BEDFORD COLDWATER
Groundwater Sustainability Authority

GROUNDWATER SUSTAINABILITY PLAN
BEDFORD-COLDWATER BASIN

| NOVEMBER 2021 |

Stantec

TODD GROUNDWATER

H&H WATER RESOURCES

BEDFORD COLDWATER
Groundwater Sustainability Authority

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November 2021

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Stantec H&H WATER RESOURCES

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Acronyms

Actions	Management Actions
AF	acre-feet
AFY	acre-foot per year
Agreement	Joint Powers Agreement forming the BCGSA
Basin Plan	Water Quality Control Plan for the Santa Ana River Basin
Basin	Bedford-Coldwater Subbasin
BCGSA	Bedford-Coldwater Groundwater Sustainability Agency
bgs	below ground surface
Board	BCGSA Board of Directors

CASGEM	California Statewide Groundwater Elevation Monitoring
CCED	California Conservation Easement Database
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
COC	constituent of concern
Corona	City of Corona
DDW	Division of Drinking Water
DMS	Data Management System
DPR	Department of Pesticide Regulation
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Water Assessment Program
EMWD	Eastern Municipal Water District
ET	evapotranspiration
ET_0	reference evapotranspiration
EVMWD	Elsinore Valley Municipal Water District
FMMP	Farmland Mapping and Monitoring Program
ft	feet
GAMA	Groundwater Ambient Monitoring and Assessment
GDE	groundwater dependent ecosystem
GIS	geographic information system
GMZs	groundwater management zones
GPS	Global Positioning System
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWMP	Groundwater Management Plan
in/yr	inches per year
InSAR	Interferometric Synthetic Aperture Radar
IRWMP	Integrated Regional Water Management Plan
JPA	Joint Powers Authority
km^2	square kilometers
M&I	municipal, commercial, and industrial
MA	Management Area
MCL	Maximum Contaminant Level
Metropolitan	Metropolitan Water District of Southern California
mg/L	milligrams per liter
mi^2	square miles
MO	Measurable Objective
MODFLOW	United States Geological Survey modular finite-difference flow model
MSHCP	Western Riverside County Multiple Species Habitat Conservation Plan
msl	mean sea level
MT	Minimum Threshold
NAD83	North American Datum of 1983

NAVD88	North American Vertical Datum of 1988
NCCAG	Natural Communities Commonly Associated with Groundwater
NCED	National Conservation Easement Database
NDMI	normalized difference moisture index
NDVI	normalized difference vegetation index
NED	National Elevation Dataset
ng/L	nanograms per liter
NO_3	nitrate
NOAA	National Oceanic and Atmospheric Administration
NPS	nonpoint source
NRCS	US Department of Agriculture, Natural Resources Conservation Service
NTU	nephelometric turbidity unit
NWIS	National Water Information System
ORP	oxidation-reduction potential
OWTS	on-site wastewater treatment system
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
ppt	parts per trillion
Projects	projects to support sustainability
QA/QC	quality assurance and quality control
RCRCD	Riverside County Resource Conservation District
RFP	Request for Proposal
RWQCB	Santa Ana Regional Water Quality Control Board
SARHCP	Upper Santa Ana River Habitat Conservation Plan
SCADA	Supervisory Control and Data Acquisition
SFR	Streamflow Routing Package
SGMA	Sustainable Groundwater Management Act
SMC	Sustainable Management Criteria
SMCL	Secondary Maximum Contaminant Level
SMP	Surface Mining Permit
SNMP	Salt and Nutrient Management Plan
SSURGO	Soil Survey Geographic Database
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
TNC	The Nature Conservancy
TVWD	Temescal Valley Water District
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UTV	Upper Temescal Valley
UWMP	Urban Water Management Plan
WMWD	Western Municipal Water District
WRF	Water Reclamation Facility

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EXECUTIVE SUMMARY

The Sustainable Groundwater Management Act (SGMA) requires local agencies in groundwater basins designated as high- or medium-priority to form Groundwater Sustainability Agencies (GSAs) and develop a Groundwater Sustainability Plan (GSP) to plan for achieving and/or maintaining sustainability within 20 years of implementing the plan. The Bedford-Coldwater Groundwater Subbasin (Basin) has been designated by the California Department of Water Resources (DWR) as very low-priority, so the preparation of a GSP is not required. However, the City of Corona (Corona), Temescal Valley Water District (TVWD), and Elsinore Valley Municipal Water District (EVMWD), the three major water purveyors and groundwater users in the Basin, are committed to protecting and maintaining sustainable groundwater conditions in the Basin into the future.

The three agencies signed a Joint Powers Agreement (Agreement) creating a Joint Powers Authority (JPA) and forming the Bedford-Coldwater Groundwater Sustainability Agency (BCGSA). The BCGSA has volunteered to become the GSA for the Bain and prepare and implement this GSP.

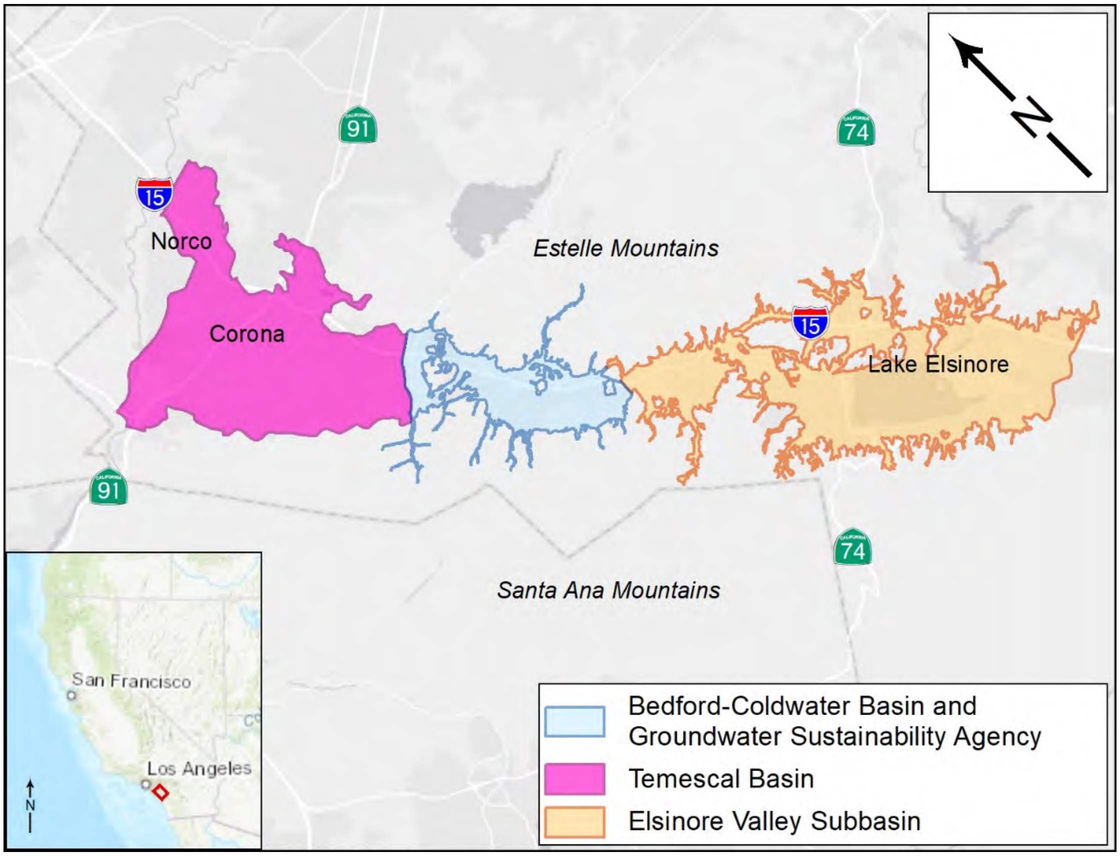
BASIN SETTING

Figure ES-1 shows the Basin located in western Riverside County. **Figure ES-1** also shows the adjacent Temescal Basin to the northwest and Elsinore Valley Subbasin to the south. The Basin is bound on the east and west by consolidated rocks of Estelle Mountain and the Santa Ana Mountains, respectively.

The Bedford-Coldwater Basin is composed of alluvial fan, alluvial valley, axial channel, and wash deposits. These deposits are sourced from the Santa Ana Mountains to the west of the Basin and the Peninsular Ranges to the east of the Basin. The alluvial fan deposits in the Coldwater area extend into the Bedford area and have been disrupted by faulting. Channel deposits along Temescal Wash and local tributaries define the eastern boundary of the Basin. In the northern Bedford area, a variety of Tertiary sedimentary units crop out and the character of these deposits and the groundwater chemistry differs from the alluvial fans to the north in the Temescal Subbasin and those to the south in the Elsinore Groundwater Basin.

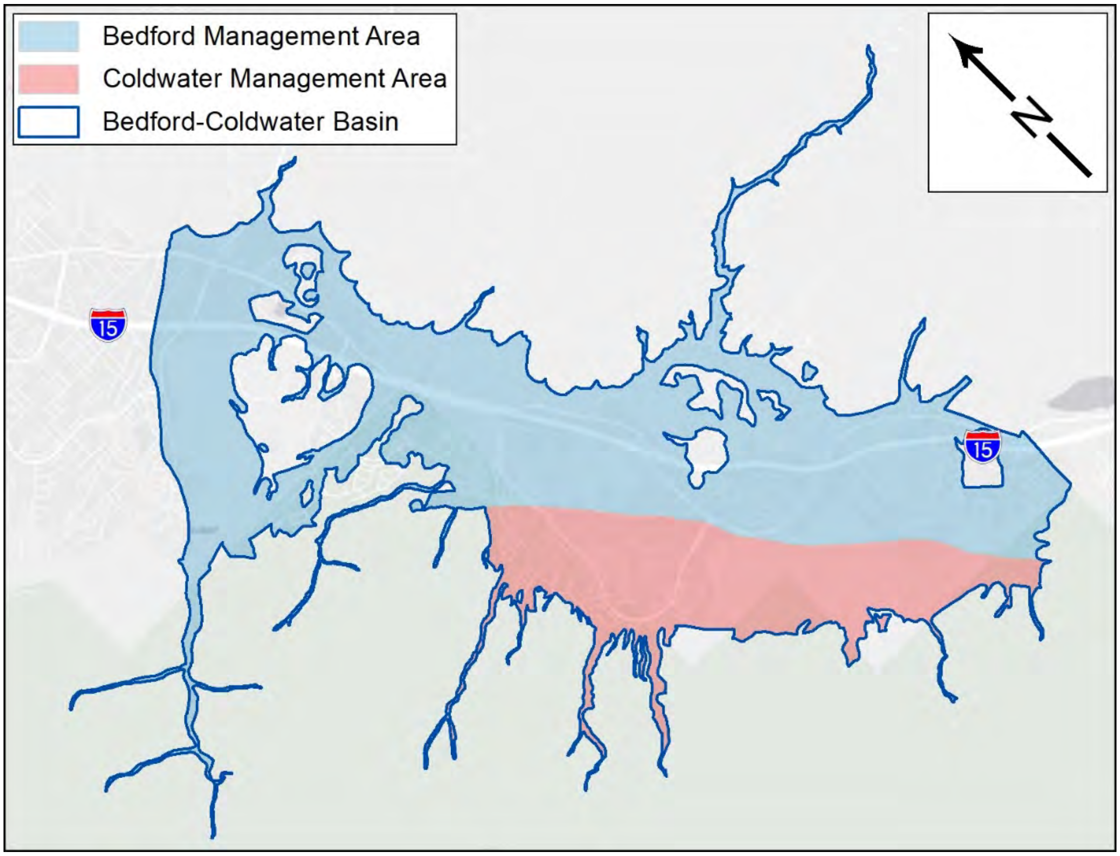
These deposits vary in depth from less than 40 feet up to 500 feet in the Bedford area (eastern portion of the Basin) and up to 800 feet in thickness in the deepest portions of the Coldwater area (western portion of the Basin).

Figure ES-1. Bedford-Coldwater Basin



The Basin is divided into two Management Areas (MAs) designed to facilitate analysis, management, and implementation of the GSP. The MAs are shown on **Figure ES-2**. The Bedford MA occupies roughly the eastern two-thirds of the Basin. It is separated from the Coldwater MA by the Glen Ivy Fault, which is a partial barrier to groundwater flow. The Coldwater MA is the part of the Basin west of the Glen Ivy Fault. Because of downward movement on that side of the fault, Basin thickness is much greater than in the Bedford MA. The partner agencies of the BCGSA are the primary groundwater users in the basin. There are no disadvantaged communities (DACs) or tribal lands in the Basin, and the BCGSA believes there are very few private wells, none of which are used for potable water supply in the Basin.

Figure ES-2. Bedford-Coldwater Basin Management Areas



GROUNDWATER CONDITIONS

Basin groundwater elevations have been relatively stable in recent years. Groundwater elevations in the northern portion of the Bedford MA show a slight decrease during the 2013 through 2015 drought but have begun to recover. Groundwater elevations in the Coldwater MA declined over the last 24 years with significant fluctuations in response to wet and dry cycles. Water levels in the Coldwater area have varied more than 350 feet during this period and there have been multiple major and minor cycles of groundwater elevation decline and recovery. The wide water level fluctuations over time in the Coldwater area likely reflect the relatively small footprint and fault-controlled flow along with the fact that most of the pumping in the Basin occurs in this area. Although long-term declines in groundwater elevations have occurred in Coldwater in the past, recent groundwater elevations have stabilized due in part to shared management of the Basin between the BCGSA agencies.

Total Dissolved Solids (TDS) and nitrate are the primary constituents of concern in the Basin. TDS concentrations are relatively low in the Coldwater MA, naturally higher in Bedford MA, and generally increase downstream. Groundwater in the Basin has been impacted by human activities in the Basin and watershed including agricultural, urban, and industrial land uses.

Nitrate has historically been the most significant constituent of concern in the Basin. Water quality in the Basin is generally within drinking water standards.

WATER SUPPLY

Sources of water supply for agricultural, Municipal and Industrial (M&I), and domestic uses include groundwater, imported water, and recycled water. Metropolitan Water District of Southern California (Metropolitan) is the wholesaler for imported water and its sources of water include the Colorado River and the State Water Project. Both Corona and TVWD receive imported water from Metropolitan for distribution in the Basin. EVMWD also receives imported water from Metropolitan through Western Municipal Water District (WMWD), but only distributes imported water within the Basin when groundwater supply to customers is insufficient.

Groundwater has been an important component of water supply in the Basin for more than 100 years. Until the 1970s, most of the groundwater production in the Basin was for agricultural supply. A few well owners have also produced small amounts of groundwater for domestic use. Production for municipal supply increased in the 1960s and 1970s and continues today.

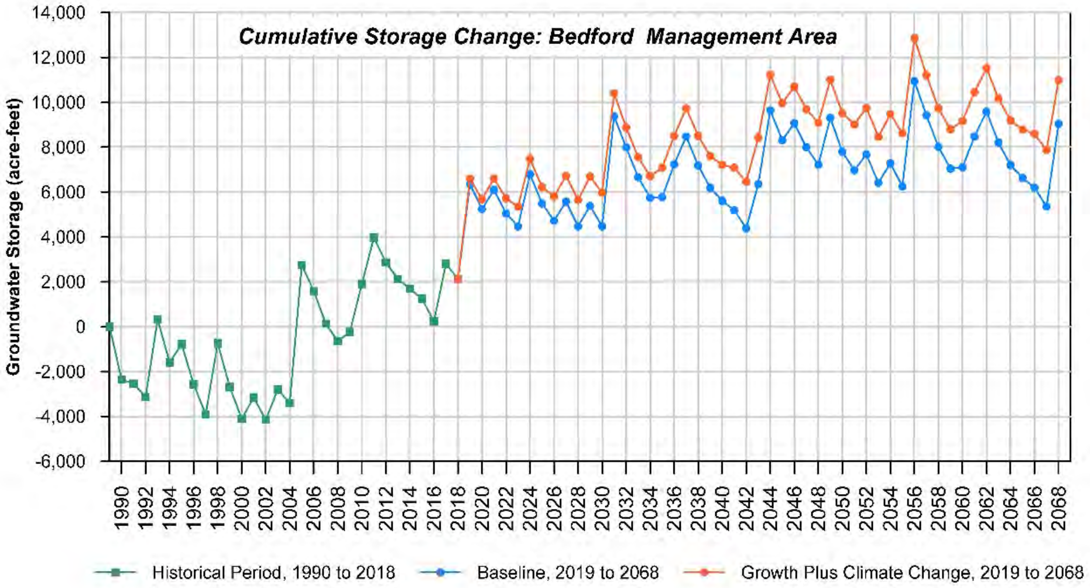
For more than 50 years, Corona, EVMWD, and TVWD have relied on groundwater from the Basin for municipal uses, and these agencies have long been responsible for managing groundwater conditions in the Basin. Corona and EVMWD have legal agreements for the management of withdrawals from the Coldwater portion of the Basin. Additionally, Corona, in coordination with TVWD, adopted a Groundwater Management Plan (GWMP) in 2008 that covers the Basin.

WATER BUDGET

A water balance (or water budget) is a quantitative tabulation of all inflows, outflows, and storage change of a hydrologic system. This GSP contains a detailed water balance for both the groundwater system and surface water system of the Basin. The water budgets were developed for time periods representing historical, current, future no project (baseline), and future growth plus climate change (growth plus climate change) conditions.

In the Bedford MA, the major inflow to the groundwater budget is percolation from streams, especially during wet years. In recent years (2012 to 2018), reclaimed water percolation has become another major inflow. The major outflows include M&I pumping and groundwater discharge to streams. Historically, agricultural pumping also contributed to outflow from the Basin, but this decreased to a negligible amount by 2007. Groundwater storage in the Bedford MA increased slightly during the historical period (**Figure ES-3**), primarily as a result of the decrease in total groundwater pumping. Outflows in the future scenarios (baseline and growth plus climate change) are predicted to increase in response to increased pumping. However, as shown in **Figure ES-3**, the Basin is still expected to have a positive change in storage (more inflow than outflow) in the future, even in growth and climate change projections. This future increase in storage is due to continued groundwater management and increased imported water use in the Basin.

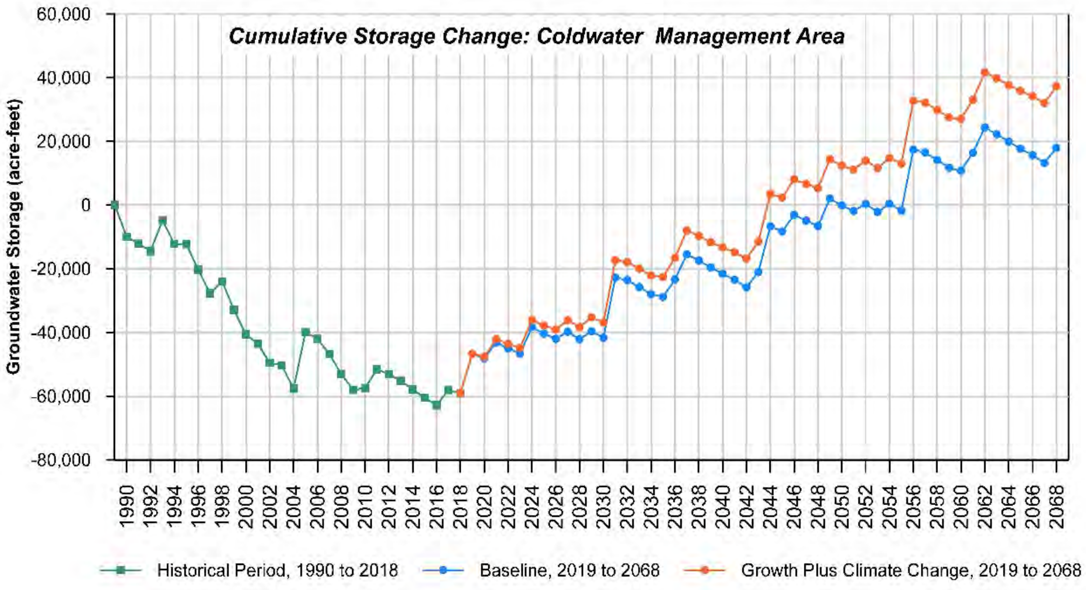
Figure ES-3. Cumulative Storage Change: Bedford Management Area



In the Coldwater MA, percolation from streams occurs as infrequent, episodic events; stream percolation can range from 15,000 acre-feet (AF) in wet years to zero in dry years. M&I pumping has dominated outflows in this MA, although it has decreased from its peak in the late 1990s. Similar to the Bedford MA, agricultural pumping was a significant outflow historically, but decreased to a negligible amount by 2001.

Estimated historical storage in the Coldwater MA declined by a cumulative total of 60,000 AF from 1990 to 2004, as shown in **Figure ES-4**. EVMWD and Corona entered into an agreement to limit pumping in the MA to a periodically re-calculated safe or sustainable yield in 2008. As a result, there was little additional cumulative decline from 2005 to 2018. In contrast, storage in both future scenarios is predicted to increase steadily over the 50 year future simulation periods. Inflows are estimated to exceed outflows in the future because of increased urban recharge and continued limitation of pumping. The rate of storage increase is slightly higher under the growth plus climate change scenario relative to the baseline scenario, which can be attributed to increased urban return flow recharge.

Figure ES-4. Cumulative Storage Change: Coldwater Management Area



SUSTAINABLE MANAGEMENT CRITERIA (SMC)

This GSP defines sustainable management as the use and management of groundwater in a manner that can be maintained without causing *undesirable results*, which are defined as significant and unreasonable effects caused by groundwater conditions occurring throughout the Basin, specifically in consideration of the following sustainability indicators:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply.
- Significant and unreasonable reduction of groundwater storage.
- Significant and unreasonable seawater intrusion. [1]
- Significant and unreasonable land subsidence that substantially interferes with surface land uses.
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

For these sustainability indicators, a GSP must develop quantitative sustainability criteria that allow the GSA to define, measure, and track sustainable management. These criteria include the following:

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[1] Seawater intrusion is noted, but no risk of seawater intrusion exists in this inland basin.

- Undesirable Result – significant and unreasonable conditions for any of the six sustainability indicators.
- Minimum Threshold (MT) – numeric value used to define undesirable results for each sustainability indicator.
- Measurable Objective (MO) – specific, quantifiable goal to track the performance of sustainable management.

The sustainability indicators and SMC are clearly defined and provide a quantitative analysis of the Basin's sustainability. As the Basin is currently sustainable, and has been managed sustainably, the following sustainability criteria are defined in to avoid future undesirable results:

- The Minimum Threshold for defining undesirable results relative to chronic lowering of groundwater levels is defined by operational considerations to maintain water levels at or above current pump intakes or screen bottoms (whichever is higher) in municipal water supply wells represented by frequently monitored Key Wells. Undesirable results are indicated when two consecutive exceedances occur in each of two consecutive years, in two-thirds or more of the currently monitored wells in each Management Area.
- The Minimum Threshold for reduction of groundwater storage for all Management Areas is fulfilled by the minimum threshold for groundwater levels as proxy.
- The Minimum Threshold for land subsidence is defined as a cumulative decline equal to or greater than one foot of decline since 2015, which represents current conditions and the SGMA start date. This is equivalent to a rate of decline equal to or greater than 0.2 feet in any five-year period. The extent of cumulative subsidence across the Basin will be monitored and evaluated using Interferometric Synthetic Aperture Radar (InSAR) data available through the SGMA Data Viewer during the 5-year GSP updates. Subsidence as a result of groundwater elevation decline is closely linked to groundwater levels and it is unlikely that significant inelastic subsidence would occur if groundwater levels remain above their minimum thresholds.
- The Minimum Thresholds for degradation of water quality address nitrate and total dissolved solids (TDS) for the entire Basin.
    - The Nitrate Minimum Threshold (in both Management Areas) is defined as 5-year average concentrations of all monitored wells not exceeding the 10 milligrams per liter (mg/L) drinking water maximum contaminant level (MCL) for Nitrate as Nitrogen.
    - The TDS Minimum Threshold (in both Management Areas) is defined as the 5-year average concentrations not exceeding the 1,000 mg/L secondary MCL for TDS.
- The Minimum Threshold for depletion of interconnected surface water is the amount of depletion associated with the lowest water levels recorded during the 2010 to 2015 drought. Specifically, undesirable results would occur if more than half of monitored wells near Temescal Wash had static water levels lower than 35 feet below the adjacent riparian vegetation ground surface elevation for a period of more than one year.

MONITORING NETWORK

The monitoring network for GSP implementation has been established to document groundwater and related surface conditions as relevant to the sustainability indicators, MTs, and MOs. The components of the monitoring network are built from existing programs and will be carried out by the BCGSA.

The BCGSA has actively engaged in assessment and improvement of its monitoring network. This process has been intensified as part of the GSP, given the need to identify data gaps and to assess uncertainty in setting and tracking sustainability criteria. Monitoring improvements such as adding or replacing monitoring infrastructure are part of GSP implementation and will be reviewed and updated for each five-year GSP update.

PROJECTS AND MANAGEMENT ACTIONS

During the preparation of the GSP, the BCGSA identified five specific management actions (Actions) and three projects (Projects) to achieve the sustainability goal. The Actions are generally focused on data collection, storage and reporting of information necessary to monitor sustainability, and assessment of when Actions may be necessary (i.e., when MTs are approached or exceeded). The projects are generally designed to reduce uncertainty in areas where data gaps have been identified during development of the GSP. The Projects and Actions in the GSP are as follows:

- **Action 1** – Provide for Collection, Compilation, and Storage of Information Required for Annual Reports and Submit Annual Reports;
- **Action 2** – Routinely Record Groundwater Levels and Take Action if Necessary;
- **Action 3** – Monitor Selected Groundwater Quality Constituents and Coordinate with the Regional Water Quality Control Board as Appropriate;
- **Action 4** – Track Trends in Groundwater Levels near Temescal Wash and Take Action as Necessary;
- **Action 5** – Review Interferometric Synthetic Aperture Radar (InSAR) Data on the California Department of Water Resources (DWR) Dataviewer During 5-Year Updates;
- **Project 1** – Investigate Groundwater/Surface Water Interaction at Temescal Wash and Install Monitoring Wells;
- **Project 2** – Initiate a Survey of Active Private Wells; and
- **Project 3** – Evaluation of the Effects of Aggregate Pits on Groundwater Flow and Quality.

The Projects and Actions will be implemented by a combination of existing resources from the three agencies within the plan area and contracted resources.

IMPLEMENTATION

The official adoption of the GSP by the BCGSA will initiate Plan implementation. After submittal of the GSP to DWR, and during the DWR review period, the BCGSA will continue to communicate with stakeholders via the BCGSA's website and begin implementing the projects and management actions described in this GSP. The Plan will be implemented to sustainably manage groundwater in the Basin under the authority of the BCGSA and its member agencies.

The BCGSA is required to submit an annual report to DWR by April 1st of each year following adoption of the GSP. The first annual report will be due in April of 2022. The BCGSA has committed to implementing the GSP upon adoption and completing the projects and management actions necessary to monitor and maintain sustainability within the first 5 years of initiation of the GSP.

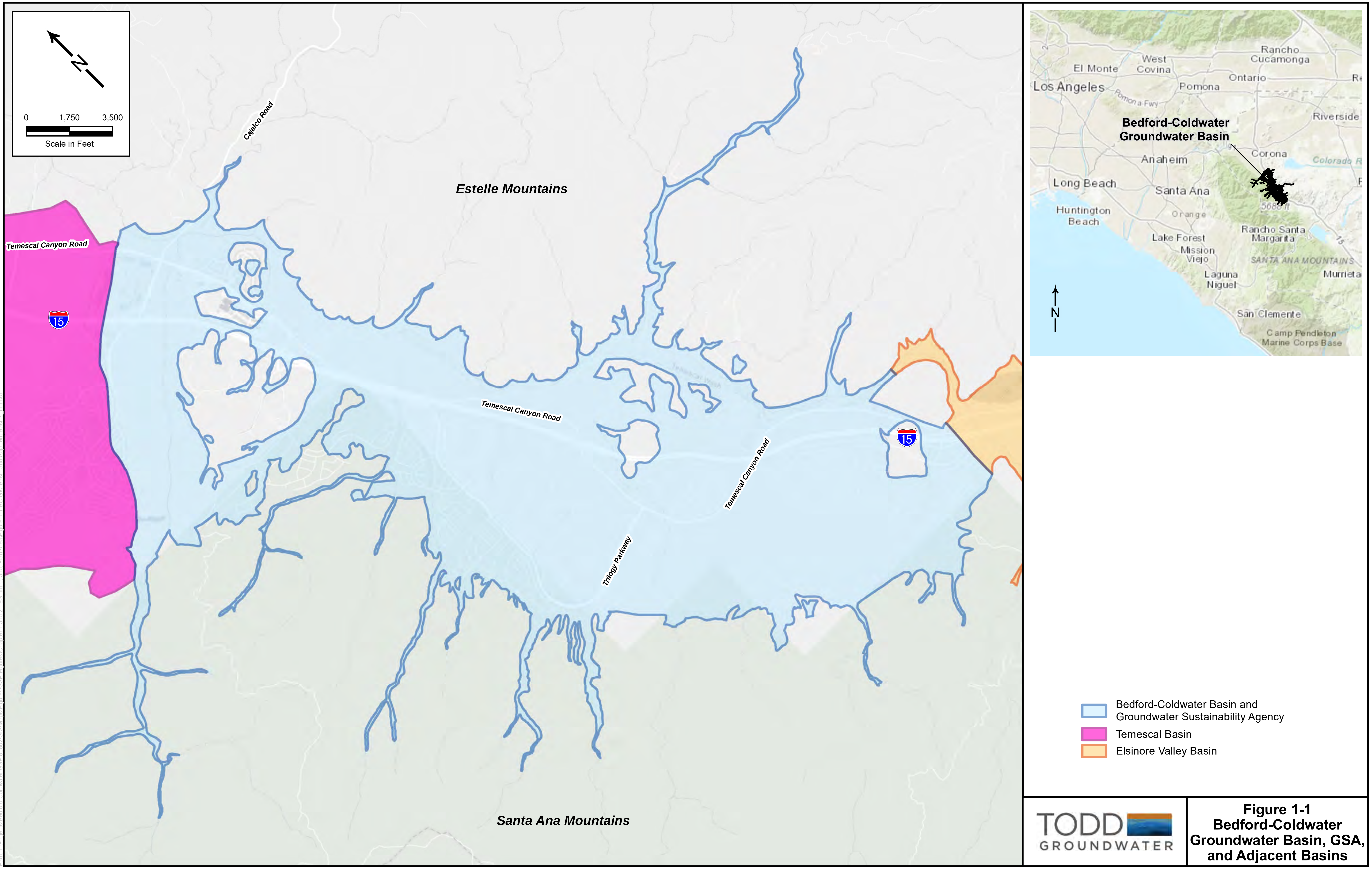
1. INTRODUCTION

The Sustainable Groundwater Management Act (SGMA), effective January 1, 2015, was enacted in California to regulate and sustainably manage groundwater basins throughout the state. SGMA provides a framework to guide local public agencies and newly created Groundwater Sustainability Agencies (GSAs) in the management of their underlying groundwater basins, especially those considered critically affected as defined by the Department of Water Resources (DWR). The Bedford-Coldwater Groundwater Sustainability Agency (BCGSA) has elected to create a Groundwater Sustainability Plan (GSP) to maintain long-term groundwater sustainability in the Bedford-Coldwater Groundwater Subbasin (Basin, **Figure 1-1**) of the Elsinore Groundwater Basin.

1.1. PURPOSE OF THE GROUNDWATER SUSTAINABILITY PLAN

SGMA requires local agencies of all basins designated as high- or medium-priority to develop a GSP to halt groundwater overdraft and achieve sustainability within 20 years of implementing the plan. Although the Basin is designated as very low-priority and does not require a GSP, the BCGSA is committed to protecting and maintaining the current sustainable conditions into the future and has opted to create and implement a GSP.

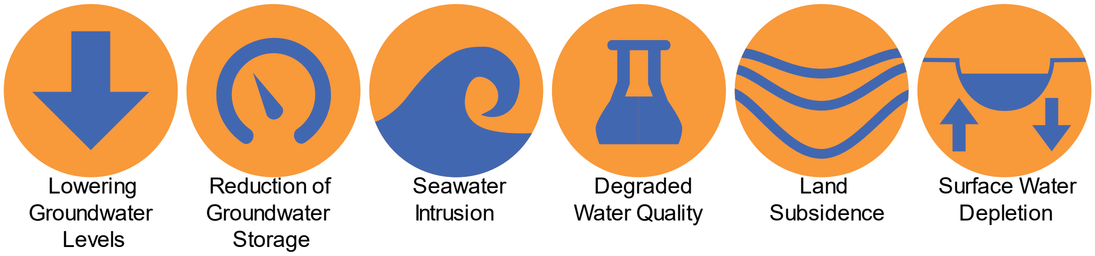
The purpose of the GSP is to provide basic information on the groundwater conditions in the Basin and to provide a plan or roadmap to maintain sustainability of beneficial use of groundwater in accordance with SGMA. The goal of the GSP is to promote Basin health by maintaining the generally balanced water budget, continue to prevent chronic overdraft, and avoid undesirable results which SGMA has divided into the six categories, represented in **Figure 1-2** below.



TODD GROUNDWATER

Figure 1-1
Bedford-Coldwater Groundwater Basin, GSA, and Adjacent Basins

Figure 1-2. SGMA Undesirable Results



The GSP assesses sustainability related to each of the categories listed above, defines thresholds for maintaining sustainability, outlines groundwater monitoring protocols, best management practices, management actions and projects designed to improve monitoring capabilities and/or to protect and enhance groundwater conditions. The GSP also includes a schedule and cost estimate for plan implementation. Each element of the GSP is designed to promote basin health and achieve and maintain the sustainability goal established for the Basin by the BCGSA.

1.2. SUSTAINABILITY GOAL

The BCGSA prepared this GSP with the goal of sustaining groundwater resources for the current and future beneficial uses of the Bedford-Coldwater Basin in a manner that is adaptive and responsive to the following objectives:

- Provide a long-term, reliable and efficient groundwater supply for municipal, industrial, and other uses;
- Provide reliable storage for water supply resilience during droughts and shortages;
- Protect groundwater quality;
- Support beneficial uses of interconnected surface waters; and
- Support integrated and cooperative water resource management.

This goal is consistent with SGMA and is based on information from the Plan Area, Hydrogeologic Conceptual Model, Groundwater Conditions, and Water Budget sections of this GSP that:

- Identify beneficial uses of Basin groundwater and document the roles of local water and land use agencies;
- Describe the local hydrogeologic setting, groundwater quality conditions, groundwater levels and storage, and inflows and outflows of the Basin; and
- Document the ongoing water resource monitoring and conjunctive management of groundwater, local surface water, recycled water and especially imported water sources that help protect groundwater quality and maintain water supply.

1.3. AGENCY INFORMATION

This section provides contact information, management structure, and legal authority of the BCGSA.

BCGSA Mailing Address:	Bedford-Coldwater Groundwater Sustainability Authority 31315 Chaney Street Lake Elsinore, CA 92530

1.3.1. Organization and Management Structure

The BCGSA consists of representatives from the three agencies overlying the Basin: The City of Corona (Corona), Elsinore Valley Municipal Water District (EVMWD), and Temescal Valley Water District (TVWD). The BCGSA is governed by a Board of Directors (Board), composed of three governing members, one member appointed by the representatives from each agency. The governing Board members will serve without terms, and at the discretion of the agency which appointed them. The Board designated a consultant to act as the Administrator for the BCGSA and provide administrative services as needed and required by SGMA and the BCGSA until the GSP is adopted. Information about the current BCGSA Board members can be found on the BCGSA website: https://www.bedfordcoldwatergsa.com/about-us/.

The point of contact for the BCGSA is the Plan Manager, Margie Armstrong. At the time of writing this GSP, the following is the current contact information:

BCGSA Plan Manager:	Margie Armstrong Deputy Treasurer Bedford-Coldwater Subbasin GSA 31315 Chaney Street Lake Elsinore, CA 92530 951-674-3146 Ext 8306 margie@evmwd.net http://www.evmwd.com/

An organizational chart for the BCGSA is presented on **Figure 1-3** below.

Figure 1-3. BCGSA Management Structure

1.3.2. Legal Authority

A Joint Powers Agreement (Agreement) to create a Joint Powers Authority (JPA) for the management of the Basin was entered into as of February 28, 2017 (**Appendix A**). The Agreement to form the BCGSA is by and between Corona, a California General Law City organized and existing under the laws of the State of California, EVMWD, a Municipal Water District organized under Water Code §§ 71000 et seq., and TVWD, a California Water District organized under California Water Code §§ 34000 et seq.. BCGSA signed a resolution to become the GSA for the Basin on March 29, 2017 (**Appendix B**, BCGSA 2017).

1.3.3. GSP Implementation Cost Estimate and Schedule

GSP implementation cost and schedule is described in detail in Section 9, Plan Implementation. Costs associated with implementing the GSP are considered to be either continually ongoing (operating) costs, or GSP implementation costs associated with specific management actions and projects. Annual operating costs in 2021 dollars are expected to be approximately $60,000. Annual implementation of management actions is estimated at approximately $266,000 per year, while total costs for recommended, one-occurrence projects is approximately $990,000 (including the first 5-Year GSP update). Estimated costs for years after the 5-Year GSP update will be reevaluated within the first 5-Year GSP update.

The BCGSA has committed to implementing the GSP upon adoption and completing the projects and management actions necessary to monitor and maintain sustainability within the first 5 years of initiation of the GSP. A preliminary schedule for implementation is provided in Section 9 as **Figure 9-1**.

1.4. GSP ORGANIZATION

This GSP was prepared according to guidance documents provided by DWR (DWR 2016a). The following outlines the GSP contents:

- **Section 1 – Introduction**, purpose of the GSP, sustainability goal, agency information, and GSP organization.
- **Section 2 – Plan Area** description, water use sectors, water supply sources, water resources monitoring and management programs, current general plans, other GSP elements.
- **Section 3 – Hydrogeologic Conceptual Model**, description of the physical basin setting including surface water features, soils, geologic setting, faults, and aquifers, defined basin bottom, recharge and discharge areas, and cross sections.
- **Section 4 – Current and Historical Groundwater Conditions**, discussion of groundwater elevations, land subsidence, groundwater quality and current monitoring, constituents of concern regarding water quality, interconnection of surface water and groundwater and the effects on groundwater dependent ecosystems (GDEs).
- **Section 5 – Water Budget**, discussion of the water budget, groundwater model, surface water and groundwater balance, change in groundwater storage, and estimate of sustainable yield.
- **Section 6 – Sustainable Management Criteria**, sustainability goal, sustainability criteria for the six undesirable results.
- **Section 7 – Monitoring Network**, discussion of the monitoring that will continue to assess sustainability in the future.
- **Section 8 – Projects and Management Actions**, descriptions of projects and management actions for the Basin.
- **Section 9 – Plan Implementation**, estimate of GSP implementation costs, schedule, plan for annual reporting and periodic evaluations.
- **Section 10 – References**

The GSP Preparation Checklist providing the chapter locations for GSP content requirements is provided in **Table 1-1** and the GSP Elements Guide detailing GSP content in comparison to SGMA articles is included in **Appendix C**. Figures in following sections are placed at the end of the section.

Table 1-1. GSP Preparation Checklist

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 3. Technical and Reporting Standards				
352.2		Monitoring Protocols	- Monitoring protocols adopted by the GSA for data collection and management - Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Section 7.2
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.4		General Information	- List of references and technical studies	Section 10
354.6		Agency Information	- GSA mailing address - Organization and management structure - Contact information of Plan Manager - Legal authority of GSA - Estimate of implementation costs	Section 1.3
354.8(a)	10727.2(a)(4)	Map(s)	- Area covered by GSP (Figure 1-1) - Adjudicated areas, other agencies within the basin, and areas covered by an Alternative (Figure 1-1) - Jurisdictional boundaries of federal or State land (Figure 2-1) - Existing land use designations (Figures 2-7, 2-8) - Density of wells per square mile (Figures 2-3 through 2-6)	Section 2
354.8(b)		Description of the Plan Area	- Summary of jurisdictional areas and other features	Section 2.1
354.8(c) 354.8(d) 354.8(e)	10727.2(g)	Water Resource Monitoring and Management Programs	- Description of water resources monitoring and management programs - Description of how the monitoring networks of those plans will be incorporated into the GSP - Description of how those plans may limit operational flexibility in the basin - Description of conjunctive use programs	Section 2.1.4 Section 2.1.4.1 Section 2.1.4.2 Section 2.1.6
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable General Plans	- Summary of general plans and other land use plans - Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects - Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans - Summary of the process for permitting new or replacement wells in the basin - Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Section 2.1.5 Section 2.1.5.3 Section 2.1.5.4 Section 2.1.5.5 Section 2.1.6
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(g)	10727.4	Additional GSP Contents	**Description of Actions related to:** - Control of saline water intrusion - Wellhead protection - Migration of contaminated groundwater - Well abandonment and well destruction program - Replenishment of groundwater extractions - Conjunctive use and underground storage - Well construction policies - Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects - Efficient water management practices - Relationships with State and federal regulatory agencies - Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity - Impacts on groundwater dependent ecosystems	Section 2.1.6
354.10		Notice and Communication	- Description of beneficial uses and users - List of public meetings - GSP comments and responses - Decision-making process - Public engagement - Encouraging active involvement - Informing the public on GSP implementation progress	Section 2.1.7 Appendix J (pending) Appendix J (pending) Section 1.3.1 Appendix D Section 2.1.7 Section 2.1.7

Table 1-1. GSP Preparation Checklist

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.14		Hydrogeologic Conceptual Model	- Description of the Hydrogeologic Conceptual Model - Two scaled cross-sections - Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	Section 3, Figure 3-8 and 3-9
9	10727.2(a)(5)	Map of Recharge Areas	- Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Figure 3-10
	10727.2(d)(4)	Recharge Areas	- Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 3.10
354.16	10727.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	- Groundwater elevation data - Estimate of groundwater storage - Seawater intrusion conditions - Groundwater quality issues - Land subsidence conditions - Identification of interconnected surface water systems - Identification of groundwater-dependent ecosystems	Section 4
354.18	10727.2(a)(3)	Water Budget Information	- Description of inflows, outflows, and change in storage - Quantification of overdraft - Estimate of sustainable yield - Quantification of current, historical, and projected water budgets	Section 5.7, Section 5.8, and Section 5.9
	10727.2(d)(5)	Surface Water Supply	- Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Section 2.1.2.1, Section 3.11, Section 5.6.2
354.20		Management Areas	- Reason for creation of each management area - Minimum thresholds and measurable objectives for each management area - Level of monitoring and analysis - Explanation of how management of management areas will not cause undesirable results outside the management area - Description of management areas	Section 5.4
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24		Sustainability Goal	- Description of the sustainability goal	Section 6.1.1
354.26		Undesirable Results	- Description of undesirable results - Cause of groundwater conditions that would lead to undesirable results - Criteria used to define undesirable results for each sustainability indicator - Potential effects of undesirable results on beneficial uses and users of groundwater	Section 6.2.1 Section 6.2.2 Section 6.2.3 Section 6.2.4
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	- Description of each minimum threshold and how they were established for each sustainability indicator - Relationship for each sustainability indicator - Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater - Standards related to sustainability indicators - How each minimum threshold will be quantitatively measured	Sections 6.2 through 6.7
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1) 10727.2(d)(2)	Measureable Objectives	- Description of establishment of the measureable objectives for each sustainability indicator - Description of how a reasonable margin of safety was established for each measureable objective - Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Sections 6.2 through 6.7

Table 1-1. GSP Preparation Checklist

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	- Description of monitoring network - Description of monitoring network objectives - Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions - Description of how the monitoring network provides adequate coverage of Sustainability Indicators - Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends - Scientific rational (or reason) for site selection - Consistency with data and reporting standards - Corresponding sustainability indicator, minimum threshold, measureable objective, and interim milestone - 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 - Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Section 7.1 Section 7.0
354.36		Representative Monitoring	- Description of representative sites - Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators - Adequate evidence demonstrating site reflects general conditions in the area	Section 7.3
354.38		Assessment and Improvement of Monitoring Network	- Review and evaluation of the monitoring network - Identification and description of data gaps - Description of steps to fill data gaps - Description of monitoring frequency and density of sites	Section 7.5 Section 7.5.1 Section 7.5.2 Section 7.1.1
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions				
354.44		Projects and Management Actions	- Description of projects and management actions that will help achieve the basin’s sustainability goal - Measureable objective that is expected to benefit from each project and management action - Circumstances for implementation - Public noticing - Permitting and regulatory process - Time-table for initiation and completion, and the accrual of expected benefits - Expected benefits and how they will be evaluated - 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. - Legal authority required - Estimated costs and plans to meet those costs - Management of groundwater extractions and recharge	Section 8.0
354.44(b)(2)	10727.2(d)(3)		- Overdraft mitigation projects and management actions	Section 8.2
Article 8. Interagency Agreements				
357.4	10727.6	Coordination Agreements - Shall be submitted to the Department together with the GSPs for the basin and, if approved, shall become part of the GSP for each participating Agency.	**Coordination Agreements shall describe the following:** - A point of contact - Responsibilities of each Agency - Procedures for the timely exchange of information between Agencies - Procedures for resolving conflicts between Agencies - How the Agencies have used the same data and methodologies to coordinate GSPs - How the GSPs implemented together satisfy the requirements of SGMA - Process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations - A coordinated data management system for the basin - 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	N/A

2. PLAN AREA

The following section, consistent with GSP Regulations §354.8, provides a description of the Plan Area.

The Bedford-Coldwater Subbasin (Basin) has been the focus of historical and ongoing collaborative groundwater basin management among three key agencies: City of Corona (Corona), Elsinore Valley Municipal Water District (EVMWD), and Temescal Valley Water District (TVWD). As noted in Chapter 1 of this Groundwater Sustainability Plan (GSP), the Basin is currently listed by the Department of Water Resources (DWR) as a very low priority groundwater basin. Therefore, preparation of a GSP is not required. The agencies that have been collaborating to manage the Basin, through the Bedford-Coldwater Groundwater Sustainability Agency (BCGSA), have confirmed their collective dedication to management for groundwater sustainability and have decided to prepare a GSP.

2.1. DESCRIPTION OF THE PLAN AREA

The following provides a general description of the Bedford-Coldwater Basin, including local jurisdictions, water resource management and monitoring programs, well permitting procedures, general plans and other land use plans, and additional groundwater management elements.

2.1.1. Geographic Area

Figure 1-1 shows the boundaries of the Plan Area, namely the Bedford-Coldwater Groundwater Subbasin located in western Riverside County. **Figure 1-1** also shows the adjacent Temescal Basin to the northwest (separated by a groundwater divide near Bedford Wash) and Elsinore Valley Subbasin located on the southern boundary. Both the Elsinore Valley Groundwater Sustainability Agency (GSA) and Temescal Subbasin GSA are in the process of developing GSPs for their respective subbasins. Bedford-Coldwater Basin is bound on the east and west by consolidated rocks of Estelle Mountain and the Santa Ana Mountains, respectively. The major drainage is Temescal Wash, traverses the three groundwater basins along its 26-mile course from Lake Elsinore to the Prado Wetlands on the Santa Ana River.

2.1.2. Jurisdictional Agencies

This section identifies agencies with land use management responsibilities. There are no economically distressed areas, disadvantaged communities, or severely disadvantaged communities in the Basin.

County. The Basin is located wholly within Riverside County. Riverside County has jurisdiction for land use planning for unincorporated areas. Riverside County also has responsibility for small water systems in the County that have between 15 and 199 service connections and those serving restaurants, schools, and industry. It also provides limited regulatory oversight to those water systems serving between 5 and 14 service connections. The County oversees on-site wastewater treatment systems (OWTS) through its Department of Environmental Health. The Department of Environmental Health also evaluates existing residential water wells and makes a determination if the water meets certain minimum standards.

City of Corona. Figure 2-1 shows the boundaries of the other jurisdiction that has land use management responsibilities, the City of Corona. General plan elements relevant to the GSP are discussed in Section 2.1.3. In addition to land use planning, Corona Department of Water and Power is responsible for stormwater management, sewage collection, and production and distribution of potable water for Corona, including the portion within the Basin.

Federal Lands. Federal lands within the Basin include United States Department of Agriculture Forest Service – Cleveland National Forest. The area is managed by the Forest Service.

Tribal Lands. There are no tribal lands in the Basin, however some tribes are included as stakeholders on the list of interested parties. The list of interested parties was developed to encourage public participation from any and all local and regional agencies, entities, and individuals. The list included tribes with land in the region even though they do not have land within the Basin. The BCGSA agencies have a long history of coordination with the regional tribal entities, and they always inform these entities of upcoming planning and/or infrastructure projects. The regional tribal entities take an interest in planning and infrastructure projects within the Basin and surrounding areas because there are important cultural resource sites within these areas. The BCGSA agencies and regional tribal entities coordinate to assess infrastructure project sites prior to groundbreaking to identify and protect potential cultural resources.

California Conservation Easement. According to the California Conservation Easement Database (CCED) there is an area of private land, Lee Lake Easement, with deed-based restrictions to limit land uses to those compatible with its status as open space. Lands under easement may be actively farmed, grazed, forested, or held as nature reserves. Easements are typically held on private lands with no public access. CCED represents California in the National Conservation Easement Database (NCED 2019), a national inventory of lands conserved as easements. NCED is managed by a consortium of non-governmental organizations including: Ducks Unlimited, the Trust for Public Land, Defenders of Wildlife, Conservation Biology Institute, and NatureServe.

Other. There are no state park lands or land owned by the California Department of Fish & Wildlife (CDFW) within the Basin.

2.1.3. Disadvantaged Communities

There are no disadvantaged communities (DACs) or severely disadvantaged communities (SDACs) mapped within the Basin (DWR 2019c).

2.1.4. Water Supply Sources

Sources for water supply for agricultural, Municipal and Industrial (M&I), and domestic uses include groundwater, imported water, and recycled water. Metropolitan Water District of Southern California (Metropolitan) is the wholesaler for imported water and its sources of water include the Colorado River and the State Water Project. Both Corona and TVWD receive imported water from Metropolitan for distribution in the Basin. EVMWD also receives imported water from Metropolitan through Western Municipal Water District (WMWD), but only distributes imported water within the Basin when groundwater supply to domestic users is insufficient.

Water Providers. The BCGSA was created through a Joint Powers Authority agreement between Corona, EVMWD, and TVWD. **Figure 2-2** shows the service areas of these providers. Other small systems are operated by private mutual water companies and some communities do not have water purveyors and systems that provide water service. These small systems and communities—plus rural businesses, schools, parks, and residents—rely on private wells and groundwater.

- **City of Corona.** A portion of the City of Corona overlies the Basin, amounting to 1,213 acres or about 5 percent of the city's area. Corona maintains three treatment facilities and serves water to more than 150,000 residents with water supply from a combination of imported water and groundwater.
- **Temescal Valley Water District (TVWD).** TVWD is the primary purveyor in the BCGSA. TVWD, formed in 1965 as Lee Lake Water District, provides water and wastewater services to the residents of the Temescal Valley in an area covering approximately 6,730 acres.
- **Elsinore Valley Municipal Water District (EVMWD).** EVMWD supplies water to customers within the Basin from a combination of groundwater and imported water supply sources.

Groundwater. Groundwater currently is a source of water supply in the Basin. Corona, EVMWD, and TVWD all pump groundwater from the Basin. Corona and EVMWD distribute this supply to users within and outside the Basin, while TVWD only supplies groundwater to users within the Basin. There are also a few private users that pump groundwater within the Basin. Groundwater produced within the Basin is used to supply municipal, agricultural, mining, recreational, and domestic uses and users throughout the Basin and in the neighboring Temescal and Elsinore Valley Subbasins (DWR 2019a).

Water Supply Wells. Figure 2-3 shows the density of water supply wells in and around the Plan Area; this map is based on the DWR Well Completion Report Map Application tool (DWR 2019b). As indicated, the density of supply wells is generally less than nine wells per square mile. Relatively high densities occur around the northern margins of the Basin, where the Corona and EVMWD wells are located. **Figures 2-4**, **2-5**, and **2-6** show the estimated density of domestic wells, production wells, and public wells. Most of the production wells, as classified by DWR, are presumably irrigation wells but also include some industrial and commercial wells.

Outside of the three major purveyors, there is only one public water system; Glen Ivy Hot Springs has one well and serves an estimated population of 750 people. The Glen Ivy Hot Springs well is located in the southwestern portion of the Basin (**Figure 2-2**).

The BCGSA is aware that there are a small number of private wells used for non-potable supply in the Basin. However, a systematic well inventory identifying all active private wells has not been completed to date. This has been identified as a data gap in the GSP, as described in Section 6.2.7.1. The GSP also includes a project to address this data gap with a survey and inventory of active private wells throughout the Basin (Project 2, Section 8.7). This project was designed to locate and characterize the construction and use of existing private wells so that they can be included in sustainable management of the Basin.

Imported Water. Corona, TVWD, and EVMWD rely on imported water from Metropolitan. Metropolitan imports water to Southern California from two main sources: the Sacramento and San Joaquin Rivers through the State Water Project and the Colorado River via the Colorado River Aqueduct. Corona receives imported water from Metropolitan through WMWD. Temescal Valley Water District receives State Water Project imported by Metropolitan and treated at the Henry J. Mills Treatment Plant in Riverside. EVMWD also receives imported water from Metropolitan through WMWD, but only distributes to domestic users if groundwater is insufficient. Imported water and other water infrastructure are shown on **Figure 2-7**.

Recycled Water. Water recycling occurs in both Corona and TVWD. Recycled water use is a relatively small but increasing supply. In TVWD, recycled water is distributed to multiple sites within TVWD’s service area, including the Retreat Golf Course in the northern portion of the Basin and the Deleo Sports Park along Sycamore Creek in the south Basin (RMC and Woodard & Curran 2017).

2.1.5. Water Use Sectors

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. In the Basin, these are summarized as follows:

- Urban water use sectors are focused in the City of Corona area but extend through the center of the Basin.
- Areas of industrial water use are limited.
- Agricultural land uses comprise limited areas of citrus in the southwestern portion of the Basin (20.5 acres).
- There is no current managed aquifer recharge in the Basin.
- Native vegetation, including rangeland, accounts for the remainder including upland areas and along streams.

2.1.6. Water Resources Monitoring and Management Programs

This section summarizes water resources monitoring and management in the Basin. Corona, EVMWD, and TVWD have entered into a Joint Powers Authority (JPA) agreement for the purpose of forming and executing the responsibilities of the BCGSA in accordance with the Sustainable Groundwater Management Act (SGMA). The BCGSA encompasses the entirety of the Bedford-Coldwater Subbasin of the Elsinore Groundwater Basin (Basin 8-004.2, DWR 2016b).

Groundwater has been an important component of water supply in the Basin for more than 100 years. Until the 1970s, most of the groundwater production in the Basin was for agricultural supply (Todd and AKM 2008). A few well owners have also produced small amounts of groundwater for domestic use (Todd and AKM 2008). Production for municipal supply increased in the 1960s and 1970s and continues today.

For more than 50 years, Corona, EVMWD, and TVWD have relied on groundwater from the Basin for municipal use, and these agencies have long been responsible for managing groundwater conditions in the Basin. Corona and EVMWD have longstanding legal agreements for the management of withdrawals from the Coldwater area portion of the Basin. Additionally, Corona, in coordination with TVWD, adopted a Groundwater Management Plan (GWMP) in 2008 that covers the Basin.

In 2008, Corona and EVMWD established a legal agreement for the Coldwater portion of the Basin where most of the pumping occurs. The 2008 agreement is intended to enhance groundwater supply in order to maximize the sustainable use of groundwater. One of the goals of the agreement is to give Corona and EVMWD the ability to estimate annual groundwater production that ensures the sustainability of the Subbasin as a water supply. Historically, Corona and EVMWD account for most of the production in the Basin, with Corona historically pumping about twice as much as EVMWD (Todd and AKM 2008). The agreement is based on this historical distribution of groundwater use and also recognizes the presence of private pumpers in the Basin. This agreement allots four percent of annual groundwater use to private pumpers.

The agreement encourages development of joint groundwater management projects to enhance recharge including the recharge of local surface water by both parties. EVMWD also has surface water rights in the Basin that can be used for recharge enhancement. The 2008 agreement provides a process for allocating production on an annual basis, accounting for production rights and a groundwater storage account. Every five years, the native safe yield is re-evaluated, and each party’s share of that yield is adjusted. To date, four annual reports have been completed (WEI 2016 and 2017b).

The only pumpers in the Bedford area of the Basin are the three agencies of the BCGSA.

Corona and TVWD service areas cover almost all of the Basin; those portions outside of these service areas are not within the service area of any local water agency. The BCGSA is coordinating with Riverside County and other agencies for these areas.

2.1.6.1. Water Resource Monitoring

The overall objective of the monitoring networks for this GSP is to yield representative information about water conditions in the Basin as necessary to guide and evaluate GSP implementation. Water resource monitoring programs considered in this section include:

- Climate
- Surface water flows
- Imported water deliveries
- Water recycling
- Land use and cropping
- Wells and groundwater pumping
- Groundwater levels
- Land subsidence
- Water quality

Monitoring programs undertaken by local, state, and federal agencies are summarized below as they are relevant to the GSP.

Climate. Climate data collection stations and records have been reviewed and assessed for the Basin and surrounding areas. Previous investigations (Todd and AKM 2008, SAIC 2007, MWH 2004) have revealed substantial variability in precipitation amounts because of elevation differences between the Temescal Valley and the nearby Santa Ana Mountains. These orographic effects result in significantly more precipitation on the upland areas of the watersheds that contribute to the Basin. However, operational rain gages exist only in EVMWD, Riverside, and at the top of Santiago Peak. Therefore, precipitation on the Basin itself and on the slopes of the Santa Ana Mountains below Santiago Peak must be modeled.

There are three currently active climate monitoring stations near the Basin: the Lake Elsinore station maintained by the National Oceanic Atmospheric Administration (NOAA), the Santiago Peak station maintained by Orange County, and the UC Riverside California Irrigation Management Information System (CIMIS). The Lake Elsinore and UC Riverside stations include daily precipitation and evapotranspiration data; the Santiago Peak station collects monthly precipitation data. Monthly data for the Santiago Peak station are from January 1949 to current, with a slight lag on recent data. The Lake Elsinore station has daily data from January 1961 through current, and monthly data from 1897. The UC Riverside station has daily data from January 1986 through the present.

In addition to station-specific climate records, PRISM Climate Group (PRISM) data are also available. PRISM gathers climate observations from a wide range of monitoring networks, applies sophisticated quality control measures, and develops spatial climate datasets. These datasets incorporate a variety of modeling techniques and are available at multiple resolutions covering the period from 1895 to the present. These datasets include elevation-varying average precipitation isohyets that can be used to estimate or simulate precipitation throughout the watershed contributing to the Basin (PRISM 2018).

Surface water flows. There are three streamflow gage stations near the Basin that are maintained by the United States Geological Survey (USGS 2018). These stations are located on Temescal Creek at about Main Street in Corona (USGS 11072100), Temescal Creek at Corona Lake (USGS 11071900), and San Jacinto River near Elsinore (USGS 11070500). These stations are all active and have records that begin in October 1980, November 2012, and January 1950, respectively.

Imported water deliveries. Imported water data and locations are monitored and available from Corona, EVMWD, and TVWD. Data are available monthly for Corona from 2005 to present, annually for TVWD from 1990 to present, and monthly for EVMWD from 1995 to present.

Recycled water. Corona and TVWD monitor and maintain records of recycled water use records and distribution locations. TVWD supplies non-potable recycled water to Retreat Golf Course on the north end of the Basin and the Deleo Sports Park along Sycamore Creek on the south end.

Wells and groundwater pumping. Groundwater production in the Basin is tracked by the Santa Ana River Watermaster, along with production in the rest of the watershed. WMWD currently coordinates groundwater use data collection.

Groundwater levels. Multiple agencies have historically monitored groundwater levels in the Basin, including Corona, EVMWD, USGS, and DWR.

Land use. Land use map data were collected from DWR, the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP), and Riverside County. The available land use maps are indicated below:

- DWR: 2014 statewide land use mapping specifically developed for SGMA and GSPs.
- FMMP: 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, and 2016
- Riverside County: 1993 and 2000

Agricultural land is currently limited to approximately 20.5 acres of citrus/subtropical fruits (avocados and others) located on the southwestern edge of the Basin.

Land subsidence. While the potential for subsidence was recognized in the 2008 Groundwater Management Plan, it has not been a known issue in the Basin and ground surface elevations have not been monitored until recently. The TRE Altamira Interferometric Synthetic Aperture Radar (InSAR) Dataset, provided by DWR through the SGMA Data Viewer (DWR 2019c) and showing vertical ground surface displacement from June 2015 to June 2018, indicates that the Basin has been characterized by uplift over that period, likely reflecting tectonic factors. No known available sources of data indicate subsidence in the Basin. Groundwater levels have been managed to stay above historical low levels to minimize the potential for ground settlement.

Water quality. Groundwater quality in the Basin is monitored by the BCGSA agencies and Glen Ivy Hot Springs for compliance with State Water Resources Board Division of Drinking Water (DDW) requirements, and by facilities regulated by the Santa Ana Regional Water Quality Control Board (RWQCB).

Section 7 of this GSP documents the BCGSA monitoring network including how these objectives are met, descriptions of how each sustainability criteria will be monitored, and protocols for measurements.

2.1.6.2. Water Resources Management

This section describes the water resources management plans developed for the Plan Area; note that monitoring is addressed in Section 2.1.4.1.

Groundwater Management Plan, 2008. A GWMP was adopted in 2008 that covers the Basin. The GMP included projects in the Bedford-Coldwater area including the Coldwater Subbasin Enhanced Recharge Project and Lee Lake Water District's (now TVWD) Recharge to Bedford Subbasin. The GMP includes a quantitative water balance for the area, but Bedford-Coldwater was not included in the numerical model developed to evaluate management programs and projects (Todd and AKM 2008).

Numerical Groundwater Modeling. There is no pre-existing numerical model that covers the entire Basin. A model of the Coldwater area was prepared by MWH in 2004 (MWH 2004), and this is the only numerical groundwater model covering any portion of the Basin. This model is documented in the *Coldwater Basin Recharge Feasibility Study* (MWH 2004). Numerical groundwater modeling for the purpose of the GSP is discussed in later chapters of this document.

Integrated Regional Water Management Plan (IRWMP), 2008. The IRWMP is a collaborative effort led by WMWD to identify regional and multi-benefit projects within member agencies service areas. Adopted in 2008, the IRWMP describes the region, provides goals and objectives, and identifies and evaluates projects and programs, including assessment of climate change.

The IRWMP identifies and prioritizes integrated regional projects for the watershed to maximize benefits to the broadest group of stakeholders in the region. Projects in the Bedford-Coldwater area include new water wells for Corona and managed recharge using recycled water infiltration in surface recharge basins or injection wells in the Bedford area (Kennedy/Jenks 2008a and 2008b).

Salt and Nutrient Management Plan (SNMP), 2017. SNMPs are required for groundwater basins throughout California and are intended to help streamline permitting of new recycled water projects while ensuring attainment of water quality objectives and protection of beneficial uses. The Upper Temescal Valley (UTV) SNMP prepared by WEI was a joint management plan, prepared by the EVMWD and the Eastern Municipal Water District (EMWD) (WEI 2017a).

Wastewater services include the treatment of wastewater generated in their respective service areas and the subsequent discharge and reuse of treated wastewater, hereafter referred to as recycled water. The goal of the SNMP was to define management activities to comply with the total dissolved solids (TDS) and nitrate concentration objectives of the groundwater management zones (GMZs) and surface water bodies that are impacted by recycled water discharge and reuse in the UTV Watershed. The UTV SNMP recommends updates to the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) for water quality objectives for the entire upper Temescal Valley but does not provide objectives for individual GMZs. Water quality objectives and ambient water quality numbers were estimated for both TDS and nitrate for the entire UTV SNMP. Ambient water quality will be recomputed periodically.

Recycled Water Plans 2007 through 2016. TVWD prepared a series of plans for its recycled water, including assessment of system-wide impacts to groundwater quality. The planning documents include:

- Recycled Water Master Plan (Lee Lake Water District 2007).
- Water System Master Plan (Lee Lake Water District 2014).
- Temescal Valley Water District Comprehensive Water, Recycled Water, and Wastewater Cost of Service Study Report (Raftelis 2016).

Water Quality Control Plan for the Santa Ana Region. The Basin Plan was approved in 1994 and provides the framework for how surface water and groundwater quality in the Santa Ana Region should be managed to provide the highest water quality reasonably possible. The Basin Plan lists beneficial uses, describes the water quality which must be maintained to allow those uses, provides an implementation plan, details State Water Resources Control Board (SWRCB) and RWQCB plans and polices to protect water quality, and presents surveillance and monitoring programs. The most recent update in 2004 revises groundwater basin boundaries, updates beneficial uses, and presents GMZ water quality objectives.

Urban Water Management Plans (UWMPs). The California Urban Water Management Planning Act requires preparation of UWMPs by urban water providers with 3,000 or more connections. The UWMPs, generally required every five years, provide information on water supply and water demand—past, present, and future—and allow comparisons as a basis for ensuring reliable water supplies. UWMPs examine water supply and demand in normal years and during one-year and multi-year droughts. UWMPS also provide information on per-capita water use, encourage water conservation, and present contingency plans for addressing water shortages. UWMPs have been prepared for Corona, TVWD, and EVMWD (KWC 2016, RMC and Woodard & Curran 2017, MWH 2016).

Despite challenges of drought, climate change, and environmental and legal factors, the three agencies have been able to provide reliable supply. This has been achieved by actively managing the portfolio of water supplies (groundwater, imported water, recycled water), by improving facilities (e.g., water treatment plants), and by promoting conservation.

2.1.7. General Plans, Land Use Planning, and Well Permitting

This section presents elements of General Plans and other land use planning in the Basin as relevant to groundwater sustainability. It summarizes the goals, objectives, policies, and implementation measures as variously described in the General Plans for Riverside County and the City of Corona, which together encompass the Basin. This section also summarizes local well permitting procedures and well ordinances.

2.1.7.1. Land Use

The Basin includes developed urban area, rural residential areas, and limited agriculture.

Figure 2-8 shows land use for 2014 (DWR 2017), which indicates that active agricultural land was limited to 20.5 acres of primarily subtropical orchard in the southwestern Basin.

2.1.7.2. General Plans

Land use planning within the Basin is guided by the General Plans for Riverside County and the City of Corona.

Riverside County General Plan. The Riverside County General Plan, adopted in 2015, incorporates a set of 15 Consensus Planning Principles drafted and endorsed by a coalition of Riverside County stakeholders. The General Plan encourages water use efficiency and requires that new developments *incorporate water conservation techniques, such as groundwater recharge basins, use of porous pavement, drought tolerant landscaping, and water recycling, as appropriate*. Additional policies ensure compliance with water efficient landscape principles, promote water conservation, and encourage the use of recycled water (Riverside County 2015).

Figure 2-9 shows general Land Use Planning Designations of the Riverside County General Plan throughout the Basin. As indicated, broad areas are designated as low and medium density residential with commercial and industrial areas near the freeway.

City of Corona General Plan. The Corona General Plan (EIP Associates 2020) was adopted in 2004 and is scheduled for update beginning in 2019. **Figure 2-9** shows the Corona planning area, including portions of the Basin.

Goals, policies, and implementation measures with relevance to groundwater sustainability include:

- Policy 1.1.4 – Accommodate the types, densities, and mix of land uses that can be adequately supported by transportation and utility infrastructure (water, sewer, etc.) and public services (schools, parks, libraries, etc.)
- Policy 1.5.14 – Require that developers demonstrate water conservation in the landscape design of their proposed projects, such as the use of drought-tolerant species.
- Policy 1.5.16 – Promote the use of recycled water for landscape irrigation, where feasible.

In addition, there are several policies linked to the development of water infrastructure to ensure that water supply and treatment and delivery systems are sustainable and cost efficient. Other policies protect water quality and minimize impact on water resources.

2.1.7.3. General Plan Influences on GSA Ability to Achieve Sustainability

Riverside County. The Riverside County General Plan addresses the importance of groundwater. The policies and implementation of the land use and public facilities/services elements indicate that the County role is to support and encourage local water agencies in ensuring that water supply is available. Similarly, with wastewater issues and protection of water quantity and quality, the County role is limited to encouragement of other agencies, developers, and landowners. The General Plan contains little policy to manage land use within the constraints of available water supply other than to encourage drought resistant plants and the use of recycled water. In the Bedford-Coldwater area, the general plan provides land use designations in the Temescal Canyon Area Plan that were used to estimate future growth.

City of Corona. Corona serves a population that is predicted to increase from 170,100 in 2020 to about 182,800 residents by 2040 (KWC 2016). Some of this growth will be along the southern edge of Corona in the Eagle Creek area within and adjacent to the Basin. The general plan indicates that Metropolitan may build an additional treatment plant in the area to meet increased water demand. Corona land use policies generally are protective of agricultural land and hillsides, and conservation policies address water efficiency, water recycling, sustainability measures, and coordination with other agencies, including TVWD.

The increased development included in the general plans was simulated by the numerical model described in Section 5 and **Appendix G**. Based on these scenarios, the basin remains sustainable even with this projected development.

2.1.7.4. GSP Influences on General Plans

The BCGSA agencies will work together to implement this GSP and rely on their portfolio of water supply to maintain sustainability. While future growth is expected based on the general plans, the agencies are committed to their agreements to limit pumping in Coldwater based on sustainable yield and import additional supplies to Bedford.

City of Corona. Implementation of the GSP will support Corona in providing continued groundwater that may be exported from the Basin to other areas of Corona. In addition, the GSP will ensure good quality water in sufficient quantities to serve its residents into the future, including drought periods.

Riverside County. The Riverside County General Plan generally assumes that local water agencies can ensure adequate high-quality water supplies into the future. The GSP provides additional specific information, documents potential challenges to water supply, and explores undesirable results that may occur with future increases in groundwater demand. Undesirable results will be defined with sustainability criteria, and if identified, will be addressed with management actions. These management actions may have ramifications for County land use planning. For example, GSPs are authorized within the GSP Plan Areas to impose well spacing requirements and control groundwater pumping and control extractions by regulating, limiting, or suspending extractions from individual groundwater wells. Such regulation may present a constraint on potential land uses.

2.1.7.5. Well Permitting

Groundwater well permitting within the Basin is currently regulated by the Riverside County Department of Environmental Health as described in Riverside County Ordinance No. 682 (as amended through 684.4). The purpose of this ordinance is to provide minimum standards for construction, reconstruction, abandonment, and destruction of all wells in order to: (a) protect underground water resources, and (b) provide safe water to persons within Riverside County pursuant to the authority cited in Chapter 13801(c) of the California Water Code. Wells regulated by Ordinance No. 682 include drinking water (domestic, industrial, community, or springs), agricultural, monitoring, and cathodic protection wells.

This ordinance is similar to the California State Guidelines for new wells under California Water Code Sections 13800 to 13806, which stipulates that local jurisdictions, including counties, cities, and water districts, have authority under the Water Code to adopt local well ordinances that meet or exceed the statewide standards. The Riverside County requirements exceed statewide standards with greater setback requirements from potentially contaminating activities such as septic systems.

The existing well permitting by the Riverside County Department of Environmental Health is the adopted standard for well permitting in this GSP.

2.1.8. Notice and Communication

As described in this section, groundwater is a source of supply in the Basin and supports a range of beneficial uses: agricultural, municipal, rural, and environmental. To some degree in the Basin, all land and property owners, residents, businesses, employees, farmers, and visitors are potentially affected by groundwater use.

The BCGSA have encouraged public participation in the ongoing planning and development activities supporting the GSP process. Domestic well owners were invited to participate and provide information on their wells, but none responded to the BCGSA data request. The BCGSA solicited information from private well owners during public meetings and through email and postal outreach but received no response. No well owners expressed concern with the GSP development.

Public workshops regarding development of the GSP have been conducted to encourage public participation and to provide educational outreach. Meeting notices have been provided to the list of interested parties that is maintained pursuant to Water Code Section 10723.2. Additionally, GSP development information and meeting notices have been posted to the BCGSA website.

Recognizing the importance of communication, multiple and diverse agencies and interested parties have been identified. These are listed in the BCGSA Stakeholder Outreach Plan, which is included as **Appendix D.**

In addition to quarterly BCGSA Board of Directors meetings open to the public, the BCGSA held two dedicated public meetings presenting information related to and components of the GSP. Summaries of these public meetings are presented in **Appendix E**.

On June 7, 2021, the BCGSA notified stakeholders, including local City and County agencies, of their intent to adopt this GSP after a 90-day review period. One letter with comments on the GSP was received in early September. This letter along with responses from the BCGSA and indications of how the GSP has been modified are included in **Appendix F**.

