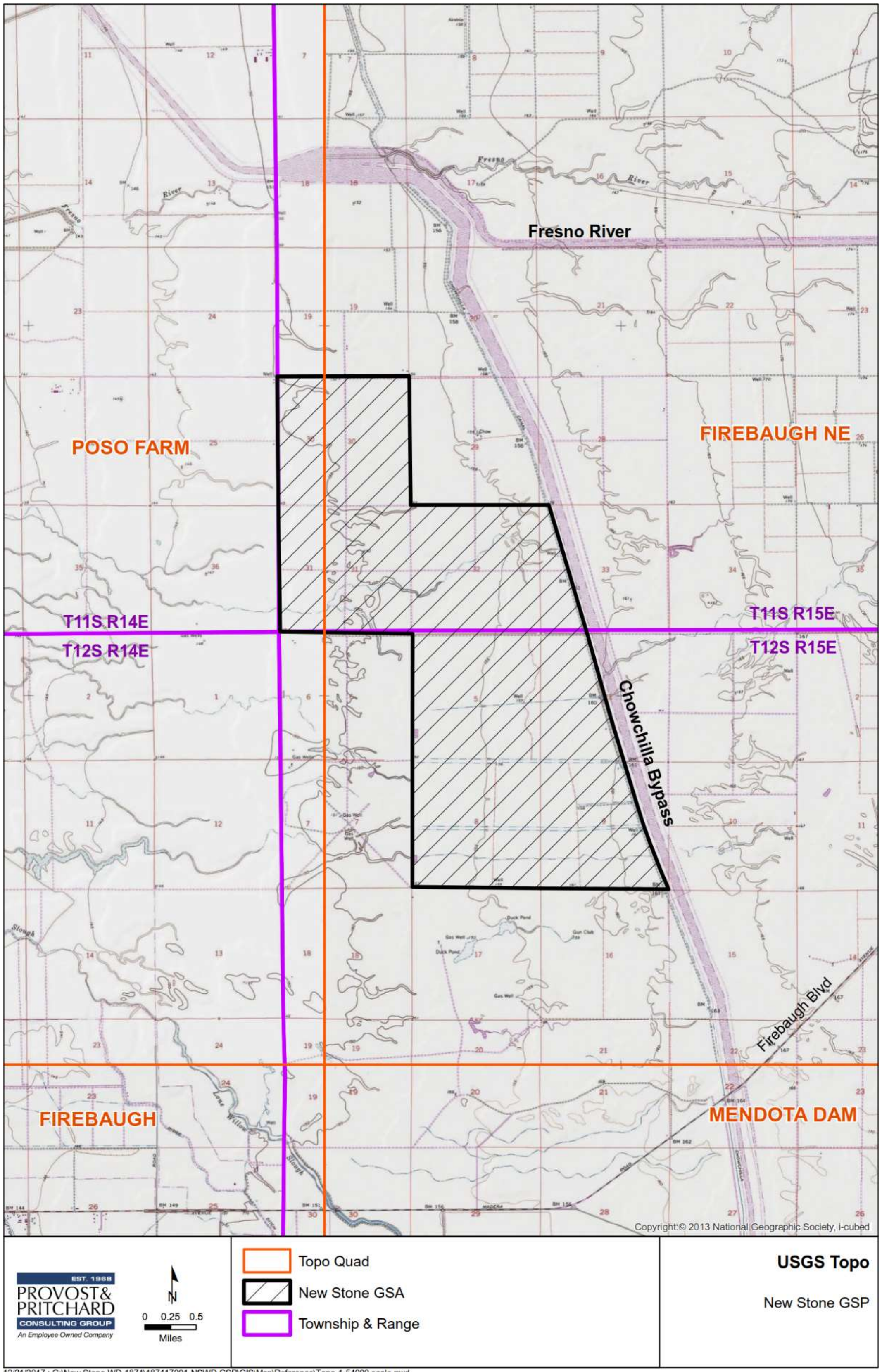

Figure 3-6 NSWDGSA Topography

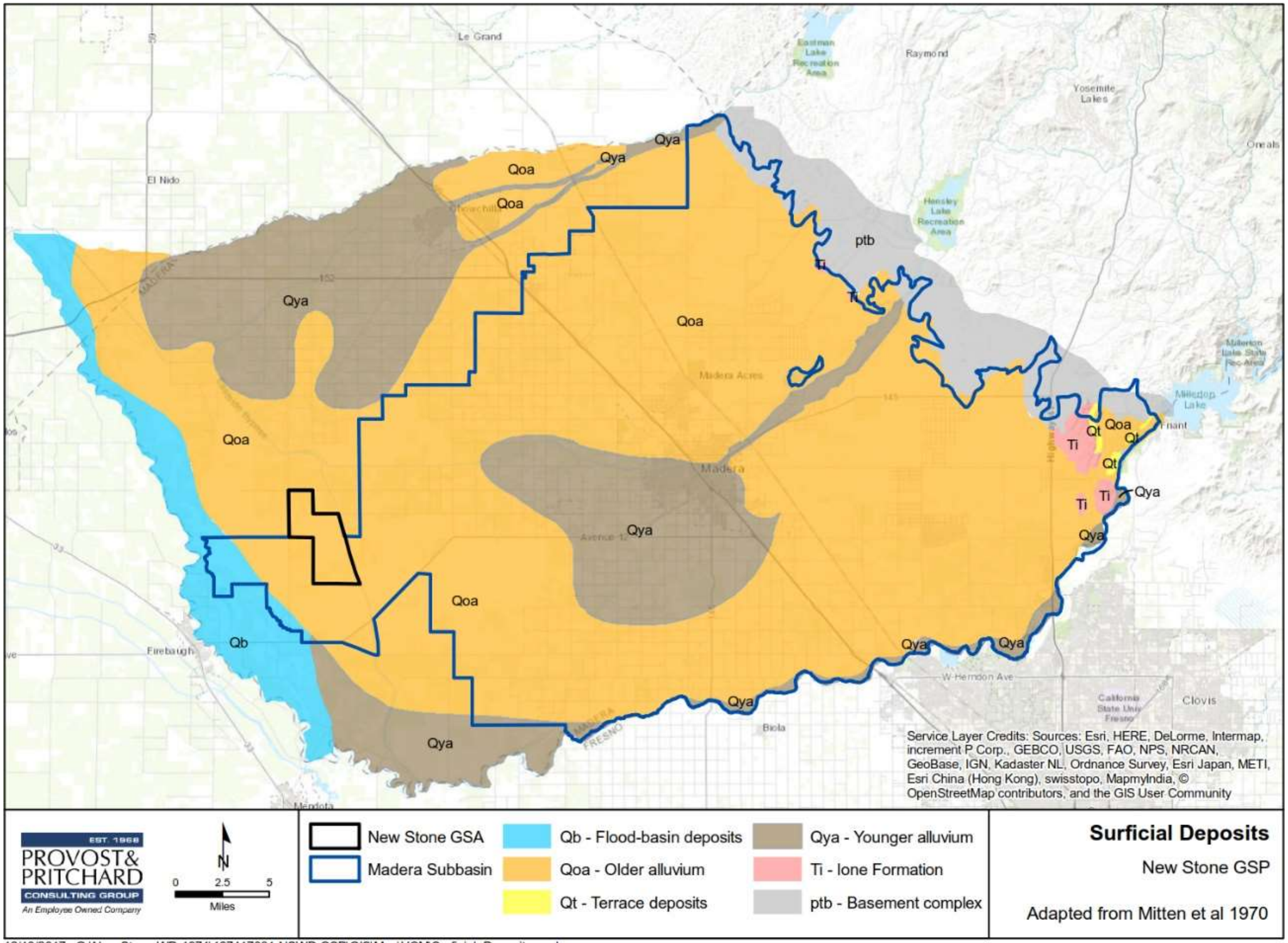

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Figure 3-7 Surficial Deposits

3.1.6 Soil Characteristics

Regulation Requirement:

§354.14(d)(3) Physical characteristics of the basin shall be represented on one or more maps that depict soil characteristics as described by the appropriate Natural Resource Conservation Service soil survey or other applicable studies.

A topsoil map based on Natural Resource Conservation Service (NRCS) soil textural classes is presented as **Figure 3-8**. For the NSWDGSA area, the NRCS has generally described soils to depths of five to seven feet. In general the dominant soil textural class is fine sandy loam. The northern portion of the NSWDGSA, between Avenue 12 and Avenue 14, is mostly composed of fine sandy loam with small bands of clay loam and a small lobe of sandy loam in the northeast corner. South of Avenue 12, soil textures in the NSWDGSA vary more and include large bands of loam and clay loam which extend from east to west. There are also small pockets of loamy sand and sandy loam.

Saturated hydraulic conductivity (Ksat) classes refer to the ease with which pores in a saturated soil transmit water. NRCS categorizes Ksat into six classes from very low in fine grained soils to very high in coarse grained soils. The soil textures mapped in NSWDGSA are rated as moderately high, with the exception of the areas mapped as loamy sand which are rated as high.

Based on NRCS soil descriptions, restrictive layers (i.e., any abrupt structural or textural change) in the soil column less than six feet in depth have also been identified. Approximately 85% of NSWDGSA soils have a restrictive layer less than 1.5 foot deep. Areas shown on **Figure 3-8** as clay loam and a few areas of loam do not have a restrictive layer above six feet. The restrictive layers are chiefly comprised of duripan soil horizons (i.e., hardpan), which for the purposes of this document are assumed to have largely been broken up through deep tillage related to historic agricultural operations throughout the area.

These soil characteristics can be useful for initial screening of potential recharge and groundwater banking sites, but the information should be confirmed with on-site investigations before projects are pursued.

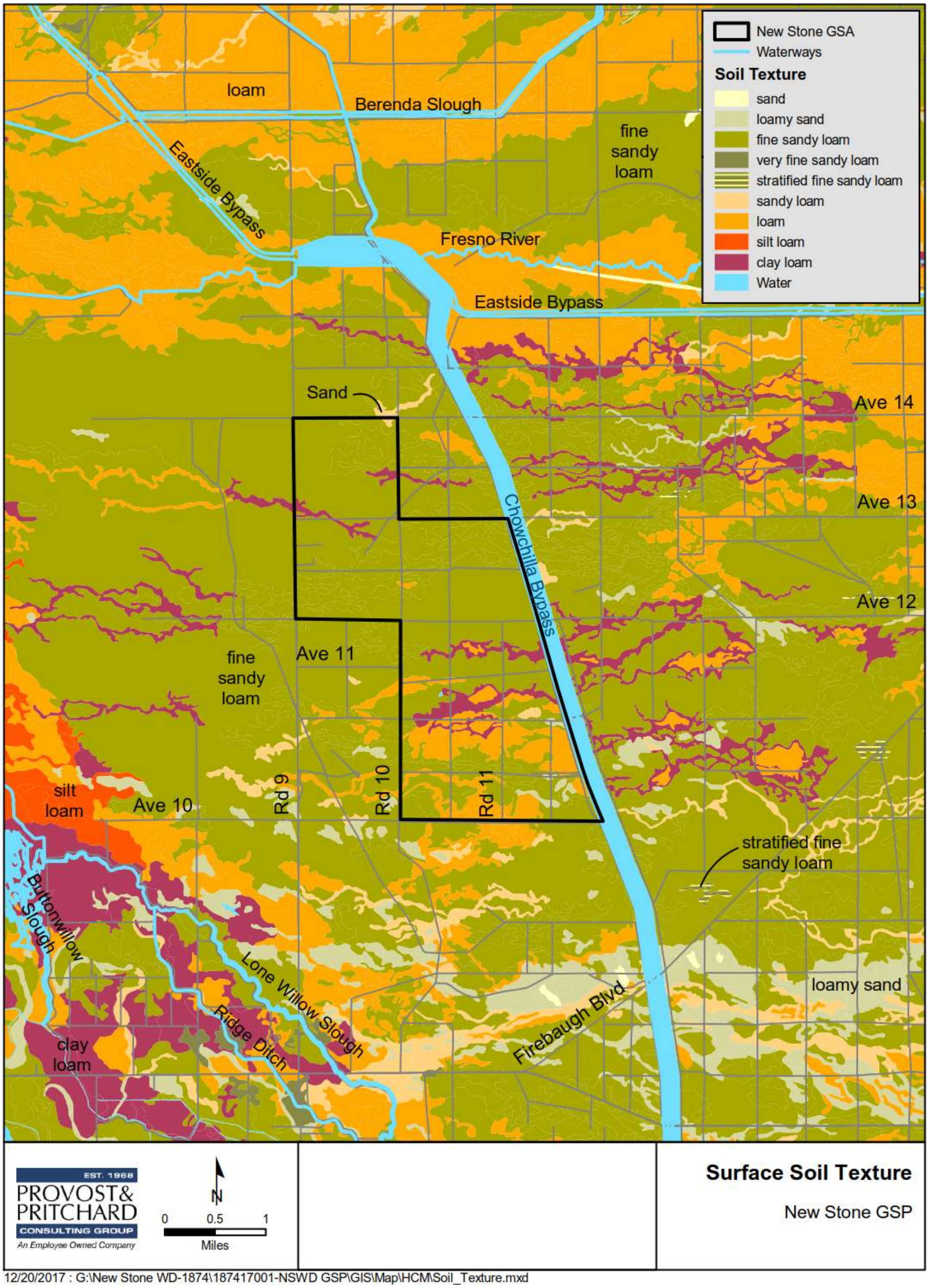


Figure 3-8 Surface Soil Texture

3.1.7 Cross-Sections

Regulation Requirement:

§354.14(c) The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.

Cross sections by Mitten et al. (1970) that transverse the NSWDGSA area are located on **Figure 3-9**. The cross sections are included to provide comparison of depths to the different units and are presented as **Figure 3-10** through **Figure 3-13**.

Regional cross-sections D-D' and E-E' transverse northwest-southeast through Madera County and are shown in **Figure 3-12** and **Figure 3-13** . Cross-section D-D' passes along the southwestern corner of the NSWDGSA. Regional cross-sections A-A', B-B' and C-C' transverse northeast-southwest through Madera County. Cross-section A-A' is not addressed outside the Madera Groundwater Subbasin. Cross-section B-B' bisects the NSWDGSA along the southern section. The regional cross-sections presented herein represent only a portion of the original regional cross sections, to more prominently display the subsurface conditions within Madera County.

As shown on the regional cross section B-B' (**Figure 3-10**), the Quaternary Older Alluvium (Qoa) is inferred from limited data to exist from the surface near Madera Canal in the east to a depth of approximately 500 feet below msl at the Lone Willow Slough, in the midwestern section of the study area. Quaternary Younger Alluvium (Qya) lies along the surface of the cross-section where it crosses the Fresno River and is present approximately three miles to the southwest. The western-most portion of the cross-section shows flood-basin deposits (Qb) beginning near the Lone Willow Slough and terminating approximately five miles to the southwest at the San Joaquin River in the town of Firebaugh. The surficial geology directly beneath the NSWDGSA is shown as Qoa to a depth of approximately 400 feet below msl, with a discontinuous clay iron pan ranging from approximately 200 to 600 feet below msl. The Corcoran Clay confining layer is at a depth of nearly 200 feet below msl.

In cross-section D-D' (**Figure 3-12**) from where it bisects cross-section B-B' to the Chowchilla Bypass, Qoa is shown from the ground surface (approximately 150 feet above msl) to more than 400 feet below msl. The Quaternary and Tertiary age continental deposits (QTc) lie beneath Qoa at depths ranging from 400 to 800 feet and are shown to depths of at least 1,400 feet. The cross-section shows flood basin deposits in the northwestern portion located within the San Joaquin River flood plain. Qya exists at the southernmost location of the D-D' cross-section, where it again intersects the San Joaquin River as the cross-section traverses to the southeast. The D-D' cross-section passes through the southwestern corner of the NSWDGSA showing Qoa at a depth of up to 600 feet below msl and the Corcoran Clay from approximately 150 to 200 feet below msl.

As shown on regional cross-section C-C' **(Figure 3-11**) located at the southern end of the Madera Subbasin outside the boundary of the NSWDGSA, the Qoa extends to a depth of approximately 900 feet in the southwest and gradually thins out to the northeast where basement complex crops out along the eastern boundary. Quaternary and Tertiary age continental deposits (QTc) lie below the Qoa to depths of at least 1,400 feet with basement complex lying 800 feet below the QTc east of Highway 41. The Corcoran Clay lies approximately 200 feet below msl at the west end of C-C' near the San Joaquin River and gradually thins until it terminates near Highway 145, approximately 15 miles from the river.

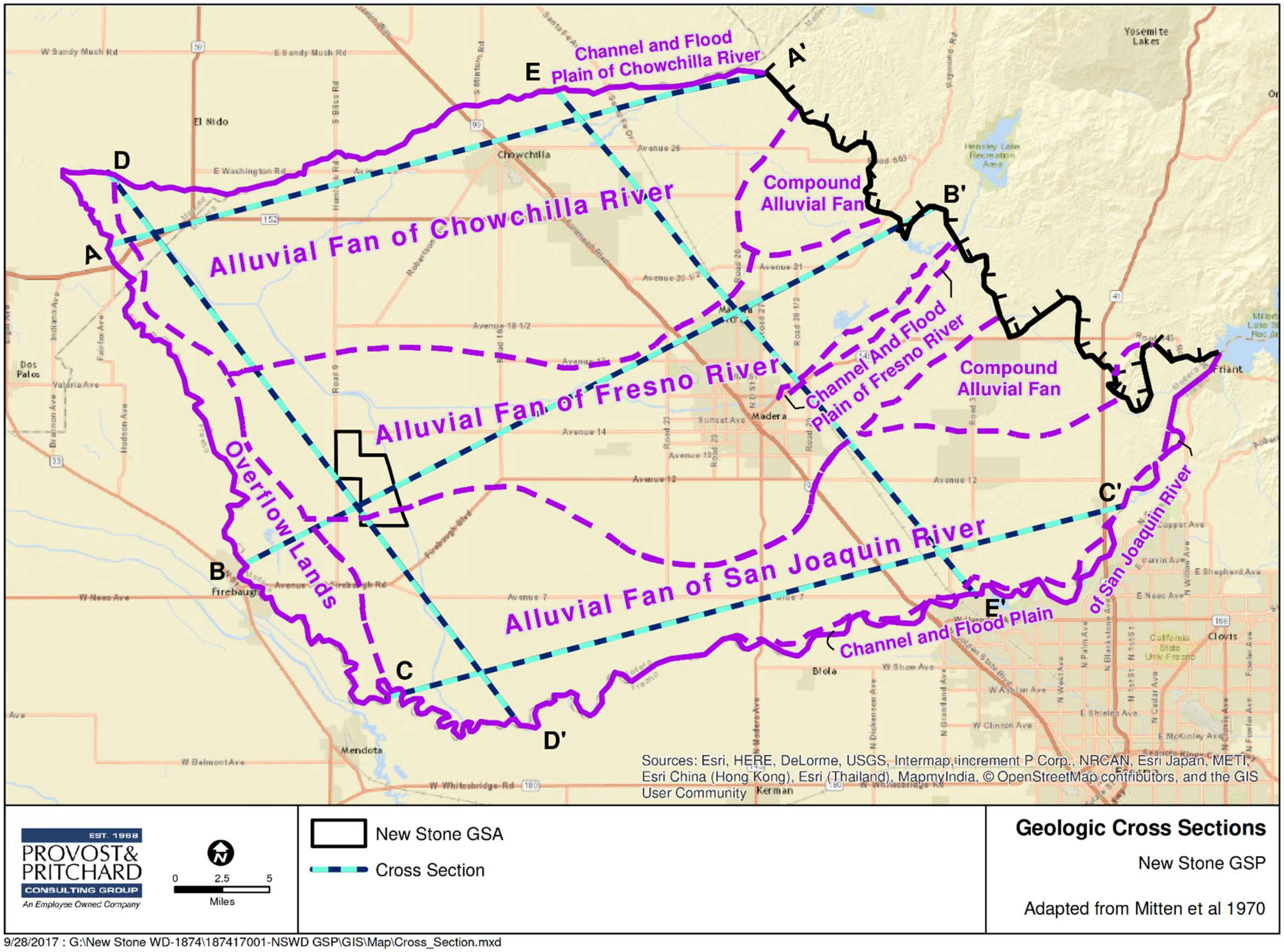


Figure 3-9 Regional Geologic Cross-section Traverses

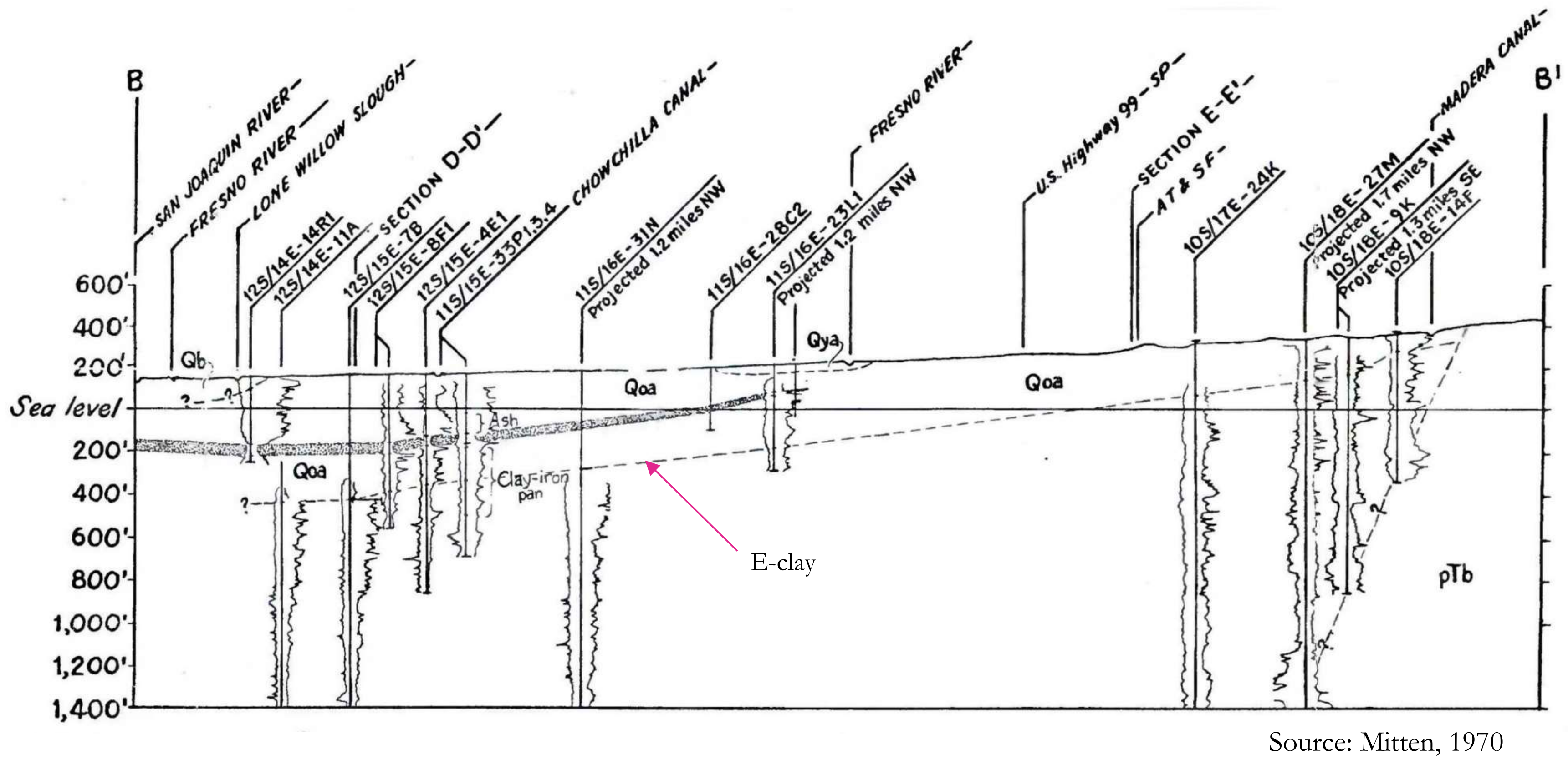


Figure 3-10 Regional Cross-Section B-B'

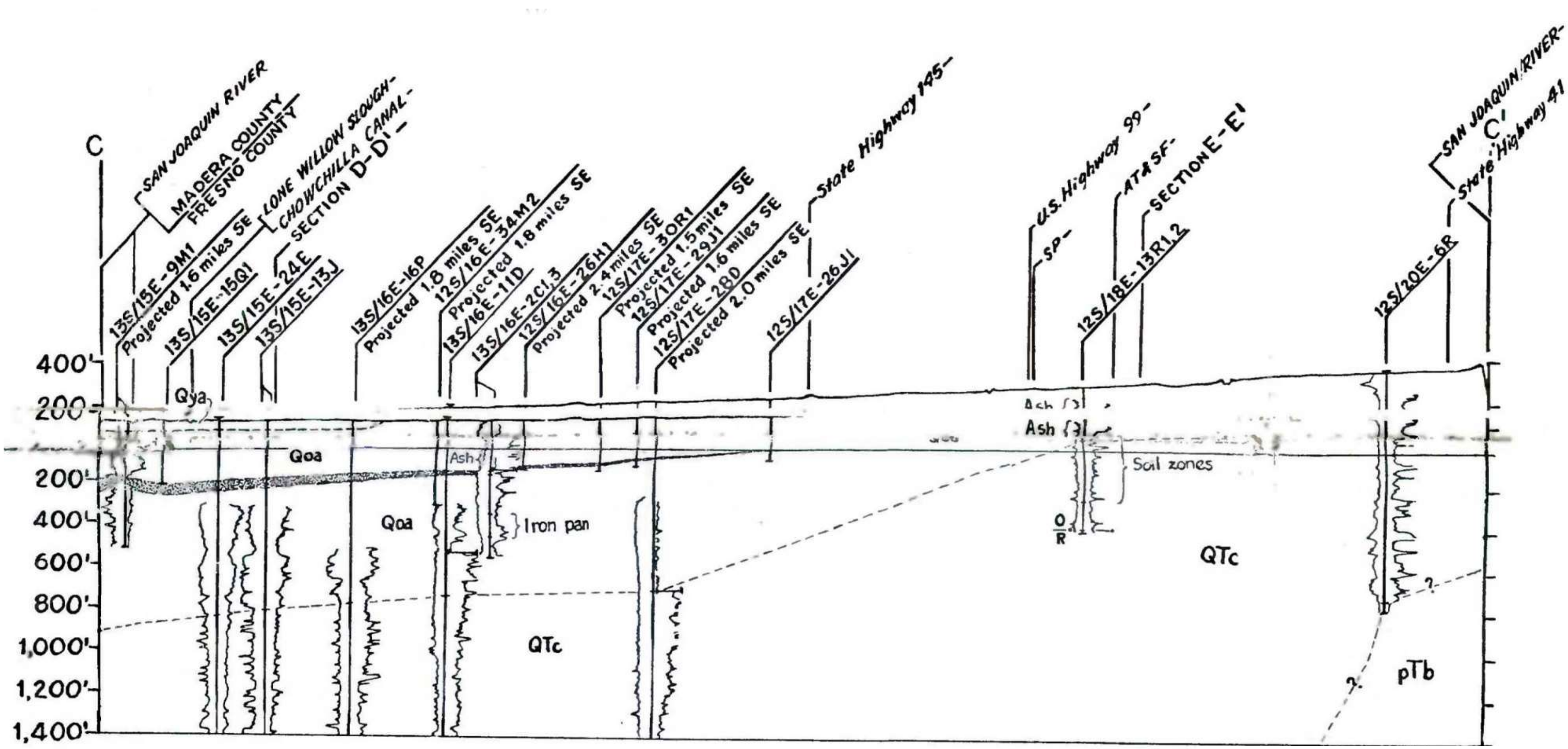


Figure 3-11 Regional Cross-Section C-C'

Source: Mitten, 1970

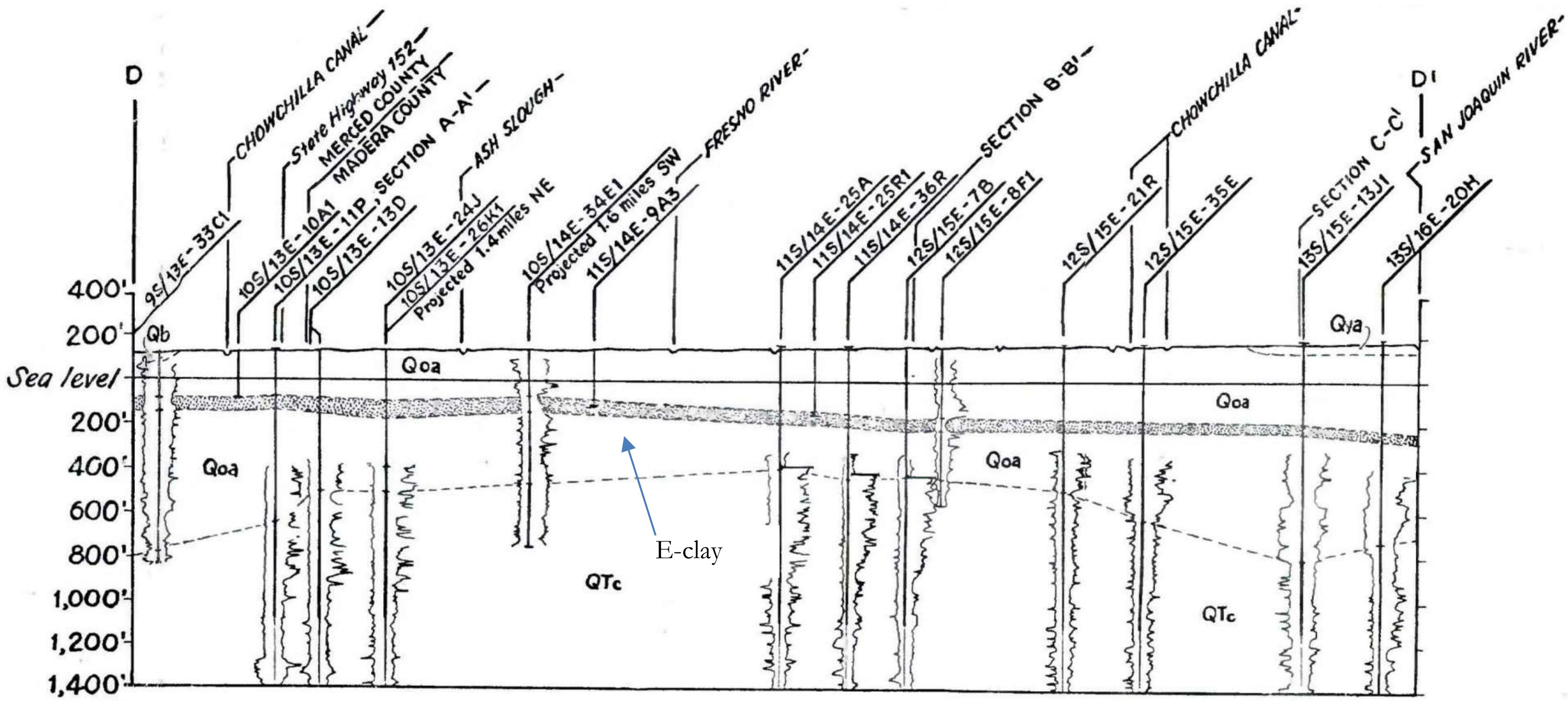
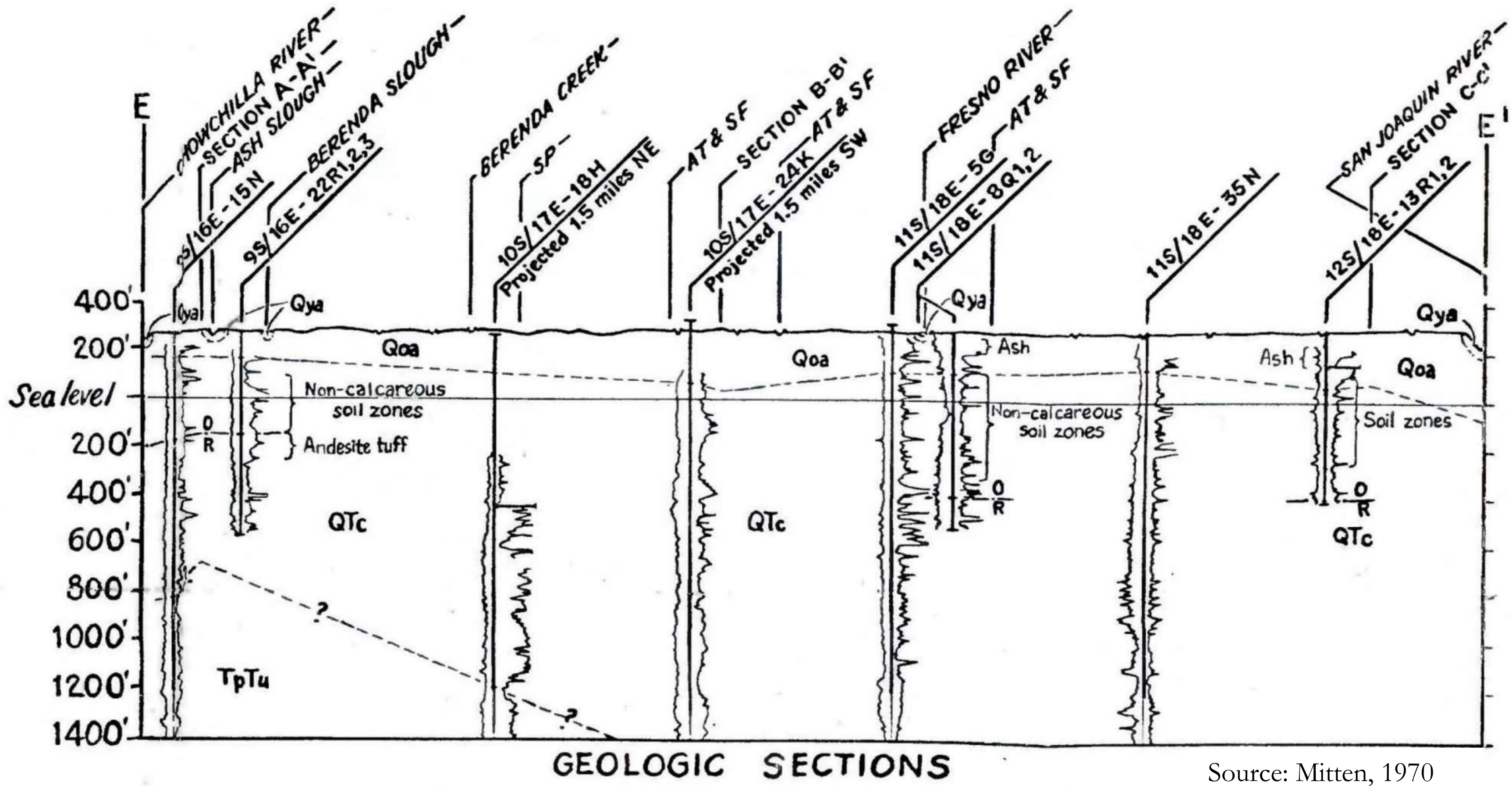


Figure 3-12 Regional Cross-Section D-D'

Source: Mitten, 1970



Source: Mitten, 1970

Figure 3-13 Regional Cross-Section E-E'

Cross-section E-E' is approximately parallel to and east of Highway 99, several miles to the east of the NSWDGSA. It shows shallow bands of Qoa ranging from a depth of approximately 250 feet below msl where it intersects with the San Joaquin River in the south, to approximately 200 feet above ground surface to the north near the Chowchilla River. Small bands of Qya lie along cross-section E-E' where it intersects the Ash Slough, Berenda Slough, Fresno River, and the San Joaquin River. QTc directly underlies Qoa along cross-section E-E' and typically remains above sea level.

3.1.8 Aquifer System

Regulation Requirement:

§354.14(b)(4) The hydrogeologic conceptual model shall be summarized in a written description that includes the principal aquifers and aquitards.

§354.14(b)(4)(c) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.

The NSWDGSA encompasses a small portion of the western-most Madera Groundwater Subbasin. The subbasin aquifer system consists of unconsolidated continental deposits of older series Tertiary (66 to 2.6 million years ago) and Quaternary (2.6 million years ago to the present) age sediments overlain by younger series deposits of Quaternary age. The Quaternary age deposits are divided into older alluvium (Qoa), lacustrine (lake) and marsh deposits, terrace deposits, younger alluvium (Qya), and flood-basin deposits (Mitten et al., 1970). Lacustrine and marsh deposits do not crop out in the Madera Groundwater Subbasin but tend to underlie the western portion of the subbasin (DWR, 2006).

Mitten, et al. (1970) states that subsurface water-bearing characteristics of the Qoa deposits are highly variable due to changes in lithology. These deposits consist mostly of interbedded layers of silts, silty/sandy clays, clay lenses, clayey and silty sands, sands, gravels, and cobbles. It contains much of the water that occurs in the unconfined aquifers in the Madera Subbasin.