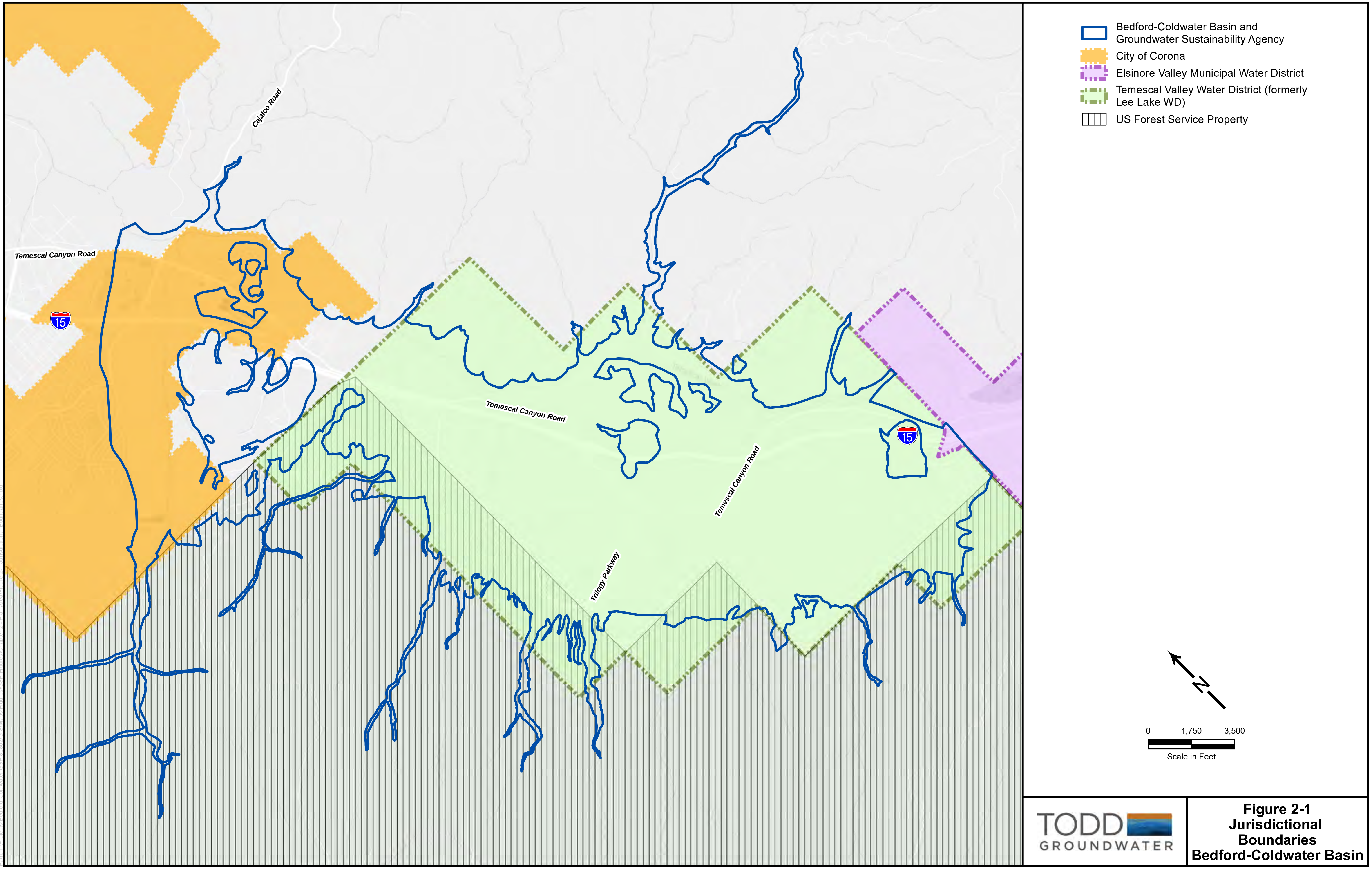
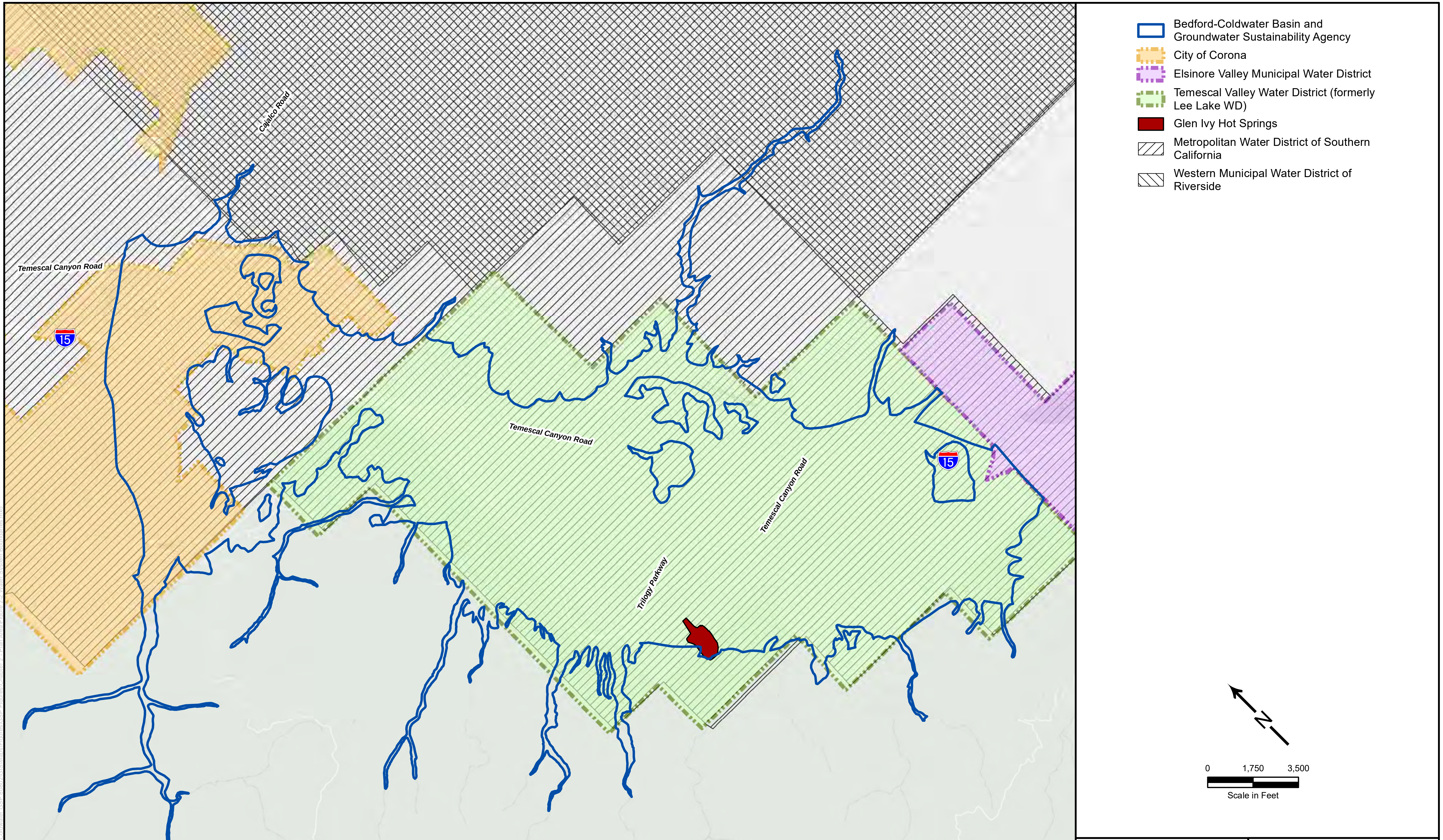


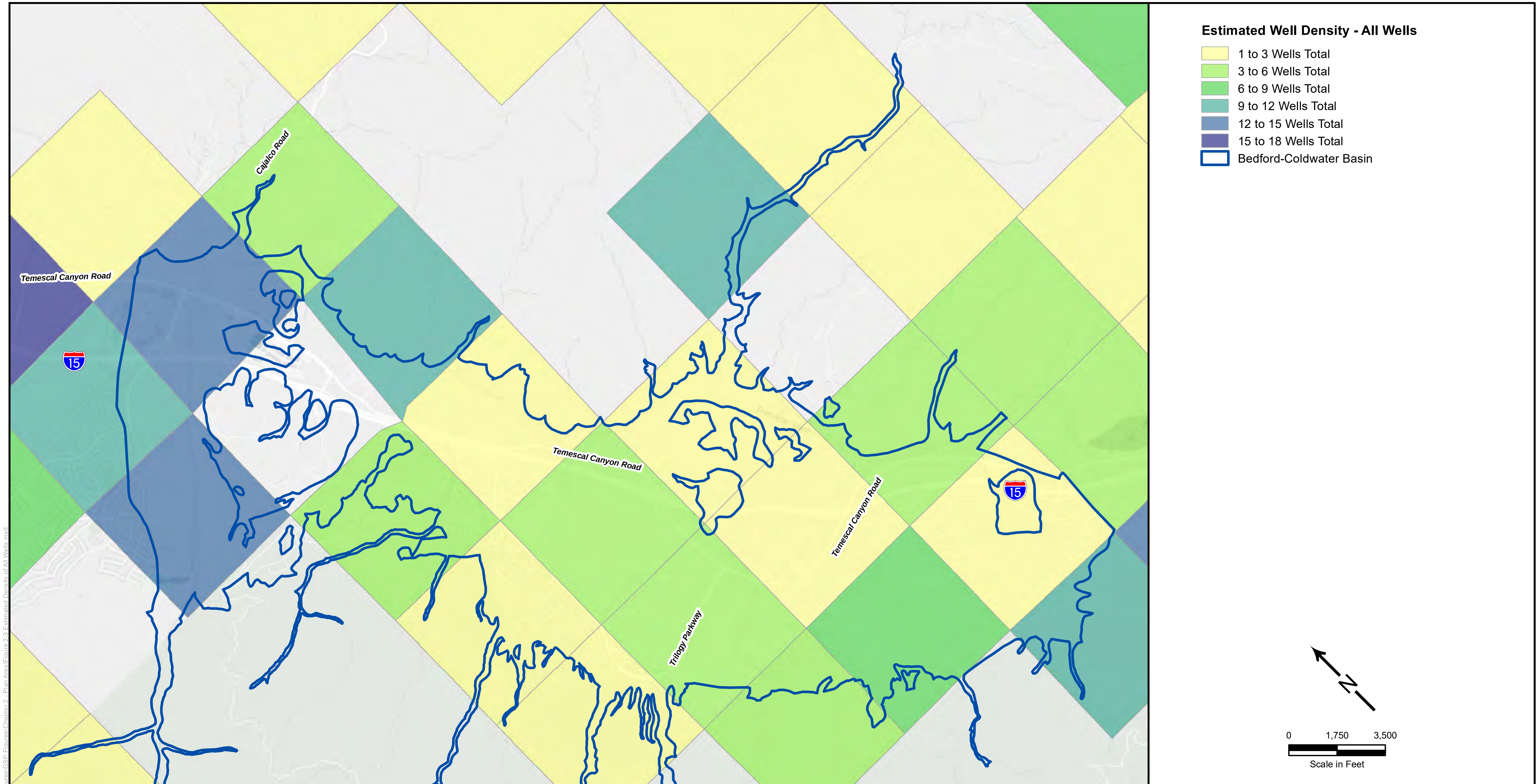
Figure 2-1
Jurisdictional Boundaries
Bedford-Coldwater Basin



TODD GROUNDWATER

Figure 2-2
Water Purveyor Boundaries
Bedford-Coldwater Basin

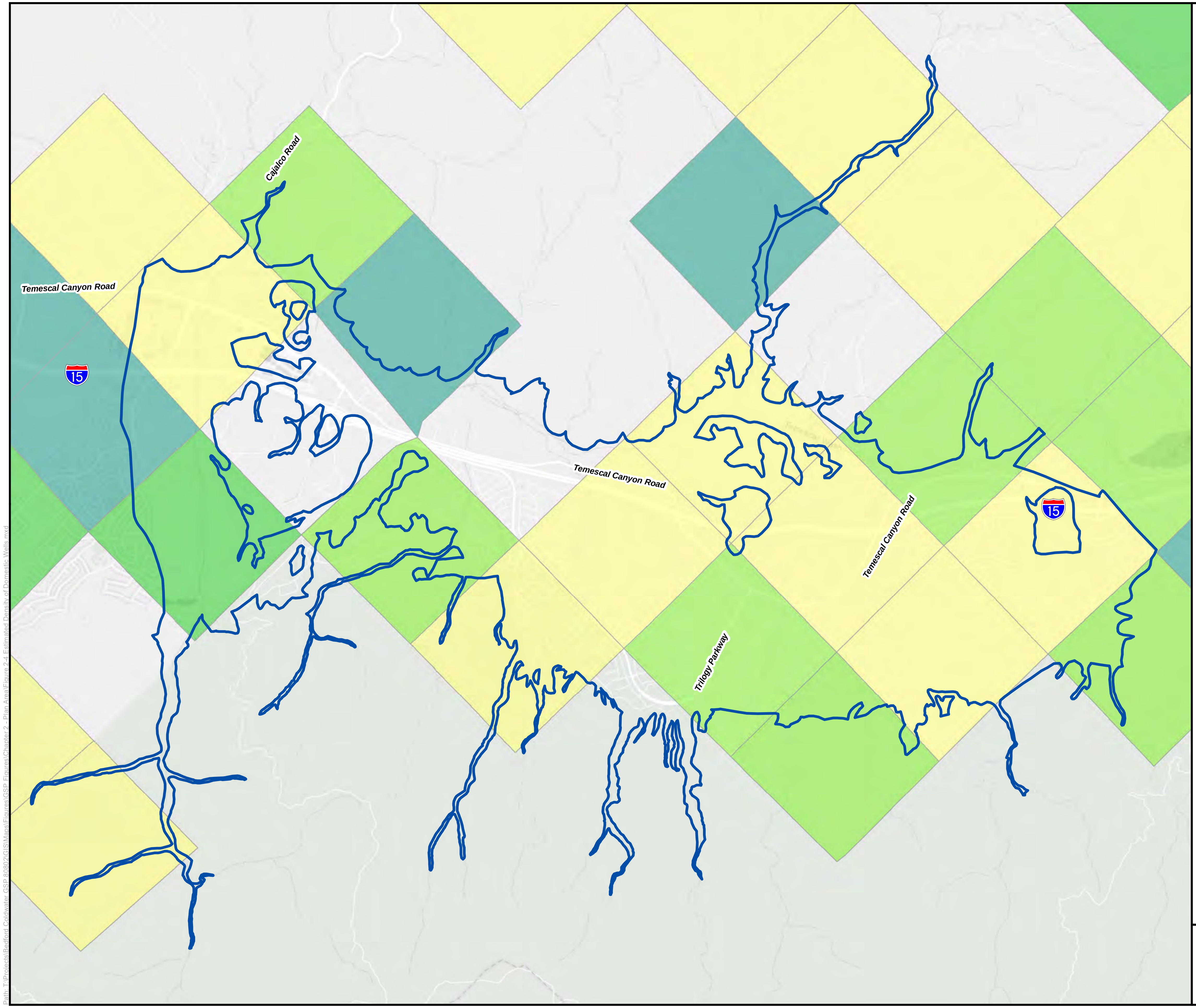
Path: T:\Projects\Bedford Coldwater GSP 80802\GIS\Maps\Figures\GSP Figures\Chapter 2 - Plan Area\Figure 2-3 Estimated Density of All Wells.mxd



* The Public Land Survey System (PLSS) is a way of subdividing and describing land in the United States. PLSS Sections are one-mile square rectangular grids of 640 miles each. All lands in the public domain are subject to subdivision by this rectangular system of surveys, which is regulated by the U.S. Department of the Interior, Bureau of Land Management (BLM).

TODD GROUNDWATER

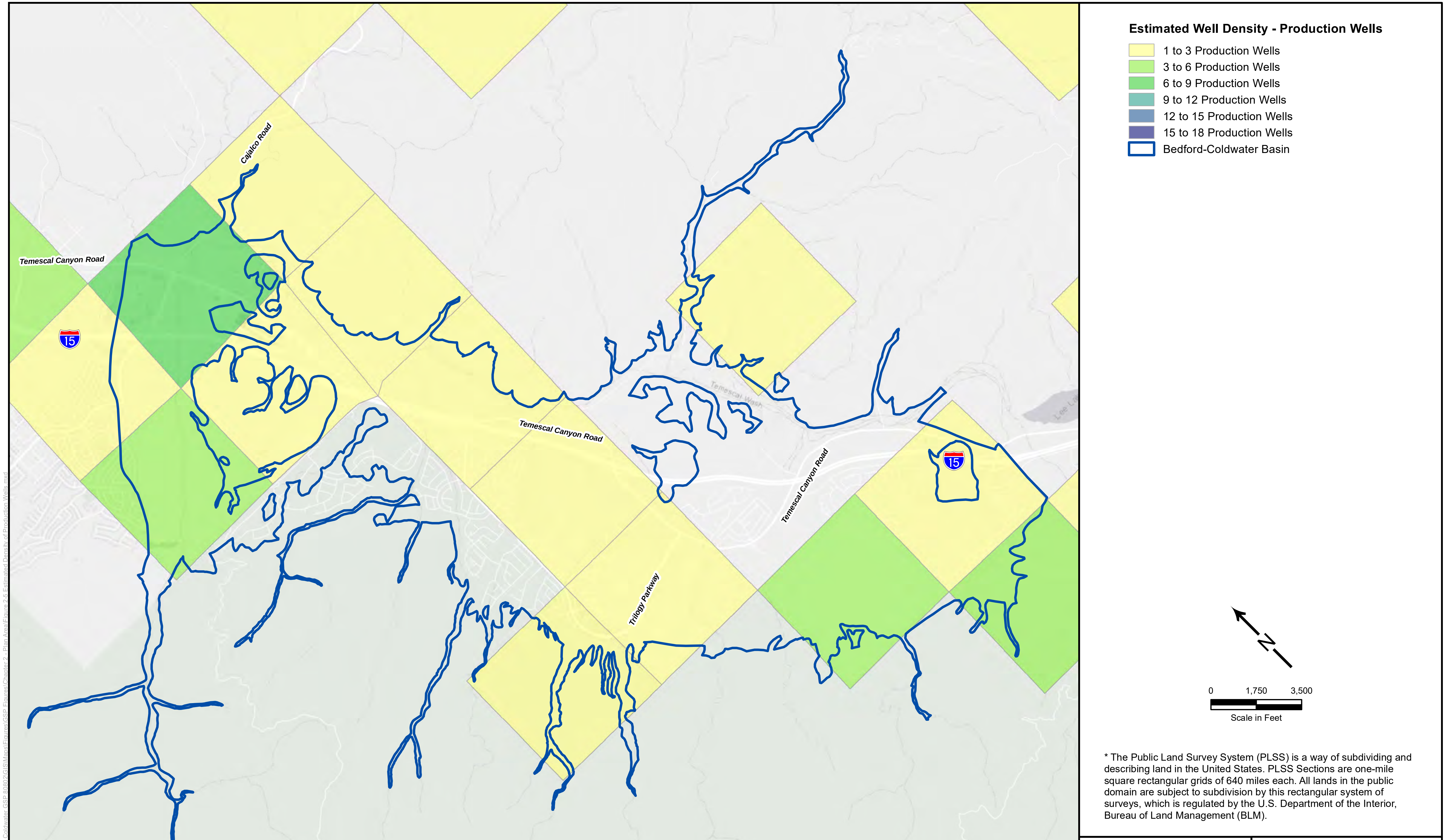
Figure 2-3
Estimated Density of All Wells Bedford-Coldwater Basin



* The Public Land Survey System (PLSS) is a way of subdividing and describing land in the United States. PLSS Sections are one-mile square rectangular grids of 640 miles each. All lands in the public domain are subject to subdivision by this rectangular system of surveys, which is regulated by the U.S. Department of the Interior, Bureau of Land Management (BLM).

TODD GROUNDWATER

Figure 2-4
Estimated Density of Domestic Wells
Bedford-Coldwater Basin



* The Public Land Survey System (PLSS) is a way of subdividing and describing land in the United States. PLSS Sections are one-mile square rectangular grids of 640 miles each. All lands in the public domain are subject to subdivision by this rectangular system of surveys, which is regulated by the U.S. Department of the Interior, Bureau of Land Management (BLM).

TODD GROUNDWATER

Figure 2-5
Estimated Density of Production Wells
Bedford-Coldwater Basin

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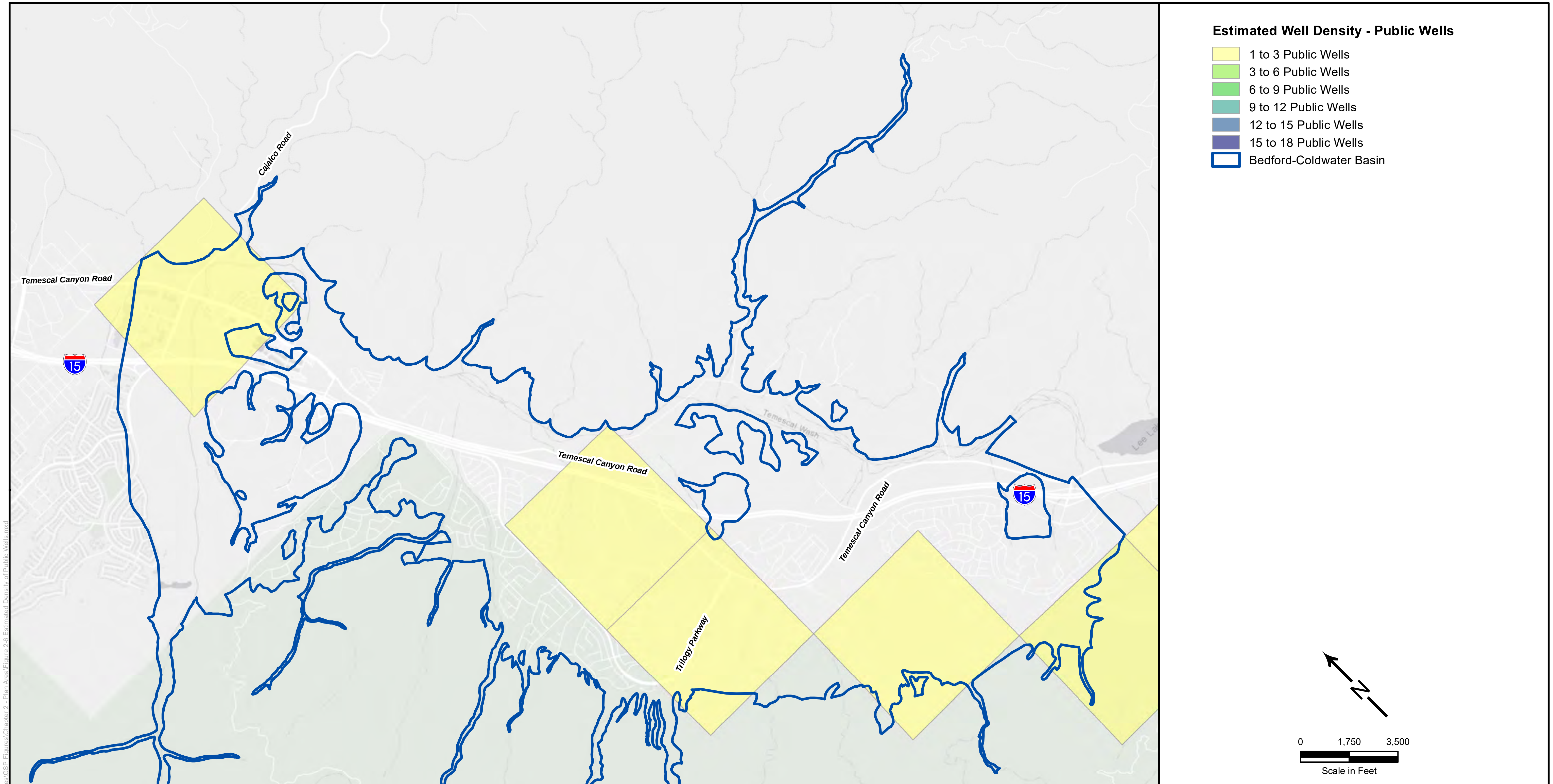

* The Public Land Survey System (PLSS) is a way of subdividing and describing land in the United States. PLSS Sections are one-mile square rectangular grids of 640 miles each. All lands in the public domain are subject to subdivision by this rectangular system of surveys, which is regulated by the U.S. Department of the Interior, Bureau of Land Management (BLM).

TODD GROUNDWATER

Figure 2-6
Estimated Density of Public Wells
Bedford-Coldwater Basin

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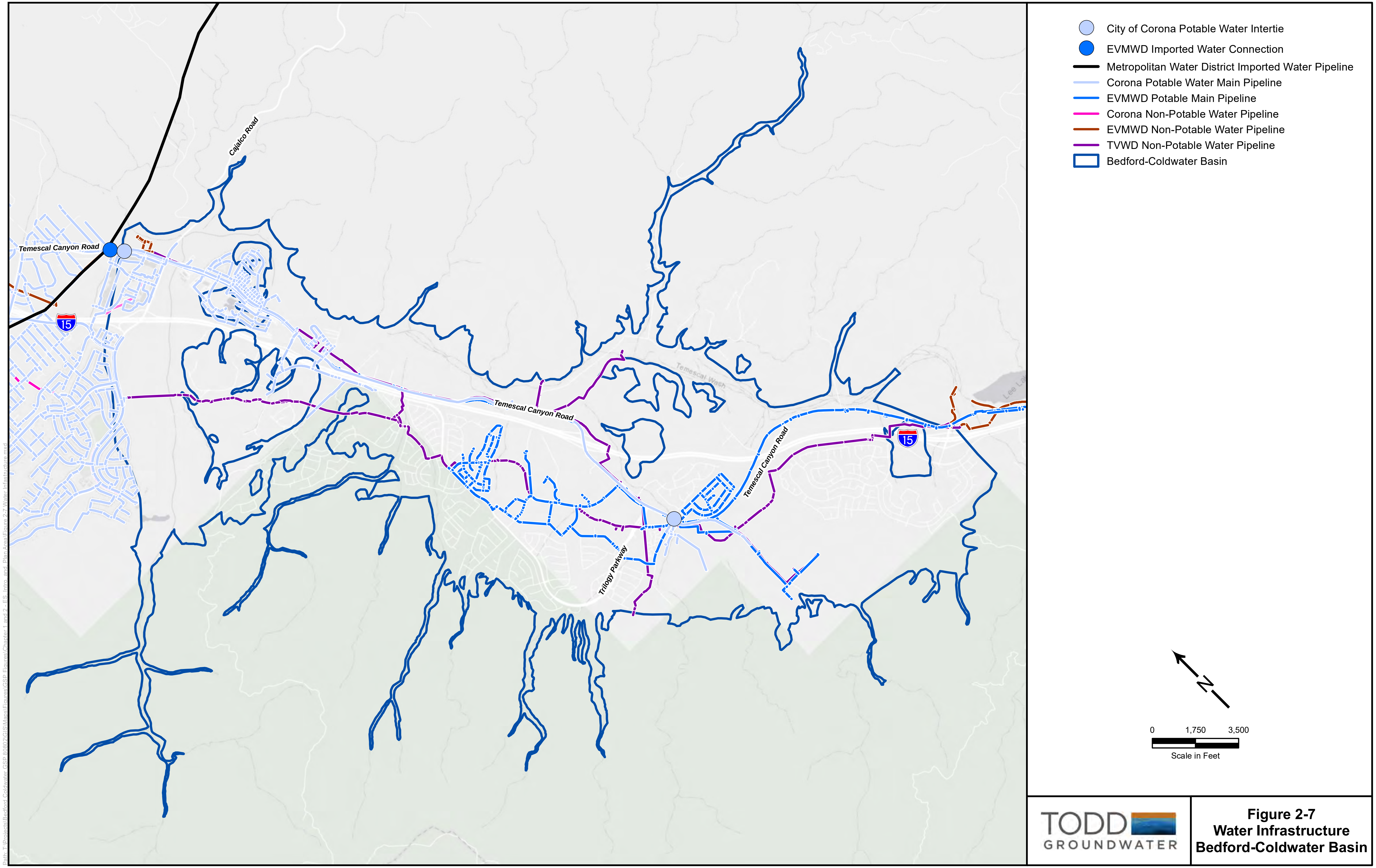
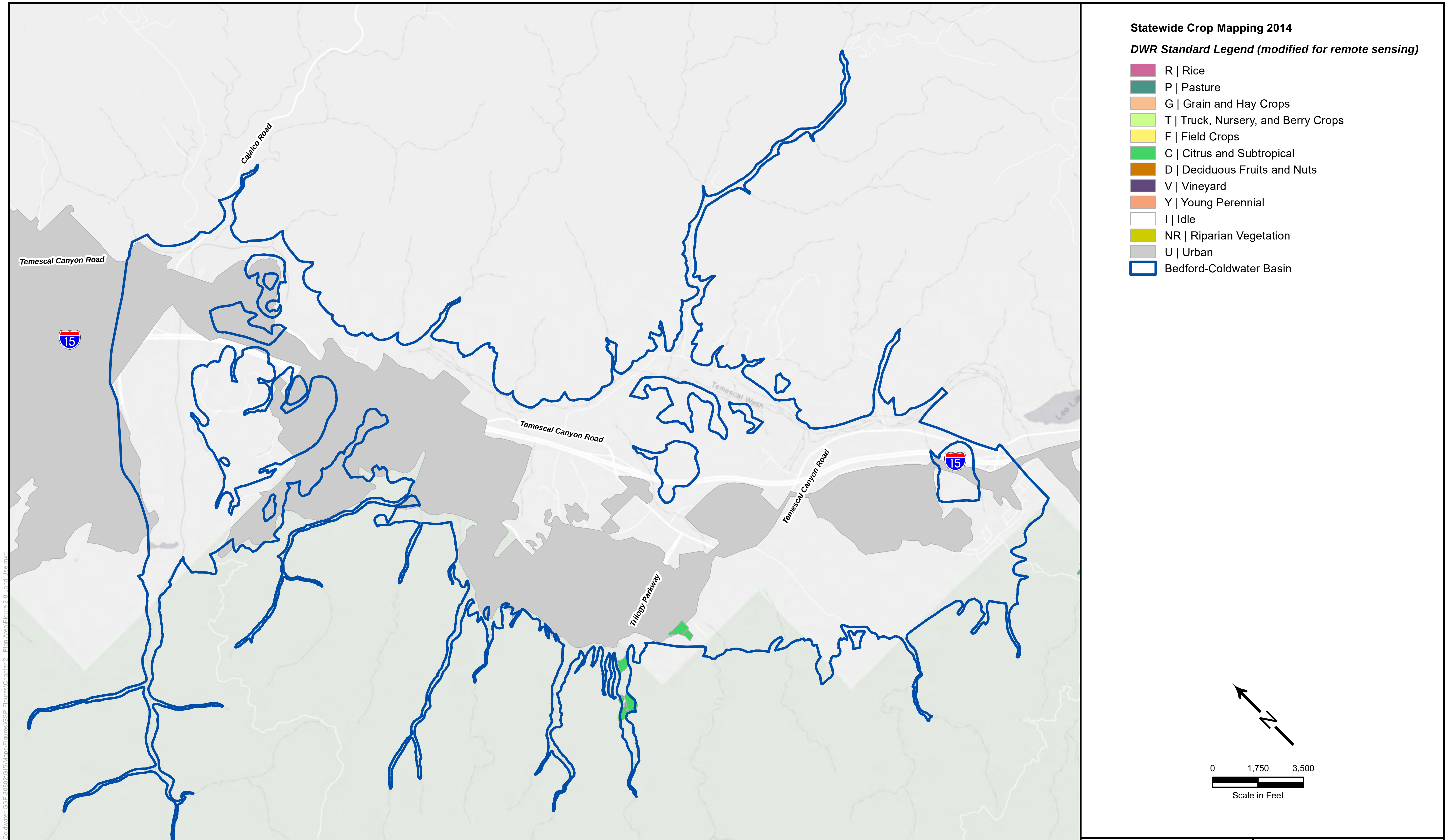


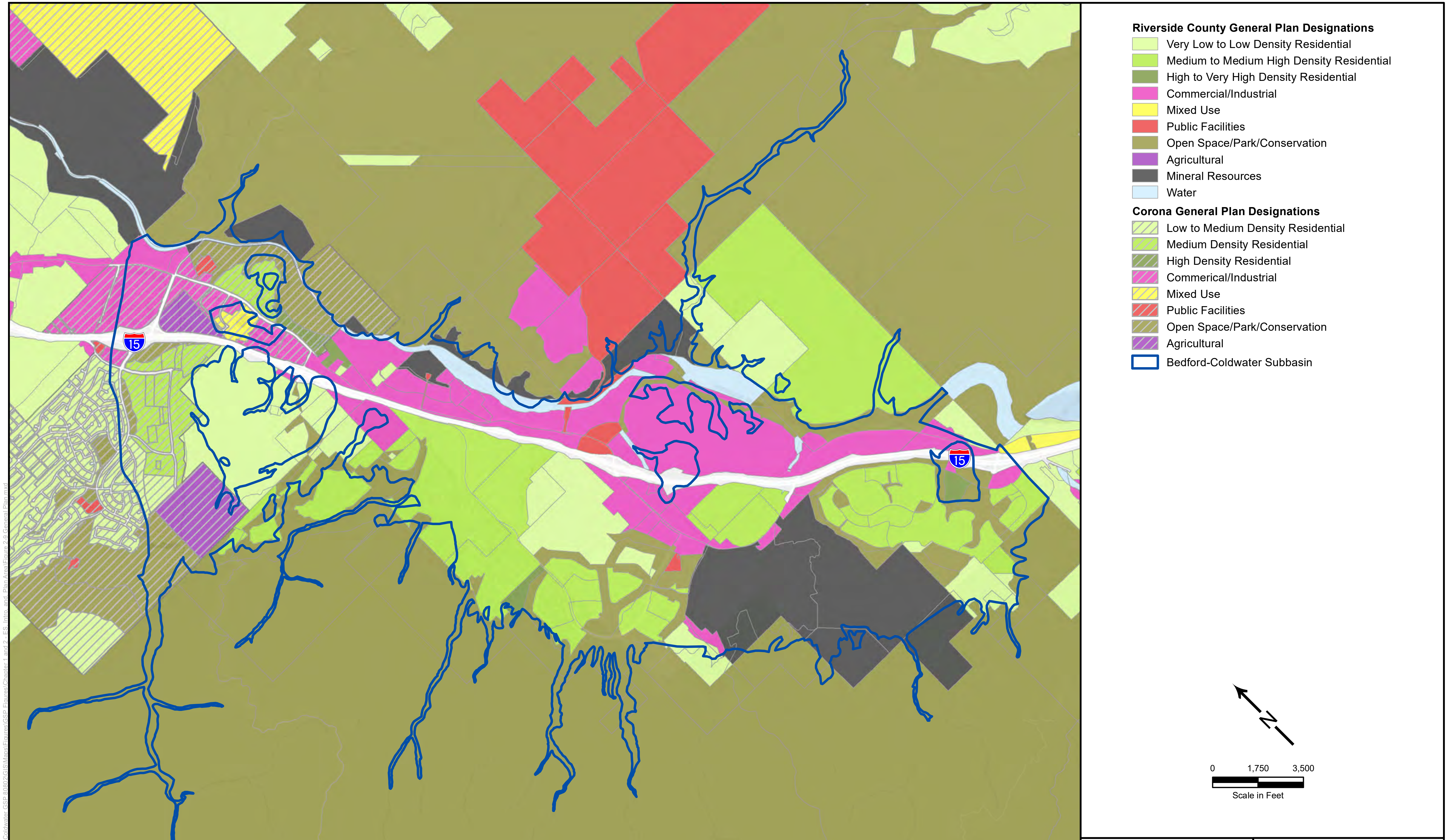
TODD GROUNDWATER

Figure 2-7
Water Infrastructure
Bedford-Coldwater Basin



TODD GROUNDWATER

Figure 2-8
2014 Land Use
Bedford-Coldwater Basin



TODD GROUNDWATER

Figure 2-9
General Plan
Land Use Designations
Bedford-Coldwater Basin

3. HYDROGEOLOGIC CONCEPTUAL MODEL

This chapter describes the hydrogeologic conceptual model of the Bedford-Coldwater Subbasin (Basin), including the basin boundaries, geologic formations and structures, and principal aquifer units. The chapter also addresses the interaction between groundwater and surface water and discusses groundwater recharge and discharge areas. The Hydrogeologic Conceptual Model presented in this chapter is a summary of relevant and important aspects of the Basin hydrogeology that influence groundwater sustainability. While the Chapter 1 Introduction and Chapter 2 Plan Area establish the institutional framework for sustainable management, this chapter, along with Chapter 4 Groundwater Conditions and Chapter 5 Water Budget, sets the physical framework.

The hydrogeologic conceptual model and basin conditions sections serve to document the technical aspects of the Basin's hydrogeology. Later sections including the water budget and sustainability criteria will refer to and rely on the technical material contained here.

3.1. PHYSICAL SETTING AND TOPOGRAPHY

The Basin underlies a portion of the Elsinore Valley in western Riverside County and covers approximately 11 square miles. The Basin is adjacent to two other groundwater basins: the Temescal Subbasin of the Upper Santa Ana Basin to the north and the Elsinore Valley Subbasin of the Elsinore Basin to the south. **Figure 3-1** illustrates the topography of the Basin and surrounding uplands.

Ground surface elevations along the valley floor are generally flat. Elevations range from approximately 1,000 feet above mean sea level (msl) at the northern boundary to approximately 1,200 feet above msl to the south, as shown by 200-foot contours on **Figure 3-1**. The tributary watersheds reach up to more than 5,600 feet msl at the highest peak in the Santa Ana Mountain watersheds west of the Basin. Watersheds east of the Basin are significantly lower in elevation and rise only to about 1,800 feet.

Annual precipitation varies from below 12 inches to more than 26 inches over the Study Area. The long-term average annual rainfall is between 12 and 14 inches per year on the Basin floor and increases to more than 20 inches along the top of the local watersheds in the Santa Ana Mountains to the west.

3.2. SURFACE WATER FEATURES

Figure 3-2 shows surface water features including rivers, streams, springs, seeps, lakes, and ponds. The sub-watershed boundaries that drain into and through the Basin are shown on **Figure 3-3**.

The Basin covers a portion of the Santa Ana River watershed. Main tributaries to the Santa Ana River include Temescal Wash which flows through the Basin from the southeast to northwest and the Bedford Wash flowing toward the northeast along the northern boundary of the Basin. These waterways are ephemeral and are dry much of the year, flowing mainly during the winter.

3.3. SOILS

Characteristics of soils are important factors in natural and managed groundwater infiltration (recharge) and are therefore an important component of a hydrogeologic system. Soil hydrologic group data from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) (NRCS 2019) are shown on **Figure 3-4**. The soil hydrologic group is an assessment of soil infiltration rates determined by the water transmitting properties of the soil, which include hydraulic conductivity and percentage of clays in the soil, relative to sands and gravels. The groups are defined as:

- Group A – High Infiltration Rate: water is transmitted freely through the soil; soils typically less than 10 percent clay and more than 90 percent sand or gravel.
- Group B – Moderate Infiltration Rate: water transmission through the soil is unimpeded; soils typically have between 10 and 20 percent clay and 50 to 90 percent sand.
- Group C – Slow Infiltration Rate: water transmission through the soil is somewhat restricted; soils typically have between 20 and 40 percent clay and less than 50 percent sand.
- Group D – Very Slow Infiltration Rate: water movement through the soil is restricted or very restricted; soils typically have greater than 40 percent clay, less than 50 percent sand.

The hydrologic group of the soil generally correlates with the potential for infiltration of water to the subsurface. However, there is not necessarily a correlation between the soils at the ground surface and the underlying geology or hydrogeology.

3.4. GEOLOGIC SETTING

The Basin is located within one of the structural blocks of the Peninsular Ranges of Southern California. The Basin occurs in a linear low-lying block, referred to as the Elsinore-Temecula trough, between the Santa Ana Mountains on the west and the Perris Plain on the east (Norris and Webb 1990). The trough extends from Corona to the southeast some 30 miles and was formed along an extensive northwest-southeast trending fault zone including the Elsinore, Chino, and related faults. The Elsinore fault zone, including the Glen Ivy Fault, bound the Basin on the west and trend along the mountain front.

As shown on **Figure 3-5**, the oldest rocks in the Study Area crop out in the Santa Ana Mountains. These uplands are composed principally of volcanic (including the Santiago Peak Volcanics) and metamorphic rocks (including the Bedford Canyon Formation) of Jurassic and Cretaceous age. A thin rim of younger sedimentary units of Tertiary age crops out along the mountain front generally lying east of the Glen Ivy Fault within the Elsinore Fault Zone.

This zone of sedimentary units broadens to the north and contains numerous mapped formations of Cretaceous and Tertiary age. The northeastern side of the valley is flanked primarily by granitic rocks of Cretaceous age. Erosion of these units has filled in the trough over time resulting in quaternary-age alluvial fan, channel, and other deposits making up the permeable portions of the groundwater Basin (Todd and AKM 2008).

The Elsinore Fault Zone forms a complex series of pull-apart basins (Morton and Weber 2003). The deep portion of the Basin in the Coldwater area is one of these pull-apart basins. Pull-apart basins are topographic depressions that form at releasing bends or steps in basement strike-slip fault systems. This initial deposition into the Basin is composed of rapid deposition of landslide and debris flow deposits which are extremely poorly sorted with a mixture of clay, sand, gravel, and boulders as seen in deep well logs. Since the movement on the faults is right-lateral, the oldest sediments are located at the lower levels in the northern part of the Basin. As the pull-apart basin formed, progressively younger sediments have been deposited from north to south. Because of this type of deposition, the lower units of the pull-apart basin can be heterogeneous.

3.5. FAULTS

The Glen Ivy fault zone separates the Bedford area from the Coldwater area, having significant impact on the depth of the basin and thickness of alluvial units. The Coldwater area of the Basin is located within a pull-apart basin between the Glen Ivy fault and the Elsinore Fault Zone located at the base of the Santa Ana Mountains. Within the basin, the Glen Ivy faults truncate and offset the alluvial units by up to 250 feet. This offset is inferred from well logs that extend to bedrock near the fault (Todd and AKM 2008 and WEI 2015b).

The Glen Ivy fault limits deep groundwater flow, resulting in a limitation of the hydraulic connection between the Coldwater and Bedford areas. At depth, the offset geologic units place the alluvial deposits in the Coldwater area against the Tertiary Bedford Canyon Formation. When groundwater levels in the Coldwater area are low, there is reduced groundwater flow across the fault. This is especially apparent during the recent periods when the groundwater levels in the Coldwater area were especially low. During these low water periods in the Coldwater area, groundwater levels are higher across the fault in the Bedford area resulting in minor inflows from Bedford into the Coldwater area. This is shown in some recent groundwater level data and supported by the groundwater modeling (**Appendix G**). However, at shallower depths, the fault offset is across alluvial deposits. During periods, or areas, when groundwater levels in the Coldwater area are high, groundwater elevation data suggests these areas appear to be well-connected when groundwater elevations in the Basin are high (Todd and AKM 2008), indicating more compartmentalization with depth. However, there is insufficient groundwater elevation monitoring information to assess the extent of this potential barrier to flow and it is therefore not considered a complete barrier to groundwater flow in the Basin.

3.6. PRINCIPAL AQUIFER

The following is a summary of the principal aquifer in the Basin, including the source and character of the sediments, lateral boundaries, and faults that potentially affect groundwater flow through the principal aquifer.

3.6.1. Description of Principal Aquifer

The principal aquifer of the Bedford-Coldwater Basin is composed of alluvium, including alluvial fan, alluvial valley, axial channel, and wash deposits. These deposits are sourced from the Santa Ana Mountains to the west of the Basin and the Peninsular Ranges to the east of the Basin. The Bedford Canyon Formation (a slightly metamorphosed sedimentary formation composed of interlayered argillite, slate, graywacke, conglomeratic graywacke, impure quartzite, and small masses of limestone and quartz-rich metasandstone) and adjacent granitic rocks are the primary source materials for these alluvial deposits. The alluvial fan deposits in the Coldwater area extend into the Bedford area and appear to have been disrupted by faulting (**Figure 3-5**). Channel deposits along Temescal Wash and local tributaries define the eastern boundary of the Basin. In the northern Bedford area, a variety of Tertiary sedimentary units crop out including the Silverado (Paleocene), Vaqueros (Miocene), Topanga (Miocene), and Puente (Miocene) formations (**Figure 3-5**). The alluvial aquifer materials in this portion of the Basin are sourced from these Tertiary sedimentary units. As such, the character of the deposits and the groundwater chemistry differ from the alluvial fans in the Coldwater area and those to the north in the Temescal Subbasin and south in the Elsinore Groundwater Basin.

Both older and recent alluvial fans have been deposited along the mountain front on the western edge of the Basin. These fans have prograded across both the Coldwater and Bedford areas from west to east. Although these deposits are relatively thick, the entire unit is heterogeneous. Sand lenses within the fan deposits collectively form the Alluvial Fan Aquifers. These aquifers from less than 40 feet up to 500 feet in the Bedford area (eastern portion of the Basin) and up to 800 feet in thickness in the deepest portions of the Coldwater area (western portion of the Basin) (Todd and AKM 2008).

3.6.2. Description of Lateral Boundaries

The bedrock units of the uplands provide distinct lateral boundaries for the basin and its alluvial units. Basin alluvium is thin in some areas, which in itself impedes groundwater flow. This is especially relevant at the northern and southern boundaries of the Basin.

3.7. DEFINABLE BASIN BOTTOM

The Basin bottom is defined by bedrock, which is shallow around the perimeter and deep in the center. Depth to bedrock ranges in depth from 10 feet to over 700 feet (Todd and AKM 2008 and WEI 2015b). The depth to the bottom of the alluvial materials in the Basin and the contact with the bedrock bottom of the Basin are shown in the contours presented in **Figure**

3-6. Aquifer thickness is greatest in the Coldwater portion of the Basin west of the Glen Ivy fault, as shown in **Figures 3-6** and **3-8**.

3.8. CROSS SECTIONS

Figure 3-7 is a map showing locations of two cross sections, **Figures 3-8** and **3-9**. The two hydrogeologic cross sections were constructed to identify hydrogeologic structures affecting groundwater, to characterize the thickness and distribution of aquifer sediments within the Basin, and to confirm aquifer descriptions presented above.

The cross sections and depth to bedrock map were prepared using available information from existing datasets and sources including the following:

- Surficial geology in geographic information system (GIS) coverage format (USGS 2004 and 2006).
- Fault locations and orientations (USGS 2004 and 2006).
- Lithologic and well construction logs from local agencies.
- Drillers Log files from California Department of Water Resources (DWR).
- National Elevation Dataset (NED) ground surface digital elevation model data for Riverside County (USGS 2019).

The two cross sections (**Figures 3-8** and **3-9)** show the bedrock profile, location of faults, nature and maximum thickness of the alluvial fan aquifers and the relationship with the Temescal Wash deposits. Locations and general construction of wells also are shown. As indicated, alluvial sediments are more than 800 feet thick in the Coldwater area and up to 500 feet thick in the Bedford area, with the thickest section occurring near the Glen Ivy Fault. The cross sections are consistent with and support the conceptual model described above and the depth to bedrock (**Figure 3-6**).

3.9. STRUCTURES AFFECTING GROUNDWATER

The Basin is defined by the lateral extents of the alluvial material in the pull-apart basin described above. This material is bounded by bedrock in the Santa Ana Mountains on the west and the Peninsular Ranges to the east. The southern and northern boundaries of the Basin are formed by areas of thin alluvial material over shallow bedrock in narrow valleys (Todd and AKM 2008 and WEI 2015b). Within the Basin the groundwater is affected by faulting in the Elsinore Fault Zone, primarily the Glen Ivy fault as described in Section 3.5 above.

3.10. RECHARGE AND DISCHARGE AREAS

Areas of major recharge and discharge are shown in **Figure 3-10**. Recharge to the Basin occurs primarily from infiltration of runoff, and to a lesser extent from deep percolation of precipitation and urban return flows, wastewater recharge, and subsurface inflow from outside the Basin.

Most of the Basin recharge comes from the infiltration of runoff from precipitation in the Santa Ana Mountains west of the Basin and the Peninsular Ranges east of the Basin. Large amounts of runoff from the mountains flow into unlined channels and the shallow subsurface at the edges of the Basin and then on into and through the Basin. The amount of water available for recharge varies annually with changes in rainfall and runoff. Runoff into the Basin is subject to evapotranspiration, infiltration, and continued surface flow to and in the Temescal Wash. The watersheds contributing to the Basin include multiple drainages, all of which flow across the Basin in generally east-west orientations. Wet years generate large amounts of water that exceed the recharge capacity of the Basin (Todd and AKM 2008).

Deep percolation of precipitation is the process by which precipitation enters groundwater. Recharge to groundwater from deep percolation occurs throughout the Basin (Todd and AKM 2008).

Return flows are those portions of applied water (e.g., landscape irrigation) that are not consumed by evapotranspiration and returned to the groundwater system through deep percolation or infiltration. Return flows associated with urban, industrial, and agricultural water uses all have the potential to contribute to recharge to the Basin (Todd and AKM 2008).

Recharge associated with wastewater occurs with discharges from the wastewater treatment facilities within and upstream from the Basin (TVWD water reclamation facility [WRF] and Corona WRF-3, and Horsethief Canyon WRF, respectively; see **Figure 4-14** for locations) and from on-site wastewater treatment systems (OWTS). Subsurface inflow occurs along the Basin boundaries both through bedrock inflow along the western and eastern Basin boundaries and from the Elsinore Subbasin to the south, but these are not considered to be a significant source of recharge to the Basin (Todd and AKM 2008).

Discharge from the Basin is almost entirely from groundwater pumping (see well locations on Figure 3-1), evapotranspiration, and mining operations (quarries on **Figure 3-10**). There is some limited discharge across the northern Basin boundary with the Temescal Subbasin of the Upper Santa Ana River Basin, but the thin alluvial material in this area limits the volume and timing of subsurface outflow along this boundary (Todd and AKM 2008 and **Appendix G**).

3.11. PRIMARY GROUNDWATER USES

The primary groundwater uses in the Basin are municipal pumping, with limited private pumping for small water system, commercial, and residential users. Groundwater use estimates are included in Section 5, Water Budget.

3.11.1. Bedford Area

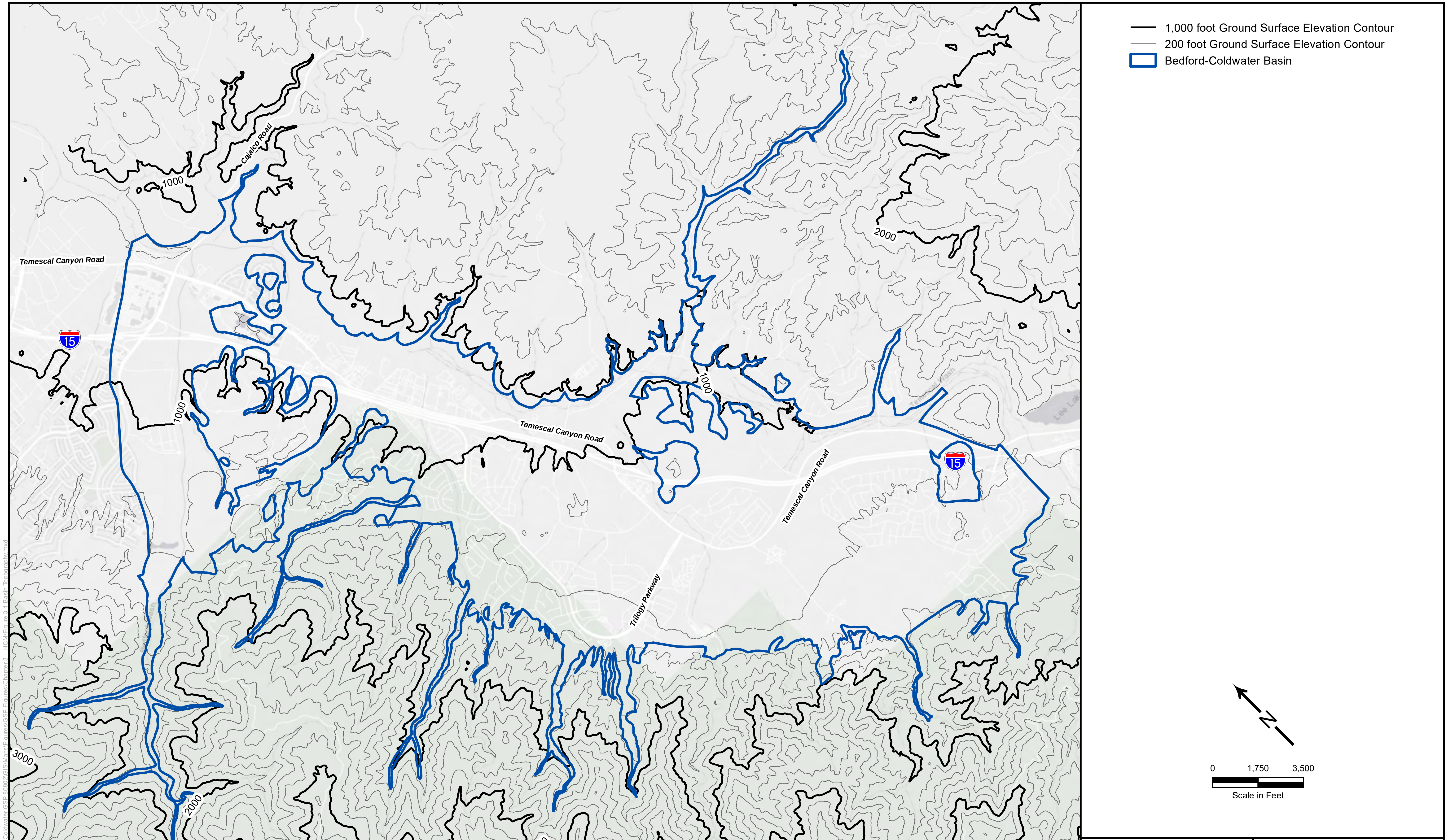
Groundwater in the principal aquifer in the Bedford area is primarily used for non-potable municipal and irrigation water supply. There are no known potable water supply wells in the Bedford area.

3.11.2. Coldwater Area

The principal aquifer in the Coldwater area is mostly used for municipal water supply. Most of the pumping in this area is from wells owned and operated by the BCGSA agencies, with some additional pumping by small community water system and small commercial users. Non-potable pumping has occurred historically in this area to support agricultural, recreational, small residential, and industrial water uses.

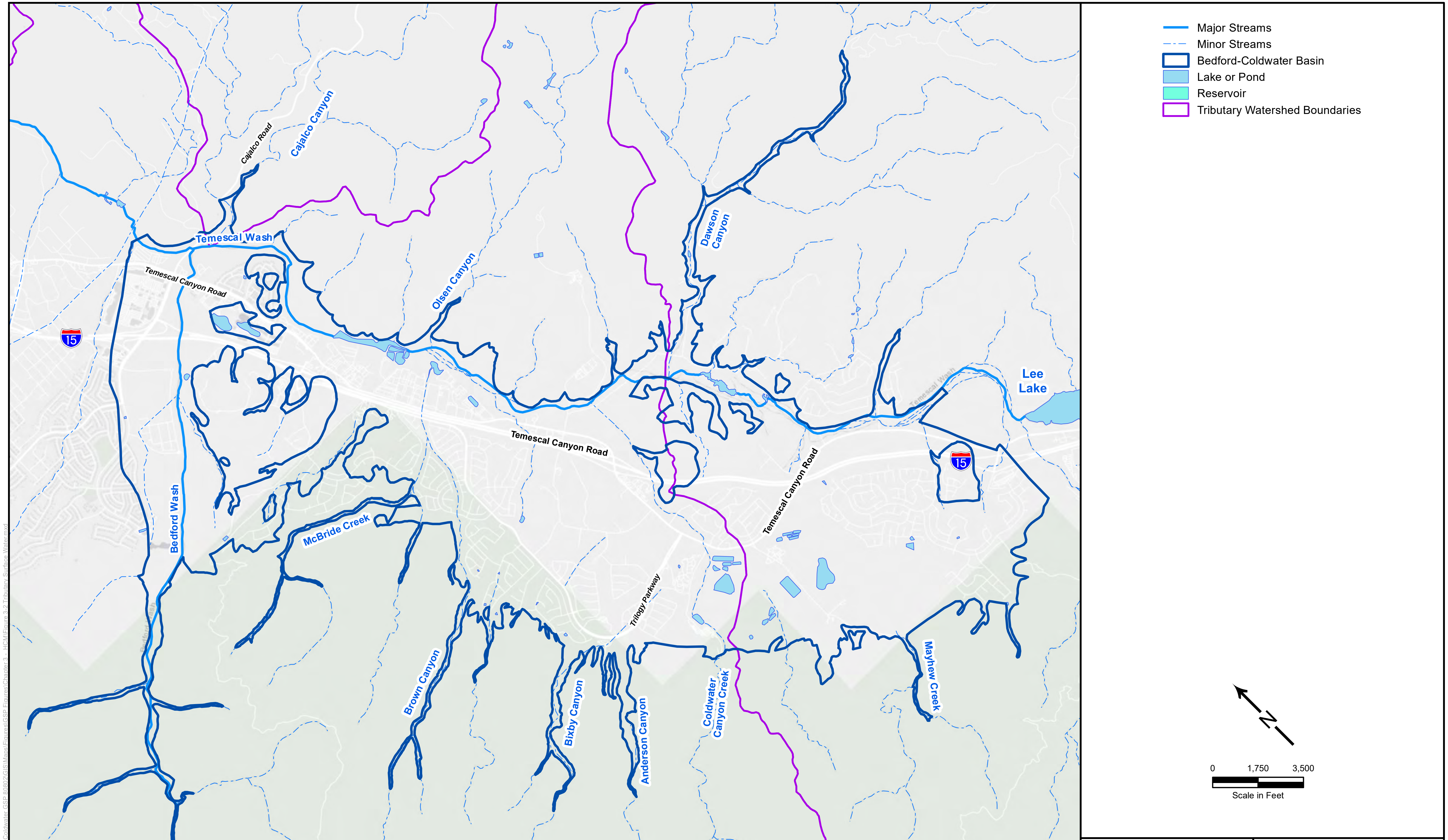
3.12. DATA GAPS IN THE HYDROGEOLOGIC CONCEPTUAL MODEL

The hydrogeologic conceptual model has not identified data gaps in available information that affect the assessment of sustainability in the Basin.



TODD GROUNDWATER

Figure 3-1
Basin Topography



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TODD GROUNDWATER

Figure 3-2
Surface Water Bodies Tributary to Basin

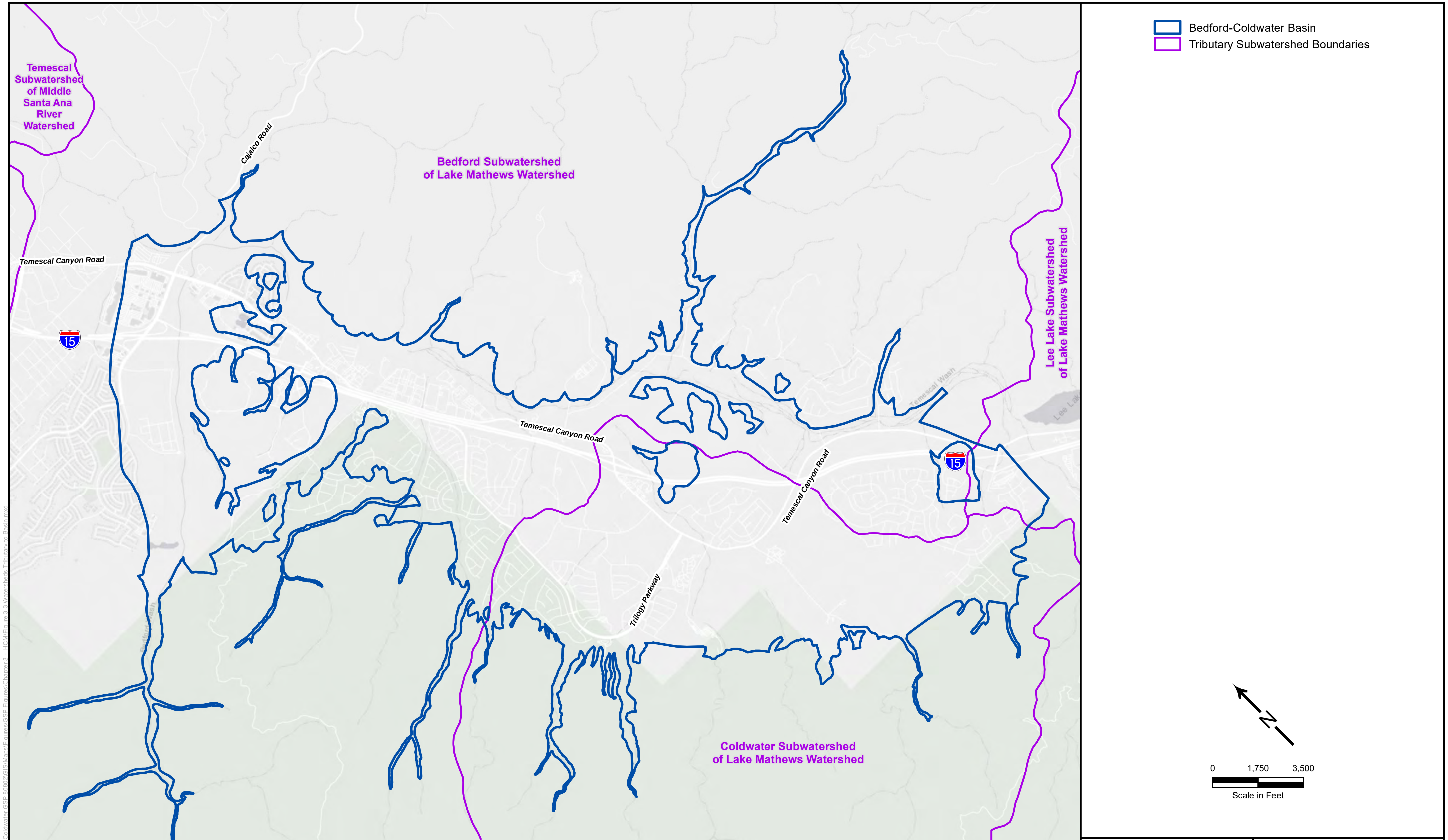
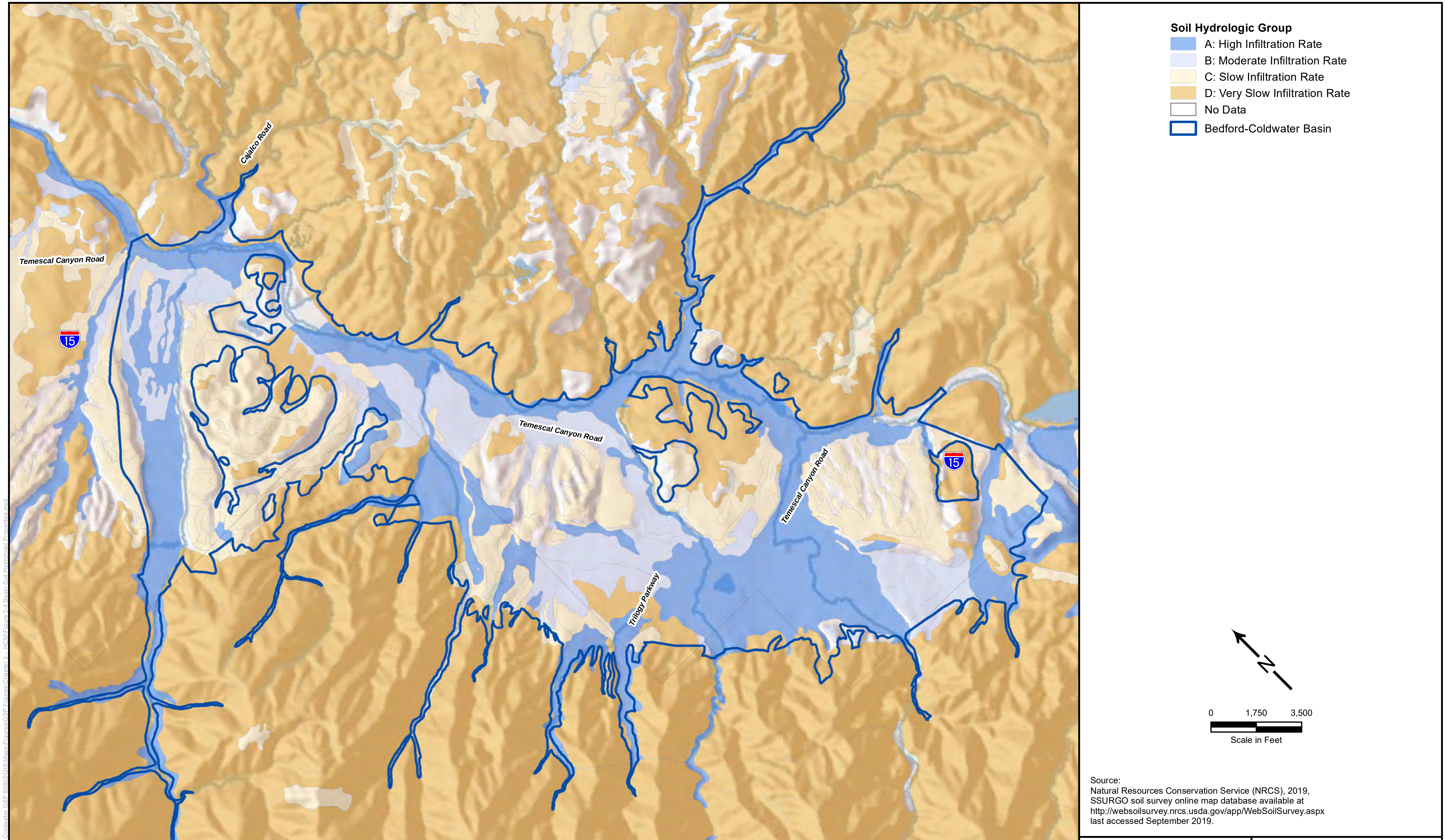


Figure 3-3
Subwatersheds Tributary to Basin



Source:
Natural Resources Conservation Service (NRCS), 2019,
SSURGO soil survey online map database available at
http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
last accessed September 2019.

TODD GROUNDWATER

Figure 3-4
Basin Soil
Hydrologic Properties

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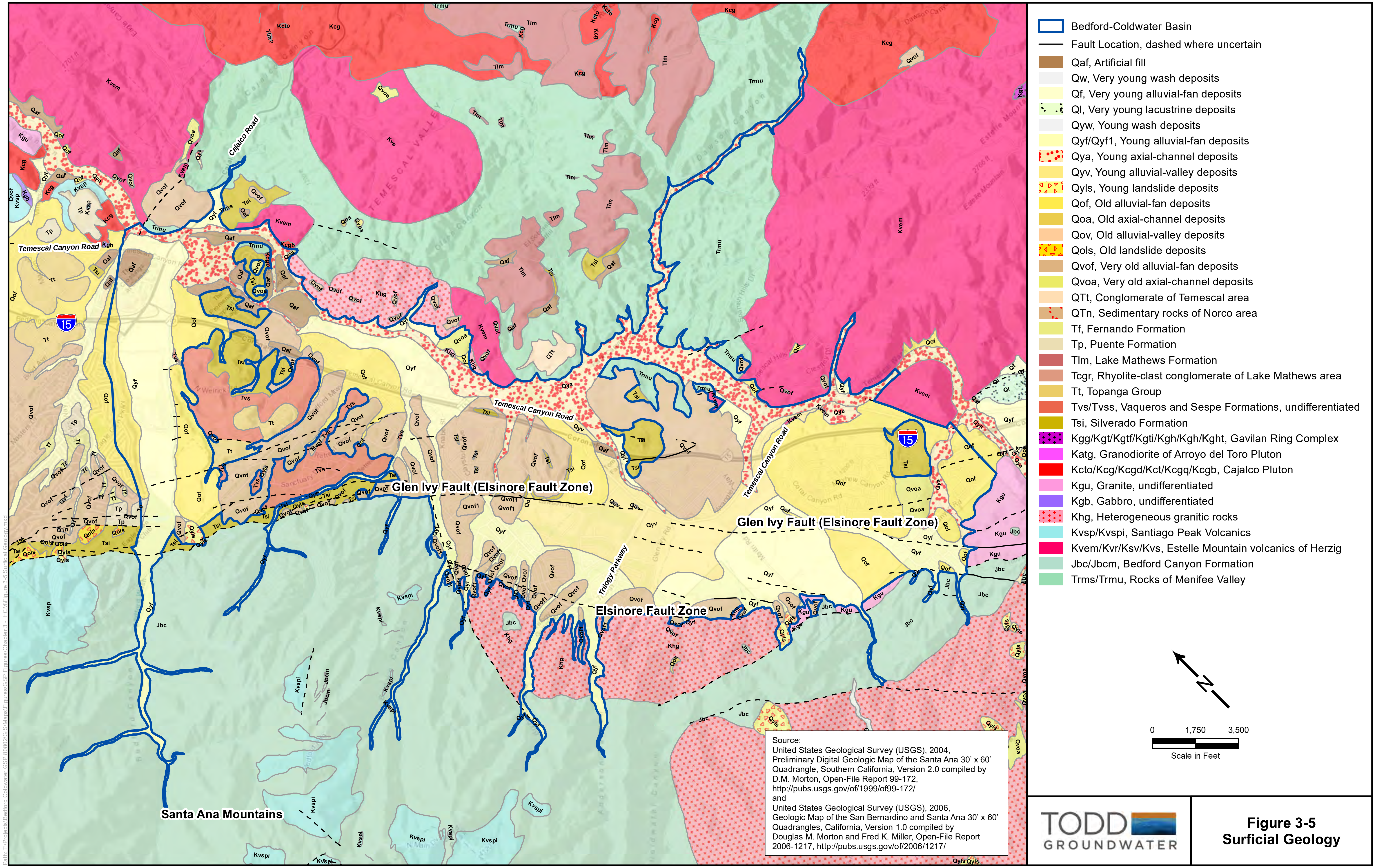


Source:
United States Geological Survey (USGS), 2004, Preliminary Digital Geologic Map of the Santa Ana 30' x 60' Quadrangle, Southern California, Version 2.0 compiled by D.M. Morton, Open-File Report 99-172, http://pubs.usgs.gov/of/1999/of99-172/
and
United States Geological Survey (USGS), 2006, Geologic Map of the San Bernardino and Santa Ana 30' x 60' Quadrangles, California, Version 1.0 compiled by Douglas M. Morton and Fred K. Miller, Open-File Report 2006-1217, http://pubs.usgs.gov/of/2006/1217/

TODD GROUNDWATER

Figure 3-5
Surficial Geology

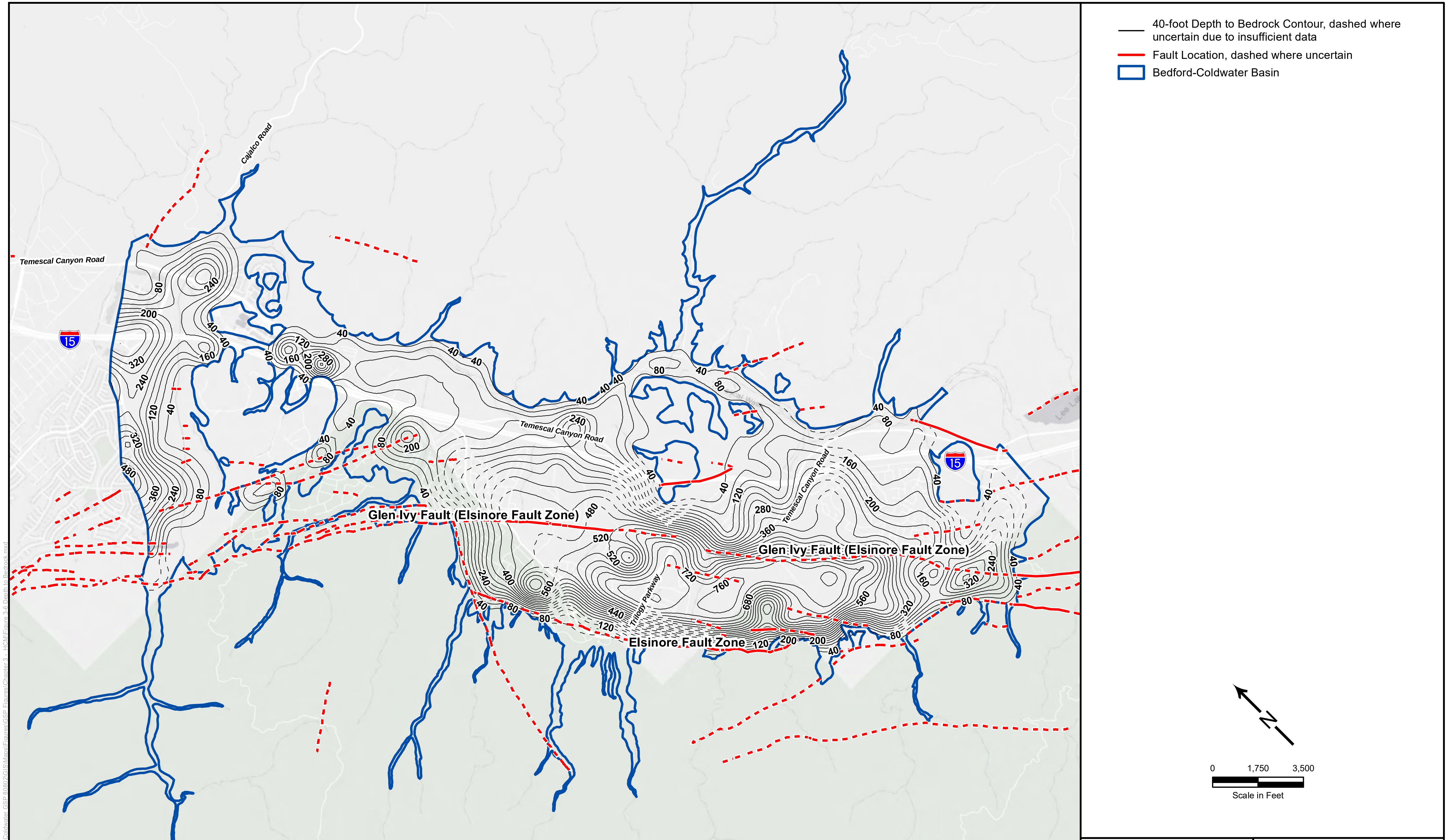
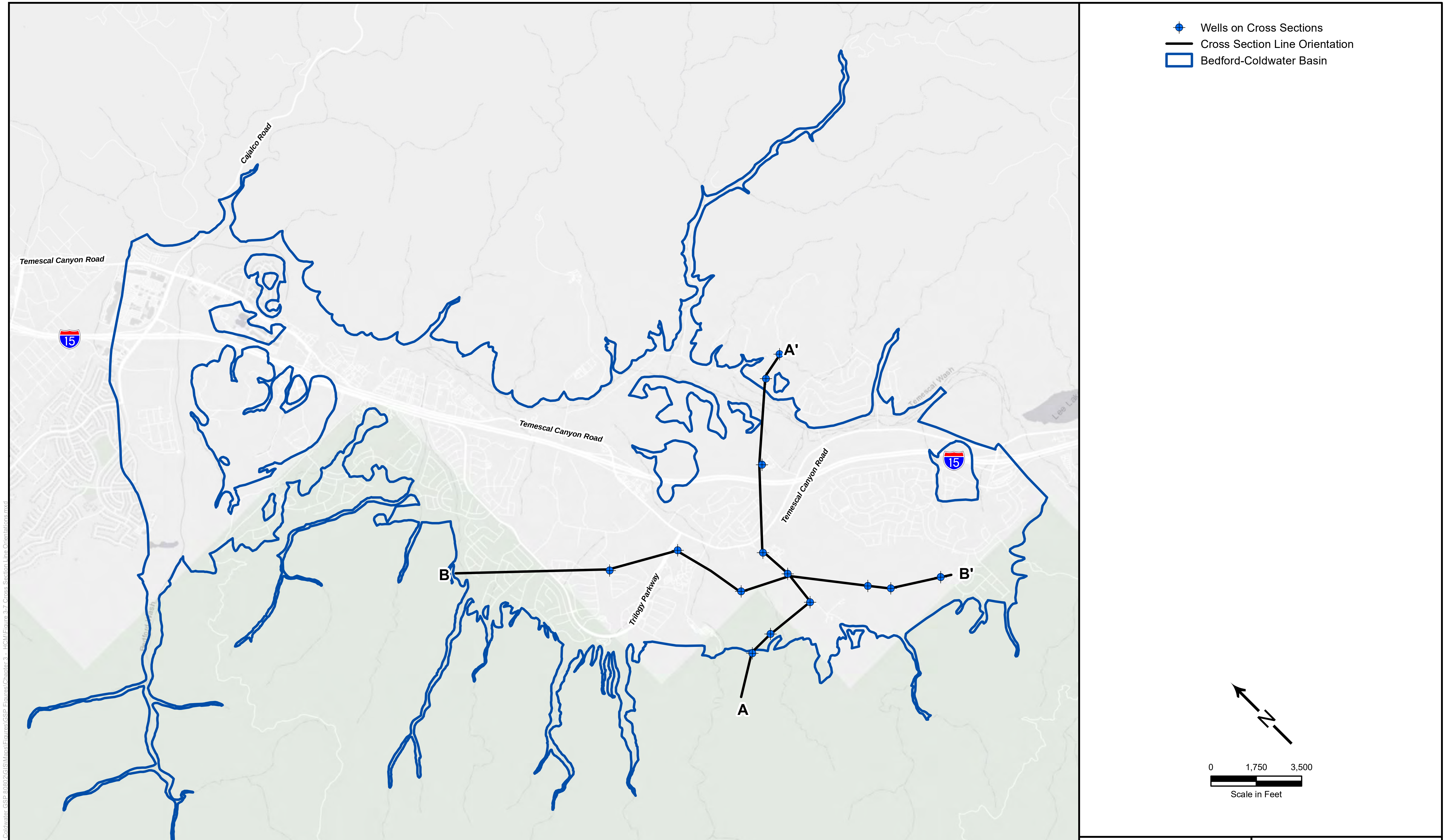
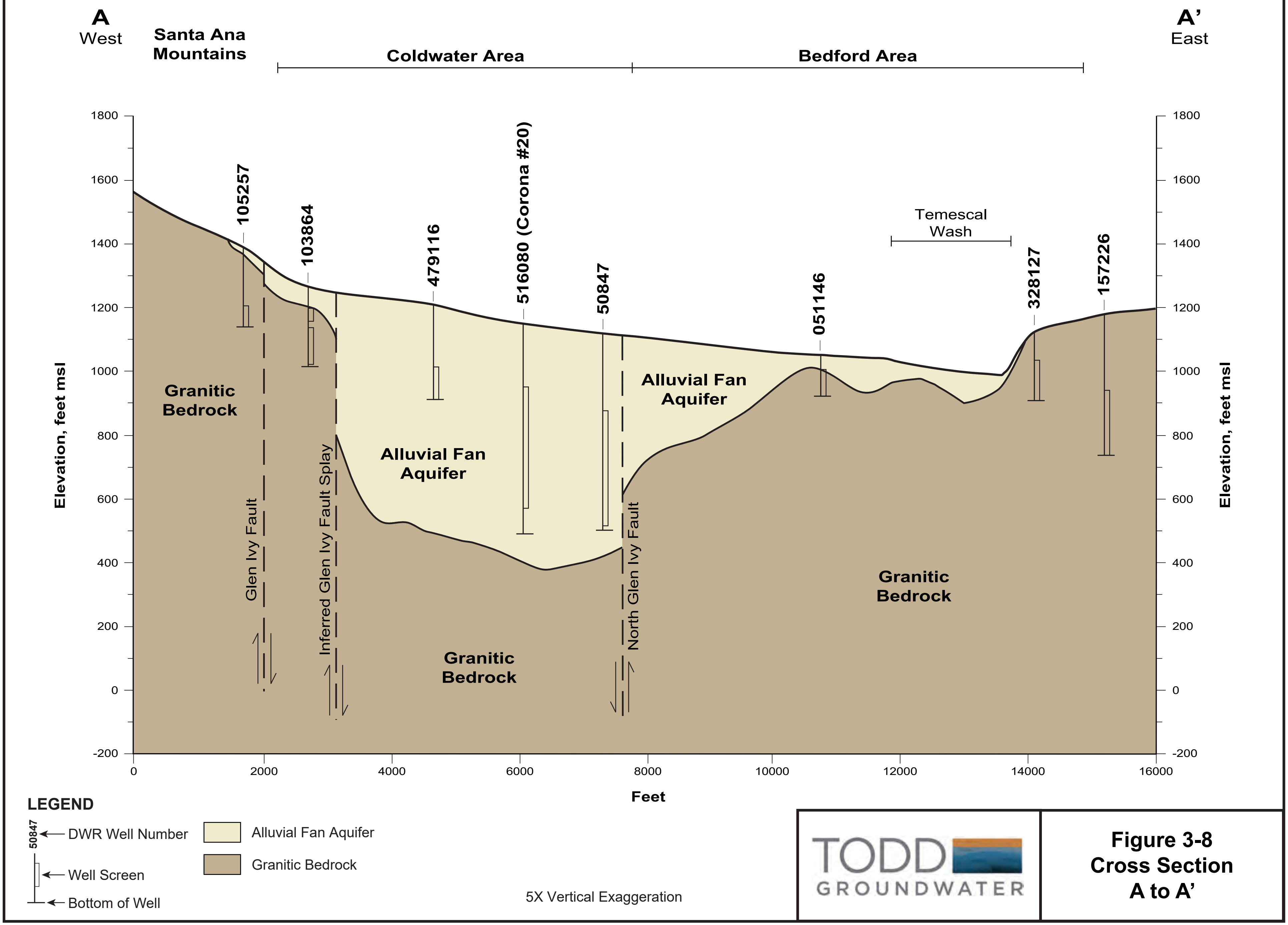


Figure 3-6
Depth to Bedrock



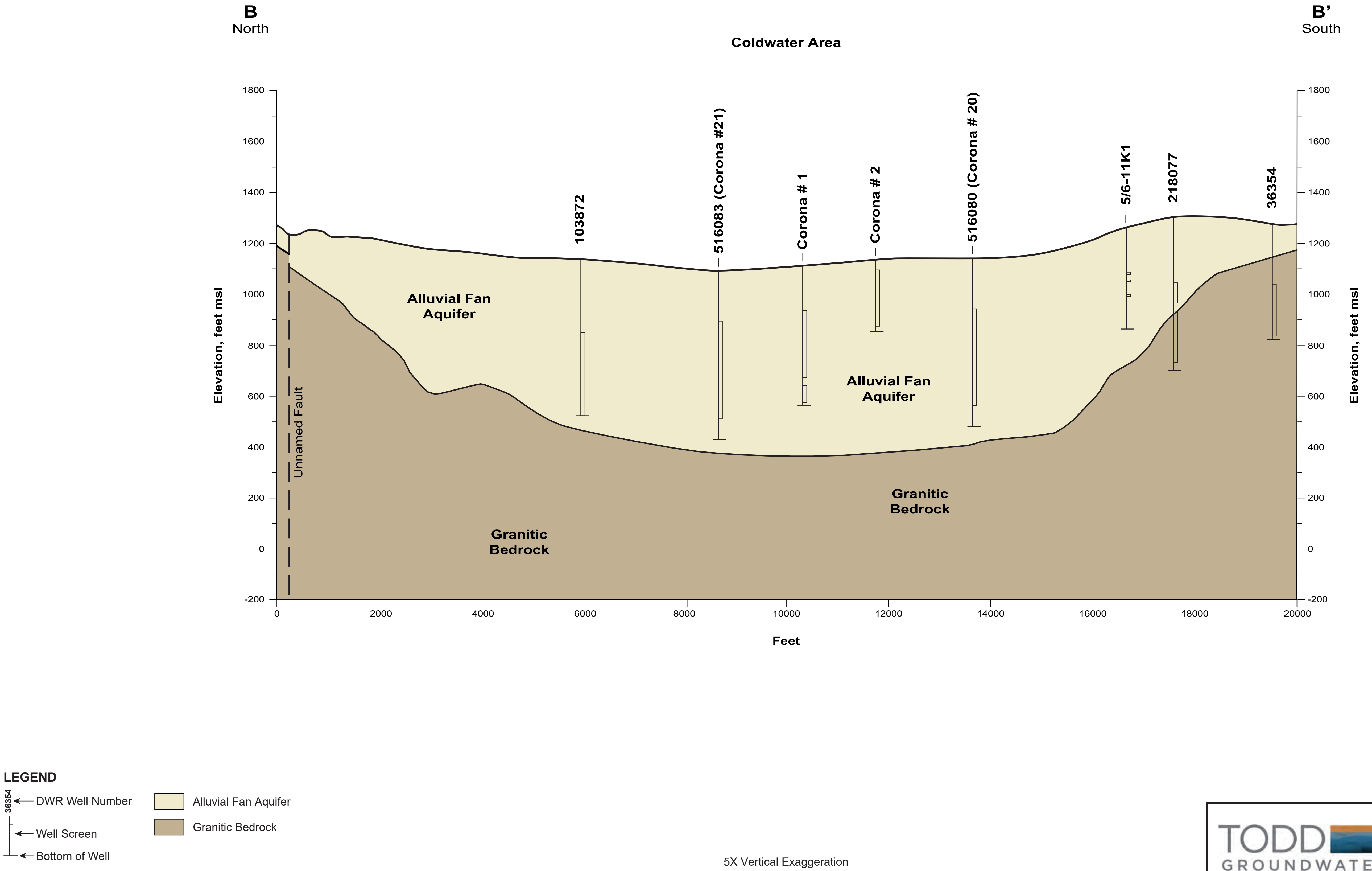
TODD GROUNDWATER

Figure 3-7
Cross Section
Line Orientation



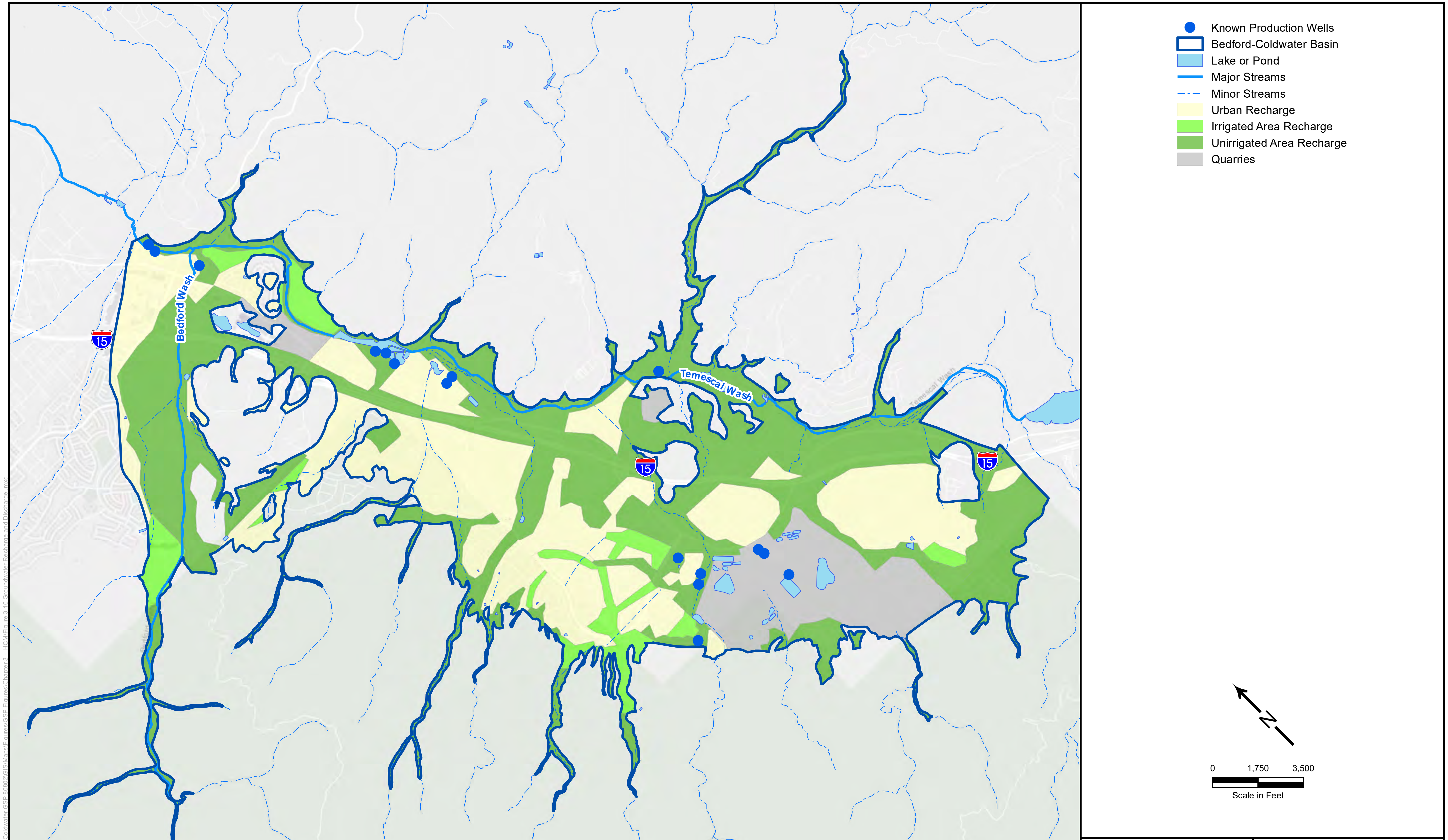
TODD GROUNDWATER

**Figure 3-8
Cross Section
A to A'**



TODD GROUNDWATER

Figure 3-9
Cross Section
B to B'



TODD GROUNDWATER

Figure 3-10
Groundwater Recharge and Discharge

4. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

The Sustainable Groundwater Management Act (SGMA) requires definition of various study periods for current, historical, and projected future conditions. Current conditions, by SGMA definition, include those occurring after January 1, 2015 and accordingly, historical conditions occurred before that date. A historical period must include at least 10 years.

The study period 1990 through 2018 is based on the cumulative departure from mean precipitation at Santiago Peak, Lake Elsinore, and Riverside climate monitoring stations. This period is representative and includes droughts and wet years, with an average annual rainfall of 12.97 inches, comparable to the long-term average of 12.9 inches (1875 to 2017). Accordingly, groundwater conditions over time are described through 2018.

Groundwater conditions are described in terms of the six sustainability indicators identified in SGMA; these include:

- Groundwater elevations.
- Groundwater storage.
- Potential subsidence.
- Groundwater quality.
- Seawater intrusion (which is not likely to occur in this inland basin).
- Interconnected surface water and groundwater dependent ecosystems.

4.1. GROUNDWATER ELEVATIONS

4.1.1. Available Data

Groundwater elevation records were collected from multiple sources, including previous investigations, City of Corona, United States Geological Survey (USGS) National Water Information System (NWIS), California Department of Water Resources (DWR), and California Statewide Groundwater Elevations Monitoring (CASGEM). Data from these sources were collected, reviewed, and compiled into a single unified groundwater elevation dataset. The wells with water level measurement records are shown on **Figure 4-1**.

4.1.2. Groundwater Occurrence

As summarized in Chapter 3, groundwater is present in one principal aquifer. Groundwater in the Bedford-Coldwater Subbasin (Basin) occurs under unconfined conditions and there are no data to suggest distinct vertical zones or to provide zone-specific groundwater elevation hydrographs or maps.

4.1.3. Groundwater Elevations and Trends

Hydrographs showing groundwater elevation trends over time were prepared for all 28 wells with elevation data in the Basin; these hydrographs then were reviewed to identify wells with long term data that could be used to present representative hydrographs. The selection of representative wells was based on a quantitative approach that considered hydrographs with long records characteristic of an area and distribution of wells across the Basin. All available groundwater elevation data were plotted as hydrographs and well locations were plotted on a basin-scale map. All wells with water level data are shown in **Figure 4-1**. Long term changes in groundwater elevations in the Basin are illustrated in representative hydrographs shown in **Figures 4-2 through 4-6** and show conditions since January 1990, where available, thus showing the study period for the Groundwater Sustainability Plan (GSP).

Representative wells with long term hydrographs were selected based the following criteria:

- Location – Wells were prioritized considering broad distribution across the Basin and availability of other wells nearby.
- Ongoing and/or recent monitoring – Wells were selected that are part of the active monitoring network or have recent data.
- Trends – Each hydrograph was assessed for continuity of monitoring, representation of local or regional trends, and presence of outliers or unrealistic data.

The northern hydrograph wells in **Figure 4-2** through **4-5** all reflect stable groundwater level conditions. These four wells show a slight decrease during the 2013 through 2015 drought but the net change is only 20 to 30 feet. The southernmost well, Corona 3 on **Figure 4-6** shows conditions in the Coldwater area where there is more variation than other areas of the Basin. As shown on the hydrograph, water levels have declined over the last 24 years with significant fluctuations in response to wet and dry cycles. Water levels in the Coldwater area have varied more than 350 feet over the last 30 years with multiple major and minor cycles of groundwater elevation decline and recovery, as illustrated on the hydrograph. Some of the short-term fluctuations may have been influenced by incomplete recovery of pumping water levels in the well. The wide water level fluctuations over time in the Coldwater area likely reflect the relatively small footprint and fault-controlled flow along with the fact that most of the pumping in the Basin occurs in this area. Although long-term declines in groundwater elevations have occurred in Coldwater in the past, recent groundwater elevations have stabilized due in part to shared management of the Basin between the three Bedford-Coldwater Groundwater Sustainability Agency (BCGSA) agencies.

Recent water levels in the Coldwater area are just below 800 feet msl (as shown on **Figure 4-6**) and reflect a recovery of approximately 60 feet from the historical low reached in late 2010. This recovery is due, in part, to a production agreement between the City of Corona (Corona) and Elsinore Valley Municipal Water District (EVMWD) for the Coldwater portion of the Basin, where most of the pumping occurs.

4.1.4. Groundwater Flow

Figures 4-7 and 4-8 are groundwater elevation contour maps constructed to examine current groundwater flow conditions and using data from fall 2015 and spring 2018, respectively. Contours were developed based on available groundwater elevation data for all wells and information from the numerical groundwater model (**Appendix G**). The fall 2015 groundwater elevation contours (**Figure 4-7**) show flow generally from south to north in the Basin and from the northwest to the northeast in the north of the Basin. A slight water table depression occurs in the Coldwater area around the active production wells. Water levels in the Bedford area near the Glen Ivy fault were higher than those across the fault in the Coldwater area, indicating flow from Bedford to Coldwater. The groundwater elevations in this period represent relatively dry conditions at the end of the most recent drought period. Spring 2018 groundwater elevation contours (**Figure 4-8**) also show flow generally south to north with easterly flow in the north of the Basin and a small depression in the Coldwater area. Spring 2018 followed a period of relatively wet conditions. However, water levels in the Basin were very similar to those during the fall 2015 dry conditions. This includes the depression in the Coldwater area and the indication of flow from Bedford to Coldwater across the Glen Ivy Fault. Both fall 2015 and spring 2018 contours show that groundwater elevations are relatively consistent.

4.1.5. Vertical Groundwater Gradients

The current monitoring network for groundwater elevations provides little information about vertical head (groundwater elevation) gradients within the Basin. Available data are almost entirely from water supply wells, which are typically screened between 200 and 500 feet below ground surface (bgs). The potentiometric head at the depth of the well screens can be different from the true water table, which is the first zone of saturation reached when drilling down from the ground surface.

4.2. CHANGES IN GROUNDWATER STORAGE

Change in storage estimates based on evaluation of groundwater elevation changes and water budget inflow and outflow have completed for the portions of the Basin in past studies (MWH 2004, SAIC 2007, WEI 2015a, 2015b, 2016, 2017b, and 2019). Such storage change estimates are based on available groundwater elevation data that are limited geographically and temporally and thus include uncertainty. In addition, the storativity, or storage coefficient (the volume of water released from storage per unit decline in hydraulic head), is largely unknown across the Basin. The volume of groundwater storage change over time can be calculated by multiplying the groundwater elevation changes during a period by the storage coefficient. Storage coefficient value and storage change estimates for the Basin have been developed through calibration of the numerical model, as described in **Appendix G**. Therefore, the numerical model is the best tool for estimating groundwater storage changes. The resulting change in storage estimates are presented in the Water Budget chapter.

4.3. LAND SUBSIDENCE AND POTENTIAL FOR SUBSIDENCE

Land subsidence is the differential lowering of the ground surface, which can damage structures and facilities. This may be caused by regional tectonism or by declines in groundwater elevations due to pumping. The latter process is relevant to the GSP. While subsidence has not been a known issue in the Basin, groundwater elevation declines in the subsurface, resulting in dewatering and compaction of predominantly fine-grained deposits (such as clay and silt) can cause the overlying ground surface to subside.

This process is illustrated by two conceptual diagrams shown on **Figure 4-9**. The upper diagram depicts an alluvial groundwater basin with a regional clay layer and numerous smaller discontinuous clay layers. Groundwater elevation declines associated with pumping cause a decrease in water pressure in the pore space (pore pressure) of the aquifer system. Because the water pressure in the pores helps support the weight of the overlying aquifer, the pore pressure decrease causes more weight of the overlying aquifer to be transferred to the grains within the structure of the sediment layer. If the weight borne by the sediment grains exceeds the structural strength of the sediment layer, then the aquifer system begins to deform. This deformation consists of re-arrangement and compaction of fine-grained units[2], as illustrated on the lower diagram of **Figure 4-9**. The tabular nature of the fine-grained sediments allows for preferred alignment and compaction. As the sediments compact, the ground surface can sink, as illustrated by the right-hand column on the lower diagram of **Figure 4-9**.

Land subsidence due to groundwater withdrawals can be temporary (elastic) or permanent (inelastic). Elastic deformation occurs when sediments compress as pore pressures decrease but expand by an equal amount as pore pressures increase. A decrease in groundwater elevations from groundwater pumping causes a small elastic compaction in both coarse-and fine-grained sediments; however, this compaction recovers as the effective stress returns to its initial value. Because elastic deformation is relatively minor and fully recoverable, it is not considered an impact.

Inelastic deformation occurs when the magnitude of the greatest pressure that has acted on the clay layer since its deposition (preconsolidation stress) is exceeded. This occurs when groundwater elevations in the aquifer reach a historically low groundwater elevation. During inelastic deformation, or compaction, the sediment grains rearrange into a tighter configuration as pore pressures are reduced. This causes the volume of the sediment layer to reduce, which causes the land surface to subside. Inelastic deformation is permanent because it does not recover as pore pressures increase. Clay particles are often planar in form and more subject to permanent realignment (and inelastic subsidence). In general, coarse-grained deposits (e.g., sand and gravels) have sufficient intergranular strength and do not undergo inelastic deformation within the range of pore pressure changes encountered from groundwater pumping. The volume of compaction is equal to the volume of groundwater that is expelled from the pore space, resulting in a loss of storage capacity. This loss of storage capacity is permanent but may not be substantial because clay layers do not typically store significant amounts of usable groundwater. Inelastic compaction, however, may decrease the vertical permeability of the clay resulting in minor changes in vertical flow.

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[2] Although extraction of groundwater by pumping wells causes a more complex deformation of the aquifer system than discussed herein, the simplistic concept of vertical compaction is often used to illustrate the land subsidence process (LSCE et al. 2014).

The following potential impacts can be associated with land subsidence due to groundwater withdrawals (modified from LSCE et al. 2014):

- Damage to infrastructure including foundations, roads, bridges, or pipelines,
- Loss of conveyance in canals, streams, or channels,
- Diminished effectiveness of levees,
- Collapsed or damaged well casings, and
- Land fissures.

4.3.1. Interferometric Synthetic Aperture Radar (InSAR)

InSAR data are provided by DWR on its SGMA Data Viewer (DWR 2020) and document vertical displacement of the land surface across a broad area of California from June 13, 2015 to September 19, 2019. The accuracy of the InSAR ground surface elevation change estimates is reported to be ±16 millimeters (mm), or ±0.052 feet (ft) (Towill 2020). The TRE Altamira InSAR Dataset, shown on **Figure 4-10** shows mapping within the Basin for land surface deformation between 2015 and 2019.

The TRE Altamira InSAR data on **Figure 4-10** uses a range of 0.05 to -0.05 ft to display the estimated ground surface elevation change in the Basin. The maximum estimated ground surface elevation rise in the Basin between 2015 and 2019 is 0.02 ft and the maximum decline is -0.05 ft. These estimated changes are less than the reported accuracy for InSAR. Thus, based on the InSAR estimates there has effectively been no change in ground surface elevation within the Basin in the 2015 to 2019 period. Given these data and the understanding of the hydrogeological conceptual model, there is no evidence of subsidence at this time.

4.4. GROUNDWATER QUALITY

The natural quality (chemistry) of groundwater is generally controlled by the interaction between rainwater and rocks/soil of the vadose zone and aquifers (Drever 1988). As rainfall infiltrates through the soil column, changes in water chemistry occur as anions and cations are dissolved into the water. These changes are influenced by soil and rock types, weathering, organic matter, and geochemical processes occurring in the subsurface. Once in the groundwater system, changing geochemical environments continue to alter groundwater quality. A long contact time between the water and sediments may allow for more dissolution and more concentrated groundwater (Drever 1988). The natural groundwater quality in a basin is the net result of these complex subsurface processes that have occurred over time.

General mineral quality of groundwater is naturally poor, especially in the Bedford area, as indicated by relatively high concentrations of total dissolved solids and sulfate. This reflects in part the occurrence in the northern Bedford area of Tertiary sedimentary units, in contrast to the alluvial fans of the Coldwater area. The Corona Groundwater Management Plan evaluated the geochemistry of the Basin, and compared the Coldwater area to the Bedford area (Todd and AKM 2008). This evaluation showed the Coldwater area had a relatively high calcium-to-sodium ratio compared to groundwater in the Bedford area and downgradient

Temescal Basin. This relationship showed a difference in the source material in the aquifer in these two locations. The aquifer material in the Coldwater area is sourced from the granitic units in the Santa Ana Mountains, while the material in the Bedford area is sourced from the Tertiary sedimentary units that outcrop within that area and east of the Basin.

Groundwater quality can vary in the Basin; some areas have good water quality while other areas have high mineral concentrations, generally presenting as elevated total dissolved solids (TDS). High TDS concentration in groundwater can be naturally occurring and also the result of anthropogenic sources such as urban runoff, historical agricultural activities, and treated wastewater discharge. Nitrate was historically elevated in parts of the Basin, but recent concentrations have been relatively low. Natural nitrate levels in groundwater are generally very low, and elevated concentrations are associated with agricultural activities, septic systems, landscape fertilization, and wastewater treatment facility discharges.

Groundwater in the Basin has been impacted by human activities including agricultural, urban, and industrial land uses. State agencies with regulatory oversight for water quality in the Basin include the Santa Ana Regional Water Quality Control Board (RWQCB) and the State Water Resources Control Board (SWRCB) – Division of Drinking Water (DDW).

4.4.1. Monitoring Networks

State Water Board GAMA Program

The State Water Board Groundwater Ambient Monitoring and Assessment (GAMA) Program (SWRCB 2019) is the primary source of groundwater quality data in the Basin. The GAMA program has water quality data from 27 wells. Only six of these wells have recent water quality data (data collected since January 2015).

Division of Drinking Water (DDW)

There are four drinking water systems (Corona, EVMWD, Temescal Valley Water District [TVWD], and Glen Ivy Golf Club), with a total of eight well locations in the Basin. These stations report water quality data to the DDW. Each system monitors and reports water quality parameters to DDW and is required to participate in the Drinking Water Source Water Assessment Program (DWSAP) to ensure wells are not subject to local contamination.

Other Agencies

The RWQCB regulates one site in the Basin, Villa Park Trucking. Groundwater quality data were collected from one well on site from 1997 to 2007. In addition, DWR monitored 17 wells in the Basin from 1955 to 1988 and the USGS monitored two wells from 2006 to 2011.

Wells with water quality data from all available sources are shown on **Figure 4-11**.

4.5. OTHER STUDIES

4.5.1. Salt and Nutrient Management Plan 2017

The RWQCB manages salinity in the Santa Ana River Basin, in part by regulating the discharge and reuse of recycled water. TDS and nitrate concentration limitations for recycled water discharge and reuse are set by the RWQCB based on the Wasteload Allocation for surface waters in the Santa Ana River Watershed and the antidegradation objectives and ambient TDS and nitrate concentrations of the receiving groundwater management zone (GMZs), as defined in the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan). While there were two GMZs in the Basin (Bedford and Coldwater), Bedford was combined into the Upper Temescal Valley GMZ.

Consistent with the 2013 SWRCB Recycled Water Policy, a Salt and Nutrient Management Plan (SNMP) was developed for the Upper Temescal Valley, including the Bedford area, in 2017 (WEI 2017a). The purpose of the SNMP was to identify sources of salts and nutrients (current and future) as context for assessing potential impacts of recycled water projects and to plan for management of salt and nutrient sources to ensure that groundwater is safe for drinking and all other beneficial uses. Beneficial uses of water and respective water quality objectives are defined by the RWQCB in the Basin Plan. The report found that TDS concentrations were highly variable across space and time, ranging from a low of 240 milligrams per liter (mg/L) to a high of 1,500 mg/L, and there was no significant long-term trend of water quality degradation or improvement. Similar to TDS, nitrate concentrations are also highly variable; however, there does appear to be a decrease in concentrations over time, which is probably due to the reduction in irrigated agriculture land uses and hence a reduction in added nitrogen in the form of fertilizers.

The SNMP recommended TDS and nitrate antidegradation objectives for the Upper Temescal Valley GMZ consistent with the 2004 Basin Plan. These proposed objectives for TDS and Nitrate as N are 820 mg/L and 7.9 mg/L, respectively (WEI 2017a). These objectives (pertinent to Bedford area) are lower (stricter) than drinking water standards.

4.6. THREATS TO WATER QUALITY

4.6.1. Regulated Facilities

The RWQCB regulates one site in the Basin, Villa Park Trucking. Groundwater quality data were collected from one well on site from 1997 to 2007, and the site has since been closed.

4.6.2. Septic Systems

Some limited areas of the Basin are not served by municipal sewer and rely on on-site wastewater treatment (OWTS or septic systems). These represent sources of salt and nutrient loading to groundwater, as well as potential sources of other contaminants. Riverside County Department of Environmental Health is the permitting agency for septic systems and wells in the County. The Riverside County Department of Environmental Health maintains an inventory of septic system installations but does not track which remain active. While it is known how many of these septic systems exist, the number is assumed minimal; most of the BCGSA area is sewered.

4.6.3. Non-point Sources

Nonpoint source (NPS) pollution is defined by the SWRCB as contamination that *does not originate from regulated point sources and comes from many diffuse sources*. NPS could occur when rainfall carries contaminants to surface water ways or percolates contaminants to groundwater. One example relevant to the Basin is loading to groundwater of nitrate from agricultural or landscaping land applications.

4.7. KEY CONSTITUENTS OF CONCERN

TDS and nitrate are the primary indicators for salt and nutrient loading and thus are key constituents of concern (COCs) for Basin management.

TDS data are available for both inflows and outflows from the Basin. There are elevated natural background TDS concentrations in groundwater. In addition, TDS can be an indicator of anthropogenic impacts (e.g., infiltration of urban runoff, agricultural return flows, and wastewater disposal).

Nitrate is the primary form of nitrogen detected in groundwater and natural nitrate levels in groundwater are generally very low. Elevated concentrations of nitrate in groundwater are associated with agricultural activities, septic systems, landscape fertilization, and wastewater treatment facility discharges. The maximum contaminant level (MCL) for nitrate (as nitrogen) is 10 mg/L. Nitrate data are available for Basin inflows and outflows, and as documented in the SNMP (WEI 2017a), elevated nitrate concentrations have been recognized. The SNMP analysis of nitrate loading found that most areas had predicted small increasing trends in nitrate in groundwater. However, no wells exceed the MCL for nitrate.

4.7.1. Key Constituents in Groundwater

TDS and nitrate are the constituents of concern in the Basin. Current average conditions (2010 through 2019) show average recent concentrations of TDS of 674 mg/L and nitrate as nitrogen concentrations of 2.75 mg/L. The values represent the average concentrations of these constituents in all drinking water and ambient groundwater monitoring events between 2010 and 2019; water quality samples from regulated facilities were not included in the analysis. These average conditions serve as a snapshot and allow a comparison of water quality conditions across the Basin.

4.7.2. Total Dissolved Solids (TDS)

As indicated above, average recent TDS concentrations in the Basin are just below the secondary MCL for drinking water (500 mg/L). Recent maximum TDS concentrations from all wells are shown on **Figure 4-12**. While recent concentrations are generally lower than 500 mg/L several historical water quality analyses from wells had higher concentrations of TDS (e.g., exceeding 500 mg/L). Based on data collected by the BCGSA agencies and Glen Ivy (a small water system) from 2010 through 2019, TDS ranges from 210 milligrams per liter (mg/L) to 1,110 mg/L. The recommended TDS secondary maximum contaminant level (SMCL) for aesthetics is 500 mg/L.

4.7.3. Nitrate as Nitrogen (NO_3 as N)

The average recent nitrate as nitrogen concentration (2.75 mg/L) is low relative to the MCL of 10 mg/L. **Figure 4-13** shows the maximum nitrate as nitrogen concentrations at each well in the Basin. Several wells in the northern portion of the Basin show elevated historical nitrate concentration of up to 24.8 mg/L. However, no current nitrate detections exceed the MCL of 10 mg/L for nitrate as nitrogen. Nitrate has multiple and widespread sources including fertilizer application (agricultural and landscaping) and wastewater disposal (both municipal and domestic). Given that these sources are on or near the ground surface, shallow groundwater typically is characterized by higher concentrations than deep groundwater.

4.7.4. Other Constituents

In 2021, the BCGSA performed a round of baseline water quality sampling for the GSP. This sampling was designed to serve as a snapshot of ambient water quality for 48 constituents, including perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). Eight wells were sampled, three in Bedford and two in Coldwater; the results of this sampling event are included in **Appendix H**. PFOS and PFOA were detectable with maximum concentration of 14 nanograms per liter (ng/L) and 25 ng/L respectively. The PFOS concentration is slightly above the response limit of 10 ng/L parts per trillion (ppt) but the PFOA concentration is below the 40 ng/L for PFOS (SWRCB 2020). The response limit for both PFOS and PFOA are based on a running four quarter average, so are not triggered by one sample.

Available water quality data indicate slightly elevated sulfate concentrations in the Basin. While historical sulfate concentrations ranged from 4 to 339 mg/L, recent samples collected in 2021 show sulfate concentrations from 110 to 270 mg/L. Concentrations in two Bedford wells were above the SMCL for sulfate of 250 mg/L but all wells were below the primary (health related) MCL of 500 mg/L. Sulfate will continue to be monitored as part of the BCGSA's monitoring program, it was not selected as a constituent of concern. The causes of elevated sulfate may be anthropogenic or naturally occurring. The anthropogenic sources of sulfate are likely from historical agricultural practices that are similar to nitrate and the natural occurrence due to geologic environment are similar to TDS. Therefore, TDS and nitrate are sufficient proxies for sulfate.

Other constituents that could impact beneficial uses or users, including arsenic, were not detected. While recent water quality data are limited, there is no indication of other constituents of concern. The BCGSA will continue to monitor water supply wells for Title 22 constituents to ensure adequate water quality in the Basin.

4.7.5. Vertical Variations in Water Quality

Water quality monitoring programs in the Basin do not show a distinct difference of water quality in depth, in part because most of the ambient monitoring wells have long screened intervals or are collected from wells with unknown construction.

4.8. SEAWATER INTRUSION CONDITIONS

The Basin is located approximately 25 miles inland from the Pacific Ocean. Lowest elevations (at the northern boundary of the Basin) are above about 1,000 feet. No risk of seawater intrusion exists in the Basin given its location.

4.9. INTERCONNECTION OF SURFACE WATER AND GROUNDWATER

Interconnection of groundwater and surface water occurs wherever the water table intersects the land surface and groundwater discharges into a stream channel or spring. These stream reaches gain flow from groundwater and are classified as gaining reaches. Conversely, connection can occur along stream reaches where water percolates from the stream into the groundwater system (losing reaches), provided that the regional water table is close enough to the stream bed elevation that the subsurface materials are fully saturated along the flow path.

Groundwater pumping near interconnected surface waterways or springs can decrease surface flow by increasing the rate of percolation from the stream or intercepting groundwater that would have discharged to the stream or spring. If a gaining stream is the natural discharge point for a groundwater basin, pumping anywhere in the basin can potentially decrease the outflow, particularly over long time periods such as multi-year droughts.

Because of the long dry season that characterizes the Mediterranean climate in Riverside County, vegetation exploits any near-surface water sources, including the water table along perennial stream channels, the wet soil areas around springs, and areas where the water table is within the rooting depth of the plants. Plants that draw water directly from the water table are called phreatophytes. They are able to continue growing vigorously during the dry season and typically stand out in summer and fall aerial photographs as patches of vegetation that are denser, taller, and brighter green than the adjacent vegetation.

4.9.1. Stream Flow Measurements

Three USGS streamflow gaging stations provide a general characterization of the stream flow regime in Temescal Wash and its tributaries. Their locations are shown in **Figure 4-14**, and daily flows during water years 2013 through 2020 are shown in **Figure 4-15**. Temescal Creek at Corona Lake (USGS 11071900) is located at the outlet of Lee Lake at the upstream end of the Basin. Flow at that location is primarily ephemeral, occurring only during and immediately following rainstorm events. No flow was recorded for three consecutive years during the recent drought. However, the gage also records recycled water discharges from Eastern Municipal Water District (EMWD), which historically have often been large enough to flow down Temescal Wash as far as Lee Lake. Those discharges were more common prior to the period of gaged flows but still occur in wet years when EMWD is unable to use or store all of its recycled water.

The gauge on Coldwater Canyon Creek has only been in operation for one year, and it is the only record of flow in any drainage on the eastern slopes of the Santa Ana Mountains. The flow regime includes high peaks during storm events and small but persistent base flow supported by drainage of groundwater from fractured bedrock in the watershed. These small flows rapidly percolate where the creek enters the Basin and do not reach Temescal Wash. All of the tributary watersheds on the west side of the Basin likely have similar flow regimes. The gauge above Main Street in Corona experiences many more peak flow events. Most of these additional flow events probably derive from impervious runoff in the surrounding urban area. A steady base flow of about 2 cubic feet per second (cfs) is not groundwater discharge, but so-called nuisance water (for example, sprinkler overspray onto paving, or pipe leaks) plus discharge from the wastewater treatment plant upstream of the gauge.

A review of 27 high-resolution aerial photographs (Google Earth 2021) between 1994 and 2020 did not reveal any reaches of Temescal wash that appeared to have groundwater discharge; that is, flowing or ponded reaches in an otherwise dry channel during the dry season. Thus, the reach of Temescal Wash that passes through the Bedford-Coldwater Basin does not appear to gain flow from groundwater seepage into the channel, at least during the dry season. Water levels in wells near the creek further suggest that the water table is usually below the creek bed elevation. Data showing depth to the water table are discussed in the next section.

4.9.2. Depth to Groundwater

Depth to groundwater provides a general indication of locations where gaining streams and riparian vegetation are likely to be present. However, available data are of limited use for this purpose due to insufficient geographic and vertical coverage. Available data are almost entirely from water supply wells, which are typically screened deep in the aquifer. The groundwater elevation (potentiometric head) at the depth of the well screen can be different from the true water table, which is the first zone of saturation reached when drilling down from the ground surface. Because recharge occurs at the land surface and pumping occurs at depth, deep alluvial basins such as this one typically have large downward head gradients within the aquifer system. Thus, water level information from wells can potentially underestimate the locations where the water table is shallow enough to support phreatophytic riparian vegetation.

Creeks and rivers that lose water commonly form a mound in the water table near the creek or river. The height and width of the mound depends on the transmissivity of the shallowest aquifer. As an example, in other basins where this condition is observed, groundwater elevations in a shallow well adjacent to the Arroyo Seco in the Salinas Valley California rose 5 to 10 feet more than groundwater elevations in wells 1,000 feet away when the river started flowing (Feeney 1994). A groundwater ridge up to 12 feet high develops beneath Putah Creek in Yolo County California during the flow season, but the width of this ridge was estimated to be only a few hundred feet (Thomasson et al. 1960). These examples suggest that shallow wells within 100 to 200 feet of a stream channel would be needed to confirm the presence of hydraulic connection between surface water and groundwater in the Bedford-Coldwater Basin.

Groundwater does not discharge into streams unless the water table is equal to or higher than the elevation of the stream bed. In addition, the water table does not provide water to phreatophytic vegetation unless it is at least as high as the base of the root zone. The depth of the root zone is uncertain, partly because the relatively few studies of rooting depth have produced inconsistent results and partly because rooting depth for some riparian species is facultative. This means that the plants will grow deeper roots if the water table declines. Many species (including cottonwood and willow) germinate on moist soils along the edge of a creek in spring. As the stream surface recedes during the first summer, the seedlings survive if the roots grow at the same rate as the water-level decline. Over a period of years, roots grow deeper as the land surface accretes from sediment deposition and/or the creek channel meanders away from the young tree or shrub.

Available water level data from wells were reviewed to identify parts of the Basin where the water table elevation might possibly be high enough to be reached by phreatophyte roots. For screening purposes, a depth to water of less than 30 feet in wells was selected as a threshold for identifying possible phreatophyte areas. This depth allows for 10 to 15 feet of root depth, 5 feet of elevation difference between the water level in the well and the overlying true water table, and 15 feet of elevation difference between well heads and the bottoms of nearby creek channels.

A second limitation of available groundwater elevation data is the sparse geographic distribution of wells with measurements. Fortunately, many wells in the Basin with water-level data are located along Temescal Wash. **Figure 4-16** shows a map of the eleven wells with relatively long-term water-level records. They are clustered into five areas. The only location where the typical spring depth to water was less than 30 feet was at the north end of the Basin, near the Flagler and Corona Non-Potable wells. Hydrographs of water levels in those wells are shown in **Figure 4-17**. Typical spring depths to water in the five wells in that area ranged from 15 to 27 feet. Slightly farther upstream—at the TVWD wells—typical depths to water were slightly greater than 30 feet. Depth to water increases rapidly to the west of Temescal Wash. At the Corona and Station 71 wells, the typical depth to water was 80 to 200 feet.

In summary, groundwater levels in the Basin appear to be too low to normally maintain a hydraulic connection with the Temescal Wash channel. Therefore, groundwater pumping does not deplete flow in Temescal Wash. Groundwater levels might be high enough to support phreatophytic riparian vegetation with roots extending 10-15 feet below the elevation of the creek bed.

4.9.3. Riparian Vegetation

Vegetation data provide mixed evidence that the water table near some reaches of Temescal Wash is shallow enough to supply water to phreatophytes. Where tree and shrub roots are able to reach the water table, riparian vegetation is typically denser and greener than along reaches where vegetation is supplied only by residual soil moisture from the preceding wet season. Patches of dense riparian vegetation visible in multiple Google Earth (2021) aerial photographs from 1994-2014 are indicated by a crosshatch pattern in **Figure 4-16**. However, older and more recent aerial photographs indicate that the vegetation has not been a permanent feature of the landscape. The figure also shows the distribution of vegetation classified as Natural Communities Commonly Associated with Groundwater (NCCAG) by The Nature Conservancy in cooperation with DWR. Based on multiple historical vegetation surveys from the early 2000s, the Nature Conservancy prepared detailed statewide mapping of NCCAG vegetation that is accessible on-line (DWR et al. 2020). The extent of NCCAG vegetation is much greater than the extent of dense riparian vegetation and includes vegetation where the water table is certainly deeper than the root zone (such as near the Corona wells). Thus, some of the vegetation in the NCCAG polygons is probably not relying on groundwater. Furthermore, some of the plant species included in the NCCAG mapping are facultative phreatophytes, which means they will exploit a water table if it is within a reachable depth but otherwise survive on soil moisture (typically with smaller stature and greater spacing between plants). These species include red willow (*Salix* laevigata), which is the most common species mapped along Temescal Wash.

An additional test for groundwater dependence of riparian vegetation was to compare changes in groundwater elevation with changes in vegetation health during the 2012 to 2015 drought. Vegetation health can be detected by changes in the way the plant canopy absorbs and reflects light. The spectral characteristics of satellite imagery can be processed to obtain two metrics commonly used to characterize vegetation health: the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Moisture Index (NDMI). Both are calculated as ratios of selected visible and infrared light wavelengths. The Nature Conservancy developed a second on-line mapping tool called GDE Pulse that provides annual dry-season averages of NDVI and NDMI for each mapped NCCAG polygon for 1985-2018 to assist with the identification of groundwater dependent ecosystems (GDEs) (TNC 2020). In **Figure 4-16**, the polygons are color-coded by the change in NDMI from 2012 to 2015, with positive values in increasingly dark shades of green and negative values in increasingly dark shades of red. Negative values indicate stress due to desiccation. The NDVI patterns were similar to the NDMI patterns.

Inconsistencies are immediately apparent. One would expect all of the polygons to have experienced moisture stress during the drought, but about one-third of them experienced little stress. In some cases, an unstressed polygon adjoins a highly stressed polygon, which would be unlikely if declining groundwater levels were the cause of the stress. In spite of these inconsistencies, the dominant pattern was a decrease in NDMI. This was notably the case for the red willow patch that occupies roughly the northern third of the Temescal Wash reach in the Basin.

Further evidence of drought stress can be seen directly in aerial photographs. **Figure 4-18** shows Google Earth (2021) photos of a reach adjacent to the golf course located about 1,000 feet upstream of the Corona Non-Potable wells. Photographs of the same location in 2012, 2014 and 2016 are shown. There was little apparent change from 2012 to 2014, but by 2016 many of the trees along the central channel appeared to be dead.

Water levels in wells with relatively shallow depth to water declined 15 to 25 feet during 2012 to 2015, albeit unevenly in some wells. Thus, the declining NDMI values and substantial vegetation mortality both occurred during the same period that groundwater levels declined. Notably, most of the water-level decline was between 2014 and 2016, which was the period when most of the vegetation mortality occurred. The correlation between groundwater levels and vegetation health does not necessarily prove causality, because other sources of water also became more scarce, including rainfall, irrigation return flow and wastewater discharges to Temescal Wash upstream of the site in the photograph. Rainfall at Elsinore during water years 2013 through 2016 averaged 5.96 inches, or 56 percent of the long-term average. The greater abundance of brown areas on the golf course fairways in 2016 relative to 2014 and 2012 suggest that irrigation had been curtailed due to the drought. The TVWD wastewater treatment plant located two miles upstream of the photo site, at the upstream end of the patch of dense riparian vegetation, normally discharges about 15 acre-feet per month (equivalent to 0.25 cfs) of treated wastewater to Temescal Wash, as shown in **Figure 4-19**. Those discharges were discontinued from November 2012 through at least November 2018 except for one three-month period in winter 2015. The normal discharge could supply roughly one-third of the summer evapotranspiration (ET) demand of the entire reach of vegetation between the discharge point and the end of the Basin.

Older historical aerial photographs show that dense riparian vegetation was not always present prior to the 1990s (that is, prior to the Google Earth imagery). **Figure 4-20** shows aerial photographs taken in 1967 of a 2-mile reach of Temescal Wash in the northern part of the Bedford-Coldwater Basin. It includes the area shown in **Figure 4-18** (green rectangle). There was almost no dense riparian vegetation anywhere along the Wash in 1967. Two factors probably contributed to the lack of vegetation. First, precipitation had been consistently below average since 1947 (see additional discussion in **Chapter 5**). Second, groundwater pumping was higher in those days to support irrigation of citrus groves (some of which are visible in the photograph). Pumping from the Bedford area averaged 3,000 acre-feet per year (AFY) during 1947 to 1967 (WEI 2015b) versus 1,800 AFY during 2015 to 2019. Both of these factors probably contributed to low surface flow and low groundwater levels, which together killed any prior dense riparian vegetation or prevented such vegetation from becoming established.

In summary, the extent, density and health of riparian vegetation has been variable historically. Vegetation appears to become denser and lusher when surface flow is more abundant and groundwater levels are consistently shallow, and it dies back during droughts and when groundwater levels are low. At any given time, the extent to which riparian vegetation along some reaches of Temescal Wash is phreatophytic and therefore affected by groundwater levels is unclear. The presence of groundwater elevations that are probably within reach of phreatophyte roots, the presence of patches of dense riparian tree canopy, and the co-occurrence of groundwater declines and vegetation stress and mortality within the past decade all suggest that some vegetation is dependent on groundwater. However, other drought-related decreases in water availability could have contributed to the observed impacts on vegetation. Additional information regarding the true water table depth in the riparian zone and a more comprehensive evaluation of rainfall, irrigation, and wastewater discharge time series is needed to confirm the degree of vegetation dependence on groundwater levels.

4.9.4. Wetlands

The NCCAG vegetation mapping tool also includes a wetlands map, which is reproduced here with simplified mapping categories in **Figure 4-21**. In the Bedford-Coldwater Basin, almost all of the wetland polygons are within the Temescal Wash channel and accounted for in the preceding discussion of riparian vegetation. The wetland categories for those polygons are mostly marsh (palustrine) or riverine and characterized as seasonally flooded. Vegetation along the low-flow channel is classified as permanently or semi-permanently flooded, which a brief inspection of aerial photographs shows is clearly incorrect. A handful of small wetland polygons were mapped in upland areas west of Temescal Wash. Most are high up in the stream canyons where perennial stream flow or shallow groundwater is sustained by small amounts of groundwater inflow from the bedrock tributary areas and not affected by pumping in the main part of the Basin. Several patches totaling 1.4 acres are midway between the wash and western Basin boundary, where regional groundwater levels are many tens of feet below the ground surface. The seasonal flooding or saturation that supports the wetland-type vegetation almost certainly derives from pooled rainfall runoff or interflow rather than discharge of regional groundwater.

The Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) was reviewed for additional information regarding plant species that might be affected by groundwater (Western Riverside County Regional Conservation Authority 2020). Two large regions mapped as *narrow endemic plants* and *criteria area species* partially overlap the Basin. However, those categories together contain 16 upland plant species that are unaffected by groundwater.

Therefore, the few small areas mapped as wetlands outside the Temescal Wash channel would not be affected by pumping and groundwater levels.

4.9.4.1. Animals Dependent on Groundwater

Animals that depend on groundwater include fish and other aquatic organisms that rely on groundwater-supported stream flow and amphibious or terrestrial animals that lay their eggs in water. Management of habitat for animals typically focuses on species that are listed as threatened or endangered under the state or federal Endangered Species Acts. That convention is followed here. Flow in Temescal Wash is too ephemeral to support migration of anadromous fish (such as steelhead trout), and the watershed upstream of the Basin does not have stream reaches with perennial cool water suitable for spawning and rearing.

The MSHCP includes mapped areas that are potential habitat for several animal species. The western edge of a very large habitat area for burrowing owl overlaps the eastern edge of the Basin. However, the owl is an upland species that is not dependent on riparian or wetland vegetation.

The coastal California gnatcatcher is a bird species federally listed as threatened. Critical habitat areas delineated by the U.S. Fish and Wildlife Service that are in or near the Basin are shown in **Figure 4-22**. The habitat polygons are all in upland areas, but a few of them overlap tributary streams underlain by narrow, shallow alluvial bodies that extend outward from the main Basin area. Groundwater in those tributary creek valleys is sustained by gradual discharge from fractured bedrock in the watershed areas, and there is little or no local groundwater pumping. To the extent that vegetation along the tributary stream valleys provides gnatcatcher habitat, it would be unaffected by pumping in the main Basin area.

In summary, there do not appear to be any listed animal species that would potentially be impacted by groundwater pumping or water levels. More common species that use riparian shrubs and trees along Temescal Wash could potentially be impacted during droughts if lowered groundwater levels cause vegetation die-back or mortality.

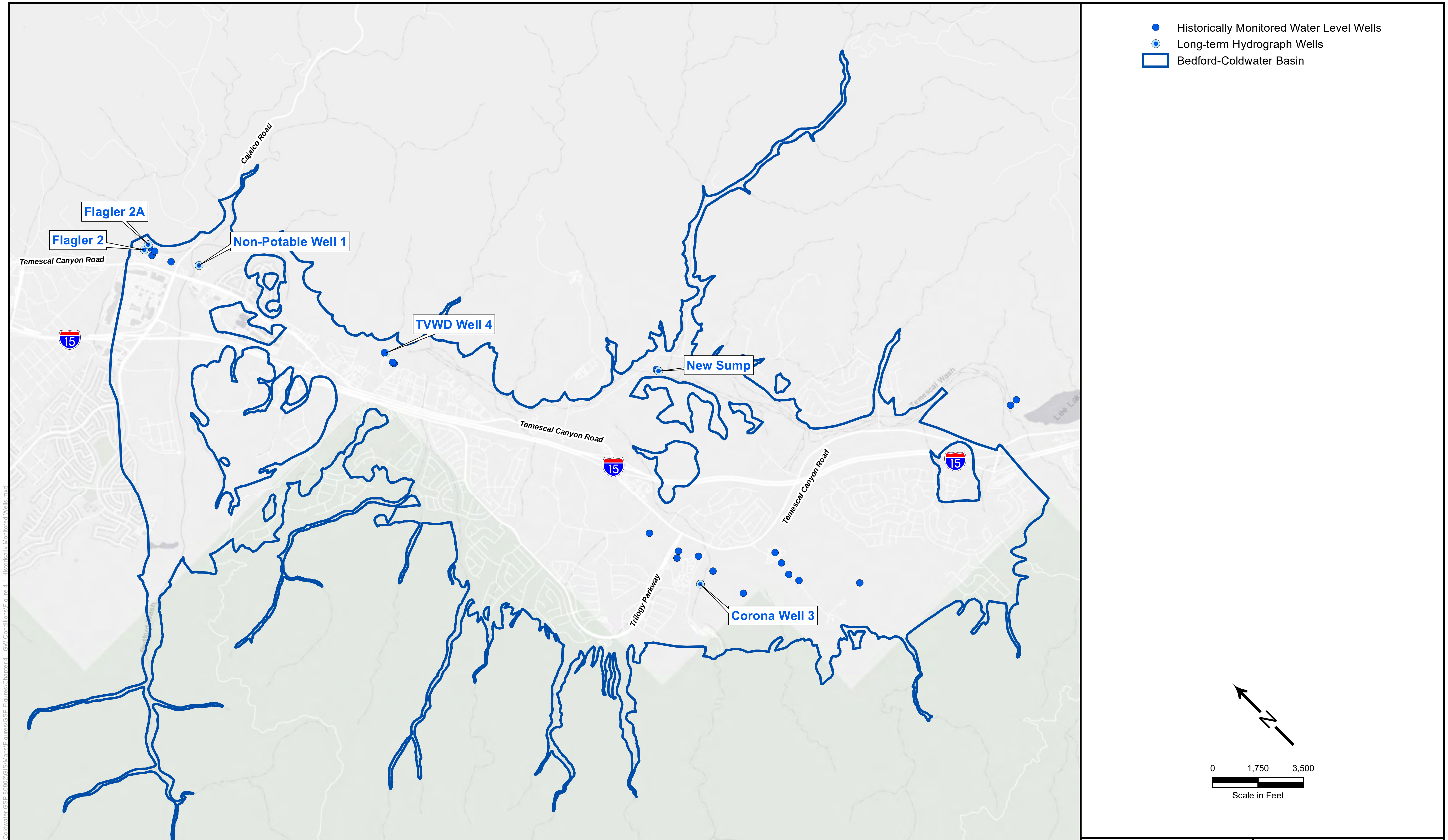
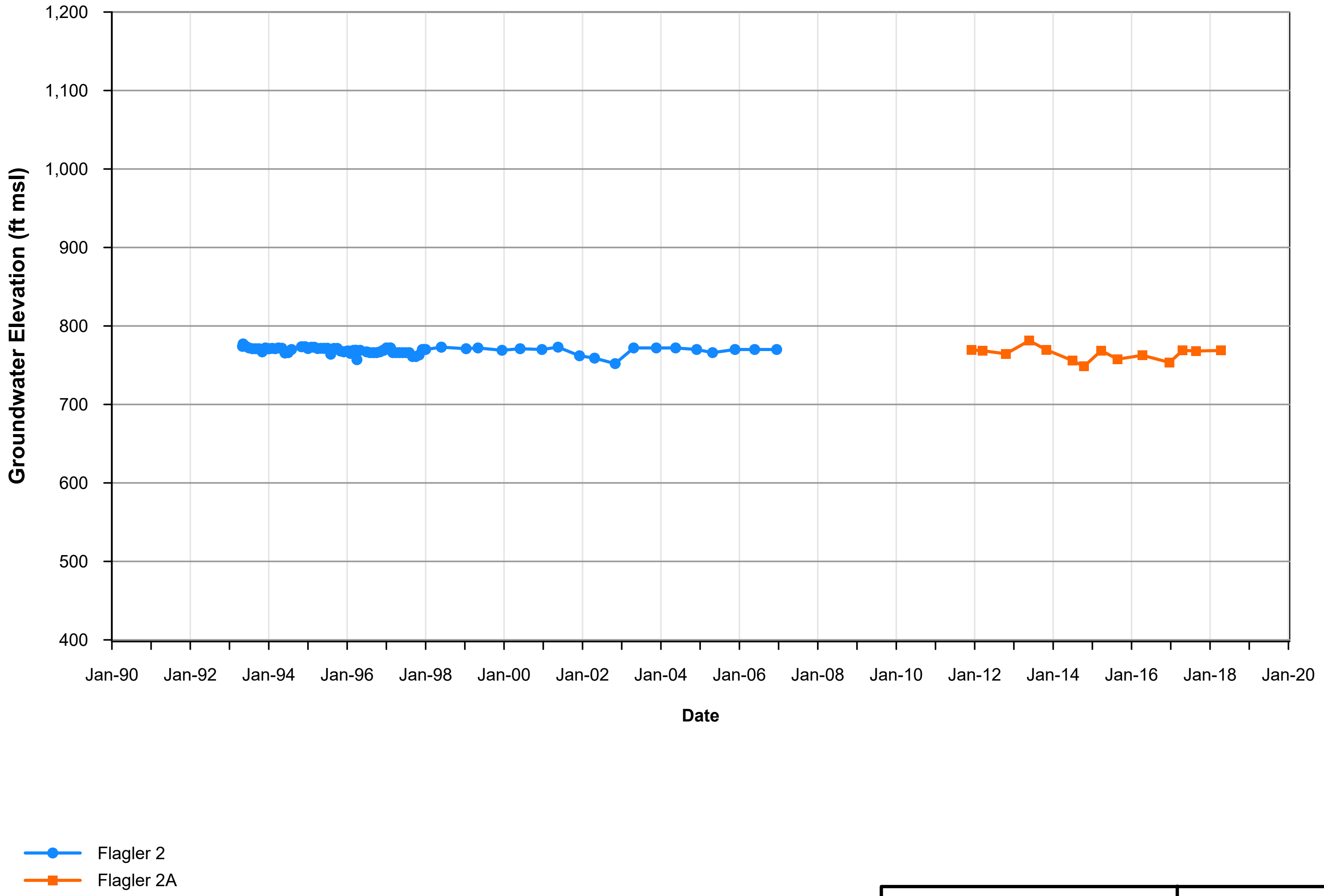


Figure 4-1
Historically
Monitored Wells

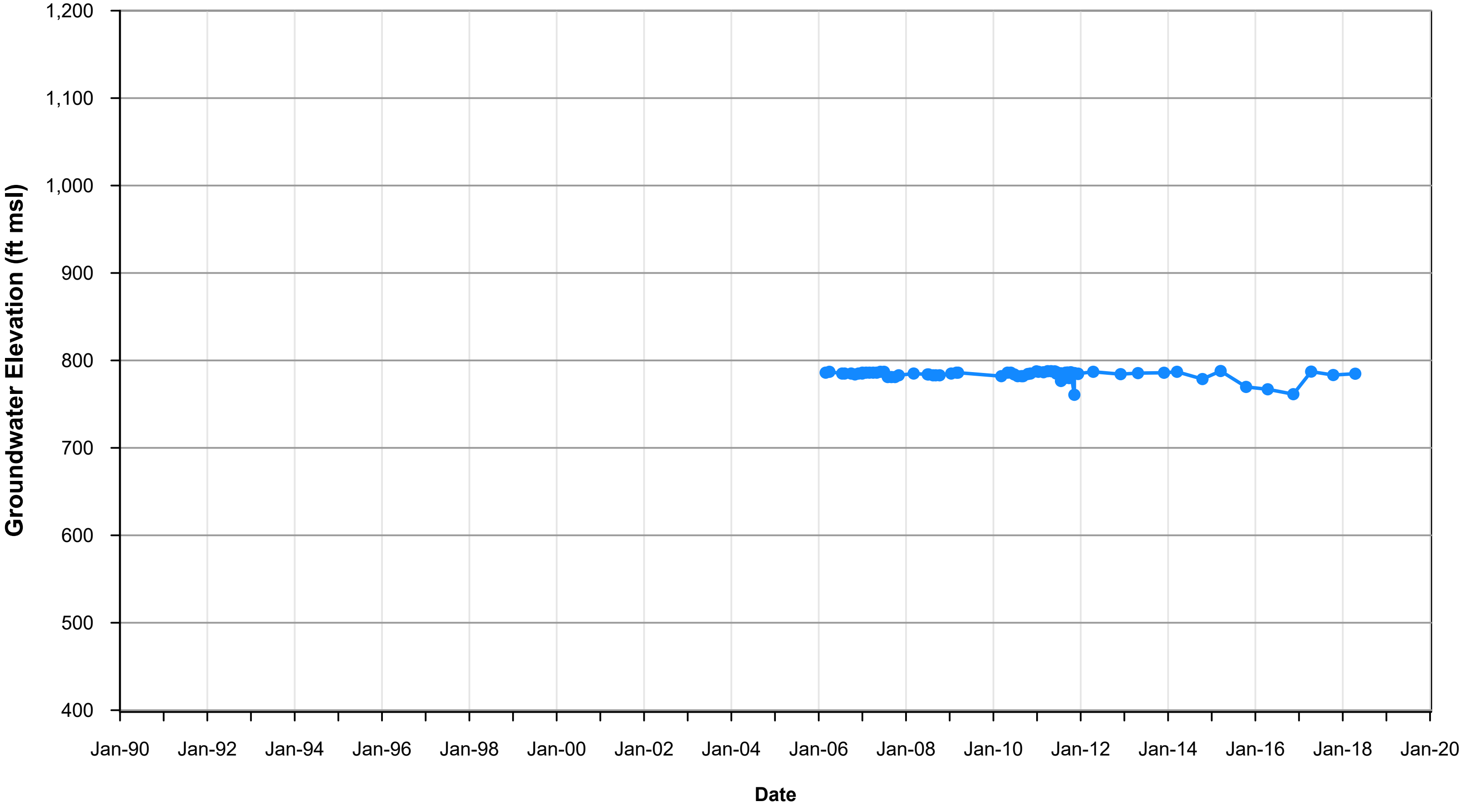
Path: T:\Projects\Bedford Coldwater GSP 80802\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-1 Historically Monitored Wells.mxd



Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 4-2 Flagler 2_2A Hydrographs.grpj

TODD GROUNDWATER

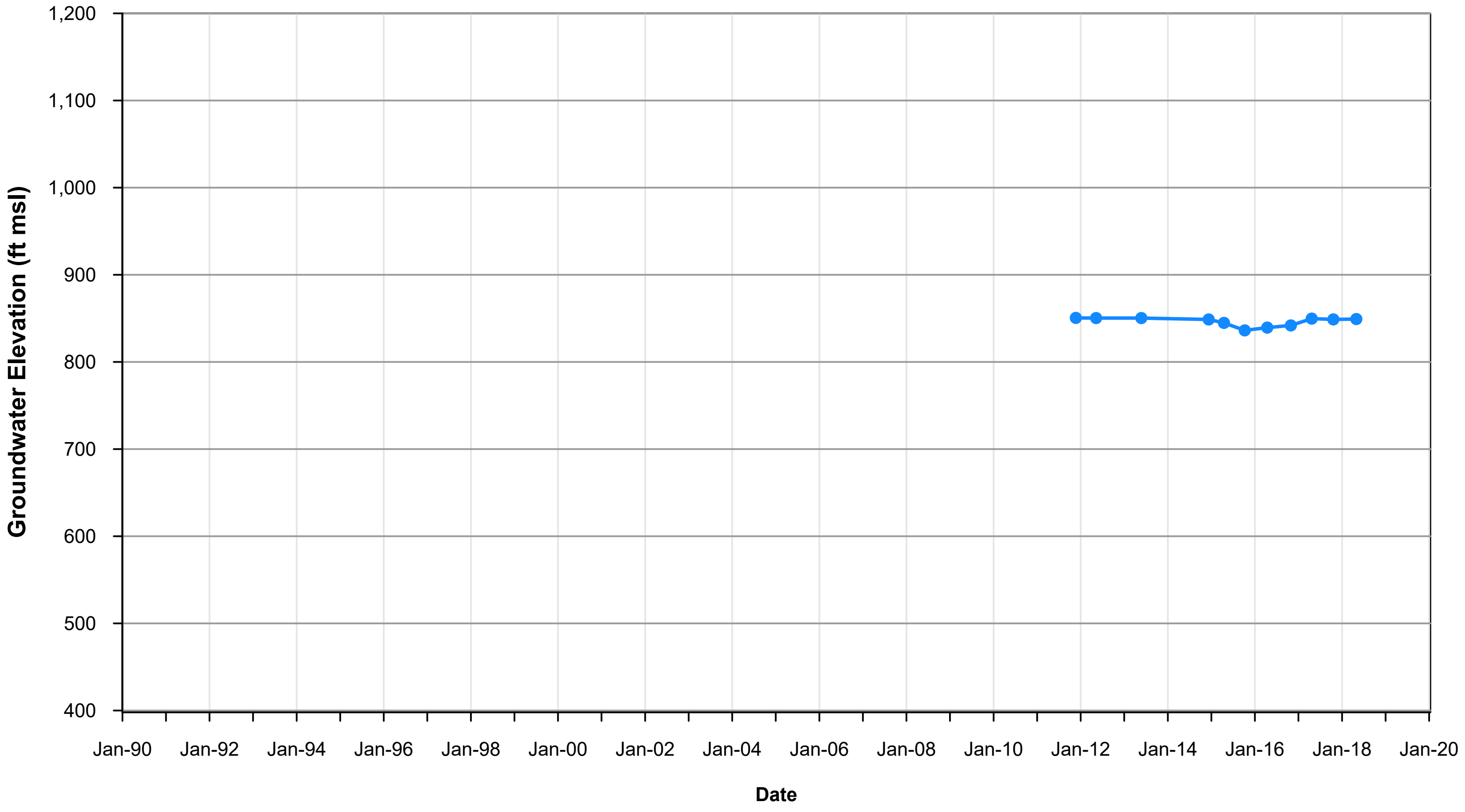
Figure 4-2
Representative
Hydrographs
Flagler Wells 2 and 2A



Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 4-3 Non-Potable Well 1 Hydrograph.gpj