A fine-grained lacustrine and marsh deposit, known as the E-clay or Corcoran Clay, acts as a confining layer separating the upper unconfined aquifer from the lower confined aquifer for much of the subbasin. The Corcoran Clay is approximately 100 feet below msl at the northeastern portion of the Madera Groundwater Subbasin and gradually gets deeper as it traverses south-southwest to the San Joaquin River and thicker as it traverses west-southwest. The Corcoran Clay confining layer is shown by cross-section D-D' to exist at a depth of approximately 150 to 200 feet below msl along the western section of the Madera Groundwater Subbasin. Cross-sections B-B' and C-C' show the Corcoran Clay as it crosses the Madera Subbasin from east to west. To the north, cross-section B-B' shows the Corcoran Clay at the San Joaquin River to the west at a depth of approximately 150 feet below msl and 50 feet thick. The Corcoran Clay layer thins to approximately 20 feet and appears to terminate approximately 100 feet above msl (100 feet bgs) to the east, a few miles before the cross-section bisects the Fresno River. Cross-section C-C' lies further south of cross-section B-B' and extends from west to east becoming gradually shallower and thinner as it reaches sea level. The Corcoran Clay from C-C' begins approximately 200 feet below msl and is approximately 50 feet thick. It terminates approximately 25 miles to the east near Highway 145.

The Corcoran Clay is present below the entirety of NSWDGSA. Below the NSWDGSA, the top of the Corcoran Clay lies between 200 to 350 feet bgs as shown in **Figure 3-14**. The Corcoran Clay under NSWDGSA is between 40 and 60 feet thick (Plate 5 of Page, 1986). See **Figure 3-15** for thickness of Corcoran Clay layer.

Where present, the Corcoran Clay is known to have confined groundwater conditions beneath it. It should be noted that newer supply wells are often sealed off from the quaternary alluvium and tap into confined

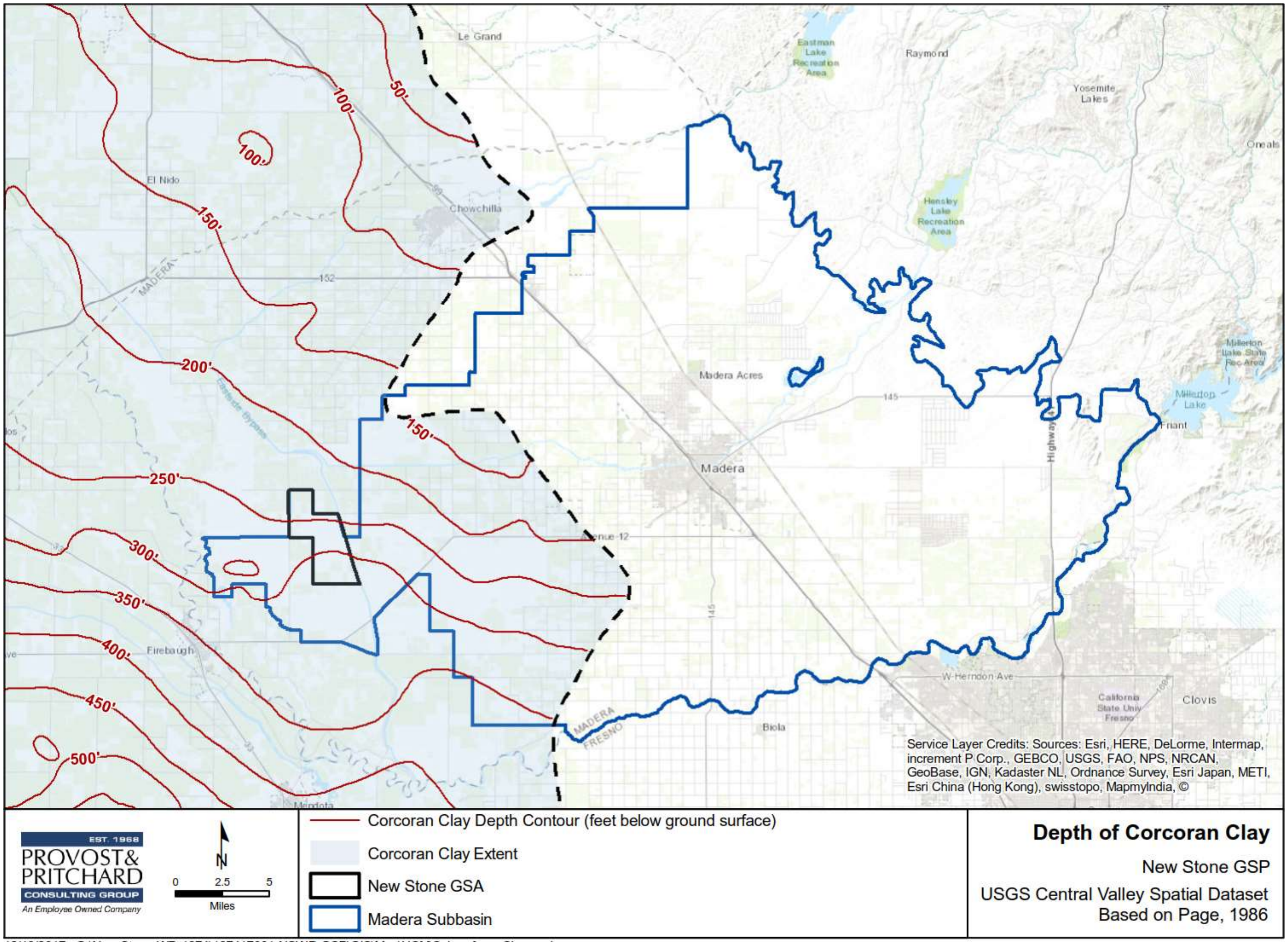


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Figure 3-14 Depth of Corcoran Clay

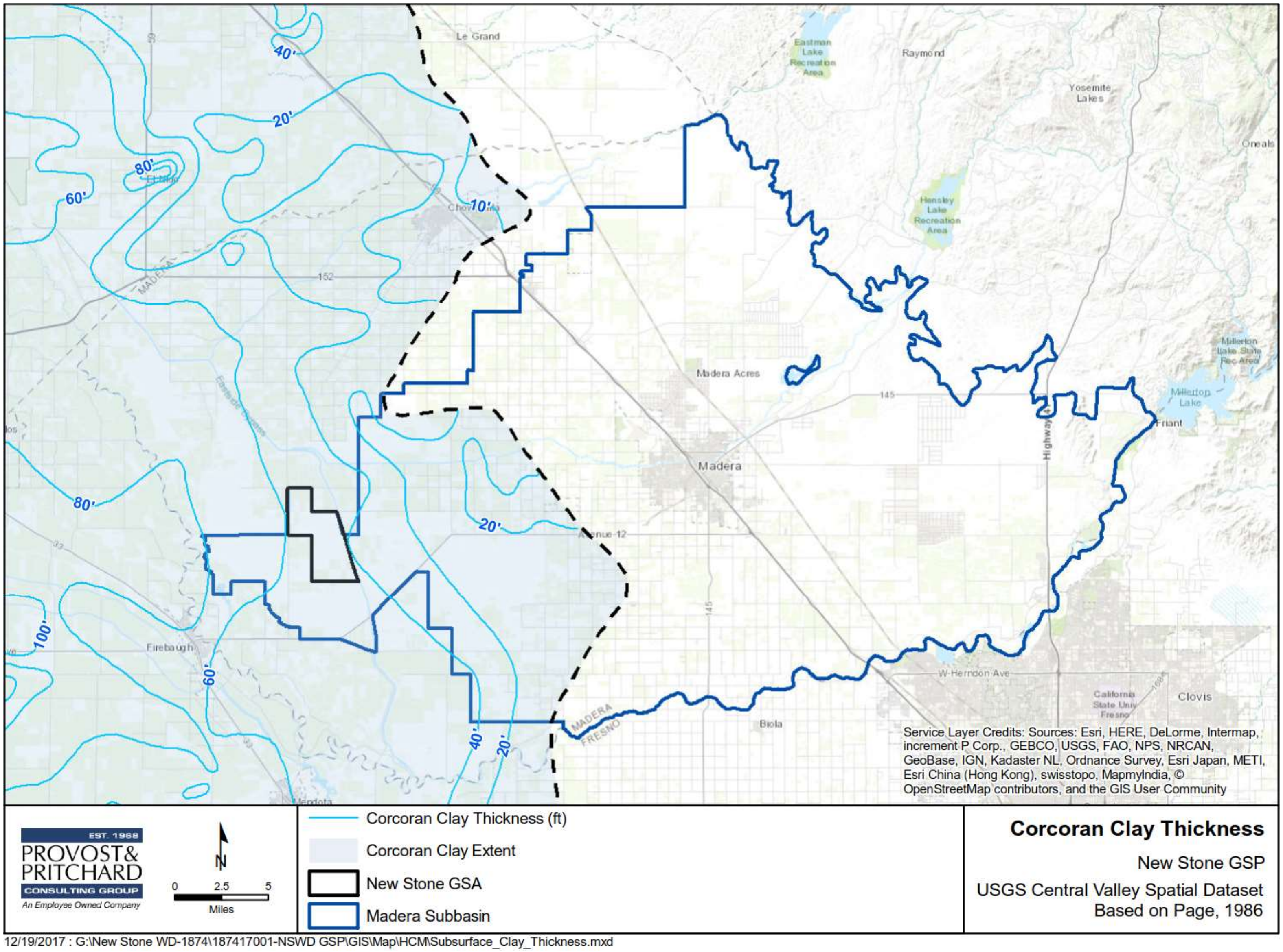

Figure 3-15 Corcoran Clay Thickness

groundwater. Within the Madera Groundwater Subbasin, less extensive confining units, known as the A-clay, exist at shallower depths; however, this confining unit is not mapped and is assumed to occur only in the southwestern portion of the subbasin. The A-clay does not extend under the NSWDGSA.

3.1.8.1 Geologic Formations

Regulation Requirement:

§354.14(b)(4)(a) Formation names, if defined.

Marchand's report (1976) contains a set of geologic maps of the Madera area. The area of NSWDGSA is mapped as Modesto Formation, primarily the lower member but with small areas of the upper member. Both the upper and lower members are described as locally derived, arkosic, alluvial sand, silt, and clay of interdistributary areas, lower fans, and flood basins that are commonly stratified (Marchand, 1976; Marchand & Allwardt, 1981). The lower member is 80 feet or thicker and is underlain by the Riverbank Formation (Marchand & Allwardt, 1981).

3.1.8.2 Aquifer Characteristics and Properties

Regulation Requirement:

§354.14(b)(3) The hydrogeologic conceptual model shall be summarized in a written description that includes the definable bottom of the basin.

§354.14(b)(4)(b) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.

Vertical Extent

The vertical extent (i.e., depth) of the aquifer system of the Madera Subbasin is comprised of two separate boundary types and has been mapped by Page (1973, 1986) and Mitten et al. (1970). As shown in **Figure 3-7**, the eastern most boundary of the Madera Subbasin aquifer system is defined vertically by the top of the basement complex. The depth to the basement complex is zero along foothills where valley alluvium pinches out. Cross-section B-B' shows the basement complex recedes steeply from the foothills and is approximately 350 feet below msl approximately two-miles to the west. The depth to the basement complex continues to increase until it is undetectable on the cross-section after approximately five miles from the base of the foothills.

The vertical aquifer boundary for the NSWDGSA (western portion of the Madera Subbasin) is the base of freshwater, which for the purposes of this HCM, is defined as groundwater with total dissolved solids (TDS) content of less than 2,000 milligrams per liter (mg/L). As shown on **Figure 3-16**, the saltwater/freshwater interface below NSWDGSA is located at approximate depths ranging from 600 to 950 feet below msl according to Mitten et al. (1970). The base of freshwater is located below the Qoa bottom within the QTc (Mitten et al., 1970). Page (1973) includes a contour map based on EC values of 3,000 µmhos/cm, a comparable value to 2,000 mg/L for TDS. Page (1973) indicates the base of freshwater under NSWDGSA is approximately 400 to 800 feet below msl.

Aquifer Characteristics

Aquifer characteristics of importance to the NSWDGSA are mainly transmissivity, hydraulic conductivity, and storativity. Storativity relates to how much space is available in the aquifer system for storage of groundwater. More specifically, storativity is the volume of water that a permeable unit will absorb or expel from storage per unit surface area per unit change in head (Fetter, 1994). In unconfined aquifers, the storativity is approximately equal to the specific yield. Therefore, as most of the published sources consulted for this

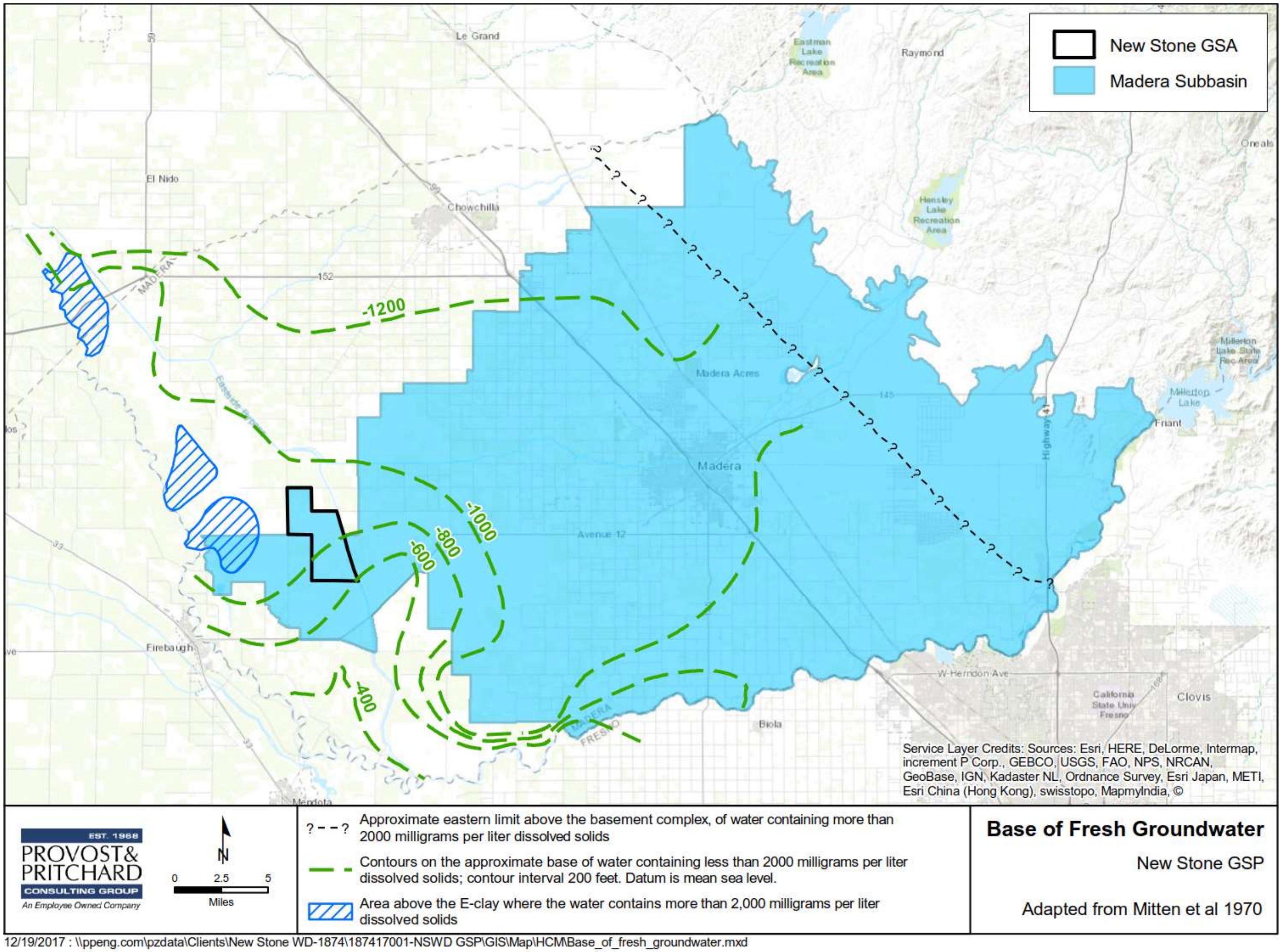

Figure 3-16 Base of Fresh Groundwater

HCM provide information on specific yield this portion of the report discusses specific yield as a close approximation of storativity in the unconfined aquifer.

Hydraulic conductivity is the rate at which water can move through a permeable medium, and the transmissivity is the amount of water that can be transmitted horizontally by the full saturated thickness of the aquifer under a hydraulic gradient of one. These two properties are related in that transmissivity is the hydraulic conductivity multiplied by saturated aquifer thickness, thus the following discussion focuses on transmissivity values alone as a representation of both these characteristics.

Specific Yield of the Deposits

The water storage capacity or specific yield in the Madera Subbasin area are related to soil textures which are determined by geomorphic units. Davis et al. (1959), DWR (2006), and Mitten et al. (1970) provide estimates of specific yields in the Madera area based on texture of the deposits. These estimates of specific yield are based on deposit descriptions (texture), electric logs, laboratory analysis of soils samples, and a relatively simple and transparent methodology.

Davis et al. (1959) sorted classification of materials from drillers logs into five major groups and assigned specific yields to each based on results of previous studies conducted on samples collected in California. The assigned specific yield values range from 3% for clay deposits to 25% for medium to coarse sand and gravel deposits. For the San Joaquin River storage unit, including the San Joaquin River alluvial plain and the valley plain west of Madera, the average specific yield from 10 to 200 feet bgs is 11.9% (Davis et al., 1959). Davis et al. (1959) also includes a table of estimated groundwater storage capacity units, by township subunits, sorted by depths of 10 to 50, 50 to 100, and 100 to 200 feet. NSWDGSA spans two townships: T11S R15E and T12S R15E. From shallow to deep, both townships have specific yields of 8.3%, 13.3% and 14.8% listed. These values are summarized in **Table 3-1**.

Mitten et al. (1970) report water bearing properties based on USGS laboratory analyses of surface samples of both older and younger alluvium in their Madera study area. The results show that specific yields are highly variable in the older alluvium and the younger alluvium is more permeable. Specific yields for older alluvium ranged from 0.5% to 22.4% in silts and 14.0% to 23.4% in sands. In the younger alluvium specific yields were higher, ranging from 18.8% to 32.8% in silts and 17.7% to 39.0% in sands. DWR (2006) estimates the average specific yield of the Madera Groundwater Subbasin is 10.4%. Davis et al. (1959) estimated specific yield for three depths by Township, which for the District area (Townships T11S and 12S, Range 15E). Williamson et al. (1989) also estimated specific yield for deeper than 150 feet to greater than 600 feet. From his study specific yield for the District area for a depth range of 200 feet to 300 feet can be estimated at 11.0%. Specific yield values at the depths of groundwater fluctuation in the NSWD are as summarized in **Table 3-1**.

Table 3-1 Summary of Specific Yield Estimates from Davis et al. (1959) & Williamson et al. (1989)

Township	Estimated Specific Yield (percent)				
	10-50 feet	50-100 feet	100-200 feet	200-300 feet	All zones
T11S R15E	8.3%	13.3%	14.8%	10-11%	13.0%
T12S R15E	8.3%	13.3%	14.8%		13.0%

Transmissivity

Estimates of and transmissivity are available from published sources including Davis, Lofgren and Mack (1964) and Provost & Pritchard (2008). Davis et al. (1964) provide information for numerous short-term pump tests in the area and provide specific capacity (discharge in gallons per minute [gpm] divided by drawdown) by township. Thomasson et al. (1960) developed an empirical relationship between specific capacity and transmissivity, which is also discussed by Driscoll (1986) and more recently by Abbott (2015).

Transmissivity can be approximated by multiplying specific capacity by a factor of 1,500 for unconfined aquifers and 2,000 for confined aquifers. At the time that these studies were done, it is likely that most wells in the San Joaquin Valley were shallow and open bottom, and the resultant transmissivities are probably more valid for the shallower portion of the aquifer comprised of the Older Alluvium. In general, transmissivity values are higher for the older alluvium than the underlying deposits. Transmissivity values can also be high in paleo channel deposits and low in deposits dominated by floodplain clays.

Short-term pump tests performed by PG&E in the San Joaquin Valley have been compiled by the USGS (Davis et al., 1964). For the two townships NSWDGSA falls within, the average discharge rate and specific capacity for T11S/R15E was 1,176 gpm and 81 gpm per foot (gpm/ft) respectively, and for T12S/R15E the discharge was 1,813 gpm with a specific capacity of 104 gpm/ft. Using the common conversion factor of 1,500 for unconfined aquifer conditions, the aquifer transmissivities would be 121,500 gallons per day per foot (gpd/ft) and 156,000 gpd/ft for T11S/R15E and T12S/R15E, respectively. These are likely pump tests of wells screened above the Corcoran Clay. These are relatively high numbers commonly found in the better portions of the aquifers of the San Joaquin Valley.

Pump tests conducted on wells within NSWDGSA were used to produce specific capacity and transmissivity values (Provost & Pritchard, 2008). With 26 wells tested, specific capacities ranged from 15 to 123 gpm/ft with an average of 41 gpm/ft. Transmissivity values ranged from 22,500 to 184,400 gpd/ft with an average of 44,000 gpd/ft. The wells are generally screened above the Corcoran Clay in the Older Alluvium. Summaries of the characteristics of the wells analyzed by Provost & Pritchard (2008) are in **Table 3-2** and estimated transmissivities in **Table 3-3.**

Table 3-2 NSWDGSA Well Characteristics and Pump Test Results (Provost & Pritchard, 2008)

Description	Units	Range	Average
Groundwater Depth	feet	51 - 110	76
Well Depth	feet	210 - 597	365
Well Diameter	inches	14 - 16	16
Pump Depth	feet	120 - 242	181
Pump Power	horse power	40 - 125	78
Specific Capacity	gpm/ft	15 - 123	41
Transmissivity	gpd/ft	22,500 - 184,400	44,000

Table 3-3 Summary of Transmissivity Estimates

Publication	Estimate of Transmissivity (gpd/ft)	Description/Notes
Davis et al. (1964)	121,500 156,000	Averages for T11S/R15E and T12S/R15E, respectively.
Provost & Pritchard (2008)	44,000	Average based on pump tests conducted on NSWDGSA wells.

3.1.8.3 Aquifer Uses

Regulation Requirement:

§354.14(b)(4)(e) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.

The aquifers in the NSWDGSA are used primarily for irrigation purposes. Groundwater pumping for agriculture is not measured, with the amount pumped varying based on the crop demand. The estimated amounts of pumping are described in Chapter 3.3 - Water Budget.

3.1.9 General Groundwater Quality

Regulation Requirement:

§354.14(b)(4)(d) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.

The discussion presented below is intended to present a generalized view of groundwater quality in the Madera Subbasin and NSWDGSA area. A more detailed discussion on groundwater quality is included in Groundwater Conditions, Section 3.2.5.

General groundwater quality of the Madera Subbasin is described by Mitten et al. (1970) and Provost & Pritchard (2014). Nitrate is an important constituent of concern in the area and specific conductance is a general indicator of water quality. The following discussion will focus on these two constituents.

Provost & Pritchard (2014) describes the Madera regional groundwater quality as generally good but further divides the study area into sub-areas. NSWDGSA is near the center of the Westerly Undistricted Sub-Area, where the only data available is for specific conductance and nitrate as nitrogen (NO_3). In the center of the sub-area, specific conductance has been documented above 1,600 micromhos per centimeter (µmhos/cm) and NO_3 appears to be above the primary maximum contaminant level (MCL) of 45 milligrams per liter (mg/L) (Provost & Pritchard, 2014).

Mitten et al. (1970) generalizes the groundwater above and east of the Corcoran Clay as predominately calcium sodium bicarbonate and sodium calcium bicarbonate type water. In the western area of the Madera Subbasin which encompasses NSWDGSA, the groundwater is a chloride type that contains more dissolved solids. Chemical analytical data is presented sorted by township. In the two townships within NSWDGSA, the average specific conductance is 650 µmhos/cm which is below the secondary MCL of 900 µmhos/cm and average NO_3 is well below the MCL at 5.3 mg/L (Mitten et al., 1970).

Water quality analytical data was collected from wells within the NSWDGSA for agronomic purposes. The data returns averages of 840 µmhos/cm and 5.6 mg/L of specific conductance and nitrate, respectively, are below their respective MCLs.

3.1.10 Surface Water Features

§354.14(d)(5) Physical characteristics of the basin shall be represented on one or more maps that depict surface water bodies that are significant to the management of the basin.

The only surface water feature in NSWDGSA is the Chowchilla Bypass (Bypass), which exists along the eastern edge of the NSWDGSA. The Chowchilla Bypass is a designated floodway into which water is diverted from the San Joaquin River only in relatively wet years. The Bypass is the only existing conveyance facility that delivers surface water to NSWDGSA lands.

New Stone Water District owns gates and a diversion pipeline at the Bypass at Avenue 12 which can pass an estimated 30,000 gpm according to the District. The District has a canal along the west side of the Bypass up to the southern end of NSWDGSA. NSWD formerly used Bypass water to irrigate crops; however, when a drip system was installed, the water could no longer be used. As a result, a canal adjacent to the Bypass was backfilled to make more room for grape vines.

3.1.11 Source and Point of Delivery of Imported Water

Regulation Requirement:

§354.14(d)(6) Physical characteristics of the basin shall be represented on one or more maps that depict the source and point of delivery for imported water supplies.

Water is not imported into NSWDGSA, except for water from the Chowchilla Bypass during flood releases. These releases occur approximately once each three years (Provost & Pritchard, 2008).

3.1.12 Recharge and Discharge Areas

Regulation Requirement:

§354.14(d)(4) Physical characteristics of the basin shall be represented on one or more maps that depict delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.

This section discusses existing and potential groundwater recharge areas and areas of groundwater discharge. The information is presented on a regional scale and provides a general assessment of the GSA's recharge potential. This information would need to be supplemented with local information for developing site-specific groundwater recharge projects.

Existing Recharge Areas

The NSWDGSA includes natural recharge areas but does not have intentional recharge from constructed recharge basins. Natural recharge in the area occurs from seepage along the San Joaquin River, Chowchilla Bypass (when water is present), intermittent streams, and reservoirs. Deep percolation of agricultural irrigation also makes significant contributions to groundwater recharge. Natural recharge from percolation of precipitation is considered minor.

Potential Recharge Areas

Potential recharge areas can be identified using the soil and geologic maps described below. These maps provide a regional assessment of recharge potential and can be useful for initial screening. It should also be recognized that land availability is generally a limiting factor in the selection of recharge areas.

Soils

A soils map based on NRCS soil textural classes is presented as **Figure 3-8.** This map generally represents soils in the upper five to seven feet of the soil profile. The NSWDGSA is primarily mapped as fine sandy loam with fingers of finer loam and clay loam oriented in an east-west direction, mostly in the southern half of the GSA. The majority of NSWDGSA surface soils have a Ksat rating of moderately high and a restrictive soil feature less than 1.5 feet deep. Refer to **Section 3.1.6** for further discussions on the soils. However, deeper conditions (7 to 50 feet in depth) are also important in the control of surface water infiltration. Based on these soil characteristics, areas within NSWDGSA could potentially produce moderate rates of groundwater recharge.

Soil Agricultural Groundwater Banking Index

The Soil Agricultural Groundwater Banking Index (SAGBI) is a composite evaluation of the feasibility of groundwater recharge on agricultural land (also called irrigation field flooding). Irrigation field flooding could have significant potential for groundwater recharge due to the large areas of irrigated agriculture in the GSA. The Index was developed by University of California, Davis, and the University of California Division of Agriculture and Natural Resources. The Index incorporates the following five parameters:

1. Deep percolation is dependent upon the saturated hydraulic conductivity of the limiting layer.
2. Root zone residence time estimates drainage within the root zone shortly after water application.
3. Topography is scored according to slope classes based on ranges of slope percent.
4. Chemical limitations are quantified using the electrical conductivity (EC) of the soil.
5. Soil surface condition is identified by the soil erosion factor and the sodium adsorption ratio.

Proximity to a water conveyance system is not a factor considered in the SAGBI composite evaluation. Each factor was scored on a range, rather than discretely, and weighted according to significance. Adjustments were then made to reflect soil modification by deep tillage (i.e., shallow hard pan is assumed to have been removed by historic farming activities). **Figure 3-17** illustrates the SAGBI Index for the NSWDGSA. Ultimately, SAGBI seeks to categorize recharge potential according to risk of crop damage at the recharge site. Usefulness of the index is diminished when evaluating locations for dedicated recharge basins. In these cases, a soil profile illustrating deep percolation potential may prove to be more useful. As is the case with any model, the SAGBI is best applied in conjunction with other available data and on-site evaluation.

Discharge Areas

There are currently no known groundwater discharges (springs, seeps, etc.) in the NSWDGSA area. Springs and artesian wells were common decades ago; however, groundwater levels have declined such that these features are no longer found in the region. Groundwater levels are further discussed in Chapter 3.2 Current and Historic Groundwater Conditions.

Wetland Areas

Wetland areas from the U.S. Forest service, National Wetland Inventory are shown on **Figure 3-18**. Most wetlands in the figure are around the Chowchilla Bypass and the small tributaries flowing west to the San Joaquin River.

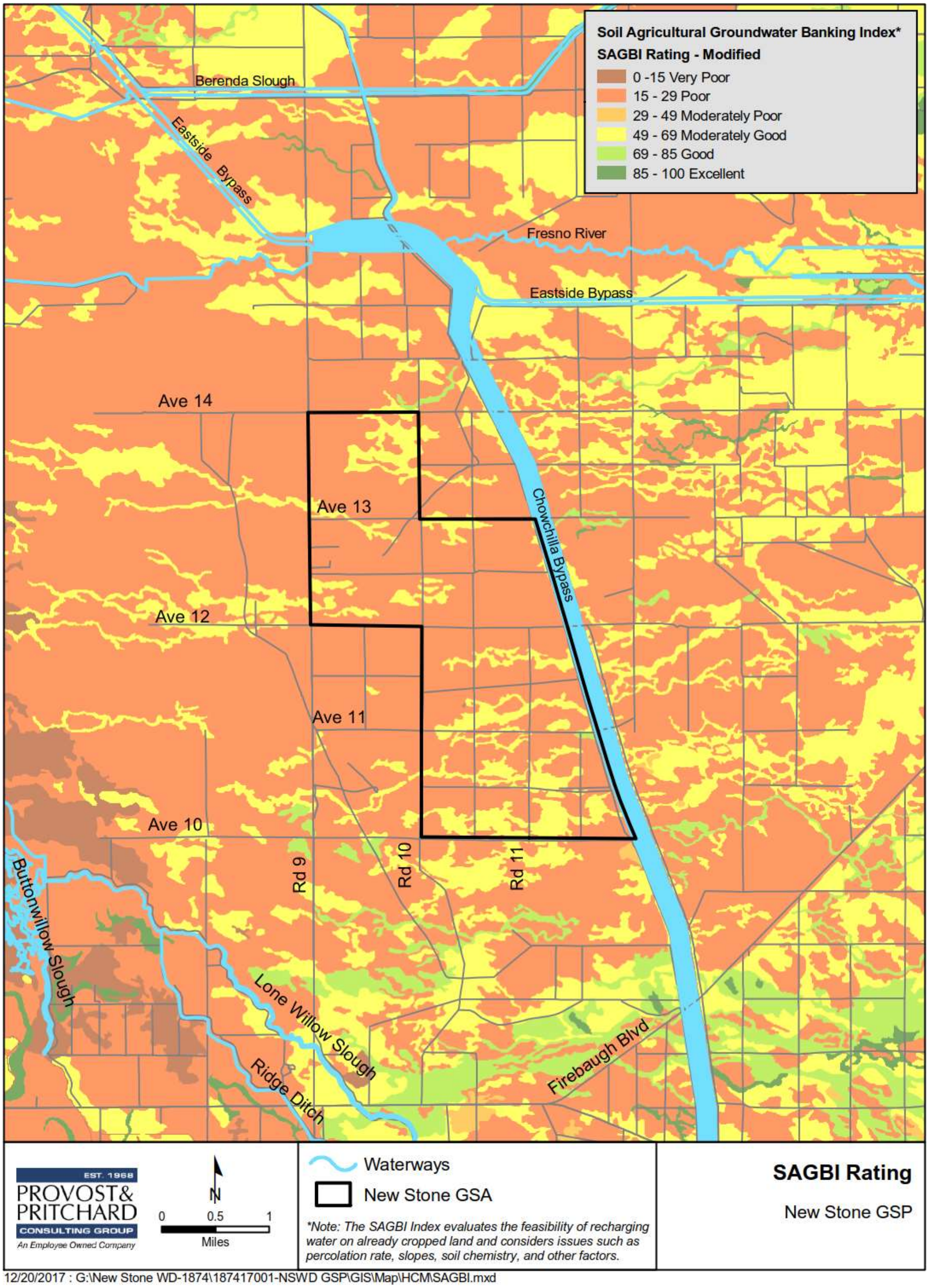

Figure 3-17 Modified Soil Agricultural Groundwater Banking Index (SAGBI) Rating

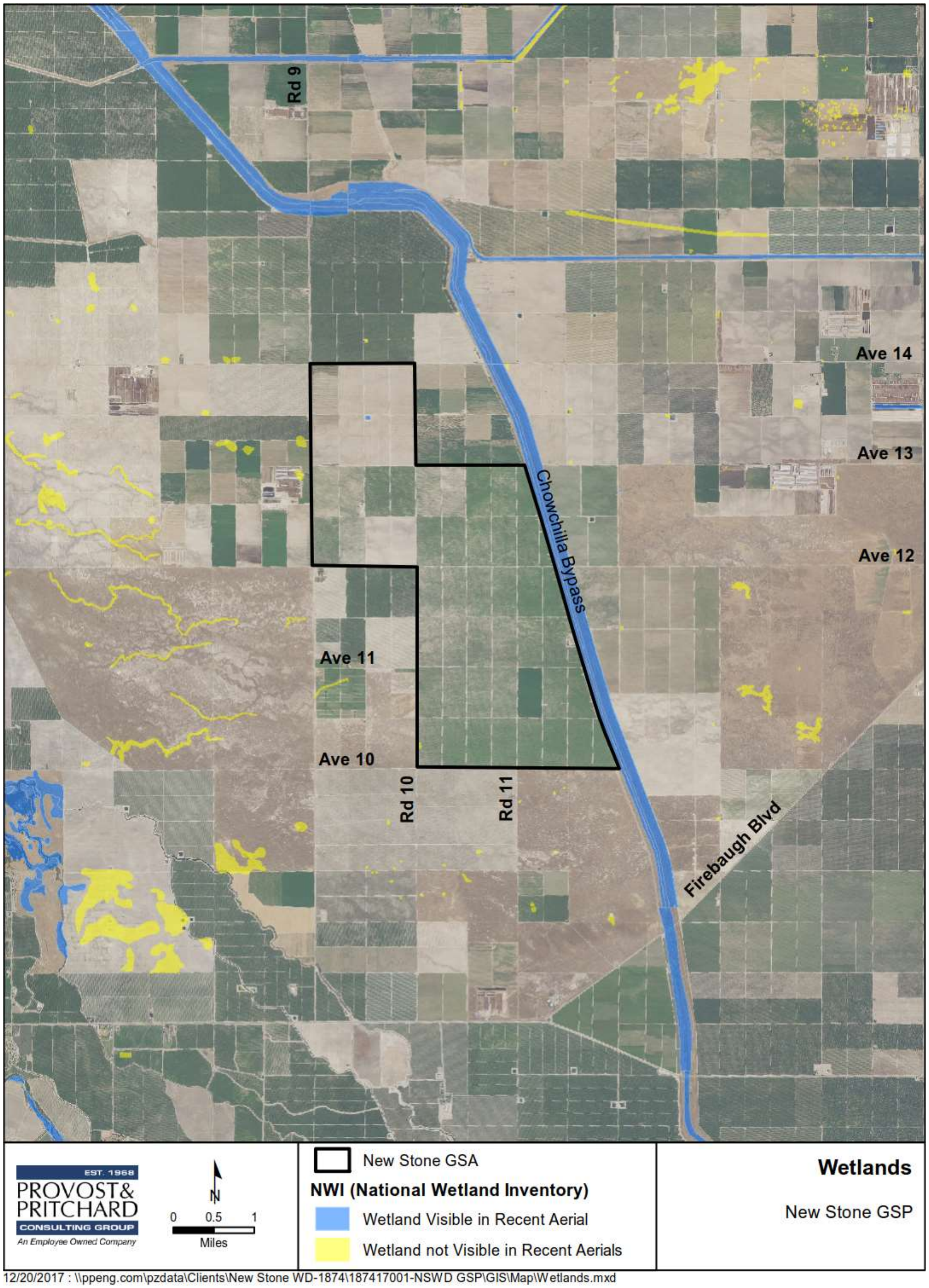

Figure 3-18 Wetlands Map

3.2 Current and Historical Groundwater Conditions

Regulation Requirement:

§354.16 Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:

This section includes a description of the current and historical groundwater conditions within NSWDGSA. The data used in this chapter includes the most recent available information, as well as historic well data, to describe groundwater trends in NSWDGSA.

3.2.1 Groundwater Elevation Data

Regulation Requirement:

§354.16(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:

1. Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.
2. Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

Irrigation well depths in the NSWDGSA (in western Madera County) can be as shallow as approximately 200 feet and as deep as nearly 600 feet. Limited well logs, construction data, and monitoring provide some uncertainty about the actual depth and structure of both the wells and lithologic column. On average, the District's well depths within the GSA are about 350 feet. Many districts nearby, and other well users within the County, have drilled deeper wells in recent decades. Existing wells have been deepened or drilled for several reasons including water level declines and water quality issues.

Wells in the GSA and within approximately two miles of the GSA boundary were identified using the State's CASGEM and Water Data Library programs. Representative wells were selected based on the amount of historical and current water level data to properly display the groundwater conditions in the District. Hydrographs for wells near the GSA are shown in Appendix A. Some hydrographs in the area have a relatively long period of record (starting in the 1940s, 1950s, and 1960s), include regular measurements, and are for wells geographically distributed across the area. It is the intent of NSWDGSA that data from these wells are used for setting sustainable management criteria and that data continues to be collected and will remain a key component of the monitoring network. Data from these hydrographs provides a good indication of historical groundwater levels in the basin. Groundwater levels fluctuate seasonally and in response to wet or dry periods; however, the long-term water level trend is decreasing. With few exceptions, the lowest groundwater levels occurred during the recent drought period with low points around 2015 and 2016.

Water table levels range from approximately 140 to 160 feet above sea level from the 1940s through the 1960s. Water levels peak in the 80s and late 90s between 120 and 100 feet above sea level. With less frequent groundwater level monitoring, current average water levels may be less reliable. Groundwater elevation data from about 2000 to present show an average water level between 40 and 60 feet above sea level.

As stated in Section 3.1, the Corcoran Clay is a major confining layer in the GSA. The B-B' cross-section shown in Figure 3-10, which bisects the GSA, shows the Corcoran Clay to be approximately 200 feet below msl. Cross-section D-D' (Figure 3-12), which traverses along western border of the GSA, shows the Corcoran Clay at 150 to 200 feet below msl. Privately owned wells, although not currently monitored, will provide additional information on groundwater conditions below NSWDGSA. As the groundwater monitoring program is developed and implemented, water level data will be gathered and used to differentiate upper aquifer monitoring and lower aquifer monitoring. The monitoring program will utilize information from the CASGEM monitoring wells to track groundwater conditions surrounding the GSA.

3.2.2 Groundwater Movement

Groundwater flow paths have changed over time. Historically, groundwater in the Subbasin flowed southwest toward the Valley trough (Mitten et al, 1970). Heavy irrigation pumping in western Madera County has caused significant changes in ground surface and groundwater elevations. This, in turn, has caused groundwater cones of depression in the Red Top Area and white area to the north of New Stone Water District GSA and redirected groundwater flow in the GSA to the northwest, as shown in groundwater elevation contour maps. Additionally, many of the natural waterways have been diverted, altering historic flow patterns. The Fresno River is one example of a waterway that has been diverted from its natural course. Often it only flows during wet water years.

Groundwater contour maps were developed from spring groundwater levels for the hydrologically average period, determined to be from 2003-2012. Maps were selected to represent the average (2003), wet (2006), and dry (2012) water years and are included as **Figures 3-19, 3-20** and **3-21**, respectively. Each figure shows groundwater flowing toward the north/northwest, as does the water from the San Joaquin River. Groundwater depressions and areas of subsidence are located north/northeast of the GSA. There is a groundwater mound northwest of the GSA and, although the water flows away from this area locally, the overall trend for groundwater flow in the subbasin remains to the northwest.

There is only one consistently monitored groundwater elevation data point within the NSWDGSA. This prevents the GSA from calculating changes in gradient, and thus groundwater flow, across the District. Due to the size of the GSA and the relative uniformity of the land, groundwater inflow and outflow is assumed to be equal. As the monitoring plan is implemented groundwater inflow and outflow can be monitored more effectively.

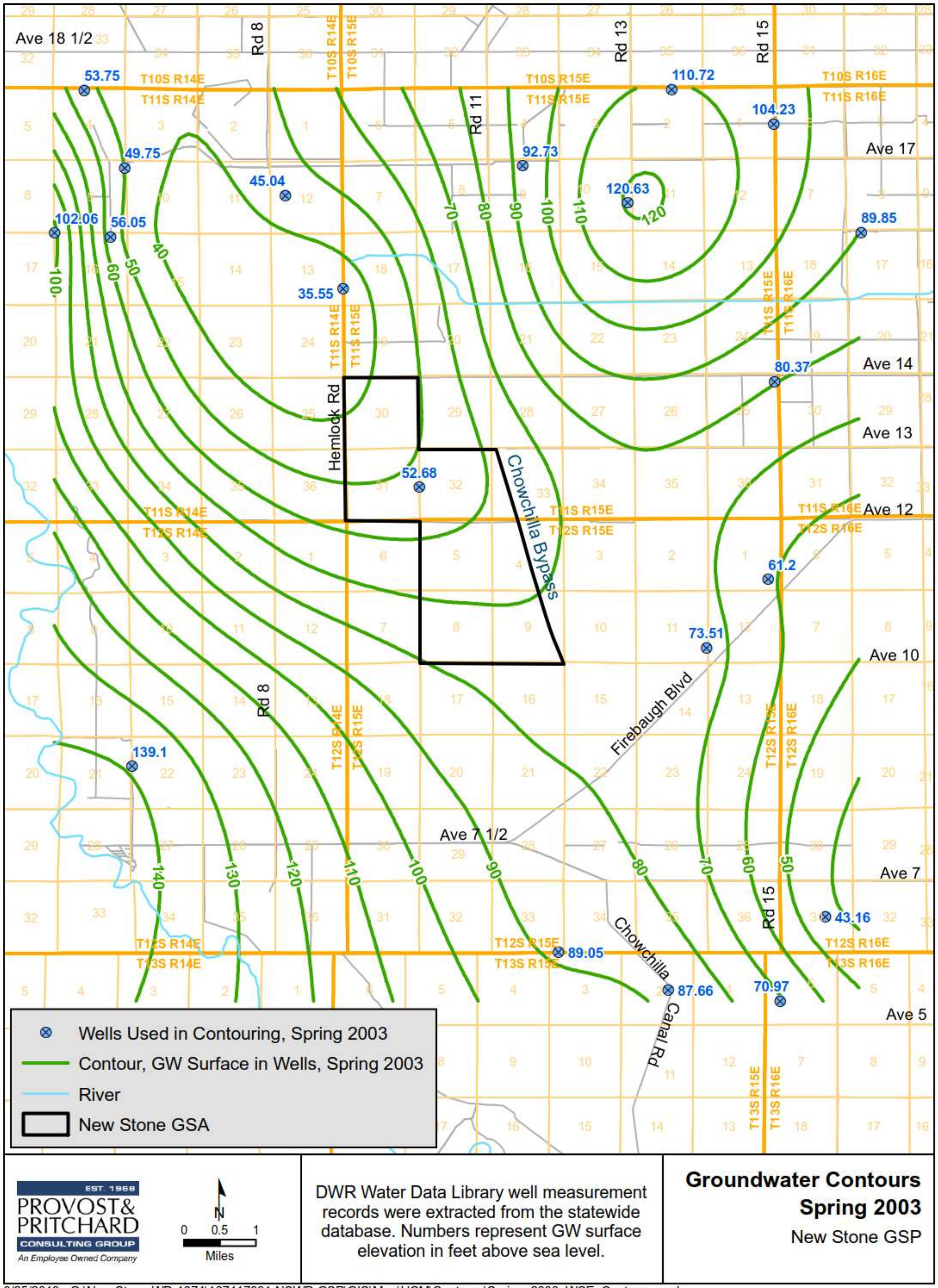

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Figure 3-19 Average-Year Contour Map

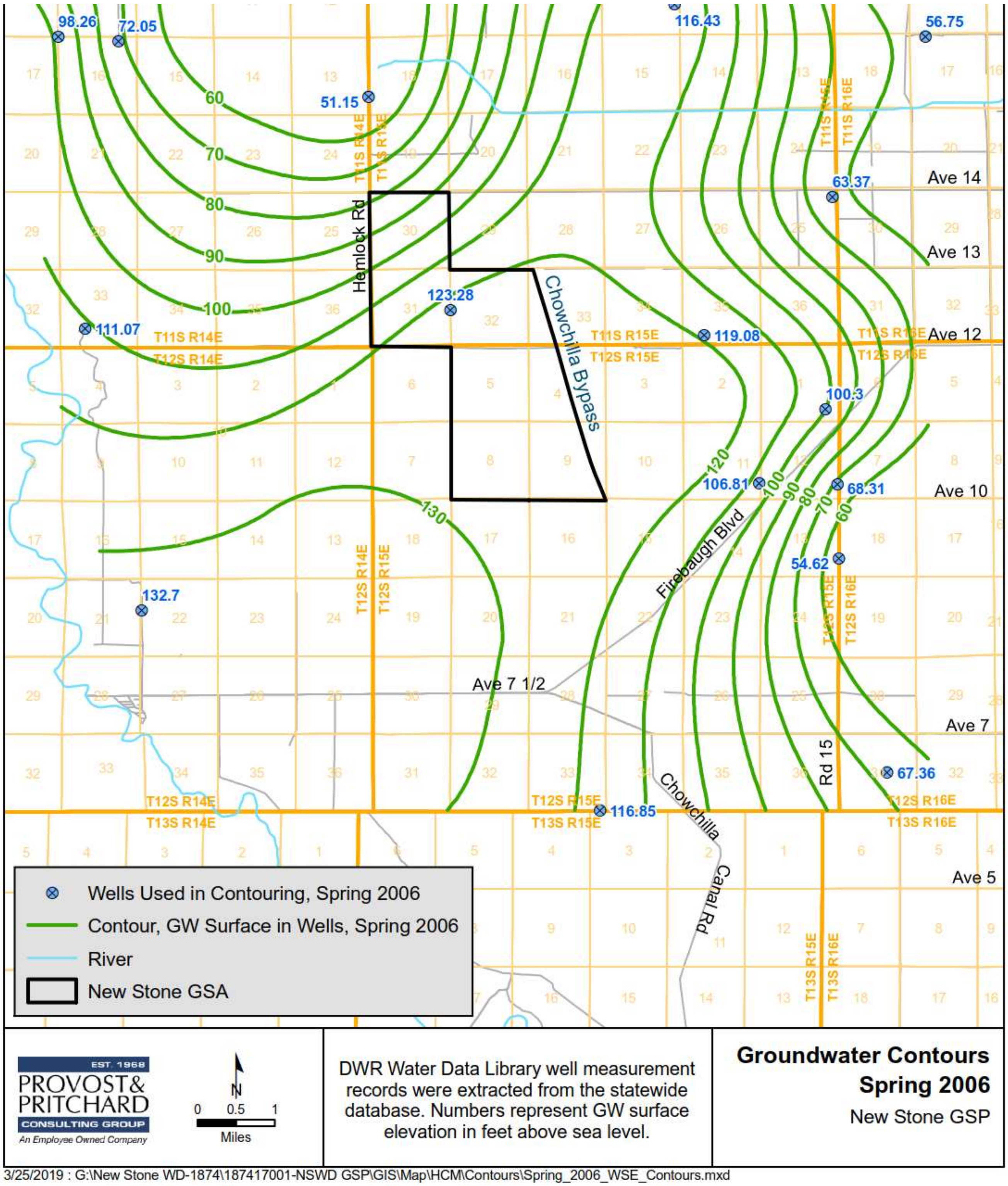

Figure 3-20 Wet-Year Contour Map

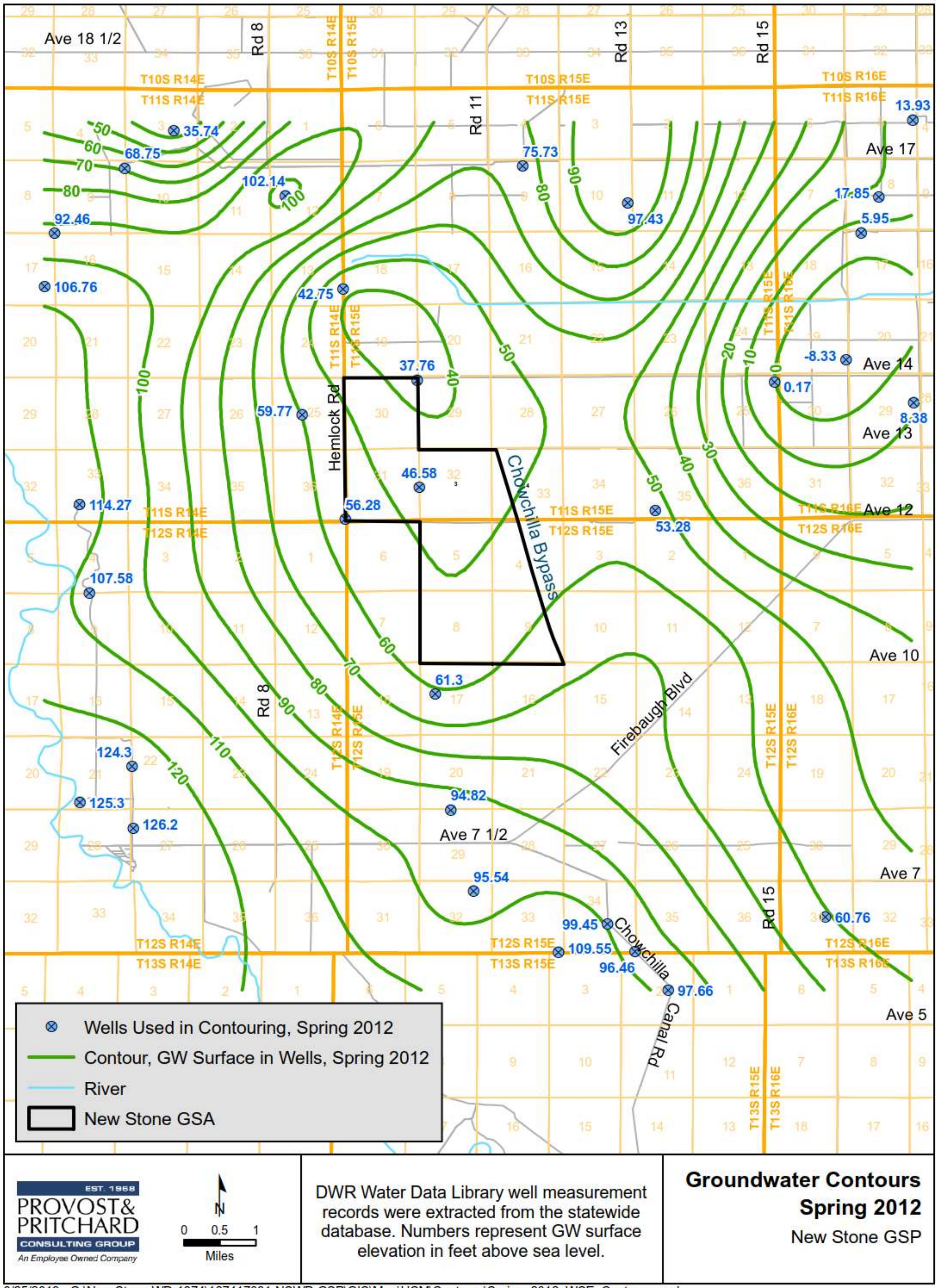

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Figure 3-21 Dry-Year Contour Map

3.2.3 Estimate of Groundwater Storage

Regulation Requirement:

> **§354.16(b)** A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.

Groundwater storage was determined using multiple methods. For each method, specific yields for each subarea (predominantly by Township) were identified for varying depths: 0 to 50, 50 to 100, and 100 to 200 feet below the ground surface (Davis et al., 1959). Each method also used depths to groundwater and groundwater surface elevations in specific wells monitored and recorded in the CASGEM and Water Data Library databases to calculate changes in water level for each year.

Method one used the water budget analytical model or the checkbook balance method. It uses inputs from all water sources, consumptive uses, and losses to determine groundwater surplus or overdraft over a hydrologically average period. The second method used average specific yield, basin area, and average change in groundwater levels to determine change in storage over the hydrological average period. The final method used GIS mapping tools to calculate the difference in volume between contour maps for each year in the hydrological average period.

Due to data gaps, there is a range of values for change in groundwater storage. See **Table 3-4** for a summary of values.

Table 3-4 Change in Storage Results

Method 1			Analytical
Water Budget Annual Change in Groundwater Storage		**(1,600 AF)**	
GW Recharge	8,100		
GW Pumping	(9,700)		
GW Outflow	0		
Method 2			Measured
Calculated Annual Change in Groundwater Storage		***(1,615 AF)***	
Average water level change during period	(3.00)	feet/year	
District size	4,141	Acres	
Assumed specific yield	0.13		

3.2.4 Seawater Intrusion

Regulation Requirement:

> **§354.16(c)** Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.

Seawater intrusion conditions do not exist in the Madera Subbasin.

3.2.5 Groundwater Quality

Regulation Requirement:

> **§354.16(d)** Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.

Available water quality data in Madera County and the Madera Groundwater Subbasin is voluminous and, therefore, only briefly summarized in this Plan. On the contrary, groundwater quality data for NSWDGSA is sparse and outdated thus not representative of trends or average conditions.

Common water quality issues in the larger region of NSWDGSA are elevated levels of nitrate and total dissolved solids (TDS). Nitrate is an important constituent of concern in the San Joaquin Valley that is not naturally occurring in groundwater. The primary maximum contaminant level (MCL) in drinking water for nitrate is 45 mg/L. TDS and specific conductance are general indicators of water quality and are commonly measured in water. Specific conductance and TDS have recommended secondary MCLs of 900 µmhos/cm and 500 mg/L, respectively. Data available within and near NSWDGSA indicates that levels of these constituents are generally below respective MCLs for drinking water. It should be noted that groundwater from NSWDGSA is not used as a drinking water supply. Below is a summary of important groundwater quality data sources applicable to NSWDGSA.

Geology, Hydrology, and Water Quality in the Madera Area, San Joaquin Valley, California
Mitten et al. (1970) generalizes the groundwater above and east of the Corcoran Clay as predominately calcium sodium bicarbonate and sodium calcium bicarbonate type water. In the western area of the Madera Subbasin where NSWDGSA lies, the groundwater is a chloride type that contains more dissolved solids. DWR (2006) reports that TDS ranges from 100 to 6,400 mg/L with a typical range of 200 to 400 mg/L and conductance ranges from 180 to 600 µmhos/cm with an average of 251 µmhos/cm in the Madera Subbasin. As of 2006, public supply well monitoring indicated that one well had reported concentrations over the MCL for nitrate, three are over the MCL for pesticides, and none are reported over the MCL for inorganics, radiological, or VOCs and SVOCs (DWR, 2006).

Chemical analytical data is sorted by township in Mitten et al. (1970). In the two townships within NSWDGSA between 1964 and 1966 the average in the unconfined wells of each constituent reported was below the applicable primary or secondary MCL. One well in the confined aquifer was reported and was also below applicable MCLs. Mitten et al. (1970) includes maps of salinity and sodium hazards (for agricultural use), nitrate and chloride concentrations, and hardness in unconfined groundwater between 1960 and 1966 (Mitten's Figures 13 to 16). In the NSWDGSA the salinity hazard was mapped as medium to high and the sodium hazard as low to medium. Nitrate concentrations were mapped as 1-10 mg/L with higher concentrations mapped immediately north and west. Chloride concentrations mapped in the NSWDGSA area ranged from 20 to 40 mg/L to greater than 250 mg/L with the highest concentrations in the southern part of the GSA and lowest concentrations in the center. Hardness mapped in NSWDGSA ranged from moderately hard to very hard.

Madera Regional Groundwater Management Plan
Provost & Pritchard (2014) describes the Madera regional groundwater quality as generally good for domestic supply and agricultural use in the Madera Regional Groundwater Management Plan (GMP). The GMP further breaks down the study area into sub-areas. NSWDGSA falls near the center of the Westerly Undistricted Sub-Area. The only data available for this sub-area is specific conductance and nitrate (as NO_3). In the center of the sub-area, specific conductance has been documented above 1,600 µmhos/cm and generally increases in concentration towards the southwest portion of the sub-area. NO_3 concentrations appear to be above the MCL near the central portion of the sub-area in the shallow aquifer. The northwestern portion of the sub-area has elevated concentrations of NO_3 between 30 and 45 mg/L, near or at the MCL. For the rest of the sub-area, concentrations are below the MCL (Provost & Pritchard, 2014).

Region 5: Updated Groundwater Quality Analysis and High-Resolution Mapping for Central Valley Salt and Nitrate Management Plan
An update of the groundwater quality for the Central Valley Salinity Alternatives for Long Term Sustainability (CV-SALTS) program was produced by Luhdorff and Scalmanini Consulting Engineers (LSCE, 2016). In the

Ambient Conditions figures of the report water quality is generally good in eastern Madera Subbasin, but moderate to high concentrations of nitrate and TDS exist on the west side of the subbasin where NSWDGSA is located. In the western portion of the subbasin, concentrations are generally mapped above 5.0 mg/L of nitrate and above 500 mg/L of TDS.

East San Joaquin Water Quality Coalition Groundwater Quality Assessment Report

The East San Joaquin Water Quality Coalition (ESJWQC) Groundwater Quality Assessment Report by Luhdorff & Scalmanini Consulting Engineers (LSCE, 2014) shows groundwater quality sampling from various data sources in the ESJWQC area, which includes the Madera Subbasin. Maps of the most recent sampling data show that few samples in the NSWDGSA area have been collected since the 1970s. The most recent nitrate concentrations in the vicinity of NSWDGSA are less than 10 mg/L in shallow wells and vary from less than 2.5 to greater than 20 mg/L in deep wells. The most recent TDS concentrations near NSWDGSA are between 500 and 999.9 mg/L in shallow wells and between 250 and 499.9 mg/L in deep wells. The LSCE (2014) figures also reveal that 1 or 2 wells near NSWDGSA have had pesticides detected between 1979 and 2011; however, concentrations do not surpass regulatory concentrations.

Groundwater Ambient Monitoring and Assessment

The Groundwater Ambient Monitoring and Assessment (GAMA) Program is California's comprehensive groundwater quality monitoring program that was created by the State Water Resources Control Board (SWRCB) and expanded by the Groundwater Quality Monitoring Act of 2001. Groundwater quality data is available from the program on the GAMA database website (http://geotracker.waterboards.ca.gov/gama/). One well in the database, MADCHOW-26, is on the boundary of NSWDGSA. Other wells near NSWDGSA with data in the database within the last 20 years are S3-Mack-M02, S3-Mack-M03, S3-Mack-M04, MADCHOW-20, MADCHOW-25, MADCHOW-30. MADCHOW-26 was analyzed in May 2008 and reported concentrations include 3 mg/L nitrate, 1310 µmhos/cm specific conductance, and 854 mg/L TDS. MADCHOW-25 and S3-Mack-M03 are east of the northern part of NSWDGSA on the east side of the Chowchilla Bypass and were sampled on May 2008 and April 2014, respectively. They were reported to have elevated specific conductance of 1650 and 2110 µmhos/cm and nitrate concentrations of 38.6 and 51 mg/L, respectively. The remainder of the wells have nitrate concentrations less than or equal to 6 mg/L, specific conductance below 950 µmhos/cm, and TDS below 650 mg/L.

The data reported by GAMA from the MADCHOW wells was used in a 2008 USGS study of the groundwater quality in the Madera and Chowchilla Subbasins (Shelton, Fram, and Belitz, 2009). The study found that concentrations exceeded the MCL for nitrate in 7% of wells, arsenic and uranium in 13% of wells, low-level DBCP in 10% of wells, and low-level EDB in 3% of wells analyzed in the Subbasins (Shelton et al., 2009). Secondary MCLs for chloride, TDS, or manganese were exceeded in 20% of the sampled wells (Shelton et al., 2009). Other compounds detected in the study area were generally below regulatory thresholds (Shelton et al., 2009).

EnviroStor & GeoTracker

According to their website (http://www.envirostor.dtsc.ca.gov/public/), EnviroStor is the Department of Toxic Substances Control's (DTSC) data management system for tracking cleanup, permitting, enforcement, and investigation efforts at hazardous waste facilities and sites with known contamination or sites where there may be reasons to investigate further. A review of the EnviroStor website shows that there are no sites listed within 5 miles of NSWDGSA. Similarly, GeoTracker is the SWRCB data management system for sites that impact or have the potential to impact water quality in California with emphasis on groundwater. The GeoTracker website (http://geotracker.waterboards.ca.gov/) lists one closed oil and gas site near the boundary of NSWDGSA and one closed leaking underground storage tank site approximately 2.5 miles south. No active sites are listed within 4 miles of NSWDGSA.

3.2.6 Land Subsidence Conditions

Regulation Requirement:

§354.16(e) The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or best available information.

Subsidence is the sinking of the ground surface resulting in a change in ground surface elevation. Five types of subsidence have been found in California and the San Joaquin Valley, including: oxidation of peat deposits in the river/delta areas, deep subsidence resulting from falling groundwater levels caused by overdraft, shallow subsidence caused by hydrocompaction of collapsible soil layers, tectonic subsidence resulting from earthquakes and ground deformation, and subsidence caused by fluid withdrawal from oil and gas fields. The main form of subsidence in the NSWDGSA area is deep subsidence from declining groundwater levels. Excessive groundwater pumping can contribute to deep subsidence across a broad area, resulting in aquifer compaction, loss of storage capacity, and adverse effects to surface features, such as bridges, canals, flood control systems, and water supply pipelines which rely on gravity flow.

Two types of subsidence can occur as a result of groundwater pumping: elastic and inelastic as shown in **Figure 3-22**. Elastic subsidence can be reversed as the water table recovers, while inelastic subsidence is permanent. Elastic subsidence generally occurs in the unconfined portions of the aquifer. Although there are several causes of inelastic land subsidence, the compression of clay as a result of groundwater extraction from confined aquifers is the cause of the vast majority of subsidence documented in the San Joaquin Valley. This results in compaction of fine-grained confining beds (clays) above and within the confined aquifer system as water is removed from pore spaces between the grains of the sediments. Once water is squeezed out of the compressible clay, the clay compacts, resulting in the lowering of the overlying land surface. The compressed clays, in which the clay particles have been re-arranged, can no longer re-absorb water, thus the subsidence in these areas cannot be reversed. This process is known as aquifer system compaction. The Corcoran Clay Member of the Tulare Formation has been mapped beneath much of the western side of the San Joaquin Valley and the aquifer beneath it is confined. Permanent subsidence in the San Joaquin Valley has historically been correlated to overdraft in the confined aquifer below the Corcoran Clay. However, with increased reliance on groundwater to meet demands, land subsidence is currently occurring in areas outside of the Corcoran clay. Even though subsidence is now occurring in areas outside of the Corcoran clay, the relative amount is less than the historical subsidence in areas underlain by the Corcoran Clay.

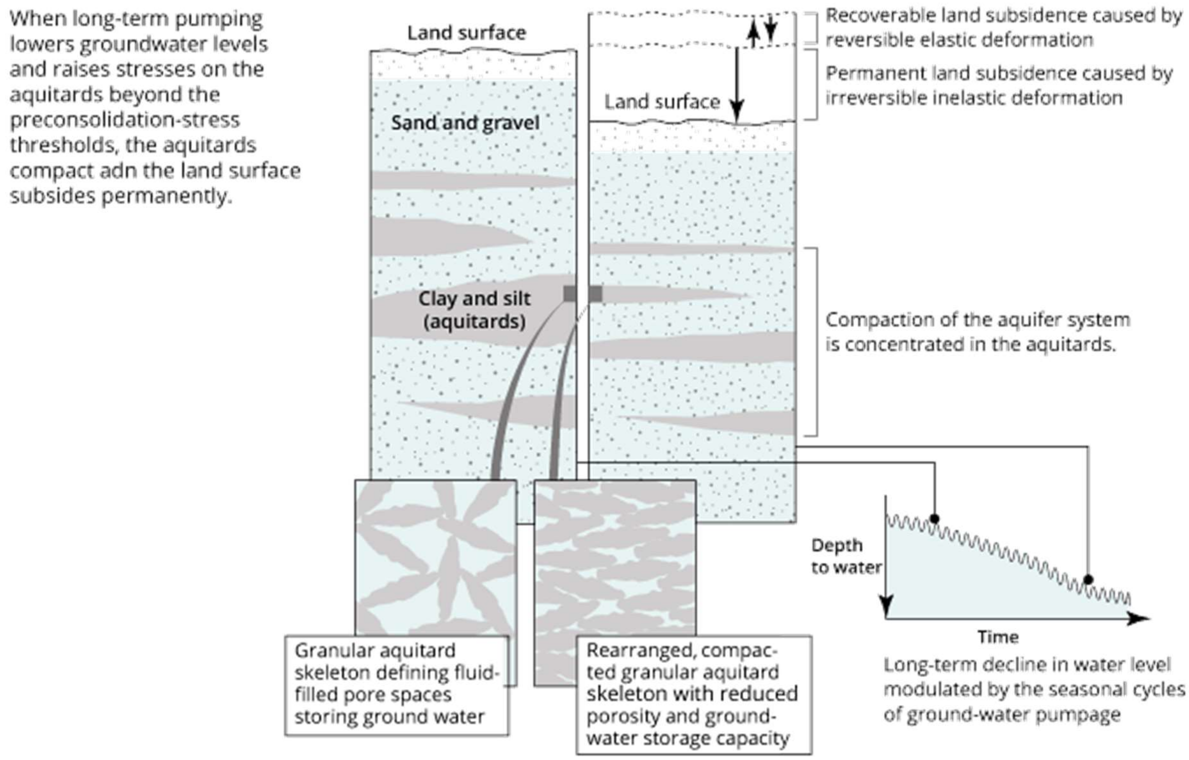

Figure 3-22 Aquifer compaction due to groundwater pumping as identified by USGS

(https://ca.water.usgs.gov/land_subsidence/california-subsidence-cause-effect.htm)

3.2.6.1 Review of Existing Data

Available land subsidence data was reviewed to determine what information exists and to assist in establishing a monitoring network. The review included examination of the Hydrogeologic Conceptual Model (Section 3.1), historic groundwater levels, historic infrastructure impacts, and on-going subsidence monitoring programs, which use various methods to track subsidence via surveys, remote sensing data, and geospatial imagery. A discussion of existing data is provided below.

Generally, areas with the most significant land subsidence are underlain by the Corcoran Clay member of the Tulare Formation. As shown on **Figure 3-14** in the HCM, the Corcoran Clay extends into the western portion of the Madera Subbasin and the entirety of NSWDGSA. Comparison of Figure 3-23 and Figure 3-24 show land subsidence is minor in the Madera Subbasin where the Corcoran Clay is not present. In addition to the presence of the Corcoran Clay, aquifer compaction and the resultant land subsidence are also dependent on over-extraction of groundwater from the confined aquifer. As discussed in 3.2.1, the long-term trend of water levels in the area has been downward due to groundwater extraction.

Nearby areas within the subbasin have experienced significant complications due to subsidence. Land subsidence in the Central Valley of California has caused serious operational, maintenance, and construction-design problems for adjacent water-delivery and flood-control canals in the San Joaquin Valley, such as the Chowchilla and Eastside Bypasses for the San Joaquin River. Several canals used for both irrigation and flood control have had reduced freeboard and structural damages. Wells, pipelines, roads, and bridges have also suffered damage due to subsidence. Combating subsidence in the County and adjacent districts has already required millions of dollars of repairs, and more repairs are expected in the future.

Subsidence Monitoring Program Results

Land subsidence has impacted the west side of the San Joaquin Valley for decades. Land subsidence was first monitored in the 1920s when there was less access to surface water. From the 1920s to 1970s, subsidence rates were at a historical high with rates around one foot per year in some areas. Subsidence rates and monitoring efforts decreased after the 1970s as surface water became more available due to the canals and water storage projects completed in California. This resulted in less reliance on groundwater to meet demands. Land subsidence monitoring increased in the 2000s due to drought conditions and environmental regulations that reduced surface water allocations, which resulted in local farmers and cities relying more heavily on groundwater. Data sources for the following discussion include the U.S. Bureau of Reclamation (USBR) San Joaquin River Restoration Project (SJRRP) and NASA InSAR data.

In a report from NASA (Farr, Jones, & Liu, 2015), which monitors subsidence in the Central Valley using InSAR data, two main areas of subsidence are evident in the San Joaquin Valley from July 2007 to 2010 and from May 2014 to January 2015. One subsidence bowl is centered around Corcoran near the intersection of the Tulare, Tule, and Kaweah Subbasins and the other is south of El Nido near the intersection of the Chowchilla, Merced, and Delta-Mendota Subbasins. The subsiding area near El Nido is approximately 25 miles in diameter (Farr et al., 2015) and its outer reach extends to NSWDGSA and the western area of the Madera Subbasin. Subsidence in the El Nido area was as much as 25 inches (2.08 feet) from July 2007 to December 2010 and 12 inches from May 2014 to January 2015 (Farr et al., 2015).

Figure 3-23 shows land subsidence rates based on the USBR SJRRP monitoring data from December 2011 to December 2017. Figure 3-24 shows SJRRP land subsidence monitoring locations and results from December 2016 to December 2017. The NSWDGSA area is shown to have land subsidence rates between -0.15 feet (-1.8 inches) and -0.6 feet (-7.2 inches) annually. Subsidence rates are higher in the northeastern portion of the GSA.

USBR monitoring point 123 is located on the Chowchilla Bypass just northeast of NSWDGSA. Since December 2011, observed subsidence rates at this point have been between 0.18 and 0.68 feet per year, with the highest annual rate measured from July 2016 to July 2017. The subsidence rate at this monitoring point from December 2011 to December 2018 is 0.52 feet per year. USBR monitoring point 1007R is located on the western boundary of NSWDGSA. At this monitoring point annual subsidence rates have ranged from 0.09 to 0.60 feet per year since December 2011. The highest annual rate at this monitoring point occurred from December 2012 through July 2014. Overall the since the program began the subsidence rate at 1007R from December 2012 to December 2018 is 0.39 feet per year. **Figure 3-25** graphs the annual subsidence rates measured by the SJRRP program from December to December and July to July.

Due to subsidence rates north of NSWDGSA, the Chowchilla Bypass that runs along the east side of the District is experiencing a change in design operation. The SJRRP with DWR has conducted a hydraulic analysis to study the effects of subsidence on the Chowchilla and Eastside Bypasses and Reach 4A of the San Joaquin River, including the Sand Slough Connector Chanel (DWR, 2018). The study was conducted for the years 2011, 2016, and projected into 2026 using DWR land subsidence data and HEC-RAS software for modeling flow.

The greatest subsidence appears to be occurring between Road 9 and the Sand Slough control structure. In turn, the bypass channel slope upstream of Road 9 and the Fresno River confluence is steepening. This increase in slope results in an increase in freeboard (more channel capacity). In the segment from Road 4 to Sand Slough, the channel slope flattens out causing an increase in water depth, resulting in reduced freeboard. Channel design capacity along with estimated channel capacity results are shown in Table 3.5.

Table 3-5 Estimated Flow Capacity in Reach 4A and the Chowchilla and Eastside Bypasses based on Freeboard Criteria (in cfs) (DWR, 2018)

Channel Segment	Flood Design Flow[a]	2008[b]	2011[b]	2016	2026
Chowchilla Bypass					
Bifurcation Structure to Fresno River	5,500	>5,500	>5,500	>5,500	>5,500
Eastside Bypass					
Fresno River to Berenda Slough	10,000	>10,000	>10,000	>10,000	>10,000
Berenda Slough to Ash Slough	12,000	>12,000	>12,000	>12,000	>12,000
Ash Slough to Sand Slough	17,500	9,500[c] – 12,500	7,500[c] – 11,500	5,700[c] – 9,500	3,400[c] - 7,500
Sand Slough to Mariposa Bypass[d]	16,500	16,000	14,500	12,500	9,800
San Joaquin River					
Reach 4A	4,500	ND	ND	3,700[e] – 4,300	2,500[e] – 3,800
Sand Slough Connector Channel	ND	ND	ND	2,100[e] – > 4,500	0[e] – > 4,500

Notes: cfs = cubic feet per second, ND = not determined as part of this study
[a] Referenced from the Lower San Joaquin River Flood Control Project Operation and Maintenance Manual.
[b] Results obtained from a previous study done by DWR in 2013.
[c] Reduced capacity assumes contribution of 4,500 cfs from Reach 4A of the San Joaquin River (creating backwater conditions).
[d] Capacity assumes diversions into the Mariposa Bypass based on the O&M Manual operating rules.
[e] Reduced capacity assumes contribution of 12,000 cfs through the Bypass Channel (creating backwater conditions).

For reference, **Figure 3-26** displays the channel sections covered in the subsidence study. Results indicate that the Chowchilla Bypass remains operable at above design capacity; however, as part of the limitations in the study, sediment transport was not considered, which could affect the hydraulics of the canal. Furthermore, downstream canals are shown to have reduced channel capacity, which limits the volume of water that can be sent down the Chowchilla Bypass.