TODD GROUNDWATER

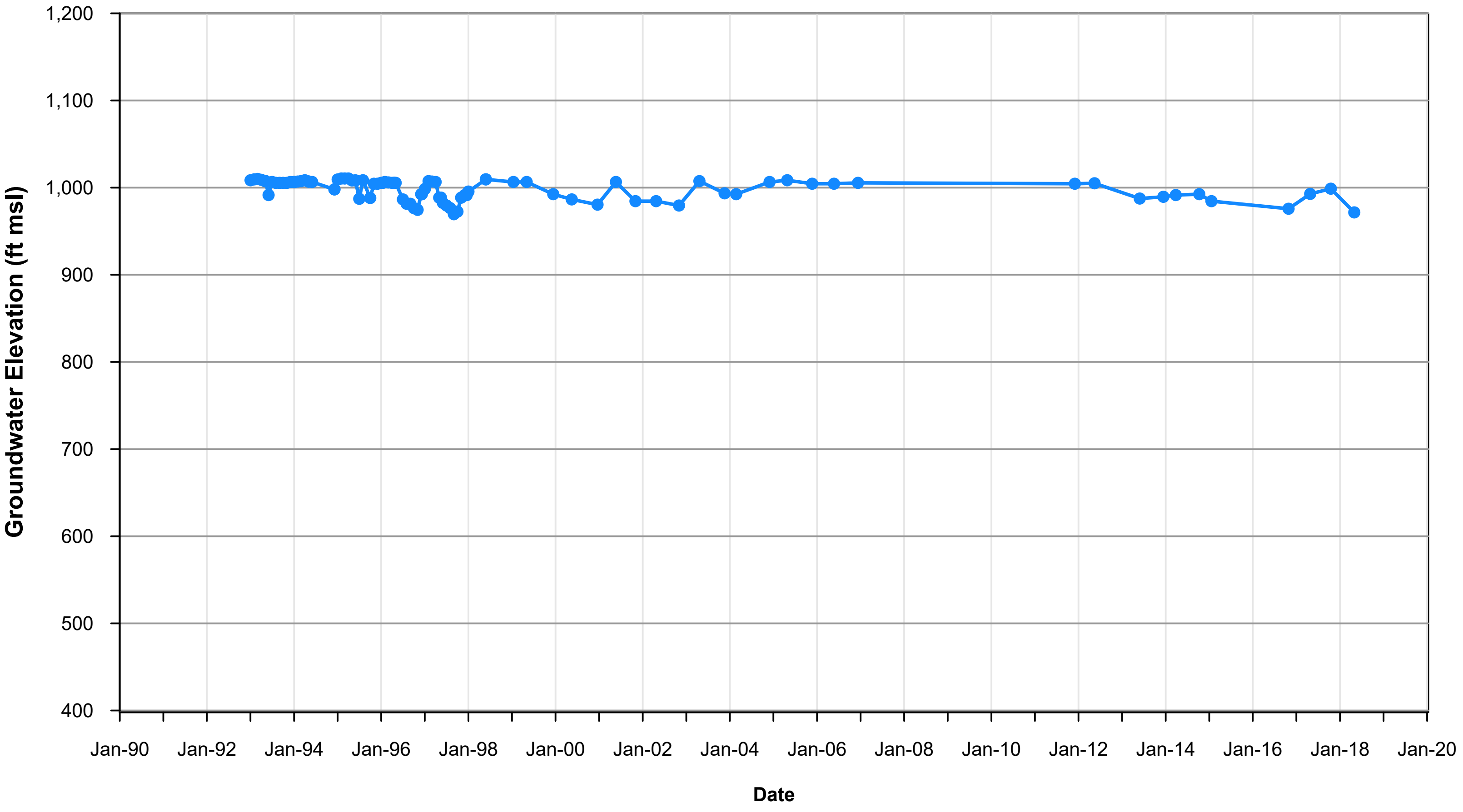
Figure 4-3
Representative Hydrograph Non-Potable Well 1



TODD GROUNDWATER

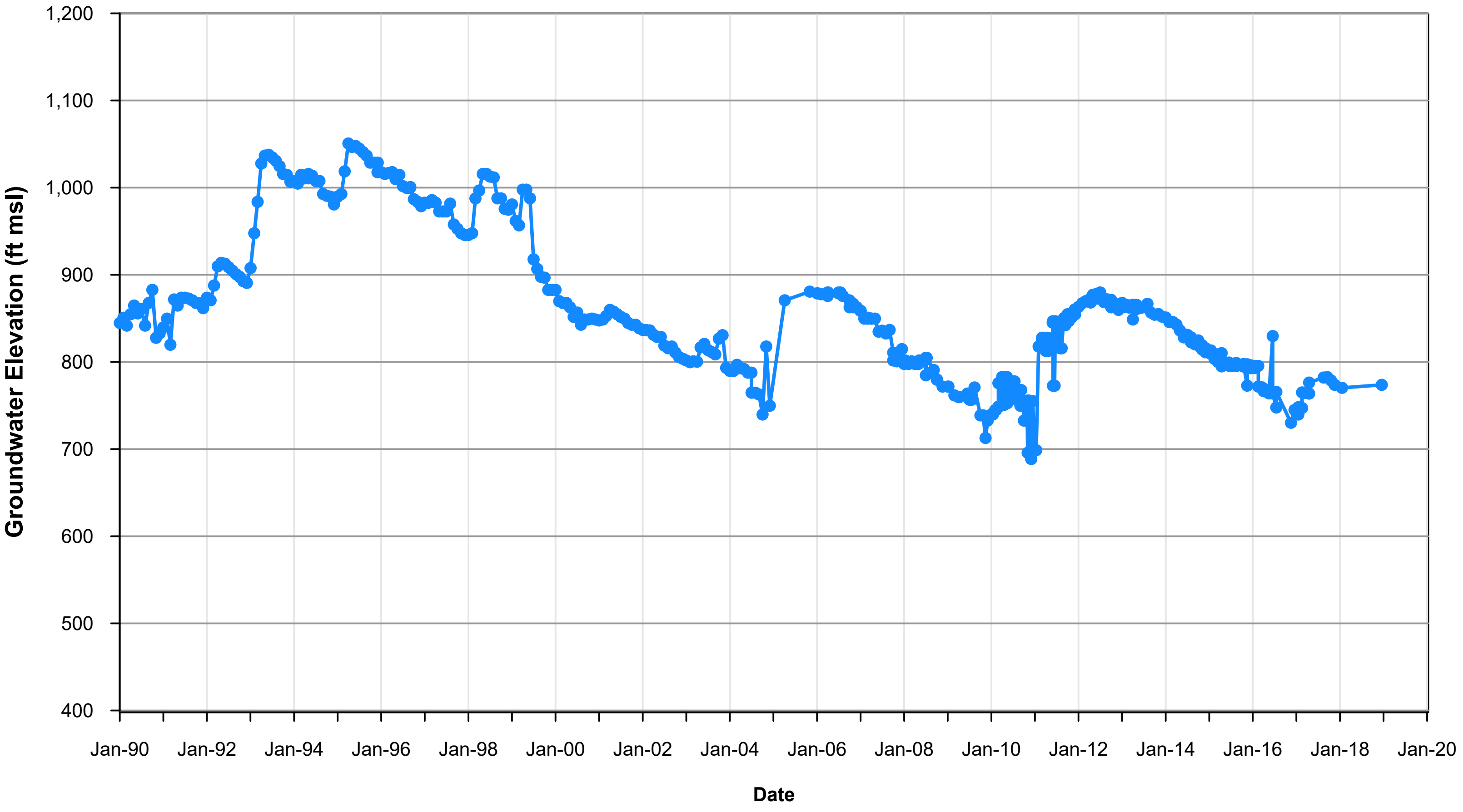
Figure 4-4
Representative
Hydrograph
TVWD Well 4

Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 4-4 TVWD Well 4 Hydrograph.gpj



TODD GROUNDWATER

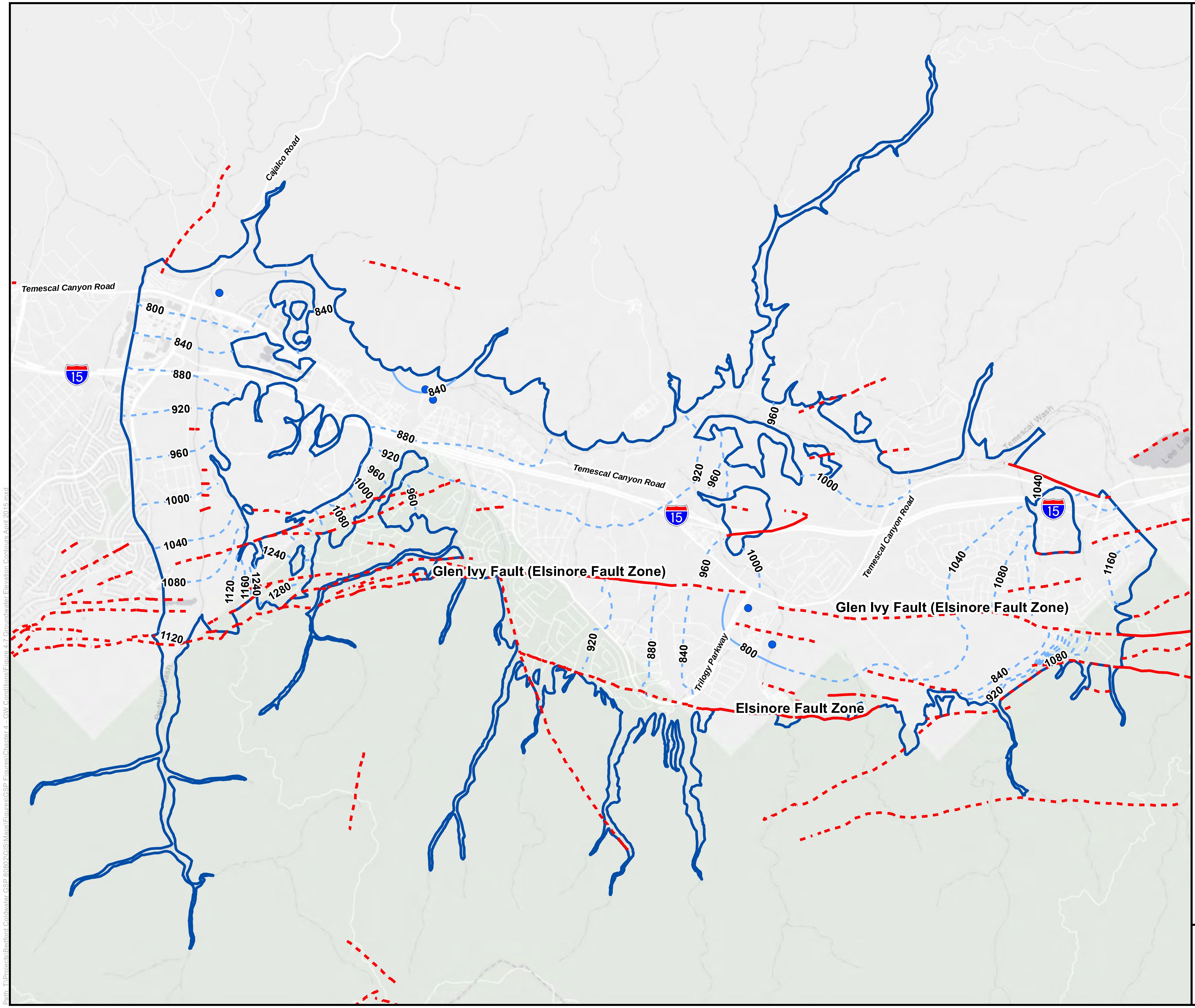
Figure 4-5
Representative
Hydrograph
New Sump



Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 4-6 Corona Well 3 Hydrograph.gpj

TODD GROUNDWATER

Figure 4-6
Representative
Hydrograph
Corona Well 3



- ● Monitored Wells, Fall 2015
- 40-foot groundwater elevation contour, feet above msl, dashed where uncertain
- Fault Location, dashed where uncertain
- ▭ Bedford-Coldwater Basin

N

0 1,750 3,500

Scale in Feet

TODD GROUNDWATER

Figure 4-7
Groundwater
Elevation Contours
Fall 2015

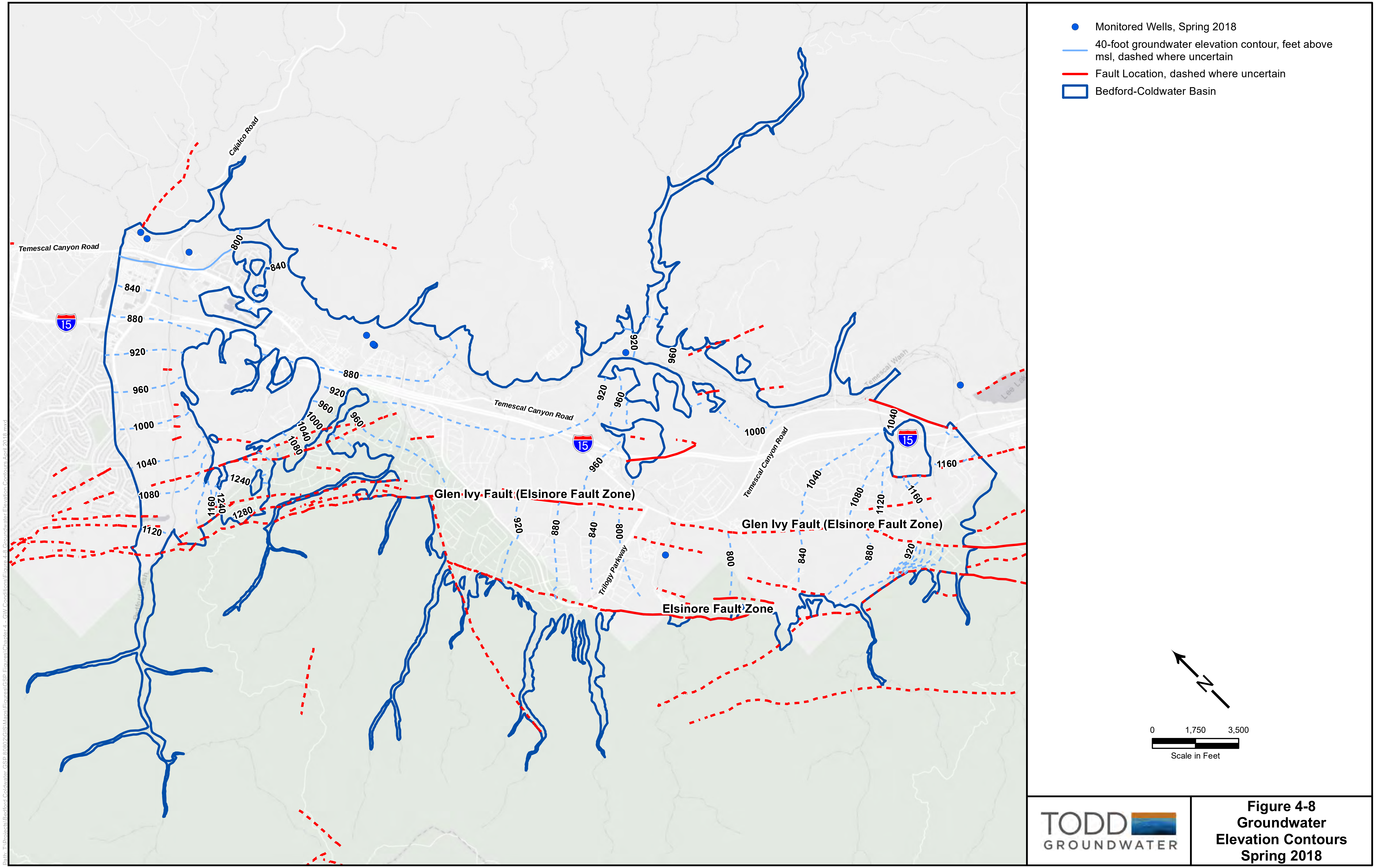
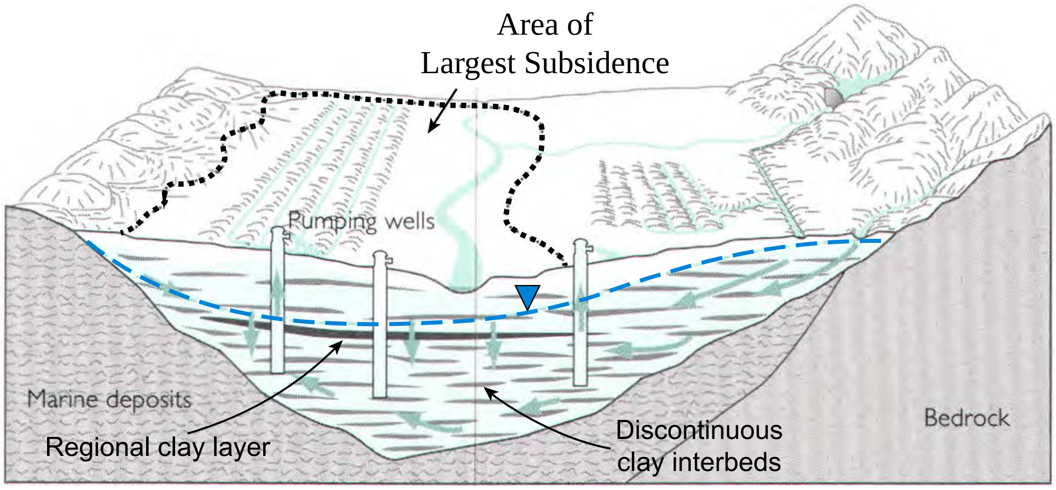
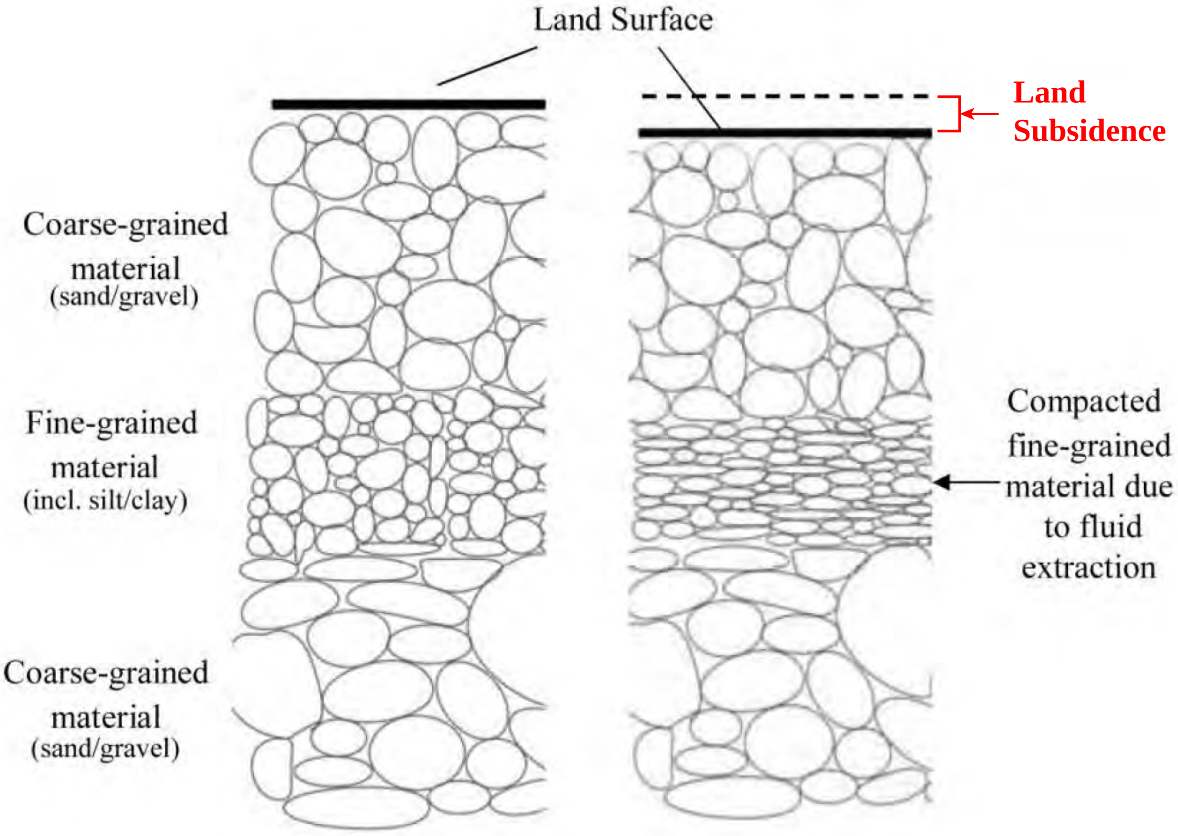


Figure 4-8
Groundwater Elevation Contours
Spring 2018



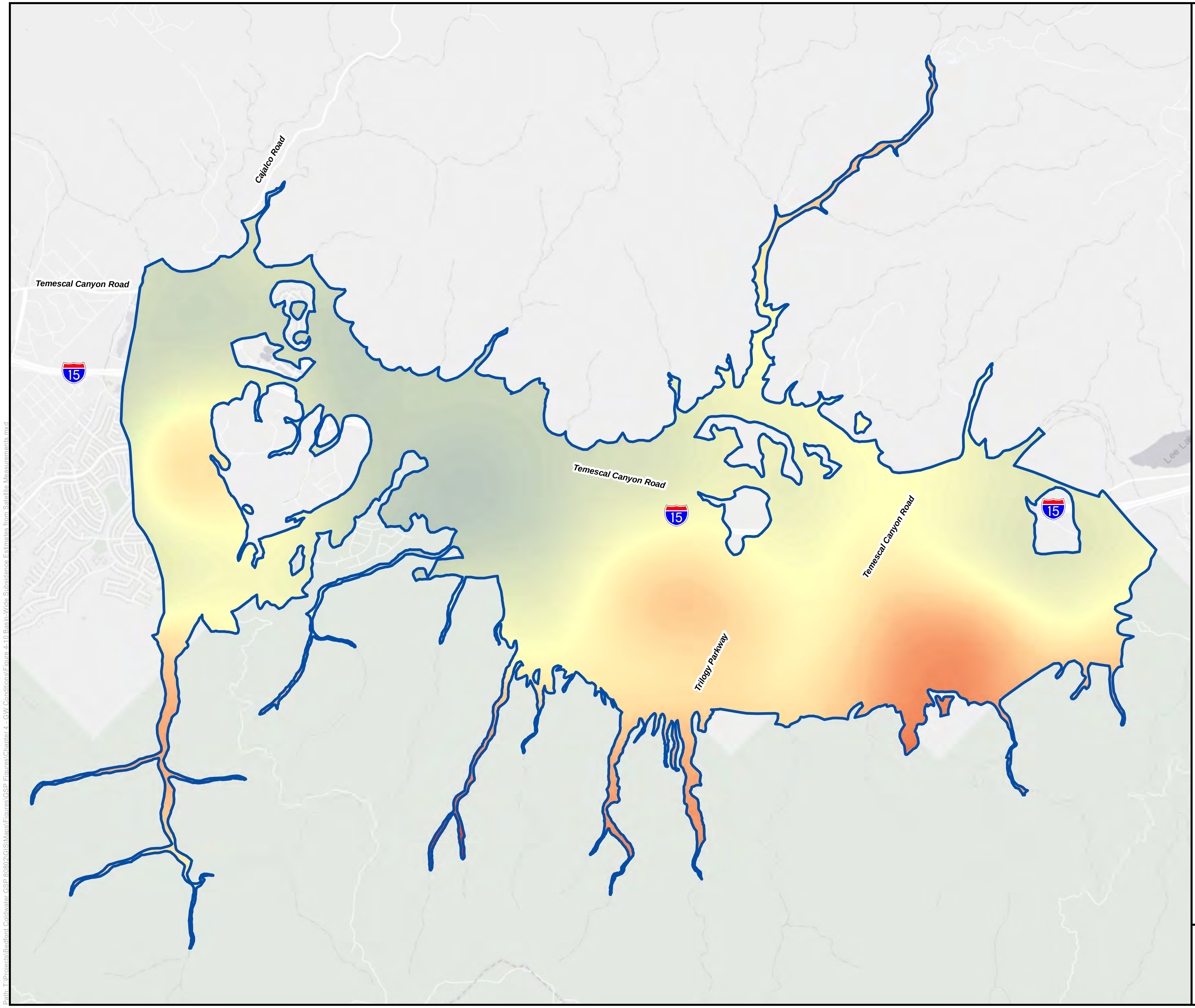
Source: Galloway et al., 1999.



After LSCE et al., 2014.

TODD GROUNDWATER

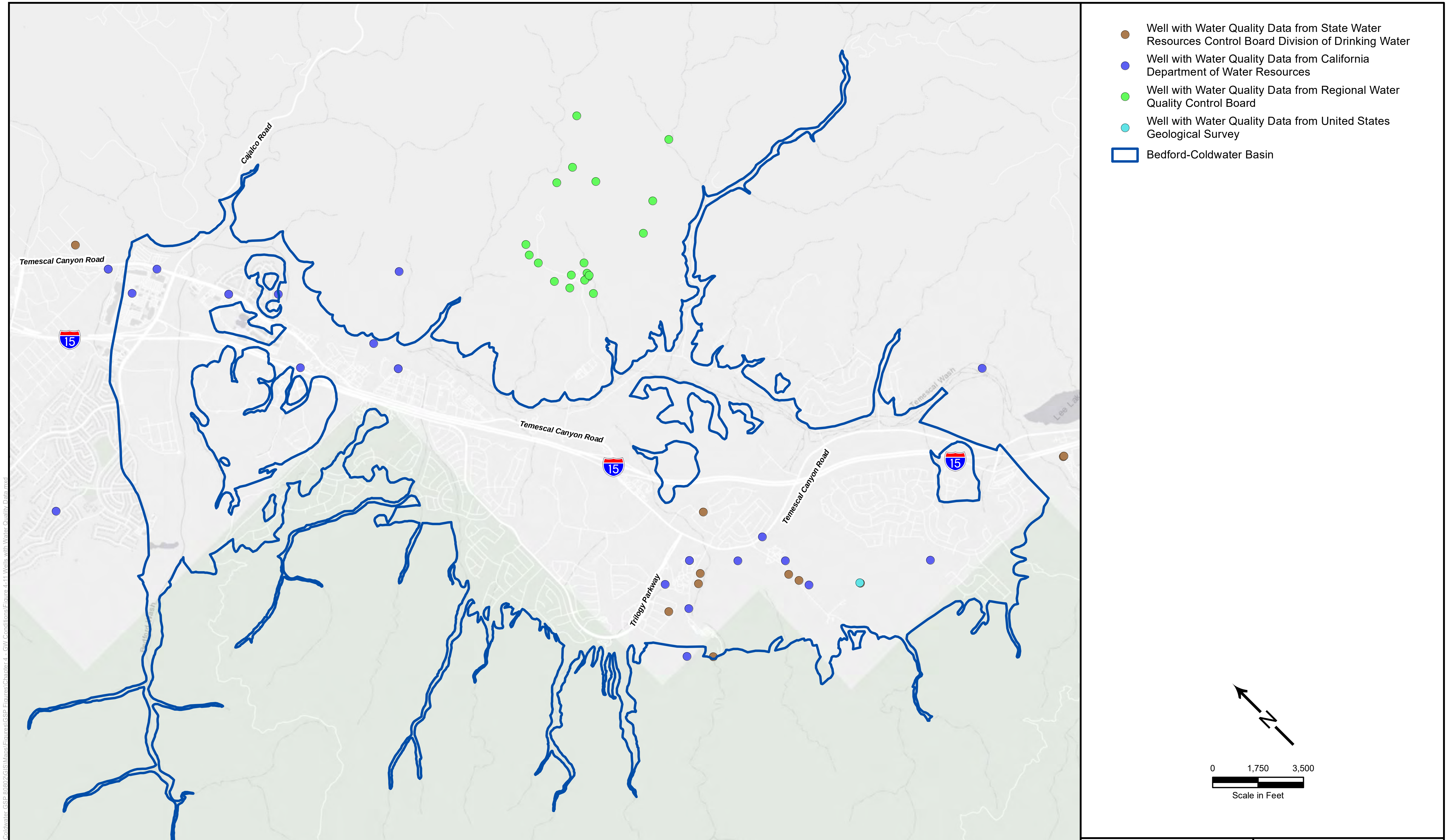
Figure 4-9
Concepts of
Land Subsidence



Data Source:
Subsidence estimates from satellite measurements provided by the TRE ALTAMIRA InSAR provided by the California Department of Water Resources.

TODD GROUNDWATER

Figure 4-10
Basin-Wide Subsidence Estimates from Satellite Measurements



TODD GROUNDWATER

Figure 4-11
Wells with
Water Quality Data

Path: T:\Projects\Bedford Coldwater GSP 80802\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-11 Wells with Water Quality Data.mxd

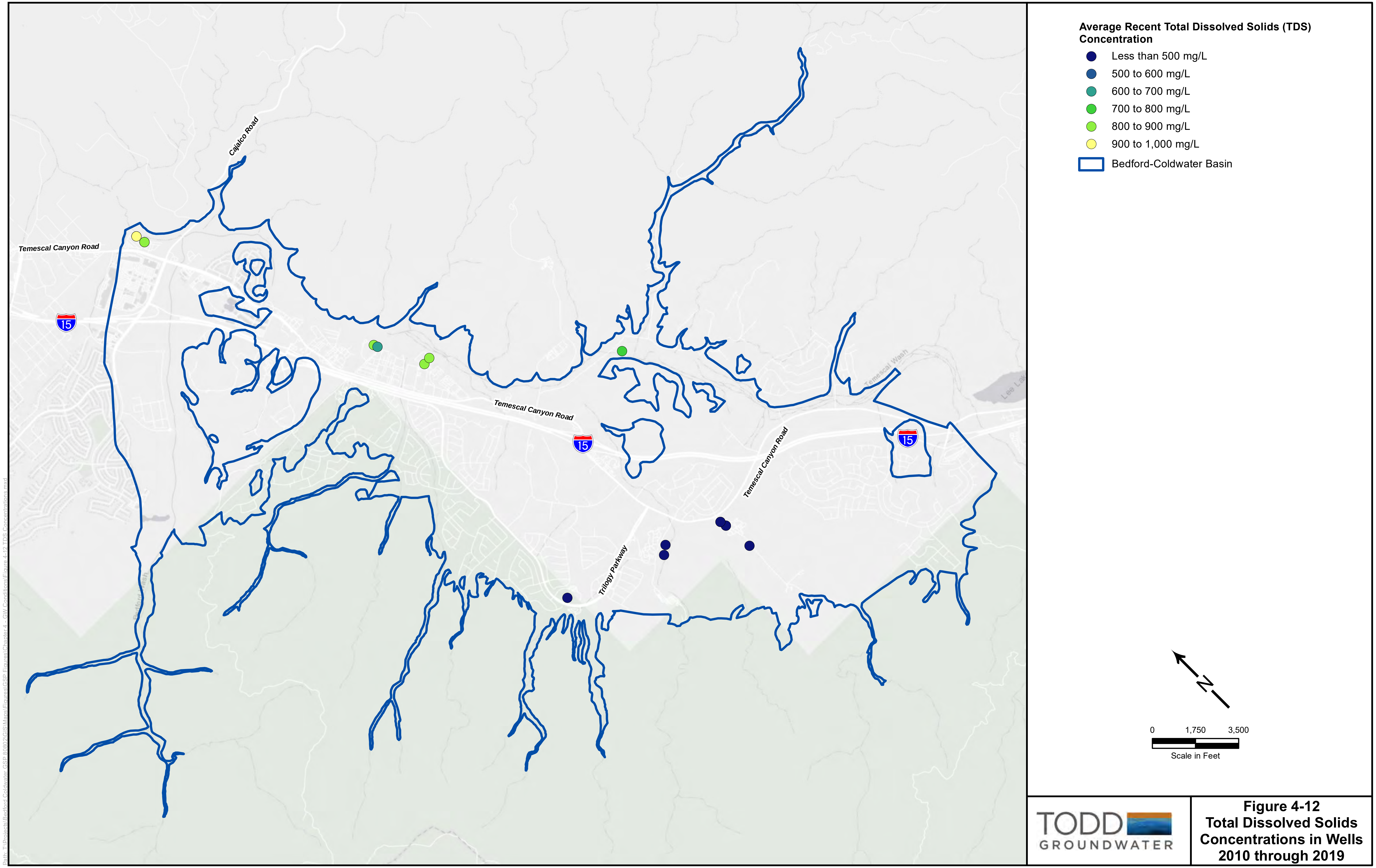


Figure 4-12
Total Dissolved Solids Concentrations in Wells
2010 through 2019

Path: T:\Projects\Bedford Coldwater GSP 80802\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-12 TDS Concentrations.mxd

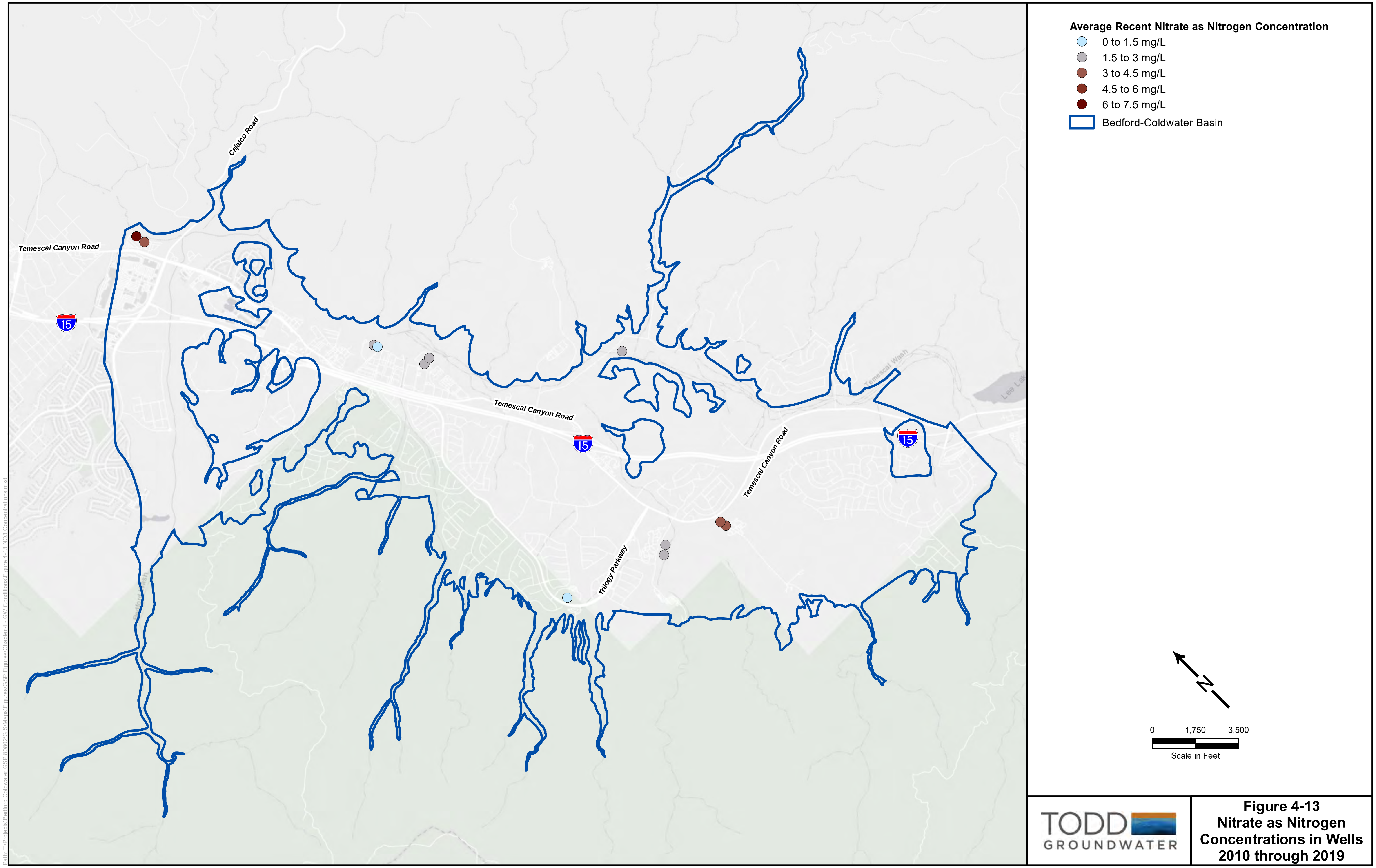
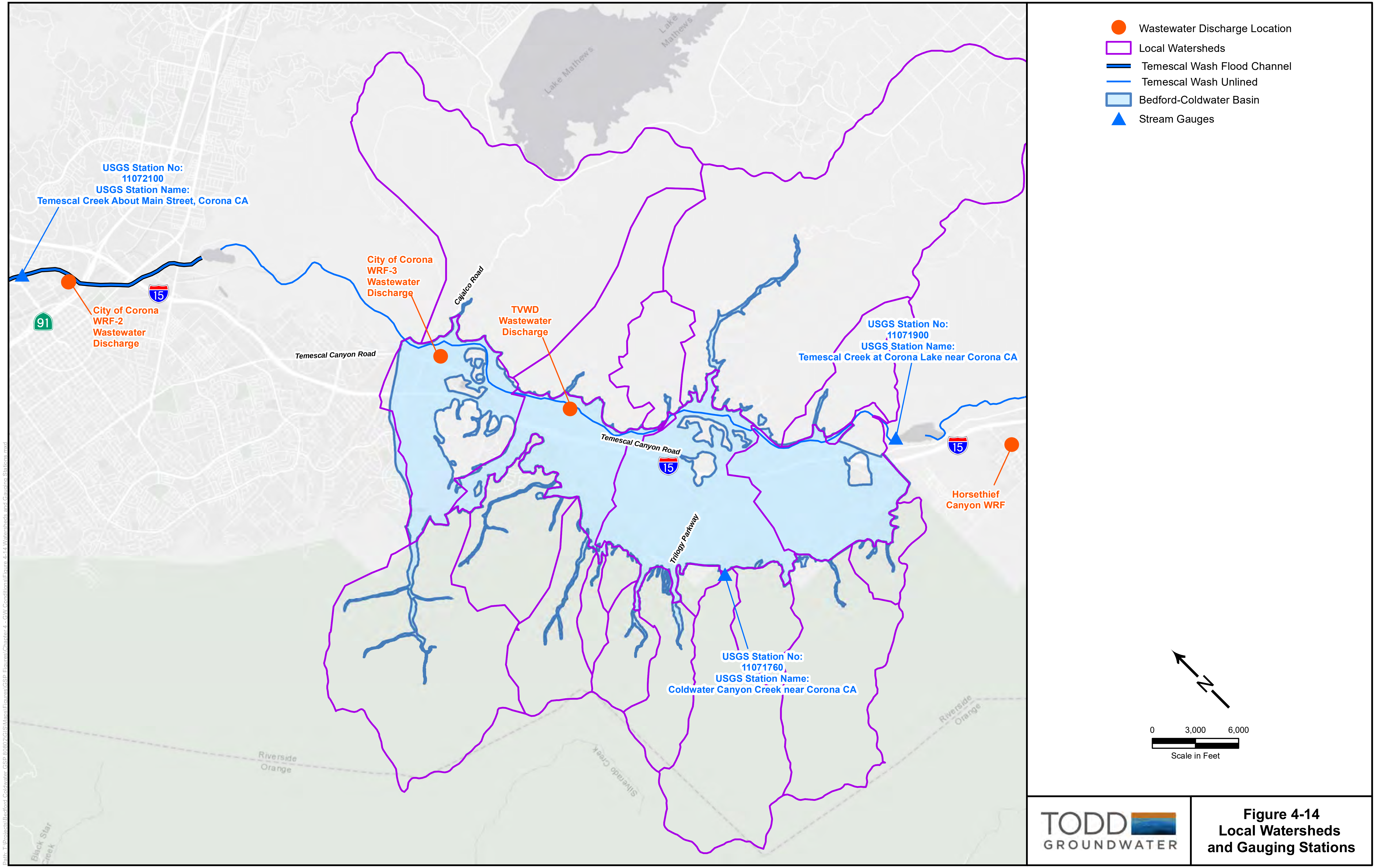
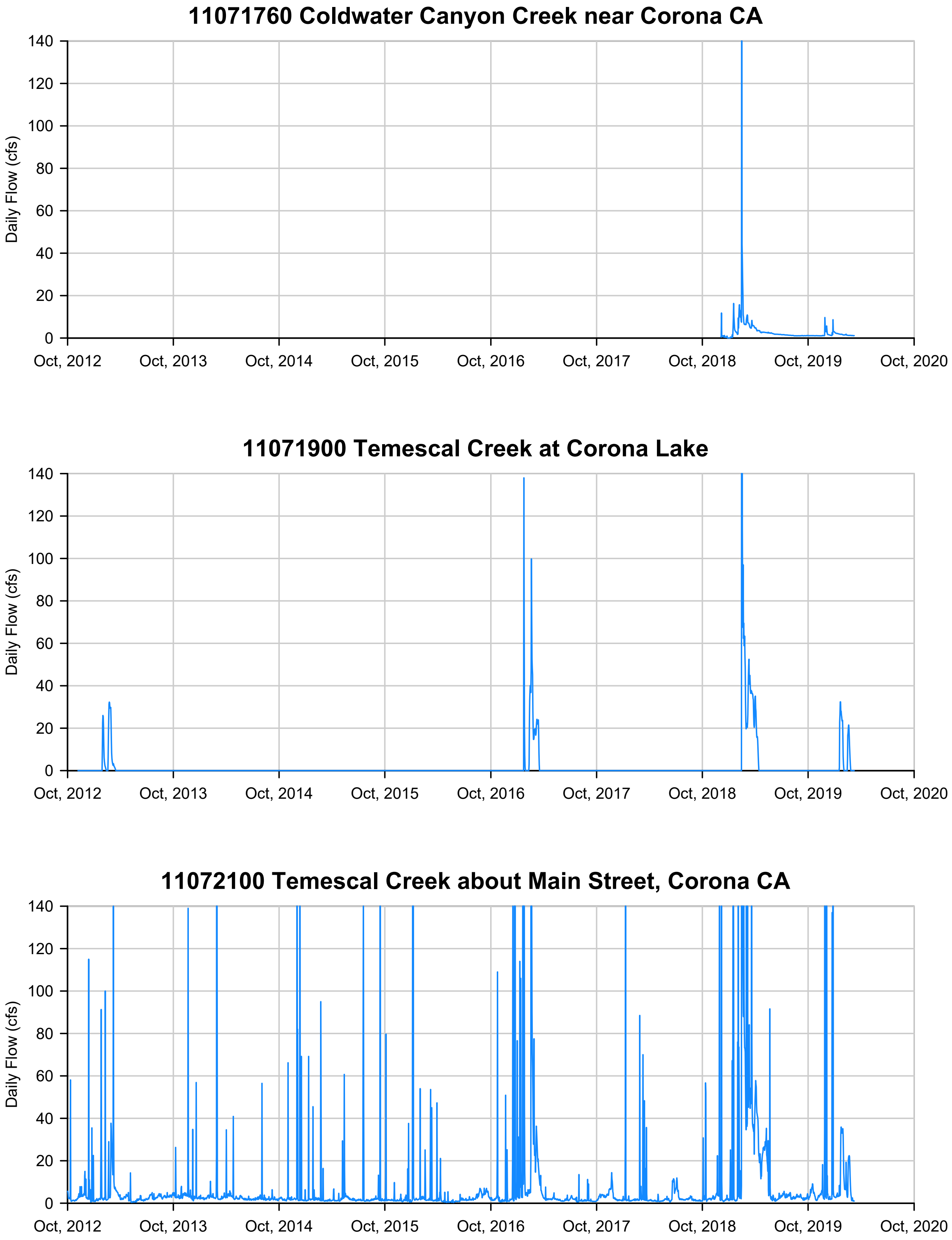


Figure 4-13
Nitrate as Nitrogen Concentrations in Wells 2010 through 2019



Path: T:\Projects\Bedford Coldwater GSP 80802\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-14 Watersheds and Gauging Stations.mxd

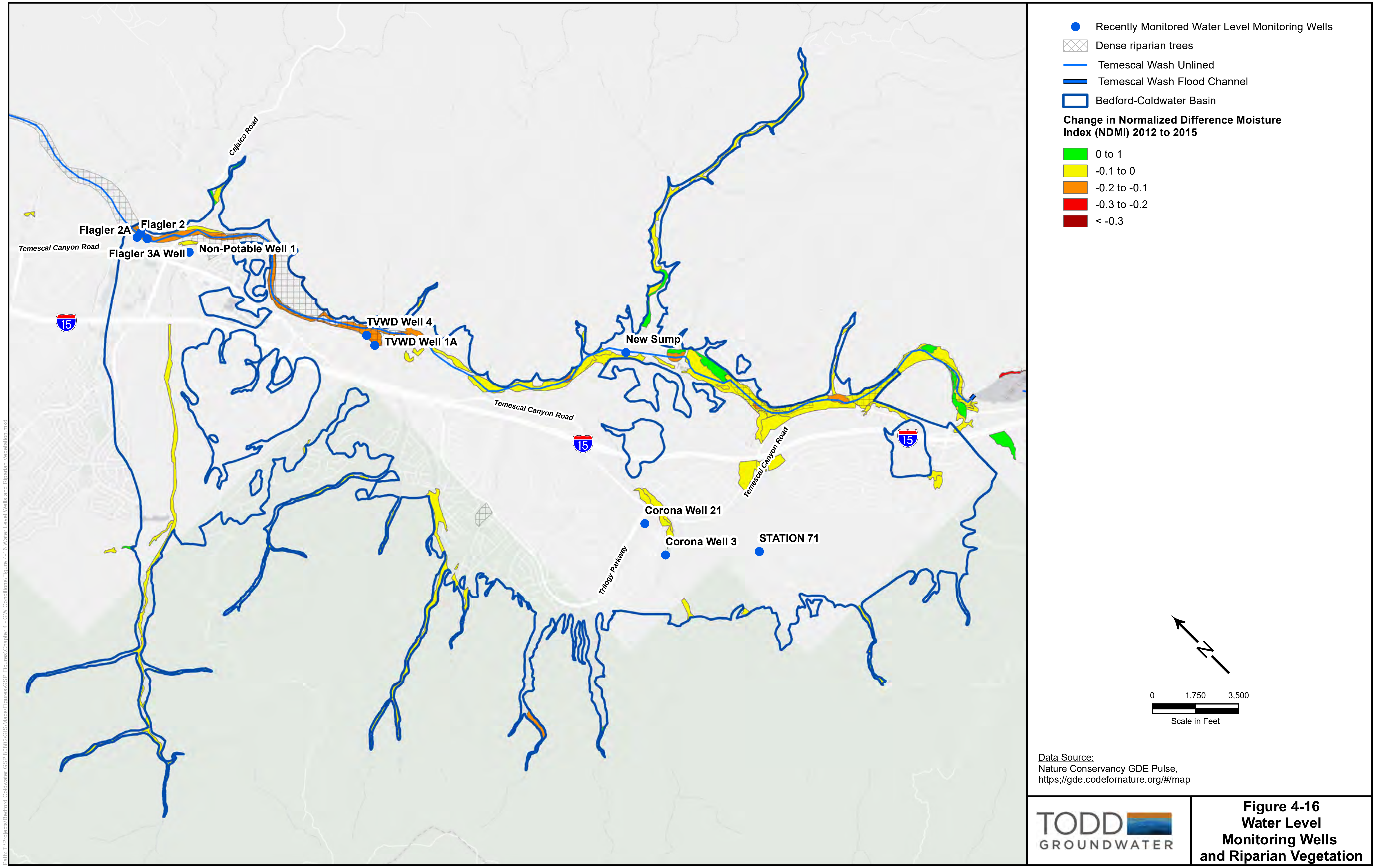
Figure 4-14
Local Watersheds and Gauging Stations



TODD GROUNDWATER

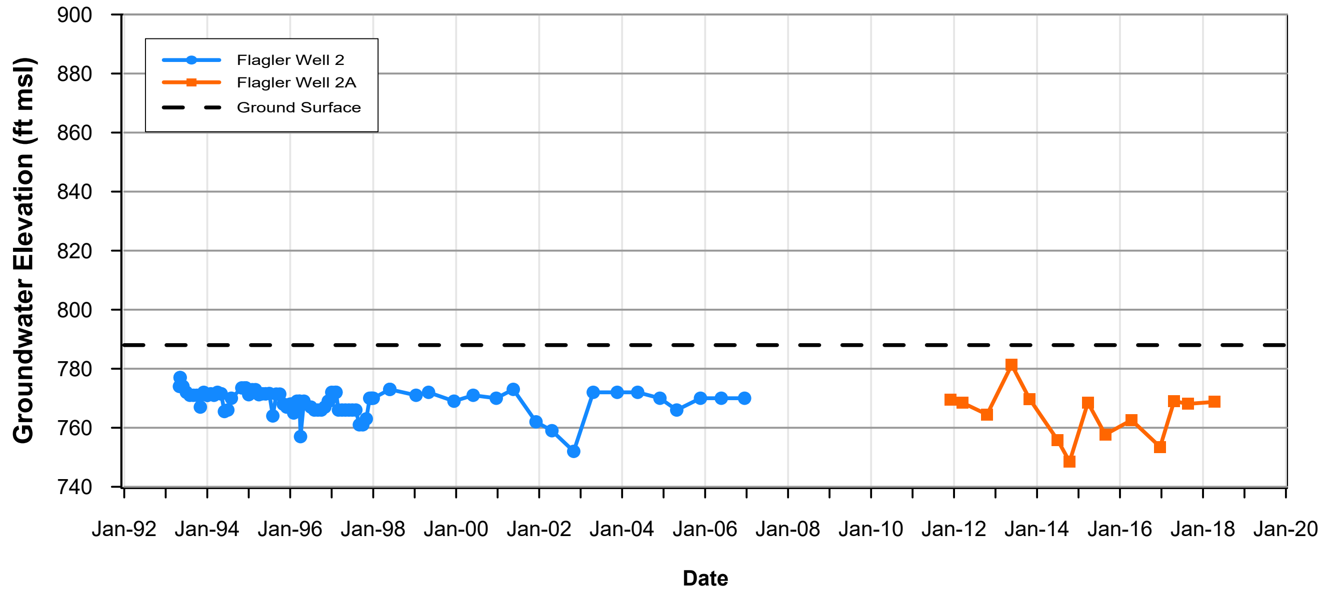
Figure 4-15
Local Streamflow
2013 through 2020

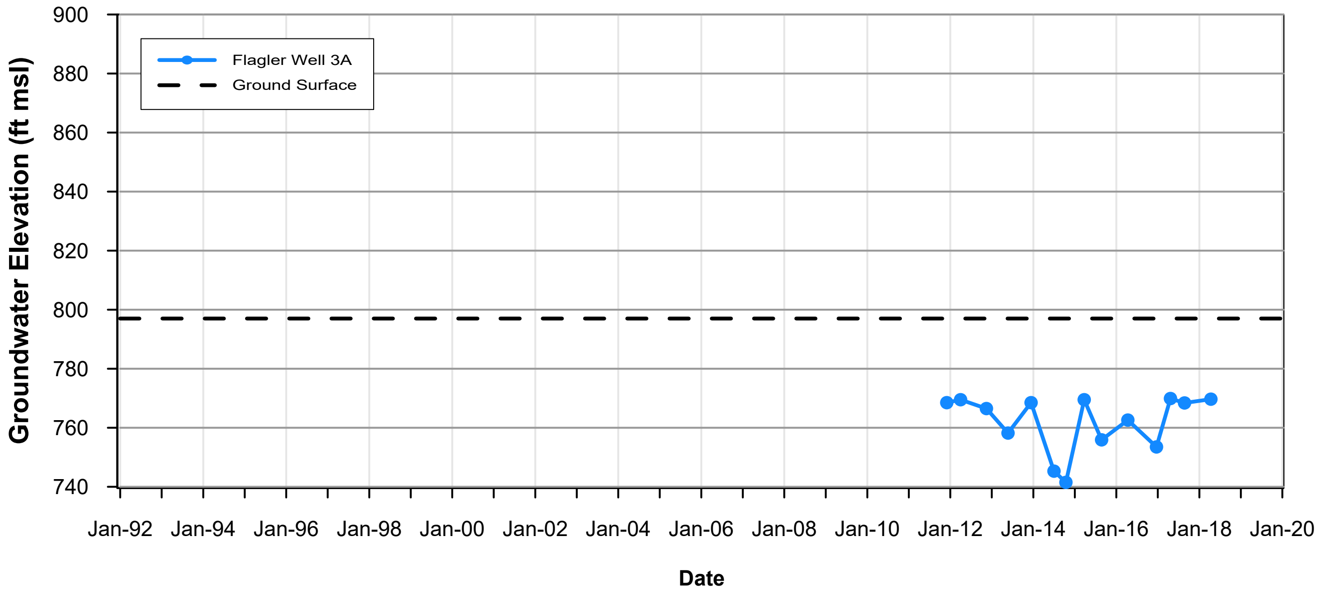
Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 4-15 Local Streamflow 2013 through 2020.gpj

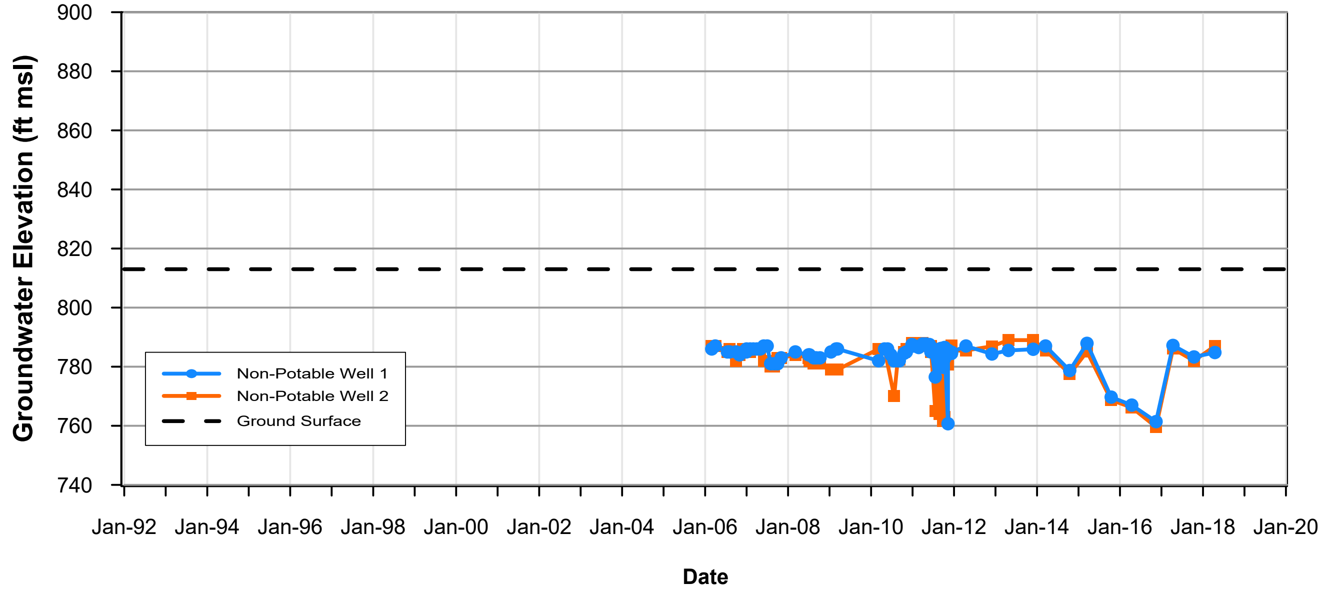


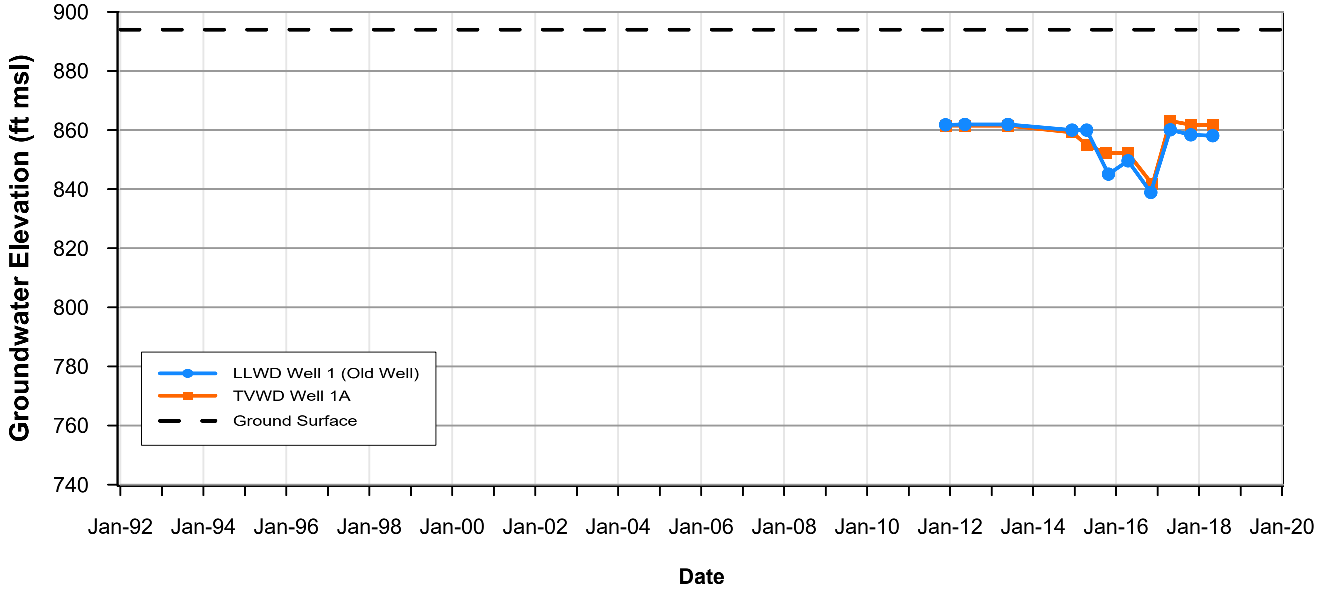
Data Source:
Nature Conservancy GDE Pulse,
https://gde.codefornature.org/#/map

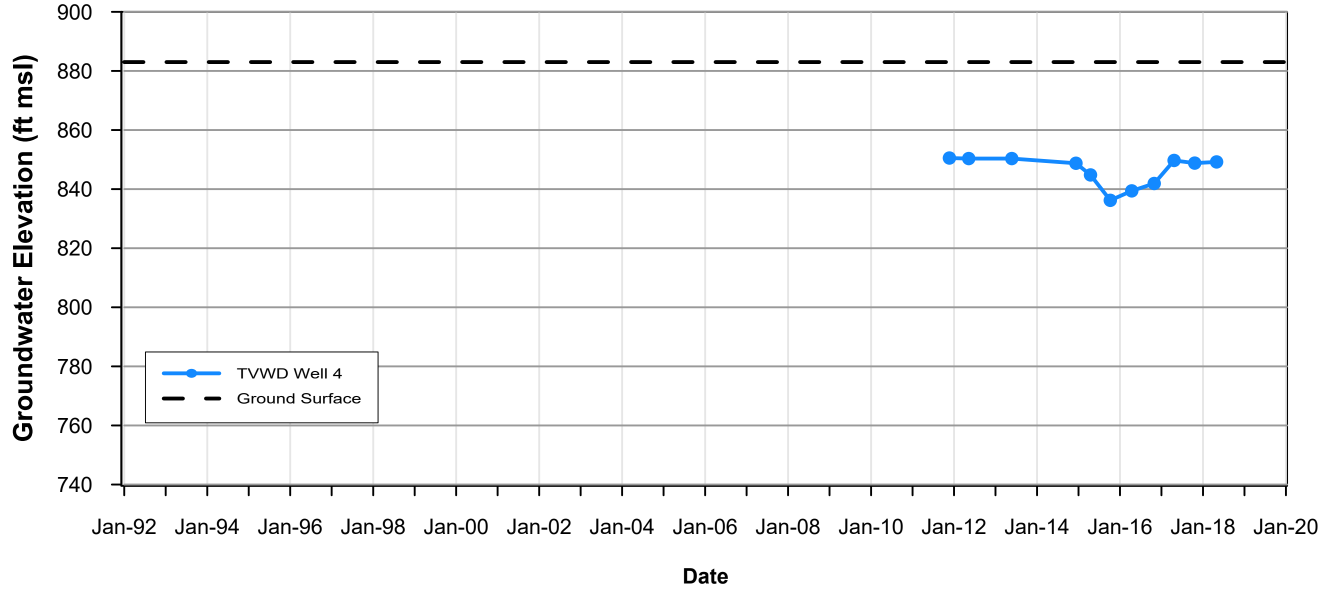
Figure 4-16
Water Level Monitoring Wells and Riparian Vegetation











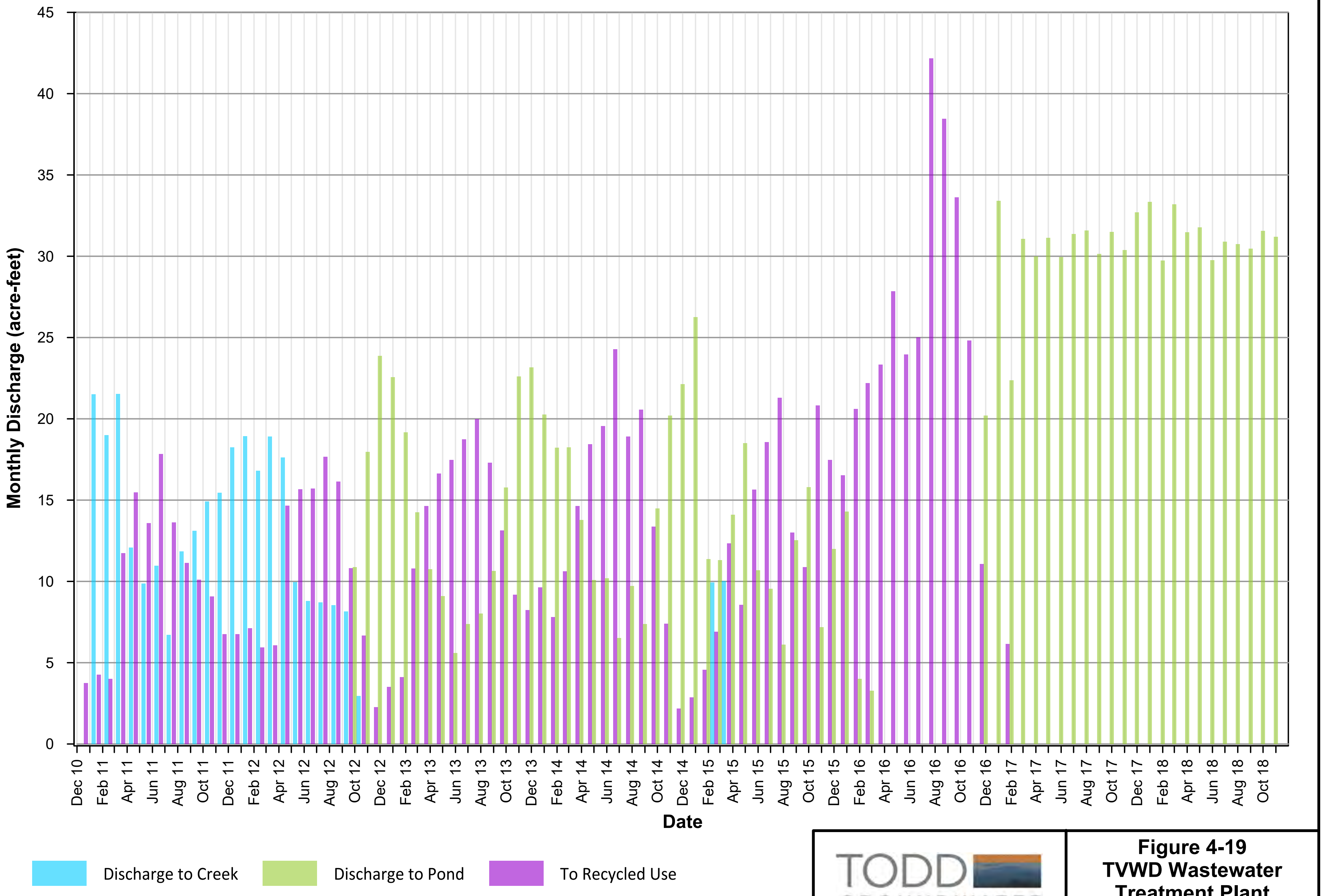
Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 4-17 Hydrographs for Wells with Shallow Depth to Groundwater.grf

TODD GROUNDWATER

Figure 4-17
Hydrographs for Wells with Shallow Depth to Water

TODD GROUNDWATER

Figure 4-18
Recent Riparian
Vegetation Aerial
Imagery



TODD GROUNDWATER

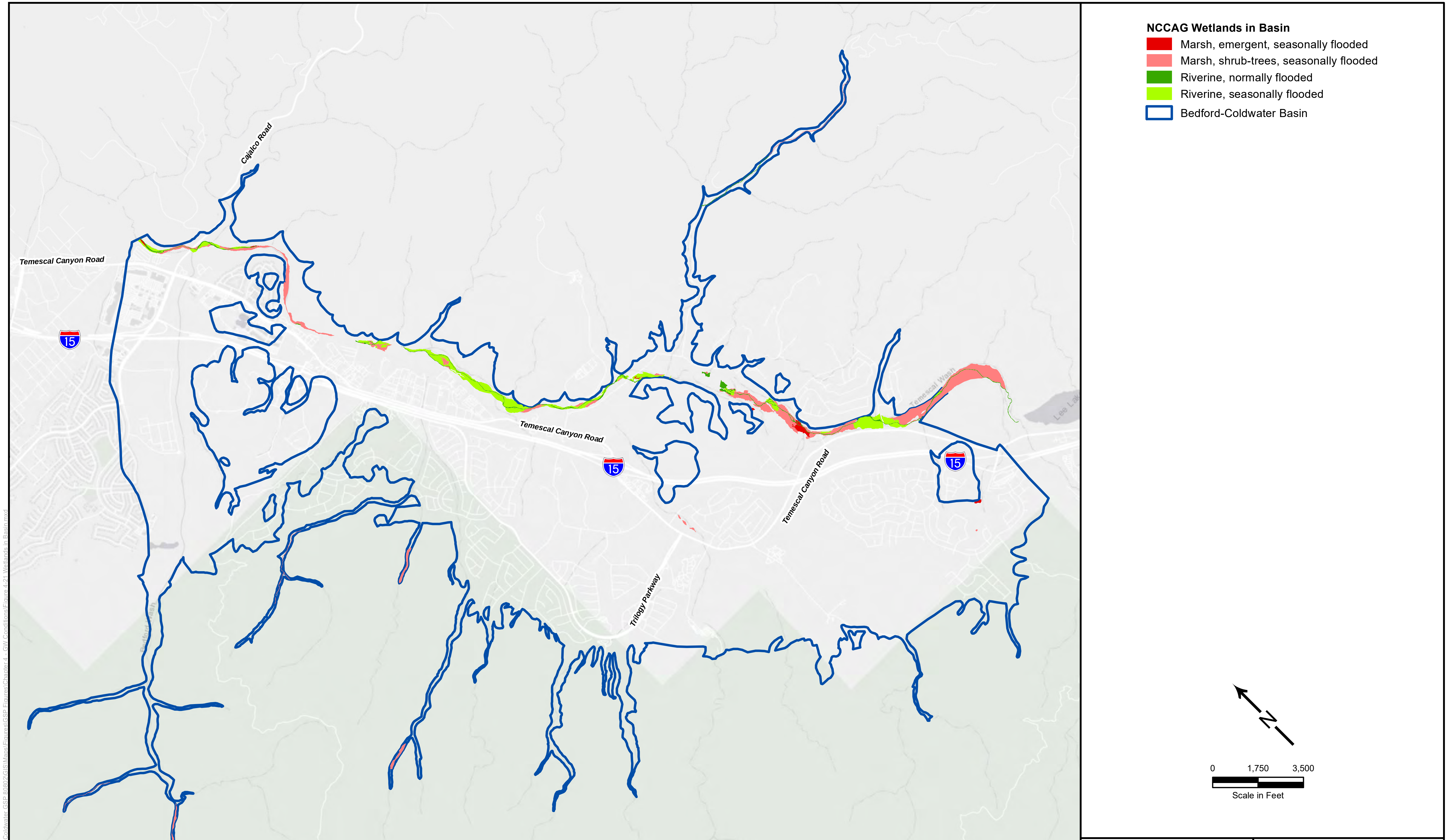
**Figure 4-19
TVWD Wastewater
Treatment Plant
Discharges, 2011 to 2018**

Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 4-19 TVWD WW Discharge.grf

TODD GROUNDWATER

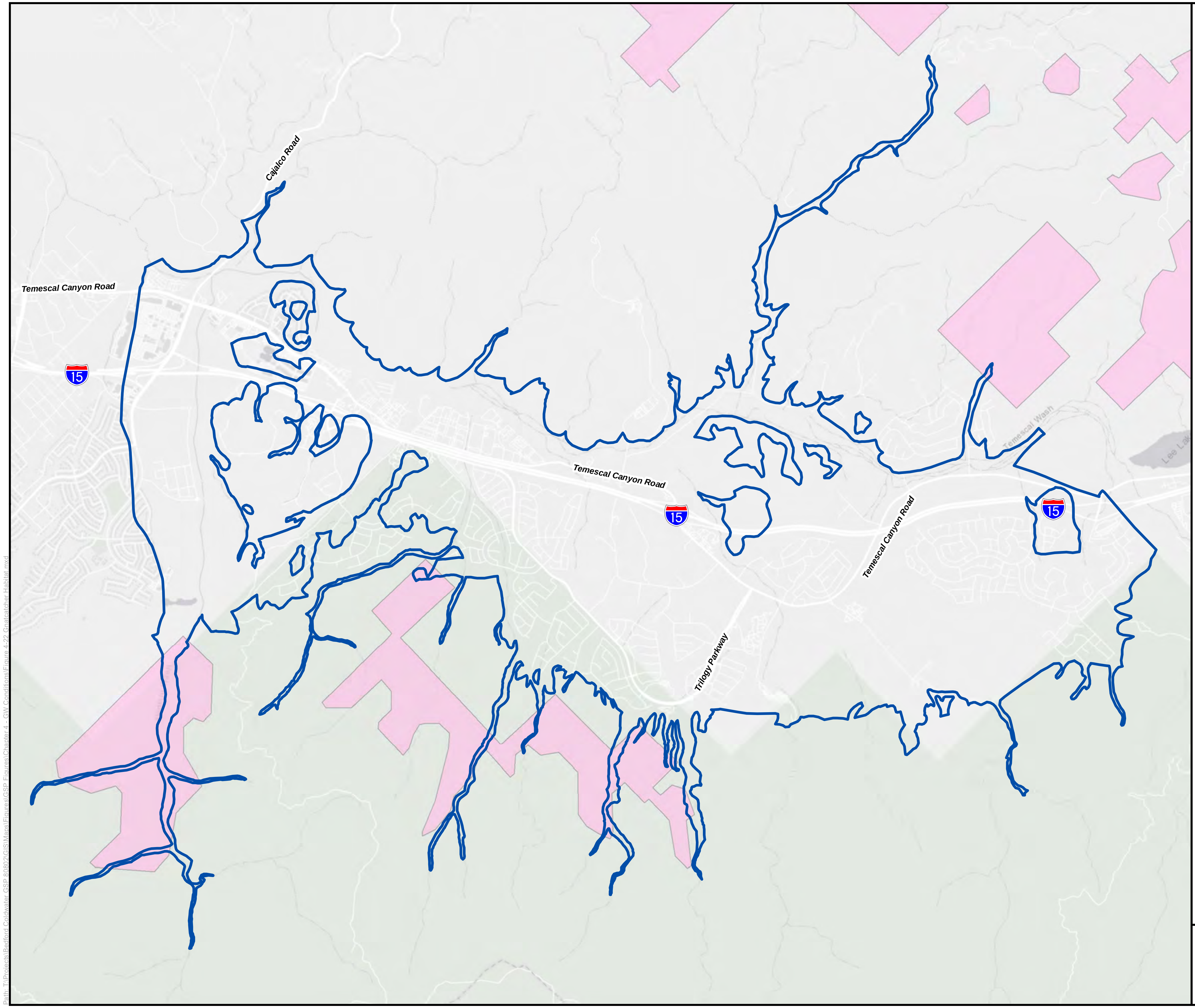
Figure 4-20 Aerial Photograph of Part of Temescal Wash in 1967

Path: T:\Projects\Bedford Coldwater GSP 80802\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-20 1967 Aerial Photo.mxd



TODD GROUNDWATER

Figure 4-21
Wetlands in Basin



▭ Bedford-Coldwater Basin

▭ Coastal California Gnatcatcher Critical Habitat

Data Source:
US Fish and Wildlife Service habitat map tool
https://ecos.fws.gov/ecp/report/table/critical-habitat.html

TODD GROUNDWATER

Figure 4-22
Coastal California Gnatcatcher Critical Habitat Area

Path: T:\Projects\Bedford Coldwater GSP 80802\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-22 Gnatcatcher Habitat.mxd

5. WATER BUDGET

A water balance (or water budget) is a quantitative tabulation of all inflows, outflows, and storage change of a hydrologic system. The Sustainable Groundwater Management Act (SGMA) requires that water balances be prepared for the groundwater system and surface water system of a basin. If a basin contains multiple management areas, separate balances must be developed for each of them. Furthermore, water budgets must be developed for time periods representing historical, current, future no project (baseline), and future growth plus climate change (growth plus climate change) conditions.

This chapter presents the basis for selecting the water budget analysis periods, describes the boundaries and general characteristics of three management areas within the Bedford-Coldwater Subbasin (Basin), describes modeling tools used to estimate some water budget items, and presents the surface water and groundwater budgets.

5.1. WATER BUDGET METHODOLOGY

Annual balances were developed for water years 1990 through 2018, the period simulated by the numerical groundwater model. This interval was selected because it is a long hydrologic period for which important water budget data were available. The model is described in **Appendix G** and provides estimates for several components of the water balance for which direct measurements are not available: flows between groundwater and surface water bodies, flows to and from adjacent basins, evapotranspiration of riparian vegetation, and storage change. The numerical model allows a dynamic and comprehensive quantification of the water balance wherein all estimated water balance elements are reconciled and are calibrated to groundwater level changes over time. Accordingly, the numerical model is the best tool to quantify those water balance components. It will be updated regularly through the Groundwater Sustainability Plan (GSP) implementation process, providing a better understanding of the surface water-groundwater system and a tool to evaluate future conditions and management actions.