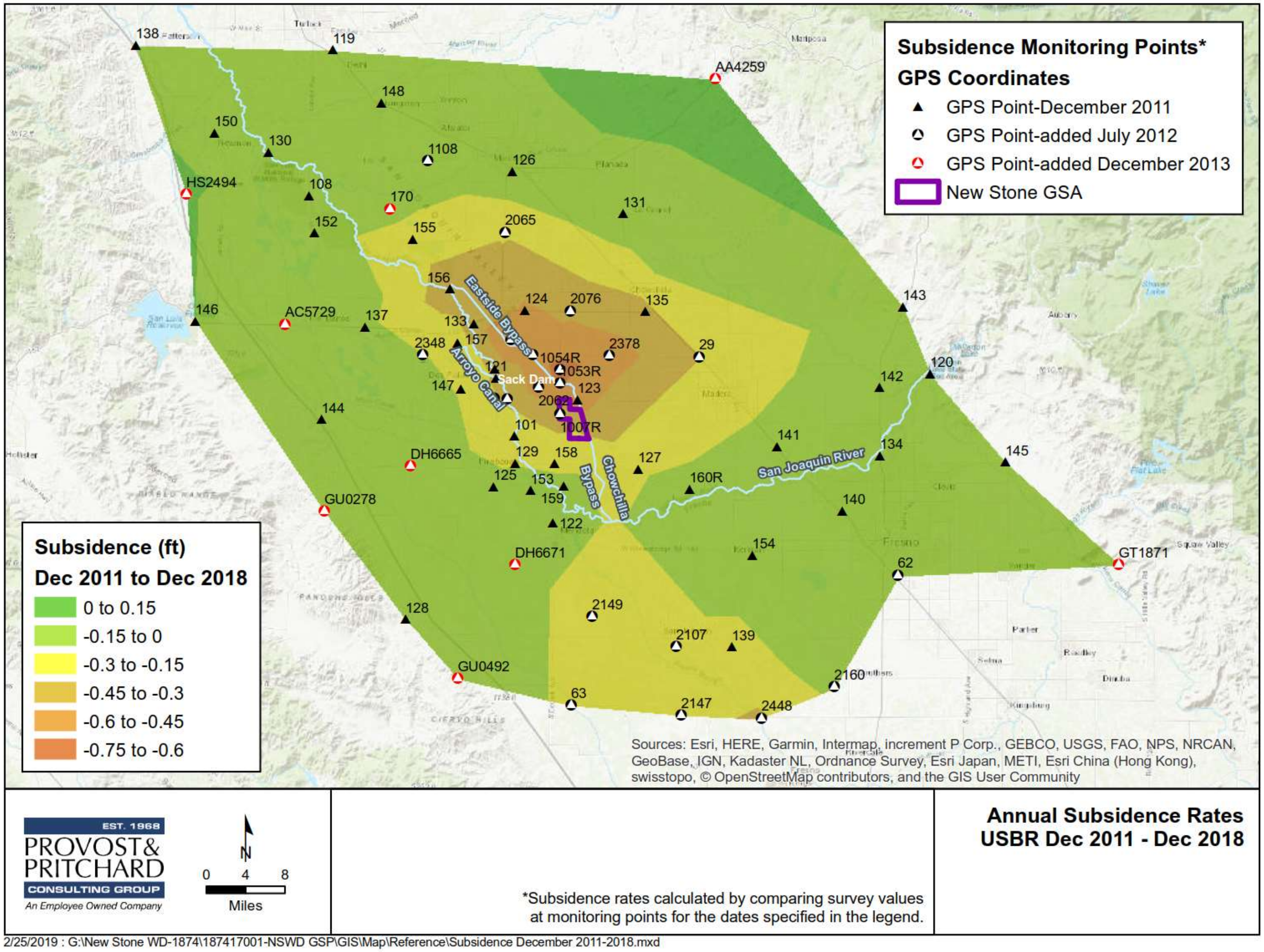

Figure 3-23 SJRRP Subsidence Data Dec. 2011 to Dec. 2018

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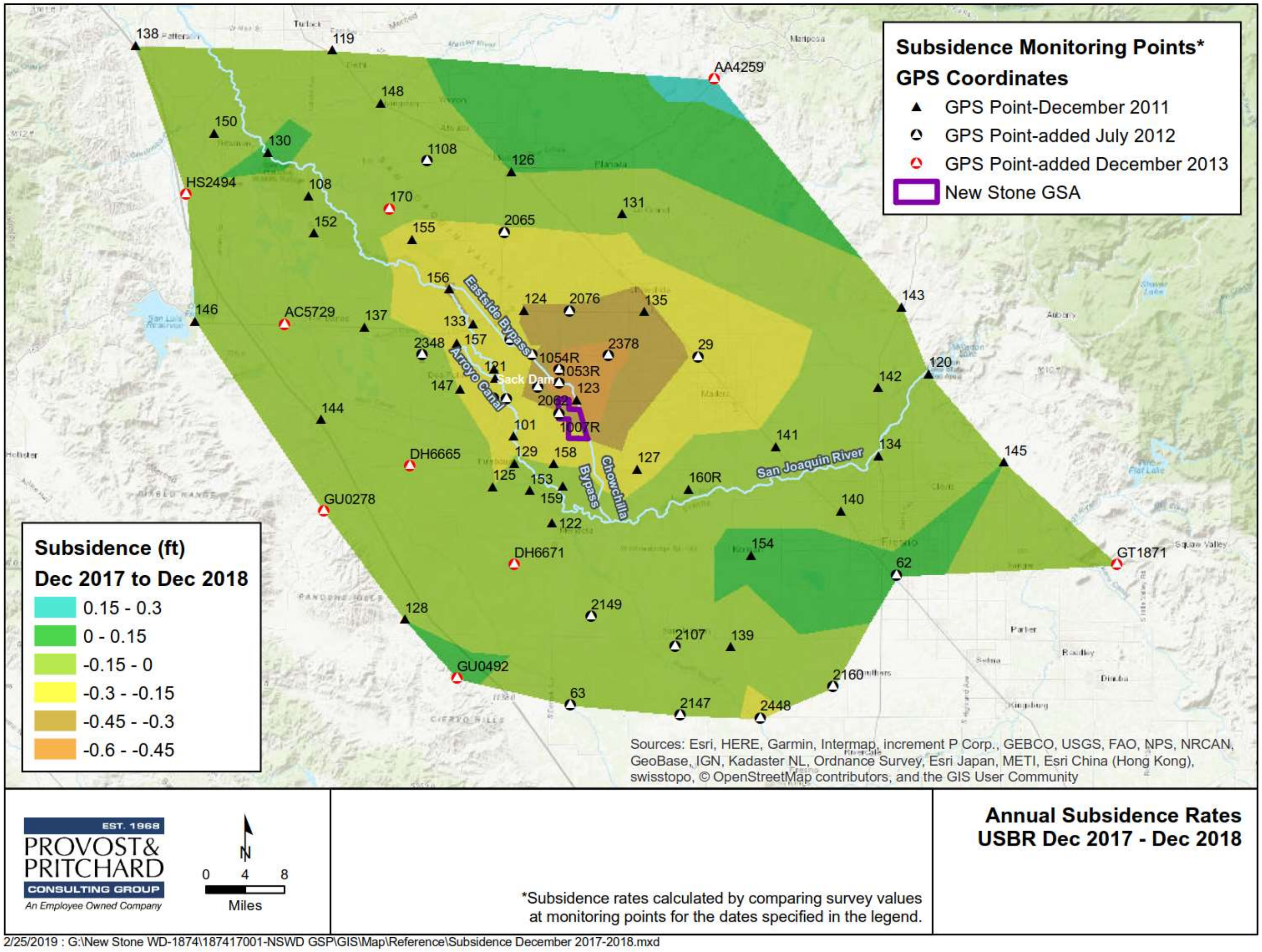

Figure 3-24 SJRRP Subsidence Data Dec. 2017 to Dec. 2018

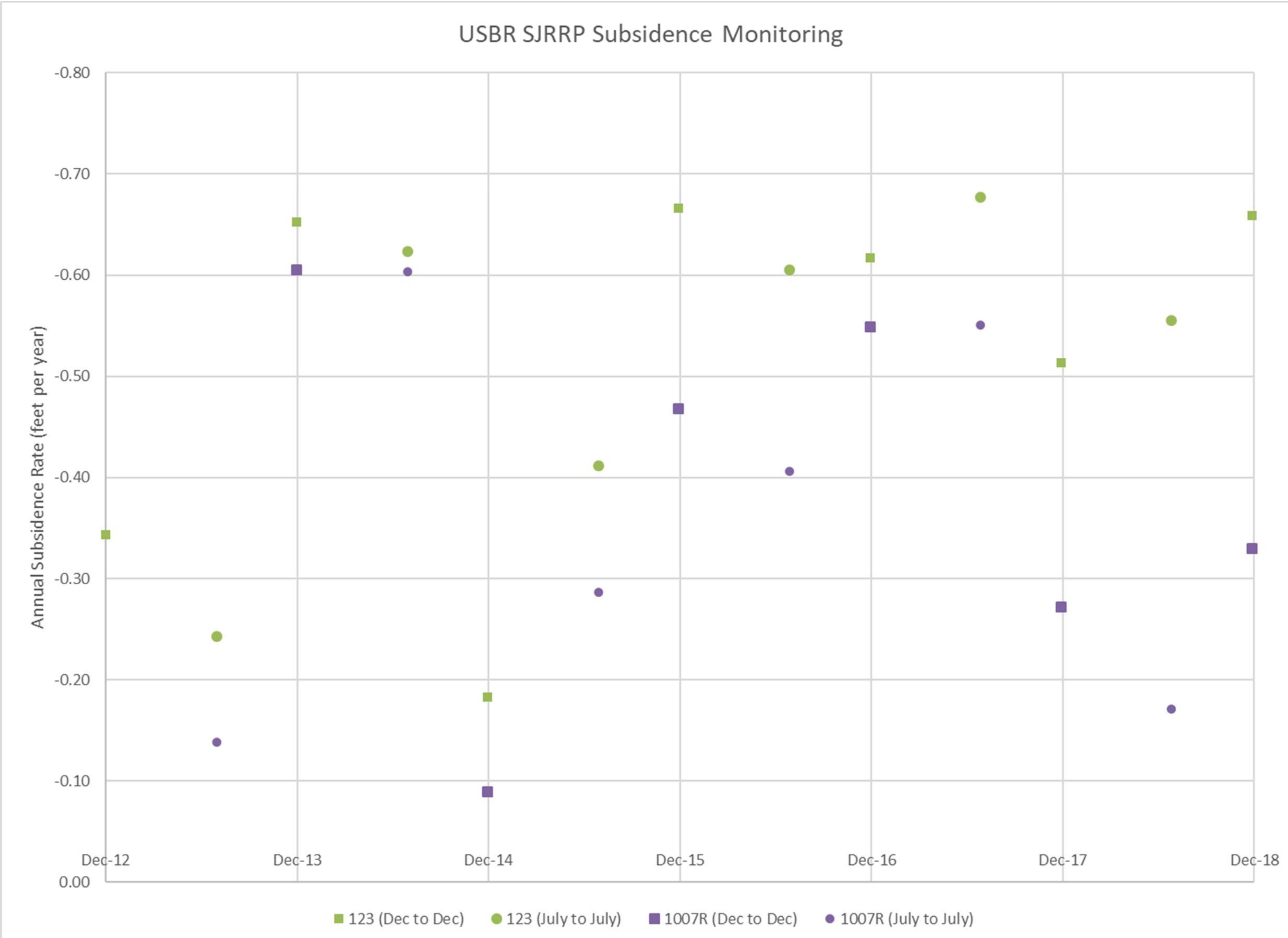

Figure 3-25 SJRRP Annual Subsidence Rates

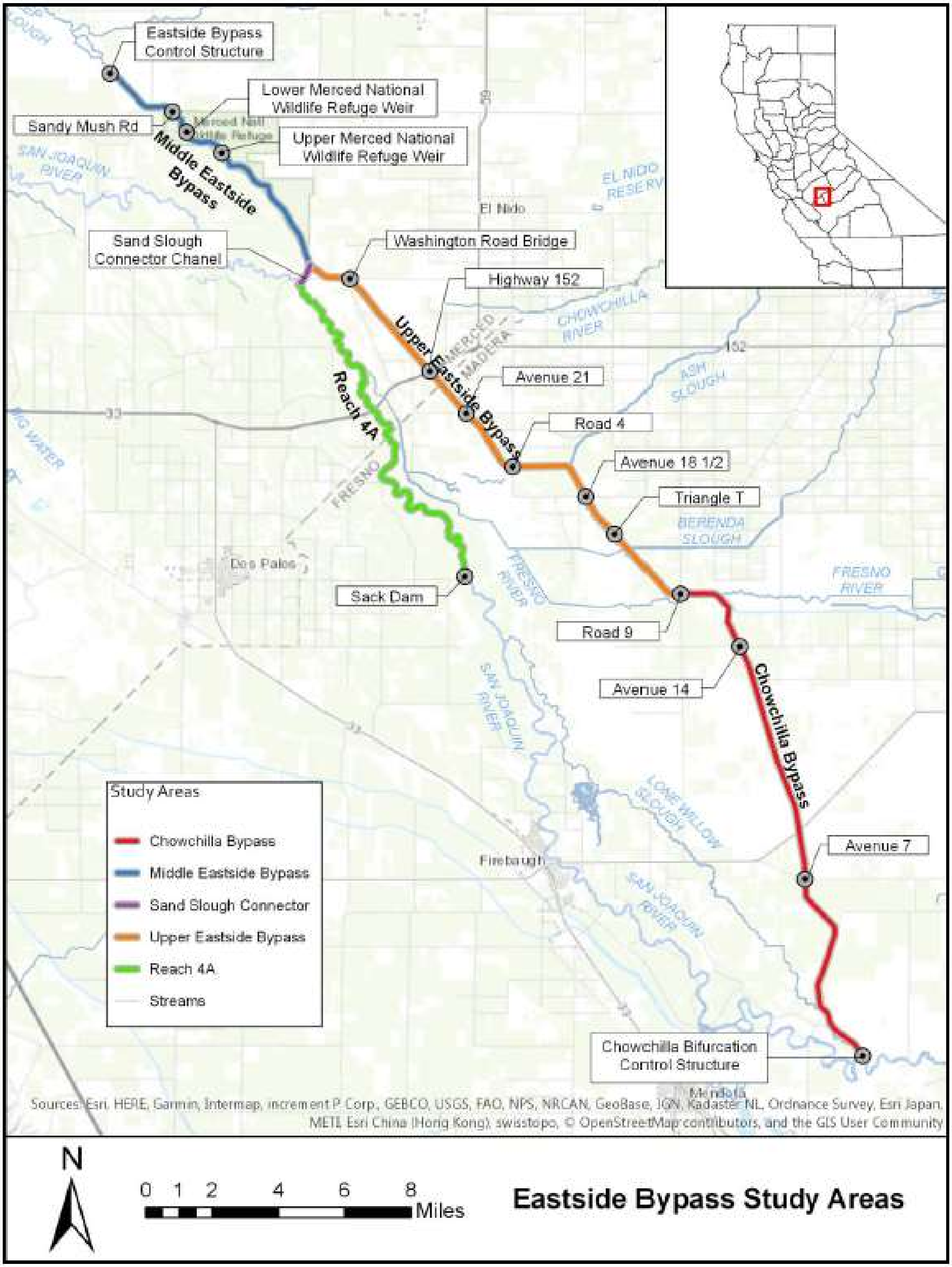

Figure 3-26 DWR (2018) Study Area

3.2.7 Surface Water and Groundwater Interconnections

Regulation Requirement:

§354.16(f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or best available information.

Major surface water systems in the Madera Subbasin are the San Joaquin and Fresno Rivers. The nearest NSWDGSA boundaries are approximately 4 miles from Reach 3 of the San Joaquin River and 1 ½ miles from the confluence of the Eastside Bypass and the Fresno River.

SGMA Regulations are concerned with the volume or rate of surface water depletion caused by groundwater pumping in basins where surface water and groundwater are interconnected. Interconnected surface water systems are defined as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted (Modeling Best Management Practices, DWR, 2016). The purpose of this section is to identify any known areas within the NSWDGSA where groundwater pumping has caused surface water depletion. Currently, there is no evidence that active wells within the GSA are causing increased seepage loss or impacts to downstream beneficial uses.

3.2.7.1 Interconnected Surface Water Systems

Only two surface water systems are within the vicinity of NSWDGSA: the Fresno River and the Chowchilla Bypass. The Fresno River joins the Eastside Bypass approximately 1 ½ miles north of New Stone Water District GSA. The Eastside Bypass is highly regulated and is often dry during the year as water is diverted for irrigation prior to reaching NSWDGSA. Due to the long dry periods in the Fresno River, which often remain for multiple years, and the distance from the GSA, there is no interconnection between the groundwater in the NSWDGSA and the Fresno River.

The Chowchilla Bypass is a flood control structure that diverts San Joaquin River water from the upper reaches of the river to the lower reaches in Merced County. The bypass only runs once every 3.5 years on average, and there is no interconnected groundwater and surface water.

3.2.8 Groundwater Dependent Ecosystems

Regulation Requirement:

§354.16(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or best available information.

There are no interconnected surface water systems throughout the NSWD and the depth of groundwater ranges from 50 to 110 feet below ground surface. With this deep to water there no groundwater dependent ecosystems within the district.

3.3 Water Budget Information

Regulation Requirement:

§354.18
(a) Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

A water budget is defined as a complete accounting of all water flowing into and out of a defined area (e.g., a subbasin or GSA) over a specified period of time. A water budget is crucial to sustainable groundwater management by quantifying the historic and current overdraft, in turn having a goal to set demand mitigation and supply augmentation objectives. The water budget for New Stone WD was developed using knowledge gathered from the hydrogeologic conceptual model, precipitation data, measurements of inflows and outflows, and other various data sets described throughout this section in more detail.

GSP regulations stipulate the need to use the best available information and the *best available science* to quantify the water budget for the basin. Best available information is common terminology that is not defined under SGMA or the GSP Regulations. Best available science, as defined in the GSP Regulations, refers to the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, which is consistent with scientific and engineering professional standards of practice. It is understood that initial steps to compile and quantify water budget components may be constrained by GSP timelines and limited funding and may consequently need to rely on the best available information that is obtainable at the time the GSP is developed.

3.3.1 Description of Groundwater Model

Regulation Requirement:

§354.18
(e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.
(f) The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.

GSP Regulations do not require the use of a model to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater. However, if a model is not used, the GSA is required to describe in the GSP an equally effective method, tool, or analytical model to evaluate projected water budget conditions. In basins with interconnected surface water systems or complex spatial and temporal variations in water budget components, quantifying and forecasting streamflow depletion and other water budget components may be extremely difficult without the use of a numerical groundwater and surface water model. NSWD has been part of a cooperative effort in the Madera Subbasin and much of the documentation for the water budget can be found in *Madera Subbasin Sustainable Groundwater Management Act Basin Boundary Water Budget* by Davids Engineering and Luhdorff & Scalmanini (DE & LSCE), dated February 2018. The purpose of the investigation was to develop a preliminary water budget for the subbasin as a whole according to DWR's GSP regulations. The subbasin boundary water budget is based on historical data and provides insight into the magnitude of the historical imbalance (or overdraft) of the subbasin. The following discussion is a summary of the conceptual water budget model from DE & LSCE for the subbasin as a whole.

Groundwater and surface water are critical resources that support agriculture and other economic activities in the subbasin. Groundwater is particularly important because it is relied upon to a significant extent in all years and serves as the main supply source in periods when surface water supplies are limited. Thus, the sustainable management of groundwater is important to the long-term prosperity of Madera County's various communities. The Sustainable Groundwater Management Act of 2014 (SGMA) allows for local control of groundwater resources while requiring sustainable management.

The lateral extent of the basin is defined by the subbasin boundaries provided on DWR's groundwater website (DWR, 2017) and is discussed in Chapters 2 and 3.1 of this GSP. The vertical boundaries of the subbasin are the land surface and the base of fresh water in the underlying aquifer (Page, 1973), as discussed in the basin wide Hydrogeologic Conceptual Model (HCM) developed during previous data collection and analysis efforts conducted by DE and LSCE (2017). The vertical extent of the basin is subdivided into a surface water system (SWS) and the underlying groundwater system (GWS) with separate but related water budgets prepared for each that together represent the overall subbasin water budget.

In accordance with GSP regulations, a base period must be selected so that the analysis of sustainable yield is performed for a representative period with minimal bias that might result from the selection of an overly wet or dry period, while recognizing changes in other conditions including land use and water demands. The base period should be selected considering the following criteria: long-term mean annual water supply; inclusion of both wet and dry periods, antecedent dry conditions, adequate data availability; and inclusion of current hydrologic, cultural, and water management conditions in the basin. To develop a preliminary base period to for sustainability analyses of the Madera Subbasin during GSP development, only historical precipitation records for the area were evaluated.

Precipitation provides an indication of the long-term mean water supply and potential for natural groundwater recharge. Monthly precipitation records acquired from the Western Regional Climate Center for a station in Madera (Station 045233) were analyzed for the period 1928 through 2015. A plot with annual precipitation, mean annual precipitation, and cumulative departure from mean annual precipitation was developed for the Madera station (**Figure 3-27**) It was determined that the period of 1989 through 2015 is a relatively balanced climatic period with a similar number of wet and dry years and some prolonged periods of wet, dry, and average conditions and represents a reasonable base period for conducting sustainability analyses.

Although the evaluation of the precipitation data at Madera suggest that 1989 through 2015 represents a good base period of 27 years for conducting GSP analyses, additional consideration with respect to the base period should be given during the GSP development as additional data review is conducted. In particular, consideration should be given to the patterns of CVP supplies and to local supplies from Hensley Lake, which may or may not be strongly correlated with local precipitation. Ultimately, the GSP base period may be selected based on some combination of these and/or other factors to define a period that is normal for the subbasin from a water budget perspective.

During review of groundwater level data needed to calculate change in groundwater storage from observed conditions, it became apparent that 1989 through 2014 would be a more appropriate analysis period for this effort because of the relative sparsity of groundwater level data (and therefore diminished quality of resulting groundwater level interpretations) available for 2015. Therefore, the analysis results discussed below are based on analysis of the period 1989 through 2014, although data and calculations of water budget components were also assembled for 2015, to the extent that suitable data exist. Based on the cumulative departure curve **Figure 3-27** used to choose time periods for analysis, using 2014 as the last year still provides a balanced hydrologic time period for the analysis. Therefore, groundwater elevation contours were produced for spring of 2014 and used for change in groundwater levels and change in storage calculations.

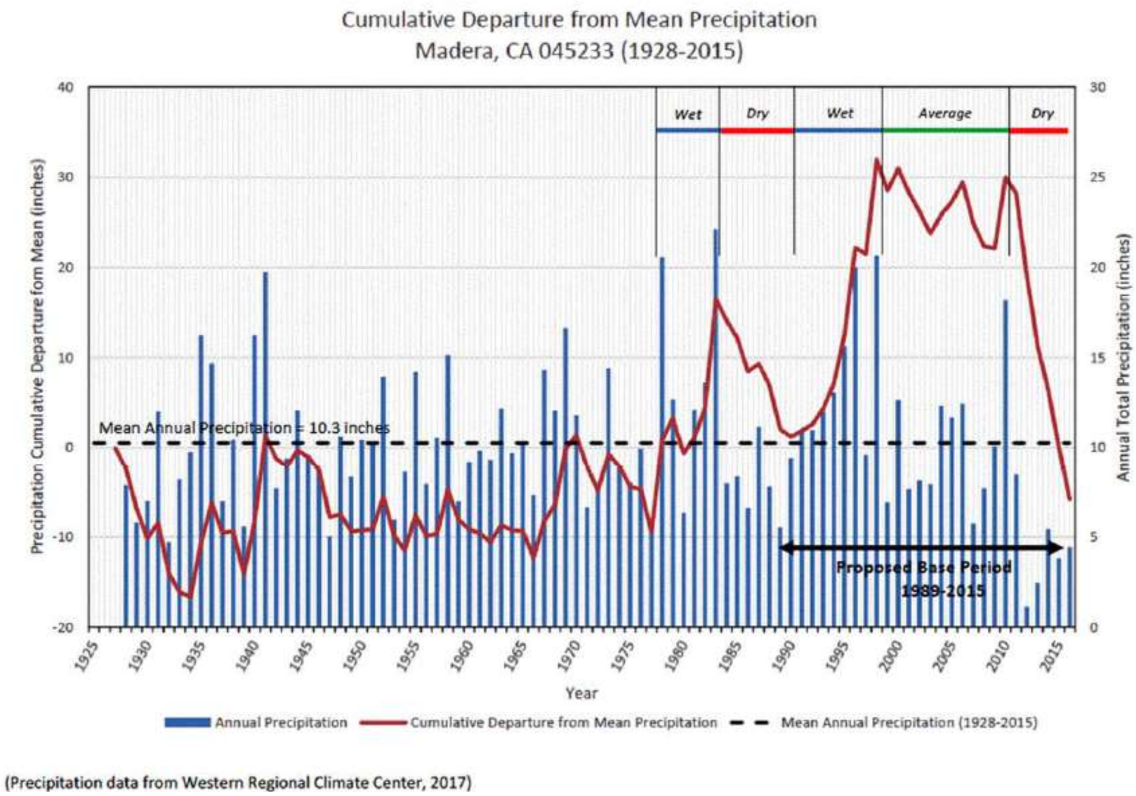

Figure 3-27 Cumulative Departure from Mean Precipitation

3.3.2 Description of Inflows, Outflows, and Change in Storage

Regulation Requirement:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data: (1) Total surface water entering and leaving a basin by water source type. (2) Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems. (3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.

Subbasin boundary inflows and outflows must be quantified according to Section §354.18(b) of the GSP Regulations. Quantification of inflows and outflows is necessary for estimating the overdraft on an average annual basis. Some variables were estimated based on best available information due to a lack of measured data. For the water budget, water supply and demand has been broken down by water source type and use. A summary of the Madera Subbasin water budget flows from DE & LSCE (2018) is provided below.

<u>Madera Subbasin Water Budget Conceptual Model</u>

A conceptual representation of the Madera Subbasin boundary water budget is simplified and presented in **Figure 3-28.** Boundary inflows include precipitation, surface water inflows (in various canals and streams), boundary watercourse seepage, and groundwater inflows from adjoining subbasins. Outflows include evapotranspiration (ET), surface water outflows (in various canals and streams), and groundwater outflows. Also represented in **Figure 3-28** are groundwater recharge and extraction, which are "internal" flows between the SWS and GWS. Subbasin boundary inflows and outflows were quantified on a monthly time step for the period 1989 through 2015, including accounting for changes in storage within each time step, such as changes in water stored in the root zone. Surface water inflows and outflows for Madera Subbasin are shown in **Figure 3-29**.

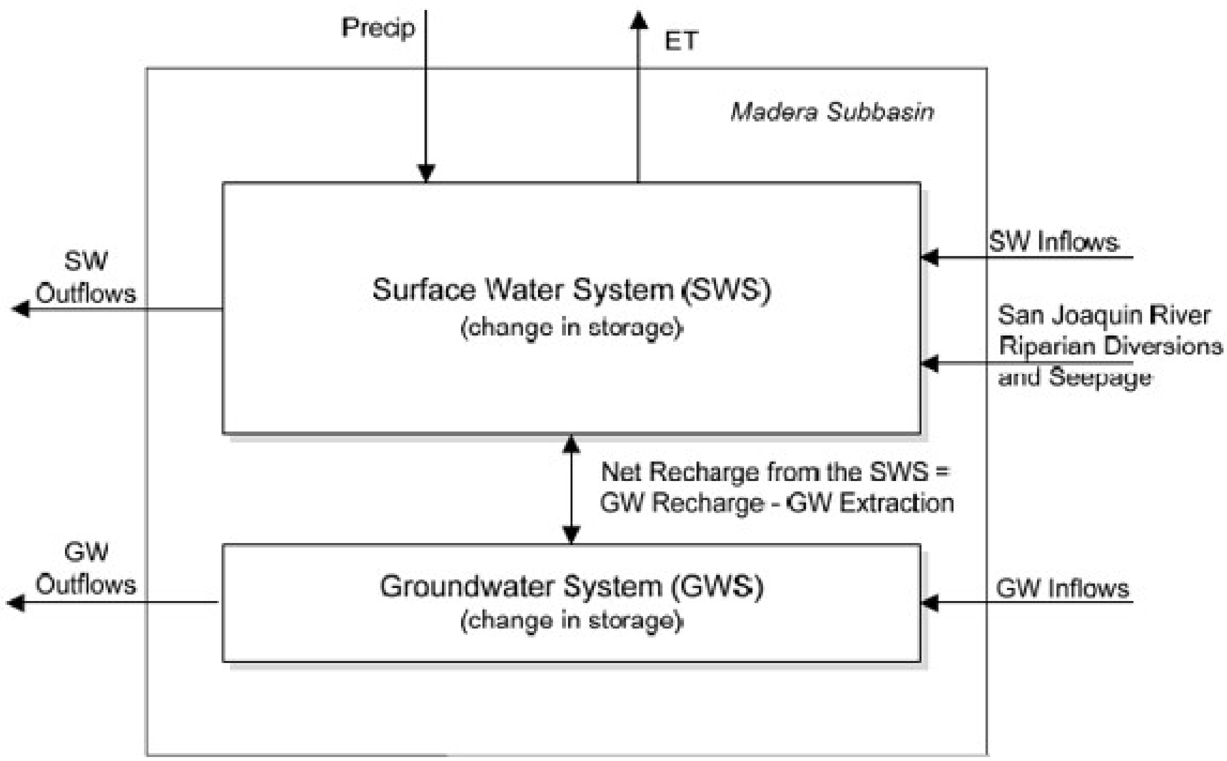

Figure 3-28 Preliminary Basin Water Budget Diagram (Davids Engineering and Luhdorff & Scalmanini, 2018)

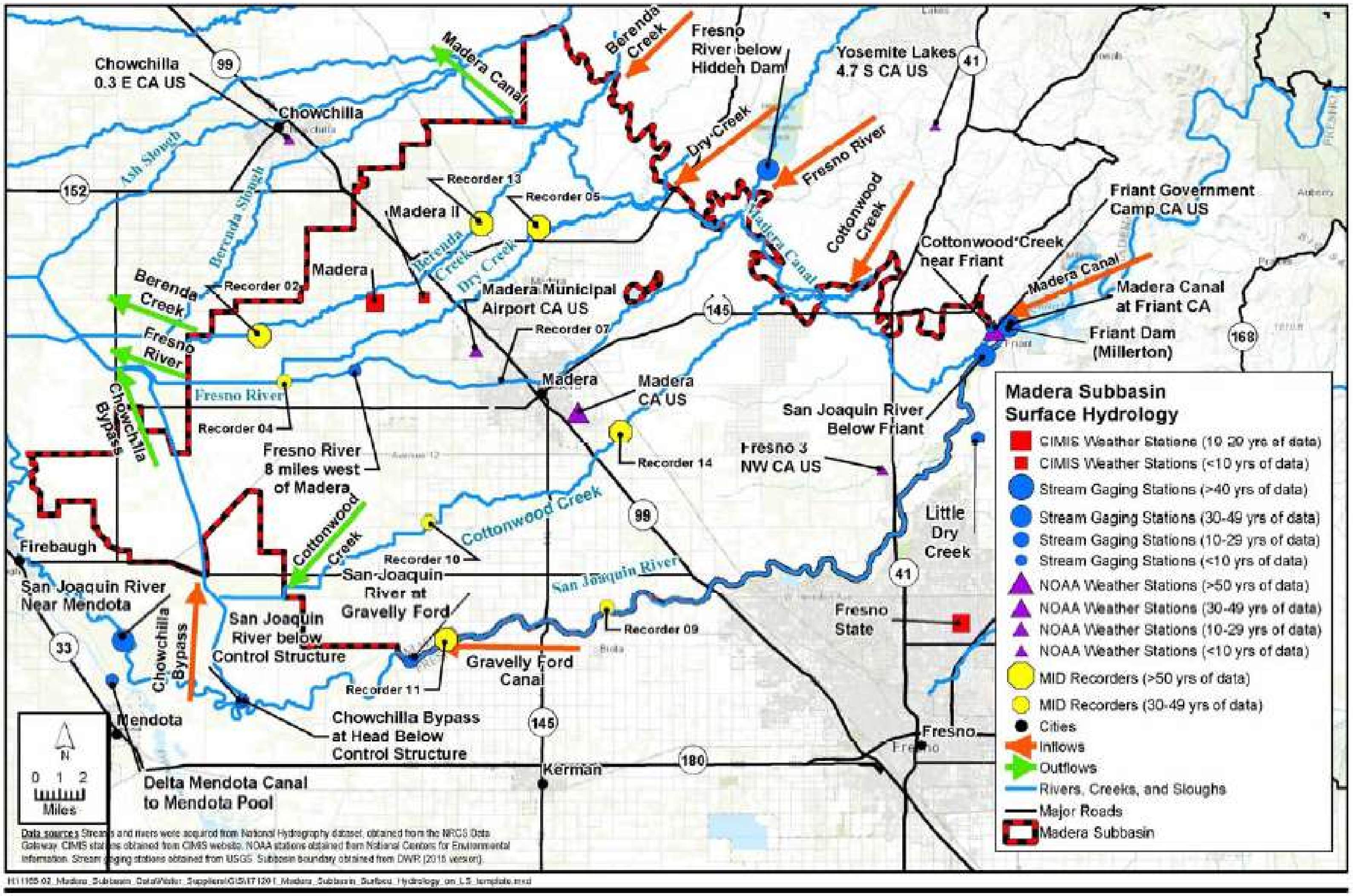

Figure 3-29 Preliminary Madera Subbasin Inflows and Outflows (Davids Engineering and Luhdorff & Scalmanini, 2018)

The SWS represents the land surface down to the bottom of plant root zone, within the lateral boundaries of the basin. The GWS extends from the bottom of the root zone to the definable bottom of the subbasin, within the lateral boundaries of the basin. The SWS basin boundary water budget was completed on a monthly time step and by calendar year. Inflows and outflows may cross the subbasin boundary or may represent exchanges of water between the SWS and the underlying GWS. **Figure 3-30**, below, shows the conceptual water budget flows including various inflows and outflows comprising recharge, extraction, and discharge from the GWS. Net recharge from the SWS to the GWS is defined as groundwater recharge minus groundwater extraction and is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS. Basin boundary inflows and outflows for Madera Subbasin were quantified on a monthly basis and any changes in storage were included, such as changes in water stored in the root zone.

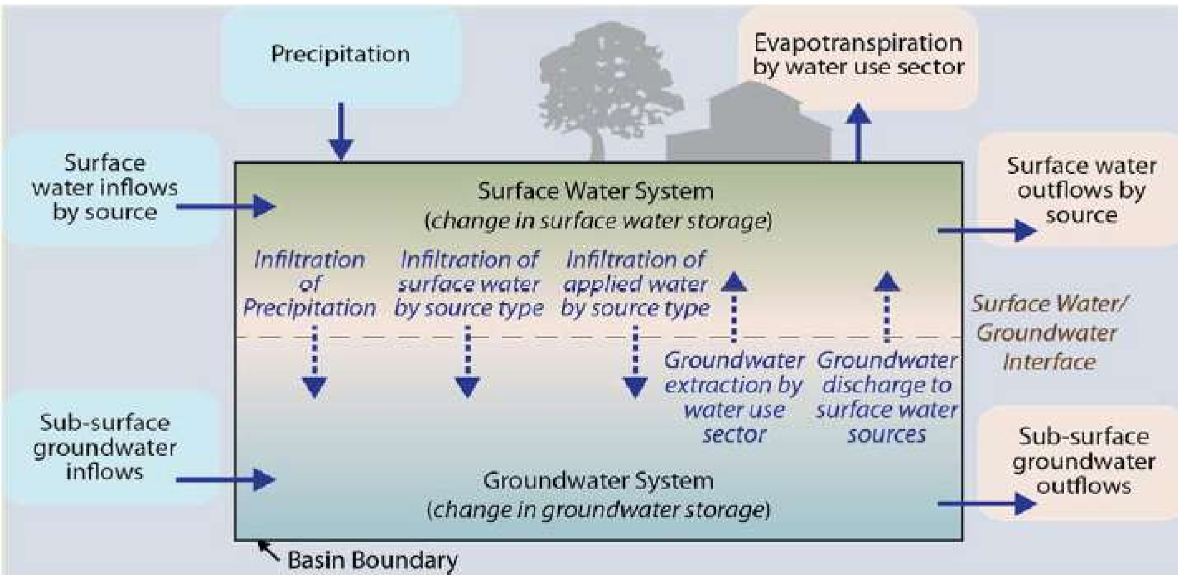

Figure 3-30 Preliminary Basin Boundary Water Budget (DWR Water Budget BMP, 2016)

The SWS is further subdivided into water use sectors identified in the GSP regulations. Water use sectors are defined in the GSP Regulations as "categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation." Water budgets for each water use sector in the subbasin will be added to the water budget during GSP development.