5.2. DRY AND WET PERIODS

Dry and wet periods in historical hydrology can be identified on the basis of individual years or sequences of dry and wet years. GSP Regulations require that each year during the water budget analysis period be assigned a water year type*,* which is a classification based on the amount of annual precipitation. **Figure 5-1** shows annual precipitation at Elsinore (National Oceanic and Atmospheric Administration (NOAA) Station GHCND:USC00042805) for water years 1899 through 2020. Water year types are also indicated and are assigned to five categories corresponding to quintiles of annual precipitation. The categories used here (dry, below normal, normal, above normal and wet) accurately describe the quintiles. These categories differ from the nomenclature commonly used in the Central Valley (critical, dry, below normal, above normal and wet) and elsewhere but do not accurately describe local categories and are based on the Sacramento River Index, which has little relevance to conditions in the Basin. The quintile divisions for precipitation during 1899 to 2020 at the Lake Elsinore station are shown in **Table 5-1**.

Table 5-1. Water Year Type Classification (Lake Elsinore station)

Water Year Type		Range as Percent of Mean	Precipitation Range (inches)
Wet	W	>139	> 16.5
Above Normal	AN	101 to 139	12.0 to 16.5
Normal	N	75 to 101	8.9 to 12.0
Below Normal	BN	56 to 75	6.6 to 8.9
Dry	D	<56	< 6.6

Average precipitation for 1899 to 2020 was 11.88 inches per year

Individual wet and dry years are not particularly useful for groundwater management in basins where groundwater storage greatly exceeds annual pumping and recharge, which is the case in the Basin. In those basins, multi-year droughts and sequences of wet years are more relevant, because they relate to the amount of operable groundwater storage needed to support sustainable groundwater management. Multi-year wet and dry periods can be identified from a plot of cumulative departure of annual precipitation, which is also shown on **Figure 5-1**. Wet periods appear as upward-trending segments of the cumulative departure curve, and droughts appear as declining segments. By far the largest climatic deviations in this record were the sustained wet conditions from 1937 to 1944 and dry conditions from 1946 to 1965. These events pre-dated the most recent 30 years, which is the period that the California Department of Water Resources (DWR) states should be used for determining year types (DWR 2016c). They also pre-date the period simulated by the groundwater model. However, large wet and dry events like those could recur in the future, and it is prudent to consider climate uncertainty in planning for groundwater sustainability.

5.3. WATER BALANCE ANALYSIS PERIODS

GSP regulations require evaluation of the water balances over historical, current, and future periods. The historical period must include at least 10 years, and the future period must include exactly 50 years. The duration of the current period is not specified, but to be consistent with SGMA concepts it needs to include several years around 2015, which was the implementation date of SGMA. Historical and current analysis periods for the Basin were selected from within the 1990 through 2018 modeling period. Ideally, each period is characterized by average precipitation and relatively constant land and water use. Urbanization in the Basin has been gradual throughout the 1990 to 2018 period. The historical period is represented by water years 1993 through 2007, and the current period by water years 2010 to 2013. Those periods had 101 percent and 102 percent of the 1899 to 2020 average annual rainfall, respectively.

The future period is intended to represent conditions expected to occur over the next 50 years. The model simulation period is only 29 years (1990 to 2018). To obtain a 50-year period, simulations of future conditions used the 1993 through 2017 sequence of rainfall and natural stream flow repeated twice. Average annual precipitation during 1993 to 2017 was 94 percent of the long-term average. For the baseline scenario, no adjustments were made to the hydrologic sequence. Adjustments made to simulate future climate change are described in following sections.

5.4. MANAGEMENT AREAS

As defined in the GSP regulations, a Management Area (MA) is an area within a basin for which the GSP may identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors. The Basin has been divided into two MAs. They are described below and in more detail in **Appendix I**, and their boundaries are shown in **Figure 5-2**.

5.4.1. Bedford Management Area

The Bedford MA occupies roughly the eastern two-thirds of the Basin. It is separated from the Coldwater MA by the Glen Ivy Fault, which is a partial barrier to groundwater flow. The Bedford MA connects to the Elsinore Subbasin in the south and the Temescal Basin at the north end of the Basin. Some subsurface inflow from the Elsinore Subbasin to the south, and subsurface outflow to the Temescal Basin is also possible. Temescal Wash flows along the length of the Bedford MA. It also exits the north end of the Basin but traverses a bedrock reach before entering the Temescal Basin.

5.4.2. Coldwater Management Area

The Coldwater MA is the part of the Basin west of the Glen Ivy Fault. Because of downward movement on that side of the fault, Basin thickness is much greater than in the Bedford MA. A large open-pit aggregate mine is located in the southern part of this MA. Several streams enter the Coldwater MA from watersheds on the eastern slopes of the Santa Ana Mountains.

5.5. METHODS OF ANALYSIS

Complete, itemized surface water and groundwater balances were estimated by combining raw data (rainfall, stream flow, municipal pumping, and wastewater percolation from septic tanks and wastewater treatment plant discharge) with values simulated using models[3].

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[3] Water balance values are shown to nearest acre-foot to retain small items, but entries are probably accurate to only two significant digits.

Collectively, the models simulate the entire hydrologic system, but each model or model module focuses on part of the system, as described below. In general, the models were used to estimate flows in the surface water and groundwater balances that are difficult to measure directly or that relate to time-dependent groundwater levels. These include surface and subsurface inflows from tributary areas, percolation from stream reaches within the Basin, groundwater discharge to streams, potential subsurface flow from the neighboring subbasin and between MAs, the locations and discharges of pumping wells, consumptive use of groundwater by riparian vegetation, and changes in groundwater storage. Descriptions of the inflows and outflows to the surface water and groundwater models are included below in Sections 5.6 and 5.7.

5.5.1. Rainfall-Runoff-Recharge Model

This Fortran-based model developed over a number of years by Todd Groundwater staff simulates hydrologic processes that occur over the entire land surface, including precipitation, interception[4], infiltration, runoff, evapotranspiration, irrigation, effects of impervious surfaces, pipe leaks in urban areas, deep percolation below the root zone, and shallow groundwater flow to streams and deep recharge. The model simulates these processes on a daily time step for 242 "recharge zones" delineated to reflect differences in physical characteristics as well as basin and jurisdictional boundaries. Simulation of watershed areas outside the Basin is included to provide estimates of stream flow and subsurface flow entering the Basin. Daily simulation results were subtotaled to monthly values for input to the groundwater model. Additional details regarding the rainfall-runoff-recharge model can be found in **Appendix G** and the model code is available on request.

5.5.2. Groundwater Model

The groundwater flow model uses the MODFLOW 2005 code developed by the United States Geological Survey (USGS) that is a public domain open-source software as required by GSP regulation §352.4(f)(3). The model produces linked simulation of surface water and groundwater, as described below. Additional documentation of the model and calibration is provided in **Appendix G**.

5.5.2.1. Surface Water Module

Stream flow in MODFLOW is simulated using the Streamflow Routing Package (SFR) where a network of stream segments represents the small streams entering the Basin from Temescal Wash and tributary watersheds.

Surface water inflows to Temescal Wash were obtained from a similar groundwater flow model of the Elsinore Subbasin. Small stream inflows were estimated using the rainfall-runoff-recharge model. Each stream segment is divided into reaches, one per model grid cell traversed by the segment. Flow is routed down each segment from reach to reach. Along each

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[4] Interception refers to precipitation that does not reach the soil, but instead falls on (and is intercepted by) plant leaves, branches, and plant litter, and is subject to evaporation loss.

reach mass balance is conserved in the stream, including inflow from the upstream reach and tributaries, inflow from local runoff, head-dependent flow across the stream bed to or from groundwater, evapotranspiration losses and outflow to the next downstream reach. Flow across the stream bed is a function of the wetted channel length and width, the bed permeability and the difference in elevation between the stream surface and groundwater at the reach cell. Wetted width and depth of the stream are functions of stream flow.

5.5.2.2. Groundwater Module

The MODFLOW groundwater model is constructed to cover the entire Basin. The model grid size is oriented at 40 degrees west of north (N40W) so that it is oriented consistent with the key hydrologic features including streams and faults. The model grid size uses a uniform 100 feet (ft) horizontal grid spacing to provide sufficient resolution to resolve hydraulic gradients, well drawdown cones, and groundwater-surface water interactions in the Basin.

The Basin extends up a number of narrow tributary stream canyons. These narrow canyons can be problematic to simulate using MODFLOW because they can cause difficult numerical stability issues. To limit these effects, the model grid extends up these canyons until the canyon is less than 3 grid cells wide, or to the extent where the alluvial sediments are regularly saturated. Areas upstream of these locations have been simulated using boundary conditions to estimate inflows based on groundwater conditions and surface water model results.

The numerical model has been constructed to reflect the hydrogeological conceptual model developed for the GSP. The vertical extent of the Basin is based on the mapped depth to consolidated rock. The elevation of surface features and streambed elevations have been derived from geographic information system (GIS) files developed from the local topography and stream information.

Citrus orchards irrigated with groundwater were common in the Basin in the early 1990s, but except for one small grove in the Coldwater MA those have all been replaced by urban development. The citrus orchards present in the early 1990s were almost all replaced by urban development by 2018. Agricultural irrigation pumping of these orchards was estimated by the rainfall-runoff-recharge model, with pumping assigned to a hypothetical irrigation well at the center of each irrigated recharge zone. This pumping was phased out over time as urban development occurred. Urban irrigation is supplied by the municipal water system, which uses imported water and local wells. Municipal well extractions are known and are entered directly into the model. All major pumpers in the Basin report their annual production to WMWD, which was the source of data for several non-municipal pumping wells. Pumping at private domestic wells is not reported and is not included in the model. The number of those wells is thought to be small, and their total production is almost certainly negligible in the context of the overall Basin water budget.

5.5.3. Simulation of Future Conditions

GSP regulations §354.18(c)(3) require simulation of three future scenarios to determine their effects on water balances, yield, and sustainability indicators. For this scenario, the growth and climate change scenarios were combined, resulting in the following two scenarios:

> **Baseline.** This represents a continuation of existing land and water use patterns, imported water availability, and climate.
>
> **Growth Plus Climate Change.** This scenario implements anticipated changes in land use and associated water use, such as urban expansion, and anticipated effects of future climate change on local hydrology (rainfall recharge and stream percolation) and on the availability of imported water supplies.

Both the future simulations assume a constant level of development and related water demand in the Basin. Development in the growth plus climate change simulation is not phased in over time. This is the best way to demonstrate whether 2068 land use is sustainable because it allows for assessment of the effects of variations in climactic conditions (wet and dry cycles) on groundwater conditions, avoids subjective decisions about the concurrent timing of droughts and development, and provides time for the full effect of future conditions on groundwater to become apparent.

5.5.3.1. Baseline Scenario

The baseline simulation is a 50-year period, as required by SGMA regulations, with water budget components developed using the criteria and assumptions described below. Initial water levels are simulated water levels for September 2018 from the historical calibration simulation. That year represents relatively recent, non-drought conditions. These simulated water levels are internally consistent throughout the model flow domain and reasonably matched measured water levels at wells with available data (see **Appendix G** for discussion of model calibration).

Surface water and other inflows came from multiple sources. Monthly inflows in Temescal Wash were obtained from the baseline and growth plus climate change simulations produced by the Elsinore Subbasin groundwater model (Carollo and Todd 2021), which is concurrently being used to develop the GSP for that Subbasin. Small stream and bedrock inflows simulated for 1993 to 2017 of the calibration model period were repeated twice to obtain 50 years of data.

In the baseline scenario, land use remains the same as the current conditions. In the model, land use is represented by 2014 land use mapped by remote sensing methods and obtained from DWR, adjusted for subsequent urbanization identified in Google Earth imagery.

Municipal, commercial, and industrial (M&I) and private pumping were assumed to remain at existing levels. Initial estimates were obtained by calculating average pumping for each calendar month during 2010 through 2018 and applying those averages in every year of the future simulation. This approach omits additions to and withdrawals from Coldwater MA storage accounts by the three municipal agencies with wells in that MA. Municipal use of imported water was also assumed to remain at existing levels. From the standpoint of the groundwater budget, total municipal water use was used only to estimate pipe leaks. Use of imported water by the Temescal Valley Water District (TVWD) was obtained from that agency's 2015 Urban Water Management Plan (RMC and Woodard & Curran 2017), and imported water use in the parts of the City of Corona (Corona) and Elsinore Valley Municipal Water District (EVMWD) service areas within the Basin were assumed to be the same on a per-acre basis for developed areas.

The Baseline scenario also assumes wastewater percolation and recycling continue as they have in recent years. Discharges from the TVWD Water Reclamation Facility (WRF) to Temescal Wash were discontinued in 2013. All of the plant outflow is recycled for irrigation during spring, summer, and fall (assumed April through November), and most or all of it is percolated in ponds at the WRF when irrigation demand is low (December through March).

5.5.3.2. Growth Plus Climate Change Scenario

The growth plus climate change scenario incorporated anticipated effects of climate change, urban development, and associated changes in water and wastewater management. In this scenario, rainfall and reference evapotranspiration (ET_0) were adjusted to 2070 conditions using monthly multipliers developed by DWR based on climate modeling studies. The multipliers were applied to historical monthly data for the 1993 to 2017 hydrologic period used in the model. DWR prepared a unique set of multipliers for each foursquare kilometer (km^2) cell of a grid covering the entire state. Nine climate grid cells overlie the Basin and its tributary watershed areas. For each recharge analysis polygon in the rainfall-runoff-recharge model, multipliers from the nearest climate grid cell were used. The climate in 2070 is expected to be drier and warmer than at present.

Figure 5-3 compares average monthly precipitation and ET_0 before and after applying the climate change multipliers. Simulations of irrigated turf in the rainfall-runoff-recharge model indicated that the combined effect of the warmer and drier climate will be to increase annual irrigation demand by about 10 percent.

In the growth plus climate change scenario, bedrock inflow and surface inflow from tributary streams along the perimeter of the Basin were re-simulated using the rainfall-runoff-recharge model to reflect the effects of urban development in some of the tributary watersheds and of climate change. Urbanization also increased surface runoff within the Basin, which was routed to small streams and Temescal Wash.

Projected land use in 2068, shown in **Figure 5-4,** was developed on the basis of population projections, land use designations in the Temescal Canyon Area Plan (Riverside County 2018), assumed urban infill, and topography. A comparison of land use acreage by land use category and management area for 1990, 2018, and 2068 is shown in **Table 5-2**. Conversion of grassland to residential land use was the dominant change in both management areas and also occurred in tributary watershed areas.

Total municipal water use in 2068 was estimated to be double the amount in 2018. This estimate is an approximate average of several factors. The Temescal Canyon Area Plan (Riverside County 2018) assigns developed land uses to almost the entire Basin area, and the area of undeveloped lands is presently about equal to the area of developed lands. Thus, the amount of developed land could plausibly double. However, the Area Plan also included estimates of future population that would extrapolate to a 2068 population only 58 percent greater than the current population. Finally, TVWD's 2015 Urban Water Management Plan (RMC and Woodard & Curran 2017) included projections of future water use out to 2040. Extrapolating those trends to 2068 indicates water use 1.55 times greater than in 2015.

For the growth plus climate change scenario, average annual groundwater pumping in the Coldwater MA was assumed to equal average historical pumping during 2010 through 2017, with an increase proportional to the estimated amount of irrigation return flow from future increased use of imported water. In the Bedford MA, average annual groundwater pumping was assumed to be equal to 2020 production volumes. Municipal pumping in Coldwater was distributed among wells in proportion to their averages during 2010 to 2017 and in Bedford it was distributed as recorded in 2020. All remaining municipal water use was assumed to be obtained from imported water.

Water pipe leak rates in the EVMWD and City of Corona service areas were assumed to decrease to 5 percent of delivered water from the rates reported in the 2015 Urban Water Management Plans (7.0 percent and 6.6 percent, respectively). The leak rate in the TVWD service area was assumed to continue at the low rate reported in 2015 (2 percent).

Wastewater generation was assumed to double by 2068, in proportion to the increase in total urban water use. Wastewater disposal was assumed to change, however. In recent years more of the outflow from the TVWD WRF has been percolated in ponds than has been recycled for irrigation. This proportion was assumed to reverse, such that all outflow would be recycled for irrigation during April through November and all would be percolated in ponds during November through March. The small discharge from Corona WRF-3 to Temescal Wash at the northern end of the Basin was assumed to be eliminated, consistent with the City of Corona's plans to decommission that WRF.

In the growth plus climate change scenario, mining operations were assumed to have ended and the mine areas to have been converted to stormwater control facilities with groundwater recharge capacity during high runoff periods.

Table 5-2. Bedford-Coldwater Basin Land Use in 1990, 2018 and 2068 (acres)

Land Use	Bedford MA			Coldwater MA			Tributary Watersheds		
	1990	2018	2068	1990	2018	2068	1990	2018	2068
Citrus	1,261	0	0	719	32	32	0	0	0
Grassland	2,403	1,603	413	187	103	33	16,703	16,429	16,174
Shrubs/Trees	368	144	64	173	138	82	13,777	13,693	13,693
Dense riparian	256	159	159	8	27	27	0	0	0
Sparse riparian	303	303	303	0	0	0	0	0	0
Open water	0	0	0	0	0	0	0	0	0
Low-density residential	199	529	485	66	88	88	0	0	0
Residential	179	1,379	2,725	76	405	606	0	94	327
Turf	7	263	326	0	170	226	0	85	107
Commercial	0	30	671	24	33	50	0	0	0
Industrial	232	469	469	0	0	0	0	0	0
Quarry	434	252	252	441	588	588	365	555	555
Vacant	785	1,232	561	38	148	0	0	0	0

Des by: GY
Ckd by: CT

T:\Projects\Bedford Coldwater GSP 80802\Model_Future\RCH - Future\RechargeIn_model_BC_growth+climate.xlsx RechargeZones

5.6. SURFACE WATER BALANCE

This section describes and quantifies the water balance of creeks and rivers that cross the Basin. All significant inflows to and outflows from these surface water bodies are included in the water balance. The surface water balance shares two flows in common with the groundwater balance: 1) percolation from surface water to groundwater and 2) seepage of groundwater into surface water. Each of these is an outflow from one system and an inflow to the other.

Annual surface water balances during 1990 to 2018 were compiled from monthly data for each MA, and average annual water balances were calculated for each of the three analysis periods (1993 to 2007 and 2010 to 2013 for the historical simulation, and 2019 to 2068 for the future simulations). Key features of the surface water balances for each management area and analysis period are described below, followed by additional information about the methods used to quantify items in the water balances.

Historical annual surface water balances for the Bedford MA during 1990 to 2018 are shown in **Figure 5-5** (upper graph). Average annual surface water budgets for the model, historical, current, and future budget analysis periods are listed in **Table 5-3** and detailed surface water budget tables are included in **Appendix J**. Inflow occurs predominantly in wet years and derives from Temescal Wash, east side tributaries and runoff, and streams entering from the Coldwater MA, in descending order of magnitude. Outflow is almost entirely surface outflow in Temescal Wash to Temescal Basin.

In the baseline simulation, discharges of reclaimed water to Temescal Wash consisted only of the small flows from Corona WRF-3; TVWD WRF discharges had already ceased in 2013. Other inflows to the Bedford MA were close to the magnitudes of those flows during the historical and current periods. In the growth plus climate change scenario, Temescal Wash inflows from the Elsinore Subbasin were slightly larger due urbanization and wastewater discharges in that area. Local tributary inflows were slightly reduced due to the warmer, drier climate. There was little change in net stream percolation and outflow to the Temescal Basin.

Annual surface water balances for the Coldwater MA are also shown in **Figure 5-5** (middle graph) and **Table 5-3**. The only inflow of significance is from tributary streams draining the eastern slopes of the Santa Ana Mountains. Those inflows decreased somewhat under the growth plus climate change scenario because of warmer, drier climatic conditions. Less inflow led to less stream percolation (33 percent lower than historical) and less outflow to the Bedford MA (14 percent lower than historical).

A substantial amount of water is imported into the Basin. It is delivered directly to users and does not flow into streams or lakes. Imports began in 1992, and annual amounts since then are shown in **Figure 5-5** (bottom graph). Imported water consists of State Water Project (SWP) water purchased from the Metropolitan Water District of Southern California (Metropolitan) and delivered to TVWD through the Temescal Valley Pipeline.

Table 5-3. Average Annual Surface Water Budgets

Inflow or Outflow	Bedford Management Area				Coldwater Management Area			
	Historical 1993 to 2007	Current 2010 to 2013	Baseline[1] 2019 to 2068	Growth Plus Climate Change[1] 2019 to 2068	Historical 1993 to 2007	Current 2010 to 2013	Baseline[1] 2019 to 2068	Growth Plus Climate Change[1] 2019 to 2068
Inflows								
Temescal Wash	13,560	10,761	10,892	12,857	0	0	0	0
Tributary inflow	8,201	8,522	7,412	6,477	6,280	6,164	5,278	4,611
Wastewater discharges	712	1,227	60	0	0	0	0	0
Groundwater flow into streams	791	1,137	990	1,380	16	2	2	1
Total Inflows	23,264	21,646	19,354	20,714	6,296	6,166	5,279	4,612
Outflows								
Stream percolation	-1,564	-2,015	-1,661	-1,714	4,160	3,216	2,780	2,779
Surface outflows	-21,700	-19,631	-17,693	-19,000	2,136	2,950	2,499	1,834
Total Outflows	-23,264	-21,646	-19,354	-20,714	6,296	6,166	5,279	4,612

[1] The 50-year future baseline simulation uses historical hydrology for 1993 to 2017 two times in succession.

Des by: GY
Ckd by: CT

5.6.1. Inflows to Surface Water

5.6.1.1. Precipitation and Evaporation

Precipitation and evapotranspiration on the land surface are accounted for in the rainfall-runoff-recharge model. Those processes are not included in the surface water balances, which address only water in stream channels, lakes, and imported water. Precipitation and evaporation on the surface of creeks and rivers are invariably miniscule percentages of total stream flow and are not included in the water budget.

5.6.1.2. Tributary Inflows

Tributary inflows to the Basin are from Temescal Wash and tributary watersheds along the east and west sides of the Basin. Temescal Wash inflows were obtained from the Elsinore Subbasin groundwater model. Surface inflows from nine Santa Ana Mountain watersheds that discharge to the Coldwater MA were estimated using the rainfall-runoff-recharge model, with daily flows subtotaled to monthly flows for input to the groundwater model. Inflows from six eastside tributary watersheds that discharge to the Bedford MA were similarly simulated.

5.6.1.3. Valley Floor Runoff

The rainfall-runoff-recharge model simulates runoff from valley floor areas, which include impervious surfaces in urban areas. Runoff from valley floor areas was added to flows in tributary streams or Temescal Wash at several locations.

5.6.1.4. Wastewater Discharges

Reclaimed water was discharged from TVWD WRF to Temescal Wash beginning around 1991 and gradually increasing to about 2 cubic feet per second (cfs) during 2008 to 2012. Discharges ceased after that as TVWD increased its capacity to percolate the water in winter and recycle it for irrigation in summer. The City of Corona's WRF-3 discharges small amounts of reclaimed water to Temescal Wash near the downstream end of the Basin, averaging about 0.2 cfs but increasing to as much as 0.6 cfs in some winters. The City plans to decommission this plant and route its inflow to WRF-1 in the Temescal Basin in Corona.

5.6.1.5. Groundwater Discharge to Streams

Groundwater discharges into streams when the adjacent water table is higher than the stream bed or the water level in the stream. This occurs sometimes along Temescal Wash in the Bedford MA. Because groundwater levels fluctuate over time, estimates of these discharges were obtained from the groundwater model.

5.6.2. Outflows of Surface Water

5.6.2.1. Net Evaporation

Evaporation from streams is almost always a negligible fraction of total flow and is not explicitly itemized in the water budgets or simulated in the model.

5.6.2.2. Surface Water Percolation to Groundwater

In wet years, percolation from streams along the reaches between the Basin boundary and Temescal Wash is a significant outflow of surface water. Along Temescal Wash in the Bedford MA, the Wash gains flow from groundwater in some reaches and loses it to groundwater in others, depending on the relationship between the stream surface and adjacent groundwater table. These exchanges vary in time as well as location, but over the long run they are of generally similar magnitudes. Because of this dynamic interaction between surface water and groundwater, estimates of flows across the bed of Temescal Wash were obtained from the groundwater model.

5.6.2.3. Surface Outflow from Management Areas and the Basin

Surface outflow from the Coldwater MA to the Bedford MA was calculated by subtracting net percolation losses along the tributary streams from their inflows at the Basin boundary. The net losses were simulated by the groundwater model. Surface outflow in Temescal Wash to the Temescal Basin was calculated as the residual in the surface water balance for the Bedford MA.

5.7. GROUNDWATER BALANCE

Annual groundwater inflows and outflows for each management area for the 1990 to 2018 model simulation period are shown as stacked bars in **Figure 5-6**. Inflows are stacked in the positive (upward) direction and outflows are stacked in the negative (downward) direction. A similar stacked-bar chart for the baseline simulation is shown in **Figure 5-7** and for the growth plus climate change simulation in **Figure 5-8**. Average annual groundwater budgets for each MA and budget analysis period are listed in **Table 5-4** and detailed groundwater budget tables are included in **Appendix J**. Highlights of the water budgets are described below, followed by additional information on methods used to quantify each budget item.

In the Bedford MA, the major inflow is percolation from streams especially during wet years. In recent years (2012 to 2018), reclaimed water percolation has become another major inflow. The major outflows include M&I pumping and groundwater discharge to streams. Historically, agricultural pumping also has contributed to outflow from the basin but decreased to a negligible amount by 2007.

Percolation from streams—principally Temescal Wash—was similar across all analysis periods. This was because Temescal Wash inflows increased under the growth plus climate change scenario, offsetting decreased inflow from local tributary streams. Meanwhile, total pumping increased by 71 percent from the historical to the growth plus climate change scenario, which resulted in a slight increase in induced percolation from the Wash. The small increase in bedrock inflow under the growth plus climate change scenario was because urbanization of parts of the tributary watersheds produced enough additional recharge to more than offset the effects of climate change. Subsurface inflow progressively decreased and subsurface outflow increased from the historical period to the growth plus climate change scenario. This was caused by declining water levels in the Coldwater MA, which reversed the direction of flow across the boundary between the MAs around the end of the historical period. Recharge from pipe leaks roughly doubled due to urbanization but remained a small fraction of total inflows (five percent) because of TVWD's low reported pipe leak rate.

Overall in the Bedford MA, both future scenarios show increases in reclaimed water percolation.

Outflows in both scenarios also increased. The net result is a slightly decreased change in storage over the historical period, but the basin is still expected to have a positive change in storage (more inflow than outflow) under future conditions, even under growth and climate change projections.

In the Coldwater MA, percolation from streams occurs as infrequent, episodic events. As shown in **Figure 5-6**, percolation can range from 15,000 acre-feet (AF) in wet years to no stream percolation in dry years. M&I pumping has dominated basin outflows although it has decreased from its peak in the late 1990s. Similar to the Bedford MA, agricultural pumping was an outflow historically but decreased to negligible by 2001.

The differences between the historical, current, and future scenarios stem mostly from the years selected for inclusion in the averaging. Bedrock inflow decreased slightly in the growth plus climate change scenario because of the warmer, drier climatic conditions. The increase in dispersed recharge on both irrigated and non-irrigated lands under the growth plus climate change resulted from urbanization. A fraction of runoff from impervious surfaces is assumed to flow to adjacent pervious soils, creating localized concentrated recharge. This was included in the recharge for non-irrigated lands. As in the Coldwater MA, pipe leaks increased due to urbanization but remained only four percent of total inflows.

Overall in the Coldwater MA, in both future scenarios inflows significantly increase from dispersed rechange over non-irrigated land. Outflows are expected to decline as M&I pumping is projected to be limited in the future based on agreements between the GSA agencies. The combined increased inflow and decreased outflow results in significantly increased storage in future conditions, which reverses the historical water level declines in the Coldwater MA.

Table 5-4. Average Annual Groundwater Budgets

	Bedford Management Area					Coldwater Management Area				
Water Balance Items	**Historical 1993 to 2007**	**Current 2010 to 2013**	**Historical 1993 to 2017**	**Baseline[1] 2019 to 2068**	**Growth Plus Climate Change[1] 2019 to 2068**	**Historical 1993 to 2007**	**Current 2010 to 2013**	**Historical 1993 to 2017**	**Baseline[1] 2019 to 2068**	**Growth Plus Climate Change[1] 2019 to 2068**
Groundwater Inflow										
Subsurface inflow	480	103	353	102	93	10	90	41	34	48
Percolation from streams	1,564	2,015	1,516	1,661	1,714	4,160	3,216	3,327	2,780	2,779
Bedrock inflow	867	816	819	776	828	583	526	536	467	435
Dispersed recharge: non-irrigated land	776	1,040	740	929	1,031	327	487	330	1,164	1,575
Dispersed recharge: irrigated land	792	578	674	559	940	468	336	396	289	396
Pipe leaks	126	156	143	33	92	30	39	35	17	32
Reclaimed water percolation	391	587	638	1,868	2,161	0	0	0	0	0
Quarry recharge	85	21	92	162	471	0	0	0	0	0
Total Inflow	**5,080**	**5,315**	**4,974**	**6,090**	**7,331**	**5,579**	**4,694**	**4,665**	**4,751**	**5,264**
Groundwater Outflow										
Subsurface outflow	-179	-370	-205	-498	-423	-92	0	-55	-15	-7
Wells - M&I and domestic	-1,235	-577	-1,110	-1,315	-1,895	-5,802	-2,969	-4,787	-3,002	-3,072
Wells - agricultural	-728	-65	-460	0	0	-929	-186	-623	-40	-88
Groundwater discharge to streams	-791	-1,137	-786	-990	-1,380	-16	-2	-10	-2	-1
Riparian evapotranspiration	-482	-732	-512	-760	-1,015	-285	-234	-281	-154	-168
Quarry Operations / Losses	-1,447	-1,845	-1,663	-2,422	-2,466	-606	-595	-653	0	0
Total Outflow	**-4,863**	**-4,726**	**-4,737**	**-5,986**	**-7,179**	**-7,730**	**-3,986**	**-6,410**	**-3,212**	**-3,337**
Net Change in Storage										
Inflows minus outflows	217	589	237	104	152	-2,152	708	-1,744	1,539	1,927

[1] : The 50-year future simulation uses historical hydrology for 1993 to 2017 two times in succession.

5.7.1. Inflows to Groundwater

Inflows to the groundwater flow system in both MAs are dominated by rainfall recharge and stream percolation, which vary widely from year to year depending on hydrologic conditions. Variations in bedrock inflow from tributary watersheds is steadier because flow through fractured bedrock in those watersheds attenuates the recharge pulses that occur in wet years. Urban sources of recharge including irrigation return flow and pipe leaks are less variable from year to year but gradually increased during the simulation period in parallel with urban growth.

5.7.1.1. Dispersed Recharge from Rainfall and Irrigation

Dispersed recharge from rainfall and applied irrigation water is estimated by the rainfall-runoff-recharge model. The model simulates soil moisture storage in the root zone, with inflows from rainfall infiltration and irrigation, and outflows to evapotranspiration and deep percolation. Simulation is on a daily basis. In recharge zones with irrigated crops—which includes urban landscaping and agricultural irrigation (citrus)—irrigation is assumed to be applied when soil moisture falls below a certain threshold. When soil moisture exceeds the root zone storage capacity, the excess becomes deep percolation. Rainfall and irrigation water comingle in the root zone and in deep percolation. For the purposes of displaying an itemized water balance, the amount of deep percolation derived from irrigation is estimated as a percentage of the simulated irrigation quantity, and the remainder of the dispersed recharge is attributed to rainfall. Deep percolation of applied irrigation water (irrigation return flow) is generally similar from year to year, whereas rainfall percolation varies significantly on an annual basis. Because urban landscape irrigation increased while agricultural irrigation decreased during the simulation period, total recharge on irrigated lands decreased only slightly. Water pipe leaks were estimated as the percentage of unaccounted for water listed in the 2015 Urban Water Management Plan (eight percent of delivered water, RMC and Woodard & Curran), distributed uniformly over areas of urban land use. Sewer pipes convey only water used indoors, and their leak rate was assumed to be half of the leak rate for water pipes. The one-dimensional dispersed recharge rates are multiplied by the surface area of each recharge zone to obtain volumetric flow rates, and those are subtotaled by management area.

Figure 5-9 shows a map of average annual dispersed recharge during 1993 to 2007. Although this period does not reflect the most current land use, it is a relatively long averaging period that includes a wide range of year types. Most dispersed recharge occurs during relatively wet years. Average annual recharge rates ranged from less than 0.4 to slightly over 13 inches per year (in/yr). Within the Basin, land use had the largest effect on recharge, with residential land uses having relatively high rates because of landscape irrigation, pipe leaks and percolation of a fraction of the runoff from impervious areas. In tributary watershed areas, partitioning of deep percolation beneath the root zone into stream base flow versus groundwater recharge had a strong influence on simulated recharge. In watersheds on the east side of the Basin, a higher percentage of deep percolation was assigned to base flow than in watersheds on the west side of the Basin in order to better match observed stream flows.

5.7.1.2. Percolation from Streams

Inflows to the stream network in the surface water module of the groundwater model include a combination of gauged flows, and simulated runoff from tributary watersheds and valley floor areas obtained from the rainfall-runoff-recharge model.

The surface water module of the groundwater model simulates percolation reach by reach along each stream that crosses the basin, including Temescal Wash and small streams emanating from 15 watersheds around the periphery of the Basin. Percolation is affected by groundwater levels where the water table is equal to or higher than the elevation of the stream bed. This is sometimes the case along Temescal Wash, but the small tributary streams are mostly high above the water table elevation except up in the canyons where they first enter the Basin.

5.7.1.3. Reclaimed Water Percolation

Reclaimed wastewater is percolated in ponds at the TVWD WRF and the City of Corona's WRF-3. However, most of the reclaimed water is recycled for irrigation. Annual or monthly data describing the partitioning of reclaimed water into irrigation, pond percolation and discharge to Temescal Wash were obtained from TVWD and the City of Corona.

5.7.1.4. Subsurface Groundwater Inflow

Subsurface inflow from an adjacent MA or a neighboring basin is simulated by the groundwater model based on water level gradients and subsurface permeability along the boundary segments. In the Coldwater MA, the only such boundary is the Glen Ivy Fault, and flow across that boundary is almost entirely outward to the Bedford MA. In addition to the Glen Ivy Fault, the Bedford MA receives a small among of subsurface inflow from the Elsinore Subbasin and generates a small amount of outflow to the Temescal Basin. Small amounts of subsurface inflow to both MAs also occurs where they abut upland tributary watersheds. Recharge in those watersheds flows toward the Basin through fractures in bedrock. This process is simulated by the rainfall-runoff-recharge model.

5.7.1.5. Quarry Recharge

Quarry recharge represents inflows of surface water into existing quarries where it is allowed to recharge into the groundwater. In the Coldwater MA, streamflow from Mayhew Creek and some other smaller streams is directed into existing quarry areas where the water is contained and allowed to percolate. Coldwater Creek has been redirected around an existing quarry. Although Coldwater Creek is not currently directed into a quarry, there have been historic instances where flood flows have gone into the quarries, especially prior to 2005. A portion of the estimated streamflow from the rainfall-runoff-recharge model for each stream is recharged to groundwater at the quarry location.

Similarly, in the Bedford MA, streamflow from Brown and McBride Creeks flows into the Mobile Sand quarry located just north of the TVWD WRF. In addition, streamflow from Temescal Wash can flow into the quarry location especially during high and flood flows. The quarry pit at this location is below the water table and is consistently flooded. To estimate the recharge, the MODFLOW model applies a boundary condition based on the observed water level in the pit to estimate the volume of quarry recharge.

5.7.2. Outflows from Groundwater

Major outflows from the Basin are groundwater pumping (municipal, industrial, agricultural, and domestic), groundwater discharge into streams, and evapotranspiration by riparian vegetation.

5.7.2.1. Pumping by Wells

Pumping from M&I wells has been measured and recorded for many years by TVWD and Western. Those data are used in the groundwater model. Total pumping for both MAs was about 11,000 (acre feet per year) AFY in the 1990s and decreased to around 3,000 AFY by 2018. This trend was caused by the replacement of groundwater-supplied citrus orchards to urban land uses supplied almost entirely by imported water. In the Bedford MA, TVWD pumps groundwater to supplement recycled water used for irrigation. In the Coldwater MA, groundwater is pumped and exported for municipal use in the Elsinore Subbasin and Temescal Basin by EVMWD and the City of Corona. Pumping is expected to remain around current volumes in the Coldwater MA, consistent with the existing agreement between Corona and EVMWD. However, pumping in the Bedford MA is expected to increase to accommodate future TVWD non-potable water demands.

5.7.2.2. Subsurface Outflow

Subsurface outflows to other MAs or external basins were calculated with the groundwater model by the same methods used to simulate subsurface inflows. The two outflow boundaries are from the Coldwater MA to the Bedford MA and from the Bedford MA to the Temescal Basin. Both of those flows are minor components of the water budget (one to four percent of total outflows).

5.7.2.3. Groundwater Discharge to Streams

Discharges from the Basin to surface water bodies are simulated by the groundwater model based on streambed wetted area, permeability, and on the amount by which the simulated groundwater elevation in a model stream cell is higher than the simulated surface water elevation. This probably occurs at times along Temescal Wash, although dry-season Google Earth aerial photographs rarely show open water in the channel. The groundwater model simulated groundwater discharge to Temescal Wash that averaged 16 percent of total outflow from the Bedford MA during 1993 to 2007.

5.7.2.4. Riparian Evapotranspiration

Evapotranspiration of groundwater by phreatophytic riparian vegetation is influenced by available soil moisture and by depth to the water table. Like other types of vegetation, phreatophytes use soil moisture supplied by rainfall when it is available. Any remaining evapotranspiration demand is met by drawing water from the water table. Phreatophyte use of groundwater is assumed to decrease from the maximum rate when the water table is at the land surface to zero when the water table is 20 feet or more below the ground surface. These calculations are applied at all model cells, but non-zero amounts only occur where the depth to water is commonly less than 20 feet. Aerial photographs indicate a correlation between those areas and the presence of dense, lush riparian vegetation.

Riparian evapotranspiration (ET) was a relatively minor component of groundwater outflow in both MAs—averaging four percent of total outflows from the Coldwater MA and 10 percent of total outflows from the Bedford MA.

5.7.2.5. Quarry Operations and Losses

Quarry outflows represents outflows associated with active or passive quarry operations to account for observed water conditions within the deeper quarry pits. In the Coldwater MA, excavations continued within the large quarry pits following periods of high groundwater levels for the period from 1990 to 2010. During model calibration, it was necessary to assume that additional pumping or other groundwater removal occurred during these operational periods to maintain the observed groundwater levels. Since 2010, it is our understanding that no additional pumping to maintain quarry water levels at the elevations necessary for deepening pits has occurred, which is supported by the historical model calibration.

In the Bedford MA, the rim of the Mobile Sand quarry located just north of the TVWD WRF is low enough to allow surface flow between the pit and Temescal Wash when water levels in the pit or Wash are high. To estimate these flows, the groundwater model applies a boundary condition based on the observed water levels in the pit and Wash to estimate the volume of into or out of the pit. This is a head-dependent boundary condition that is able to calculate either quarry recharge or outflow based on groundwater conditions.

5.8. CHANGE IN GROUNDWATER STORAGE

Figure 5-10 shows the cumulative change in storage from the model for the two Management Areas during 1990 through 2068. The baseline and growth plus climate change scenario results for 2019 to 2068 are displayed as continuations of the historical storage changes from 1990 to 2018.

As shown, groundwater storage in the Bedford MA increased slightly during 1990 to 2018, presumably as a result of the decrease in total groundwater pumping. Consistent with total simulated inflows and outflows, the storage trend during 2019 to 2068 was level to slightly increasing for both future scenarios. Storage was slightly higher during droughts under the growth plus climate change scenario relative to the future baseline scenario. This is because urban recharge continues during droughts. High recharge in wet years tended to reset storage for both scenarios to a similar elevation that is partly limited by interaction with Temescal Wash.

Simulated historical storage in the Coldwater MA declined by a cumulative total of 60,000 AF from 1990 to 2004. EVMWD and Corona entered into an agreement to limit pumping in the MA to safe or sustainable yield in 2008 (Corona and EVMWD 2008). As a result, there was little additional cumulative decline from 2005 to 2018. As a result of decreased pumping, storage under both future scenarios increased steadily from 2019 to 2068. Inflows exceeded outflows in the water budget because of increased urban recharge and continued limitation of pumping. The rate of storage increase was slightly higher under the growth plus climate change scenario relative to the baseline scenario, which can be attributed to increased urban return flow recharge.

5.9. ESTIMATE OF SUSTAINABLE YIELD

The sustainable yield is defined as the volume of pumping that the Basin can sustain without causing undesirable effects. It is not a fixed or inherent natural characteristic of a groundwater basin. Rather, it is influenced by land use activities, importation of water, wastewater and stormwater management methods, potential recharge with recycled water, and the locations of wells with respect to interconnected streams. The estimates of sustainable yield presented in this section reflect the current status of those variables under the historical and future scenarios and evaluates whether there would be a long-term increase or decrease in basin storage if those conditions continued over a 50-year future period.

A long analysis period is needed to evaluate yield because of the episodic nature of natural recharge. Whereas pumping, irrigation return flow, and pipe leaks are fairly constant from year to year, recharge from precipitation and streams varies widely. Because of evolving land use during 1990 to 2018, no subset of years is ideal for estimating sustainable yield. For the purposes of this GSP historical sustainable yield was calculated based on 1993 to 2017, which is representative of long-term average conditions in terms of precipitation and stream flow. Sustainable yield was estimated for each management area for the historical simulation (using 1993 to 2017) and the two future simulations (both using all 50 years of the simulation). A simple estimate of sustainable yield can be obtained by adding average annual pumping to average annual change in storage, as shown in **Table 5-5**.

Table 5-5. Estimated Sustainable Yield

	Sustainable Yield (acre-feet per year)		
Management Area	**Historical 1993 to 2017**[1]	**Baseline 2019 to 2068**[2]	**Growth Plus Climate Change 2019 to 2068**[2]
Bedford	1,808	1,419	2,047
Coldwater	4,319	4,581	5,088
Total	6,127	6,000	7,134

[1] For the historical sustainable yield estimate, average annual water budgets during 1993 to 2017 were used.

[2] The 50-year future simulation uses historical hydrology for 1993 to 2017 two times in succession.

The baseline simulation generally produces a better estimate of sustainable yield for planning purposes because it incorporates existing land and water use patterns and a long averaging period that more completely captures climatic and conjunctive use cycles. The sustainable yield under baseline conditions was estimated by the same method used for the historical budget analysis period: simulated average annual storage change over the 50-year simulation was added to average annual pumping for each MA.

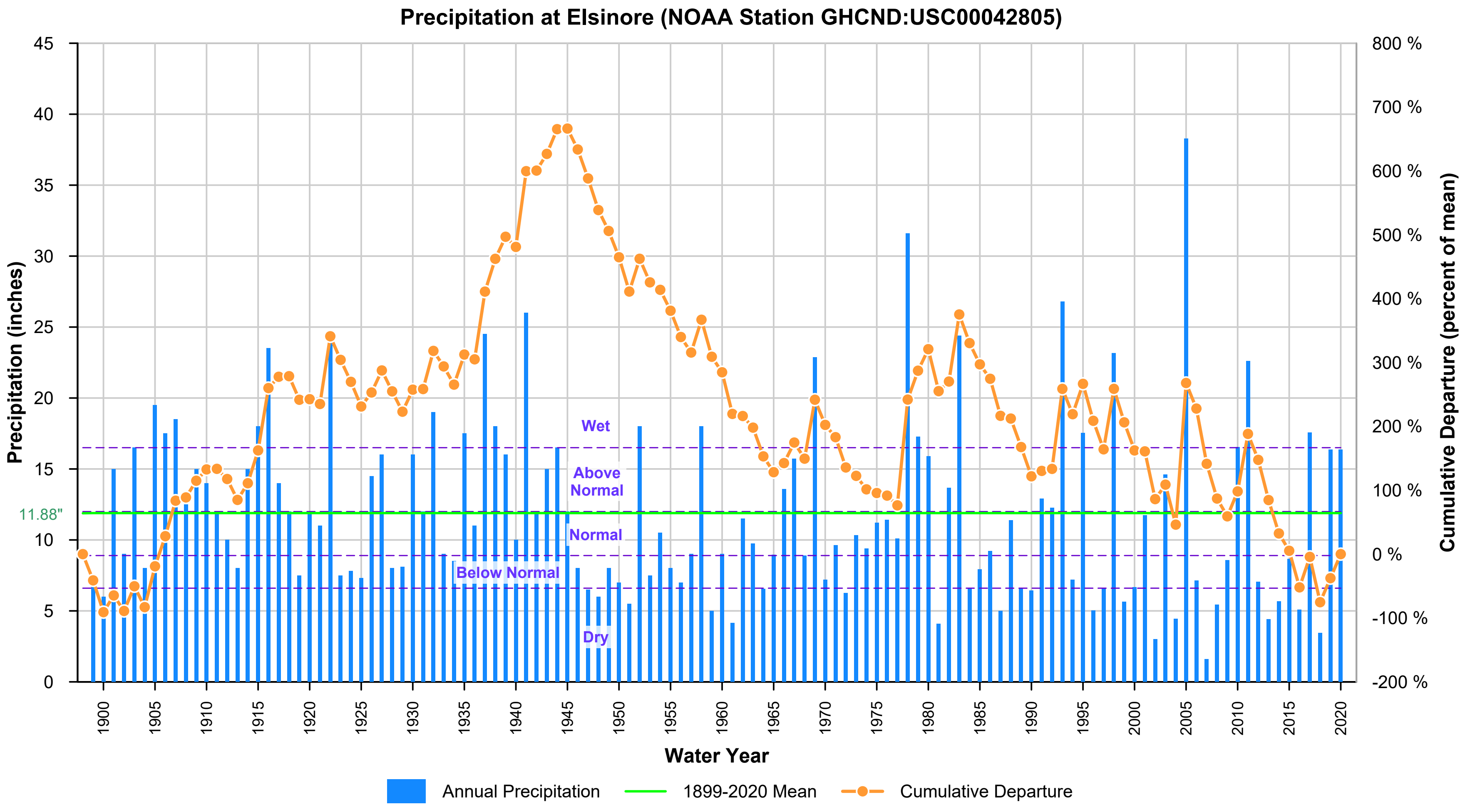
This method of estimating sustainable yield ignores head-dependent responses to pumping in the water budget. In other words, storage change is not the only variable that responds to an increase in pumping. In reality, the response is spread out among storage change, subsurface inflow, subsurface outflow, percolation from streams and groundwater seepage into streams. If those head-dependent boundaries are major parts of the flow system, then an increase in pumping will result in an increase in the estimate of sustainable yield. This boundary interaction effect was not revealed in the Coldwater MA because head-dependent boundary flows there are relatively minor. However, the simulations in the Bedford MA show some variability in sustainable yield as a result of variable pumping in the simulations. The sustainable yield estimates for the Bedford MA understate sustainable yield because of the high degree of interconnection between groundwater and surface water in Temescal Wash. Additional pumping increases net percolation from the Wash at times when the Wash is flowing. This increase in recharge approximately balances increased pumping, thereby preventing a long-term decrease in storage. This situation results in higher estimates of sustainable yield, as shown in the Bedford MA growth plus climate change sustainable yield in Table 5-5.

The estimates of sustainable yield presented here for the two management areas differ from previous estimates that had different objectives. A previous study of groundwater development potential for the Bedford MA quantified many aspects of the water budget but did not explicitly state an estimated sustainable yield (WEI 2015b). It was asserted that a yield estimate based on historical data would not be representative of future conditions and that future pumping and recharge could strongly affect net percolation from Temescal Wash and therefore also the calculated sustainable yield. The study also did not discuss recharge and pumping related to mining activities, which current modeling shows are important components of the water budget. However, the study recommended that total pumping of no more than 2,000 AFY be implemented in conjunction with water-level monitoring to track the associated long-term changes in storage.

For the Coldwater MA, an estimated yield of 3,300 AFY was the basis of a 2008 agreement between City of Corona and EVMWD regarding sharing of yield (Corona and EVMWD 2008). This is roughly consistent with pumping and storage change in the current period water budget (**Table 5-4**), but it is smaller than the yield estimates calculated here for the baseline and growth plus climate change scenarios.

The sustainable yield estimates presented here are the result of a comprehensive review of the historical and future water budget components throughout the Basin. The higher future yield values are the result of increased urban recharge as development progresses in the Basin, as required for SGMA.

Sustainable yields calculated from the future scenarios are based on projections far into the future. Slight imbalances in estimated water budgets can result in large cumulative changes in storage, and hence in the calculated yields. By the same token, the long planning horizon provides ample time to adjust water management (recharge and pumping) to maintain basin operation within the sustainable yield if long-term rising or falling trends in cumulative storage in fact occur. In the context of this GSP, sustainable yield estimated from the water budget is contingent on the absence of undesirable results related to water levels, storage, subsidence, water quality, or depletion of interconnected surface water. Quantitative sustainability criteria are presented in Section 6 that define thresholds at which groundwater conditions become undesirable for each of those sustainability indicators. For example, if pumping at the above estimates of sustainable yield caused subsidence or significant impacts on riparian or aquatic habitats, the yield may need to be reduced to avoid those impacts. Accordingly, this sustainable yield value is a broad indicator. It indicates no overdraft based on the water budget, but it must be interpreted through evaluation of undesirable results.



Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 5-1 Cumulative Departure of Precipitation.gpj

TODD GROUNDWATER

Figure 5-1
Cumulative Departure
of Annual Precipitation

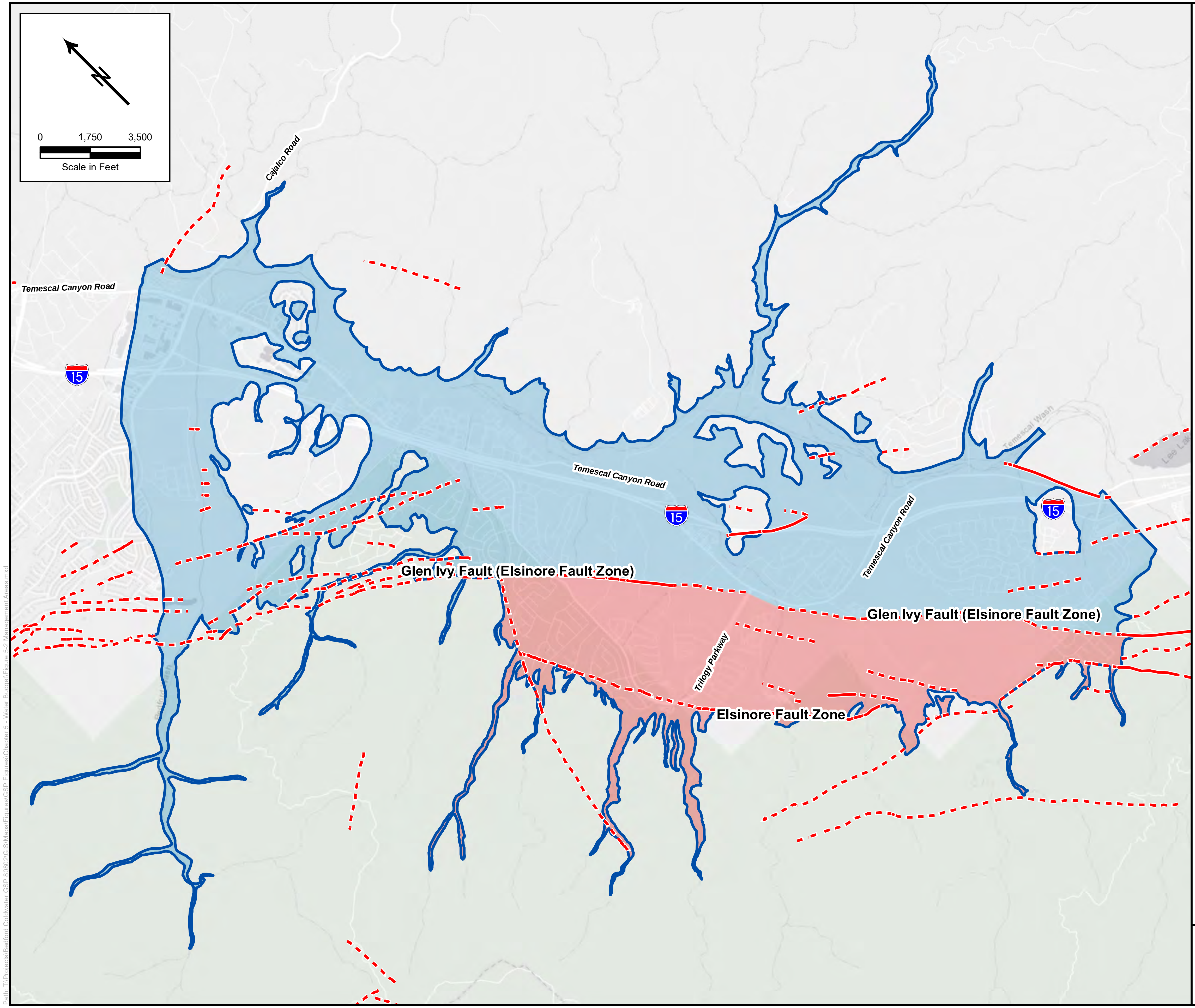
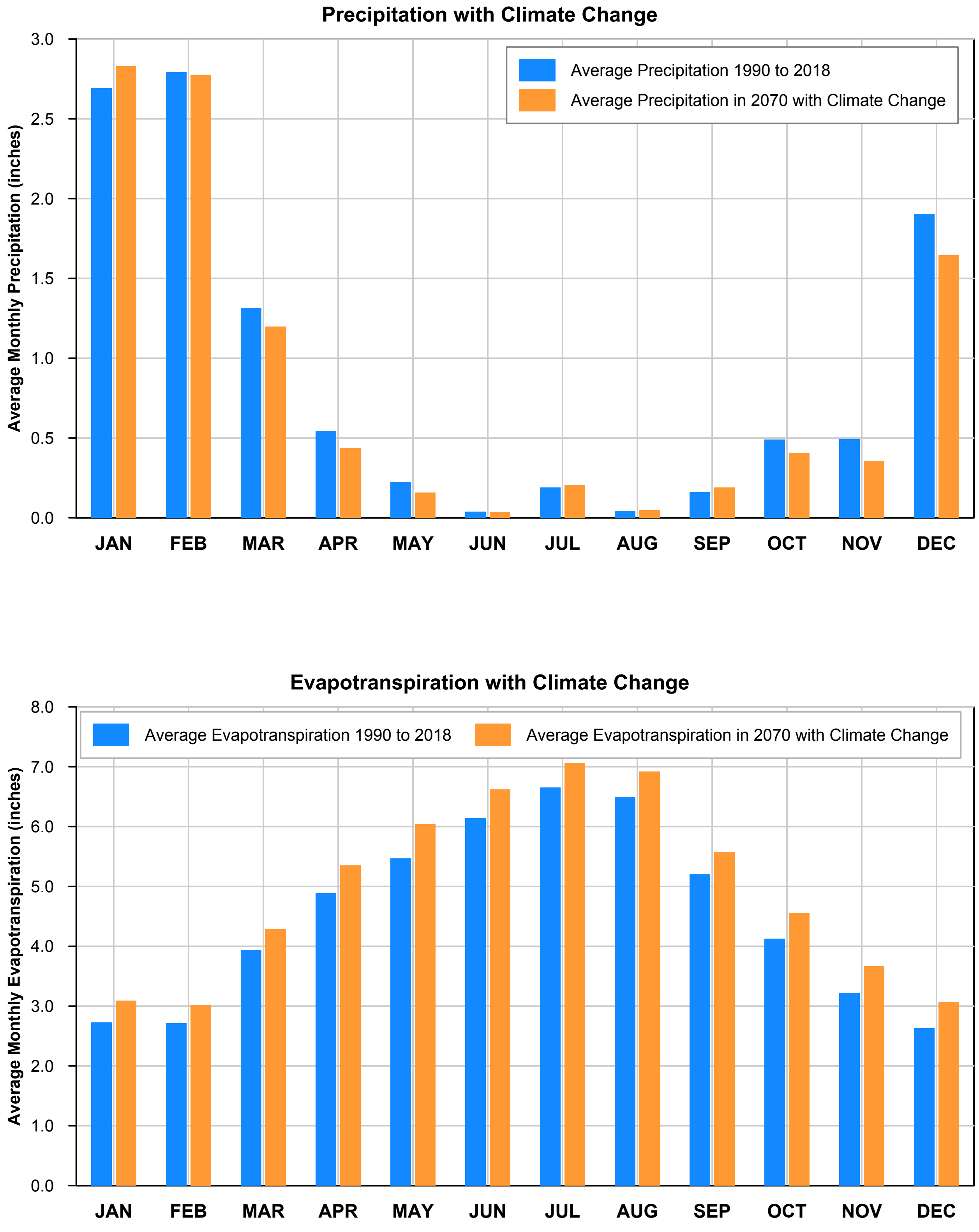


Figure 5-2
Management Areas



TODD GROUNDWATER

Figure 5-3
Effect of Climate Change on Precipitation and Evapotranspiration

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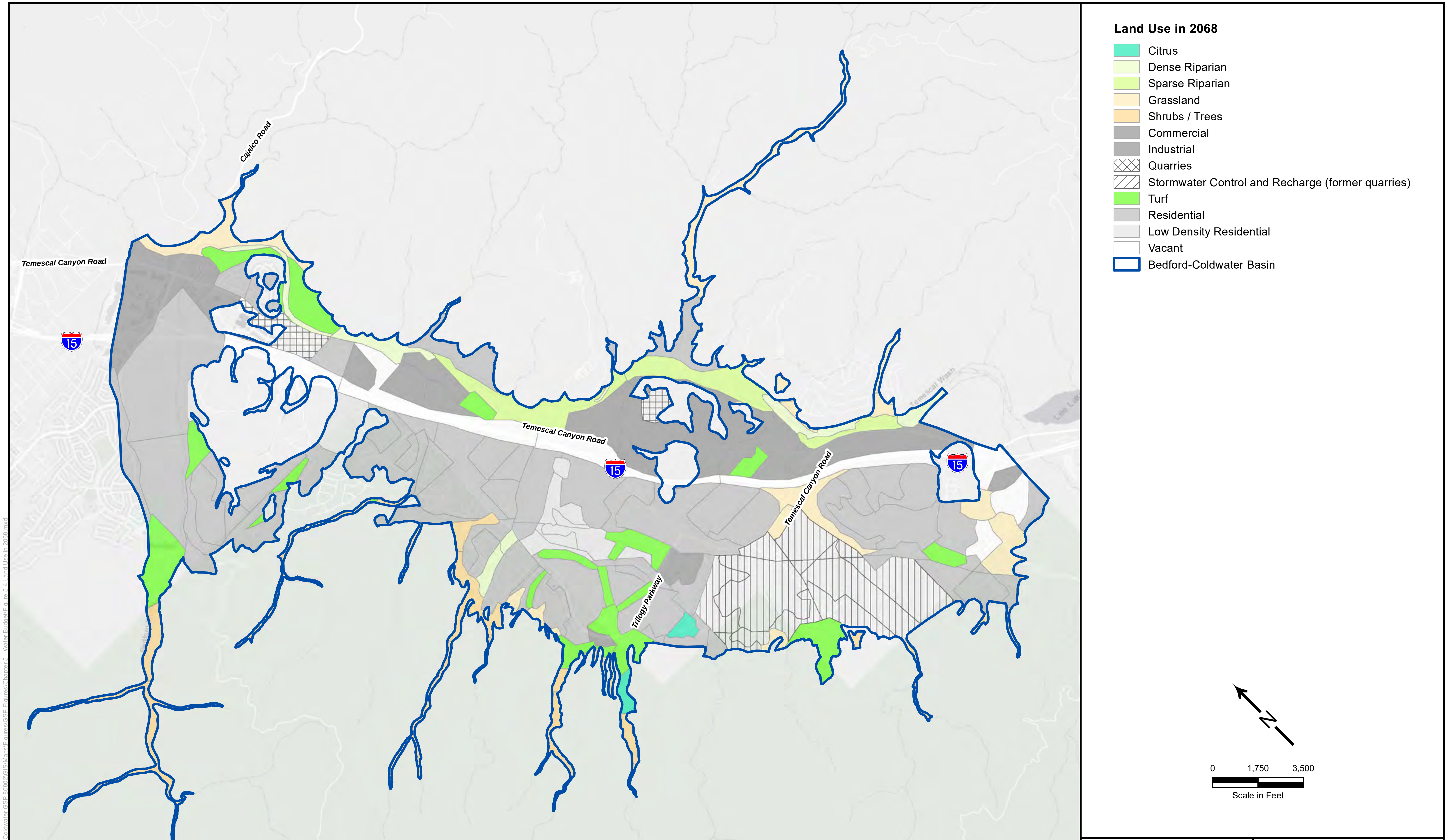

TODD GROUNDWATER

Figure 5-4
Land Use in 2068

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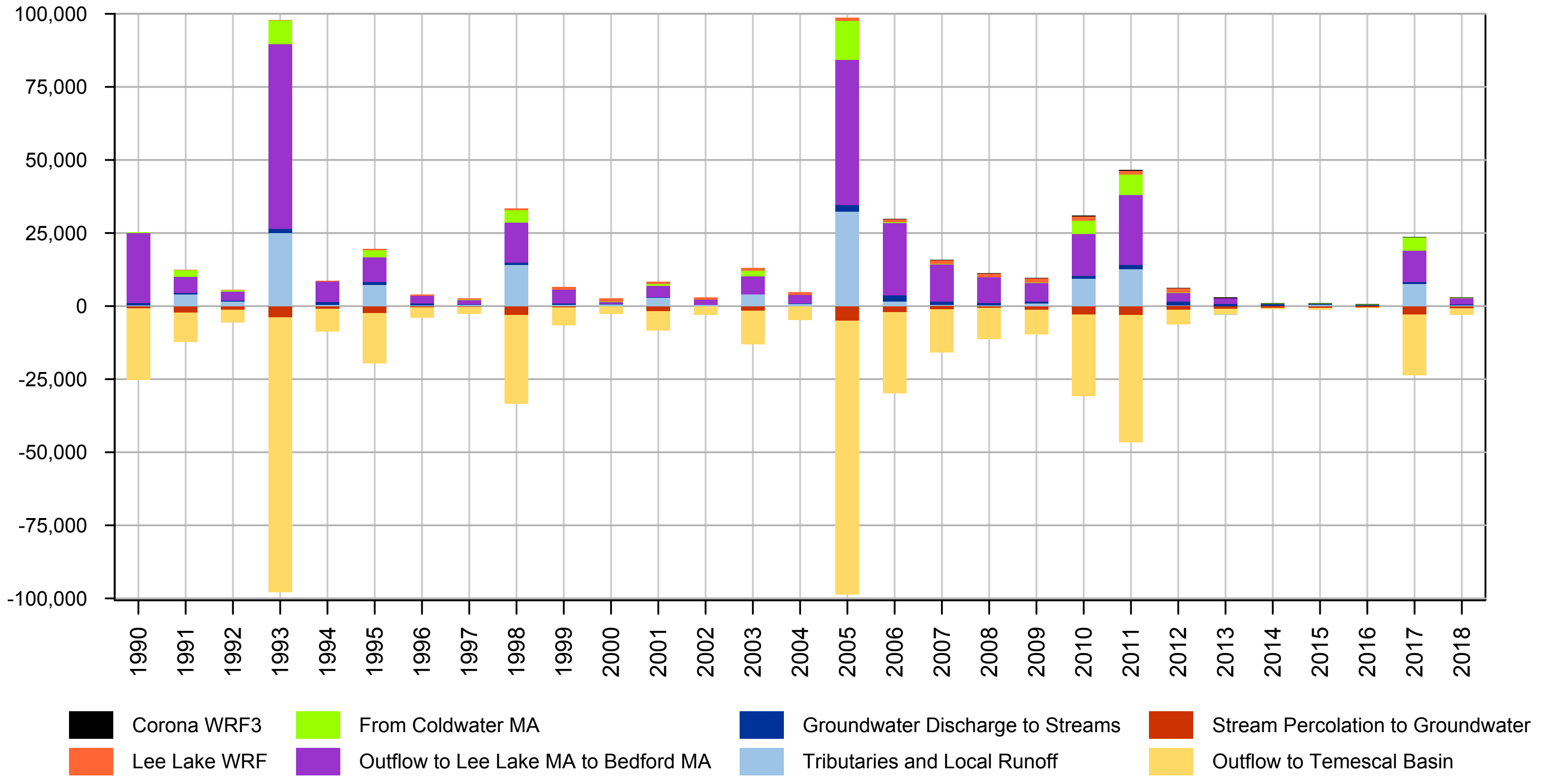
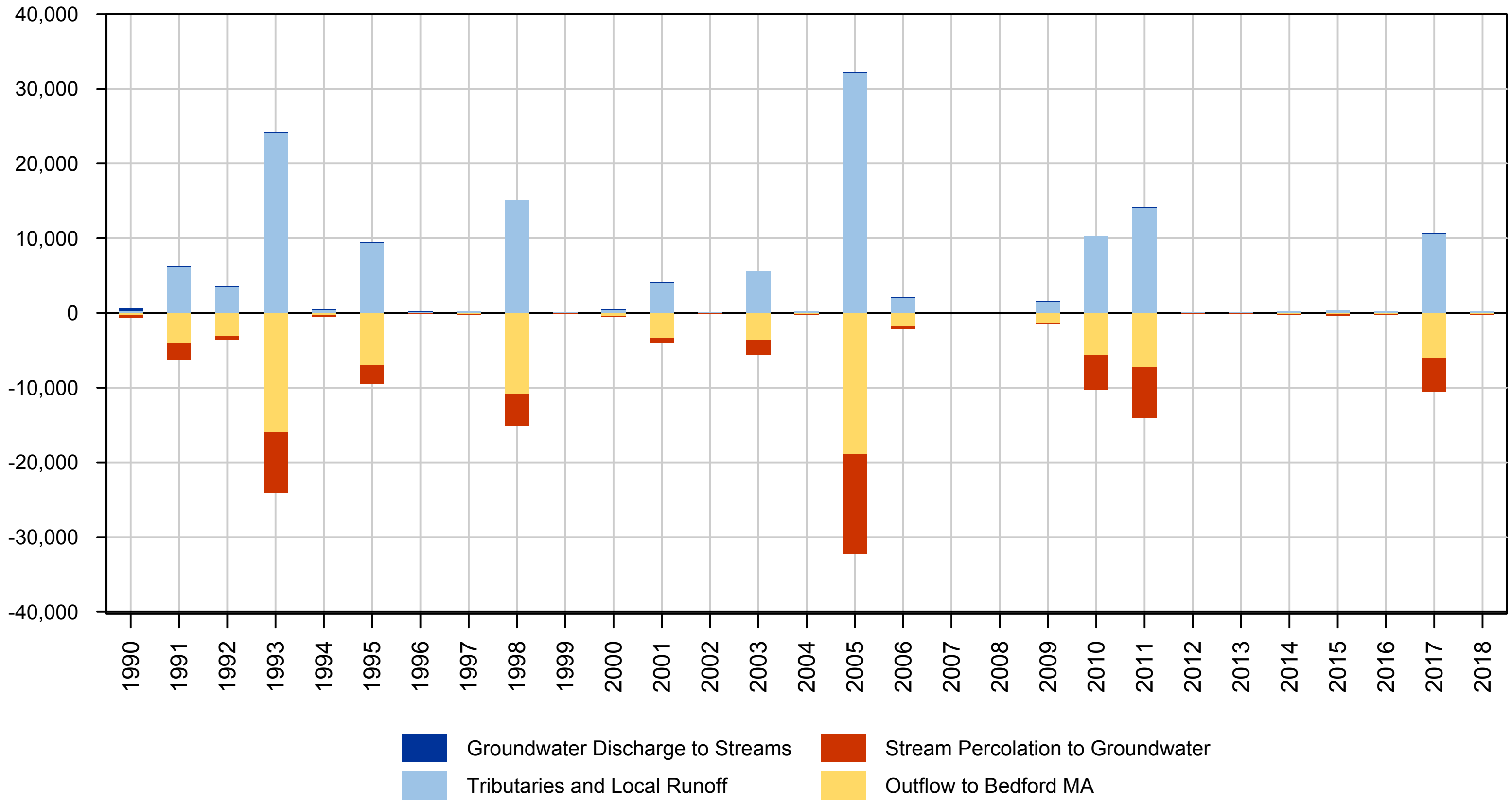
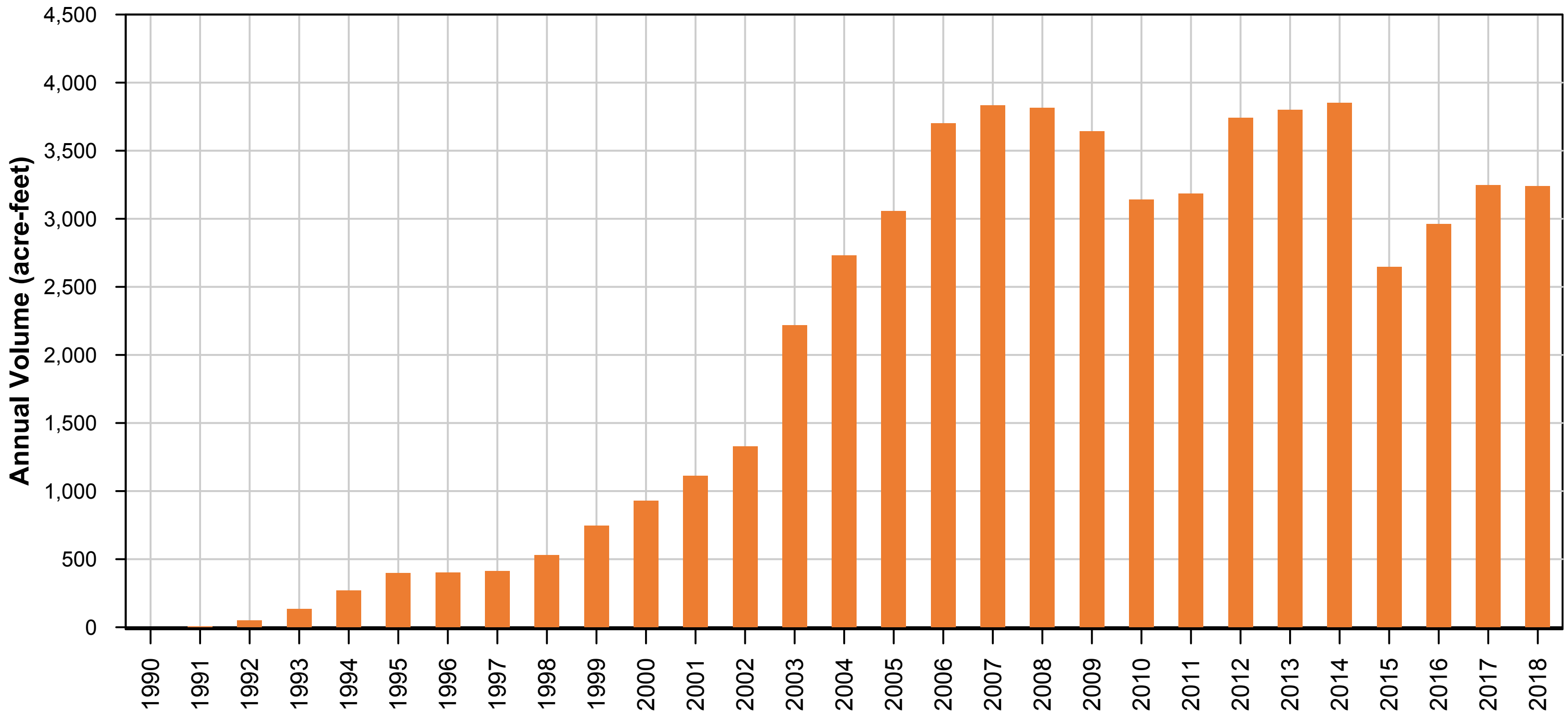
Bedford Management Area Surface Water Budget