Preliminary estimates of subbasin overdraft derived from the SWS and GWS water budgets are briefly described in the following sections. Note: the report estimates an initial Preliminary Sustainable Yield across the entire Madera Subbasin and does not quantify local variability, including the variability between the different GSAs. The preliminary sustainable yield for the overall Madera Subbasin will change once a more detailed analysis is performed. This GSP will quantify local variability for NSWD GSA.

Sustainable yield is defined as the maximum quantity of water, calculated over a base period representative of long-term conditions (in this case 1989 through 2014) in the subbasin that can be withdrawn annually from a groundwater supply without causing an undesirable result (CA Water Code 10721). This includes accounting for any temporary water surpluses

For this preliminary analysis, three calculation methods were used to estimate sustainable yield in the Madera Subbasin. The three methods use different combinations of SWS and GWS water budget results to calculate sustainable yield. These preliminary sustainable yield estimates do not include an evaluation of the spatial distribution of pumping and recharge within the subbasin in relation to sustainability indicators. More detailed analyses will be performed during preparation of the GSP to provide this essential additional detail.

The results of all three sustainable yield calculations are similar in magnitude as indicated in **Table 3-6**. The first method is based on subtracting historical change in groundwater storage from historical pumping, indicating an average sustainable yield of slightly more than 300,000 acre-feet annually. The second method is based on summing the total inflow to the GWS, indicating a sustainable yield of slightly less than 300,000 acre-feet. Finally, the third method is based on numerical modeling of the subbasin in which water demands are reduced until extraction (pumping) from the subbasin is balanced by recharge. This method also indicates a sustainable yield of slightly more than 300,000 acre-feet. The second and third methods each depend on the water budget results and, therefore, may not be completely independent. These results will be refined during GSP development.

Table 3-6 Preliminary Sustainable Yield Calculation Results

Qualification Method	Average Volume (AF)*	Estimated Confidence Interval (CI) (percent)	CI Source	Average minus CI (AF)	Average plus CI (AF)
GW pumping and GW Change in Storage	301,500	16%	Calculation	253,900	349,100
Total Inflows to GWS	298,200	28%	Calculation	214,900	382,400
"Simulation" of Reduced Demand	303,100	20%	Professional Judgment	242,500	363,700

*1989 through 2014

Based on these preliminary results, which represent recent historical conditions and reflect the 410,000 to 420,000 acre-feet of groundwater extractions occurring on an average annual basis in the subbasin, it is estimated that groundwater recharge would need to be increased by approximately 110,000 to 120,000 acre-feet annually to achieve sustainable operation of the groundwater system. Alternatively, some combination of increased groundwater recharge and decreased groundwater pumping and water consumption totaling to approximately 110,000 to 120,000 acre-feet annually would be needed to achieve sustainable operation of the groundwater system. This estimate assumes that all other water budget parameters (namely surface water supplies and GWS inflows and outflows) would remain the same in the future as they were during the period of analysis. More detailed analysis during GSP preparation will assess the reasonableness and validity of these assumptions, taking into account climate change and other possible local changes.

<u>New Stone Water District Water Budget Model</u>

In place of a model, the complete water budget including historical, current, and projected, for NSWD was created using information from the basin setting discussed earlier in this chapter along with data from sources such as California Irrigation Management Information System (CIMIS), National Oceanic and Atmospheric Administration (NOAA), DWR, Irrigation Training & Research Center (ITRC), etc. The period of record chosen to analyze the historical data was 2003-2012. This period was chosen because it represents 100% of the long-term calculated natural flow (1901-2016) in the San Joaquin River and it closely reflects current management practices and facilities available to the District. Also, this period includes a mix of dry, normal, and wet years.

<u>Inflows</u>

Surface Water for Irrigation

NSWD has limited access to surface water. During high flow years, water is diverted from the SJR to the Chowchilla Bypass flood control structure. The District has an appropriative water right along the Chowchilla Bypass (referred to as Eastside Bypass/Chowchilla Canal in permit) of 15,700 acre-feet/year (permit number 19615). Currently, NSWD only has one turnout on the Bypass to serve the District. Due to the location of the turnout and the infrastructure within the District, NSWD has not always exercised their water right in the past years. As for projecting into the future, the District plans to use their water right to its full potential.

Surface Water for M&I
There are no municipal surface water systems in the area.

Spill Inflows
There are no spill inflows in NSWD.

Precipitation
Monthly precipitation data was collected from the National Climactic Data Center (NCDC) for the period of record. The closest weather station to New Stone WD with the available data is the Madera Station (045233); therefore, this station was utilized to represent the District. Also, this station had historic data that dates back more than 50 years. The Madera Station has records of precipitation from 1928-2017. It should be noted that the District lies directly between the Madera Station and the Firebaugh CIMIS station. It may be prudent in the future to take precipitation from the Firebaugh CIMIS station into account to more accurately estimate precipitation in the NSGSA.

Averages were calculated for the entire recorded period, the most recent 50-year period, and the hydrologically average period (2003-2012). The averages were compared to ensure that the historically average period does not vary too much from the 50-year and total historic averages. There is a less than 10% difference in the calculated average precipitation for each of the periods.

The historic water budget considers the water years from 2003-2012 to calculate an average annual precipitation of 9.60 inches, while the projected budget assumes the average annual precipitation over the last 50 years of 10.8 inches will continue into the future.

Deep Percolation
Deep percolation occurs in NSWD from precipitation and applied irrigation water. When precipitation or irrigation causes the soil to reach field capacity (become saturated), water begins to move downward through the soil due to gravity. When it passes the root zone, it is considered part of the groundwater system. Deep percolation of precipitation is calculated using **Equation 3-1** (Williamson, Prudic, & Swain, 1989):

Equation 3-1 Deep Percolation of Precipitation

$$DP = 0.64 * P - 6.2$$

Where:
DP = Deep Percolation (inches)
P = Annual Precipitation (inches)

Deep percolation of irrigation water is estimated by assuming that any water applied in excess of evapotranspiration requirements, due to irrigation efficiency, trickles through the root zone and reenters the groundwater system. With an average irrigation efficiency of 81% in NSWD (based on NRCS efficiency tables), approximately 1,800 AF of water is recharged through deep percolation of irrigation water. Deep percolation of precipitation was assumed to be 5% for the 10-year precipitation average which equates to 200 AF.

Surface Water Seepage

A potentially large source of groundwater recharge occurs through seepage of unlined canals, streams, lakes, and reservoirs. For the purposes of this GSP, seepage is considered an inflow of surface water from the perspective of groundwater. Water infiltrates through the soil below unlined canals, reservoirs, and ponds leaving the surface water system and entering the groundwater system. NSWD does not currently contain any large reservoirs for the banking of water nor does it have much in the way of surface water distribution.

River and Local Stream Recharge
The Chowchilla Bypass runs along the eastern edge of the District and contributes a substantial amount of seepage to the groundwater system when it runs. The channel has a design capacity of 5,500 cfs, however at times flows to can exceed 8,000 cfs at the head gate. Varying flows lead to varying top widths of the channel, due to the cross-section of the channel which includes a smaller pilot channel. An illustration of the cross section can be seen in **Figure 3-31**. The recharge volume varies depending on the wetted area.

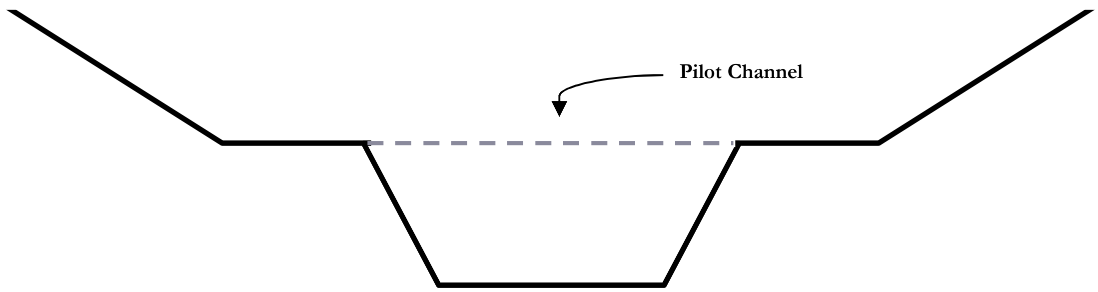

Figure 3-31 An Example of a Cross Section Representative of the Chowchilla Bypass

CDEC data is available for water flowing into the Chowchilla Bypass gauging station (CBP). It was determined that the pilot channel is exceeded at around 4,300 CFS. Along the 3.25 miles of the Bypass along the NSWD GSA border, the top width of the pilot channel was found to be about 160-feet wide, and the full width of the bypass was found to be about 580-feet wide.

For the period of record (2003 – 2012), the average annual days per year that water was available in the Bypass was 38 days. The average annual days per year with more than 4,300 CFS for the same time period was 11.3 days and 26.7 days with less than 4,300 CFS. Based on the seepage rate of 0.748 ft/day (weighted average of SSURGO seepage rate data provided by Davids Engineering based on soil type along the NSWD GSA border). This value was then divided by 2 to represent that NSWD only borders one-side of the Bypass. The total estimated annual average seepage for NSWD GSA from the Bypass is therefore approximately 1,600 acre-feet. This calculated historic seepage is expected to remain the same into the future, as it is assumed that flood flows will continue to flow in the Chowchilla Bypass at the same frequency.

Urban Stormwater Recharge
There is no urban stormwater recharge in New Stone WD.

Intentional Groundwater Recharge
Historically, NSWD has not used intentional groundwater recharge as a method for banking water. Water for recharge is only available during high flow years when the Bypass is running. When averaged over the 10-year average period, recharge equals 1,600 AF. Looking into the future, recharge ponds will be built to better capture the high flow water in the Bypass.

Groundwater Inflow
Water movement occurs due to hydraulic and pressure gradients, which is true above ground or below. Calculation of groundwater movement is done using transmissivity values based on soil type, groundwater

level contours, and cross boundary flow directions. Transmissivity changes with depth due to variations in soil types; however, an average transmissivity value was used for each boundary line for the depth of the aquifer. The largest inflow of groundwater into NSWD is through subsurface flows of approximately 4,500 AF/year. The projected budget into 2040 assumes the same subsurface flow.

Outflows

Evaporation and Runoff of Precipitation

Evaporation and runoff of precipitation is a surface outflow. It is calculated as the volume of precipitation that has not been attributed to deep percolation or effective precipitation. It has a negligible effect on groundwater storage changes. This value is calculated to be 1,500 AF for NSWD.

Groundwater Pumping for Irrigation

Groundwater pumping for irrigation of crops is usually an unknown factor due to the lack of historic regulation and monitoring of pumping. However, private groundwater pumping can be estimated with land use cropping data, ET data, and effective precipitation. Effective precipitation is the amount of rainfall that is beneficially used by the crops and is calculated for each year in the hydrologic period using the set of three equations seen below (MacGillivray, 1989).

Equations 3-2 Effective Precipitation

$$Nov - Feb = -0.54 + (0.94 * P)$$
$$Mar = -1.07 + (0.837 * P)$$
$$Oct = -0.06 + (0.635 * P)$$

Where:
P = Precipitation for the months listed (inches)

The average annual effective precipitation over the base period is subtracted from the crop ET values, obtained from the ITRC, for a typical year to get applied water demand.

The average effective precipitation is subtracted from the average consumptive use of crops (crop ET) for the hydrologic period. Land use data from DWR surveys and the United States Department of Agriculture's (USDA) CropScape database was used along with ET values from the ITRC. This value is known as crop water demand, or the amount of water that needs to be beneficially applied to the crop, typically given in acre-feet per acre (af/a). To capture the most recent land use, 2015 data from the Agricultural Commissioner of Madera County was used as the base for estimating private groundwater pumping for the current and projected budget. Average annual crop water demand and annual demand were calculated. Total effective precipitation was applied to crop ET supplementing pumping requirements.

Not all water that reaches the field is beneficially used by the crop due to irrigation inefficiencies. Thus, irrigation efficiency was considered in estimating groundwater pumping for irrigation. Irrigation techniques were assigned to various crops based on available DWR data, which indicated the most popular irrigation system for various crops. System efficiency was assumed based on NRCS efficiency tables and was found to be 81%. An average irrigation efficiency was applied to the total crop water demand to calculate the volume of water that will need to be applied as irrigation. As mentioned before, the volume of water applied that exceeds crop water demand is assumed to percolate back into the groundwater system.

Lastly, to get to the estimated volume of pumped groundwater, surface supplies and transportation losses must be considered. Known surface water diversions from the Chowchilla Bypass minus losses were taken out of the applied groundwater demand.

Using the method described above, the total groundwater pumping used for irrigation within NSWD for the period of record was found to be 9,700 AF/year.

Groundwater Pumping for Municipal and Industrial Use
There are no municipal or industrial agency wells in the area.

Evapotranspiration
Evaporation and evapotranspiration are not direct sources of groundwater outflow as pumping is; however, they are the main nonrecoverable losses, other than groundwater outflow. Some of the water pumped for irrigation purposes goes back into the system through deep percolation, while the majority permanently leaves the system through evapotranspiration, known as a consumptive use. This occurs to water used for irrigation of crops or municipal water used for irrigation of landscaping, so a portion of both water-use sectors contribute to nonrecoverable loss of groundwater. The evapotranspiration of the District was broken down into the evapotranspiration of applied water, effective precipitation, and municipal and industrial.

Evapotranspiration of applied water was determined by using data from the Cal Poly's ITRC, which provides average pan evaporation and crop ET for regions in the State of California. NSWD lies within ITRC Region 15. Only monthly average pan evaporation data was used from ITRC, which was combined with crop coefficient (k_c) values to calculate crop ET. It was determined that the evapotranspiration of applied water for NSWD was 7,900 AF/year.

To calculate evapotranspiration of effective precipitation, it was assumed that half of all annual precipitation is effective precipitation. An effective annual precipitation of 1,600 AF/year was determined for the District.

Municipal and industrial water use is assumed negligible due to the minimal agencies within the District.

Groundwater Outflow
Based on groundwater contours and operations within the District, groundwater outflows were assumed to be negligible.

3.3.3 Quantification of Overdraft

Regulation Requirement:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
(4) The change in the annual volume of groundwater in storage between seasonal high conditions.
(5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.
(6) The water year type associated with the annual supply, demand, and change in groundwater stored.
(7) An estimate of sustainable yield for the basin.

Subbasin

For the basin, **Table 3-7** documents the change in storage. **Figure 3-32** illustrates the total change in levels and the average yearly change in groundwater levels over the base period, using Water Surface Elevation (WSE) in feet (ft) and feet/year (ft/yr) in the Madera Subbasin.

Table 3-7 Preliminary Summary of Calculated and Model-Based Results of Change in Groundwater Storage (AFY)

Source	Estimate	Sy Estimate	Analysis Period	Wet Period	Average Period	Dry Period
			1989-2014	1990-1998	1999-2010	2011-2014
Calculated	Average Annual Upper Aquifer	*C2VSim*	-160,398	-103,073	-126,875	**-358,755**
		CVHM	-99,212	-107,480	-43,246	**-158,242**
		DWR	-71,368	-53,510	-50,600	**-143,466**
		GMP	-89,210	-66,887	-63,262	**-179,333**
		Average	-105,047	-82,738	-70,996	**-209,949**
Model-Based	Average Annual Upper Aquifer		-87,895	-37,890	-110,164	**-105,771**
	Average Annual Lower Aquifer		-8,009	684	-13,044	**-9,024**
	Total		-95,904	-37,205	-123,208	**-114,796**

Overall Estimated Change in Groundwater Storage from Groundwater System Analyses Over Analysis Period[1]	-110,000 to -120,000 AFY

1) The overall estimated storage change of -110,000 to -120,000 AFY is based on the average of the calculated methods of the Upper Aquifer plus the average model-derived value for the Lower Aquifer.

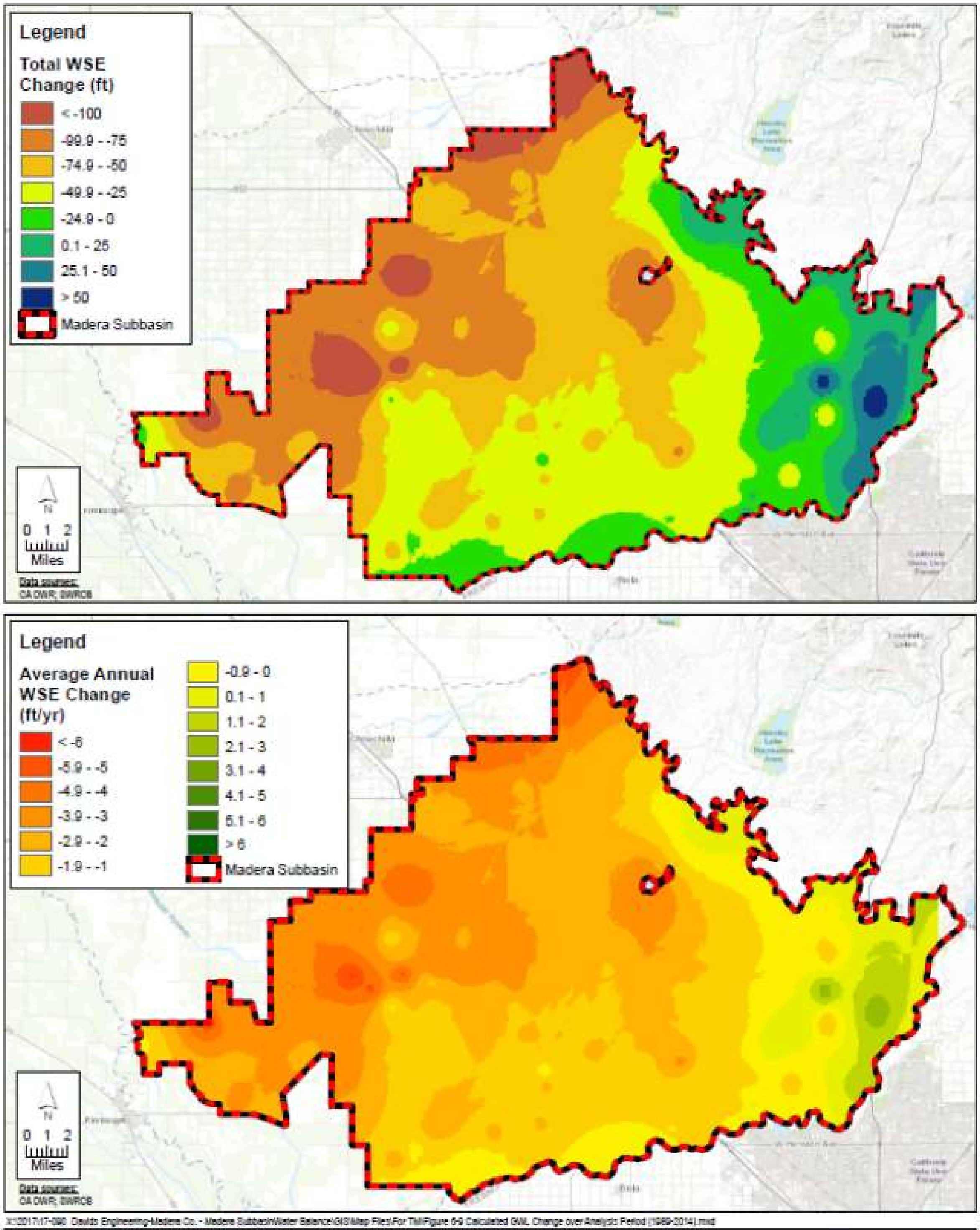

Figure 3-32 Preliminary Calculated Groundwater Level Change Over Analysis Period (1989-2014) (Davids Engineering and Luhdorff & Scalmanini, 2018)

Figure 3-33 graphically displays the change in groundwater storage in relation to a dry period, a wet period, and a typical period.

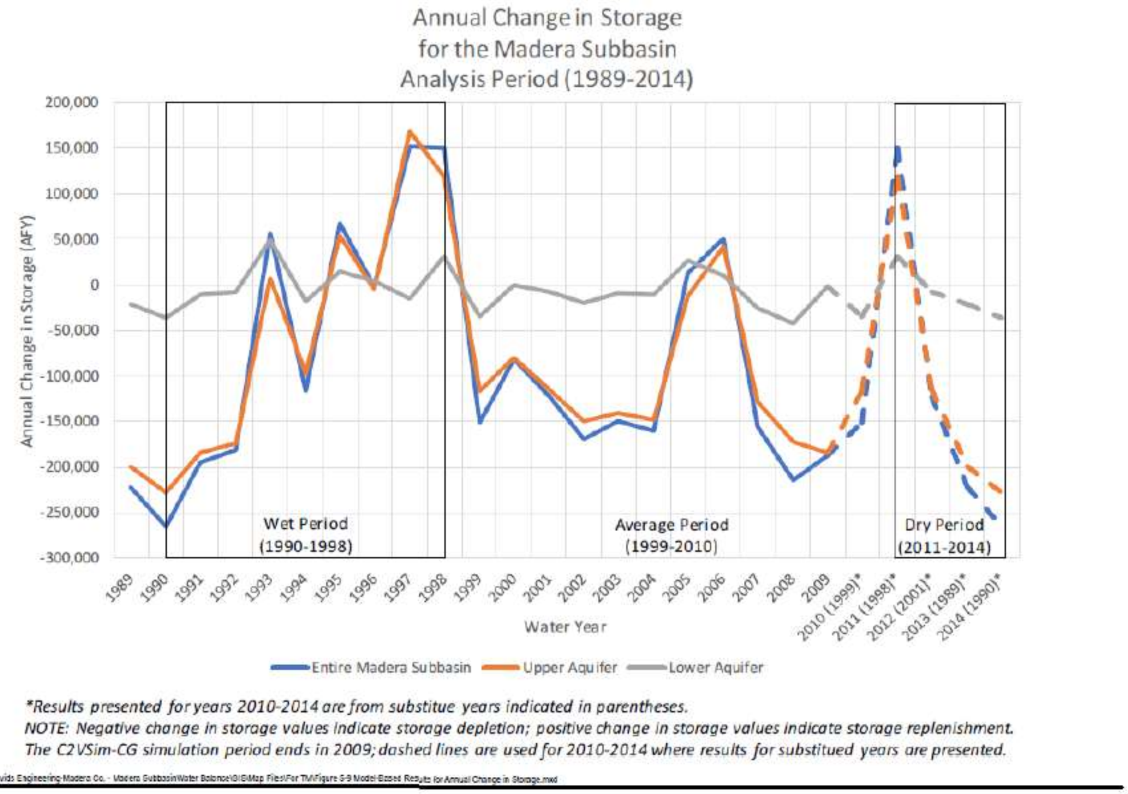

Figure 3-33 Preliminary Model-Based Results for Annual Change in Storage (Davids Engineering and Luhdorff & Scalmanini, 2018)

The third method for calculating overdraft reduced the evapotranspiration of applied water (ETaw) proportionately across all months, crops, and years until the net groundwater recharge from the SWS discussed in the water budget section was increased to an average annual value of zero. The reduction in ETaw resulted in a reduction in average annual groundwater pumping that increased the net groundwater recharge from the SWS. Again, applying judgement based on experience with similar water budgets, Confidence Intervals (CI) were estimated for the input values, and a CI was calculated (Clemmens and Burt, 1997) for the preliminary sustainable yield, resulting in a 95 percent CI between 242,500 and 363,700 AFY (**Table 3-8**).

Table 3-8 Preliminary Sustainable Yield Calculated from Simulation for Net Recharge from the SWS Equal to Zero (Davids Engineering and Luhdorff & Scalmanini, 2018)

Inflow/Outflow	Quantification Method	Average Volume (AF)*	Estimated CI (percent)	CI Source	Average Minus CI (AF)	Average plus CI (AF)
Sustainable Yield**	Calculation	303,100	20%	Professional Judgement	242,500	363,700

*1989 through 2014
**Estimated average annual groundwater pumping with net recharge from the SWS equal to zero

New Stone Water District GSA

Quantification of groundwater overdraft was calculated using the following simple equation:

$$\Delta\, Storage = Inflows - Outflows$$

Where:
Inflows = Subsurface inflow, deep percolation of irrigation water and precipitation, and seepage from the Chowchilla Bypass
Outflows = Groundwater pumping for irrigation demand (AF/year)

The above parameters are quantified and summarized in tables in the following section. The change in storage based on the above equation was compared to the calculated annual change in groundwater storage based on average annual water level decline and specific yield. The assumed specific yield for NSWD is 0.13 (Davis et al., 1959) and average annual water level decline across the district is 3.0 feet per year. This method for calculating annual change in groundwater uses Equation 3-3:

Equation 3-3: Groundwater Storage Change (Specific Yield Method)

$$\Delta\, Storage = SY * \Delta WL * A$$

Where:
SY = Specific Yield (%)
ΔWL = Change in Water Level (feet/year)
A = Area of GSA (acres)

The overdraft for the District was calculated to be about 1,600 AF/year.

3.3.4 Current, Historical, and Projected Water Budget

Regulation Requirement:

§354.18

(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:

(1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.

(2) Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:

(A) A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.

(B) A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.

(C) A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.

(3) Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:

(A) Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.

(B) Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.

(C) Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.

(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:

(1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.

(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.

(3) Projected water budget information for population, population growth, climate change, and sea level rise.

<u>New Stone Water District</u>

Table 3-9 summarizes the historic, current, and projected water budget parameters and estimates.

Table 3-9 NSWD Historical, Current, and Projected Water Budgets

		Volume (AF)		
	Description	**Historic**	**Current (2017)**	**Projected (2040)**
Supply				
1)	Surface Water for Irrigation	0	270	2,600
2)	Surface Water for M&I	0	0	0
3)	Groundwater Pumping for Irrigation (Private Wells)	9,700	9,400	7,000
4)	Groundwater Pumping for M&I (Agency Wells)	0	0	0
5)	Precipitation	3,300	3,600	3,600
6)	Other Supply:	0	0	0
	Total Supply	**13,000**	**13,270**	**13,200**
Demand				
7)	Evapotranspiration Crop Requirement	7,900	7,900	7,200
8)	Evapotranspiration met by Effective Precipitation	1,600	1,900	1,400
9)	Evapotranspiration of M&I	0	0	0
	Consumptive Subtotal	**9,500**	**9,800**	**8,600**
Groundwater Recharge				
10)	Groundwater Inflow	4,500	4,500	4,500
11)	Deep Percolation of Irrigation Water	1,800	2,100	1,600
12)	Deep Percolation of Precipitation	200	400	400
13)	Deep Percolation of M&I Water	0	0	0
14)	Seepage of Channels & Pipelines	0	0	0
15)	Urban Stormwater - Recharge	0	0	0
16)	Local Streams/Rivers - Recharge	1,600	1,600	1,600
17)	Groundwater - Intentional Recharge	0	0	0
18)	Other Recharge:	0	0	0
	GW Recharge Subtotal	**8,100**	**8,600**	**8,100**
Nonrecoverable Losses				
19)	Groundwater - Outflow	0	0	0
20)	Evaporation - Recharge Basins	0	0	0
21)	Precipitation - Evaporation and Runoff	1,500	1,500	1,500
22)	Other Losses:	0	0	0
	Nonrecoverable Subtotal	**1,500**	**1,500**	**1,500**
	Estimated Annual Change in Groundwater Storage	**(1,600)**	**(800)**	**4,600**
	GW Recharge - #10 thru #18	8,100	8,600	8,100
	GW Pumping - #3 and #4	(9,700)	(9,400)	(7,000)
	GW Outflow - #19	0	0	0

Historic Water Budget

As previously mentioned, the historic water budget was prepared using data from 2003-2012, which represents a typical hydrologic period. This period mostly came into play when calculating various aspects of precipitation data, such as effective precipitation and deep percolation. Groundwater water inflow in terms of seepage from the Chowchilla Bypass were assumed to be constant at an average annual value. As discussed earlier in the chapter, the District is primarily made up of farmland, which means high water demand for irrigation. Total water demand has remained fairly constant over the years while surface supplies are variable. Historically, water year type has a limited effect on groundwater overdraft on a year to year basis. The District is mainly groundwater dependent; however; seepage from the Chowchilla Bypass has kept water levels stable. New Stone's historic overdraft is estimated to be 1,600 AF/year.

Current Water Budget

The current year (2017) water budget was designated as a wet year. This wet year hydrology was utilized with the historic ET demand and bypass channel deliveries.

Projected Water Budget

The goal of a projected water budget is to estimate future baseline conditions in response to GSP implementation. The projected water budget must include 50 years of historical precipitation, evapotranspiration and streamflow, while using the most recent land use and water supply information as the baseline condition. In formulating future baseline conditions, the effects of climate change on water availability and use must be considered.

Historical precipitation, evapotranspiration, and streamflow were not continuously recorded within the district for any 50-year period which necessitated using modeled climate data to project future conditions. The GSA does not have surface water allocations, so the effects of climate change on streamflow were not quantified. Instead water rights off the Chowchilla Bypass, which on average has been available every four years, were considered a source of surface water that would be diverted for recharge. This period was kept in place for the projected water budget, diversions up to 15,700 AF was used.

Monthly time-series precipitation and minimum and maximum temperature data was obtained from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) historical datasets. PRISM is a gridded monthly dataset that includes monthly temperature maximum and minimum and precipitation accumulation. All PRISM grid cells that are either fully or partially within the GSA boundaries were used for the period of interest. The segmented maximum temperature, minimum temperature, and precipitation values were averaged for each parameter by month in the period.

Historical evapotranspiration measurements are not available for the GSA before the mid-1980s implementation of California Irrigation Management Information System (CIMIS). Thus, monthly evapotranspiration was calculated with PRISM temperature data using the Hargreaves-Samani equation, shown below as Equation 3-4, from the DWR California Simulation of Evapotranspiration of Applied Water (Cal-SIMETAW) model. This equation provides a monthly reference ET estimate derived from mean temperature and long-term average radiation for a centroid of the GSA. This model was used to calculate monthly reference ET values.

Equation 3-4: Hargreaves-Samani Equation

$$ETo = 0.0023\,(T_{mean} + 17.8) * \sqrt{T_{max} - T_{min}} * R_a$$

where: *ETo* is reference monthly evapotranspiration
T is monthly temperature
Ra is the monthly average extraterrestrial radiation at the given latitude

DWR provided a dataset containing factors to apply to historical data to estimate future climate. This method, known as climate period analysis, preserves the historical variability while dampening or amplifying the magnitude of events based upon projected changes in precipitation and temperature. The provided climate change factors for two future 30-year periods, centered on 2030 and 2070, were derived from statistical analysis of an ensemble of 20 global climate model projections.

Using the same method as with the PRISM grid, the monthly climate change factors provided by DWR were averaged over the spatial extent of the GSA. The monthly change factors were then applied to the PRISM derived monthly precipitation and ET and then summed by water year. The 2030 climate change factors, which are applicable to the climate period of 2016-2045, were used for projected years through 2045. For the projected years of 2046-2070, the 2070 climate change factors were used.

A yearly sequence was chosen to line up historical data to projected years from 2020 to 2070. This sequence was developed by the Basin Technical Committee and Davids Engineering. **Table 3-10** shows the matching surrogate years for this period.

Table 3-10 Water Year Type

Year	Equivalent Water Year	Water Year Type
2020	1967	W
2021	1968	D
2022	1969	W
2023	1970	AN
2024	1971	BN
2025	1972	D
2026	1973	AN
2027	1974	W
2028	1975	W
2029	1976	C
2030	1977	C
2031	1978	W
2032	1979	AN
2033	1980	W
2034	1981	D
2035	1982	W
2036	1983	W
2037	1984	AN
2038	1985	D
2039	1986	W
2040	1987	C
2041	1988	C
2042	1989	C
2043	1990	C
2044	1991	C
2045	1992	C
2046	1993	W
2047	1994	C
2048	1995	W
2049	1996	W
2050	1997	W
2051	1998	W
2052	1999	AN
2053	2000	AN
2054	2001	D
2055	2002	D
2056	2003	BN
2057	2004	D
2058	2005	W
2059	2006	W
2060	2007	C
2061	2008	C
2062	2009	BN
2063	2010	AN
2064	2011	W
2065	2012	D
2066	2013	C
2067	2014	C
2068	2015	C
2069	1965	W
2070	1966	BN
Average (00-15)	100%	
Source	CDEC Data (MIL Full Natural Flow)	

Note: Water Year Type is based on DWR Water Year Index. Wet = Wet(W), Normal = Above Average(AN) & Below Average(BN), Dry = Dry(D) & Critical(C)

A simplified model was used to calculate the projected water budget for 2020-2070. This method was based on selecting three basic water year types that were identified based upon historical indices of the Dry, Normal, and Wet water year types were kept the same for projected years and not recalculated based upon climate change (note on Table 3-10: Dry has Dry and Critical, and Normal has Above Average and Below Average). For each one of these year types water budget components had specified volumes, which were applied to the projected year that climate was derived from. The values of these components were derived from representative years, included from the historical water budget. The water budget was computed for each year individually, so inter-year trends and variability did not affect water budget components.

In addition to the uncertainties of changes in climate and land use, weaknesses exist to this approach. The lack of inter-year variability led to compounding effects of wet or dry years. No change in land use was considered, so effects of drought and water shortage beyond the conditions of the origin years were not considered. Crop coefficients to determine ET were held at the most recent calculation, so changes in growing seasons brought by climate change and variations in future crop management were not taken into account.

3.3.5 Surface Water Supply Available for Recharge

At this time, NSWD anticipates using its water right of surface water from the Chowchilla Bypass for direct recharge in the future. This water will be stored in recharge basins as well as be used to flood the fields when the crops are dormant to promote deep percolation throughout the District. The District will also deliver the surface water directly crops when available during the growing season.

3.4 References

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4 Sustainable Management Criteria

Regulation Requirement:

§354.22 This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.

SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. The avoidance of undesirable results is important to the success of the GSP. Several requirements from GSP regulations have been grouped together under the heading of Sustainable Management Criteria, including a Sustainability Goal, Undesirable Results, Minimum Thresholds, and Measurable Objectives for various indicators of groundwater conditions. Development of these Sustainable Management Criteria is dependent on basin information developed and presented in the hydrogeologic conceptual model, groundwater conditions, and water budget chapters of the New Stone Water District GSA plan (DWR, 2017).

Indicators for the sustainable management of groundwater were determined by SGMA based on properties that are important to the health and general well-being of the public. There are six indicators that must be monitored throughout the planning and implementation period of the GSP including groundwater levels, groundwater storage volume, land subsidence, water quality, interconnected surface water, and seawater intrusion. This chapter will describe the indicators and why they are significant and will define the management thresholds.

The Sustainable Management Criteria described herein were prepared following the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 3 (§354.22 through §354.30).

4.1 Sustainability Goal

Regulation Requirement:

§354.24 Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.

"GSAs must develop a sustainability goal that is applicable to the entire basin. If multiple GSPs are developed for a single basin, the sustainability goal must be presented in the basin wide coordination agreement. Unlike the other sustainable management criteria, the sustainability goal is not quantitative. Rather, it is supported by the locally defined minimum thresholds and undesirable results. Demonstration of the absence of undesirable results supports determination that the basin is operating within its sustainable yield and, thus, that the sustainability goal has been achieved." (DWR, 2017)

Goal Description

The goal for the GSP is to provide a tool for managing groundwater, basin-wide, on a long-term basis and to meet measurable objectives for each indicator by maintaining a sustainable yield, thus avoiding undesirable results. The participants in the Madera Subbasin will work collectively to manage groundwater resources in the basin, importation of water supplies to the basin, develop recharge projects, and implement programs to stabilize water levels. Information laid out in Chapter 3 has provided insight to current and historical groundwater conditions, including a water budget to quantify overdraft. This knowledge was used to determine a sustainable yield, which will stabilize groundwater levels at a lower level than experienced today based upon a recognition that it will take time, money, and regulatory approvals to develop the programs that are needed to overcome the shortfall currently experienced. This will be done in a manner that is open to the public and stakeholders such that the local citizenry has a voice in the outcome and development of the programs.

Discussion of Measures
In order to achieve the goals outlined in the GSP, a combination of projects and management actions will be implemented over the course of the next 20 years. Surface water supply and infrastructure projects will be crucial for supplementing the use of groundwater and providing space for recharge. Management actions will be implemented to help mitigate overdraft on the demand side. Projects and management actions are discussed in further detail in Chapter 6, including a general timeline on when implementation will take place. When combined with consistent monitoring practices for each of the sustainability indicators, NSWDGSA will ensure that the District operates within its sustainable yield on an average annual basis.

Explanation of how the goal will be achieved in 20 years
The water budget, described in Section 3.3, accounts for historical water supplies and water demands by water use sector and quantifies the average annual overdraft. This value gives the basin and the GSA a goal by which to either improve supply or mitigate demand. NSWDGSA proposes to develop surface water supply projects, including recharge basins to augment groundwater supply, as well as implementing demand reduction programs. Areas sensitive or vulnerable to reaching an undesirable result will be given first consideration to groundwater recharge. To ensure that the goal will be achieved in the 20-year timeframe, interim goals for every 5 years have been established. Understanding that projects and programs take time and money to implement, the interim goals have considered exponential mitigation rates, meaning that overdraft will be reduced by 10, 40, 70, and 100 percent within 5, 10, 15, and 20 years respectively. Funding for projects, management actions, and monitoring will be secured by grant applications and NSWDGSA.

Designated monitoring networks have been chosen for keeping track of groundwater levels, change in storage volume, land subsidence, and water quality. The monitoring networks, described in detail in Chapter 5, will allow the GSA to evaluate the success of the plan and make changes accordingly throughout the implementation process.

4.2 Groundwater Levels

Groundwater depths across the GSA currently vary from approximately 100 to 200 feet below ground surface. A cone of depression, or an area of high pumping, occurs just north of district boundaries causing groundwater to flow mostly north; however, historically this was not the case. Significant groundwater pumping has caused levels to drop drastically, which has created higher energy costs and the need for well deepening.

4.2.1 Undesirable Results

4.2.1.1 Criteria to Define Undesirable Results

Regulation Requirement:

> **§354.26** (a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

If groundwater levels continue to deteriorate to a significant and unreasonable level, it will be considered an undesirable result. The terms "significant and unreasonable" are not defined by regulations, rather the conditions leading to this classification are determined by the GSA, beneficial users, and the basin they are a part of. The process used to develop criteria for determining undesirable results began with the review of DWR well construction records for choosing monitoring wells and through discussions with stakeholders and landowners.

For NSWDGSA, the lowering of groundwater levels is considered significant and unreasonable if pumping of groundwater has caused 25 percent of wells in the District to go dry, thus reaching an undesirable result.

4.2.1.2 Evaluation of Multiple Minimum Thresholds

Regulation Requirement:

§354.26 (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

Due to variation in monitoring site locations in the GSA, each representative monitoring site may have a different minimum threshold and measurable objective based on the most sensitive sustainability indicator in the area.

4.2.2 Minimum Thresholds

Regulation Requirement:

§354.28 (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26. (d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

4.2.2.1 Description of Minimum Thresholds

Regulation Requirement:

§354.28 (b) The description of minimum thresholds shall include the following: (1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting. (2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators. (3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals. (4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests. (5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference. (6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

Minimum thresholds have been set at each of the representative monitoring sites for the necessary sustainability indicators at a level that will avoid undesirable results. When monitoring sites are not meeting minimum threshold requirements, more strict pumping regulations may be enforced to reverse the trend in the area and avoid undesirable results. Whether or not a minimum threshold is being exceeded will be based on a five-year rolling average of fall and spring measurements, due to yearly and seasonal variations in water levels. The methodologies are described below, and groundwater conditions are quantified.

Minimum thresholds set by NSWDGSA will more than likely have little effect on the ability of adjacent basins to avoid undesirable results. Surrounding areas are dealing with the similar issues of groundwater depletion. Assuming average well depths are similar in surrounding areas, reasonable thresholds set by NSWDGSA will benefit water users in the surrounding areas as well. Even so, discussions between the GSAs will occur to ensure that minimum thresholds are acceptable.

4.2.2.2 Relationship for each sustainability indicator

Regulation Requirement:

> **§354.28** (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
> (1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
> (A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.
> (B) Potential effects on other sustainability indicators.

Groundwater levels can be directly related to groundwater storage change and, in many cases, groundwater quality. Lowering of groundwater levels also has a direct impact on land subsidence when it is caused by pumping water from below a confining clay layer. Each of the sustainability indicators must be monitored to watch for minimum thresholds; whichever indicator is most sensitive to groundwater level reduction may be the controlling factor in the surrounding area.

4.2.2.3 Selection of Minimum Thresholds to Avoid Undesirable Results

Minimum thresholds are set as a precursor to reaching an undesirable result. It is designed to be a last resort warning before more severe measures must be taken to protect groundwater resources and the impact of depleting aquifers on water users.

A groundwater conditions report was completed for NSWD in 2012 including hydrogeologic characterization, as well as aquifer and well characteristics. Video logs were taken on 25 of the wells used for pump tests, meaning depth to the bottom of the well was measured. Using the sample of 25 known well depths, it was estimated that 25 percent of wells in NSWD are shallower than 241 feet, measured from ground surface elevation. To avoid reaching this established undesirable result, the minimum threshold for chronic lowering of groundwater levels will be established throughout the District at a depth of 231 feet below ground surface elevation. The current average rate of groundwater level decline in the GSA is approximately 2.9 feet per year. By setting the minimum threshold 10 feet above the undesirable result, the GSA will have about three years to reverse the trend if they are to still be operating as they are in current day. However, if groundwater levels were allowed to reach this level of degradation, land subsidence in areas near key infrastructure may be the deciding factor in whether or not a minimum threshold has been met. The minimum threshold will be applied to the three groundwater level monitoring wells in the District that have historical data and are spatially distributed.

4.2.2.4 Impact of Minimum Thresholds on Water Uses and Users

Due to the nature of infrastructure development and program implementation, water levels will continue to drop at current rates in the next few years before programs have an effect on the stabilization of levels. Lowering groundwater levels will continue to increase the cost of energy for pumping. If minimum threshold levels are reached, there will be some wells that go dry and will require deepening to reach the water table.

4.2.2.5 Measurement of Minimum Thresholds

Measurement of groundwater levels will be done through the sounding tube twice a year to obtain seasonal high and seasonal low values in each of the monitoring wells. To determine whether or not a measurable threshold is being exceeded, a five-year rolling average will be used due to seasonal and year-to-year variation. For more information on the monitoring of water levels see Chapter 5 – Monitoring Network.

4.2.3 Measurable Objectives

Regulation Requirement:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.
(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.
(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.
(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.
(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

4.2.3.1 Description of measurable objectives

The DWR Water Data Library was used to find wells within the District that have decent water level data covering the last 20 years or so. Three wells spatially distributed, as seen in **Figure 4-1**, were discovered in or adjacent to the District and can provide enough historical data to create trend lines and project water levels into the planning and implementation horizon.

Setting measurable objectives for groundwater levels was done based on the historical trend and by applying assumed mitigation values in the following steps:

1. Plot and display trend line for groundwater level data within the last 20 years.
2. Apply slope of the trend line to the last available point of data and extend to 2020 to estimate potential future water level.
3. Calculate the rate of decline for the implementation period by applying a 10-, 30-, 30-, and 30-percent cumulative mitigation to the historical decline rate for 2025, 2030, 2035, and 2040 respectively.
4. Starting at the estimated 2020 water level, apply the groundwater level decline rate associated with each year in the implementation period.
5. By 2040, there should no longer be a long-term average decline; therefore, the water level estimated for 2040 becomes the measurable objective.

Figure 4-2 graphically displays how the minimum thresholds (MT) along with measurable objectives (MO) were set for each of the three wells by specifically showing well 11S15E30A001M

Figure 4-1 Location of Wells with Groundwater Level SMCs

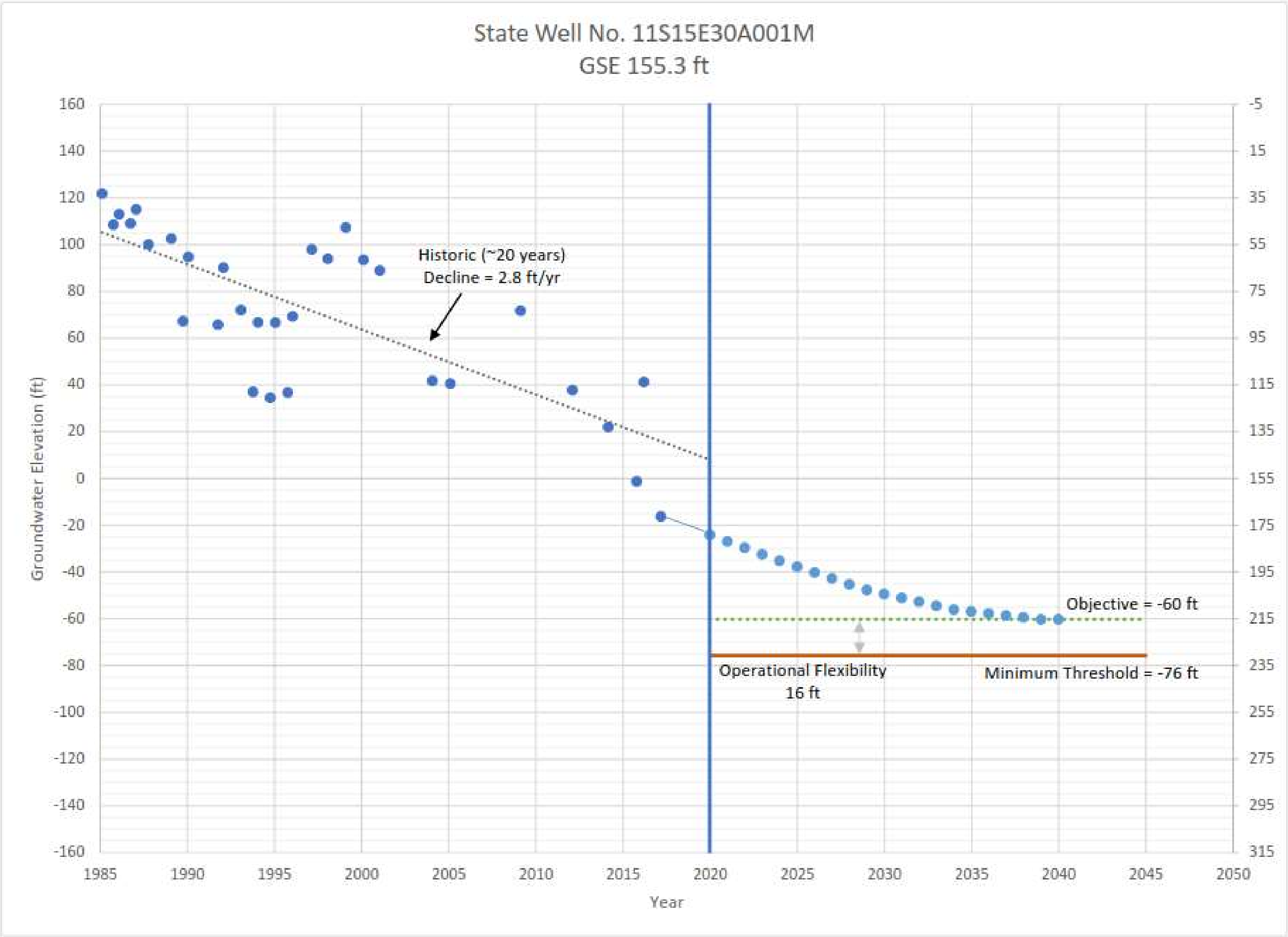


Figure 4-2 Hydrograph for setting MO and MT for State Well Number 11S15E30A001M

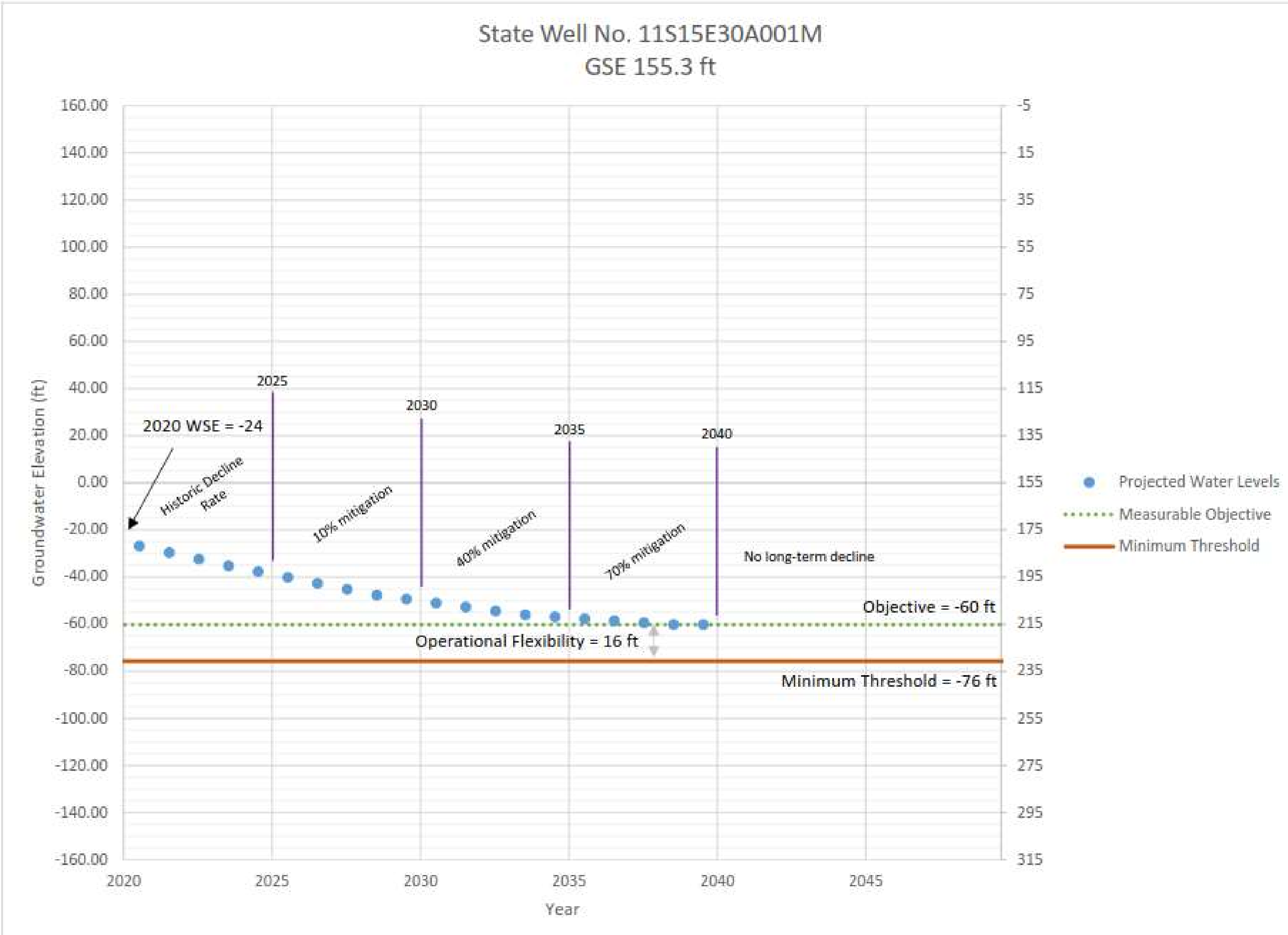


Figure 4-3 Detail of Projected Groundwater Levels, Measurable Objective, and Minimum Threshold

4.2.3.2 Operational Flexibility

Operational flexibility is considered the difference between the measurable objective and the minimum threshold. It allows for variation in groundwater levels due to seasonal and yearly variations. Drought years may cause pumping to increase, but wet years may bring enough opportunity to recharge what was lost. The operational flexibility for each well in the District will vary based on current groundwater levels and rate of decline. Most areas in the GSA will have plenty of operational flexibility during drought years; however due to heavy pumping on the north side of the district, groundwater levels decline at a faster rate. **Figure 4-2** shows the groundwater level trend and measurable objective for the representative SMC well in the northern portion of the district. The operational flexibility is less than at other wells since allowing lower levels may incur undesirable results. The minimum operational flexibility in the District is 16 feet and the maximum flexibility is 113 feet.

4.2.3.3 Path to achieve measurable objectives

The measurable objective for each of the wells was set with interim milestones in mind for every 5 years. It is the intent of the GSA to mitigate the rate of groundwater level decline by 10 percent in 2025 and an additional 30 percent at each of the following five-year intervals (2030, 2035, and 2040). Mitigation of decline will be achieved through implementation of projects to bring in additional water supply and programs that will decrease water demand. Programs may be adjusted over the implementation period in response to conditions and whether or not Plan goals are being met. **Table 4-1** summarizes the groundwater level goals for each of the interim years, along with the overall measurable objectives and minimum thresholds for each of the wells chosen for setting groundwater level SMCs.

Table 4-1 Groundwater Level Interim Goals, Measurable Objectives, and Minimum Thresholds

Well Number	Groundwater Elevations				Measurable Objective	Minimum Threshold
	2020	2025	2030	2035		
11S15E30A001M	-24	-38	-49	-57	-60	-76
12S15E16A001M	56	51	47	44	43	-70
11S14E36R001M	29	18	8	2	0	-81

4.3 Groundwater Storage

4.3.1 Undesirable Results

4.3.1.1 Criteria to Define Undesirable Results

Regulation Requirement:

> **§354.26** (a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

The chronic depletion of groundwater storage volume to a significant and unreasonable level, is considered an undesirable result. The terms "significant and unreasonable" are not defined by regulations, rather the conditions leading to this classification are determined by the GSA, beneficial users, and the basin they are a part of. The process used to develop criteria for determining undesirable results began with the review of DWR well construction records for choosing monitoring wells and through discussions with stakeholders and landowners.

For NSWDGSA, the depletion of groundwater storage is considered significant and unreasonable when the volume of water being extracted causes 25% of ag wells to go dry. Calculation of the storage change necessary to cause an undesirable result has been done by using the water level at which this will occur. However, large depletion of storage volume from a localized area may cause an undesirable result to occur at a lower storage change. Due to lack of well construction information throughout the basin, it is difficult to quantify storage change for undesirable results at such a localized scale. When more data becomes available during the implementation phase of this plan, undesirable results may be updated.

4.3.1.2 Evaluation of Multiple Minimum Thresholds

Regulation Requirement:

§354.26 (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

Change in groundwater storage has been calculated using data and SMCs from the same three wells used for groundwater levels. A surface has been created across the GSA using GIS software in order to consider variation in groundwater elevation when calculating the minimum threshold of storage change.

4.3.2 Minimum Thresholds

Regulation Requirement:

§354.28 (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26. (d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

Information and criteria used to determine a minimum threshold for groundwater storage includes most recent available groundwater elevation data, specific yield data, and a GSA determined minimum threshold elevation. The groundwater level minimum threshold was determined to avoid undesirable results. Groundwater elevation data has been collected using DWR Water Data Library, and GIS software has been used to create surfaces for minimum thresholds and current levels. Specific yield data was analyzed for the water budget to determine historical storage change and safe yield. Refer to Section 3.3 for more information on specific yield data that was gathered.

4.3.2.1 Description of Minimum Thresholds

Regulation Requirement:

§354.28 (b) The description of minimum thresholds shall include the following: (1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting. (2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators. (3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals. (4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests. (5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference. (6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4. **§354.28** (c) Minimum thresholds for each sustainability indicator shall be defined as follows: (2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.

The minimum threshold for storage volume change was calculated by using the most recent available groundwater elevation contours (Spring 2012) and groundwater level minimum thresholds. The volume of groundwater storage depletion allowed before reaching the minimum threshold is approximately 68,000 AF Since groundwater volume storage change is directly related to groundwater levels, depletion of storage volume to the minimum threshold will not cause an undesirable result to occur with regards to groundwater levels. From a groundwater storage perspective, it is reasonable to use the minimum threshold value set for groundwater level decline considering the total volume of storage in the aquifer below NSWDGSA boundaries is 440,000 AF. If storage declines to the minimum thresholds set for groundwater levels, less than 15% percent of total storage will have been depleted.

4.3.2.2 Selection of Minimum Thresholds to Avoid Undesirable Results

By using criteria set for groundwater levels to calculate thresholds for storage change, undesirable results will be avoided. Potential for undesirable results arises if all storage change is coming from a localized area, in which case wells may go dry.

4.3.2.3 Impact of Minimum Thresholds on Water Uses and Users

Due to the nature of infrastructure development and program implementation, groundwater storage will continue to decrease at current rates in the next few years before programs have an effect on the stabilization of levels. Decrease in groundwater storage will continue to increase the cost of energy for pumping. If minimum threshold levels are reached, there will be some wells that go dry and will require deepening to reach the water table.

4.3.2.4 Measurement of Minimum Thresholds

Measurement of groundwater storage change will continue to be through the use of groundwater elevation contours created from a network of monitoring wells with available data. Storage change will be calculated on an annual basis using the seasonal high measurements, which is usually in the spring and the specific yield. For more information regarding the wells in the monitoring network, refer to Chapter 5.

4.3.3 Measurable Objectives

Regulation Requirement:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.
(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.
(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.
(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.
(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

4.3.3.1 Description of Measurable Objectives

The measurable objective for change in groundwater storage volume is to become stable by the end of the 20-year implementation phase. After 2040, the District should see a net zero change in groundwater storage on a 10-year rolling average basis. The total volume of storage depletion between most recent available levels (Spring 2012) and 2040 measurable objectives was calculated similarly to minimum thresholds. Using surfaces created by GIS software, the difference between current levels and 2040 measurable objectives was calculated and multiplied by the specific yield. The volume of storage depletion allowed before reaching the measurable objective is approximately 26,000 AF.

4.3.3.2 Operational Flexibility

Operational flexibility is the difference between the measurable objective and minimum threshold. As previously mentioned, the success of meeting the objective is based on a rolling average, allowing room for expected overdraft in dry years as long as wet years allow for recharge. There is approximately 42,000 AF of allowable storage change between the measurable objective and minimum threshold.

4.3.3.3 Path to Achieve Measurable Objectives

The measurable objective for groundwater storage change was set with interim milestones in mind for every 5 years. It is the intent of the GSA to mitigate the rate of groundwater level decline by 10 percent in 2025 and an additional 30 percent at each of the following five-year intervals (2030, 2035, and 2040). The same interim goals apply to storage change as well. Mitigation of decline will be achieved through implementation of projects to bring in additional water supply and programs that will decrease water demand. Programs may be adjusted over the implementation period in response to conditions and whether or not Plan goals are being met.

4.4 Groundwater Quality

4.4.1 Undesirable Results

4.4.1.1 Criteria to Define Undesirable Results

Regulation Requirement:

§354.26 (a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

If groundwater quality deteriorates to a significant and unreasonable level, it will be considered an undesirable result. The terms "significant and unreasonable" are not defined by regulations, rather the conditions leading to this classification are determined by the GSA, beneficial users, and the basin they are a part of. The process used to develop criteria for determining undesirable results began with discussions with stakeholders and landowners.

In NSWDGSA, water quality degradation is considered significant and unreasonable when concentrations of contaminants, such as nitrogen and salts, have reached levels that drastically impact crop yield. For the purposes of this Plan, significantly degraded water quality is when 25% of wells contain nitrate and have electrical conductivity (EC) higher than that of the minimum thresholds.

4.4.1.2 Evaluation of Multiple Minimum Thresholds

Regulation Requirement:

§354.26 (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

The minimum threshold for water quality will be set uniformly across the District. The undesirable condition will be determined based on data from all the monitoring locations, and if too many wells fall below the threshold, then an undesirable result will occur.

4.4.2 Minimum Thresholds

Regulation Requirement:

§354.28 (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.
(d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

Currently, NSWDGSA is not experiencing any water quality conditions causing crop yield to be noticeably affected. Limited data is available for determining current nutrient concentrations based on groundwater depth and location. As discussed in Section 3.2.5, a couple of samples in or near the District have shown elevated concentrations of nitrates and salts, but the majority of the region is generally below MCLs. Depth to water containing elevated concentrations of constituents is difficult to determine and will be monitored more thoroughly moving forward. If it is determined that depth to water is linked to water quality issues, minimum thresholds for groundwater levels may be adjusted based on groundwater quality.

4.4.2.1 Description of Minimum Thresholds

Regulation Requirement:

§354.28 (b) The description of minimum thresholds shall include the following:
(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.
(2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.
(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.
(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.
(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.
§354.28 (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be used on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.

NSWDGSA will primarily focus on nitrogen and salt with regards to water quality management since they are presently the only constituents that are of concern in the area. Water quality characteristics can have varying effects on agricultural practices depending on soil type, irrigation method, and crop type. Land in the GSA is almost solely used for agriculture, thus agricultural water quality standards will be applied as minimum thresholds. Furthermore, grapes are the main crop grown in the GSA; therefore, sensitivity to nutrient loading for vineyards specifically will be used to establish minimum thresholds. According to Ayers & Westcot (1985), grapes are sensitive to excess nitrogen in irrigation water which may cause late maturity with lower yields and a lower sugar content. In Libya, no fruiting occurred in grapes when water containing greater than 50 mg/L of nitrogen was applied; however, greater than 30 mg/L can cause severe effects on crop growth as well. In general, grapes are also moderately sensitive to salinity, having only approximately 75 percent of their yield potential when using irrigation water with an EC of 2.7 dS/m (2,700 μmhos/cm).

Based on the information discussed above, and in the interest of growers within the GSA, water quality minimum thresholds have been set as follows:

Agricultural Water Quality:

- *Nitrogen:* Concentration levels should not exceed 45 mg/L for applied irrigation water.
- *Electrical Conductivity:* Concentration levels should not exceed levels causing an electrical conductivity of 2,700 μmhos/cm for applied water.

Note: minimum thresholds are applied to the groundwater that is being *applied* to the crops. Meaning, if one well on a landowner's property has high concentrations of nitrogen, it may be treated or mixed with another water source to remain above the threshold. Minimum thresholds for water quality have not been set for domestic users due to the lack of beneficial users for this water use.

4.4.2.2 Selection of Minimum Thresholds to Avoid Undesirable Results

Minimum thresholds were selected to protect crop production for farmers and to prevent the necessity of paying for water treatment. If water quality is maintained at or above minimum threshold standards, then significant and unreasonable decline in crop yield will be avoided. Keep in mind that the concentration levels listed above are only meant to be short term. If minimum thresholds have been reached, it is highly recommended that action is taken to reverse the trend and reach the measurable objective.

4.4.2.3 Impact of Minimum Thresholds on Water Uses and Users

If water quality is allowed to deteriorate to levels set by minimum thresholds, growers may experience a decrease in crop yield and/or crop quality. Poor water quality would cause a buildup of salts and nitrates in the surface layers of soil.

4.4.2.4 Measurement of Minimum Thresholds

Water quality data will be monitored and sampled for analysis according to the monitoring network, as discussed in Chapter 5. This includes sampling every year for analysis of nitrogen and electrical conductivity. Samples will be taken during the summer pumping season.

4.4.3 Measurable Objectives

Regulation Requirement:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.
(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.
(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.
(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.
(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

4.4.3.1 Description of Measurable Objectives

Measurable objectives for water quality have been set similarly to measurable thresholds, based on crop sensitivity. The goal is for the quality of groundwater to remain in a condition that is beneficial to growers, meaning there is minimal impact on crop yield. If nitrogen concentrations are kept below 30 mg/L for continued application of irrigation water, crop yield and crop quality should not be affected. According to Ayers and Westcot (1985), TDS concentrations causing an EC of 1,700 µmhos/cm or higher can lead to a 90 percent crop yield or less. Therefore, measurable objectives are as follows:

Agricultural Water Quality:

- *Nitrogen:* Concentration levels should not exceed 30 mg/L for applied irrigation water.
- *Electrical Conductivity:* Concentration levels should not exceed levels causing an electrical conductivity of 1,700 µmhos/cm for applied water.

Note: one result of higher concentration does not mean the objective has not been met. Two consecutive measurements of concentration levels will be used to determine whether the objective is being met.

4.4.3.2 Operational Flexibility

The operational flexibility is considered the difference between the minimum threshold and the measurable objective. In this case, the operational flexibility based on nitrogen allows for up to a 15 mg/L difference. If levels are steadily dropping towards the minimum threshold, actions may be taken to avoid falling below. For EC, there is an operational flexibility of 1,000 µmhos/cm.

4.4.3.3 Path to Achieve Measurable Objectives

As mentioned, there is a lack of current and historical data on groundwater quality in the District. However, the data available shows that NSWDGSA is currently operating at measurable objectives. The path to remain operating within objectives includes a more accurate monitoring network for collecting data on a yearly basis and adjusting nutrient management strategies as needed at each five-year milestone. Being a part of the East San Joaquin Water Quality Coalition, which exists to help growers monitor and manage nutrient pollution, will aid NSWDGSA in achieving water quality goals.

4.5 Land Subsidence

4.5.1 Undesirable Results

If land subsidence occurs to significant and unreasonable levels, it will be considered an undesirable result. The terms "significant and unreasonable" are not defined by regulations, rather the conditions leading to this classification are determined by the GSA, beneficial users, and the basin they are a part of. The process used to develop criteria for determining undesirable results began with discussions with stakeholders and landowners.

4.5.1.1 Criteria to Define Undesirable Results

Regulation Requirement:

> **§354.26** (a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

In NSWDGSA, land subsidence is considered significant and unreasonable when critical infrastructure, such as the Chowchilla Bypass, or distribution systems, wells, and pumps begin to fail or take critical damage. Current land subsidence rates in NSWDGSA range from -0.15 to -0.45 feet per year from south to north over the years 2011 to 2017. However, there have been no reports of infrastructure being damaged due to this subsidence. As discussed in Section 3.2.6, the Chowchilla Bypass has been steepening in slope, which increases the velocity, causing freeboard to increase.

4.5.1.2 Evaluation of Multiple Minimum Thresholds

Regulation Requirement:

> **§354.26** (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

Monitoring for land subsidence will be done by evaluating data released from USBR SJRRP and NASA InSAR; therefore, minimum thresholds will be set District wide and evaluated by mapping the subsidence over the area. Monitoring sites for these programs may or may not be within NSWDGSA boundaries; however, the data is adequate for covering the District using contouring and interpolation techniques.

4.5.2 Minimum Thresholds

Regulation Requirement:

> **§354.28** (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.
> (d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

As previously mentioned, NSWD is not currently experiencing any issues with infrastructure due to subsidence. According to the hydraulic analysis on the Chowchilla Bypass, if subsidence is to continue into 2026 as it has, the capacity of this channel would remain above design capacity due to the steepening slope.

4.5.2.1 Description of Minimum Thresholds

Regulation Requirement:

§354.28 (b) The description of minimum thresholds shall include the following:
(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.
(2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.
(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.
(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.
(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.
§354.28 (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(5) Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:
(A) Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including and explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.
(B) Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.

The most significant subsidence is occurring directly to the north of NSWDGSA. The Eastside Bypass and Sand Slough are experiencing decreased design capacity due to this subsidence; however, the Chowchilla Bypass maintains its capacity. Therefore, the minimum threshold for land subsidence in NSWDGSA is a range from approximately -0.15 feet per year on the south end to -0.45 feet per year on the north end, corresponding to recent historical trends from 2011 to 2017.

Figure 4-4 displays the recent historical land subsidence that was used in setting the minimum thresholds.

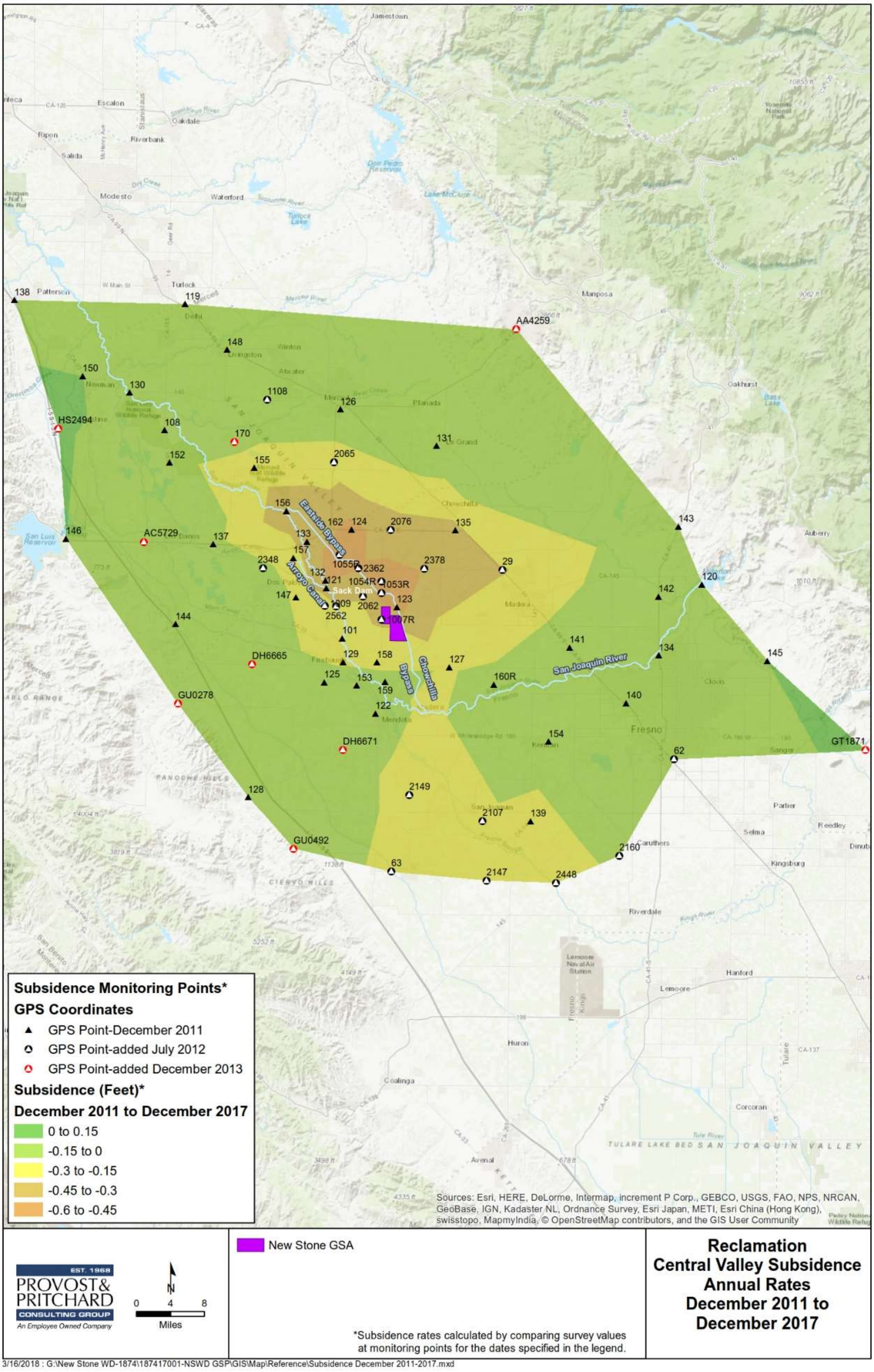


Figure 4-4 Land Subsidence Rates from 2011 to 2017 for Setting Minimum Thresholds

4.5.2.2 Selection of Minimum Thresholds to Avoid Undesirable Results

If subsidence stays at or above minimum thresholds, critical damage to the Bypass may be avoided.

4.5.2.3 Impact of Minimum Thresholds on Water Uses and Users

If subsidence rates stay at or above the minimum threshold, the impact on water uses and water users should be minimal. The capacity of the Chowchilla Bypass is expected to remain the same, if not increase. Since there has been no major damage reported on private property, it is assumed there will be no future impact due to minimum thresholds.

4.5.2.4 Measurement of Minimum Thresholds

Measurement of land subsidence data is taken by the USBR SJRRP and NASA. The monitoring density is considered of adequate density and frequency to determine subsidence annually. If data from these programs becomes unavailable, a new monitoring network will be formed. For more information on the monitoring network, refer to Section 5.6.3.

4.5.3 Measurable Objectives

Regulation Requirement:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.
(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.
(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.
(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.
(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

4.5.3.1 Description of Measurable Objectives

Setting measurable objectives for land subsidence was done based on historical rates and by applying assumed mitigation values at the same rates as groundwater levels. Calculate the rate of subsidence for the implementation period by applying a 10-, 30-, 30-, and 30-percent cumulative mitigation to the historical subsidence rate for 2025, 2030, 2035, and 2040 respectively. The objective is for land subsidence to be around zero by 2040.

4.5.3.2 Operational Flexibility

The operational flexibility is the difference between the minimum threshold and the measurable objective. Therefore, the operational flexibility ranges from 0.15 to 0.45 feet per year.

4.5.3.3 Path to Achieve Measurable Objectives

Over the implementation phase of this Plan, measurable objective for land subsidence is to reduce it to a negligible amount. **Table 4-2** presents values of land subsidence based on the mitigation rates discussed above for each of the interim milestone years. Following the interim objectives, the total subsidence experienced from 2020 to 2040 would be approximately -2 feet in the southern portion of the District up to -6 feet in the northern portion in the District.

Table 4-2 Preliminary Interim Milestones for Land Subsidence Objectives

	Subsidence Rate Range (feet)	
Year	South	North
2020	-0.15	-0.45
2025	-0.12	-0.36
2030	-0.09	-0.27
2035	-0.05	-0.14
2040	0	0

4.6 Seawater Intrusion

Regulation Requirement:

§354.26 (d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

§354.28 (e) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

By definition, seawater intrusion occurs when saline water from the ocean infiltrates the groundwater system and begins to flow into areas of freshwater due to pressure differentials, in many cases caused by groundwater pumping. The Madera Subbasin and NSWDGSA do not need to account for seawater intrusion since they are not located adjacent to the coast.