Coldwater Management Area Surface Water Budget



TVWD Imported Water



TODD GROUNDWATER

Figure 5-5
Surface Water Budgets
1990 through 2018

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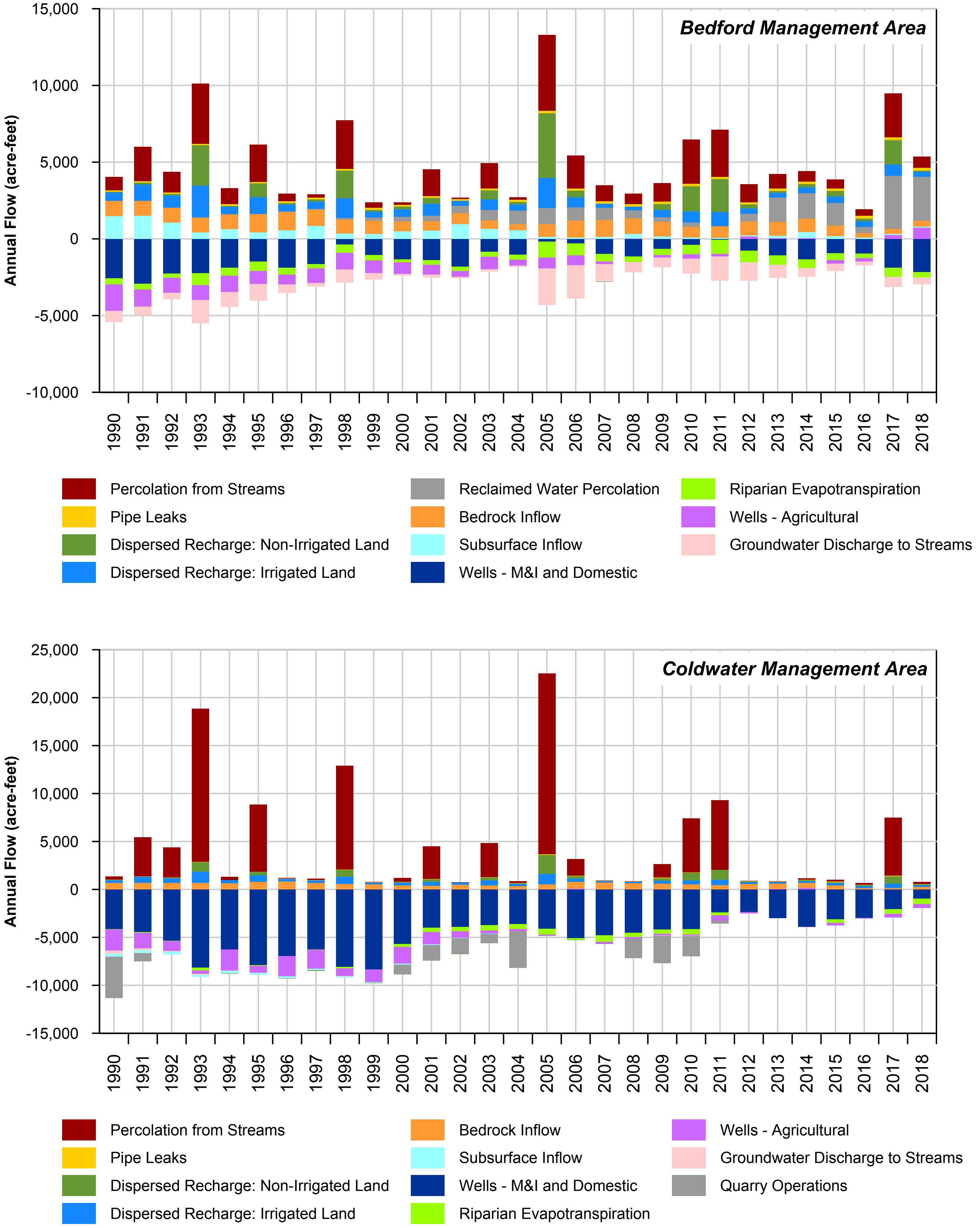
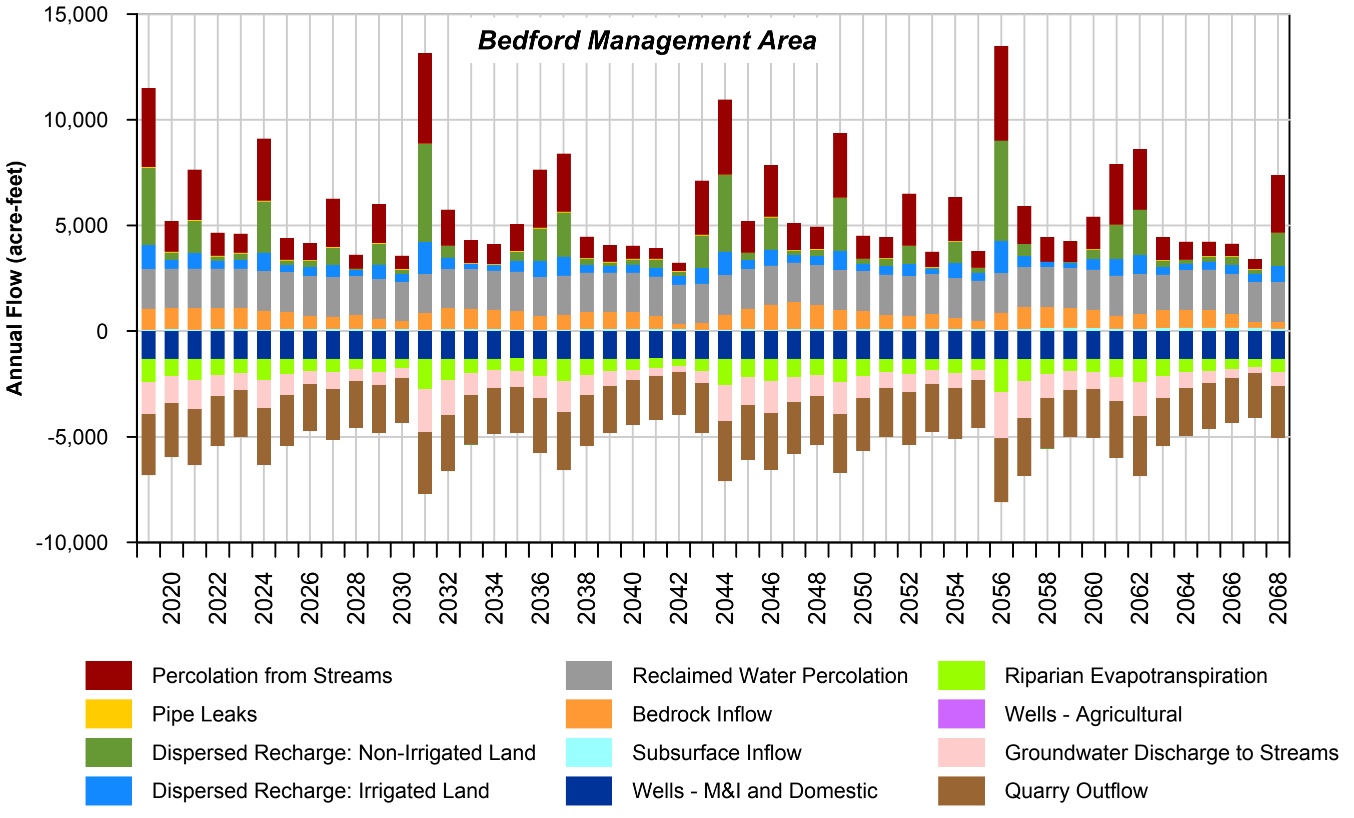
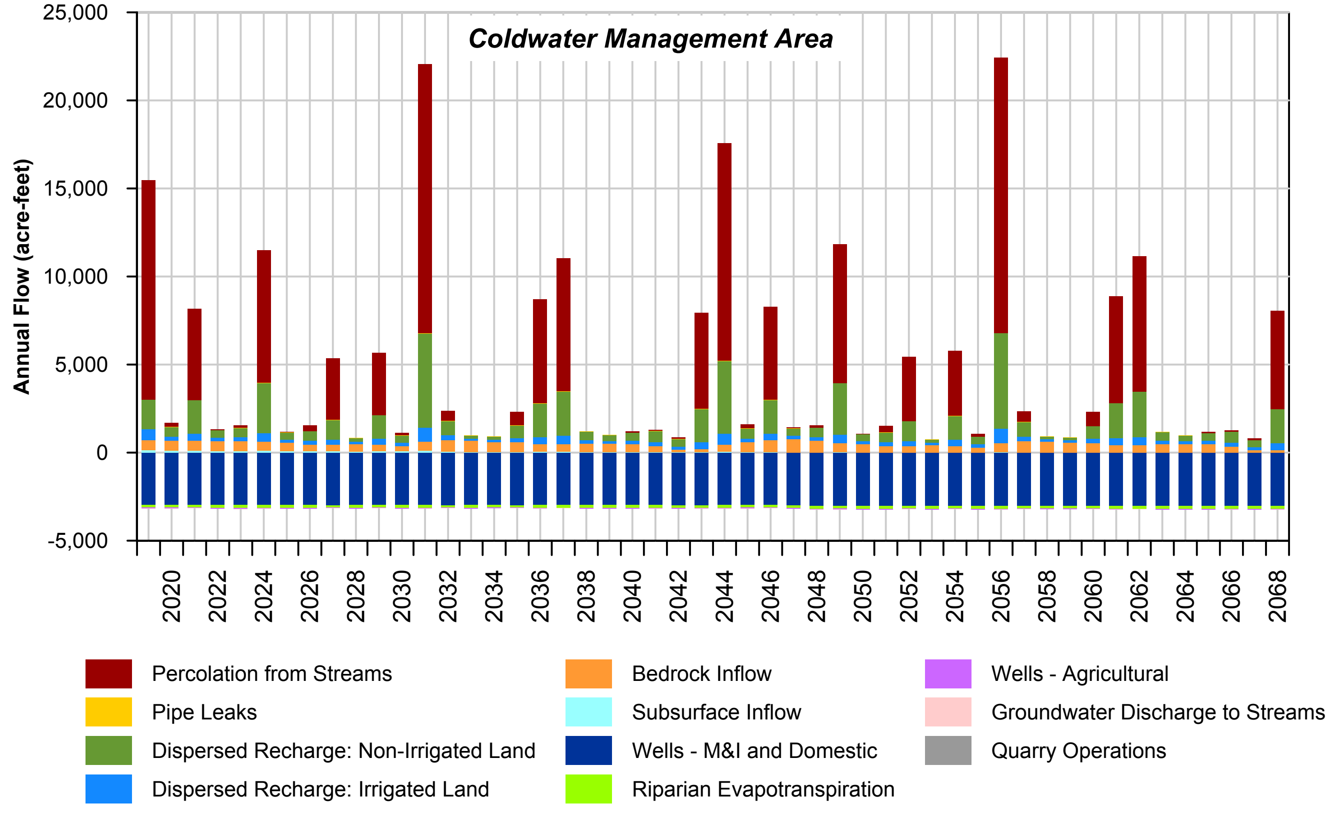


Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 5-6 Annual Groundwater Budgets 1990-2018.gpj

TODD GROUNDWATER

Figure 5-6
Annual Groundwater Budgets, 1990 to 2018

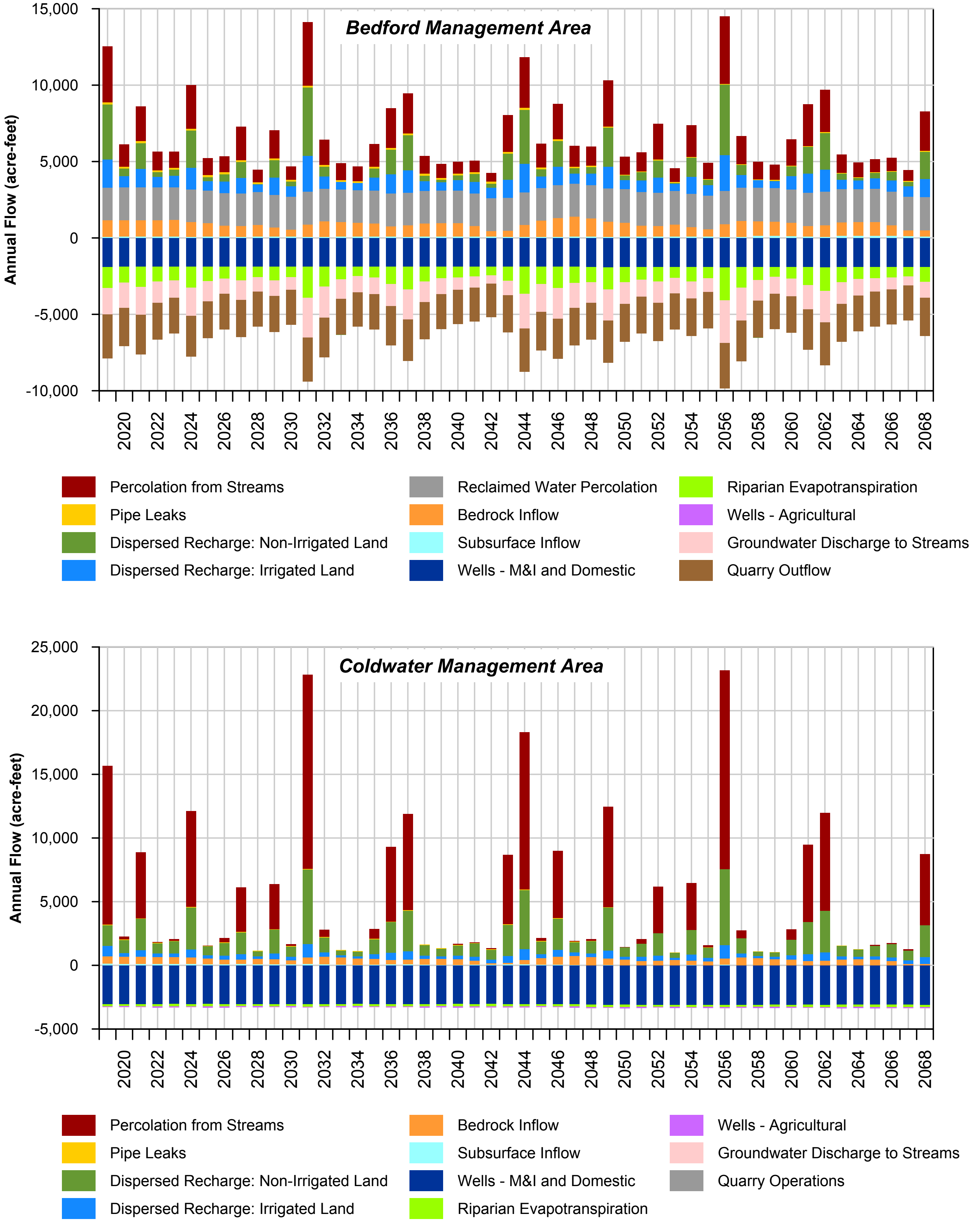




Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 5-7 Annual Groundwater Budgets - Future Baseline.gpj

TODD GROUNDWATER

Figure 5-7
Annual Groundwater Budgets, Baseline



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TODD GROUNDWATER

Figure 5-8
Annual Groundwater Budgets, Growth Plus Climate Change

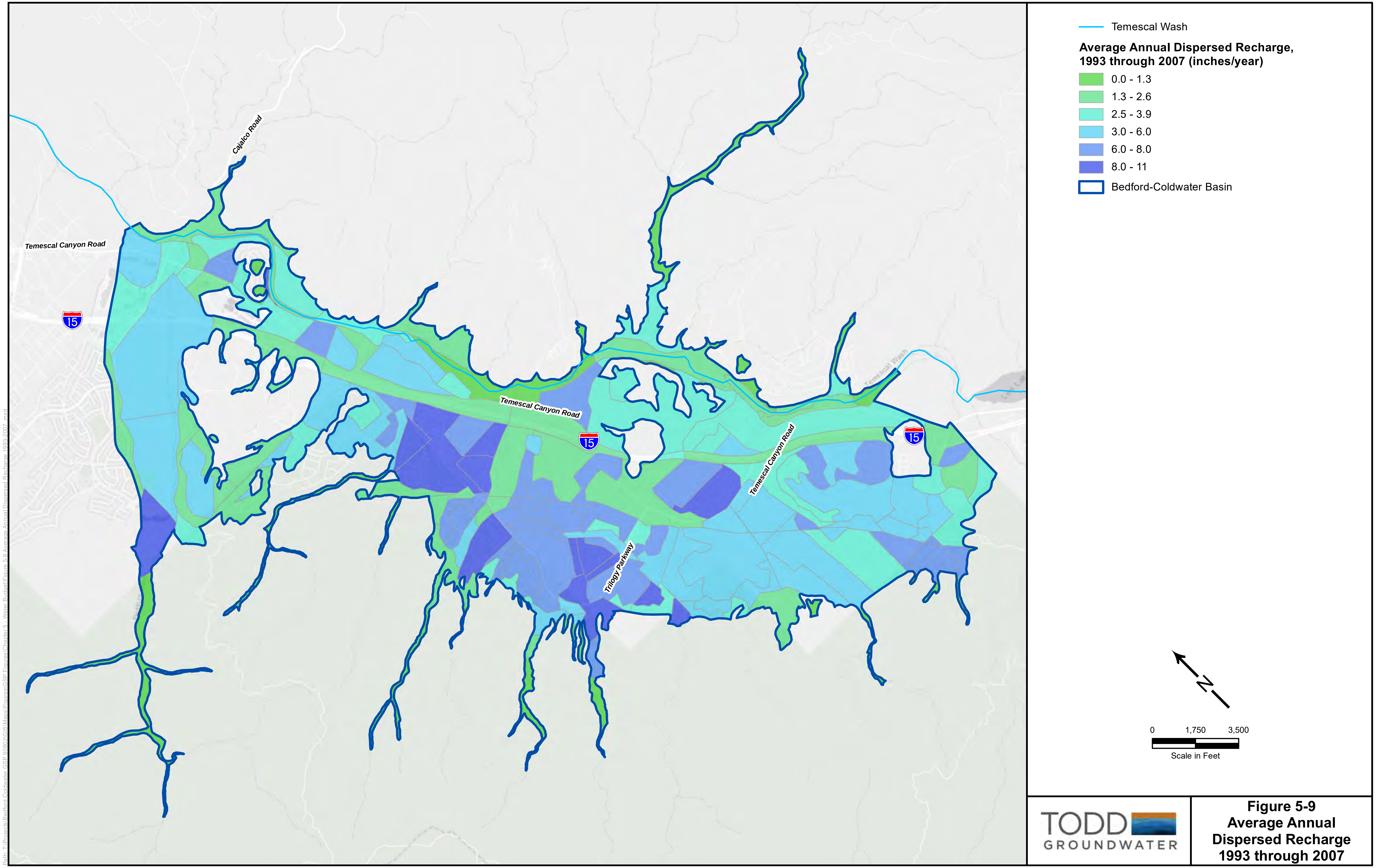

Figure 5-9
Average Annual
Dispersed Recharge
1993 through 2007

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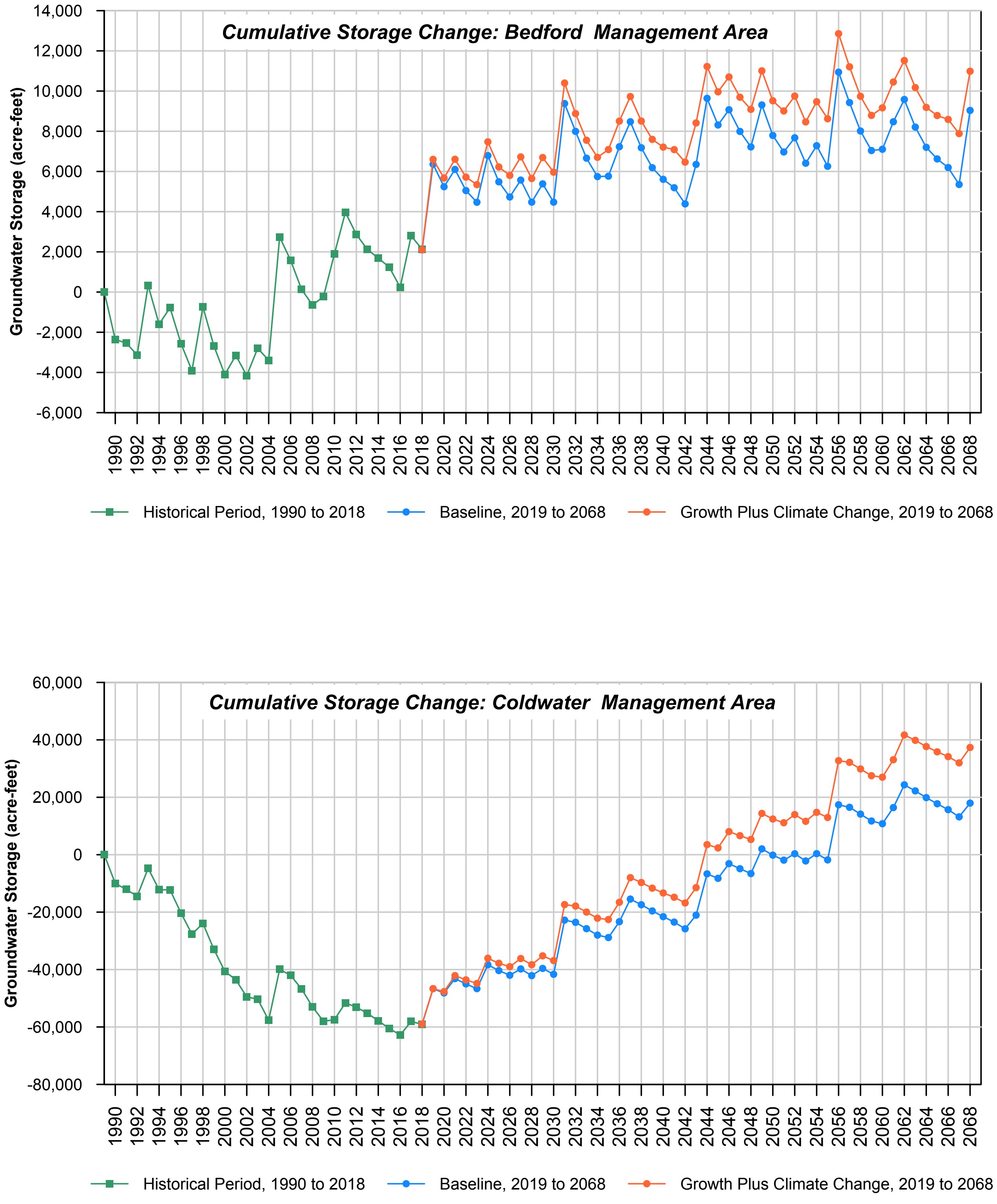

Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 5-10 Cumulative Storage Changes 1990-2068.gpj

TODD GROUNDWATER

Figure 5-10
Cumulative Storage Changes
1990 to 2068

6. SUSTAINABLE MANAGEMENT CRITERIA

The Sustainable Groundwater Management Act (SGMA) defines sustainable management as the use and management of groundwater in a manner that can be maintained without causing *undesirable results*, which are defined as significant and unreasonable effects caused by groundwater conditions occurring throughout the Bedford-Coldwater Subbasin (Basin), which include:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply.
- Significant and unreasonable reduction of groundwater storage.
- Significant and unreasonable seawater intrusion.
- Significant and unreasonable land subsidence that substantially interferes with surface land uses.
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

For these sustainability indicators[5], a Groundwater Sustainability Plan (GSP) must develop quantitative sustainability criteria that allow the Groundwater Sustainability Agency (GSA) to define, measure, and track sustainable management. These criteria include the following:

- Undesirable Result – significant and unreasonable conditions for any of the six sustainability indicators.
- Minimum Threshold (MT[6]) – numeric value used to define undesirable results for each sustainability indicator.
- Measurable Objective (MO) – specific, quantifiable goal to track the performance of sustainable management.

Together, these sustainability criteria provide a framework to define sustainable management and delineate between favorable and unfavorable groundwater conditions. This framework also supports quantitative tracking that identifies problems promptly, allows assessment of management actions, and demonstrates progress in achieving the goal of sustainability.

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[5] If one or more undesirable results can be demonstrated as not present and not likely to occur, a GSA is not required to establish the respective sustainability criteria per GSP Regulations §354.26(d); in the inland Bedford-Coldwater Basin (Basin) seawater intrusion is not present and not likely to occur.

[6] The abbreviations for Minimum Threshold (MT) and Measurable Objective (MO) are provided because these terms are used often; however, the full unabbreviated term is used when helpful for clarity or when included in a quotation.

6.1. SUSTAINABILITY GOAL

The sustainability goal can be described as the mission statement of the GSA for managing the Basin; it embodies the purpose of sustainably managing groundwater resources and reflects the local community's values—economic, social, and environmental. The sustainability goal for the Basin, stated below, was developed through discussion at several GSA meetings.

6.1.1. Description of Sustainability Goal

The goal of the GSA in preparing this GSP is to sustain groundwater resources for the current and future beneficial uses of the Bedford-Coldwater Basin in a manner that is adaptive and responsive to the following objectives:

- Provide a long-term, reliable and efficient groundwater supply for municipal, industrial, and other uses;
- Provide reliable storage for water supply resilience during droughts and shortages;
- Protect groundwater quality;
- Support beneficial uses of interconnected surface waters; and
- Support integrated and cooperative water resource management.

This goal is consistent with SGMA and is based on information from the Plan Area, Hydrogeologic Conceptual Model, Groundwater Conditions, and Water Budget sections that:

- Identify beneficial uses of Basin groundwater and document the roles of local water and land use agencies;
- Describe the local hydrogeologic setting, groundwater quality conditions, groundwater levels and storage, and inflows and outflows of the Basin; and
- Document the ongoing water resource monitoring and conjunctive management of groundwater, local surface water, recycled water and especially imported water sources that help protect groundwater quality and maintain water supply.

6.1.2. Approach to Sustainability Indicators

The approach to assessing the sustainability indicators and setting the sustainability criteria has been based on:

- Review of available information from the Plan Area, Hydrogeologic Conceptual Model, Groundwater Conditions, and Water Budget sections of the GSP.
- Discussions with Bedford-Coldwater stakeholders and local agency representatives, GSA manager meetings, and workshops.

This approach has developed throughout the process and generally began with definition of what an undesirable result is; this initially has been exploratory and qualitative and based on plain-language understanding of what *undesirable* means. Potential minimum thresholds have been explored in terms of when, where, how long, why, under what circumstances, and what beneficial use is adversely affected. This step identified seawater intrusion as not present and not likely to occur.

Beyond a qualitative identification of what is undesirable, the approach to defining sustainability indicators varies among the undesirable results. Several of the undesirable results are directly or indirectly related to groundwater levels, including conditions related to groundwater storage, subsidence, and interconnected surface water. The definition began in terms of groundwater levels in individual wells but has recognized that storage depletion, subsidence, and impacts on connected surface water occur as water levels decline. As a result, the sustainability criteria for those indicators are interrelated across space and time, and are coordinated, consistent, and reasonable based on the available data.

The consideration of the causes and circumstances of undesirable results is an important one in Bedford-Coldwater as multiple agencies rely on this small Basin. Water is produced and used in the Basin by Temescal Valley Water District (TVWD) and produced for use in the Basin and in the neighboring Temescal and Elsinore Basins by the City of Corona (Corona) and Elsinore Valley Municipal Water District (EVMWD), respectively. Cooperative groundwater management between these three major agencies is essential to ensure sustainability.

The intent is to quantify and qualify sustainability criteria such that they guide good management without setting off false alarms or triggering costly, ineffective, or harmful management actions.

6.1.3. Summary of Sustainable Management Criteria

This section documents the six sustainability criteria as relevant to Bedford-Coldwater Basin and as guided by the Sustainability Goal. As documented in this section, the Basin has been and is being managed sustainably relative to all criteria (except seawater intrusion, which does not apply because the Basin is over 20 miles from the ocean). Accordingly, sustainability does not need to be achieved, but it does need to be maintained through the planning and implementation horizon. This will involve continuation and improvement of existing management actions. It also will include improvement and expansion of management actions and monitoring. These improvements are addressed for each sustainability criterion specific subsections.

While the Bedford-Coldwater Basin has been managed sustainably, the following sustainability criteria are defined in this section because potential exists for future undesirable results.

- The Minimum Threshold for defining undesirable results relative to chronic lowering of groundwater levels is defined at each Key Well by operational considerations to maintain water levels at or above current pump intakes or screen bottoms (whichever is higher) in municipal water supply wells. Undesirable results are indicated when two consecutive exceedances occur in each of two consecutive years, in two-thirds or more of the currently monitored wells in each Management Area.

- The Minimum Threshold for reduction of groundwater storage for all Management Areas is fulfilled by the minimum threshold for groundwater levels as proxy.
- The Minimum Threshold for land subsidence is defined as a cumulative decline equal to or greater than one foot of decline since 2015, which represents current conditions and the SGMA start date. This is equivalent to a rate of decline equal to or greater than 0.2 feet in any five-year period. The extent of cumulative subsidence across the Basin will be monitored and evaluated using Interferometric Synthetic Aperture Radar (InSAR) data available through the SGMA Data Viewer during the 5-year GSP updates. Subsidence as a result of groundwater elevation decline is closely linked to groundwater levels and it is unlikely that significant inelastic subsidence would occur if groundwater levels remain above their minimum thresholds.
- The Minimum Thresholds for degradation of water quality address nitrate and total dissolved solids (TDS) for the entire Basin.
    - The Nitrate Minimum Threshold (in both Management Areas) is defined as 5-year average concentrations of all monitored wells not exceeding the 10 milligrams per liter (mg/L) drinking water maximum contaminant level (MCL) for Nitrate as Nitrogen.
    - The TDS Minimum Threshold (in both Management Areas) is defined as the 5-year average concentrations not exceeding the 1,000 mg/L secondary MCL for TDS.
- The Minimum Threshold for depletion of interconnected surface water is the amount of depletion associated with the lowest water levels recorded during the 2010 to 2015 drought. Specifically, undesirable results would occur if more than half of monitored wells near Temescal Wash had static water levels lower than 35 feet below the adjacent riparian vegetation ground surface elevation for a period of more than one year.

6.2. CHRONIC LOWERING OF GROUNDWATER LEVELS

Chronic lowering of groundwater levels can indicate significant and unreasonable depletion of supply, causing undesirable results to domestic, agricultural, or municipal groundwater users if continued over the planning and implementation horizon. As a clarification, drought-related groundwater level declines are not considered chronic if groundwater recharge and discharge are managed such that groundwater levels recover fully during non-drought periods.

Declining groundwater levels directly relate to other potential undesirable effects (for example regarding groundwater storage, land subsidence and interconnected surface water); these are described in subsequent criterion specific sections.

Groundwater elevation trends in the Basin are represented by hydrographs documented in Groundwater Conditions Section 4.1. Over time, groundwater elevations have varied in response to precipitation, groundwater pumping, and groundwater use trends; however, the

Basin does not display widespread chronic groundwater level declines and is not characterized by overdraft.

6.2.1. Description of Undesirable Results

As groundwater levels decline in a well, a sequence of increasingly severe undesirable results will occur. These include an increase in pumping costs and a decrease in pump output. With further declines, the pump may break suction, which means that the water level in the well has dropped to the level of the pump intake. This can be remedied by lowering the pump inside the well, which can cost thousands of dollars. Chronically declining water levels will eventually drop below the top of the well screen. This exposes the screen to air, which can produce two adverse effects. Water entering the well at the top of the screen will cascade down the inside of the well, and entraining air may result in cavitation damage to the pump. The other potential adverse effect of exposure to air is accelerated corrosion of the well screen. Over time, corrosion creates a risk of well screen collapse, which often renders the well unusable. If water levels decline by more than about half of the total thickness of the aquifer (or total length of well screen), water might not be able to flow into the well at the desired rate regardless of the capacity or depth setting of the pump. This might occur where the thickness of basin fill materials is relatively thin. While describing a progression of potential adverse effects, at some point the well no longer fulfills its water supply purpose and is deemed to have "gone dry." For the purposes of this discussion, a well going dry means that the entire screen length (to the bottom of the deepest screen) is unsaturated.

For purposes of setting a Minimum Threshold, undesirable results are defined as a well going dry. This appears to be a low standard and not protective of private wells but there are very few private wells in the Basin. The rationale is summarized as follows with more explanation in the following sections:

- There are very few active private wells in the Basin, as residential users are connected to municipal water supplies. The BCGSA is aware of a small number of private wells used for non-potable supply in the Basin. A systematic well inventory identifying all active private wells will be conducted to locate active wells and identify their uses, as described in Section 8.7. This project was designed to locate and characterize the construction and use of existing private wells so that they can be included in sustainable management of the Basin.
- Known private wells are for non-potable uses and are of similar depths and construction to the monitored municipal supply wells. No private wells have been reported to have water shortages in the California Department of Water Resources (DWR) led *Household Water Supply Shortage Reporting System* (DWR 2021).
- Responsibility for potential undesirable results to shallow wells is shared between a GSA and a well owner; there is a reasonable expectation that a well owner would construct, maintain, and operate the well to provide its expected yield over the well's life span, including droughts.

6.2.2. Potential Causes of Undesirable Results

For Bedford-Coldwater Basin, the primary potential cause of declining groundwater levels and associated undesirable results would be increased groundwater production and/or reduced inflows (recharge). Given that the Bedford-Coldwater Basin is not characterized by basin-wide chronic groundwater level declines, then the undesirable results of a well losing yield, having damage, or "going dry" represent a more complex interplay of causes and shared responsibility.

Some of the potential causes are within the Bedford-Coldwater Groundwater Sustainability Agency (BCGSA) responsibility; most notably, a GSA is responsible for groundwater basin management without causing undesirable results such as chronic groundwater level declines. SGMA also requires that a GSA address significant and unreasonable effects caused by groundwater conditions *throughout the basin.* This indicates that a GSA is not solely responsible for local or well-specific problems and furthermore that responsibility is shared with a well owner. A reasonable expectation exists that a well owner would construct, maintain, and operate the well to provide its expected yield over the well's life span, including droughts, and with some anticipation that neighbors also might construct wells (consistent with land use and well permitting policies).

6.2.3. Definition of Undesirable Results

As context, the Bedford-Coldwater Sustainability Goal has the objective to provide a long-term, reliable, and efficient groundwater supply for municipal, industrial, and other uses.

In that light, the definition of undesirable results would be the chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. This is defined by groundwater conditions occurring throughout the Basin, with a focus on operation of wells. This definition also recognizes that chronic lowering of groundwater levels could affect groundwater flow to or from the hydraulically connected Temescal and Elsinore Basins, and thereby potentially affect their ability to maintain sustainability.

As documented in Groundwater Conditions Section 4.1, analysis of hydrographs reveals that Bedford-Coldwater is not characterized by basin-wide chronic groundwater level declines. While affected at times by drought, groundwater levels in broad areas of the Basin have been maintained at relatively stable levels. Moreover, the Bedford-Coldwater area has not been marked by reports of significant impacts to shallow supply wells as a result of water level declines. In the absence of reported well problems associated with declining groundwater levels, it can be concluded that undesirable results for the chronic lowering of water levels are not occurring in the Bedford-Coldwater and that the Basin is managed sustainably relative to groundwater levels.

6.2.4. Potential Effects on Beneficial Uses and Users

Groundwater is a source of supply in the Basin and supplies water for municipal, industrial, and other beneficial uses. Groundwater has been and is being used for the range of beneficial uses, even during drought, and with reasonable operation and maintenance by well owners.

6.2.5. Sustainable Management Criteria for Groundwater Levels

The general approach to defining sustainability criteria (minimum thresholds and measurable objectives) for groundwater levels has involved selection of representative monitoring wells, review of groundwater level data, and review of supply well location/construction information to gage potential undesirable effects on wells. Specifically, this has included evaluating historical water levels and well operations in monitored wells. This approach is founded on the idea that undesirable results are the reduction of available supply in these monitored wells.

6.2.5.1. Selection of MT by Well

The approach includes selection of existing wells currently monitored in the Basin. Sustainability criteria would be defined for each of these wells, and each would be monitored for groundwater levels with respect to MTs and MOs. These wells are primarily production wells, which is not optimal for monitoring because pumping lowers water levels resulting in monitoring that is sometimes not representative of aquifer conditions. On the other hand, they are generally representative of production wells throughout the Basin.

Groundwater level data and hydrographs of each monitored well have been reviewed along with well construction and pumping equipment details in each monitored well. These data were used to review wells that the BCGSA currently monitors to confirm that they are suitable for use as Key Wells for defining MTs and MOs. This process showed that all the wells that the BCGSA agencies currently monitor are appropriate for use as Key Wells and monitoring of these wells will continue in the future. **Table 6-1** shows information on the Key Wells in the Basin. The table also shows well construction and pump intake information along with maximum historical depth to water and well-specific MT. The locations of the Key Wells are shown on **Figure 6-1**.

Table 6-1. Minimum Thresholds for Groundwater Levels

Local Well Name	Agency	Management Area	Monitoring Frequency	Total Well Depth (feet)	Screen Interval Depths (feet)	Pump Intake Depth (feet)	Historical Maximum Depth to Water (feet)	Date of Maximum Depth to Water	Threshold Description	Threshold Depth to Water (feet)
Corona Well 20	Corona	Coldwater	Static - Monthly	660	200 to 580	460	375.10	1/17/2017	Pump intake	460
Corona Well 21	Corona	Coldwater	Static - Monthly	660	200 to 580	460	398.00	12/1/2001	Pump intake	460
Corona Well 3	Corona	Coldwater	Static - Monthly	543	100 to 530	479	392.00	12/16/2016	Pump intake	479
Corona Non-Potable Well 1	Corona	Bedford	Continuous (SCADA)	Unkown	Unkown	Unkown	55.60	11/13/2016	Nearby pump intake	80
Corona Non-Potable Well 2	Corona	Bedford	Continuous (SCADA)	Unkown	Unkown	Unkown	55.40	11/13/2016	Nearby pump intake	80
EVMWD Flagler 2A Well	EVMWD	Bedford	Continuous (SCADA)	105	51 to 92	80	48.00	10/18/2019	Pump intake	80
EVMWD Flagler 3A Well	EVMWD	Bedford	Continuous (SCADA)	100	51 to 90	80	57.00	10/18/2019	Pump intake	80
Corona & EVMWD Trilogy	EVMWD	Coldwater	Quarterly	579	250 to 360 and 390 to 450	No pump	359.30	10/12/2016	Ten feet above bottom of screen	440
EVMWD Station 71	EVMWD	Bedford	Quarterly	600	239 to 588	507	499.92	7/21/2017	Pump intake	507
EVMWD Mayhew Well 2	EVMWD	Coldwater	Quarterly	740	300 to 730	507	440.99	11/28/2017	Pump intake	507
TVWD Well 1 (Old well)	TVWD	Bedford	Continuous (SCADA)	100	40 to 80	No pump	42.50	11/1/2016	Ten feet above bottom of screen	70
TVWD Well 1A	TVWD	Bedford	Continuous (SCADA)	100	40 to 80	85	53.40	11/15/2016	Ten feet above bottom of screen	70
TVWD Well 4	TVWD	Bedford	Continuous (SCADA)	100	40 to 80	85	46.80	10/7/2015	Ten feet above bottom of screen	70
TVWD TP-1	TVWD	Bedford	Continuous (SCADA)	103	39 to 99	85	Unknown	Unknown	Pump intake	85
TVWD TP-2	TVWD	Bedford	Continuous (SCADA)	90	30 to 85	85	Unknown	Unknown	Ten feet above bottom of screen	75
TVWD Foster	TVWD	Bedford	Continuous (SCADA)	93	38 to 88	84	Unknown	Unknown	Ten feet above bottom of screen	78
TVWD New Sump	TVWD	Bedford	Continuous (SCADA)	74	Unkown	66	101.67	8/1/1994	Pump intake	66

6.2.6. Minimum Thresholds

According to GSP Regulations Section 354.28(c)(1), the minimum threshold for chronic lowering of groundwater levels must be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. MTs for chronic lowering of groundwater levels are to be supported by information on the rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the Basin. However, as documented in the Groundwater Conditions Section 4.1.3, groundwater levels are not chronically declining in Bedford-Coldwater. While groundwater levels decline in dry and critically-dry years, they have recovered in normal, above normal, and wet years. Groundwater levels in some wells were at historical lows after the recent drought ending in 2016 but are recovering.

Currently, none of the wells have groundwater levels below their respective MTs and no undesirable results are known to have occurred in the past. Nonetheless, MTs have been developed because the potential exists for chronic lowering of groundwater levels in the future.

Using available recent and reliable information on the construction of existing supply wells, the MT levels shown in **Table 6-1** are protective of most supply wells. Based on historical lows, the MTs account for historical groundwater level variations, and consideration has been given to supporting Basin management flexibility, for example to avoid setting off false alarms or triggering costly, ineffective, or harmful management actions.

The MTs shown in **Table 6-1** were developed making use of available data. However, uncertainties exist as summarized below:

- The geographic distribution of wells in the groundwater level monitoring program is uneven.
- Information on vertical groundwater gradients is lacking and groundwater levels in shallow wells may not be represented adequately by relatively deep wells.
- The specific location, status, and construction of most existing private wells is not known, or the information is not readily available (in databases).

These uncertainties have been recognized and are being addressed in this GSP as follows:

- Mapping and prioritization of geographic gaps in the monitoring program.
- Installation of two new dedicated monitoring wells sited and designed to support the groundwater level monitoring program (among other objectives) and to become Key Wells.
- Identification and mapping of existing active private production wells within the Basin, as described in Section 8 Projects and Management Actions.

The benefits of these efforts will accrue over the next few years and will support review and update of the MTs in the 5-Year GSP Update in 2027.

6.2.6.1. Minimum Thresholds and Criteria for Undesirable Results

Undesirable results are based on exceedances of MT levels and must be defined not only in terms of how they occur (as described in Section 6.2.2 Potential Causes of Undesirable Results), but also when and where. By definition, undesirable results are not just drought-related but chronic and are not just local but basin-wide.

The distinction between drought and chronic declines may not be clear when declines are occurring, particularly during drought when it is not known whether subsequent years will bring recovery. Moreover, effects of declining levels on individual well owners may be real problems, whether or not they represent basin-wide sustainability issues.

The BCGSA will perform quarterly or more frequent groundwater level monitoring. Accordingly, groundwater level monitoring and annual reporting provides an early warning system that allows response by the BCGSA and local groundwater users. From this perspective, two consecutive exceedances in each of two consecutive years is regarded as indicating when an undesirable result is occurring. The exceedances would be measured at a Key Well as part of the regular quarterly monitoring program. It should be noted that GSA responses do not have to wait for two years and may involve a staged response as in urban water shortage contingency plans.

While undesirable results relate to groundwater conditions throughout the Basin, the Basin has been organized into two management areas (MAs). As discussed in Section 5.4, this reflects the fact that the Basin is separated by a fault zone, limiting (but not eliminating) flow between the two MAs. Groundwater level MTs will be evaluated separately for each MA, because the groundwater histories are distinct, albeit linked. As a result, undesirable results could occur in one MA and not the other. Accordingly, undesirable results are indicated to be occurring when two-thirds or more of the currently monitored wells in the MA have had two consecutive exceedances in each of two consecutive years.

To summarize for the Bedford-Coldwater Basin:

> The **Minimum Threshold** for defining undesirable results relative to chronic lowering of groundwater levels is defined at each Key Well by operational considerations to maintain water levels at or above current pump intakes or screen bottoms (whichever is higher) in municipal water supply wells. Undesirable results are indicated when two consecutive exceedances occur in each of two consecutive years, in two-thirds or more of the currently monitored wells in each Management Area.

6.2.6.2. Relationship of Minimum Threshold to Other Sustainability Indicators

The establishment of MTs also needs to consider potential effects on other sustainability indicators. These indicators are discussed later in this section; the following are brief discussions.

- **Groundwater Storage**. The MTs for groundwater levels are protective of groundwater storage. These MTs are defined in terms of operational considerations for wells used to support beneficial uses in the Basin. The major concern expressed in the Sustainability Goal is to have reliable storage for drought conditions. As the water level MTs support maintenance of production capacity in wells, they also support maintenance of reliable storage.

- **Seawater Intrusion.** There is no possibility of seawater intrusion in the Bedford-Coldwater Basin as it is more than 20 miles from the ocean. Accordingly, there is no seawater intrusion minimum threshold and no relationship with other minimum thresholds.
- **Subsidence.** Subsidence is linked to groundwater levels. It is unlikely that significant inelastic subsidence would occur if groundwater levels remain within the operational range of water levels, which have been used to define groundwater level MTs. Accordingly, the minimum threshold for groundwater levels is consistent with and supportive of the objective to prevent subsidence undesirable results.
- **Water Quality.** General relationships are recognized, for example that contaminants may be mobilized by changing groundwater levels or flow patterns. Maintenance of groundwater levels within historical operational ranges would minimize any effects on maintenance of water quality at or above minimum thresholds. The groundwater quality issues in Bedford-Coldwater Basin are associated primarily with salt and nutrient loading and not likely to be affected by groundwater levels or flow within operational ranges.
- **Interconnected Surface Water.** The set of monitoring wells used to evaluate interconnected surface water overlaps with the set of wells used for the groundwater levels minimum threshold. In general, the MTs for interconnected surface water are similar to or higher than those for groundwater levels; the higher MTs would be controlling.

6.2.6.3. Effect of Minimum Threshold on Sustainability in Adjacent Areas

The Bedford-Coldwater Basin is adjacent to the Temescal Basin and the Elsinore Basin. Groundwater flow directions are from the Elsinore Basin through Bedford MA to the Temescal Basin with some drainage into the Temescal Wash. The Bedford-Coldwater groundwater level MTs would support maintenance of groundwater levels above their respective MTs in Bedford MA. This in turn will support maintenance of groundwater levels in the Temescal Basin.

6.2.6.4. Effect of Minimum Threshold on Beneficial Uses and Users

Groundwater is the major source of supply in the GSP Area and supplies wells for municipal, industrial, and other beneficial uses and users. The MTs are based generally on well operations, which recognizes that groundwater has been and is being used reasonably for the range of beneficial uses even during drought, and with reasonable operation and maintenance by well owners. The MTs quantify undesirable results as involving two-thirds of wells in a MA with two consecutive exceedances in each of two consecutive years, which provides early warning of declining groundwater levels.

While there are a small number of private wells in the Basin, there are no DACs or SDACs in the Basin and the only private domestic well in the Basin belongs to the Glenn Ivy Hot Springs.

The BCGSA believes that all other private wells in the Basin are used for non-potable supply. Project 2 (described in Section 8.7) is designed to locate and characterize the construction and use of all existing active private wells to ensure that the minimum threshold for groundwater levels is protective of all users in the Basin, recognizing the human right to water.

6.2.6.5. Relationship of Minimum Threshold to Regulatory Standards

No federal, state or local standards exist for groundwater levels.

6.2.6.6. How Management Areas Can Operate without Causing Undesirable Results

The establishment of MTs has been consistently conceived and applied across both Management Areas. MTs are based on well operations, which vary from well to well representing local conditions that do not necessarily occur at the same time across the MAs. Maintenance of water levels within the operational range in wells is not anticipated to cause undesirable results between the two MAs.

6.2.6.7. How the Minimum Threshold will be Monitored

Monitoring for the groundwater levels MT will be conducted as part of the BCGSA groundwater level monitoring program, data and analytical results will be presented in the Annual GSP Reports. The BCGSA monitoring program includes wells monitored by Corona, EVMWD, and TVWD.

6.2.7. Measurable Objectives

Measurable Objectives are defined herein as an operating range of groundwater levels, allowing reasonable fluctuations with changing hydrologic and surface water supply conditions and with conjunctive management of imported water and groundwater. The groundwater level MTs represent the bottom of the operating range and are protective of groundwater users. The top of the operating range is generally where the water table approaches the soil zone and ground surface, except where groundwater and surface water are interconnected or groundwater dependent ecosystems exist. Section 6.7 addresses these areas and potential undesirable results with Depletions of Interconnected Surface Water. With these important exceptions, the top of the operating range is below the soil zone, thereby minimizing potential agricultural drainage problems.

> The **Measurable Objective** is to maintain groundwater levels above the historical maximum depth to groundwater, and to maintain groundwater levels within the operating range as defined in this section.

Groundwater conditions with respect to chronic groundwater level declines are already sustainable. Therefore, no interim milestones are needed to achieve sustainability by 2042.

6.2.7.1. Discussion of Monitoring and Management Measures to be Implemented

Data gaps and sources uncertainties have been identified in this section, including the lack of reliable and accessible information on active private well pumping and construction.

Management actions to maintain groundwater levels have been ongoing and effective for decades. These actions (consistent with the Sustainability Goal objective to support integrated and cooperative water resource management) have included acquiring imported water for direct use, providing recycled water for irrigation, and other conjunctive use operations. The BCGSA will also implement management actions to inventory existing active private wells. This will include identification of locations and construction information for active wells throughout the Basin to support refinement of the groundwater level MTs and MOs in the 5-year GSP update.

Monitoring improvements are discussed in Section 7, including results of the Dedicated Monitoring Well Program initiated in June 2020.

6.3. REDUCTION OF GROUNDWATER STORAGE

Groundwater storage is the volume of water in the Basin and provides a reserve for droughts or surface water supply shortages. The MT for reduction of groundwater storage is the volume of groundwater that can be withdrawn from a Basin or MA without leading to undesirable results. Undesirable results would involve insufficient stored groundwater to sustain beneficial uses throughout drought or water supply shortage. The storage criteria are closely linked to groundwater levels. The sustainability indicator for groundwater storage addresses the ability of the groundwater Basin to support existing and planned beneficial uses of groundwater, even during drought and surface water supply shortage.

For the each of the two MAs of the Bedford-Coldwater Basin, the water budget has been calculated using the numerical model, as described in Water Budget Section 5. In brief, this has included analyses of the cumulative change in storage for each of the two MAs for the historical and current period, 1990 through 2018, and for simulated future conditions (see **Figures 5-5** and **5-6**). The water budget analyses have shown the dynamic effects of drought and changes in groundwater use and indicate that groundwater storage in the Basin has been sustainably managed relative to storage. The water budget inflow and outflows have been balanced over the long term. Furthermore, as indicated in Section 6.2, none of the water supply wells have been reported as going dry in the Basin during the historical period of record.

6.3.1. Description of Undesirable Results

Given that Bedford-Coldwater Basin has not experienced any impacts to wells related to groundwater storage, the undesirable result associated would be an insufficient supply to support beneficial uses during droughts. Storage is related to groundwater levels. Thus, undesirable results associated with storage would likely be accompanied by one or more undesirable results associated with groundwater levels, including reduced well yields, subsidence, and depletion of interconnected surface water.

6.3.2. Potential Causes of Undesirable Results

For groundwater storage in the Basin, the basic cause of undesirable results would be an imbalance of the water budget, such that outflows exceed inflows resulting in reduction of groundwater storage. This imbalance could be caused in turn by reduced surface water supplies and associated groundwater recharge. Such reduction could potentially include the following conditions: 1) increased pumping due to disruption of imported water, 2) reduced percolation from Temescal Wash, 3) reduced natural recharge due to increased impervious area (development), or 4) increased pumping due to reduced recycled/non potable discharge and use. Undesirable results also could occur because of changes in land use causing increased demand for groundwater; this would be most problematic in portions of the Basin without access to other water supplies.

6.3.3. Definition of Undesirable Results

Undesirable results are defined with the understanding that the objective of groundwater management is to provide reliable storage for water supply resilience during droughts and shortages. Accordingly, the definition of potential undesirable results for storage reduction includes consideration of how much storage has been used historically (i.e., operating storage) and how much stored groundwater reserve is needed to withstand droughts.

In considering conceptual operating storage or groundwater reserves, it is important to bear in mind that these are not the total amount of groundwater that could potentially be extracted from the Basin. Most wells are in the range of 75 to 700 feet deep.

The depth of the Basin ranges from less than 40 feet in some areas to more than 800 feet in others (see **Figure 3-9**). Groundwater wells used for water supply are generally located in the deeper portions of the Basin. Additional groundwater storage could be utilized, with the foremost assumption that withdrawals and reduction are followed by commensurate recharge and recovery. This could occur as part of enhanced conjunctive use programs.

6.3.4. Potential Effects on Beneficial Uses and Users

Groundwater is a source of water supply in the GSP Area and supplies wells for municipal, industrial, and other beneficial uses. Reduction of groundwater storage would reduce access to that supply with adverse effects on the community, economy, and environmental setting of the Temescal Valley. However, groundwater has been and is being used for the beneficial uses, even during drought.

6.3.5. Sustainable Management Criteria for Groundwater Storage

The general approach to defining sustainability criteria for groundwater storage has involved review of historical cumulative change in storage and expected future storage declines during droughts. Review of historical change in storage is useful to estimate about how much storage has been used in each Management Area, effectively defining an *operating storage*. Similarly, the approach focuses on the beneficial uses of the Basin and acknowledges much of the pumping occurs in larger municipal wells with dynamic operations. Sustainability criteria for groundwater levels also take into account historical ranges and the management of dynamic operation of municipal wells.

6.3.5.1. Description of Historical Cumulative Change in Storage: 1990 through 2018

The cumulative change in storage by management area for historical and current conditions (1990 through 2018) as simulated by the numerical model is discussed and shown in tables and figures in Section 5. Observations about the historical operating storage for each of the Management Areas are as follows:

Bedford Management Area. The average annual change in groundwater storage was stable over the model period, 1990 through 2018, with an average increase in storage of 73 acre-feet per year (AFY). This increase in storage is due to decreased pumping from 2005 to the end 2019, when pumping in the MA averaged about 1,000 AFY. The change in storage during this same period increased on average about 400 AFY. For the early portion of the model (1990 through 2004), groundwater pumping was approximately 2,500 AFY, which resulted in a slight decline in groundwater storage. The average annual decrease in storage during this period was 22 AFY. This storage response indicates the Basin can support this range of operation, given appropriate natural recharge. Groundwater storage has increased a total of 2,215 acre-feet (AF) over the model period. The simulated increasing trend of groundwater storage in this MA provides an operational range that would support beneficial uses.

Coldwater Management Area. The average annual change in groundwater storage over the model period was an average annual decrease of about 2,000 AFY. Declines in storage in this MA were more pronounced early in the model period, averaging over 3,800 AFY between 1990 and 2004. Recent groundwater storage change has been relatively stable even with a significant drought period from 2014 to 2017. The local agencies pumping from the Coldwater MA have agreed to limit their pumping to a sustainable yield volume based on available recharge. Accordingly, groundwater pumping has declined from an average of over 6,500 AFY between 1990 and 2008 to approximately 3,000 AFY from 2009 through 2018. In the Coldwater MA, the simulated groundwater storage stabilized and largely recovered during the one to two years following droughts, but still showed a general decrease in groundwater storage due to increased groundwater production over the model period. Given the storage stability in the current period (2008 through 2018) and current groundwater management practices, groundwater storage will likely continue to increase on average and recover from short term droughts on the order of one to two years. These groundwater management practices include the existing agreement between local agencies to pump within a sustainable yield.

Ongoing aggregate mining in the Coldwater MA (and to a lesser extent Bedford MA) may impact both the inflows and outflows used to calculate the change in storage. Uncertainty exists about the role in storage changes of open pits used in quarry operations, specifically their contribution to additional recharge in wet years and/or additional outflow through evaporation or other processes. A potential management action to collect additional data related to quarry operations is discussed in Section 8.

6.3.6. Minimum Threshold

Undesirable results relative to groundwater storage have not occurred in the Basin and numerical modeling of future conditions indicate that groundwater storage can continue to be operated within historical limits. However, given the dynamic nature of the Bedford-Coldwater production wells, additional storage outside of the historical limits may be needed. According to SGMA, the minimum threshold for storage is to be defined as the maximum groundwater volume that can be withdrawn without leading to undesirable results.

GSP Regulations allow the use of the groundwater level sustainability criteria (MTs and MOs) as a proxy for groundwater storage, provided that the GSP demonstrates a correlation between groundwater levels and storage. Groundwater levels and storage are directly related. This is demonstrated by comparison of groundwater level and storage trends, which reveal the same patterns of changes in pumping, response to drought, and recovery, as discussed in Section 5. The relationship of groundwater levels and storage is embodied in the calibrated numerical model.

The rationale for using groundwater levels as a proxy metric for groundwater storage is that the groundwater level MTs and MOs are sufficiently protective to prevent significant and unreasonable results relating to storage. Groundwater level MTs have been defined to protect supply wells (see Section 6.2.6) and are based on the following:

- A broad geographic distribution of Key Wells that are representative of production wells in the Basin;
- MTs that are based on operational parameters for existing water supply wells;
- Analysis of existing municipal supply wells with construction information and setting of MTs to avoid operational failure in these wells; and
- Groundwater level MTs that include two consecutive quarters in two years, providing early warning for storage changes, while also involving two-thirds or more of the Key Wells in each MA, thus involving a broad area, consistent with storage change.

As a practical matter, the availability of groundwater in storage will be constrained by MTs for water levels (including groundwater level proxies for depletion of interconnected surface water). The MTs for groundwater levels will be sufficiently protective of groundwater storage.

To summarize for the Bedford-Coldwater Basin:

> The **Minimum Threshold** for reduction of groundwater storage for all MAs is fulfilled by the minimum threshold for groundwater levels. The **Minimum Threshold** for defining undesirable results relative to chronic lowering of groundwater levels is

defined at each Key Well (two consecutive quarters in two years, providing early warning for storage changes, in two-thirds or more of the Key Wells in each MA).

The Sustainability Goal for the Bedford-Coldwater Basin includes an objective to provide reliable storage for water supply resilience during droughts and shortages. Use of groundwater levels as a proxy also fulfills that objective. No additional MT definition is needed.

6.3.6.1. Relationship of Minimum Threshold to Other Sustainability Indicators

- **Water Levels.** The minimum thresholds for groundwater levels are protective of the beneficial use of the Basin – municipal, industrial, and other water supply; therefore, these levels are protective of and serve as a proxy for groundwater storage and the provision of reliable storage for drought and shortage.
- **Seawater Intrusion.** There is no possibility of seawater intrusion in Bedford-Coldwater Basin. Accordingly, there is no minimum threshold and no relationship with other minimum thresholds.
- **Subsidence.** Subsidence is linked to groundwater levels. Because the storage reduction minimum threshold would not cause water levels to drop below their minimum thresholds, it would not interfere with the subsidence minimum threshold.
- **Water Quality.** Maintenance of groundwater storage within historical and operational ranges would minimize any effects on water quality relative to water quality minimum thresholds. Groundwater quality issues in Bedford-Coldwater Basin are associated primarily with salt and nutrient loading and not likely to be affected by groundwater storage within historical and operational ranges.
- **Interconnected Surface Water.** The minimum thresholds for depletion of surface water flow are linked to groundwater levels near stream reaches with shallow groundwater. Those water levels are generally equal to or higher than the minimum thresholds for water levels in those areas. Thus, it is likely that the interconnected surface water threshold would constrain storage utilization.

6.3.6.2. Effect of Minimum Threshold on Sustainability in Adjacent Areas

The Bedford-Coldwater Basin is located downstream from the Elsinore Valley Subbasin along Temescal Wash. Groundwater flow directions are from the Elsinore Valley Subbasin to the Bedford-Coldwater Basin. The groundwater level MTs for the Bedford-Coldwater Basin would support maintenance of groundwater levels and storage within the operational range in the Bedford MA adjacent to the Elsinore Valley Subbasin. This in turn will support maintenance of operational groundwater storage in the neighboring Elsinore Valley Subbasin.

6.3.6.3. Effect of Minimum Threshold on Beneficial Uses and Users

Beneficial uses and users of groundwater storage include maintenance of interconnected surface water and associated groundwater dependent ecosystems (GDEs) and municipal, industrial and other groundwater users. The MTs for groundwater levels are based generally on operational considerations for wells, which recognizes that groundwater has been and is being used reasonably for the range of beneficial uses even during droughts. The storage minimum threshold is consistent with the water level minimum threshold, which means that available storage will be adequate to supply beneficial uses as long as water levels remain above their minimum thresholds.

6.3.6.4. Relationship of Minimum Threshold to Regulatory Standards

Other than SGMA, no federal, state or local standards exist for reduction of groundwater storage.

6.3.6.5. How Management Areas Can Operate without Causing Undesirable Results

A storage change in one Management Area would be associated with a change in water levels. That change could affect groundwater flow between that Management Area and an adjoining one. The boundary flow would only change if storage and water levels in the adjoining Management Area did not experience a similar change. Therefore, no incompatibility among Management Areas with respect to storage declines is anticipated.

6.3.6.6. How the Minimum Threshold will be Monitored

Monitoring for the groundwater levels MT, which is the proxy for groundwater storage, will be part of the BCGSA groundwater level monitoring program (as described in Section 7). Data and analytical results, including assessment of change in storage, are presented in GSP Annual Reports.

6.3.7. Measurable Objectives

Measurable Objectives is defined in GSP regulations as an operating range of groundwater storage, allowing changes in groundwater storage with varying hydrologic and surface water supply conditions and as with conjunctive management of surface water and groundwater. The groundwater level MTs provide a protective level that corresponds to the minimum threshold for storage, which would keep groundwater storage within the historical operating range. The 5-Year GSP Update could include consideration of using more of this storage locally as part of ongoing conjunctive use while also protecting shallow wells.

> The **Measurable Objective** for storage is fulfilled by the MO for groundwater levels, which maintains groundwater levels above the historical maximum groundwater depths in each Key Well (as quantified above in **Table 6-1**).

Groundwater conditions with respect to depletion of groundwater storage are already sustainable. Therefore, no interim milestones are needed to achieve sustainability by 2042.

6.3.7.1. Discussion of Monitoring and Management Measures to be Implemented

Management actions to prevent chronic reduction of groundwater storage and to provide groundwater reserves for drought will be the same actions for maintenance of groundwater levels. No other specific management actions for storage have been identified and no specific implementation is warranted.

6.4. SEAWATER INTRUSION

Seawater intrusion does not occur in the Bedford-Coldwater Basin because of its inland location. According to the GSP Regulations, the GSP is not required to establish criteria for such undesirable results that are not likely to occur. Accordingly, the remaining discussion in this section does not address seawater intrusion.

6.5. LAND SUBSIDENCE

Subsidence has not been a known issue in the Bedford-Coldwater Basin and undesirable results have not been reported. Nonetheless, the potential has been recognized that subsidence could occur as a result of groundwater pumping and groundwater level declines, typically in areas underlain by thick layers of fine-grained alluvial sediments.

As described in Section 4.3, available information on vertical land displacement (subsidence) includes estimates from InSAR satellite data systems. InSAR data provide mapping of ground surface elevations across the Basin, presented at regular (typically monthly) intervals.

InSAR data are made available by DWR from the TRE Altamira InSAR Dataset with vertical displacement data beginning in June 2015 and in monthly intervals thereafter until September 2019. The accuracy of the InSAR ground surface elevation change estimates is reported to be ±16 millimeters (mm), or ±0.052 feet (ft) (Towill 2020). While these data do currently represent a relatively short period of record, the InSAR data do not show significant changes in ground surface elevation in the Basin, which is characterized by small changes within the margin of error. Given the short records of these datasets and small vertical displacements, these data have not been analyzed systematically to identify specific areas that might be subject to long-term subsidence. As datasets are updated, that may be warranted in the future.

There are no data relating potential subsidence to water levels or groundwater pumping in the Basin. SGMA allows groundwater level data to be used as a proxy for subsidence; however, relationships between pumping, groundwater levels, and subsidence have not been determined to support that. Subsidence information from DWR InSAR data will be reviewed as it becomes available.

6.5.1. Description of Undesirable Results

Land subsidence is the differential lowering of the ground surface, which can damage structures, roadways, and hinder surface water drainage. Subsidence remains a potential risk and inelastic subsidence is irreversible. Potential undesirable results associated with land subsidence due to groundwater withdrawals include the following:

- Potential damage to building structures and foundations, including water facilities, due to variations in vertical displacement causing potential cracking, compromised structural integrity, safety concerns and even collapse.

- Potential differential subsidence affecting the gradient of surface drainage channels, locally reducing the capacity to convey floodwater and causing potential drainage problems and ponding.
- Potential differential subsidence affecting the grade or drainage of other infrastructure such as railroads, roads, and sewers.
- Potential subsidence around a production well, disrupting wellhead facilities or resulting in casing failure.
- Potential non-recoverable loss of groundwater storage as fine-grained layers collapse.

None of these undesirable results has been observed in the Basin. However, subsidence may be subtle and cumulative over time. Accordingly, the potential for future subsidence cannot be ruled out if regional groundwater levels were to decline below historical lows and minimum thresholds.

6.5.2. Potential Causes of Undesirable Results

As described in Section 4.3, changes in ground surface elevations may be caused by regional tectonism or by subsidence related to declines in groundwater elevations due to pumping. Regarding the former, the InSAR data show a general rising trend in the western portion of the Basin suggesting regional tectonic rise. In contrast, inelastic subsidence associated with groundwater pumping and level declines would generally show a long-term downward trend, with greater subsidence occurring during times of groundwater level decline (e.g., drought) and a flattening trend with no recovery during times of rising groundwater levels and reduced pumping (e.g., wet years).

As groundwater levels decline in the subsurface, dewatering and compaction of predominantly fine-grained deposits (such as clay and silt) can cause the overlying ground surface to settle. Land subsidence due to groundwater withdrawals can be temporary (elastic) or permanent (inelastic). While elastic deformation is relatively minor, fully recoverable, and not an undesirable result, inelastic deformation involves a permanent compaction of clay layers that occurs when groundwater levels in a groundwater basin decline below historical lows. This causes not only subsidence of the ground surface, but also compaction of sediments and loss of storage capacity.

Given the above, the potential for problematic land subsidence is affected by the proportion, overall thickness, and configuration of fine-grained sediments (with greater proportions and thicknesses suggesting greater potential). Because of the variability of local sediments, subsidence also is likely to be geographically variable. Moreover, the potential for subsidence is affected by the history of groundwater level fluctuations, such that areas with previous groundwater level declines may have already experienced some compaction and subsidence.

Subsidence is possible in Coldwater MA, due to the thickness of sediments and larger amount of pumping in this area. However, there is no evidence of thick, laterally continuous fine-grained materials that would be susceptible to subsidence. No data indicate that permanent inelastic subsidence has occurred.

6.5.3. Potential Effects on Beneficial Uses and Users

The lack of any reports of undesirable results is an indication of no noticeable effects. Nonetheless, some subsidence could have occurred because of historical groundwater level declines without being noticed and could have contributed to drainage or flooding problems, which are also affected by multiple and sometimes more noticeable factors including variable weather, changes in streams and drainage systems, land use changes in the watershed, erosion and sedimentation. Accordingly, continued tracking of subsidence is warranted.

6.5.4. Minimum Threshold

According to the GSP Regulations Section 354.28(c)(5), the minimum threshold for land subsidence is defined as the rate and extent of subsidence that substantially interferes with surface land uses. This section first addresses the rate at which subsidence substantially interferes with surface land uses and then describes how available InSAR data can be used to measure rate and extent across the Basin.

> The M**inimum Threshold** for subsidence is defined as a cumulative decline equal to or greater than one foot since 2015, which represents current conditions and the SGMA start date. This corresponds to a rate of decline equal to or greater than 0.2 feet in any five-year period.

The one-foot criterion is reasonable based on standards for flooding and drainage and on empirical data for well casing collapse:

- In the southwestern part of the Sacramento Valley, where documented cumulative subsidence has reached several feet, video surveys of 88 undamaged wells and 80 damaged wells showed that casing damage was uncommon in wells where subsidence was less than one foot (LSCE 2014).
- Ground floor elevations are recommended or required to be at least one foot above the Base Flood Elevation in some jurisdictions (see for example FEMA 2011 and City of Temecula 2020). Subsidence above one foot may cause some buildings to become flooded.
- The minimum freeboard along roadside ditches is often required to be one foot above the maximum anticipated water level (see for example San Diego County 2005). Greater subsidence may cause sewer and stormwater flows to flow in unintended directions.

Subsidence impacts can be relatively rapid and noticeable. However, in the Basin any subsidence in the future is likely to be gradually cumulative as would be its undesirable results. Accordingly, the 0.2 ft per 5-year rate of decline is an appropriate criterion, with the understanding that it will be re-evaluated in the 2027 GSP Update.

Based on available data and using the above criterion, significant and unreasonable subsidence has not occurred since 2015 in the Basin. Moreover, it is unlikely that the criterion will be exceeded in the future as groundwater pumping will be constrained with the MT set for groundwater levels and storage.

The extent of cumulative subsidence across the Basin will be monitored using the InSAR data provided on DWR's SGMA Data Portal website. The data consist of a closely spaced grid of elevation points approximately 300 feet apart and are characterized by considerable "noise," meaning that adjacent points often have very different readings at the scale of 1-2 inches. These data will be smoothed to provide results at a spatial scale at which subsidence would plausibly occur. These values for cumulative elevation change will then be compared annually with the minimum threshold criterion.

6.5.4.1. Relationship of Minimum Threshold to Other Sustainability Indicators

Subsidence related to groundwater is closely linked to groundwater levels. It is unlikely that significant inelastic subsidence would occur if groundwater levels remain above historical lows, which have been used to define groundwater level MOs. In addition, the operationally defined MT levels will prohibit significant pumping if water levels decline below historical lows. Accordingly, the minimum threshold for groundwater levels is consistent with and supportive of the objective to prevent subsidence undesirable results.

The subsidence MT would have little or no effect on other MTs. Specifically, subsidence MTs would not result in significant or unreasonable groundwater elevations, would not affect pumping and change in storage, would not affect groundwater quality, or result in undesirable effects on connected surface water.

6.5.4.2. Effect of Minimum Threshold on Sustainability in Adjacent Areas

The Bedford-Coldwater Basin is adjacent to the Temescal Basin and Elsinore Valley Subbasin. Groundwater flow directions are from the Elsinore Valley Subbasin to the Bedford-Coldwater Basin and from the Bedford-Coldwater Basin to the Temescal Basin with some drainage into the Temescal Wash. The MTs for the Basin represent current conditions; establishment of MTs and maintenance of groundwater levels would not affect the ability of the either the Temescal Basin or Elsinore Valley Subbasin GSAs to achieve or maintain sustainability, as the flows between the basins are relatively minimal, and therefore groundwater levels and, thus, subsidence, in one basin would not affect the other.

6.5.4.3. Effect of Minimum Threshold on Beneficial Uses and Users

Subsidence has not been reported in the Basin, but subsidence remains a potential undesirable result that may contribute incrementally to reduced drainage, increased flooding, or other undesirable results. The effects of establishing the numerical subsidence MT are beneficial because they support a greater chance of detecting subsidence, supporting management actions to maintain groundwater levels, and preventing significant subsidence.

6.5.4.4. Relationship of Minimum Threshold to Regulatory Standards

There are no federal, state or local standards specifically addressing subsidence. There are standards for flood depth, floodplain encroachment, freeboard in ditches and canals and slopes of gravity-flow plumbing pipes. These vary somewhat from jurisdiction to jurisdiction, but they are generally similar and were used as the basis for selecting the MT.

6.5.4.5. How Management Areas Can Operate without Causing Undesirable Results

The MTs are consistently conceived and applied across both MAs. Tracking and analysis of InSAR mapping over the next five years (until the 5-Year GSP update) may be revealing about the potential for subsidence in the Basin. Meanwhile, maintenance of groundwater levels at or above historical lows consistent with the water level MOs will tend to maintain current conditions between the successive MAs from upstream to downstream.

6.5.4.6. How the Minimum Threshold will be Monitored

The minimum threshold will be monitored using available InSAR areal data to identify any occurrence and areal extent of subsidence. Over the next few years, this evaluation will involve review of temporal InSAR data to discern seasonal elastic fluctuations and potential inelastic declines. In addition, any areal extent will be examined; this may involve smoothing of elevation changes over the InSAR grid to summarize the results to a spatial scale at which subsidence would plausibly occur. The cell values for cumulative elevation change will then be compared with the minimum threshold criterion.

6.5.5. Measurable Objectives

The Sustainability Goal includes the objective to prevent subsidence. Accordingly, the MO is zero subsidence. Undesirable subsidence results have not been reported, and accordingly, no interim milestones are defined.

6.5.5.1. Representative Monitoring

It is assumed that the InSAR subsidence monitoring programs will continue for the foreseeable future and InSAR data will be available from the DWR website. The GSP monitoring program for subsidence will involve annual download of InSAR data with analysis for signs of cumulative inelastic subsidence.

6.5.5.2. Discussion of Management Actions to be Implemented

Management actions to prevent subsidence will be coordinated with actions relative to maintenance of groundwater levels. These actions involve maintaining groundwater levels above historical low water levels and will prevent significant inelastic subsidence. No other specific management actions for subsidence have been identified and no specific implementation is warranted.

6.6. DEGRADATION OF WATER QUALITY

Degraded water quality can impair water supply and affect human health and the environment. Impacts to drinking water supply wells can result in increased sampling and monitoring, increased treatment costs, use of bottled water, and loss of wells, which may be taken offline because of quality issues. As described in Groundwater Conditions Sections 4.6

and 4.7, elevated concentrations in drinking water of some constituents, such as nitrate, can adversely affect human health.

Consideration of the causes and circumstances of water quality conditions is important in Bedford-Coldwater because general mineral quality is naturally poor, especially in the Bedford MA. Nonetheless, groundwater has been used for beneficial purposes including irrigation, municipal, and domestic purposes. Sustainable management is about use and management of groundwater without causing undesirable results but does not necessarily include reversing natural undesirable conditions. According to SGMA (§10727.2(b)(4)), a GSP may—but is not required to—address undesirable results that occurred before and have not been corrected by the SGMA benchmark date of January 1, 2015.

Salt and nitrate loading also are recognized as sources of groundwater quality deterioration. The sustainability goal to protect groundwater quality is not to reverse undesirable water quality conditions by 2042 but rather to prevent circumstances wherein future management activities might make water quality worse, and insofar as possible to improve water quality in the long run. Implementation of management actions is recognized as needed now and, whether or not the results are perceptible in the short term, such actions will be helpful in the long term.

6.6.1. Potential Causes of Undesirable Results

The quality of groundwater in Bedford-Coldwater Basin is characterized as mineralized, in part reflecting natural hydrogeologic processes (see Groundwater Conditions Section 4.4). Groundwater also has been affected by human activities including historical agriculture and current urban, industrial, and other land uses. While contaminant sources of groundwater quality degradation exist, these are effectively regulated as described in Groundwater Conditions Section 4.6 and regularly tracked as part of other monitoring programs.

As described in the Groundwater Conditions section, TDS and nitrate are constituents of concern for the Basin. While there are elevated natural background TDS concentrations in groundwater, TDS also is an indicator of human impacts including infiltration of urban runoff, agricultural return flows, and treated wastewater discharge. Natural nitrate levels in groundwater are generally very low, and elevated concentrations are associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facility discharges.

Other constituents considered to be contaminants have been documented (see Groundwater Conditions Section 4.6.1 and 4.7) but occurrences of these are either under regulation by the Santa Ana Regional Water Quality Control Board (RWQCB) and State Water Resources Control Board (SWRCB) (e.g., perfluorooctanesulfonic acid [PFOS] and perchlorate) or are naturally occurring with no recent exceedances of MCLs and limited potential for mobilization due to management actions. In addition, mining activities are also regulated through the County Planning Department, the Surface Mining and Reclamation Act, and RWQCB discharge permits.

6.6.2. Description of Undesirable Results

The processes and criteria relied on to define Undesirable Results included review of available data and information summarized in the Plan Area and Groundwater Conditions sections and discussions with Bedford-Coldwater stakeholders and local agency representatives.

Undesirable Results are defined in the GSP Regulations (§354.26) as occurring when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the Basin. The GSA is not responsible for local problems or degradation caused by others. While the Bedford-Coldwater Basin includes regulated facilities with soil and groundwater contamination (see Groundwater Conditions Sections 4.4 and 4.6.1), these sites are under regulatory oversight by State and County agencies; the GSA does not have the mandate or authority to duplicate these programs. This GSP avoids management actions that would spread groundwater contamination through managed aquifer recharge, pumping, or other activities.

6.6.3. Potential Effects on Beneficial Uses and Users

Groundwater is a major source of supply in the Basin and supports a range of beneficial uses including municipal, recreational, industrial, and other uses. Beneficial uses of water and respective water quality objectives are defined by the RWQCB in the Santa Ana River Basin Water Quality Control Plan (Basin Plan).

6.6.4. Sustainable Management Criteria for Groundwater Quality

The definition of an Undesirable Result due to degraded water quality—TDS and nitrate concentrations—was evaluated in the context of regulatory objectives in each MA.

The GSA has selected a minimum threshold based on average conditions in monitored supply wells and regulatory limits. The average concentrations are totaled from each well and then divided by the total number of supply wells, to achieve a single value representing average conditions over the entire Basin. While this is slightly different than the suggested methods to determine sustainability, the GSA desired a single quantitative value to guide management. This is because the issues of concern in Bedford-Coldwater are focused on regional nitrate and salt loading, data are insufficient to define plumes or volumes of water, and the position of isocontours is not applicable.

6.6.4.1. Water Quality Monitoring Program

Currently 12 wells are regularly monitored for TDS and/or nitrate in the Basin by GSA member agencies, shown on **Table 6-2**. The wells generally are sampled semi-annually with lab analysis for general minerals and physical parameters. Accordingly, this data set can be used to detect a range of problems quickly, to track trends, allow geochemical investigation, and support focused management actions.

Table 6-2. Bedford-Coldwater Water Quality Monitoring Wells

Local Well Name	Agency
Corona Well 21	Corona
Corona Well 3	Corona
EVMWD Flagler 2A Well	EVMWD
EVMWD Flagler 3A Well	EVMWD
EVMWD Station 71	EVMWD
EVMWD Mayhew Well 2	EVMWD
TVWD Well 1A	TVWD
TVWD Well 4	TVWD
TVWD TP-1	TVWD
TVWD TP-2	TVWD
TVWD MW 2 - Driving Range	TVWD
Glen Ivy Well 1	Glen Ivy

6.6.4.2. Additional Water Quality Programs

In addition to existing monitoring, the BCGSA will conduct the following ongoing water quality coordination activities:

- Periodic review of data submitted to the Department of Pesticide Regulation (DPR), SWRCB Division of Drinking Water (DDW), Department of Toxic Substances Control (EnviroStor), and GeoTracker as part of the Groundwater Ambient Monitoring and Assessment (GAMA) database.
- Continue to participate in Salt and Nutrient Management Plan (SNMP) activities that include the Bedford MA portion of the Basin.
- Coordinate with the RWQCB and Riverside County Division of Environmental Health to discuss constituent trends and concerns in the BCGSA in relation to groundwater pumping.

The purpose of these reviews will be to monitor and summarize the status of constituent concentrations throughout the Basin with respect to typical indicators such as applicable MCLs or secondary MCLs (SMCLs). The GSP Annual Report and 5-Year Update will include a summary of the coordination and associated analyses of conditions. The GSP 5-year updates may include evaluation of whether additional minimum thresholds are needed.

6.6.5. Minimum Thresholds

Minimum Thresholds have been developed for nitrate and TDS using the best available information. MTs for nitrate and TDS are based on current conditions represented by average water quality results from all monitored wells between 2014 and 2019. The average value for each constituent was calculated for each well using results from all samples collected between 2014 and 2019. For wells with one sample, the single value was used; for wells with two or more samples, the average value was used.

These individual well averages were then averaged together for all wells in each MA and all wells in the Basin, as shown in **Table 6-3**. The resulting MA and Basin-wide average concentrations provide a simple metric for evaluating TDS and nitrate concentrations in the Basin. For reference, the MCL for nitrate as N is 10 mg/L and the SMCL for TDS is 1,000 mg/L.

Table 6-3. Summary of Recent Average Total Dissolved Solids (TDS) and Nitrate Concentrations by Management Area

	Bedford MA Average Concentration, 2014 - 2019	Coldwater MA Average Concentration, 2014 - 2019	Basin Wide Average Concentration, 2014 - 2019
Nitrate as N	3 mg/L	2 mg/L	3 mg/L
TDS	788 mg/L	488 mg/L	713 mg/L
Number of Wells	**9**	**3**	**12**

According to GSP regulations Section 354.28(c)(4) the minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the GSA to be of concern for the Basin. In setting minimum thresholds for degraded water quality, the GSA shall consider local, state, and federal water quality standards applicable to the basin. For the Bedford-Coldwater Basin, water quality MTs are based on the total number of wells (currently 12) and set for the entire Basin including both MAs.

> The TDS water quality **Minimum Threshold** Basin-wide is defined as 5-year average concentrations not exceeding the 1,000 mg/L Secondary MCL for TDS.
>
> The nitrate water quality M**inimum Threshold** Basin-wide is defined as 5-year average concentrations not exceeding the 10 mg/L drinking water MCL for Nitrate as Nitrogen.

These MTs are presented with full recognition of data gaps and uncertainties, and with commitment incorporated in this GSP to investigate increasing trends in nitrate and salt loading if they occur, and to coordinate appropriate management actions with regulatory agencies such as the RWQCB.

While the TDS and Nitrate MTs were selected based on the MCL (drinking water standards) to protect the beneficial uses of the Basin, it is recognized that there are other water quality objectives. The Upper Temescal Valley SNMP sets forth anti-degradation goals for the Bedford portion of the Basin, and the RWQCB Basin Plan has additional objectives for the Coldwater MA. As noted in Section 4.5.1, the SNMP objectives for the Bedford area are lower than the MCLs. However, the fundamental approach of this GSP is to protect beneficial uses as identified in the Sustainability Goal (Section 6.1). The BCGSA will work with other agencies to help achieve their objectives for water quality but will not define sustainability based on those objectives.

Given historical and ongoing groundwater use, current water quality conditions are considered sustainable. As described in Section 6.6.6, Measurable Objectives, the approach is to implement management actions that will maintain or reduce TDS and nitrate concentrations in the future.

6.6.5.1. Relationship of Minimum Threshold to Other Sustainability Indicators

Three of the other sustainability indicators (groundwater level declines, storage depletion, subsidence) are directly linked to groundwater levels, while the sustainability indicator for connected surface water-groundwater dependent ecosystems is related to a rate or volume of surface water depletion, also linked to groundwater levels. The MTs for water quality are not known to be directly related to specific groundwater levels or fluctuations in groundwater levels. Nonetheless, general relationships are recognized, for example that contaminants may be mobilized by changing groundwater levels or flow patterns. Accordingly, the water quality MTs will help guide potential projects that alter groundwater levels or flow.

6.6.5.2. Effect of Minimum Threshold on Sustainability in Adjacent Areas

The Bedford-Coldwater Basin is adjacent to the Elsinore Subbasin and Temescal Basin. Given the likelihood of continued flow between these basins remaining relatively similar current conditions, groundwater flow is likely to remain unchanged and groundwater quality in Bedford-Coldwater is unlikely to affect downstream Temescal Basin.

6.6.5.3. Effect of Minimum Threshold on Beneficial Uses and Users

The establishment of the MTs reflects the available data regarding the current condition of the Basin relative to TDS and nitrate concentrations. Establishing the MTs represents no change and recognizes that groundwater has been and is being used reasonably for the range of beneficial uses. The MTs represent a quantified starting point for protection of groundwater quality and for projects and management actions to improve groundwater quality, consistent with a best management practices approach.

6.6.5.4. Relationship of Minimum Threshold to Regulatory Standards

The MTs have been established with direct reference to regulatory standards, most notably the State-established MCLs. Other standards exist (including the Basin Plan Objectives set by the RWQCB and the Salt Nutrient Management Plan) that are lower (more strict) than the MTs. However, the Sustainability Goal and MTs are based on drinking water standards in order to protect local beneficial uses of groundwater.

6.6.5.5. How Management Areas Can Operate without Causing Undesirable Results

For both MAs, the goal is to protect groundwater quality with reference to beneficial uses and all MTs are based on available information and current conditions. It is not known if the current conditions represent equilibrium conditions between the two MAs or if future changes may occur between them. Future implementation of management actions and projects will be guided by monitoring data and by the consistent goal to protect groundwater quality in both MAs.

6.6.5.6. How the Minimum Threshold will be Monitored

The GSP is using the best available data from the BCGSA member agencies. The existing monitoring program will be improved and expanded to include dedicated monitoring wells. These will be included within the regular sampling schedule of the BCGSA and will build on historical records with data on specific constituents and parameters. The data from these dedicated wells will be used to reassess this threshold at the next GSP 5-Year update.

6.6.6. Measurable Objectives

The sustainability goal is to protect groundwater quality with reference to beneficial uses, with general objectives of maintaining groundwater quality, preventing circumstances where future management activities might make water quality worse, and improving groundwater quality in the long term.

6.6.6.1. Description of Measurable Objectives

Measurable Objectives are defined in this GSP using the same metrics and monitoring data as used to define MTs and are established to maintain or improve groundwater quality. Given uncertainties presented by data limitations, a reasonable margin of safety includes the possibility of “negative” monitoring results while positive progress is being made.

> The **Measurable Objective for TDS** is defined as maintaining or reducing 5-year average concentration in the Basin below the TDS Secondary MCL (1,000 mg/L) based on conditions documented in the Annual Reports.
>
> The **Measurable Objective for nitrate** is defined as maintaining or reducing the 5-year average concentration in the Basin below the nitrate as nitrogen MCL (10 mg/L) based on conditions documented in the Annual Reports.

Measurable Objectives will be evaluated in increments of five years and the numeric values will be presented with comparison to current conditions. This comparison will be discussed in the context of actual progress in implementing measures to improve monitoring and management.

6.6.6.2. Discussion of Monitoring and Management Measures to be Implemented

The strategy of this GSP is to identify and implement monitoring and management measures to reduce nitrate and TDS loading. Monitoring and management actions already undertaken are summarized in Plan Area Section 2.1.4. and would be continued. Additional monitoring measures are discussed in following sections.

6.7. DEPLETIONS OF INTERCONNECTED SURFACE WATER

This section builds and extends the discussion in Chapter 4 and the discussion of interconnection of surface water and groundwater. That section provided information on surface water-groundwater connections (both seasonally and with wet years and drought), identification of potential GDEs, distribution of riparian vegetation, and assessment of animal species that rely on groundwater-supported streamflow.

6.7.1. Description of Undesirable Results

If a stream is hydraulically connected to groundwater, pumping from nearby wells can reduce the amount of stream flow by intercepting groundwater that would have discharged into the stream or by inducing seepage from the stream. Undesirable results associated with stream flow depletion include reduced quality and quantity of aquatic and riparian habitats and reduced water supply to downstream users. Conceptually, adverse habitat impacts can result from decreased rainfall, decreased stream flow and/or lowered groundwater levels. These variables are highly correlated in time: droughts include rainfall reductions, decreased stream flows, and lowered groundwater levels at a time when habitat impacts are usually the most severe. Furthermore, droughts and wet periods are a natural feature of California's climate and are associated with waxing and waning of habitat conditions.

6.7.2. Potential Causes of Undesirable Results

Depletion of interconnected surface water by groundwater pumping can impact a variety of beneficial uses of surface water. A systematic evaluation of each potential impact is warranted, including impacts on downstream water users, habitats around isolated springs and wetlands, and plants and animals that rely on flow or shallow water table conditions along streams.

6.7.2.1. Surface Water Users

There are no known diverters of surface water from Temescal Wash. Lee Lake Dam and reservoir (just upstream of the Basin) were built in the late 19th century on the site of a small natural lake for the purpose of storing and supplying water to what is now the City of Corona (Ellerbee 1918). The lake no longer serves a water supply function, and in recent years it has been operated solely for recreational fishing under the name "Corona Lake".

Although not exactly a diversion, EVMWD obtained a permit that is listed as a diversion to reduce its historical discharges of treated effluent from the Regional Wastewater Reclamation Facility (WRF) to Temescal Wash upstream of the Basin, instead discharging most of that water to Lake Elsinore. Up to 3.87 cubic feet per second (cfs) of wastewater discharges that had been going to the Wash have been diverted to Lake Elsinore since 2008, as part of a lake level management plan (Permit 21165 [Application30502]). On January 24, 2020, the SWRCB approved EVMWD's request for a time extension to generate and divert the full amount of wastewater indicated in the permit. Downstream of the Basin there is no required minimum discharge from Temescal Wash into the Prado Wetlands at the downstream end of the Wash, near Corona. However, there are minimum required discharges of treated wastewater into the wetlands from several wastewater treatment plants in the Corona area north of the Bedford-Coldwater Basin.

6.7.2.2. Isolated Springs and Wetlands

Small off-channel wetlands are included in the Natural Communities Commonly Associated with Groundwater (NCCAG) on-line vegetation geodatabase (DWR et al. 2020). Almost all areas mapped as wetlands are along Temescal Wash and covered by the evaluation of riparian vegetation presented in detail below. A handful of polygons totaling 1.4 acres in the Bedford-Coldwater Basin are located along tributary streams or in low areas west of Temescal Wash. The vegetation is described as “seasonally flooded”, and the depth to groundwater at those locations is over 100 feet. The mapped vegetation is thus supported by seasonal ponding of rainfall runoff, not groundwater.

6.7.2.3. Animals Dependent on Groundwater

Animals dependent on groundwater include fish that permanently reside in Temescal Wash or migrate up and down the Wash during the high flow season, amphibians, and birds that inhabit riparian vegetation. Temescal Wash historically supported a steelhead trout run, remnants of which persist as resident rainbow trout in Coldwater Canyon Creek (which enters the Bedford-Coldwater Basin from the Santa Ana Mountains). Currently, perennially ponded areas along the lower reaches of the creek support robust population of invasive and exotic predatory species including bass, bullhead, sunfish, carp, and some slider turtles (Russell 2020). Arroyo chub is another fish that was once present in the Santa Ana River watershed, but it has been extirpated in most streams due to these exotic predators. Riverside County Resource Conservation District (RCRCD) implemented the Temescal Creek Native Fish Restoration Project in the early 2000s, which focused on eliminating nonnative plant and animal species that prey upon or create unfavorable habitat conditions for native fish species (Western Riverside County Regional Conservation Authority 2020). However, flow conditions in Temescal Wash do not currently support native fish (Russell 2020).

Animals dependent on riparian vegetation can also be considered dependent on groundwater. The Western Riverside County Multi-Species Habitat Conservation Plan (MSHCP) evaluates the presence and habitat needs of 146 species. The only ones mapped in the vicinity of the Basin are upland plants and burrowing owls, none of which are dependent on groundwater (Western Riverside County Regional Conservation Authority 2020). The federally threatened California coastal gnatcatcher is a bird species associated with sage scrub environments. The designated critical habitat areas are almost exclusively in upland areas outside the Basin. However, edges of a few mapped habitat areas border the Temescal Wash corridor (see **Figure 4-20**).

The Upper Santa Ana River Habitat Conservation Plan (SARHCP) also covers the Temescal Wash watershed and differs from the Western Riverside County MSHCP primarily in providing Endangered Species Act compliance for an additional set of activities related to water infrastructure construction and operation (USARSRA 2020). Although the SARHCP documents habitat suitability and historical observations of several listed species along Temescal Wash, its main focus is on habitat along the mainstem Santa Ana River. Species with fewer than five historical sightings and little suitable habitat include Arroyo chub, southwestern pond turtle, southwestern willow flycatcher, and yellow-breasted chat. There have been more than 25 historical sightings of Least Bells vireo, but no suitable habitat is mapped along Temescal

Wash. The flow regime in Temescal Wash is characterized as ephemeral (correct in many locations) because flow is “heavily diverted for human use” (incorrect) and that local areas of persistent flows result from agricultural return flows (incorrect). No mention is made of wastewater discharges, which are a larger factor in the flow regime. The surface hydrologic model used to support the SARHCP analysis only extends about one mile up the lowermost channelized reach of Temescal Wash. A groundwater model used to support the SARHCP projected declining water levels in the Prado wetlands area, but the plan includes no mitigation measures related to groundwater.

In summary, Temescal Wash does not appear to be a significant habitat for any listed animal species that would potentially be impacted by groundwater pumping or water levels. However, riparian shrubs and trees and non-listed animal species that use them could potentially be impacted during droughts if lowered groundwater levels cause vegetation die-back or mortality.

6.7.2.4. Riparian Vegetation

The beneficial use of interconnected surface water most likely to be impacted by groundwater pumping is riparian vegetation along Temescal Wash. The Wash traverses three groundwater basins along its 26-mile course from Lake Elsinore to the Prado Wetlands on the Santa Ana River. The entire length of the Wash was evaluated for this GSP to maximize the available information relating vegetation to groundwater and surface flow conditions. The assortment of vegetation types is roughly the same along the entire Wash and includes (in decreasing order of abundance) red willow, California sycamore, Gooddings willow, mulefat and Fremont cottonwood.

The extent and health of riparian vegetation along Temescal Wash was evaluated using three data sets: 1) Google Earth aerial imagery dating back to 1994 (Google Earth 2021), 2) NCCAG mapping of riparian vegetation representing a composite of numerous vegetation mapping efforts around the state (most dating from the early 2000s) (DWR et al. 2020), and 3) TNC’s GDE Pulse on-line mapping tool showing vegetation moisture status based on satellite data (TNC 2020).

Inspection of the aerial imagery revealed substantial mortality of riparian trees at many locations along the entire length of Temescal Wash from 2014 to 2016 and little recovery by 2018 (the most recent image). As an example, the evolution of vegetation along the reach that passes through Dos Lagos Golf Course (near Temescal Canyon Road and Cabot Drive) is illustrated by images from 1994, 2006, 2014, 2016, and 2018 in **Figure 6-2**. In 1994, which was just after a prior drought and before urban development, there was moderate coverage of riparian trees in the Temescal Wash channel. Canopy extent and density increased incrementally through 2006 and up to 2014. The 2014 through 2016 drought caused extensive tree mortality evident in the 2016 photo. Only a few trees had recovered by 2018, in spite of wet conditions in 2017.

The health and vigor of riparian vegetation cannot be reliably detected in aerial photographs. However, spectral analysis of light reflected from the vegetation does provide that information. Two commonly used metrics of vegetation health and vigor are the normalized difference vegetation index (NDVI) and normalized difference moisture index (NDMI), both of which involve ratios of selected visible and infrared wavelengths. NDVI relates to the greenness of vegetation and NDMI relates to transpiration. These metrics detect sub-lethal vegetation stress not visible in normal aerial imagery. TNC compiled these two metrics from historical satellite imagery for riparian vegetation throughout California and incorporated it into the GDE Pulse on-line mapping tool (TNC 2020). The tool evaluates the metrics for every vegetation polygon in the NCCAG maps. For each polygon, the tool displays time series plots of annual summertime NDVI and NDMI from 1985 through 2019. GDE Pulse data for NDVI and NDMI confirmed large declines in both of those metrics during 2013 through 2016 in most vegetation polygons along Temescal Wash. Some uncertainty in the methodology is apparent in occasional large differences in trends between adjoining polygons. Declines during 1984 through 1990 were of similar magnitude but not as abrupt in most locations.

A key question is whether vegetation die-back during the recent drought was due to lowered groundwater levels or reduced surface flow. There reportedly was year-round surface flow in the Wash derived from wastewater discharges prior to the drought, and a combination of reduced discharges and drought conditions killed up to 80 percent of the tree canopy in some locations along the Wash (Russell 2020). A careful comparison of the locations and timing of vegetation changes during the 1990 to 2018 period with the location and timing of changes in surface flow, groundwater pumping, and groundwater levels allows some tentative conclusions to be drawn about which factors contribute to vegetation die-back.

6.7.2.4.1. Groundwater Pumping and Shallow Groundwater Levels 1990 through 2018

Pumping from wells in the Warm Springs and Lee Lake MAs in the Elsinore Valley Subbasin upstream from the Basin and the Bedford MA in the Bedford-Coldwater Basin along Temescal Wash was about three times greater during 1990 through 1993 than during the 2013 to 2016 drought, as shown in **Figure 6-3**. If water levels were only a function of pumping, they would have been lower in the early 1990s than during the recent drought, but that was not the case (except for 1990). Hydrographs of groundwater levels are available for about 22 wells at about 10 locations along the 15-mile length of Temescal Wash in the Elsinore and Bedford-Coldwater Basins. Many of the wells are in clusters at a single location. At five of the locations, water level records date back to the early 1990s. Hydrographs of water levels at selected wells near Temescal Wash are shown in **Figure 6-4**. Many wells with water-level data are production wells with significant, frequent pumping drawdown. Estimation of static water levels in those wells can be inaccurate in years when the well was operated frequently because it can take days for water levels a pumping to recover to background static levels, and pumping schedules do not always allow that much downtime.

Progressive water level declines during 2012 through 2015 were the largest in the period of record for most wells. However, at the two locations with records dating back to 1990 (Gregory and Barney Lee), water levels were as low or lower in 1990 as in the 2012 to 2015 period. 1990 was the final year of another major drought, which can be seen as the declining trend in the cumulative departure of rainfall during 1984 through 1990. This suggests that low groundwater levels during 1984 through 1990 might also have caused substantial die-back, after which vegetation slowly recovered.

6.7.2.4.2. Surface Flow 1990 through 2018

Surface flow in Temescal Wash is not strongly correlated with vegetation die-back when the full 1990 through 2018 period is considered. Natural flow in Temescal Wash is mostly ephemeral and sporadic, as indicated by flows at various stream gages in the region (see **Figure 4-15**). Large natural flow events occur only in response to storm events in winter. In the absence of a shallow water table, intermittent winter flow events would not be sufficient to sustain riparian vegetation through the dry season.

In contrast, discharges from wastewater reclamation facilities are generally more sustained and have also contributed significant flow to Temescal Wash. Monthly average discharges from four wastewater reclamation facilities along Temescal Wash during 1990 through 2018 are shown in **Figure 6-5** and are described below:

- **Eastern Municipal Water District (EMWD)**. By far the largest discharges have been from EMWD near the upper end of Temescal Wash in the Elsinore Subbasin. EMWD's service area is located outside the Bedford-Coldwater Basin and beyond the jurisdiction of this and neighboring GSPs. The EMWD discharges since 2005 have typically been around 40 to 50 cfs, which is enough to produce flow down the entire length of Temescal Wash. This is confirmed by gaged flows at the outlet of Lee Lake (7 miles downstream of the discharge), which are also shown in the **Figure 6-5**. Peak flows at that location coincided with EMWD discharges and were about 20 cfs smaller, reflecting percolation losses between the discharge point and the lake.
- **Elsinore Valley Municipal Water District (EVMWD) Regional WRF**. The Regional WRF is also located near the upstream end of Temescal Wash. Its discharges shifted primarily from the Wash to Lake Elsinore starting around 2008. A small (0.77 cfs) discharge has been required continuously since then, and larger discharges occasionally resume when lake levels are high. The change in discharge operations pre-dated the drought by about 6 years, and vegetation along the 5-mile reach immediately downstream of the discharge location remained relatively healthy throughout the drought. Therefore, the change in EVMWD discharges did not appear to be a significant contributor to vegetation mortality during 2014 through 2016.
- **Temescal Valley Water District (TVWD) Lee Lake WRF**. The Lee Lake WRF is located about halfway down the Bedford-Coldwater Basin reach of Temescal Wash. Its discharges decreased starting in 2013, which coincided with the start of the drought. The discharges had not been large (about 0.8 cfs) and had already decreased by about half since 2005 due to increased wastewater recycling.
- **City of Corona WRF-3**. This WRF discharges a relatively small (about 0.2 cfs) flow to Temescal Wash upstream of Cajalco Road near the downstream end of the Bedford-Coldwater Basin. Those discharges would not influence vegetation patterns observed upstream.

The hiatus in EMWD discharges between January 2013 and February 2017 coincided with the drought and with the observed vegetation mortality. Because groundwater levels also declined to exceptionally low levels during that time, the cause of vegetation die-back cannot be uniquely determined based solely on information for that time period.

Looking farther back in time, riparian vegetation was generally able to increase in extent during the 1990s and early 2000s, when EMWD discharges were rare and generally small. This indicates that the vegetation was not dependent on those flows to become established. By inference, the mortality during 2014 through 2016 was not caused solely by the interruption in the discharges.

6.7.2.5. Riparian Vegetation Summary

The relationship between groundwater pumping, groundwater levels, and vegetation die-back is not clear-cut. If there were a direct correlation between the variables, one would expect to have seen lower groundwater levels and more die-back during the 1990s than during the 2014 to 2016 period, which was not the case. At a more general level, however, riparian vegetation along Temescal Wash was continuously dense and healthy in the Warm Springs portion of the Elsinore Subbasin, where groundwater pumping was very small throughout 1990 to 2018, large wastewater discharges were immediately upstream, and groundwater levels remained consistently shallow. The greatest impacts were along the downstream end of the Bedford Management Area in the Bedford-Coldwater Basin, where groundwater pumping was relatively intense, local wastewater discharges were relatively small, and groundwater levels experienced large declines during 2012 to 2016 (no data for 1990).

6.7.3. Definition of Undesirable Results

The Sustainability Goal includes an objective to support beneficial uses in the Basin, and specifically those related to interconnected surface water. Consistent with that objective, undesirable results of excessive depletion of surface water are:

> Riparian vegetation die-back or mortality during droughts of a magnitude that disrupts ecological functions or causes substantial reductions in populations of riparian-associated species.

6.7.4. Potential Effects on Beneficial Uses and Users

The analysis presented in this section demonstrates that groundwater conditions are currently sustainable with respect to inter-connected surface water and GDEs. There are no users of surface water in the Basin and there does not appear to be a correlation between groundwater levels and streamflow. Basin outflows appear sufficient to meet the needs of downstream water users. The distribution and health of riparian vegetation does appear to be correlated with groundwater levels, but those levels have recovered since the most recent drought and riparian vegetation is in the process of recovering as well.

6.7.5. Sustainable Management Criteria for Interconnected Surface Water

SGMA requires that the minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results (§354.28(c)(6)). However, GSP Regulations allow GSAs to use groundwater elevation as a proxy metric for any of the sustainability indicators when setting minimum thresholds and measurable objectives (23 California Code of Regulations [CCR] § 354.28(d) and 23 CCR § 354.30(d)).

It would be difficult to define a minimum threshold in terms of flow depletion in this Basin because phreatophytic riparian vegetation appears to be more correlated with areas where depth to water is consistently shallow than with the magnitude or duration of surface flow. Because there are undoubtedly gains and losses of surface flow along Temescal Wash, and the vegetation impacts are associated with a low water table when surface flow is not present, it is reasonable to define the minimum threshold in terms of water levels instead of flow.

6.7.6. Minimum Threshold

Given the above, the minimum threshold is defined here by groundwater levels. As noted previously, wells in the groundwater levels monitoring program are production wells with relatively deep screens that have not been sited and designed for tracking surface water-groundwater interactions. The lack of such shallow monitoring wells is a data gap and a source of uncertainty. Hence, the minimum threshold described here is initial. Nonetheless, it is intended to be protective of GDEs until the monitoring program can be refined to better represent near-stream shallow conditions.

Therefore, in the Bedford-Coldwater Basin:

> The **Minimum Threshold** for depletion of interconnected surface water is the amount of depletion that occurs when the depth to water in wells near areas supporting phreatophytic riparian trees is greater than 35 feet for a period exceeding one year.

This threshold corresponds approximately to the depth to water beneath the creek channel near water-level monitoring wells during 2014 through 2016 and is defined for static water levels in the wells listed in Section 6.7.6.5. Given the above uncertainty in the relationships between groundwater pumping, groundwater levels and the health of riparian vegetation, the minimum threshold for interconnected surface water presented here must be considered tentative and subject to revision in future GSP updates. The BCGSA is committed to monitoring vegetation and examining possible management actions to avoid undesirable results. However, given the uncertainty of the relationships between pumping, stream flow, water levels and riparian vegetation health, exceedance of the minimum threshold will first trigger additional study to assess how GSA pumping is affecting shallow water levels.

Undesirable results are considered to commence if water levels along more than half of the total length of reaches in the Basin with dense riparian trees exceed the minimum threshold.

By this definition, undesirable results did occur in the Bedford-Coldwater Basin during the recent drought, because vegetation die-back occurred along about 3.9 miles of the channel, or about 57 percent of the total length of Temescal Wash in the Basin.

6.7.6.1. Relationship of Minimum Threshold to Other Sustainability Indicators

- **Groundwater Levels.** All the wells used to evaluate the minimum threshold (see Section 6.7.6.5) are also representative wells used for compliance with the minimum threshold for groundwater levels. The groundwater level minimum threshold involves two consecutive quarterly water-level measurements rather than a period of one year. For the wells included in both sets of criteria, the interconnected surface water threshold water levels are generally higher than the water-level thresholds. That is, along the GDE stream reaches, the interconnected surface water criteria restrict water-level declines more than the water-level criteria do. This is the logical result of the different objectives of the two sets of criteria.
- **Groundwater Storage.** The minimum threshold for interconnected surface water would similarly be more restrictive than the minimum threshold for groundwater storage near GDE reaches, because the latter is functionally the same as the minimum threshold for water levels.
- **Seawater Intrusion.** Seawater intrusion would not occur in the Basin due to its inland location. No minimum threshold was defined and there is no consistency issue.
- **Land Subsidence.** Significant land subsidence is only likely to occur with groundwater levels below historical minimum levels. The levels specified as minimum thresholds for interconnected surface water are within the historical range and thus unlikely to cause subsidence.
- **Water Quality.** Water quality issues in the Basin are primarily associated with dispersed loading of nitrate and salinity and long-term increases in ambient concentrations of those constituents. Those processes are generally independent of groundwater levels. Groundwater outflow is an important mechanism for salt removal that requires relatively high groundwater levels on a long-term average basis. High levels and groundwater discharge into streams also benefit riparian vegetation and aquatic habitat. Therefore, the minimum threshold for interconnected surface water is consistent with the minimum threshold for water quality.

6.7.6.2. Effect of Minimum Threshold on Sustainability of Adjacent Areas

The areas of interconnected surface water in the Basin are those that are upstream of and adjoining the Temescal Basin. Groundwater and surface water flow is from the Bedford-Coldwater Basin toward the Temescal Basin, consistent with topography. If water levels in the Bedford Management Area were lowered, outflow to the Temescal Basin would decrease. The water levels used to define the minimum threshold for depletion of interconnected surface water are within the historical range of water levels and thus would not cause unreasonable impacts on groundwater availability in the Temescal Basin. By protecting vegetation along the Temescal Wash—which is a shared waterway between the basins—the minimum threshold will protect those resources for the benefit of both Basins.

6.7.6.3. Effect of Minimum Threshold on Beneficial Uses

Surface diversions are not a source of supply in the Basin; all water uses are supported by imported water or groundwater. With respect to groundwater, this GSP does not propose increases in groundwater pumping above existing amounts, so groundwater levels are expected to remain within the historical range. In areas where the minimum-threshold water level for interconnected surface water is higher than the minimum-threshold for chronic lowering of groundwater levels, the interconnected surface water threshold improves groundwater availability.

The minimum threshold is expected to protect beneficial uses of surface water for riparian habitat maintenance.

6.7.6.4. Relationship of Minimum Threshold to Regulatory Standards

Other than SGMA, there are no local, state, or federal regulations that specifically address stream flow depletion by groundwater pumping. The California and federal Endangered Species Acts protect species listed as threatened or endangered, including California coastal gnatcatcher. The minimum threshold for depletion of surface water is designed to prevent groundwater conditions from impacting those species beyond the level of impact that has historically occurred.

6.7.6.5. How the Minimum Threshold Will Be Monitored

Eight wells that are currently monitored for water levels are near stream reaches where interconnected surface water has been identified. These wells are listed below and shown on **Figure 6-1**.

- TVWD TP-1 and TP-2
- TVWD Well 1 (old well)
- TVWD Well 4
- EVMWD Flagler 2A and 3A
- Corona Non-Potable Wells 1 and 2

The wells listed above are all mostly water supply wells with relatively deep screens. They are useful for relating future conditions to historical ones, but they do not provide a reliable indication of the true water table elevation near the ground surface because shallow wells can have different water levels than deep wells.

Shallow monitoring wells are needed in riparian areas to provide accurate water table information and elucidate the relationship between deep water levels and vegetation conditions. One of the management actions in this GSP is to conduct surveys of Temescal Wash to evaluate the feasibility and need for installing shallow monitoring wells. Over time, minimum threshold groundwater elevations can be refined as a result of these surveys.

6.7.7. Measurable Objective

The measurable objective for interconnected surface water is an amount of depletion that is less than the amount specified as the minimum threshold. Given the uncertainty in the correlation between groundwater levels and vegetation health, no specific rise in shallow groundwater levels or increase in stream flow is identified as providing a preferred set of GDE conditions.

Groundwater conditions with respect to interconnected surface water and most GDE parameters are currently sustainable. Therefore, no interim milestones are needed to achieve sustainability at this time.

6.7.8. Data Gaps

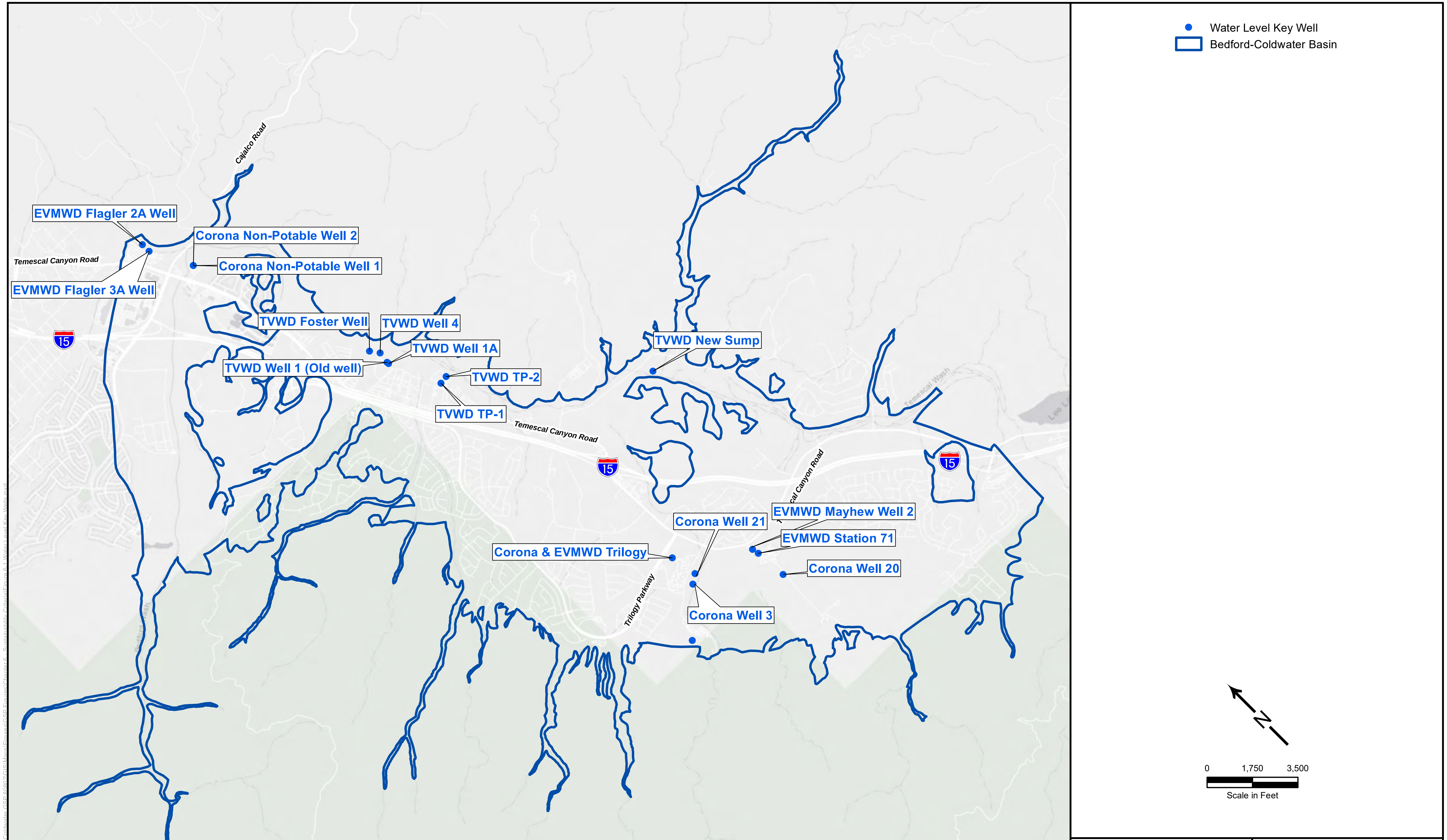
There are several data gaps that might be contributing to the lack of clear relationships between groundwater pumping, groundwater levels and vegetation die-back. These include:

- Wells with water-level data are clustered in a small number of locations. Water levels are unknown in many areas that experienced vegetation die-back.
- Almost all wells with water-level data are also production wells. Water-level drawdown that results from pumping is greater and more persistent near a pumping well than in areas far from the well. Consequently, it is difficult to accurately estimate depth to the water table in areas where there is no nearby pumping.
- The wells with data are not in the creek channel or within the areas with dense riparian vegetation, and the vertical distance between the wellhead and creek channel has not been surveyed at any well locations. The elevation difference can be estimated, but the lack of measured data produces uncertainty in estimating the depth to water at the channel.
- Vertical water-level gradients within the aquifer system are largely unknown. Pumping commonly creates vertical water-level gradients within basin fill materials, such that the true water table near the land surface is higher than the water level in a deep production well at the same location. Some indication of vertical gradients can be gleaned from a study of flow and vegetation along Temescal Wash downstream of EVMWD's Regional WRF in 2007 to 2008 (MWH 2008). Although the WRF is in the Elsinore Subbasin, vertical gradients caused by pumping would be similar in the Bedford MA. Shallow (seven-foot-deep) piezometers were installed in the channel at several locations along a four-mile reach extending downstream from the WRF. Water levels at piezometer TW7, CM2 and TW2 are included in the hydrographs for the Alberhill and Cemetery wells (see **Figure 6-4**). Unfortunately, most of the piezometers are not located near production wells. In terms of depth to water, the piezometer water levels appear generally shallower and more stable than are water levels in the nearest monitored production wells, which is consistent with the presence of vertical gradients caused by pumping at depth.

6.7.8.1. Discussion of Monitoring and Management Measures to be Implemented

Management actions to improve monitoring and management of interconnected surface water in the Basin will include tracking trends in groundwater levels near Temescal Wash,

investigating groundwater/surface water interactions near Temescal Wash and taking action as necessary.



TODD GROUNDWATER

Figure 6-1
Water Level
Key Wells


May 1994

June 2006

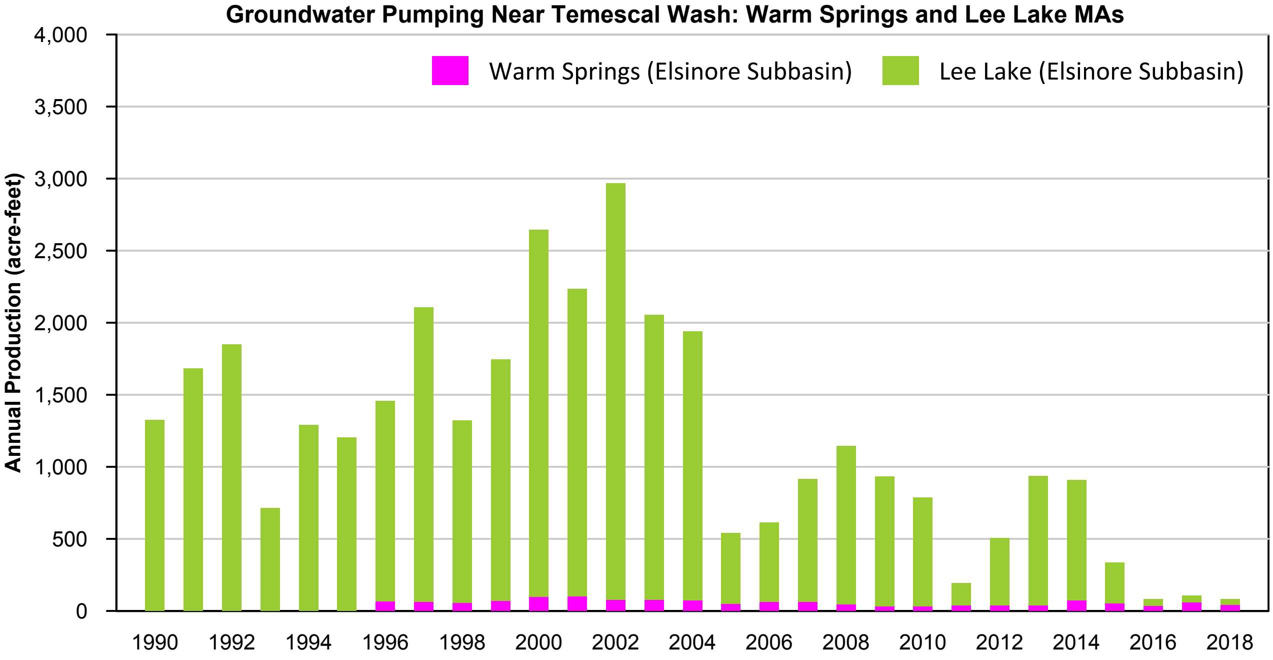
April 2014

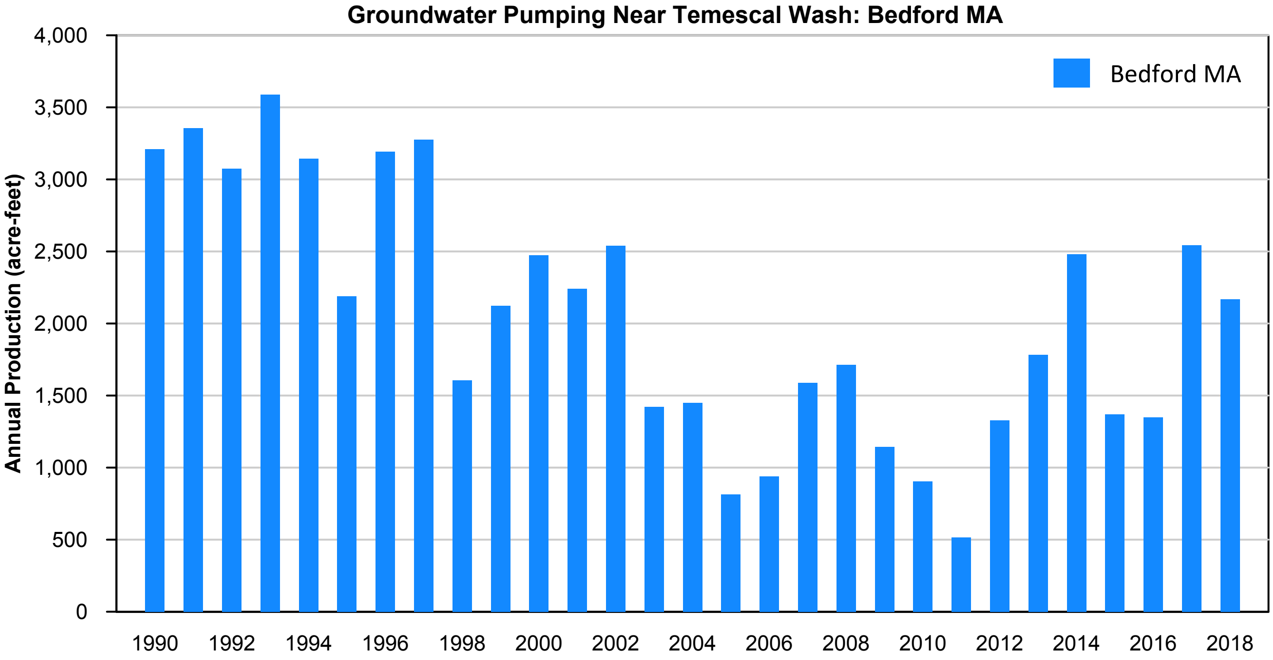
October 2016

June 2018

TODD GROUNDWATER

Figure 6-2
Aerial Images of
Riparian Vegetation
1994-2018



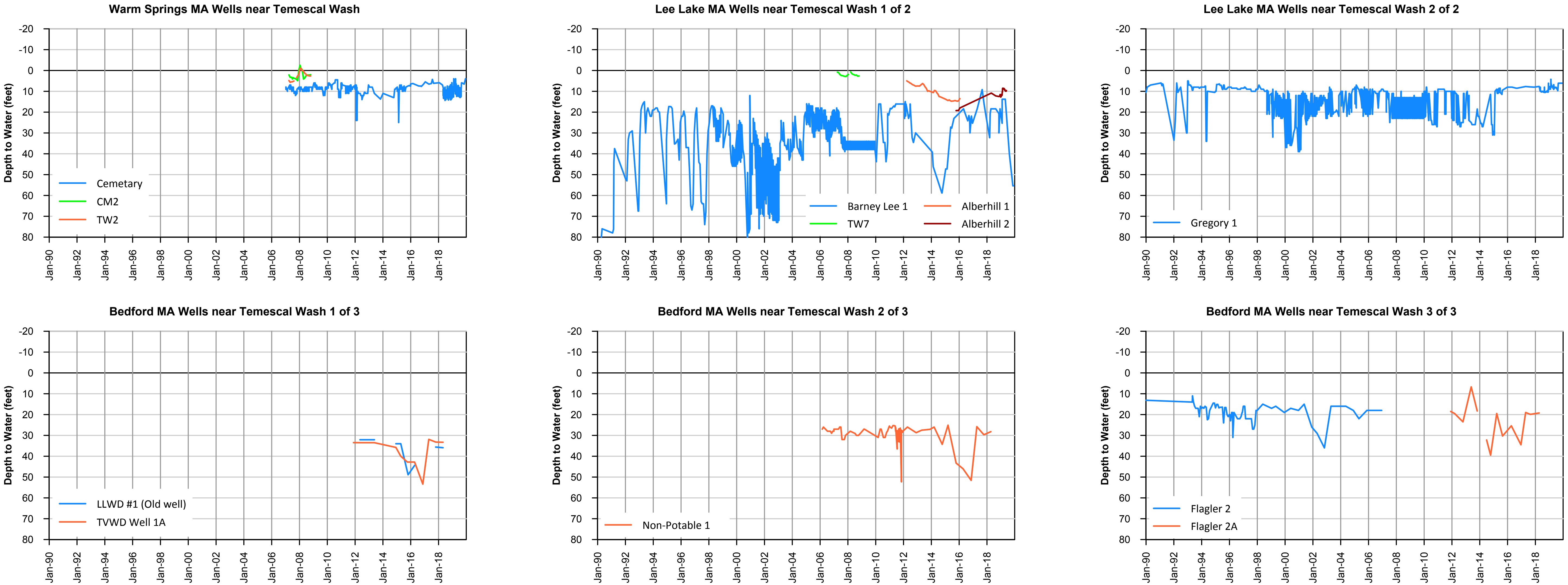


Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 6-3 Annual Groundwater Pumping near Temescal Wash, 1990-2018.gpj

Note:
The Warm Springs and Lee Lake areas in the upper chart are outside the Bedford-Coldwater Basin. These are portions of the Elsinore Subbain upstream of the Bedford-Coldwater Basin.

TODD GROUNDWATER

Figure 6-3
Annual Groundwater Pumping Near Temescal Wash, 1990-2018



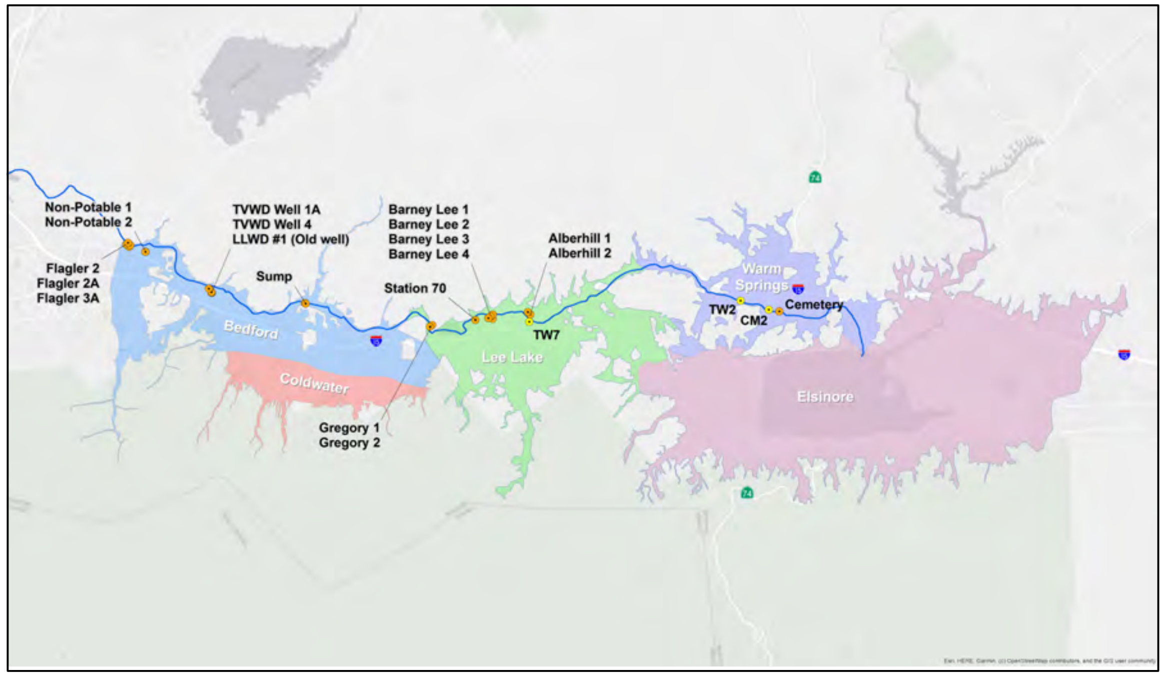
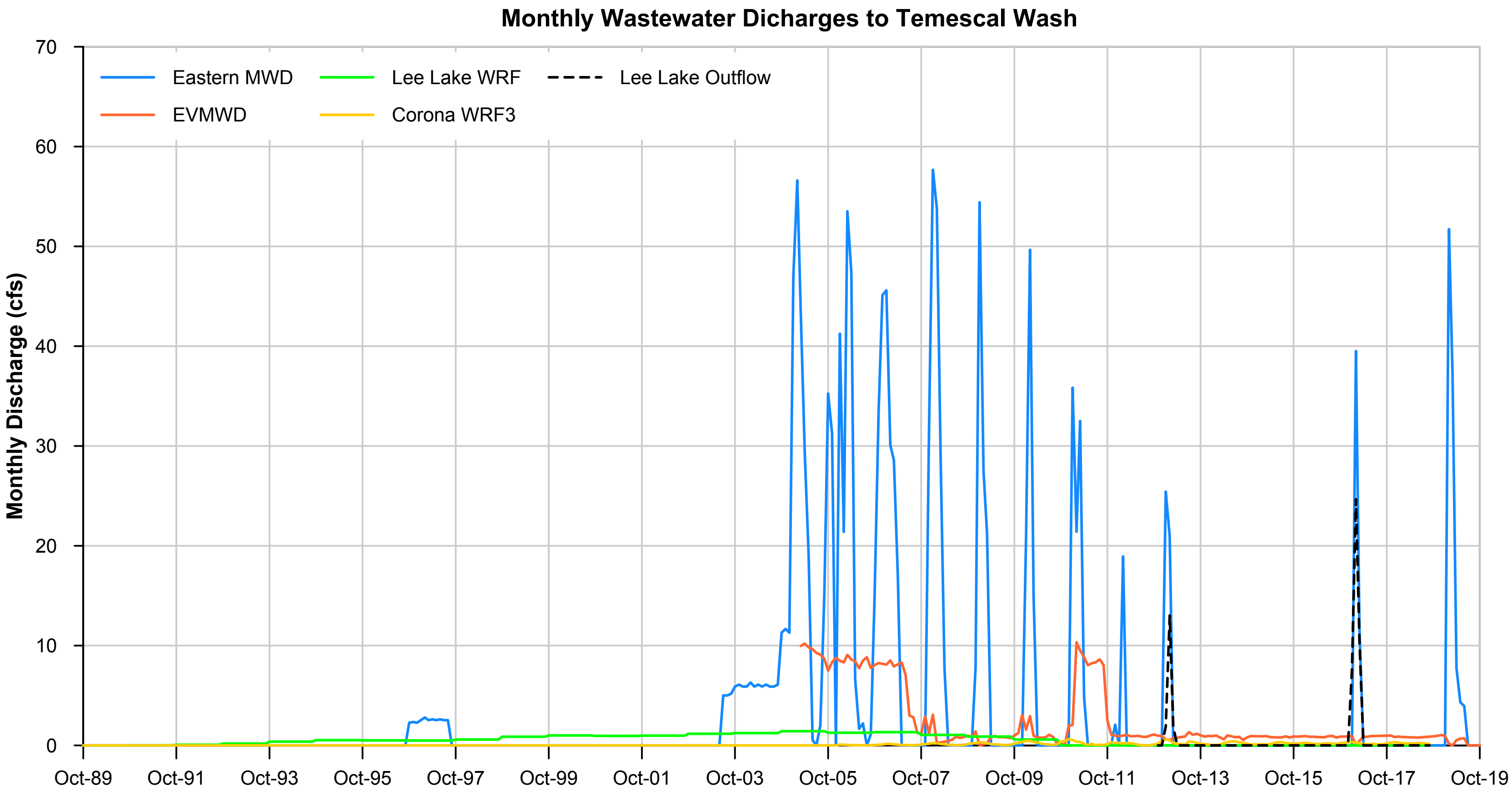


Figure 6-4
Water Levels in Wells Near Temescal Wash

TODD GROUNDWATER

Path: T:\Projects\Bedford Coldwater GSP 80602\GRAPHICS\Figure 6-4 Water Levels in Wells Near Temescal Wash.gpj



TODD GROUNDWATER

Figure 6-5
Wastewater Discharges to Temescal Wash
1989-2019

Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 6-5 Wastewater Discharges to Temescal Wash, 1990-2018.gpj

7. MONITORING NETWORK

The overall objective of the monitoring network for this Groundwater Sustainability Plan (GSP) is to yield representative information about water conditions in the Bedford-Coldwater Subbasin (Basin) as necessary to guide and evaluate GSP implementation. Specifically, monitoring network objectives are to:

- Build on the existing monitoring network data to represent the entire Basin,
- Reduce uncertainty and provide better data to guide management actions, document the water budget, and better understand how the surface water/groundwater system works,
- Monitor groundwater conditions relative to sustainability criteria, and
- Identify and track potential impacts on groundwater users/uses and better communicate the state of the Basin.

With the intent to provide sufficient data for demonstrating short-term, seasonal, and long-term trends in groundwater and related surface conditions, this GSP builds on existing monitoring programs (summarized in Chapter 2, Plan Area) that provide historical information and a context for monitoring. Data gaps are addressed in terms of information needed for understanding the basin setting, evaluation of the efficacy of Plan implementation, and the ability to assess whether the Basin is being sustainably managed.

This GSP Section describes the monitoring network as enhanced to fulfill Sustainable Groundwater Management Act (SGMA) requirements and explains how it will be implemented. This includes description of the monitoring protocols for data collection, the development and maintenance of Bedford-Coldwater Groundwater Sustainability Agency (BCGSA) data management system (DMS), and the regular assessment and improvement of the monitoring program.

7.1. DESCRIPTION OF MONITORING NETWORK

The monitoring network for GSP implementation has been established to document groundwater and related surface conditions as relevant to the sustainability indicators: groundwater levels, storage, land subsidence, water quality, and interconnected surface water[7]. The components of the monitoring network are presented in **Table 7-1**.

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[7] Seawater intrusion is noted, but no risk of seawater intrusion exists in this inland basin.

Table 7-1. Bedford Coldwater Monitoring Network Summary

Monitored Variable	Type of Measurement	Locations	Data Interval	Data Collection Agency	Database Storage Agency	Notes
Groundwater levels						
Bedford-Coldwater Basin	Depth to water, feet	17 monitored wells (see Table 6-1), plus two new dedicated monitoring wells	Continuous to Annual	City of Corona, Elsinore Valley Water District (EVMWD), and Temescal Valley Water Disrict (TVWD)	Bedford-Coldwater Groundwater Sustainability Agency (BCGSA)	Data from all sources compiled into unified groundwater elevation database. Continuous data recorded with and on data logging transducers.
Groundwater storage						
Rainfall	Rain gauge, daily total, inches	Lake Elsinore, Santiago Peak, and Riverside	Daily and Monthly	NOAA, Orange County, and UC Riverside CIMIS	BCGSA	Download from web annually for annual water budget and model update
Rainfall (Interpolated)	Interoplated spatially from point data	Basin-wide		PRISM Climate Group	BCGSA	Rainfall gauges are not within the basin, and PRISM data helps interpolate in regions with climatic variation
Reference ET (ET_0)	Daily ETo, inches	Lake Elsinore and Riverside	Daily	NOAA, UC Riverside CIMIS	DWR	Download from web
Stream flow	Daily average flow, cfs	Three active USGS gages near Beford-Coldwater Basin	Daily	USGS	USGS	Download from web
Wastewater pond water budgets	WWTP effluent discharge, evaporation, percolation, AF	Corona and TVWD	Monthly	Corona and TVWD	BCGSA	
Recycled water use	Recycled water delivery, AF	Basin-wide	Monthly	Corona and TVWD	BCGSA	Recycled water use is a relatively small but increasing supply
Imported Water	Volume imported water AF	Imported to Bedford Colwater	Monthly	Corona, EVMWD, and TVWD	BCGSA	
Land Use Maps	Maps of Land Use	Basin-wide		DWR (2014, 2016, and future) and Riverside County (1993 and 2000)	DWR and Riverside County	DWR data is statewide, remotely sensed, and includes agriculture by crop
Municipal Water Use	Metered water use by sector	EVMWD, Corona, and TVWD	Monthly	Corona, EVMWD, and TVWD	BCGSA	Annual data reported in by BCGSA agencies and to Western Municipal Water District as Watermaster for the watershed, includes imported, groundwater, and recycled water use
Groundwater pumping						
Community Water Systems	Estimated	Basin-wide	Annual	Santa Ana Watermaster	BCGSA	Annual estimates provided in water budget updates of Annual Report
Groundwater Production	Annual Volume, AFY	Basin-wide	Annual	Santa Ana Watermaster, Corona, EVMWD, and TVWD	Western Municipal Water District as Watermaster and BCGSA	Annual data for all pumpers reported to Santa Ana Watermaster, monthly production data for BCGSA agencies availble from those agencies.
Rural domestic, commercial, industrial	Estimated	Basin-wide	Annual	Santa Ana Watermaster, Corona, EVMWD, and TVWD	BCGSA	Annual estimates provided in water budget updates of Annual Report
Subsidence						
Subsidence	InSAR satellite mapping of ground displacement	Basin-wide	Annual change	DWR (InSAR)	DWR SGMA Data Portal	Download annually, smooth InSAR raster datasets, compare cumulative elevation change since 2015 against Minimum Threshold criterion.
Groundwater quality						
Groundwater Quality	Major and minor ions and contaminants	14 monitored wells	Quarterly/ Semi-annual	Corona, EVMWD, TVWD, SWRCB GAMA , DDW, RWQCB	BCGSA	Wells with water qualtiy data may be added or removed over time
Interconnected Surface Water and GDEs						
Groundwater Depth to Water	Depth to water, feet	8 monitored wells	Continuous to Annual	Corona, EVMWD, and TVWD	BCGSA	Measurements are sparse, but groundwater in some areas may be shallow enough to support riprarian vegetation

7.1.1. Chronic Lowering of Groundwater Levels

As described in Plan Area Section 2, 19 wells in the Basin with elevation data are monitored by the BCGSA or its member agencies. **Figure 7-1** shows the 19 wells that will be part of the groundwater level monitoring program. Of these 17 have been actively monitored within the past five years and 2 new wells (BCGSA MW-1 and MW-2) are being installed as part of GSP development. The new wells are currently being installed and are expected to be part of the network by 2022. Their planned locations are shown on **Figure 7-1**. The distribution of existing monitoring wells is uneven, with most monitoring wells clustered in the Coldwater Management Area (MA) and along the Temescal Wash in the Bedford MA. The new monitoring wells were designed to fill key data gaps in the northwestern portion of the Basin and to monitor water levels related to the potential effects of the Glen Ivy Fault. All the wells in the GSP monitoring network are listed in **Table 7-2** and will continue to be monitored by the BCGSA or its member agencies. (Glen Ivy Well 1 also is listed as a planned water quality monitoring well).

Data for GSP implementation collected by the BCGSA and/or its member agencies will be compiled by the BCGSA into the DMS developed as part of the GSP. Benefits of these efforts will accrue over the next few years and will support review and update of the monitoring program in the 2027 Five-Year GSP Update. Additional groundwater elevation data from previous investigations may be used to supplement the current monitoring program.

7.1.1.1. Spatial and Vertical Coverage

Figure 7-1 shows locations of wells in the groundwater level monitoring program, while **Table 7-2** provides a summary of relevant monitoring wells. All monitoring wells are owned by the City of Corona (Corona), Elsinore Valley Municipal Water District (EVMWD), and Temescal Valley Water District (TVWD).

Well density has been a consideration in identifying new dedicated monitoring well sites and adding existing wells to the monitoring program. California Department of Water Resources (DWR) guidance (DWR 2016d) generally recommends a monitoring well density of 4 wells per 100 square miles (mi^2), which would equate to 0.44 wells for the 11 mi^2 Basin. The BCGSA monitoring program is consistent with this guidance. Many of the active wells are clustered in the Coldwater MA.

Data on vertical groundwater gradients generally are lacking, as discussed in the Hydrogeologic Conceptual Model, Section 3. Vertical gradients also have not been distinguished because most monitoring data are from public supply wells, which generally have long screen zones and have not been designed to assess or monitor vertical gradients in the Basin.

7.1.1.2. Monitoring Frequency

SGMA and the California Statewide Groundwater Elevation Monitoring (CASGEM) program require collection of static groundwater elevation measurements at least two times per year to represent seasonal low and seasonal high groundwater conditions. Currently, the 17 water level wells are monitored at least quarterly, and most are monitored either monthly or continuously. Data logging transducers have been installed for measuring groundwater elevation data in most of the groundwater monitoring wells. These transducers collect water level measurements at least monthly, and data are either transmitted to data collection and operation systems or downloaded quarterly.

7.1.2. Reduction of Groundwater in Storage

As described in GSP Section 6.3, groundwater level Minimum Thresholds (MTs) are used as a proxy metric for groundwater in storage. Accordingly, the monitoring of groundwater levels described above in Section 7.1.1 also pertains to tracking sustainability for groundwater in storage.

In addition, GSP regulations require annual evaluation and reporting of change in groundwater in storage.

For the GSP, the numerical groundwater model has been used to quantify the water budget and change in storage (see Water Budget, Chapter 5) using available information from the Monitoring Well Network. The numerical model (described in **Appendix G**) fulfills data and reporting standards described in Title 23 of the California Code of Regulations (CCR), Section 352.4.

As described in Plan Area Section 2.1.4.1 and summarized in **Table 7-1**, the BCGSA monitoring program provides information needed to update the water budget and assess annual change in groundwater storage. This program compiles and reviews information on climate (rainfall and evapotranspiration), stream flow, imported water deliveries, wastewater percolation and water recycling, and groundwater pumping (municipal, industrial, and other). Groundwater in storage will be assessed annually by estimating storage changes as the product of groundwater level change (feet), basin area (acres) and storativity values for each MA.

7.1.2.1. Spatial Coverage

Evaluation of change in groundwater in storage involves several of the monitored variables listed in **Table 7-1**; monitoring locations are described in the table. **Table 7-1** identifies climate stations and stream gage locations. While the closest climate stations and stream gages are located outside the Basin, they are still sufficient to provide information about local conditions.

7.1.2.2. Surface Water Monitoring

There are three active stream flow monitoring gages near the Basin. These gages are monitored by the United States Geological Survey (USGS). Data from these gages will continue to be collected by the BCGSA.

7.1.2.3. Monitoring Frequency

Table 7-1 describes the data interval for the monitored variables that contribute to evaluation of groundwater in storage. Groundwater in storage will be assessed annually using the numerical model, which will be recalibrated during each five-year GSP update.

7.1.3. Seawater Intrusion

There is no monitoring for seawater intrusion and no gaging of tidal influence. The Basin is located over 20 miles inland from the Pacific Ocean, and its lowest elevations are around 1,000 feet above sea level. No risk of seawater intrusion exists in the Basin given its location and therefore no monitoring is needed.

7.1.4. Subsidence

The monitoring program will review Interferometric Synthetic Aperture Radar (InSAR) satellite-based data to identify and evaluate land subsidence in the Basin (see **Table 7-1**). These data will be used to monitor the rate and extent of ground surface elevation change as applicable and with reference to the MT and Measurable Objective (MO), which are described in Sustainability Criteria Sections 6.4. These data represent measurements of ground surface displacement and thus are directly applicable to scientific assessment of potential subsidence.

7.1.4.1. Spatial Coverage

The InSAR data provide adequate coverage of the Bedford Coldwater Basin including both MAs, as described in Groundwater Conditions Section 4.3 and Sustainability Criteria Section 6.4. InSAR data are available for the entire Basin (and beyond), as shown with recent InSAR information from DWR on **Figure 4-10**. InSAR data will be cross-checked, and in conjunction with local groundwater level and pumping data will be used to assess relationships between groundwater levels, pumping, and subsidence data.

7.1.4.2. Monitoring Frequency

Assuming continued data availability, the monitoring program will involve annual download of InSAR data with analysis for any signs (rate and extent) of cumulative inelastic subsidence. To date there have been no reports or other indications of subsidence in the Basin. While data will be reviewed annually, at this time detailed analysis relative to the Minimum Threshold and Measurable Objective is planned as part of the five-year GSP update. The reporting will be consistent with GSP Regulations.

7.1.5. Degraded Water Quality

In addition to the general monitoring objectives listed above, specific objectives for the GSP water quality monitoring program include the following:

- Collect groundwater quality data from the principal aquifer to identify and track trends of any water quality degradation,
- Map the movement of degraded water quality,

- Define the three-dimensional extent of any existing degraded water quality impact,
- Assess groundwater quality impacts to beneficial uses and users, and
- Evaluate whether management activities are contributing to water quality degradation.

Figure 7-2 shows the location of the existing wells that are sampled for water quality. The existing water quality monitoring programs for the Basin are described in Plan Area Section 2.1.4, Groundwater Conditions Section 4, and Sustainability Criteria Section 6.6. To summarize, the BCGSA monitoring program relies on other agencies and their annual or semi-annual measurements, including Corona, EVMWD, TVWD, the Santa Ana Regional Water Quality Control Board (RWQCB), and State Water Resources Control Board Division of Drinking Water (SWRCB-DDW). The BCGSA agencies currently monitor 12 wells periodically for general minerals, physical parameters, and selected constituents of concern. In addition, one private well (Glen Ivy Hot Springs) is sampled regularly, and water quality data are provided to the SWRCB-DDW. Two new dedicated monitoring wells will be added to the monitoring network as part of GSP development. These wells (BCGSA MW-1 and MW-2) are shown on **Figure 7-2**. As described in Groundwater Conditions Section 4 and discussed in depth in Section 6.6, a broad suite of inorganic constituents is sampled and analyzed and known regulated contamination sites are tracked. Total dissolved solids (TDS) and nitrate have been identified as the key constituents of concern for which sustainability criteria have been defined.

7.1.5.1. Spatial and Vertical Coverage

The current monitoring network in the Basin contains spatial and vertical gaps. **Figure 7-2** shows the spatial distribution of wells currently monitored, including the new dedicated monitoring wells that will be sampled regularly.

As with the groundwater level monitoring program, existing wells in the BCGSA groundwater quality monitoring program will be evaluated relative to 23 CCR § 352.4 requirements for well information. The new dedicated monitoring wells are designed to meet requirements while addressing data gaps in the water quality monitoring program as well as the water level monitoring program.

Vertical coverage is discussed in Groundwater Conditions Section 4.9, which indicates that the water quality monitoring programs in the Basin do not reveal vertical differences in water quality. Otherwise, vertical differences in water quality are uncertain; this reflects the fact that most monitored wells are pumping wells with long screens.

As stated in Section 6.6, the BCGSA will continue to improve and expand the monitoring program if needed to address spatial and vertical coverage.

7.1.6. Depletion of Interconnected Surface Water

The minimum threshold for depletion of interconnected surface water is defined by groundwater levels monitored near dense riparian vegetation along the Temescal Wash. At this time, wells in the groundwater level monitoring program are production wells with relatively deep screens that have not been sited and designed for tracking surface water-groundwater interactions. The lack of shallow monitoring wells has been identified as a data gap.

7.1.6.1. Spatial and Vertical Coverage

Figure 7-1 is a map showing locations of key wells currently selected for groundwater levels and those located along selected stream reaches can be used to monitored groundwater-surface water interaction. The identification of key stream reaches is described in Sustainability Criteria Section 6.7 and has addressed all management areas. **Table 7-2** provides a summary of the monitoring wells in the network.

The scientific rationale for identification of wells for inclusion in the shallow groundwater level monitoring program has involved the following:

- Location adjacent to riparian vegetation along Temescal Wash.
- Length, completeness, and reliability of historical groundwater level record with measurements.
- Regular access to the well for measurements.

The selected wells are all water supply wells with relatively deep screens and therefore do not provide the needed vertical (shallow) coverage. The BCGSA will investigate the connection between shallow groundwater, surface water, and riparian vegetation as indicated in Section 8, Projects and Management Actions. These investigations will focus on identifying the need for additional shallow groundwater monitoring near areas of interconnected surface water.