4.7 Interconnected Surface Water and Groundwater

Regulation Requirement:

§354.26 (d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

§354.28 (e) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

As discussed in Groundwater Conditions, Section 3.2.7, NSWDGSA does not contain interconnected surface and groundwater systems. The Chowchilla Bypass is the only surface water system that exists within or on the GSA boundaries. It is only run during wet years when flood flows are released, thus it is most frequently dry. Depth to water table along the Bypass ranges from approximately 46 to 67 feet above sea level, which is 80 to 100 feet below the ground surface elevation. Due to the lack of connected water systems, interconnected surface water will not be monitored or considered when making management decisions.

4.8 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirement:

§354.26 (b) The description of undesirable results shall include the following:
(1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.
(2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.
(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

At present there are no conditions resulting in undesirable effects in the GSA. Going forward there are factors that have the potential to cause changes leading to undesirable effects such as the following:

1. **Climate Change**
    a. Some information developed by the State of California Department of Water Resources (DWR, 2018) suggests that warmer conditions could lead to more rain and less snowpack. This would lead to more runoff earlier on and less reliability in water source.
    b. The same studies indicate that increased temperatures could result in higher evapotranspiration rates which would increase demand.
    c. Some studies suggest more variability in water year types with dry years becoming more dry and wet years becoming more wet, which could lead to more flooding in wet years and worse droughts in dry years.
2. **Changing Crop Patterns**. Alfalfa, corn and grapes are grown within NSWDGSA with vineyards making up the majority of the acreage. A change in cropping to include more nuts such as almonds or pistachios would increase crop demand.
3. **Lack of Access to Surface Supply**. NSWD currently relies almost completely on groundwater; therefore, to meet sustainability goals set forth in the GSP, surface water will be required to use for recharge or in-lieu of groundwater.
4. **Excess Nutrient application**. The accumulated effects of nutrient application and other farming practices could lead to higher concentrations of nitrogen or TDS.

Potential effects of reaching undesirable results on beneficial users will vary slightly depending on location and which indicator has defaulted. When an undesirable effect has occurred due to significant lowering of groundwater levels, beneficial uses impacted will include irrigation and municipal demand. The domestic wells are the shallowest in the district; meaning if levels decline enough to cause any wells to go dry, residential water users will be impacted first. Thus, if an undesirable result has occurred, the effect would be that the water users with dry wells will need to pay to have them deepened. Excessive groundwater storage depletion will have similar effect on water users.

As for land subsidence, if an undesirable result has occurred, the potential impact to the Chowchilla Bypass may be decreased carrying capacity due to alteration of levees. Since the Bypass is used as a flood control structure to pass water and already exceeds its design capacity in really wet years, decreased capacity could hinder the ability of the Bypass to mitigate flooding. Downstream water users could also be impacted by decreased capacity of the channel by not receiving the expected flow.

Impacts of significantly degraded water quality includes decreased crop productivity and more expensive water treatment for residential users.

4.9 References

Ayers, R. S. and D. W. Westcot. (1985). *Water Quality for Agriculture*. FAO Irrigation and Drainage Paper. Food and Agriculture Organization of the United Nations. Retrieved on February 12, 2019 from. http://www.fao.org/3/T0234E/T0234E00.htm

California Department of Water Resources (DWR). (2018, April). *Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development.*

California Department of Water Resources (DWR). (2017). *Sustainable Management Criteria Best Management Practice.*

5 Monitoring Network

Regulation Requirement:

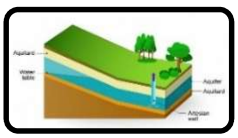
> **§354.32** This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.

Monitoring is a fundamental component of a groundwater management program and is needed to measure progress of reaching measurable objectives and the goal of groundwater sustainability. **Table 5-1** includes the monitoring programs of sustainability indicators needed to comply with SGMA monitoring and reporting requirements.

Table 5-1 Monitoring Requirements

Groundwater Levels

- Monitoring of static groundwater levels each spring and fall

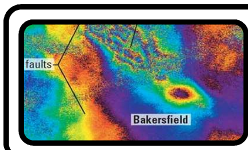


Groundwater Storage

- Measurement of the annual change in groundwater storage

Water Quality

- Monitoring for water quality degradation that could impact available groundwater supplies

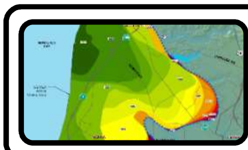


Land Subsidence

- Surface land subsidence caused by groundwater extraction

Depletion of Interconnected Surface Water

- Loss of permanent connections between surface water and groundwater



Seawater Intrusion

- Intrusion of seawater into local aquifers. This is not applicable to the NSWD GSA

Monitoring programs for these indicators are described below including the history of the monitoring programs, proposed monitoring to comply with SGMA, and the adequacy and scientific rationale for each monitoring network. Monitoring of groundwater pumping, groundwater recharge and surface water deliveries is discussed in Section 3.3 – Water Budget Information.

5.1 Introduction

Regulation Requirement:

§354.34(a) Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan Implementation.

§354.34(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

This chapter describes the current and developing monitoring networks in the New Stone Water District Groundwater Sustainability Agency (NSWDGSA or GSA) that will collect data to determine short-term, seasonal, and long-term trends in groundwater and related surface conditions. This data collected from the monitoring networks will yield information necessary to support the implementation of this Plan, evaluation of the effectiveness of this Plan, and guide decision making by the NSGSA management. Information and data from historical monitoring efforts can be found in Section 3.2 – Current and Historical Groundwater Conditions. **Figure 5-1** and **Figure 5-2** show the monitoring network site locations.

5.1.1 Monitoring Network Objectives

§354.34(b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following: 1) Demonstrate progress toward achieving measurable objectives described in the Plan. 2) Monitor impacts to the beneficial uses or users of groundwater 3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds. 4) Quantify annual changes in water budget components.

The objectives of the various monitoring programs include the following:

1. Establish a baseline for future monitoring;
2. Provide warning of potential future problems.
3. Use data gathered to generate information for water resources evaluation.
4. Help to quantify annual changes in water budget components.
5. Develop meaningful long-term trends in groundwater characteristics.
6. Provide comparable data to Madera Subbasin Coordinator for reporting to DWR.
7. Demonstrate progress toward achieving measurable objectives described in the Plan.
8. Monitor changes in groundwater conditions relative to minimum thresholds.
9. Monitor impacts to the beneficial uses or users of groundwater.

5.1.2 Sustainability Indicator Monitoring Networks

Regulation Requirement:

§354.34(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator: [§354.34(c)(1) through §354.34(c)(6) are individually listed below]

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.

> **§354.34(g)(3)** For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

> **§354.38(a)** Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

The following sections 5.2 through 5.7 include descriptions of the GSA's monitoring networks designed to meet criteria for the six sustainability indicators: groundwater levels, groundwater storage, seawater intrusion, water quality, land subsidence, and depletion of interconnected surface water. For each sustainability indicator, the adequacy of the monitoring network is discussed, as well as the quantitative values for the minimum thresholds, measurable objectives, and interim milestones. The sections also include a review of each monitoring network for monitoring frequency and density, identification of data gaps, plans to fill data gaps, and future site selection. This information will be reviewed and evaluated during each five-year assessment.

There are three general types of data gaps to consider for monitoring networks:

1. **Temporal**: Insufficient frequency of monitoring. For instance, data may be available from a well only in the fall since it is rarely idle in the spring. In addition, a privately owned well may have sporadic access due to locked security fencing, roaming dogs, change in ownership, etc.
2. **Spatial**: Insufficient number or density of monitoring sites in a specific area.
3. **Insufficient quality of data**: Data may be available but be of poor or questionable accuracy. Poor data may at times be worse than no data, since it could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having information on perforation depth, etc. Past experiences have shown that well location information on Well Construction Reports is often poor, making it difficult or impossible to match wells with their well logs.

New monitoring networks will be developed, and existing networks enhanced when necessary, using the Data Quality Objective (DQO) process, which follows the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). The DQO process is also outlined in the DWR's Best Management Practices for monitoring networks (2016a) and monitoring protocols (2016b). The DQO process helps to ensure a repeatable and robust approach to collecting data with a specific goal in mind.

5.2 Groundwater Levels

Regulation Requirement:

> **§354.34(c)(1)** Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:
> A. A sufficient density of monitor wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
> B. Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

5.2.1 Monitoring Network Description

The California State Groundwater Elevation Monitoring (CASGEM) program was created by SBx7 6, Groundwater Monitoring, a part of the 2009 Comprehensive Water Package. Groundwater levels have been regularly monitored in wells within or on the border of the GSA for the CASGEM program. CASGEM wells that will be included in the monitoring network have state well IDs 11S14E36R001, 11S15E30A001, and 12S15E16A001. Water depths have been measured in these wells by the U.S. Bureau of Reclamation on a bi-annual basis since the late 1950s or early 1960s. A well log with construction information is not available for 12S15E16A001; however, it is believed to be perforated in the unconfined aquifer, as the other two wells' construction information shows.

Three District wells that are not part of CASEGEM will also be included in the monitoring network. The wells have District numbers 10, 34, and 37. Unique CASGEM or state well IDs will be assigned to the wells. These three wells are perforated in the confined aquifer.

5.2.2 Quantitative Values

Minimum thresholds, measurable objectives, and interim milestones for groundwater levels are discussed in **Section 4.2**. The minimum threshold for the groundwater levels in the GSA is 235 feet bgs, which is an elevation of -75 to -85 feet msl. The measurable objectives and interim milestones set in **Section 4.2** are shown in **Table 5-2** below.

Table 5-2 Groundwater Level Interim Goals, Measurable Objectives, and Minimum Thresholds

Well Number	Groundwater Elevations				Measurable Objective	Minimum Threshold
	2020	2025	2030	2035		
11S15E30A001M	-24	-38	-49	-57	-60	-76
12S15E16A001M	56	51	47	44	43	-70
11S14E36R001M	29	18	8	2	0	-81

5.2.3 Review and Evaluation of Monitoring Network

5.2.3.1 Monitoring Frequency and Density

Regulation Requirement:

§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:

1) Amount of current and projected groundwater use.
2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.
4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

The CASGEM Groundwater Elevation Monitoring Guidelines (DWR, 2010) estimates the density of wells needed. The densest estimate is 10 wells per 100 square miles. For NSWDGSA, which is less than 7 square miles in area, this estimate would require 0.7 wells be monitored in the GSA. The three wells in each aquifer included in the monitoring network exceeds this density. Three elevations are required to define a water surface; thus, three wells per aquifer is the minimum density to be used for NSWDGSA.

Some of the wells are not considered "High Quality Monitoring Points." Such wells are defined as wells with reliable access each spring and fall, information on the well depth and perforated interval, and sufficient depth to accommodate seasonal fluctuations. Wells that do not meet these guidelines will be maintained in the network, as they can still provide useful information. Well construction information on the monitored wells may be obtained in the future, and it is desired to keep wells that have a long period of record. During development of groundwater contours, those wells with and without well construction information will be labeled to assist with the analysis.

Groundwater levels will be monitored in the spring (March) and fall (October) of each year. Spring measurements are designed to capture the recovery of the groundwater levels after an extended period of minimal agricultural and landscape irrigation demand, assuming a normal rainfall. The fall measurement would capture a period after peak irrigation and summertime urban demands have ceased, thereby showing the cumulative impacts on the groundwater basin before any natural recovery has taken place.

5.2.3.2 Identification of Data Gaps

§354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.
§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.

The three District wells in the monitoring network have not been measured for water levels in the past and thus do not have historic data.

The existing groundwater level monitoring network has provided adequate data to prepare groundwater contour maps and identify groundwater level trends over the decades. The density of the groundwater level monitoring network is adequate.

Well construction information is not known for one of the CASEGEM wells. Data on the depth and perforated interval is required according to SGMA guidelines. While this represents a data quality gap, it will continue to be used until additional well attribute data can be collected.

5.2.3.3 Plans to Fill Data Gaps

Regulation Requirement:

(d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

In the future, the District will oversee water level measurements in the GSA to better regulate data collection intervals.

The data quality gap in the groundwater level network can be filled using the four alternatives below:

- **Collect well completion reports.** Well Completion Reports will provide the needed information. These could be collected from the landowner or Department of Water Resources; however, several challenges exist. First, landowners may not have the report or may not be willing to provide them. The GSA has found it very difficult to match up Well Completion Reports from DWR with actual wells, since so many have been drilled in the area, and location maps in the reports are often poor or erroneous, or wells have since been destroyed.
- **Perform a video inspection of each well to obtain construction information.** A video inspection can be performed on desired wells to determine the total depth and perforated interval. The cost of each inspection is about $1,500 (2017), but up to $15,000 may also be needed to lift a pump to provide access. Additional costs would also be incurred for administration and outreach to landowners. Permission would be needed from the well owner; however, they may agree since they would obtain a free well assessment.
- **Replace monitoring point with a dedicated monitor well.** Dedicated monitor wells could be installed and used in place of private wells. The construction information would be known and there would be no access issues. Dedicated monitor wells are expensive to construct, and their installation will depend on available funding.

- **Replace monitor point with another private well.** Private wells without construction information could be replaced with another private well that has well construction information. This may be simpler and less costly than a video inspection. However, replacing monitor well locations is not always desirable, since it is preferred to continue measurements in wells that have a long period of record (i.e., long hydrograph).

5.2.3.4 Site Selection

Regulation Requirement:

§354.34(g) Each Plan shall describe the following information about the monitoring network: **(1)** Scientific rationale for the monitoring site selection process.

The rationale for the groundwater level monitoring network includes the following:

- The monitoring points contribute to the minimum density of 3 wells per aquifer in the GSA.
- The monitoring point has performed adequately for several decades in providing information for annual reporting, groundwater contour maps, and estimation of storage change.
- Many existing wells have a significant period of record (i.e., greater than 20 years) and are useful for long-term evaluations.

The following scientific rationale will be used to add new wells to the groundwater level monitoring network:

- Add wells whenever necessary to maintain minimum monitor well density (3 wells in the GSA).
- Avoid wells perforated across multiple aquifers.
- Select dedicated monitor wells over production wells where feasible.
- Select wells with available construction information (i.e., depth, perforated interval).

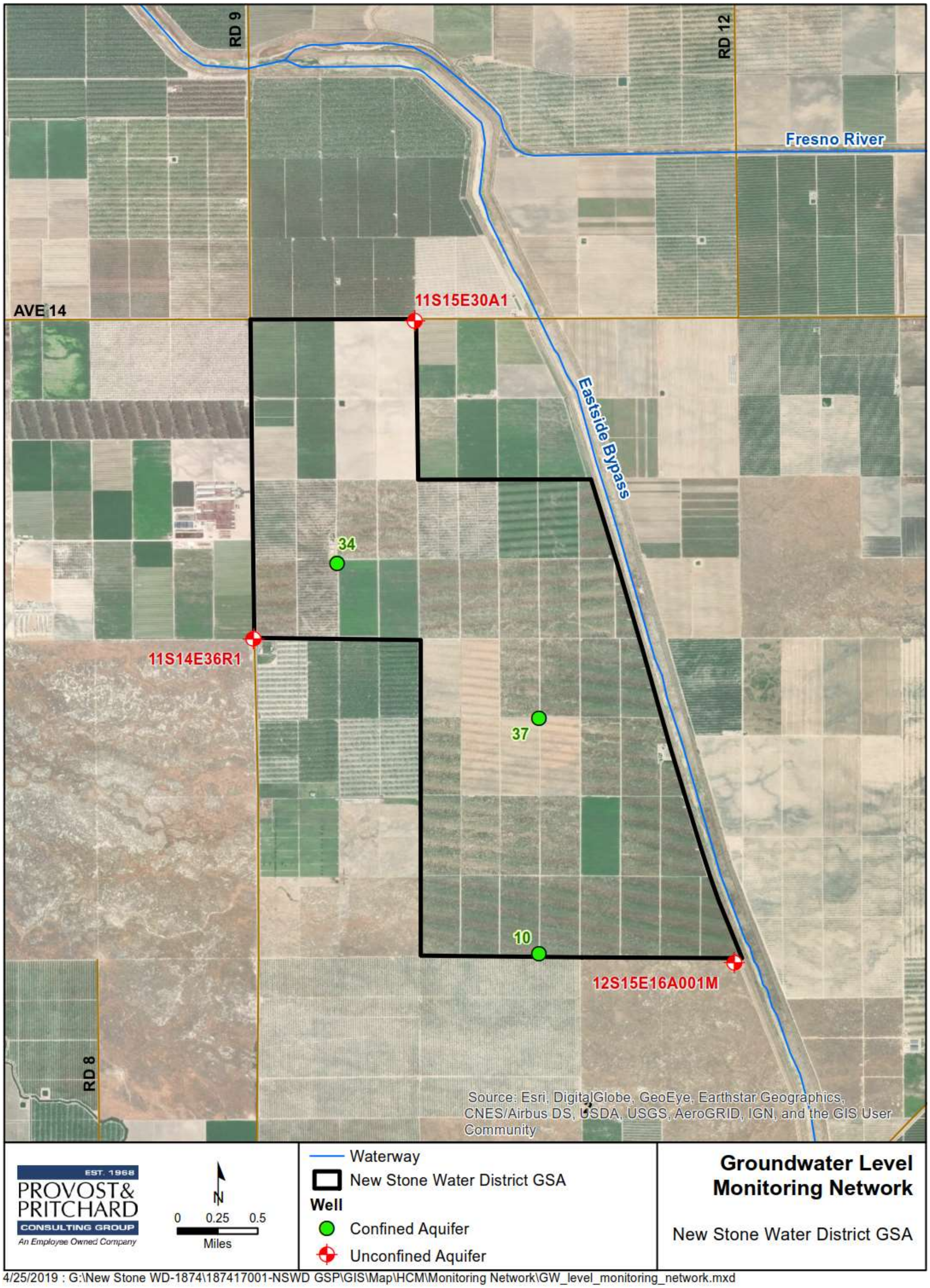


Figure 5-1 Groundwater Level Monitoring Network

5.3 Groundwater Storage

Regulation Requirement:

§354.34(c)(2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.

5.3.1 Monitoring Network Description

Groundwater storage was determined using multiple methods in Chapter 3.2 – Current and Historical Groundwater Conditions, Section 3.2.3. Method one used the water budget analytical model or the checkbook balance method. It uses inputs from all water sources, consumptive uses, and losses to determine groundwater surplus or overdraft over a hydrologically average period. The second method used average specific yield, basin area, and average change in groundwater levels to determine change in storage over the hydrological average period. The final method used GIS mapping tools to calculate the difference in volume between contour maps for each year in the hydrological average period. The general methodology used in those efforts will continue to be used by the GSA. Groundwater storage calculations are largely dependent on the groundwater level network and will consist of the same wells in the groundwater level monitoring network (Figure 5-1).

5.3.2 Quantitative Values

Minimum thresholds, measurable objectives, and interim milestones for groundwater storage are discussed in **Section 4.3**. The groundwater storage minimum thresholds are the same as the thresholds for groundwater levels shown in Figure 5-5. Measurable objectives for groundwater storage have a net zero change in groundwater storage on a 10-year rolling average basis after 2040. Specific interim milestones are not set for groundwater storage but are inherent in the groundwater level milestones.

5.3.3 Review and Evaluation of Monitoring Network

5.3.3.1 Monitoring Frequency and Density

Groundwater storage change will be estimated annually, based on spring groundwater levels. Groundwater storage changes will be based largely on the geographic availability of specific yield data (see Section 3.1.8). The areas used are considered reasonable, since overdraft is typically estimated on a regional scale; estimating overdraft on a very small or local scale may provide misleading results. Only wells with reasonable and reliable data will be used to develop groundwater contours and estimate storage change.

5.3.3.2 Identification of Data Gaps

Data gaps were identified in the groundwater storage network are the same as the groundwater level gaps described above, since storage change is dependent on groundwater level readings.

5.3.3.3 Plans to Fill Data Gaps

The steps to fill data gaps are the same as the groundwater level network. Collection of well attribute information described above will benefit groundwater storage monitoring. The program would be enhanced with refined specific yield values.

5.3.3.4 Site Selection

Change in groundwater storage is based on a calculation involving the specific yield and change in groundwater levels. Site selection for the groundwater level monitoring network is discussed in Section 5.2.3.4.

5.4 Seawater Intrusion

Regulation Requirement:

§354.34(c)(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.

The GSA is approximately 80 miles from the ocean and, therefore, seawater intrusion is not feasible. In addition, there are no saline water lakes in or near the GSA. As a result, seawater intrusion is not discussed hereafter in this chapter as allowed by §354.34(j). Saline water intrusion from up-coning of deep saline groundwater is a potential problem and will be monitored as part of general water quality monitoring.

5.5 Water Quality

Regulation Requirement:

§354.34(c)(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.

5.5.1 Monitoring Network Description

Water quality monitoring is an important aspect of groundwater management in the area and serves the following purposes:

- Spatially characterize water quality according to soil types, soil salinity, geology, surface water quality, and land use;
- Compare constituent levels at a specific well over time (i.e., years and decades);
- Determine the extent of groundwater quality problems in specific areas;
- Identify groundwater quality protection and enhancement needs;
- Determine water treatment needs;
- Identify impacts of recharge and surface water use on water quality;
- Identify suitable crop types that are compatible with the water characteristics; and
- Monitor the migration of contaminant plumes (such as nitrate).

A discussion on groundwater quality in the NSWDGSA is in Section 3.2.5 – Groundwater Quality. Several agencies are involved in the monitoring and mitigation of groundwater quality in the surrounding area. These agencies include the County of Madera, State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCB), United States Geological Survey (USGS), and California Department of Toxic Substances Control (DTSC). Data from these sources indicate that common constituents of concern in NSWDGSA and the region are nitrate and total dissolved solids (TDS). Data available within and near the GSA show that levels of these constituents are generally below respective regulatory levels for drinking water (see Section 3.2.5 for details). Contaminant plumes are not known within the GSA.

Though water quality has been periodically analyzed within the GSA for irrigation suitability, a monitoring program is not in place with defined temporal and spatial distribution. The three District wells in the groundwater level network (10, 34, 37) will be analyzed once every three years for nitrogen and electrical conductivity (EC). **Figure 5-1** shows the NSWD wells selected for water quality monitoring.

5.5.2 Quantitative Values

Minimum thresholds and measurable objectives for groundwater quality are discussed in **Section 4.4**. Minimum thresholds of 45 mg/L for nitrogen and 2,700 µmhos/cm for EC have been set in the GSA. Measurable objectives for nitrogen and EC are 30 mg/L and 1,700 µmhos/cm, respectively. Two consecutive measurements or a three-year rolling average of concentration levels will be used to determine whether the objective is being met.

5.5.3 Review and Evaluation of Monitoring Network

5.5.3.1 Monitoring Frequency and Density

Water quality sampling will occur every three years. The sampling will be conducted during the summer pumping to get a good representation of the water quality. Because there are no known contaminant plumes to be monitored in the GSA, this sampling interval will be sufficient to determine if water quality is being degraded. If a quality issue should be recognized, more frequent sampling will be conducted as appropriate.

Similar to the groundwater level monitoring network, a minimum of three water quality data points is required to define spatial trends. Three wells have been selected for water quality monitoring in the confined aquifer.

5.5.3.2 Identification of Data Gaps

Though water quality has been periodically analyzed within the GSA for irrigation suitability, a groundwater quality monitoring program is not in place with defined temporal and spatial distribution. The water quality monitoring network described above that will be implemented does not contain temporal data gaps.

Spatial gaps are present in that no wells in the unconfined aquifer have been identified for monitoring. Wells owned by NSWD landowners that have construction information do not include wells exclusively screened in the unconfined aquifer.

Data quality gaps will be avoided by following the monitoring protocols discussed in section 5.9.

5.5.3.3 Plans to Fill Data Gaps

Spatial data gaps will be filled by:

- Collecting well construction information for additional wells in NSWD as described in 5.2.3.3 to identify wells in the unconfined aquifer, or
- Obtaining permission from the owners of CASGEM wells in the groundwater level monitoring network to collect water quality samples.

5.5.3.4 Site Selection

The scientific rationale for selecting water quality monitoring sites includes:

- Select dedicated monitor wells over production wells where feasible.
- Lateral distribution is such that water quality can be defined across the GSA.
- Select wells with available construction information (i.e., depth, perforated interval).
- Avoid wells perforated across multiple aquifers.
- Select site so that each aquifer is represented (vertical distribution).

5.6 Land Subsidence

Regulation Requirement:

§354.34(c)(5) Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.

5.6.1 Monitoring Network Description

Land subsidence is discussed in detail in Section 3.2.6 – Land Subsidence Conditions. The GSA is included in areas monitored by NASA and the U.S. Bureau of Reclamation (USBR) San Joaquin River Restoration Project (SJRRP). **Figure 5-2** shows the SJRRP monitoring points surrounding the GSA. Data from these sources show that subsidence has been occurring at significant rates within and surrounding the GSA. The monitoring network for NSWDGSA will utilize the USBR SJRRP and NASA InSAR data to continue to monitor the areas of subsidence.

5.6.2 Quantitative Values

Minimum thresholds, measurable objectives, and interim milestones for land subsidence are discussed in **Section 4.5**. The minimum threshold for land subsidence in NSWDGSA is a range from approximately -0.15 feet per year on the south end to -0.45 feet per year on the north end. Measurable objectives are obtained by applying a 10-, 30-, 30-, and 30-percent cumulative mitigation to the historical subsidence rate for 2025, 2030, 2035, and 2040 respectively. Interim milestones based on the measurable objectives are shown in Table 5-3.

Table 5-3 Preliminary Interim Milestones for Land Subsidence Objectives

	Subsidence Rate Range (feet)	
Year	South	North
2020	-0.15	-0.45
2025	-0.12	-0.36
2030	-0.09	-0.27
2035	-0.05	-0.14
2040	0	0

5.6.3 Review and Evaluation of Monitoring Network

Land subsidence will be primarily be monitored utilizing the USBR SJRRP and NASA InSAR land subsidence surveying programs. This is considered adequate considering the high density of monitoring in the region and the small area of the NSWDGSA. If data from these sources becomes unavailable in the future, a new monitoring network will be established to monitor land subsidence.

5.6.3.1 Monitoring Frequency and Density

The subsidence monitoring network has adequate density and frequency to determine land subsidence in the NSWDGSA area annually.

5.6.3.2 Identification of Data Gaps

Data gaps were not identified in the land subsidence monitoring network for the NSWDGSA.

5.6.3.3 Plans to Fill Data Gaps

There are no plans to fill data gaps as there are no data gaps identified.

5.6.3.4 Site Selection

Land subsidence in the NSWDGSA area is monitored with agency and government land subsidence surveying programs. This is considered adequate, especially because the area is closely monitored due to the high subsidence rates.

If additional monitoring locations are added, the following scientific rationale will be used:

- Add sites that can be easily surveyed and tied back to a nearby monument.
- Add sites where the ground surface is unlikely to be modified by future construction and will remain undisturbed.

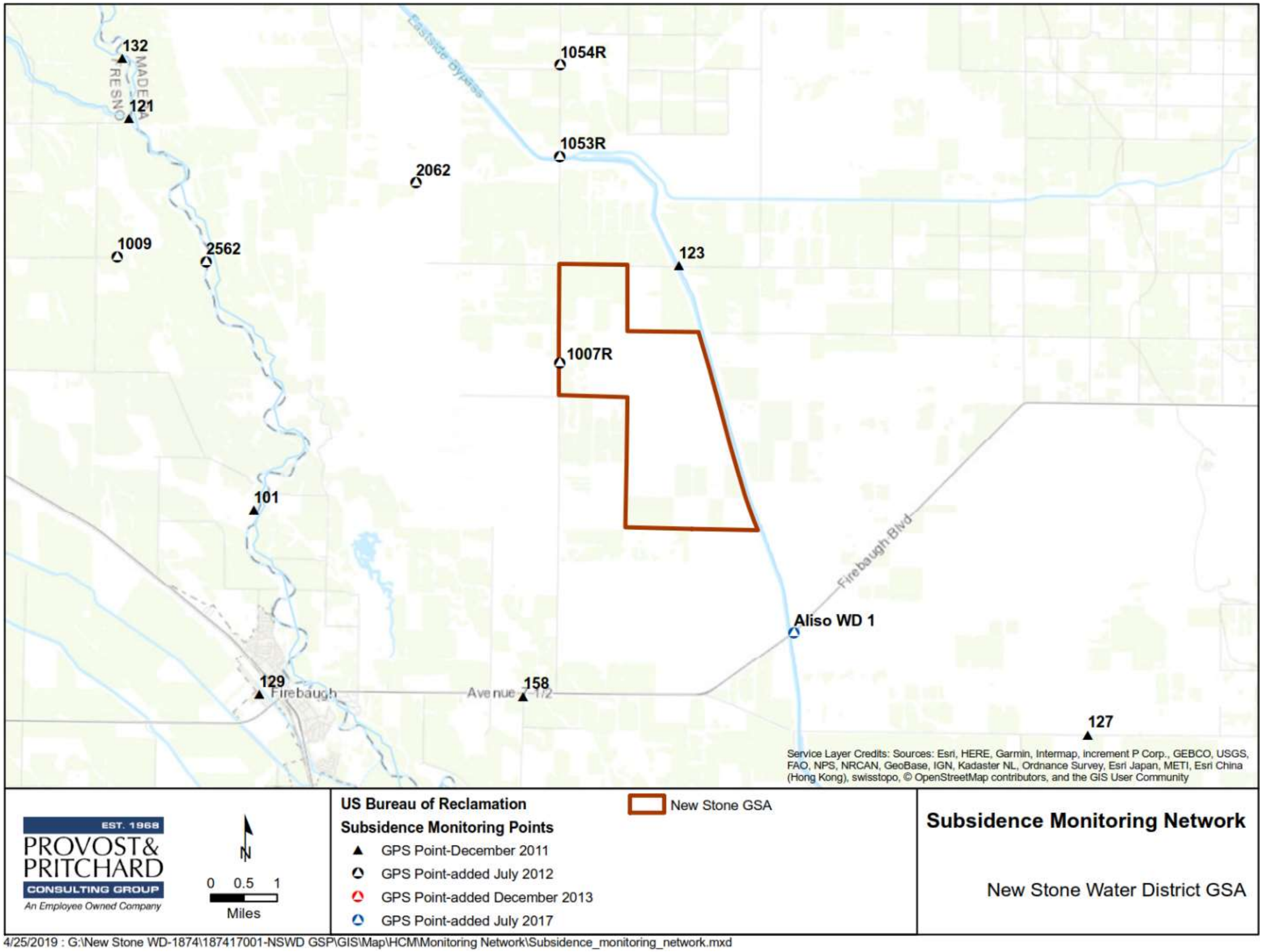


Figure 5-2 Subsidence Monitoring Network

5.7 Depletion of Interconnected Surface Water

Regulation Requirement:

> **§354.34(c)(6)** Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:
> A. Flow conditions including surface water discharge, surface water head, and baseflow contribution.
> B. Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
> C. Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
> D. Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

There are not any interconnected surface water systems within NSWDGSA due to distance from rivers and lack of water in the adjacent Chowchilla Bypass (see Section 3.2.7). As a result, depletion of interconnected surface water is not discussed hereafter in this chapter as allowed by §354.34(j).

5.8 Consistency with Standards

Regulation Requirement:

> **§354.34(g)** Each Plan shall describe the following information about the monitoring network:
> **(2)** Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.

The data gathered through the monitoring networks is and will continue to be consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix A**.

- Data reporting units and accuracy
- Monitoring site information
- Well attribute reporting
- Map standards
- Hydrograph requirements
- Groundwater and surface water models
- Availability of input and output files to DWR

5.9 Monitoring Protocols

Regulation Requirement:

> **§354.34(i)** The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.

The DQO process will be used to develop monitoring protocols that assist in meeting the measurable objectives and sustainability goals of this GSP. The DQO process includes the following:

1. State the problem.
2. Identify the goal.
3. Identify the inputs.
4. Define the boundaries of the area/issue being studied.

5. Develop an analytical approach.
6. Specify performance or acceptance criteria.
7. Develop a plan for obtaining data.

Groundwater level, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, December 2016b). Refer to **Appendix B** for a copy of the BMP. The GSA may develop standard monitoring forms in the future.

The following comments and exceptions to the BMP should be noted:

1. SGMA regulations require that groundwater levels be measured to the nearest 0.1 feet. The BMP suggests measurements to the nearest 0.01 feet; however, this is not practical for many measurement methods. In addition, this level of accuracy would have little value since groundwater contours maps typically have 10- or 20-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot. The accuracy of groundwater level measurements will vary based on the well type and condition. For instance, if significant oil is found in an agricultural well, then readings to the nearest foot are achievable.
2. Well sounding equipment will be decontaminated after use if used in a well with suspected or known contamination or if there are obvious signs of contamination, such as oil.
3. Wells will be surveyed to a vertical accuracy of 0.5 feet.
4. Unique well identifiers will be labeled on private wells if permission is granted by well owner.

5.10 Representative Monitoring

Regulation Requirement:

§354.36 Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:

§354.36(a) Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:
…1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

Representative monitoring sites are designated in Chapter 4 of the GSP. NSWDGSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

5.11 Data Storage and Reporting

Regulation Requirement:

§354.40 Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

The GSA will develop and maintain a data management system for storing and reporting information for the implementation of this GSP.

The rest of this section is to be prepared later after the GSA has prepared a comprehensive Data Management System as part of the Madera Basin Coordinated Effort. DWR has also stated that they will provide further guidance on this topic, possibly in the form a Best Management Practices Report, but it has not been released as of January 2019.

5.12 References

California Department of Water Resources (DWR). (2010, December). *Groundwater Elevation Monitoring Guidelines.*

California Department of Water Resources (DWR), (2016a, December). *Monitoring Networks and Identification of Data Gaps BMP.*

California Department of Water Resources. (DWR). (2016b, December). *Monitoring Protocols, Standards, and Sites BMP.*

United States Environmental Protection Agency. (2006, February). *Guidance on Systematic Planning Using the Data Quality Objectives Process.*

6 Projects and Management Actions

Regulation Requirement:

§ 354.44. Projects and Management Actions
(a) Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.
(b) Each Plan shall include a description of the projects and management actions that include the following:
(1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:
(A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.
(B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.
(2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.
(3) A summary of the permitting and regulatory process required for each project and management action.
(4) The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.
(5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.
(6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.
(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.
(8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.
(9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.
(c) Projects and management actions shall be supported by best available information and best available science.
(d) An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.

6.1 Potential GSP Projects and Programs

Implementation of projects and management actions will ensure that NSWD GSA will achieve groundwater sustainability by 2040. NSWDGSA analyzed several project types and groundwater management programs during the GSP planning process, which can be summarized into the following categories:

- Groundwater Recharge Projects
- Surface Water Acquisition Projects
- Water Conservation Projects
- Management Programs

6.1.1 Groundwater Recharge Projects

<u>Recharge Basins</u>
When excess surface water is available, it can be diverted into recharge basins, which allow water to percolate to the groundwater table and replenish the upper aquifer. Surface water is stored underground and extracted at a later time for beneficial use. Benefits to groundwater recharge via recharge basins include stabilization of groundwater tables, improved flood risk management, reduced land subsidence, and increased subsurface storage of local or imported water for later use (especially for use in dry years). The volume of water recharged is limited by availability of and access to surface water, infiltration rates of soils, losses due to

evaporation and groundwater migration, acreage of basins, constraints in existing infrastructure, and the ability to construct new infrastructure.

Water stored in recharge basins must be utilized in a timely manner or the benefits are lost. The SWRCB recognizes a first-in, first-use policy. This means the volume of water diverted for storage below ground is counted as the first water extracted during irrigation. There is little concern of losses once surface water is diverted to underground storage. For districts like New Stone that use more groundwater than they artificially recharge, water will be extracted before it can migrate out of the District. The District currently does not have any recharge basins.

<u>In-Lieu Recharge</u>

Decreased dependence on groundwater supplies can be achieved through in-lieu recharge when excess surface water is available. When the availability of excess surface water coincides with irrigation demands primarily met through groundwater pumping, the excess surface flows can be used for irrigation in-lieu of pumping. This may create an increase in groundwater storage or reduce the rate at which stored groundwater is depleted by allowing groundwater, that would normally be used to satisfy irrigation demands, to remain in storage. The water remaining in underground storage could be extracted at a later time for beneficial use. Typical benefits of recharge basins apply to in-lieu recharge as well. Limitations of in-lieu recharge include availability of and access to surface water coinciding with irrigation demands that are primarily met with groundwater pumping as well as crop dormant seasons. It can also be limited by constraints in existing infrastructure and the possible need to construct new infrastructure to allow for surface water delivery to users who do not have existing connections to conveyance systems.

<u>Groundwater Injection Wells</u>

Groundwater injection wells recharge groundwater by pumping surface water into the aquifer through a well or set of wells. This type of recharge can be beneficial for recharging the lower aquifer. Typical benefits of recharge basins apply to injection wells, but the limitations are vastly different. Injection wells are not as limited by available land due to their small footprint and are not affected by evaporation losses. Injection wells also have the potential to directly recharge the confined aquifer. They are dependent on soil types for recharge rates, but not in the same way as recharge basins. Limitations unique to injection wells are potential requirements to treat surface water prior to injection to protect aquifer water quality, variations in recharge rates due to differing water quality and air content between injected water and groundwater, and additional permitting.

<u>Banking Water Outside of District</u>

There is potential to recharge water on lands outside of NSWD if suitable recharge pond locations cannot be found or acquired within the District. There are lands adjacent to NSWD that are currently not farmed and could be purchased or annexed into the District with the understanding that the lands are to be used for surface water recharge. This land would also increase the GSA's overall acreage, reducing the overdraft per acre and count toward a potential fallowing program. Currently, no adjacent landowners are willing to sell their land or agree to the District's terms for annexation.

6.1.2 Surface Water Acquisition Programs

<u>Acquisition of Chowchilla Bypass Flood Water</u>

Securing new sources of surface water for import into a district/basin is a vital component of basin and groundwater sustainability. During years with significantly above average precipitation, non-contracted water sourced from high flow events is released into the San Joaquin River from Millerton Dam. If the lower reaches of the SJR are at capacity, excess flows are diverted into the Chowchilla Bypass via the bifurcation structure operated by the Lower San Joaquin Levee Control District. Acquiring water rights for surplus flows in Chowchilla Bypass will allow this previously abandoned water to be put to beneficial use and promote groundwater sustainability in the basin. Uses for this water can include, but are not limited to, groundwater banking and recharge via recharge basins, on-farm recharge, and in-lieu recharge. Excess surface flows often occur during the non-irrigation season when demands are very low or non-existent. In this case, surplus flows can be stored in basins until there is an irrigation demand or flooded on fields when the crops are dormant for in-lieu recharge. Benefits to importing new sources of surface water via water rights acquisition include stabilization of groundwater levels, reduced dependence on groundwater pumping, improved flood risk management, reductions in land subsidence, and increased storage of water underground for later use, especially in critically dry years or during extended droughts. Currently, NSWD has an appropriated water right along the Chowchilla Bypass for 15,700 AF of water.

Acquisition of USBR 215 Flood Water
Section 215 of the Reclamation Reform Act of 1982 (Public Law 97-293) defines temporary non-storable water supplies that can be released by the USBR from their facilities. The release of Section 215 water occurs during years of above-average precipitation when water levels encroach on flood-control levels. Section 215 flows are defined as unusually large temporary water supplies that cannot be stored for project purposes. Acquiring a Section 215 contract allows for these flows to be applied to lands that would otherwise not be eligible to receive Federal water. Benefits to importing new sources of surface water via a Section 215 Contract include stabilization of groundwater levels, reduced dependence on groundwater pumping, improved flood risk management, reductions in land subsidence, and increased storage of water underground for later use, especially in critically dry years or during extended droughts.

Water Exchanges/Transfers/Purchases
The GSA could exchange, transfer, or purchase water from other public or private agencies as opportunities arise. These prospects could be used within NSWD for direct or indirect recharge to help alleviate overdraft conditions and promote aquifer sustainability. If a lack of infrastructure prevents purchased water from being used within the GSA, agreements could be made with neighboring agencies to bank or recharge the water on behalf of NSWD.

6.1.3 Conservation and System Projects

Irrigation Efficiency Improvements
NSWD is approximately 4,200 acres made up of farmland and irrigated primarily by District wells. Most of the wells in the District range between 300 to 680 feet in depth. Typical irrigation methods include sprinklers, drip/micro irrigation, and surface/flood irrigation. Over the 10-year historic water budget period, it was estimated average on-farm irrigation efficiency is approximately 81%. This number may not reflect current irrigation efficiencies as irrigation techniques move from flooding to drip and micro. Implementing projects to increase on-farm efficiencies can promote aquifer sustainability by reducing or eliminating water that leaves the District via irrigation runoff, as wind and spray losses and leaks. Increasing on-farm efficiencies may not significantly impact aquifer sustainability if water is pumped from the upper aquifer because it is assumed any water applied in excess of crop evapotranspiration will percolate and return to the upper, unconfined aquifer. However, actual irrecoverable losses due to irrigation efficiency may be underestimated. Other benefits may be seen by growers as irrigation efficiency increases, such as decreased operational and pumping costs and possible increases in yield per acre-foot of water applied.

Increasing the overall District irrigation efficiency by capturing and reusing any water leaving the GSA could promote basin sustainability. Recaptured water can be used for artificial groundwater recharge or be directly used for irrigation to reduce the amount of required groundwater pumping.

Installing Well Meters
Groundwater pumping is currently the primary source of irrigation for NSWD. Installing flow meters on all irrigation wells would allow for better management of groundwater extractions by allowing the GSA to quantify pumping and its effects on groundwater storage, quality, and other sustainability indicators. Metering groundwater pumping would also allow the GSA to determine additional areas of improvement. Monitoring

and collecting volumetric groundwater extraction data may be necessary if pumping restrictions are implemented in the future, where penalties are developed and implemented for over pumping. This data will also aid the District in maintaining a balanced aquifer. The GSA may decline to require existing wells be fitted with meters; however, metering is mandatory for any new wells drilled in Madera County.

6.1.4 Management Programs

Proposition 218 – Fee Assessment to Implement GSP

The proposition 218 assessment is used to develop a fee schedule for members lying within the district being assessed. The purpose is to generate income to implement the GSA's mission and keep members of the district in compliance with local, state, and federal laws. For the purposes of assessing a GSA, districts would likely consider land uses, total acreage, number of wells, groundwater pumping and overall water use, access to surface water, and existing privately-operated management programs. Fees would then be assessed and either attached to an individual's property taxes or be collected directly by the districts. This would replace voluntary assessments and prevent districts from requesting money on an as-needed basis, but it would ensure that funds were available for project implementation and GSP maintenance and updates.

Subsidies for Surface Water Use, Groundwater Conservation Improvements, & Crop Conversions

Subsidies for surface water use, groundwater conservation improvements, and crop conversions to lower water-demand crops may be implemented by the GSA as incentives to help alleviate current overdraft conditions.

Irrigating with surface water in-lieu of groundwater pumping may increase groundwater storage or reduce the groundwater extraction rate. Subsidies could be awarded to users who utilize surface water as incentive to reduce groundwater extractions for irrigation.

Subsidies could also be awarded to users who engage in groundwater conservation improvements, such as implementing on-farm best management practices (BMPs). These practices can include installing soil moisture sensors, utilizing high-efficiency irrigation methods, and metering to apply precise irrigation amounts. Increasing groundwater conservation practices can promote aquifer sustainability by decreasing extractions and overdraft.

Replacing existing crops with lower-demand crops could increase basin sustainability and reduce groundwater overdraft through a reduction in extractions for irrigation. Growers may be incentivized through subsidies for crop conversions.

Fallowing Rotation

Land fallowing is the practice of taking crops out of production, allowing the land to be used for recharge purposes or to remain bare. Removing high water demand crops from production can balance groundwater levels and increase basin stability and sustainability by reducing the demands on the aquifer, especially if the fallowed land was irrigated with composite or deep-water wells.

Agency Reporting

GSAs will need some amount of reporting to meet the minimum requirements of SGMA and to establish representative monitoring networks. However, internal reporting will assist GSAs in determining impacts or benefits of management actions as well as protecting GSAs if disputes should arise in neighboring basins. Reporting will also assist GSAs in identifying problems and areas of concern, potential improvements or programs to achieve sustainability, and will likely prevent internal disputes.

6.2 Project Selection to Achieve Sustainability

NSWD GSA has not dismissed any of the proposed project types. For the purposes of this GSP, only projects currently being considered by the District are described further. If other projects described previously become feasible in the future, they will be addressed and prioritized in subsequent GSP updates.

6.2.1 Construct Chowchilla Bypass Turnout, New Canals, and Recharge Basins

6.2.1.1 Project Description

During extreme wet years, non-contracted water sourced from high flow events is released into the San Joaquin River. When the lower reaches of the SJR are at capacity, water is diverted from those lower reaches into the Chowchilla Bypass (Bypass or CBP), a man-made flood control structure that runs along the east boundary of NSWD. Diversions from the SJR to the Bypass occur at the bifurcation structure operated by the Lower San Joaquin Levee Control District. The Bypass diverts flood waters from the lower reaches of the SJR to prevent flooding from Mendota northward past Highway 152 where it reconnects with the SJR. The Bypass only runs during high-flow years when the combined flows from both the SJR and the Kings River exceed the capacity of the lower SJR.

Constructing a turnout on the Chowchilla bypass ½ mile south of Avenue 12, new canals to convey the water, and up to three 80-acre recharge basins (Project) would allow NSWD GSA to implement groundwater recharge, in-lieu recharge, and flood relief projects. This project proposes to divert the District's appropriated high-flow waters from the Bypass via a new turnout owned and operated by the District. Water will be delivered from the Bypass to the proposed recharge basins and on-farm recharge areas within NSWD. Water will be applied directly to crops until land for a recharge basin can be acquired and developed. The turnout will be similar to others on the Bypass in the surrounding area and will divert water using slant mount pumps on the Bypass levee or a slide gate-controlled gravity pipeline turnout that will cut through the levee and end at sump pump on the field side of the Bypass levee. Fish screens will be required on both alternatives. The new canals will then convey the water through the District and terminate at the new recharge basins.

Additional groundwater recharge would also occur along the new canals. Excess water beyond the capacity of the proposed recharge basins could be stored in the canals, turning it into a linear recharge pond and allowing water to recharge the groundwater table. Also, turnouts to landowners can be installed along the canals so that they could use the water for irrigation purposes or flood the fields when the crops are dormant for another groundwater recharge opportunity.

Flows for the 20-year duration of available data (1997-2017) were analyzed to determine the frequency and duration of flows down the Bypass. There were significant flows in the Bypass in 1998, 2005, 2006, 2011, and 2017. The Bypass typically flows every 4 years between mid-January to mid-July (**Figure 6-1**). During high flow years (2006, 2011, 2017), the Bypass ran between 146 to 192 days. Flow rates in the Bypass are measured every 15 minutes at the California Data Exchange Center (CDEC) at the CBP station.

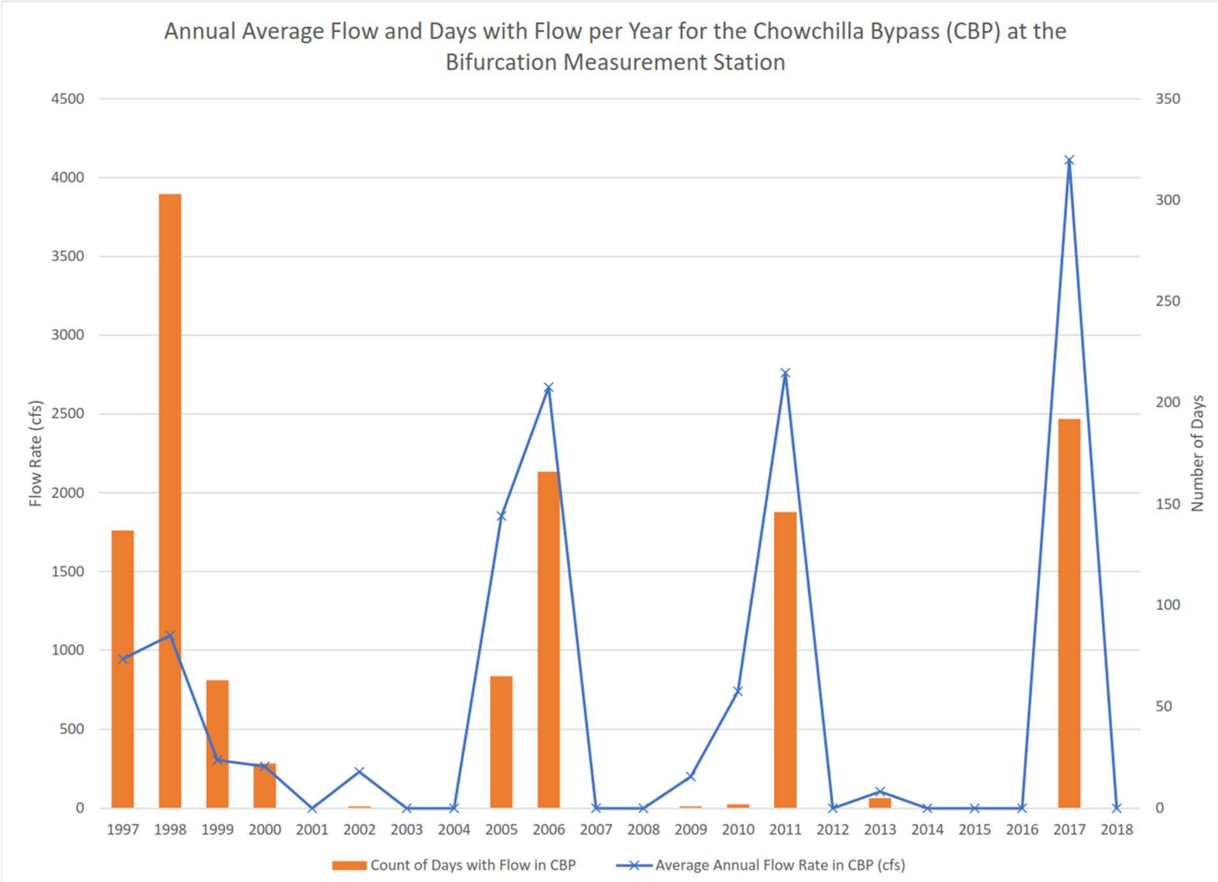


Figure 6-1 Chowchilla Bypass Historical Flow

The Bypass is operated by the Levee District. Flows for Bypass operations are measured in the SJR upstream of the Bifurcation Structure/control structure (Upstream flow SJR) and downstream of the Bifurcation Structure/control structure (Downstream flow SJR), and Chowchilla Bypass (Chowchilla Canal CCBP, CBP). When flows exceed the 2,500 cfs capacity of the SJR below the Bifurcation Structure, water is diverted down the Bypass. The Bypass at the CBP Station has a capacity of 5,500 cfs; however, if both the capacity of the SJR below the Bifurcation Structure (2,500 cfs) and the CBP Station (5,500 cfs) are exceeded, it is at the Levee District's discretion to operate the system with the objective of minimizing damage. According to the Levee District, due to additional constraints in SJR channel capacity below the Bifurcation Structure, the Bypass operates when flows in downstream are expected to exceed 1,300 cfs. Because the Bypass is operated as a flood control structure, there are many years when it does not run and there is no available water for users along the Bypass.

6.2.1.2 Measurable Objectives

The main objective of the Project is to divert the District's 15,700 AF appropriated water right during time of high flows. The GSA has an estimated annual groundwater deficit of 1,600 acre-feet per year. If NSWD GSA is able to divert 15,700 AF of water from the Bypass every 4 years, they should be able to correct their deficit and achieve sustainability. Flows will be diverted from the Bypass to the proposed recharge basins via a new turnout and conveyance facilities. Using existing wells in the area, water elevations will be monitored, and water samples will be collected. This data will be used to establish baselines for groundwater elevations and quality for comparison to quantify project impacts. Surface water delivered to the recharge basins will be metered and sampled for water quality issues, although none are anticipated.

6.2.1.3 Circumstances for Implementation

NSWD GSA lies within a critically overdrafted groundwater basin, which causes basin-wide aquifer depletion, land subsidence, and unstable groundwater levels. Constructing a Bypass turnout and new recharge facilities will play a vital role in remediating basin unsustainability. Implementation will depend on the availability of land for new recharge basins and acquiring a source of funding.

6.2.1.4 Permitting and Regulatory Process

It is anticipated that approvals from the following agencies will be required:

- *Army Corps of Engineers (Army Corps), 404 Permit* – work within a Water of the US.
- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *Central Valley Flood Protection Board (CVFPB), Encroachment Permit* – For work within a State Designated Floodway.
- *Department of Fish and Wildlife, Stream Bed Alteration Agreement* – for work within the CBP, a Water of the State.
- *Madera County, Building Permit* – for any electrical work to service facilities.
- *Mosquito Abatement* – for operation of an open body of water that could host vectors.
- *Regional Water Quality Control Board (RWQCB), Section 401 Water Quality Certification* – for compliance with the Clean Water Act in conjunction with the Army Corps 404 permit.
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction that disturbs a surface area of 5 acres or more.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* – for construction that disturbs more than five acres.

6.2.1.5 Project Schedule

This project is in the conceptual phase. Once project funding is secured, a comprehensive schedule including environmental review, design, permitting, and construction will be developed. Environmental review, permitting, and project agreements could be completed in 3 to 6 months, where design and construction could be completed in a year. It is anticipated that NSWD GSA will start working on securing funding prior to or within the first 5 years of GSP implementation.

6.2.1.6 Project Benefits

Groundwater is the primary water supply within NSWD, and the project will increase the reliability of the groundwater supply and basin sustainability. The benefits of this project are flood damage reduction, groundwater recharge, improving groundwater levels, and creation of a dry-year water supply. During high flows of the SJR when flows are diverted through the Bypass, redistribution of surface water mitigates the possibility of flooding to cities and lands downstream. These flood flows can then be used for groundwater recharge to alleviate chronic overdraft conditions. The amount of recharge will depend on how many acres are available for the proposed recharge facilities, the amount and duration of available water, and the infiltration rate of the recharge facilities. The removal of approximately up to 240 acres of permanent crops for the Project will also reduce pumping in the District by about 550 AF annually (assuming a District average pumping rate of 2.3 acre-feet/acre).

6.2.1.7 Project Implementation

This project will be implemented by NSWD as an integral piece of the GSA's overall effort to reach sustainability. It will be implemented, managed, and operated by the GSA. Project implementation includes the construction of recharge facilities and water conveyance systems. Benefits would begin as soon as water is applied to the constructed recharge facilities. The Project has been determined to be a high priority project based on the urgent need to correct critical overdraft.

6.2.1.8 Legal Authority

NSWD GSA would need to purchase the land necessary for the proposed groundwater recharge facilities and acquire easements for the new turnout and the conveyance systems. The project would be owned and operated by NSWD GSA. An agreement with the CVFPB and Army Corps will be required for constructing the turnout in the Bypass levee system. It is anticipated that the connection will need to be constructed outside of flood season.

6.2.1.9 Project Cost Estimate/Acre-Foot of Yield

Construction costs are based on similar projects for the conceptual level design and include permitting, the turnout, conveyance canal, and basin construction. The total cost of the project is estimated at about $7.7 million, Assuming a 3% interest rate loan, annualized over a 50-year period, the annual repayment cost is expected to be $400,000. The material required to complete this project is expected to last 50 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $70 per acre-foot for an annual yield of 6000 acre-feet. Costs will be further developed once the project proceeds to a more detailed level of design. Based on being a conceptual level, a -20%/+30% contingency was presumed.

6.2.1.10 Management of Groundwater Extractions and Recharge

The project would be owned and operated by NSWD GSA as a necessary part of meeting the demands of SGMA. Management of groundwater extractions and recharge is possible by monitoring groundwater levels, recharge basin inflows, and diversions over time. Data could be reported to the GSA to make sure groundwater levels do not continue to decline beyond sustainable levels. During times of drought or in the occasion that the recharge rate is insufficient to mitigate overdraft to the measurable objective, management actions may be enacted. The severity of the situation will dictate the required actions. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit-to-cost ratio.

6.3 Management Actions

GSAs have a variety of tools which can be used to achieve sustainable groundwater management. The project previously identified in this chapter primarily focuses on the capture and use of surface water supplies within the GSA. Alternatively, there are other management actions which primarily focus on the reduction of groundwater demand and increase of data collection including education and outreach, regulatory policies, incentive-based programs, and enforcement actions.

If basin overdraft isn't mitigated or if sustainable thresholds are not being met after implementation of NSWD GSA and landowner projects, the management actions and other potential projects listed below may be enacted, and the priority of these projects will be increased. The severity of the situation will dictate the actions taken. Priority will be given to actions and projects that can be implemented in a relatively short amount of time and have a high benefit-to-cost ratio.

The following sections will discuss a suite of management options NSWD GSA may consider during the GSP implementation. The menu of management actions discussed below may not be implemented in a strictly linear fashion, as numbered in the GSP. It is expected that NSWD GSA will further develop and craft management actions in response to stakeholder input on parallel timelines and adapt to the estimated schedules according to the best available information and best available science at any given time. NSWD GSA understands there are various levels of uncertainty with program implementation, and it is not unusual for implementation to take longer than originally estimated. In addition, the accrual of expected benefits may take multiple years to be individually realized and vary substantially year to year.

The legal authority and basis for the management actions described in this GSP Chapter 6 are outlined in SGMA and related provisions. SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively. These GSA authorities include adopting regulations, regulating groundwater extractions, imposing fees, monitoring, enforcing programs, and more. Though the law grants the GSA these powers, the pursuit and implementation of the projects and management actions is the GSA's responsibility. The GSA may enforce their legal authority to the extent necessary to achieve sustainable groundwater management for all beneficial users within the GSA.

6.3.1 Groundwater Allocation

The GSA may adopt a policy which provides a finite groundwater allocation on a per acre basis. The sustainable yield and ultimate groundwater allocation may take into consideration the existing water rights holders, disadvantaged communities (DACs), groundwater-dependent ecosystems (GDEs), and CA Native American tribes. The GSA may determine whether an equal-, reduced-, or zero-allocation is given to lands with unexercised groundwater rights.

The GSA may adopt a policy which provides a gradual decrease to the initial groundwater allocation on a per acre basis to allow growers to adjust to the pumping restrictions over a 5-year period. The GSA may adopt a policy which states an adaptive management approach, whereby the groundwater allocation may be reviewed, changed, and reestablished every 5 years or during extreme drought as necessary to achieve long-term sustainability.

The GSA may adopt a policy to determine the method or methods to quantify the groundwater extractions. The GSA may consider a variety of methods including, but not limited to 1) aerial flyovers or remote sensing of irrigated area, 2) annual crop survey alongside aerial flyovers or remote sensing of irrigation areas including crop coefficients, 3) energy records and meter calibrations, 4) flow meter readings of pumped water, 5) remote sensing of evapotranspiration, or 6) other methods.

6.3.1.1 Measurable Objective

The goal is to ensure a fair groundwater allocation which clearly defines the acceptable groundwater extraction volume per year. The measurable objective is the volume of groundwater extraction in acre-feet.

6.3.1.2 Program Benefits

The development of a groundwater allocation per acre may be based on the GSA's current sustainable yield. The expected benefits would be mitigation of overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner. To enforce this program, monitoring of groundwater extractions would be necessary, thus creating a better database for future understanding of groundwater conditions.

6.3.1.3 Program Costs

Exact costs are difficult to determine; however, qualitative costs include personnel to draft and adopt the policy as well as implementation and enforcement of the policy on a yearly basis.

6.3.1.4 Circumstances of Implementation

The policy may be considered as part of the implementation of the plan and continue indefinitely or it may only be established when measurable objectives or minimum thresholds of sustainability indicators are not being met. The policy may be adapted or changed based on current or future conditions.

6.3.2 Groundwater Market and Trading

The GSA may adopt a policy to define groundwater allocation carryover provisions and/or allowing multi-year pumping averages. The inter-annual flexibility may be useful to growers who could change cropping patterns or fallow. However, there is a risk that extreme drought may induce exceptionally high pumping in a single year.

The GSA may adopt a policy to define a groundwater banking program. The GSA must acknowledge and discuss any other existing water bank/credit systems. The GSA must approve of all replenishment projects and determine the timeframe for any banking efforts prior to banking program adoption. The GSA may consider adjusting banked credits if groundwater allocations require adjustment of safe yield. The GSA may define a "leave-behind" amount for groundwater migration and operational and evaporative losses, as well as to buffer against impacts to neighboring wells. The GSA may consider finite timelines for banked water or ongoing "leave-behind" amounts.

The GSA may adopt a policy to define a groundwater trading structure. The GSA may consider a variety of structures including, but not limited to 1) bilateral contracts or "coffee shop" markets, 2) brokerage, 3) bulletin boards, 4) auctions and reverse auctions, 5) electronic clearing-houses or "smart markets," or 6) other trade structures. Trading may be executed through short-and long-term leases, permanent transfers, inter-annual water exchanges, or dry-year option contracts. The GSA may determine physical trade limitations, such as distance, aquifer, soil conditions, or management areas.

The GSA may adopt a policy to prohibit groundwater allocation transfers outside of the GSA Management Area boundaries. The GSA may assure performance by enforcing rigid penalties for illegal actions. The GSA may approve external transfers in limited quantities for emergency situations and levy fees for metering the transferred amount.

6.3.2.1 Measurable Objectives

The goal is to provide groundwater users (excluding de minimis extractors) with more flexibility in utilizing their groundwater allocation. It may also provide groundwater users an optional banking program to fairly and responsibly bank groundwater allocations.

6.3.2.2 Program Benefits

The expected benefits may provide groundwater extractors more flexibility year to year and encourage other on-farm changes, such as crop conversion, crop rotation, deficit irrigation, and other best management practices. The method of evaluation may consider the number of participants, cost, accounting, and legal defense. This management action allows sustainable carryover allocations but may not generate a quantifiable demand reduction.

6.3.2.3 Program Costs

Exact costs are difficult to determine; however, qualitative costs include personnel to draft and adopt the policy as well as implementation and enforcement of the policy on a yearly basis.

6.3.2.4 Circumstances of Implementation

The policy may be implemented shortly after the adoption of the groundwater allocation per acre and remain indefinitely. Prerequisites of banking may include the installation of a flowmeter for participants and payment of any GSA assessments, penalties, or fees.

6.3.3 Groundwater Fees and Subsidies

The GSA may adopt a policy to levy tiered fees for pumping beyond the current groundwater allocation. The GSA may consider cease and desist orders for excessive abuse. The GSA may adopt a policy to incentivize groundwater extractors through subsidies to change crop type to one with a lower water demand.

6.3.3.1 Measurable Objective

The objective of these types of policies would be to directly decrease water demand and to enforce sustainable yield policies.

6.3.3.2 Program Benefits

The program may enforce sustainable yield allocations by imposing a tiered fee structure and would bring in additional income for the GSA. Subsidies for crop conversion would directly impact water demand, thus helping the District remain sustainably managed.

6.3.3.3 Program Costs

Exact costs are difficult to determine; however, qualitative costs include personnel to draft and adopt the policy as well as implementation and enforcement of the policy on a yearly basis.

6.3.3.4 Circumstances of Implementation

The policy may be implemented shortly after the adoption of GSP and remain indefinitely. It may instead be adopted if sustainability goals are not being met.

7 Plan Implementation

The adoption of the GSP will be the official start of the Plan Implementation for NSWD. The GSA will continue its efforts to secure the necessary funding to successfully monitor and manage groundwater resources within the District in a sustainable manner. While the GSP is being reviewed by DWR, NSWD GSA will begin the implementation of both projects and management actions.

The following chapter outlines the estimated proposed budget and implementation timeline for the suggested projects and management actions of the NSWD GSP. All the projects discussed have been evaluated as potential investments that would assist in achieving the long-term goals of the GSA. The potential schedules and budgets outlined below are purely estimates and may be adapted or eliminated should the GSA board deem it necessary.

7.1 Estimate of GSP Implementation Costs

There are two main types of expenses that require funding in order to successful implement the NSWD GSP: Ongoing Administrative Expenses and Project Costs.

<u>Ongoing Administrative Expenses</u>
These include but are not limited to the cost of annually operating the GSA, including the executive officer's salary, fiscal agent and staff expenses, audit, annual data collection and reporting, outreach, legal, and other administrative costs. This does not include agency specific project implementation costs but may include GSA-wide efforts, such as identification of construction information for wells in the monitoring network. Costs are estimated to be in the range of approximately $40,000 to $105,000 annually as seen in Table 7-1 below.

Table 7-1 Estimated Administrative Costs

	2020	2021	2022	2023	2024
Annual Monitoring	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000
Basin Coordination	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000
Five Year Plan Update					$ 65,000
	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 105,000

Table 7-1 is referring to the estimated administrative costs that may be seen on an annual basis for fulfilling typical responsibilities of the GSA. The above costs were compiled purely as an estimation and may be adapted or eliminated should the Board of Directors deem it necessary. It is impossible to accurately determine how many hours may be required on a weekly basis to complete the regular responsibilities of the GSA. The line items seen in **Table 7-1** may not accurately represent all the actions said funding would be contributed to.

<u>Project Costs</u>
Projects which may include infrastructure or management programs will be required to achieve groundwater sustainability. Project costs may include planning, capital, financing, and operations and maintenance of infrastructure. The project costs listed throughout this chapter are estimates and may be adapted or eliminated by the GSA Board should it be deemed necessary. Additionally, the implementation of the projects is dependent on both obtaining funding and the availability of flood water to be utilized. Further discussion regarding projects and their individual components, as well as their estimated timelines, can be found in Chapter 6 Projects and Management Actions.

Table 7-2 Estimated NSWD GSA Project Costs

PROVOST & PRITCHARD CONSULTING GROUP EST. 1968 An Employee Owned Company

DRAFT PRELIMINARY
ENGINEER'S OPINION OF PROBABLE COST

New Stone Waste District
GSP Management Actions
July 23, 2019

Item No.	Item Description	Quantity	Unit	Unit Price	Amount
CHOWCHILLA BYPASS TURNOUT					
1-1	Chowchilla Bypass Diversion Channel Excavation	7,000	CY	$ 4	$ 28,000
1-2	F&I Fish Screen in Bypass Diversion Channel	2	EA	$ 91,000	$ 182,000
1-3	F&I Slant Pump (50 CFS, 175 HP)	2	EA	$ 150,000	$ 300,000
1-4	Site Electrical with PG&E Service	1	LS	$ 100,000	$ 100,000
1-5	Levee Crossing and Replacement - Open Trench	600	CY	$ 14	$ 8,400
1-6	F&I 42" Steel Discharge Pipes	700	LF	$ 210	$ 147,000
1-7	F&I Flow Meter	2	EA	$ 10,000	$ 20,000
1-8	F&I Rip Rap	250	TN	$ 80	$ 20,000
1-9	Construct Flashboard Check Structure at D/S End	1	LS	$ 155,000	$ 155,000
	ESTIMATED CONSTRUCTION SUBTOTAL				**$ 960,000**
DISTRIBUTION SYSTEM					
2-1	Canals	7,000	CY	$ 4	$ 28,000
2-2	Lift station	1	EA	$ 91,000	$ 91,000
2-3	Road crossings	20	EA	$ 30,000	$ 600,000
2-4	Settling Basins	40	EA	$ 20,000	$ 800,000
	ESTIMATED CONSTRUCTION SUBTOTAL				**$ 1,519,000**
RECHARGE BASINS (10,000AF/yr)					
3-1	Earthwork (3 - 80 ac basins)	200,000	CY	$ 4	$ 800,000
3-2	Interbasin structures	6	EA	$ 15,000	$ 90,000
3-3	Rip-rap	450	TON	$ 80	$ 36,000
	ESTIMATED CONSTRUCTION SUBTOTAL				**$ 926,000**
LOWER AQUIFER PUMPING REDUCTION					
4-1	New shallow wells	5	EA	$ 450,000	$ 2,250,000
4-2	Lower aquifer well rehabilitation	5	EA	$ 55,000	$ 275,000
	ESTIMATED CONSTRUCTION SUBTOTAL				**$ 2,525,000**
AQUIFER STORAGE (6,000AF/ year)					
2-1	Water treatment Equipment	8	EA	$ 250,000	$ 2,000,000
2-2	Basins	8	EA	$ 65,000	$ 520,000
2-3	Well equipment	8	EA	$ 120,000	$ 960,000
2-4	Filters	8	EA	$ 65,000	$ 520,000
	ESTIMATED CONSTRUCTION SUBTOTAL				**$ 4,000,000**

Table 7-2 lists the estimated costs for the proposed projects as seen in Chapter 6 Projects and Management Actions. The existing project list is not necessarily definite and may be altered by the GSA Board of Directors. It is the intention of the GSA Board that the proposed projects would contribute substantially to NSWDGSA sustainability goals.

Grant Funding

NSWD GSA will explore federal and state grant funding opportunities to help finance the initial steps of plan implementation.

Table 7-3 Estimated Costs for Implementing Management Actions

Implementation of Projects and Management Actions	Estimated Costs Per 5-Year Period				Total 20-Year Cost
	2020 - 2025	2025 - 2030	2030 - 2035	2035 - 2040	
Bypass Turnout	$125,000	$125,000	$125,000	$125,000	$500,000
Distribution System	$375,000	$375,000	$375,000	$375,000	$1,500,000
Recharge Basins/Canal	$200,000	$200,000	$200,000	$200,000	$800,000
New wells	$500,000	$500,000	$500,000	$500,000	$2,000,000
Aquifer Storage	$750,000	$750,000	$750,000	$750,000	$3,000,000
Total Cost	$1,950,000	$1,950,000	$1,950,000	$1,950,000	$7,800,000
Average Annual Cost	$390,000	$390,000	$390,000	$390,000	

Table 7-3 indicates the estimated costs to the GSA associated with the proposed management actions as seen in Chapter 6 Projects and Management Actions. **Table 7-3** explains the estimated costs associated with each proposed management action as it is implemented and indicates their conceivable annual costs. These estimates may be altered by the GSA Board of Directors if deemed necessary and may be additionally adjusted during the 5-year GSP review. **Table 7-3** is an estimation of these and other costs, actual values may be in exceedance of, or less than those depicted above.

7.2 Identify Funding Alternatives

The Madera Subbasin has qualified for funding for developing and pursuing planning for the development and writing of the GSP. NSWDGSA has been a part of this effort and the NSWDGSA is grateful. Hopefully, Proposition 1 grant funding will be available to offset some of the capital improvement costs. Because Proposition 3 did not pass in this last election, there is some doubt that there will be grant or low interest loan money available to help offset some of the costs.

7.3 Schedule for Implementation

The GSA's overdraft was estimated to be approximately 1,600 AF prior to the development of the GSP. It is evaluated that by 2025, the pre-existing overdraft value will have decreased by approximately 10% due to both the implementation of projects and management actions. Of that amount, approximately 75% of that change will have developed from new or existing GSP projects and 25% will come from the implementation of NSWD GSA management actions. In the year 2030 it is estimated that the implementation of both GSP projects and management actions will have decreased the amount of overdraft by an additional 30% with 50% coming from project implementation and 50% from management actions. The progress of this trend is cumulative and will continue to increase throughout the GSP's implementation until sustainability is met.

7.4 Data Management System

The GSA's data management system will be developed in cooperation with the neighboring GSAs and the Madera Subbasin. The expectation is that over time the system will be modified to allow easier sharing of data within the region. The logistics of data flow, timing, and individual GSA management will be further defined after GSP adoption when more specific information is available.

7.5 Annual Reporting

Regulation Requirement:

§356.2. Annual Reports
Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:

(a) General information, including an executive summary and a location map depicting the basin covered by the report.

(b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:

(1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:

(A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.

(B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.

(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.

(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.

(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.

(5) Change in groundwater in storage shall include the following:

(A) Change in groundwater in storage maps for each principal aquifer in the basin.

(B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.

(c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.

The GSA will annually report the result of basin operations including current groundwater levels, extraction volume, surface water use, total water use, groundwater storage change, and progress of GSP implementation in accordance with SGMA law §356.2. Annual Reports.

7.6 Periodic Evaluations

Regulation Requirement:

§356.4. Periodic Evaluation by Agency
Each Agency shall evaluate its Plan at least every five years and whenever the Plan is amended, and provide a written assessment to the Department. The assessment shall describe whether the Plan implementation, including implementation of projects and management actions, are meeting the sustainability goal in the basin, and shall include the following:

(a) A description of current groundwater conditions for each applicable sustainability indicator relative to measurable objectives, interim milestones and minimum thresholds.

(b) A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.

(c) Elements of the Plan, including the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives, shall be reconsidered and revisions proposed, if necessary.

(d) An evaluation of the basin setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the Agency's evaluation shows that the basin is experiencing overdraft conditions, the Agency shall include an assessment of measures to mitigate that overdraft.

(e) A description of the monitoring network within the basin, including whether data gaps exist, or any areas within the basin are represented by data that does not satisfy the requirements of Sections 352.4 and 354.34(c). The description shall include the following:

(1) An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of Section 354.38.

(2) If the Agency identifies data gaps, the Plan shall describe a program for the acquisition of additional data sources, including an estimate of the timing of that acquisition, and for incorporation of newly obtained information into the Plan.

(3) The Plan shall prioritize the installation of new data collection facilities and analysis of new data based on the needs of the basin.

(f) A description of significant new information that has been made available since Plan adoption or amendment, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the Plan, including the evaluation of the basin setting, measurable objectives, minimum thresholds, or the criteria defining undesirable results.

(g) A description of relevant actions taken by the Agency, including a summary of regulations or ordinances related to the Plan.

(h) Information describing any enforcement or legal actions taken by the Agency in furtherance of the sustainability goal for the basin.

(i) A description of completed or proposed Plan amendments.

(j) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.

(k) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733.

The GSA will report, at least every five years and when the GSP is amended, the result of basin operations and progress in achieving sustainability including current groundwater conditions, status of projects or management actions, evaluation of undesirable results relating to measurable objectives and minimum thresholds, changes in monitoring network, summary of enforcement or legal actions, and agency coordination efforts in accordance with SGMA law §356.4. Periodic Evaluation by Agency.