7.1.6.2. Temporal Coverage and Monitoring Frequency

The monitoring for groundwater levels adjacent to areas of riparian vegetation in Temescal Wash will be implemented as part of the overall groundwater level monitoring program as described in Section 7.1.1. Monitoring of existing wells in the program will be continued, serving as the Key Wells for monitoring relative to the Minimum Thresholds defined in GSP Sustainability Criteria Section 6. Once sited and installed, the periods of record for new dedicated shallow wells will be established. Groundwater level data will be reviewed annually (for each annual report) with reference to the Minimum Threshold. Detailed analyses of the relationships among deep and shallow groundwater level data, stream flow, and riparian conditions will be provided in the Five-Year Update (or sooner if extreme drought conditions and riparian mortality occur; see GSP Section 6.7).

7.2. PROTOCOLS FOR DATA COLLECTION AND MONITORING

This section focuses on groundwater level monitoring (including regional and surface water-oriented) and groundwater quality sampling by BCGSA. Other data (e.g., climate, streamflow, municipal pumping, subsidence) are compiled by other agencies.

This section describes general procedures for documenting wells in the monitoring program and for collecting consistently high-quality groundwater elevation and groundwater quality data. In general, the methods for establishing location coordinates (and reference point elevations for elevation monitoring) follow the data and reporting standards described in the GSP Regulations (23 CCR § 352.4) and the guidelines presented in USGS Groundwater Technical Procedures (Cunningham and Schalk 2011 and USGS 2021). These procedures are summarized below.

7.2.1. Field Methods for Monitoring Well Data

Background data for each monitoring well is required for its inclusion in the monitoring program. These data are generally available for wells in the network described on **Table 7-2** and shown on **Figures 7-1**. As part of GSP implementation, location and elevation data will be acquired where missing, revised if conditions at a monitored well change, and added when new wells are brought into the program. The methods for acquiring these data follow:

- Location coordinates will be surveyed with a survey grade global positioning system (GPS) device. The coordinates will be in Latitude/Longitude decimal degrees and reference the North American Datum of 1983 (NAD83) datum.
- Reference point elevations will also be surveyed with a survey grade GPS device with elevation accuracy of approximately 0.5 feet.
    - During surveying, the elevations of the reference point and ground surface near the well will be measured to the nearest 0.5 foot.
    - All elevation measurements will reference North American Vertical Datum of 1988 (NAVD88) vertical datum.

7.2.2. Field Methods for Groundwater Elevation Monitoring

Reference points and ground surface elevations will be documented as described above prior to groundwater elevation monitoring in the field. Field methods for collection of depth-to-water measurements are described below:

1. Measurements in all wells will be collected within a three-day window whenever possible.
2. Active production wells should be turned off prior to collecting a depth to water measurement.
3. The standard period of time that a well needs to be off before a static measurement is taken is at least 24 hours (48 hours recommended).
4. To verify that the wells are ready for measurement, BCGSA field staff will coordinate with well operators and/or owners as necessary.
5. Coordination with well operators/owners should occur approximately four days prior to the expected measurement date.
6. Depth to groundwater measurements collected by either electric sounding tape (Solinst or Powers type sounders), by steel tape methods, or data logging transducers. Depth-to-water measurement methods are described in DWR's

Groundwater Elevation Monitoring Guidelines (DWR 2010). Depth to groundwater will be measured and reported in feet to at least 0.1 foot.

7.2.3. Field Methods for Groundwater Quality Monitoring

Groundwater sampling is conducted by trained professionals from the three agencies in the BCGSA or specialty contractors. Sampling follows standard monitoring well sampling guidelines such as those presented in the National Field Manual for the Collection of Water-Quality Data (USGS 2021).

Generally, the wells have been pumped prior to sample collection, or are purged. Purging is conducted until field instruments indicate that water quality parameters (pH, oxidation-reduction potential (ORP), specific conductance, and temperature) have stabilized and turbidity measurements are below five Nephelometric Turbidity Unit (NTUs). The pumping or purging prior to sample collection demonstrates that the sample collected is representative of formation water and not stagnant water in the well casing or well filter pack. For groundwater, field temperature and conductivity are recorded while the well is being purged to ensure that physical parameters have stabilized before collecting a sample.

All groundwater samples are collected in laboratory-supplied, pre-labeled containers and include prescribed preservatives. The filled sample containers will then be placed in an ice-filled cooler for storage and transported to the laboratory for analysis under chain of custody procedures.

All field measurements are recorded in a field logbook or worksheets and the sample containers are labeled correctly and recorded on the chain-of-custody form. The applicable chain-of-custody sections are completed and forwarded with the samples to the laboratory. Upon receipt of the samples at the laboratory, laboratory personnel complete the chain-of-custody.

Quality assurance and quality control (QA/QC) assessment of field sampling includes use of field blanks. Field blanks identify sample contamination that is associated with the field environment and sample handling. These samples are prepared in the field by filling the appropriate sample containers with the distilled water used for cleaning and decontamination of all field equipment. One field blank per sampling event is collected.

Samples are sent to a State-certified laboratory that has a documented analytical QA/QC program including procedures to reduce variability and errors, identify and correct measurement problems, and provide a statistical measure of data quality. The laboratory conducts all QA/QC procedures in accordance with its QA/QC program. All QA/QC data are reported in the laboratory analytical report, including: the method, equipment, and analytical detection limits, the recovery rates, an explanation for any recovery rate that is less than 80 percent, the results of equipment and method blanks, the results of spiked and surrogate samples, the frequency of quality control analysis, and the name of the person(s) performing the analyses. Sample results are reported unadjusted for blank results or spike recovery.

7.3. REPRESENTATIVE MONITORING

To allow quantification and tracking of sustainability criteria, representative monitoring sites, or wells, have been identified for 1) regional groundwater level monitoring and 2) for monitoring shallow groundwater conditions where surface water-groundwater connection is likely and tied to groundwater dependent ecosystems (GDEs). These Key Wells are shown on **Figure 7-1** and listed in **Table 7-2**. These have been designated by BCGSA as the point at which sustainability indicators are monitored. Information on the quantitative values for MTs, MOs, and interim milestones is included in Sustainability Criteria Section 6.

As discussed in Sustainability Criteria Section 6.3, change in groundwater in storage is closely related to groundwater levels, which can serve as a proxy for monitoring change in storage. Moreover, groundwater level MTs and MOs are sufficiently protective to ensure prevention of significant and unreasonable results relating to storage. Accordingly, continued monitoring of wells for groundwater levels also serve to track sustainability for storage.

As discussed in Section 6.4, the definition of undesirable results and the quantification of the MT and MO for subsidence are based on InSAR information on vertical displacement of the ground surface; these spatial and temporal data are publicly available from DWR.

Section 6.5 discusses seawater intrusion, which is not possible in this inland basin.

Section 6.6 describes undesirable results and defines sustainability criteria for water quality. MTs and MOs are quantified in terms of the percentage of wells with concentrations exceeding the local and state goals for nitrate and TDS based on current conditions. The BCGSA water quality monitoring wells shown on **Figure 7-2** and listed in **Table 7-2** are sampled regularly to identify water quality problems and to track water quality trends.

Table 7-2. Wells in the Bedford-Coldwater Groundwater Sustainability Agency Monitoring Network

Local Well Name	State Well Number	CASGEM Identification Number	Well Owner	Production Well	Management Area	X Coordinate (feet State Plane CA Zone 6, NAD 83)	Y Coordinate (feet State Plane CA Zone 6, NAD 83)	Ground Surface Elevation (feet)	Reference Point Elevation (feet)	Completion Date	Total Well Depth (feet)	Screen Interval Depths (feet)	Water Level Monitoring Well (Yes/No)	Surface Water Monitoring Well (Yes/No)	Water Quality Monitoring Well (Yes/No)
Corona Well 20	005S006W11D001	Not Applicable	City of Corona	Yes	Coldwater	6,187,462.780	2,220,777.903	1,147.58	1,149.48	10/2/1998	660	200 to 580	Yes	No	Yes
Corona Well 21	005S006W03J005	Not Applicable	City of Corona	Yes	Coldwater	6,185,101.479	2,224,408.672	1,128.00	1,128.49	5/22/1998	660	200 to 580	Yes	No	Yes
Corona Well 3	005S006W03K001	Not Applicable	City of Corona	Yes	Coldwater	6,184,790.810	2,222,918.852	1,137.70	1,143.57	1/26/1935	543	100 to 530	Yes	No	No
Corona Non-Potable Well 1	004S006W16G004S	46729	City of Corona	Yes	Bedford	6,179,815.144	2,245,270.386	808.92	809.34	Unknown	Unknown	Unknown	Yes	Yes	Yes
Corona Non-Potable Well 2	004S006W16G005S	46730	City of Corona	Yes	Bedford	6,179,827.292	2,245,270.240	808.77	808.90	Unknown	Unknown	Unknown	Yes	Yes	Yes
Corona & EVMWD Trilogy	005S006W03H001S	Not Applicable	Corona & EVMWD	Yes	Coldwater	6,184,906.094	2,224,253.480	1,101.86	1,101.86	2/5/2016	579	250 to 360 and 390 to 450	Yes	No	No
EVMWD Flagler 2A Well	004S006W16C003S	46732	Elsinore Valley Municipal Water District	Yes	Bedford	6,179,006.482	2,247,223.539	791.71	796.96	3/30/2005	105	51 to 92	Yes	Yes	Yes
EVMWD Flagler 3A Well	004S006W16C002S	46733	Elsinore Valley Municipal Water District	Yes	Bedford	6,179,002.084	2,246,859.661	794.16	795.72	3/18/2005	100	51 to 90	Yes	Yes	Yes
EVMWD Station 71	005S006W11C001	Not Applicable	Elsinore Valley Municipal Water District	Yes	Bedford	6,187,370.000	2,222,025.759	1,166.45	1,168.53	7/22/1971	600	239 to 588	Yes	No	Yes
EVMWD Mayhew Well 2	005S006W11G001	Not Applicable	Elsinore Valley Municipal Water District	Yes	Coldwater	6,187,322.670	2,222,291.946	1,241.00	1,242.33	10/27/1989	740	300 to 730	Yes	No	Yes
TVWD Well 1 (Old well)	004S006W22P003S	Not Applicable	Temescal Valley Water District	No	Bedford	6,182,456.123	2,237,346.855	894.00	881.40	Unknown	100	40 to 80	Yes	Yes	No
TVWD Well 1A	Not Available	Not Applicable	Temescal Valley Water District	Yes	Bedford	6,182,464.822	2,237,273.854	895.00	882.68	Unknown	100	40 to 80	Yes	No	Yes
TVWD Well 4	004S006W22P004S	Not Applicable	Temescal Valley Water District	Yes	Bedford	6,182,523.828	2,237,795.159	883.00	878.97	Unknown	100	40 to 80	Yes	Yes	Yes
TVWD TP-1	Not Available	Not Applicable	Temescal Valley Water District	Yes	Bedford	6,183,364.598	2,235,315.457	901.46	902.29	6/18/2015	103	39 to 99	Yes	Yes	Yes
TVWD TP-2	Not Available	Not Applicable	Temescal Valley Water District	Yes	Bedford	6,183,683.778	2,235,349.830	902.37	902.62	5/18/2017	90	30 to 85	Yes	Yes	Yes
TVWD Foster Well	004S006W22N002	Not Applicable	Temescal Valley Water District	Yes	Bedford	6,182,288.775	2,238,133.791	871.74	872.94	6/9/2015	93	38 to 88	Yes	No	Yes
TVWD New Sump	004S006W35G002	47928	Temescal Valley Water District	Yes	Bedford	6,189,460.269	2,229,866.527	955.71	953.57	Unknown	74	Unknown	Yes	No	Yes
BCGSA MW-1	Not Available Yet	Not Applicable	Bedford-Coldwater GSA	No	Bedford	6,181,386.544	2,228,000.186	Not Available Yet	Not Available Yet	Construction Planned Mid-2021	Not Available Yet	Not Available Yet	Yes	No	Yes
BCGSA MW-2	Not Available Yet	Not Applicable	Bedford-Coldwater GSA	No	Coldwater	6,181,488.573	2,231,333.213	Not Available Yet	Not Available Yet	Construction Planned Mid-2021	Not Available Yet	Not Available Yet	Yes	No	Yes
Glen Ivy Well 1	Not Available	Not Applicable	Glen Ivy Hot Springs	Yes	Coldwater	6,183,187.330	2,221,453.024	Unknown	Unknown	Unknown	Unknown	Unknown	No	No	Yes

7.4. DATA MANAGEMENT SYSTEM (DMS)

The BCGSA has been collecting and compiling groundwater data including water levels, water quality, and water use for the GSP. Before the creation of the GSA, the individual agencies of the BCGSA (Corona, EVMWD, and TVWD) monitored water levels and water quality independently. These data from other sources are compiled in relational databases, which consists of Access databases and ESRI geodatabases that have the capabilities for queries to quickly check and summarize data. As part of the GSP, the DMS has been modified to be practicable, usable, and intuitive for the purpose of GSP preparation and implementation. **Appendix K** details the final DMS. The databases include easy to update tables and other datasets that assist in comparison of real time conditions and sustainability goals.

7.5. ASSESSMENT AND IMPROVEMENT OF MONITORING NETWORK

The BCGSA has actively engaged in assessment and improvement of its monitoring network. This process has been intensified as part of the GSP, given the need to identify data gaps and to assess uncertainty in setting and tracking sustainability criteria. Monitoring improvements are a major part of GSP implementation and will be reviewed and updated for each five-year GSP update.

7.5.1. Identification and Description of Data Gaps

The limited data gaps that have been identified in this GSP are summarized in **Table 7-3** according to major monitored variable and described in terms of insufficient number of monitoring sites and utilization of monitoring sites that are unreliable (including those that do not satisfy minimum standards). Data gaps also are described in terms of the location and reason for data gaps in the monitoring network, and local issues and circumstances that limit or prevent monitoring. Data gaps listed in **Table 7-3** do not include gaps in understanding, which build on the monitoring network but also require investigation and analysis. These planned studies are described as Projects and Management Actions in GSP Chapter 8.

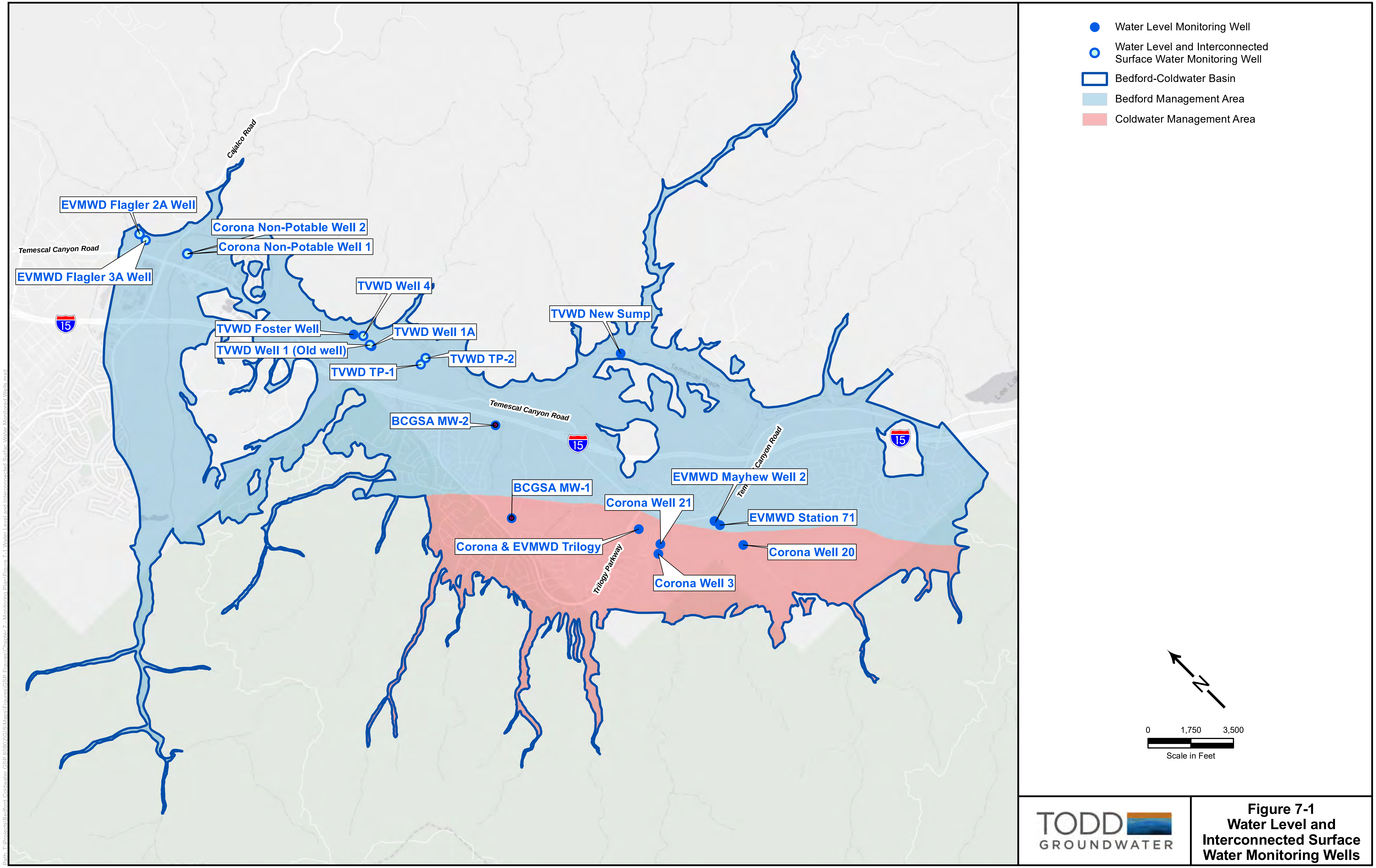
Table 7-3. Identification and Description of Data Gaps

Monitored Variable	Insufficient Sites	Local Issues
Regional Groundwater levels	No	The water level network has historically relied on production wells, but new dedicated wells have been installed and the production wells are well suited to monitoring conditions related to water supply for municipal, industrial, and other beneficial uses.
Stream flow	No	
Groundwater extraction	No	Most pumping is reported; there may be unreported pumping but it is assumed to be de minimis.
Groundwater quality	No	Water quality sampling in the Basin is typically tied to regulatory requirements. The BCGSA will perform regular monitoring of the well network and collect water quality data from all available sources.
Shallow groundwater levels	Yes	No shallow dedicated groundwater monitoring wells in Basin. Long well screens in monitoring wells limit vertical groundwater quality characterization.

7.5.2. Description of Steps to Fill Data Gaps

Monitoring data gaps have been identified for shallow groundwater level measurements.

Additional shallow groundwater level monitoring is required to better monitor interconnected surface water and GDEs in the Basin. The management actions the BCGSA will undertake towards filling this data gap are described in Section 8, Projects and Management Actions.



TODD GROUNDWATER

Figure 7-1
Water Level and Interconnected Surface Water Monitoring Wells

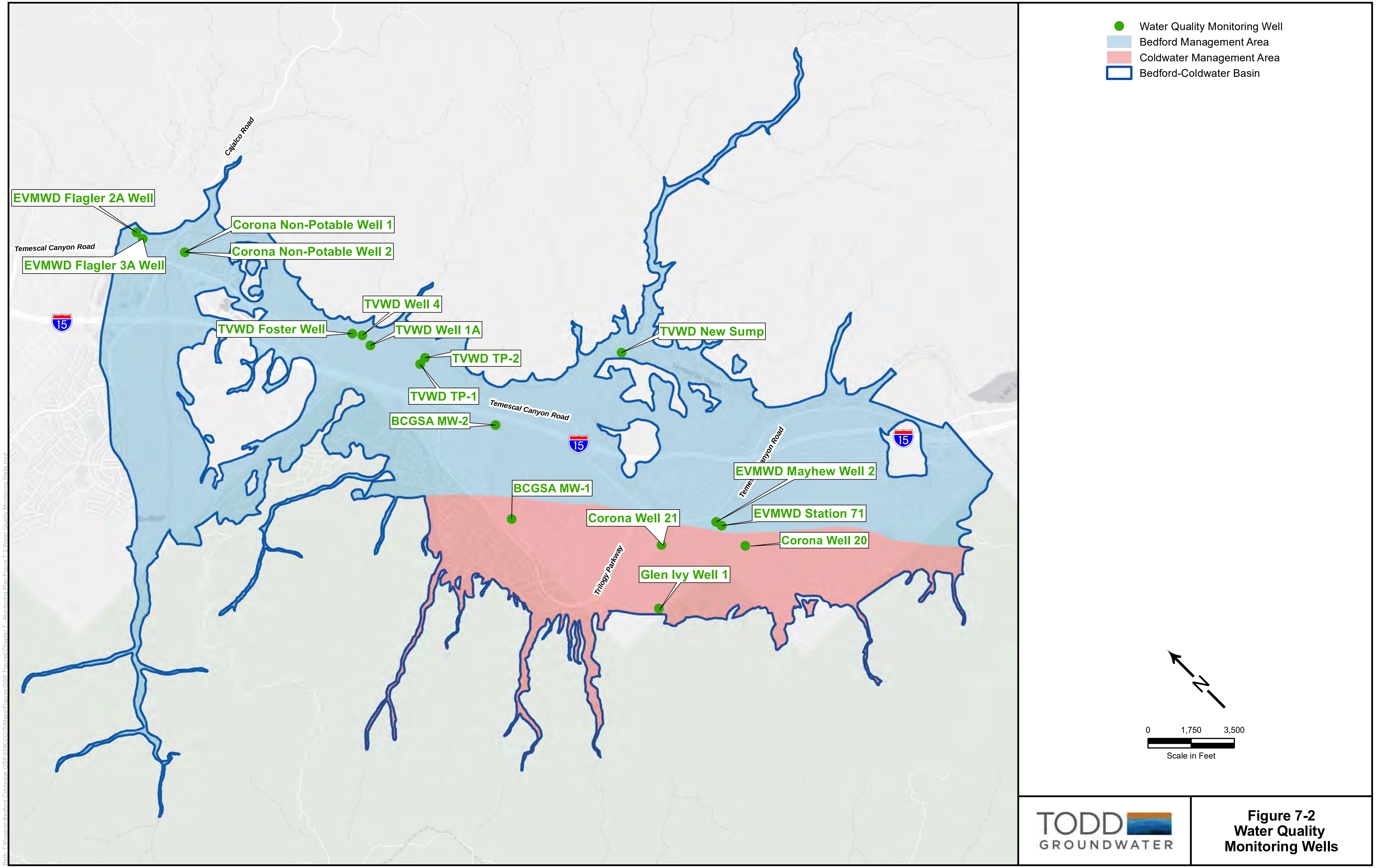


Figure 7-2
Water Quality Monitoring Wells

8. PROJECTS AND MANAGEMENT ACTIONS

During the preparation of the Groundwater Sustainability Plan (GSP) for the Bedford-Coldwater Subbasin (Basin), five (5) specific management actions (Actions) and three (3) projects (Projects) were identified to achieve the sustainability goal. The Actions are generally focused on data collection, storage and reporting of information necessary to monitor sustainability, and assessment of when Actions may be necessary (i.e., when minimum thresholds (MTs) are approached or exceeded). The projects are generally designed to reduce uncertainty in areas where data gaps have been identified during development of the GSP.

The Projects and Actions will be implemented by a combination of personnel resources from the three agencies within the plan area (Elsinore Valley Municipal Water District [EVMWD], City of Corona [Corona], and Temescal Water District [TVWD]) and contracted resources as described in Section 9. The Projects and Actions in the GSP are as follows:

- **Action 1** – Provide for Collection, Compilation, and Storage of Information Required for Annual Reports and Submit Annual Reports;
- **Action 2** – Routinely Record Groundwater Levels and Take Action if Necessary;
- **Action 3** – Monitor Selected Groundwater Quality Constituents and Coordinate with the Regional Water Quality Control Board as Appropriate;
- **Action 4** – Track Trends in Groundwater Levels near Temescal Wash and Take Action as Necessary;
- **Action 5** – Review Interferometric Synthetic Aperture Radar (InSAR) Data on the California Department of Water Resources (DWR) DataViewer During 5-Year Updates;
- **Project 1** – Investigate Groundwater/Surface Water Interaction at Temescal Wash and Install Monitoring Wells;
- **Project 2** – Initiate a Survey of Active Private Wells; and
- **Project 3** – Evaluation of the Effects of Aggregate Pits on Groundwater Flow and Quality.

The Projects and Actions are described in the following sections. Further details regarding each project and management action are summarized in **Table 8-1** through **Table 8-8** at the end of this section. A periodic 5-year update of the GSP is described in Chapter 9.

8.1. ACTION 1 – PROVIDE FOR COLLECTION, COMPILATION, AND STORAGE OF INFORMATION REQUIRED FOR ANNUAL REPORTS AND SUBMIT ANNUAL REPORTS

The Sustainable Groundwater Management Act (SGMA) requires Groundwater Sustainability Agencies (GSAs) to submit annual reports to DWR each April 1st following adoption of a GSP. The report provides information on groundwater conditions and the status of implementation of the GSP over the prior water year. Action 1 will facilitate gathering the required information and producing the annual report (with the exception of collecting and compiling water levels, which is facilitated under Action 2).

As required by Title 23 of the California Code of Regulations (CCR), Section 356.2, the annual report produced by the Bedford-Coldwater GSA (BCGSA) will include the following components for the preceding water year:

(a) General information, including an executive summary and a location map depicting the Basin.
(b) A detailed description and graphical representation of the following conditions of the Basin:
    (1) Groundwater elevation data from monitoring wells identified in the monitoring network and collected as part of Action – 2 will be analyzed and displayed as follows:
        (A) Groundwater elevation contour maps for the 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 or imported 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 collection methods will be evaluated and modified as necessary as part of this Action.
    (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.

Action 1 also provides for production and transmittal of the annual report described above.

8.2. ACTION 2 – ROUTINELY RECORD GROUNDWATER LEVELS AND TAKE ACTION IF NECESSARY

Each agency will collect static groundwater elevation data at the wells they own and operate. Depth to groundwater measurements will be collected at a minimum frequency of once per month, except in cases where a production well is active and shutting the well down to collect a static water level will cause operational problems due to interrupted supply. In these cases, quarterly measurements will be made. Several wells in the basin are monitored continuously via supervisory control and data acquisition (SCADA). In these cases, care will be taken to document the depth and elevation of the transducer, as well as the accuracy of the transducer, which can be expressed either as a percentage of full scale or in absolute terms. Depth to groundwater measurements from a known elevation under static (non-pumping) conditions using an electric probe will be periodically compared to transducer readings to determine the elevation of the transducer such that groundwater elevation hydrographs can be produced from SCADA records. The BCGSA administrator will be responsible for facilitating collection of groundwater elevation data in the proper format. Field methods for collection of depth to groundwater information are specified in Section 7.

The BCGSA administrator and each agency will note trends in depth to groundwater information, and agencies will coordinate to reduce pumping rates or durations if a trend toward the MT is observed. Agencies will curtail pumping in the affected area if a MT is reached.

8.3. ACTION 3 – MONITOR SELECTED GROUNDWATER QUALITY CONSTITUENTS AND COORDINATE WITH THE REGIONAL WATER QUALITY CONTROL BOARD AS APPROPRIATE

Each agency will collect groundwater samples at the wells they own and operate and deliver to a common laboratory for analysis. Field methods for collection of groundwater samples are specified in Section 7. Groundwater sampling results will be delivered to the BCGSA administrator who will compile and report results.

The BCGSA administrator will note trends in groundwater quality, and the BCGSA will coordinate with the Regional Water Quality Control Board as appropriate if a trend toward the MT is observed. The BCGSA administrator will be responsible for compiling groundwater quality data and adding it to the GSA Data Management System (DMS) in standardized format.

8.4. ACTION 4 – TRACK TRENDS IN GROUNDWATER LEVELS NEAR TEMESCAL WASH AND TAKE ACTION AS NECESSARY

Each agency will collect groundwater elevations at the wells they own and operate in the vicinity of Temescal Wash as described in Sections 6 and 7. Depth to groundwater measurements will be collected at a minimum frequency of once per month, except in cases where a production well is active and shutting the well down to collect a static water level will cause operational problems due to interrupted supply. Several wells in the Basin are monitored continuously via SCADA. SCADA records will be corrected for groundwater elevation as described in Section 8.2. Field methods for collection of depth to groundwater information are specified in Section 7.

The BCGSA administrator and each agency will note trends in depth to groundwater information, and agencies will coordinate to reduce pumping rates or durations if a trend toward the MT regarding interconnected surface water at Temescal Wash is observed. Agencies will curtail pumping in the affected area if an MT is reached.

8.5. ACTION 5 – REVIEW INSAR DATA ON THE DWR DATAVIEWER ANNUALLY AND COMPILE DURING 5-YEAR UPDATES

In other basins in California, extensive groundwater withdrawals from aquifer systems have caused land subsidence. Land subsidence can damage to structures such as wells, buildings, and highways. They also can create problems in the design and operation of facilities for drainage, flood protection, and water conveyance. Two factors generally needed for groundwater withdrawals to cause subsidence are 1) relatively large declines in groundwater levels combined with 2) relatively thick sequences of collapsible clays (such as ancestral lake deposits). Neither of these conditions exist in the Basin, and subsidence due to groundwater withdrawals has not been observed or expected. DWR has developed SGMA DataViewer to include updated subsidence information to help GSAs, water managers, and others to implement SGMA. The BCGSA will review the DataViewer information during the annual update and summarize the findings in the 5-year update.

8.6. PROJECT 1 – INVESTIGATE GROUNDWATER/SURFACE WATER INTERACTION AT TEMESCAL WASH

As noted in Section 6.7.8, there are several data gaps related to depletions of interconnected surface water along Temescal Wash. Data gaps include lack of water level data in certain areas, lack of dedicated monitoring (vs. production) wells, lack of wells within or near the wash channel, and uncertainty regarding vertical gradients. The objective of Project 1 is to address these data gaps and improve protection of a potentially groundwater-dependent ecosystem (GDE) along Temescal Wash. Project 1 will be initiated in two phases: an initial feasibility study and permitting review, and a second phase of installation of monitoring facilities and on-going vegetation and shallow groundwater monitoring.

The BCGSA will develop a request for proposals (RFP) from qualified firms to conduct the initial study to evaluate the interaction of surface water and groundwater and the relationship of groundwater elevation on the health of riparian vegetation in Temescal Wash. The purpose of this study is to reduce uncertainty regarding the riparian habitat and ultimately to improve the MT and protect groundwater-dependent ecosystems. The study may involve field biological surveys, review of historical surface flows, review of historical photographs and remote sensing data, and investigation and field studies regarding evapotranspiration and root depth of riparian vegetation in and around Temescal Wash. An outcome of the first phase of the project is to identify appropriate locations and associated permitting requirements for monitoring wells along Temescal Wash. The work will result in recommendations for future riparian monitoring protocols and permitting requirements for installation of piezometers or drive points close to the wash itself.

Although the second phase of the project will be dependent on the results of the initial phase, the following work is anticipated:

1. Install four shallow monitoring wells along Temescal Wash, spread out along the wash, one or two near pumping wells to ascertain vertical gradients, others upstream near dense riparian vegetation.
    a. During 5-year GSP updates, relate those water levels to production well water levels and stream flow, and refine MTs.
2. Conduct a survey for perennial pools along the entire length of the Temescal Wash in the Basin. Ideally, this would be done sometime during August to October in a normal year and again in a dry year.
    a. If pools are found, a fisheries biologist should survey the fish species present in them.
3. The next time water levels start approaching the interconnected surface water MTs, conduct a vegetation survey along the Wash to look for drought stress.
    a. If stress correlates with increased depth to water, start reducing pumping (Management Action 4).

8.7. PROJECT 2 – INITIATE A SURVEY OF ACTIVE PRIVATE WELLS

As noted in Section 6, there are very few known active private wells in the Basin. Because there are records (DWR and other sources) of many more wells than are known to exist and be active, it is believed that most have been abandoned, destroyed, or are no longer equipped or used, as residential users have been connected to municipal water supplies. Known active private wells are for non-potable uses and are of similar depths and construction to the monitored municipal supply wells. During the recent drought, the Basin was not marked by reports of significant water level decline impacts to shallow production wells.

Nevertheless, there still remains some uncertainty about the existence, use, and construction characteristics of local, active, private (non-municipal) wells. For this reason, the BCGSA will initiate a survey of active private wells in order to confirm that the MTs are protective of the use of private wells being put to beneficial use.

8.8. PROJECT 3 – EVALUATION OF THE EFFECTS OF AGGREGATE PITS ON GROUNDWATER FLOW AND QUALITY

Significant aggregate (sand and gravel) resources mining occurs south of Corona within and along Temescal Wash and north of Lake Elsinore which has been active since the late 1940s (CDMG 1991). In 2007, the State of California reported that the active mines in local areas other than Temescal Valley are "nearly exhausted" and that the fast-growing county now relies on Temescal Valley for much of its aggregate needs. As a result, the Temescal Valley Production District has become the largest sand and gravel production district in the United States, having produced about 12 million tons of aggregate in 2005. Per a 2007 report issued by the California Geological Survey, the region's 50-year aggregate demand is 1,122 million tons. As of 2007, a total of approximately 355 million tons were being supplied by permitted aggregate resources; 32 percent of the forecast demand. Data indicate that approximately 6,000 million tons of mineral resources are secured within the region (County of Riverside 2015).

Current surface mining permits (SMPs) include:

- SMP-133 (Coldwater Aggregates) which expires in 2040;
- SMP-139 (Mayhew Aggregates and Mining Reclamation) does not have an expiration date as an inert landfill site;
- SMP-143R2 (Foster's Sand and Gravel) which expires in 2065; and
- SMP-202 (Chandlers Palos Verdes Sand and Gravel Company) which expires in 2036.

These permits note the ultimate use of the mining pits as stormwater recharge basins (KWC 2017), and therefore the mining pits will clearly have an impact on groundwater management (albeit at least 18 years into the future). The surface aggregate mining involves deepening and widening open pits as the mining operation expands. In doing so, the pits encounter groundwater. As groundwater levels rise and fall, the bottoms of the pits are exposed. Therefore, it is clear that there is communication between the surface water in the pits and the adjacent groundwater body which currently exists and will continue well into the future.

Groundwater modeling conducted as part of the GSP development (Section 5 and **Appendix G**) and groundwater sampling from wells near the pits suggest that the pits may have an effect on the local water budget and on groundwater quality in ways that are not completely understood. For example, model calibration efforts suggest consumptive use near the pits is higher than recorded pumping of adjacent wells, and the Corona Well 21 was shut down due to a high heterotrophic plate count (a measure of bacteria in water), potentially as a result of groundwater under the influence of surface water from the aggregate pits.

Therefore, to improve further modeling involving aggregate mines or simulation of proposed stormwater capture in the mines, a project is proposed to evaluate and improve the hydrogeologic conceptual model in the vicinity of the mines. The BCGSA will initiate the investigations after adoption of the GSP by issuing an RFP to qualified firms. Although details of the study of aggregate mining’s effect on groundwater are yet to be determined, it is anticipated that the study may involve detailed review of the aggregate pit water budget (pumping, evapotranspiration, precipitation, and surface water flow infiltration), historical remote sensing images, historical hydrograph and streamflow information review, monitoring well construction, and/or interviews with local mine managers.

Table 8-1. Action 1 – Provide for Collection, Compilation, and Storage of Information Required for Annual Reports and Submit Annual Reports

Description of the Project or Management Action - §354.44(a)	**Project/management action benefits - §354.44(b)(5)**
Routinely collect, compile, and store groundwater extractions by water use sector, groundwater extractions measurement methods and accuracy, surface water sources, and total water use and methods used to determine total water use. Prepare annual reports.	Collection of this information is required for annual reporting, but it will also assist in evaluation of trends and relationship to the sustainability of the management areas.
Description of the measurable objective(s) addressed - §354.44(b)(1)	**How the project/management action will be accomplished - §354.44(b)(6)**
Maintain groundwater elevations above the historical minimum elevation and maintain groundwater levels within the historical operating range.	The information will be collected by BCGSA agency personnel for the facilities (including wells) that they own and manage. This information will be transmitted to the a contracted BCGSA administrator on a monthly basis who will compile and store the information and complete annual reports. Information from private well owners which exceed de minimis levels will be compiled by the administrator.
Circumstances and criteria for implementation - §354.44(b)(1)(A)	**Legal authority - §354.44(b)(7)**
Information gathering will be implemented immediately upon GSP adoption.	CWC § 10725.4 (a)(1) provides GSAs the authority to determine the need for groundwater management and (2) to prepare and adopt a groundwater sustainability plan and implementing rules and regulations.
Process to provide the public notice of implementation - §354.44(b)(1)(B)	**Estimated cost and funding source - §354.44(b)(8)**
Notice of implementation with be provided in the public review period of the GSP and adoption of the GSP. Implementation of the management action will be internal and not affect landowners or water users in the Basin.	$126,000 Annual cost. Funding source to be contributions from BCGSA member agencies
Quantification of methods to mitigate overdraft, if overdraft conditions are identified - §354.44(b)(2)	**Management of groundwater extractions and recharge - §354.44(b)(9)**
If overdraft is identified, the management action will be to curtail pumping as agreed upon by BCGSA staff.	The BCGSA will manage reductions in pumping rates or duration if trends indicate historical maximum groundwater levels will be reached. Individual agencies will be responsible for monitoring their wells and informing the BCGSA if this trend becomes apparent.
Permitting and regulatory process - §354.44(b)(3)	**Supporting information and science - §354.44(c)**
No additional permitting or regulatory processes will be required.	The BCGSA will utilize BMPs and data formats specified by the DWR.
Timeframe for expected project/management action start and completion, accrual of benefits - §354.44(b)(4)	**Level of uncertainty - §354.44(d)**
Information gathering will be implemented immediately upon GSP adoption and will continue until the next 5-year update.	Level of uncertainty will be identified during the process of evaluating measurement methods and accuracy.

Table 8-2. Action 2 – Routinely Record Groundwater Levels and Take Action if Necessary

Description of the Project or Management Action - §354.44(a)	**Project/management action benefits - §354.44(b)(5)**
Routinely measure and record water levels in selected wells identified in the monitoring plan. Monitor trends and reduce pumping if a trend toward a minimum threshold is observed. Curtail pumping in the event of reaching a minimum threshold.	Regular water level monitoring will benefit the maintenance of sustainability by decreasing the uncertainty regarding sustainable depths to groundwater in order to avoid undesirable results.
Description of the measurable objective(s) addressed - §354.44(b)(1)	**How the project/management action will be accomplished - §354.44(b)(6)**
Maintain groundwater elevations above the historical minimum elevation and maintain groundwater levels within the historical operating range.	Static groundwater levels will be collected and compiled by BCGSA agency personnel for the wells they own and manage at a minimum frequency of monthly. Transducers will be utilized where practical. This information will be transmitted to the BCGSA administrator who will compile and store the information and complete annual reports. In cases where active production wells are monitored, frequency may be reduced to quarterly to minimize water supply interruption.
Circumstances and criteria for implementation - §354.44(b)(1)(A)	**Legal authority - §354.44(b)(7)**
Water level monitoring will be implemented once the GSP is adopted. The minimum threshold is defined at each key well by either the depth to groundwater equivalent to the current pump intake or 10 feet above the bottom of the deepest screen section, whichever is shallower. Undesirable results are indicated when exceedances occur in two consecutive quarters in each of two consecutive years in at least two thirds of key wells in each management area. If a trend toward the minimum threshold is observed, pumping rates or durations will be reduced in the affected areas.	CWC § 10725.4 (a)(1) provides GSAs the authority to determine the need for groundwater management and (2) to prepare and adopt a groundwater sustainability plan and implementing rules and regulations.
Process to provide the public notice of implementation - §354.44(b)(1)(B)	**Estimated cost and funding source - §354.44(b)(8)**
Notice of implementation with be provided in the public review period of the GSP and adoption of the GSP. Implementation of the management action will be internal and not affect landowners or water users in the Basin.	$110,000 Annual cost. Funding source to be contributions from BCGSA member agencies
Quantification of methods to mitigate overdraft, if overdraft conditions are identified - §354.44(b)(2)	**Management of groundwater extractions and recharge - §354.44(b)(9)**
Pumping will be reduced if a trend toward a minimum threshold is identified.	The BCGSA will manage reductions in pumping rates or duration if trends indicate historical maximum groundwater levels will be reached. Individual agencies will be responsible for monitoring their wells and informing the BCGSA if this trend becomes apparent.
Permitting and regulatory process - §354.44(b)(3)	**Supporting information and science - §354.44(c)**
No additional permitting or regulatory processes will be required.	The BCGSA will use the water level monitoring to add to existing data of historical maximum depths to water.
Timeframe for expected project/management action start and completion, accrual of benefits - §354.44(b)(4)	**Level of uncertainty - §354.44(d)**
Water level monitoring will be ongoing, beginning with adoption of the GSP. The benefit of more consistent data and understanding of groundwater levels will increase with time and continued monitoring.	There is inconsistency of data in some areas of the Basin which regular standardized monitoring will mitigate.

Table 8-3. Action 3 – Monitor Selected Groundwater Quality Constituents and Coordinate with the Regional Water Quality Control Board as Appropriate

Description of the Project or Management Action - §354.44(a)	**Project/management action benefits - §354.44(b)(5)**
Routinely monitor water quality throughout the Basin as described in the monitoring plan. If a significant upward concentration trend is observed in areas that contribute to potable supply, cooperate with the Regional Water Quality Control Board for appropriate action. If a minimum threshold is observed in areas that contribute to potable supply, cooperate with the Regional Water Quality Control Board for appropriate.	Regular water quality monitoring will benefit the Basin by serving as an early warning system to identify trends toward potential groundwater quality concerns in order to avoid undesirable results.
Description of the measurable objective(s) addressed - §354.44(b)(1)	**How the project/management action will be accomplished - §354.44(b)(6)**
Maintain or reduce the 5-year average concentrations of nitrate and total dissolved solids based on conditions assessed in each 5-year update.	Groundwater samples will be collected BCGSA agency personnel for wells they own and operate. This information will be transmitted to the BCGSA administrator who will compile and store the information and complete annual reports.
Circumstances and criteria for implementation - §354.44(b)(1)(A)	**Legal authority - §354.44(b)(7)**
Water quality monitoring will be implemented once the GSP is adopted. The minimum threshold for nitrate is defined as 5-year average concentrations (Basin-wide) not exceeding the 10 mg/L drinking water MCL for Nitrate as Nitrogen. The minimum threshold for TDS is defined as 5-year average concentrations (Basin-wide) not exceeding the 1,000 mg/L Secondary MCL for TDS. If significant upward concentration trends toward the minimum thresholds are observed in areas that contribute to potable supply, the GSA will coordinate with the Regional Water Quality Control Board as appropriate..	CWC § 10725.4 (a)(1) provides GSAs the authority to determine the need for groundwater management and (2) to prepare and adopt a groundwater sustainability plan and implementing rules and regulations.
Process to provide the public notice of implementation - §354.44(b)(1)(B)	**Estimated cost and funding source - §354.44(b)(8)**
Notice of implementation with be provided in the public review period of the GSP and adoption of the GSP. Implementation of the management action will be internal and not affect landowners or water users in the Basin.	$24,000 Annual cost. Funding source to be contributions from BCGSA member agencies
Quantification of methods to mitigate overdraft, if overdraft conditions are identified - §354.44(b)(2)	**Management of groundwater extractions and recharge - §354.44(b)(9)**
Overdraft will not be a factor in this management action.	Groundwater extractions and recharge will not be a factor in this management action.
Permitting and regulatory process - §354.44(b)(3)	**Supporting information and science - §354.44(c)**
No additional permitting or regulatory processes will be required.	Analysis shall be conducted by a certified laboratory with the State of California through the California Water Boards Environmental Laboratory Accreditation Program (ELAP). The BCGSA will incorporate data from the RWQCB when assessing water quality concentration trends.
Timeframe for expected project/management action start and completion, accrual of benefits - §354.44(b)(4)	**Level of uncertainty - §354.44(d)**
Water quality monitoring will be ongoing, beginning with adoption of the GSP. The benefit of more consistent data of groundwater quality will increase with time and continued monitoring.	Uncertainty when assessing potential water quality concerns may be communicated to the Regional Water Quality Control Board.

Table 8-4. Action 4 – Track Trends in Groundwater Levels near Temescal Wash and Take Action as Necessary

Description of the Project or Management Action - §354.44(a)	**Project/management action benefits - §354.44(b)(5)**
Routinely track water levels in wells located near Temescal Wash and take action as specified.	Regular water level monitoring at Temescal Wash will benefit the Basin by decreasing the uncertainty of sustainable groundwater depths relating to riparian vegetation health.
Description of the measurable objective(s) addressed - §354.44(b)(1)	**How the project/management action will be accomplished - §354.44(b)(6)**
The measurable objective is the amount of surface water depletion that is less than the amount specified as the minimum threshold. Given the weak correlation between groundwater levels and vegetation health, no specific rise in shallow groundwater levels or increase in stream flow is identified as providing a preferred set of GDE conditions.	Static groundwater levels will be collected and compiled agency personnel who own and operate individual wells at a minimum frequency of monthly. Transducers will be utilized where practical. This information will be transmitted to the GSA administrator who will compile and evaluate trends toward the minimum threshold. If a trend toward the minimum threshold is observed, pumping rates or durations will be reduced in the affected area. Should a minimum threshold occur, pumping will be curtailed in the affected area.
Circumstances and criteria for implementation - §354.44(b)(1)(A)	**Legal authority - §354.44(b)(7)**
The minimum threshold is defined as more than two-thirds of monitored wells near Temescal Wash with static water levels lower than 35 feet below the adjacent channel elevation for a period of more than one year. If a trend toward the minimum threshold is observed, pumping rates or durations will be reduced in affected areas. If the minimum threshold is met, pumping will be curtailed in the affected area until groundwater levels recover.	CWC § 10725.4 (a)(1) provides GSAs the authority to determine the need for groundwater management and (2) to prepare and adopt a groundwater sustainability plan and implementing rules and regulations.
Process to provide the public notice of implementation - §354.44(b)(1)(B)	**Estimated cost and funding source - §354.44(b)(8)**
Notice of implementation with be provided in the public review period of the GSP and adoption of the GSP. Implementation of the management action will be internal and not affect landowners or water users in the Basin.	$2,000 Annual cost. Funding source to be contributions from BCGSA member agencies. The majority of costs for this MA is covered under MA-2
Quantification of methods to mitigate overdraft, if overdraft conditions are identified - §354.44(b)(2)	**Management of groundwater extractions and recharge - §354.44(b)(9)**
Transducers installed in wells near Temescal Wash where practical and/or manual measurements will be performed on selected wells.	The BCGSA will manage reductions in pumping rates or duration if trends indicate historical maximum groundwater levels will be reached. Individual agencies will be responsible for monitoring their wells and informing the BCGSA if this trend becomes apparent.
Permitting and regulatory process - §354.44(b)(3)	**Supporting information and science - §354.44(c)**
No additional permitting or regulatory processes will be required.	The BCGSA will use the water level monitoring to add to existing data of historical maximum depths to water.
Timeframe for expected project/management action start and completion, accrual of benefits - §354.44(b)(4)	**Level of uncertainty - §354.44(d)**
Water level monitoring at Temescal Wash will be ongoing, beginning with adoption of the GSP. The benefit of more consistent data and understanding of the groundwater levels will increase with time and continued monitoring.	There is uncertainty regarding the relationship between water levels in production wells adjacent to Temescal Wash and the health of the riparian vegetation in the wash. For this reason, a specific project will be developed in an attempt to resolve this data gap and update the minimum threshold as required.

Table 8-5. Action 5 – Review InSAR Data on the SGMA Dataviewer During Updates

Description of the Project or Management Action - §354.44(a)	**Project/management action benefits - §354.44(b)(5)**
Interferometric synthetic aperture radar (InSAR) data will be reviewed on the SGMA Dataviewer during 5-year updates. If a subsidence trend is observed, the GSA will initiate studies to evaluate the causes of subsidence and/or potential errors.	Undesirable results relating to land subsidence have not been observed in the Basin, however subsidence may be subtle and cumulative over time. The benefit of regular monitoring of subsidence will be to potentially identify subsidence concerns early and initiate studies to evaluate the causes before undesirable results occur.
Description of the measurable objective(s) addressed - §354.44(b)(1)	**How the project/management action will be accomplished - §354.44(b)(6)**
The measurable objective for the land subsidence affecting land uses sustainability indicator is zero subsidence, acknowledging measurement error and other uncertainties.	InSAR data will be monitored annually and compiled on a 5-year basis by the GSA during completion of 5-year updates.
Circumstances and criteria for implementation - §354.44(b)(1)(A)	**Legal authority - §354.44(b)(7)**
Subsidence monitoring will be implemented once the GSP is adopted. The minimum threshold is defined as a rate of decline equal to or greater than 0.2 feet in any 5-year period with 2015 as the baseline condition. If a subsidence trend is observed, studies will be initiated to evaluate the causes of subsidence.	CWC § 10725.4 (a)(1) provides GSAs the authority to determine the need for groundwater management and (2) to prepare and adopt a groundwater sustainability plan and implementing rules and regulations.
Process to provide the public notice of implementation - §354.44(b)(1)(B)	**Estimated cost and funding source - §354.44(b)(8)**
Notice of implementation with be provided in the public review period of the GSP and adoption of the GSP. Implementation of the management action will be internal and not affect landowners or water users in the Basin.	$4,000 Funding source to be contributions from BCGSA member agencies
Quantification of methods to mitigate overdraft, if overdraft conditions are identified - §354.44(b)(2)	**Management of groundwater extractions and recharge - §354.44(b)(9)**
Overdraft will not be a factor in this management action.	Groundwater extractions and recharge will not be a factor in this management action.
Permitting and regulatory process - §354.44(b)(3)	**Supporting information and science - §354.44(c)**
No additional permitting or regulatory processes will be required.	The BCGSA will use InSAR data available on the SGMA Dataviewer to monitor for future potential subsidence.
Timeframe for expected project/management action start and completion, accrual of benefits - §354.44(b)(4)	**Level of uncertainty - §354.44(d)**
Subsidence monitoring will begin with adoption of the GSP and will be reported during 5-year updates. The benefit of more consistent data will increase with time and continued monitoring.	Many factors may contribute to subsidence, therefore if a trend is observed, studies will be initiated to evaluate the cause(s) before further action is considered.

Table 8-6. Project 1 – Investigate Groundwater/Surface Water Interaction at Temescal Wash

Description of the Project or Management Action - §354.44(a)	**Project/management action benefits - §354.44(b)(5)**
Phase 1 includes field studies and review of historical remote sensing and surface flow data in order to better understand the relationship between groundwater elevations and health of riparian habitat in Temescal Wash. Phase I will also include siting and identifying permitting requirements for new facilities to monitor shallow groundwater along Temescal Wash. Phase 2 will include installation of monitoring wells or drive points and on-going monitoring.	Technical studies and monitoring of shallow groundwater at Temescal Wash will benefit the Basin by decreasing the uncertainty of sustainable groundwater depths relating to riparian vegetation health and improving the minimum threshold for groundwater/surface water interaction.
Description of the measurable objective(s) addressed - §354.44(b)(1)	**How the project/management action will be accomplished - §354.44(b)(6)**
The measurable objective is the amount of surface water depletion that is less than the amount specified as the minimum threshold. Given the weak correlation between groundwater levels and vegetation health, no specific rise in shallow groundwater levels or increase in stream flow is identified as providing a preferred set of GDE conditions.	The GSA will develop a request for proposal from qualified firms to conduct an initial study to evaluate the interaction of surface water and groundwater and the relationship of groundwater elevation on the health of riparian vegetation in Temescal Wash. The study may involve field biological surveys, review of historical surface flows, and/or review of historical photographs and remote sensing data. The work will result in recommendations for future monitoring and permitting requirements for installation of piezometers of drive points. A second phase will involve installation of monitoring facilities and on-going monitoring of groundwater and vegetation.
Circumstances and criteria for implementation - §354.44(b)(1)(A)	**Legal authority - §354.44(b)(7)**
The minimum threshold is defined as more than two-thirds of monitored wells near Temescal Wash with static water levels lower than 35 feet below the adjacent channel elevation for a period of more than one year. If a trend toward the minimum threshold is observed, pumping rates or durations will be reduced in affected areas. If the minimum threshold is met, pumping will be curtailed in the affected area until groundwater levels recover.	CWC § 10725.4 (a)(1) provides GSAs the authority to determine the need for groundwater management and (2) to prepare and adopt a groundwater sustainability plan and implementing rules and regulations.
Process to provide the public notice of implementation - §354.44(b)(1)(B)	**Estimated cost and funding source - §354.44(b)(8)**
Notice of implementation with be provided in the public review period of the GSP and adoption of the GSP. Implementation of the management action will be internal and not affect landowners or water users in the Basin.	$514,000 One-occurrence cost. Funding source to be contributions from BCGSA member agencies
Quantification of methods to mitigate overdraft, if overdraft conditions are identified - §354.44(b)(2)	**Management of groundwater extractions and recharge - §354.44(b)(9)**
Pumping will be reduced if a trend toward a minimum threshold is identified.	The BCGSA will manage reductions in pumping rates or duration if trends indicate historical maximum groundwater levels will be reached. Individual agencies will be responsible for monitoring their wells and informing the BCGSA if this trend becomes apparent.
Permitting and regulatory process - §354.44(b)(3)	**Supporting information and science - §354.44(c)**
Permitting or regulatory processes will be evaluated in the initial study.	Review of historical remote sensing and biological surveys will be utilized.
Timeframe for expected project/management action start and completion, accrual of benefits - §354.44(b)(4)	**Level of uncertainty - §354.44(d)**
The project will start within 6 months of adoption of the GSP with the development of a request for proposal. The project is expected to last approximately two years. Benefits of the project will be to improve monitoring and required action to protect groundwater-dependent ecosystems.	There is uncertainty regarding the relationship between water levels in production wells adjacent to Temescal Wash and the health of the riparian vegetation in the wash. The reason for this project is to reduce that uncertainty and improve minimum thresholds regarding GDEs, and ultimately, protection of GDEs

Table 8-7. Project 2 – Initiate a Survey of Private Wells

Description of the Project or Management Action - §354.44(a)	**Project/management action benefits - §354.44(b)(5)**
Field studies and review of information in order to better understand the location and construction characteristics of local private wells	Further information regarding private wells in the subbasin will benefit achievement of the sustainability goal by decreasing the uncertainty related to the construction characteristics and location of the private wells.
Description of the measurable objective(s) addressed - §354.44(b)(1)	**How the project/management action will be accomplished - §354.44(b)(6)**
Maintain groundwater elevations above the historical minimum elevation and maintain groundwater levels within the historical operating range [such that private wells are not adversely affected.	The GSA will initiate a survey of private wells in order to confirm that the minimum thresholds are protective of the use of private wells for beneficial use.
Circumstances and criteria for implementation - §354.44(b)(1)(A)	**Legal authority - §354.44(b)(7)**
The private well survey will be initiated after adoption of the GSP when resources are available.	CWC § 10725.4 (a)(1) provides GSAs the authority to determine the need for groundwater management and (2) to prepare and adopt a groundwater sustainability plan and implementing rules and regulations.
Process to provide the public notice of implementation - §354.44(b)(1)(B)	**Estimated cost and funding source - §354.44(b)(8)**
Notice of implementation with be provided in the public review period of the GSP and adoption of the GSP. Implementation of the management action will be internal and not affect landowners or water users in the Basin.	$60,000 One-occurrence cost. Funding source to be contributions from BCGSA member agencies
Quantification of methods to mitigate overdraft, if overdraft conditions are identified - §354.44(b)(2)	**Management of groundwater extractions and recharge - §354.44(b)(9)**
Overdraft will be mitigated by reduction in pumping if identified.	The BCGSA will manage reductions in pumping rates or duration if trends indicate historical maximum groundwater levels will be reached. Individual agencies will be responsible for monitoring their wells and informing the BCGSA if this trend becomes apparent.
Permitting and regulatory process - §354.44(b)(3)	**Supporting information and science - §354.44(c)**
Permitting or regulatory processes are not required for the survey of private wells	Existing well construction reports, well logs, and knowledge of local personnel
Timeframe for expected project/management action start and completion, accrual of benefits - §354.44(b)(4)	**Level of uncertainty - §354.44(d)**
The project will start after adoption of the GSP and will be conducted by the GSA administrator. Benefits of the project will be to improve understanding and protection of local wells.	There is uncertainty regarding the exact location and design of local private wells. The reason for this project is to reduce that uncertainty and improve protection of private wells.

Table 8-8. Project 3 – Evaluation of the Effects of Aggregate Pits on Groundwater Flow and Quality

Description of the Project or Management Action - §354.44(a)	**Project/management action benefits - §354.44(b)(5)**
The GSA administrator will initiate the investigations after adoption of the GSP by issuing an RFP to qualified firms. Although the details of the study of aggregate mine's effect on groundwater are yet to be determined, it is anticipated that the study may involve detailed review of the aggregate pit water budget (pumping, evapotranspiration, precipitation, and surface water flow infiltration), historical remote sensing images, historical hydrograph and streamflow information review, monitoring well construction, and/or interviews with local mine managers.	The benefits of investigating the interconnectivity of surface water within the open pit aggregate mines and adjacent groundwater will improve the hydrologic conceptual model and benefit the GSA in understanding methods to maintain sustainability in the vicinity of the mines.
Description of the measurable objective(s) addressed - §354.44(b)(1)	**How the project/management action will be accomplished - §354.44(b)(6)**
The measurable objective is the amount of surface water depletion that is less than the amount specified as the minimum threshold.	The GSA Administrator will develop a request for proposals from qualified firms and manage progress of the contractor.
Circumstances and criteria for implementation - §354.44(b)(1)(A)	**Legal authority - §354.44(b)(7)**
The project will be implemented prior to the first 5-year update after the GSP has been adopted.	CWC § 10725.4 (a)(1) provides GSAs the authority to determine the need for groundwater management and (2) to prepare and adopt a groundwater sustainability plan and implementing rules and regulations.
Process to provide the public notice of implementation - §354.44(b)(1)(B)	**Estimated cost and funding source - §354.44(b)(8)**
Notice of implementation with be provided in the public review period of the GSP and adoption of the GSP. Implementation of the management action will be internal and not affect landowners or water users in the Basin.	$165,000 One-occurrence cost. Funding source to be contributions from BCGSA member agencies
Quantification of methods to mitigate overdraft, if overdraft conditions are identified - §354.44(b)(2)	**Management of groundwater extractions and recharge - §354.44(b)(9)**
Overdraft will not be a factor in this management action.	The BCGSA will manage reductions in pumping rates near the aggregate mines if appropriate based on investigations
Permitting and regulatory process - §354.44(b)(3)	**Supporting information and science - §354.44(c)**
If piezometers or monitoring wells will be installed as part of the project, well permits will be acquired from the County of Riverside Department of Environmental Health.	The BCGSA will use data gathered during the project and existing best practices to develop methods of avoiding undesirable results around the aggregate mines.
Timeframe for expected project/management action start and completion, accrual of benefits - §354.44(b)(4)	**Level of uncertainty - §354.44(d)**
The project is expected to be completed before the first 5-year update after the GSP has been adopted. Benefits will increase over time with a greater understanding of the relationship between aggregate mining and the local groundwater system.	There is uncertainty about the water budget in the vicinity of the aggregate mines. The project will seek to fill these data gaps.

9. PLAN IMPLEMENTATION

The official adoption of the Groundwater Sustainability Plan (GSP) by the Bedford Coldwater Groundwater Sustainability Authority (BCGSA) will initiate Plan implementation. After submittal of the GSP to the California Department of Water Resources (DWR) and during the DWR review period, the BCGSA will continue to communicate with stakeholders via the BCGSA's website and begin implementing the projects and management actions (Actions) described in Section 8. The Plan will be implemented to sustainably manage groundwater in the Bedford-Coldwater Subbasin (Basin) under the authority of the BCGSA and its member agencies.

9.1. PLAN IMPLEMENTATION RESOURCES AND RESPONSIBILITIES

Resources to implement the GSP will be derived from three different sources: a contracted GSP Administrator, personnel from the three BCGSA agencies (City of Corona [Corona], Elsinore Valley Municipal Water District [EVMWD], Temescal Valley Water District [TVWD]), and contracted firms qualified to perform specialized services.

The GSP Administrator will be generally responsible for facilitating (though not necessarily performing) all aspects of GSP implementation through the first 5 years, including annual reporting and a 5-year update described in a following section. After 5 years, the BCGSA may elect to renew the term of the Administrator or issue a new RFP for GSP administration.

Personnel from the three BCGSA agencies will be responsible for collection of information from their respective facilities or within their area of influence in the Basin. This will include depth to groundwater measurements, collection of groundwater quality samples, groundwater extractions, use of surface water supplies, and total water use. This information will be reported to the GSP Administrator for compilation, quality control and standardization, ultimately, storage in the BCGSA Data Management System (DMS).

For specialized studies such as biological surveys or other specialized work that cannot be accomplished by the Administrator, the Administrator will be responsible for coordinating with the BCGSA to develop RFPs and facilitating consultant selection by the BCGSA. After the consultant is selected by the BCGSA, the Administrator will be responsible for management of the specialty consultant, including monitoring/reviewing the work and providing recommendations regarding consultant progress payments. **Table 9-1** provides examples of GSP implementation tasks and the anticipated responsible party.

Table 9-1. Example GSP Implementation Responsibilities

GSP Task	Responsible Party
Collect information on groundwater extractions by water use sector, surface water sources, and total water use and report this data to the Administrator	Agency Personnel
Collect and compile static water levels in wells and report this information to the Administrator	Agency Personnel
Complete annual reports	GSP Administrator/Specialty Consultant
Coordinate appropriate action if measurement thresholds are exceeded	GSP Administrator
Maintain Data Management System (DMS)	GSP Administrator
Monitor selected groundwater quality all active production wells. Coordinate with RWQCB if action required	GSP Administrator
Review Interferometric Synthetic Aperture Radar (InSAR) data annually from the DWR DataViewer, and during 5-year updates	GSP Administrator
Complete 5-year updates including groundwater modeling updates	GSP Administrator/Specialty Consultant
Develop RFPs and manage specialty contractors	GSP Administrator
Maintain BCGSA website with periodic stakeholder communication	GSP Administrator
Conduct private well survey	GSP Administrator
Develop quarterly JPA board updates and cost estimates	GSP Administrator
Identify and apply for potential grant funding	GSP Administrator
Project No 2: Private Well Survey	GSP Administrator
Project No 1: Investigation of Interconnected Surface Water	Specialty Consultant
Project No 3: Investigation of Aggregate Pits	Specialty Consultant

9.2. PLAN IMPLEMENTATION COSTS

The costs associated with implementing the GSP can be considered either continually ongoing (operating) costs, or GSP implementation costs associated with specific management actions and projects. Estimated costs for both of these categories are provided below.

9.2.1. Operating Expenses

The cost of operating the BCGSA includes staff expenses, coordination between member agencies, maintenance of the BCGSA website and DMS site, legal expenses, auditing expenses, insurance, bank fees, and other administrative costs. These costs are estimated at approximately $60,000 annually (2021 dollars) based on experience since the BCGSA was formed.

9.2.2. GSP Implementation Costs

Implementation costs include costs to implement management actions and projects. As detailed in Tables 8-1 through 8-8 and summarized in Table 9-2, total annual costs (2021 dollars) are estimated at approximately $266,000 per year, while estimated one-occurrence costs for recommended projects and the first 5-year periodic GSP update is approximately $990,000.

Table 9-2. GSP Implementation Cost Estimates

Management Action and Projects	Estimated Annual Costs
Action 1 - Provide for Collection, Compilation, and Storage of Information Required For Annual Reports and Submit Annual Reports	$126,000
Action 2 - Routinely Record Groundwater Levels and Take Action if Necessary	$110,000
Action 3 - Monitor Selected Groundwater Quality Constituents and Coordinate with the Regional Water Quality Control Board as Appropriate	$24,000
Action 4 - Track Trends in Groundwater Levels near Temescal Wash and Take Action as Necessary (field costs included in Action 2)	$2,000
Action 5 - Review InSAR Data on the DWR DataViewer During Annual and 5-Year Updates	$4,000
Total Estimated Annual Implementation (Non-Operating) Costs	$266,000
Project 1 – Investigate Groundwater/Surface Water Interaction at Temescal Wash and Install Monitoring Wells	$514,000
Project 2 – Initiate a Survey of Active Private Wells	$60,000
Project 3 – Evaluation of the Effects of Aggregate Pits on Groundwater Flow and Quality	$165,000
First Periodic 5-year GSP Update	$251,000
Total Estimated One-Occurrence Costs (First 5 years)	$990,000

9.2.3. Funding Methods for Operating Expenses and GSP Implementation Costs

The funding method for operating expenses and GSP implementation costs is by contributions by BCGSA member agencies (Corona, EVWMD, and TVWD). This is the same mechanism utilized to fund development of the GSP (with significant supplemental contribution though

California Proposition 1 Grant funding). The estimated costs are well within budget projections for the next several years provided to the BCGSA Board of Directors.

9.3. ANNUAL REPORTING

The BCGSA is required to submit an annual report to DWR by April 1st of each year following adoption of the GSP. The first annual report will be due in April of 2022. The annual report will be facilitated by implementing Actions 1 and 2, which provide for collection of the required information and production of the annual report. The annual report will include the following components as described in GSP Regulations for the preceding water year:

- General information – Executive summary, location map.
- Detailed description and graphical representation of the following components of the Basin:
  - Groundwater elevation data from monitoring wells within the monitoring network;
  - Groundwater extraction data for the preceding water year;
  - Surface water supply used or available for use;
  - Total water use; and
  - Change in groundwater storage.
- Description of progress towards implementing the Plan – implementation of projects or management actions since the previous annual report.

It is currently anticipated that the annual reports will be produced by the GSP Administrator or Specialty Consultant. The costs associated with producing these reports will be incorporated into the annual budget of the BCGSA.

9.4. NEW INFORMATION AND CHANGES

The GSP has been developed based on the best available information. However, it is recognized that during implementation of the GSP, new information on groundwater conditions, changes in land use or climate, and or changes in the regulatory environment can be expected. Changes in GSP administration may also be appropriate based on experience. When these changes occur, the BCGSA will react with appropriate changes in GSP administration, data collection, and/or groundwater management methods. If the changes are significant, stakeholders and the BCGSA Board of Directors will be kept informed of these changes via Board minutes, the BCGSA website, and emails to stakeholders.

9.5. PERIODIC EVALUATIONS

BCGSA will evaluate the GSP at least every five years and provide an assessment to DWR as required by SGMA Regulations. The assessment will provide an update on the progress of achieving sustainability goals in the Basin and will include the following:

- A description of current groundwater conditions for each sustainability indicator applicable to the Basin relative to measurable objectives and minimum thresholds.
- A description of the implementation of any projects or management actions and their effect on groundwater conditions.
- Any revisions to the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives.
- An evaluation of the basin setting as a result of any significant changes, new information, or changes in water use.
- A description of the monitoring network within the Basin, including any data gaps and areas of the Basin that are represented by data that does not satisfy the requirements of SGMA requirements outlined in Title 23 of the California Code of Regulations (CCR) Sections 352.4 and 354.34(c).
- A description of significant new information that has been made available since GSP adoption, amendment, or last five-year assessment.
- A description of relevant actions taken by the BCGSA, including a summary of regulations or ordinances related to the GSP.
- Information describing any enforcement or legal actions taken by the BCGSA to continue the sustainability goals of the Subbasin.
- A description of completed or proposed GSP amendments.

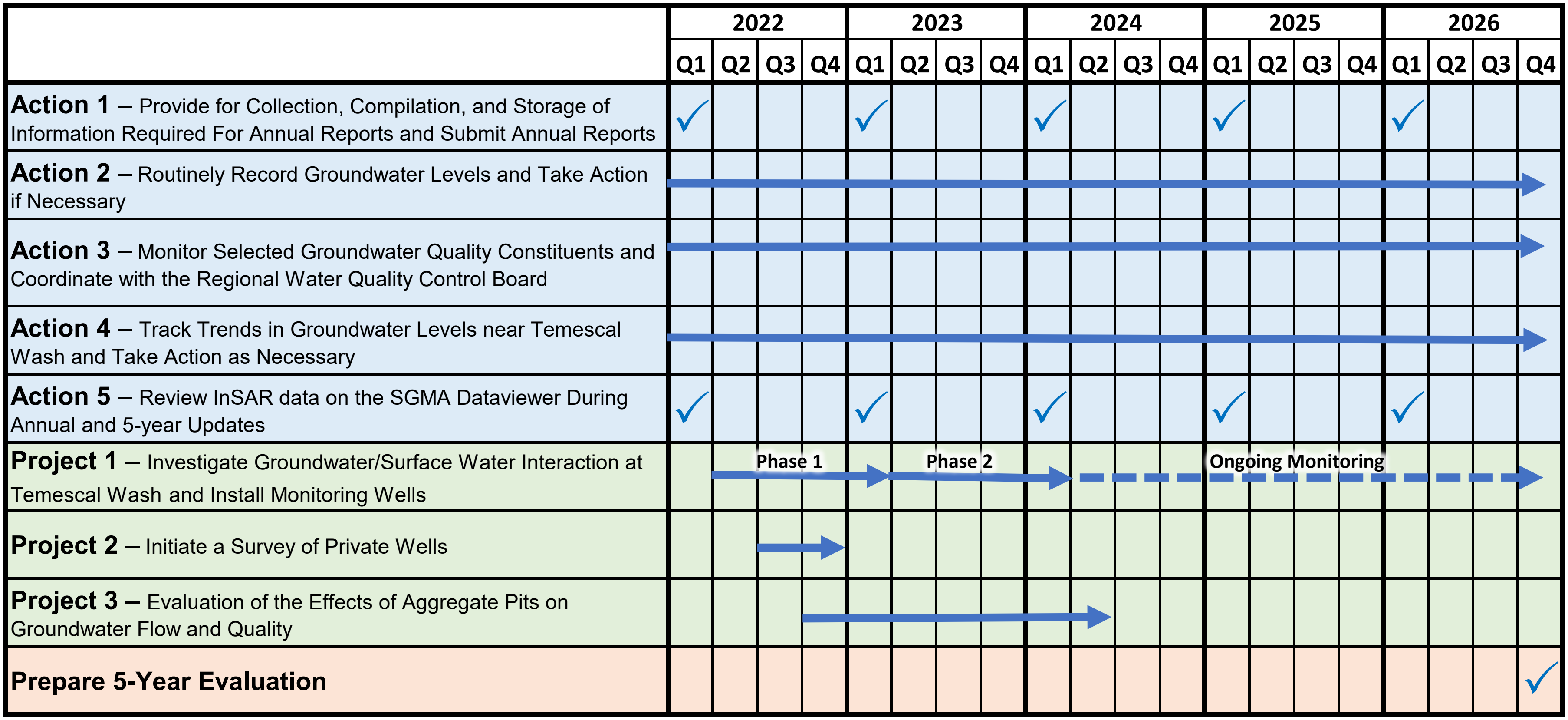
As with the annual reports, the GSP Administrator/Specialty Consultant will be responsible for completion of the five-year assessment with assistance from BCGSA staff. Both annual reports and periodic updates will be available to the public via the BCGSA website as well as the DWR SGMA website.

The cost of the periodic updates is dependent on the complexity of changes occurring in the Basin since the adoption of the GSP but are estimated to be in the range of $250,000 per update (2021 dollars).

9.6. SCHEDULE FOR IMPLEMENTATION

The BCGSA has committed to implementing the GSP upon adoption and completing the projects and management actions necessary to monitor and maintain sustainability within the first 5 years of initiation of the GSP. A preliminary schedule for implementation is shown in **Figure 9-1**. The GSP Administrator will conduct the survey of private wells and develop RFPs for surface/groundwater and aggregate pit studies within the first year of GSP implementation.

Figure 9-1. Schedule for GSP Implementation



	2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Action 1 – Provide for Collection, Compilation, and Storage of Information Required For Annual Reports and Submit Annual Reports	✓				✓				✓				✓				✓			
Action 2 – Routinely Record Groundwater Levels and Take Action if Necessary	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Action 3 – Monitor Selected Groundwater Quality Constituents and Coordinate with the Regional Water Quality Control Board	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Action 4 – Track Trends in Groundwater Levels near Temescal Wash and Take Action as Necessary	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Action 5 – Review InSAR data on the SGMA Dataviewer During Annual and 5-year Updates	✓				✓				✓				✓				✓			
Project 1 – Investigate Groundwater/Surface Water Interaction at Temescal Wash and Install Monitoring Wells		→	Phase 1 →	→	→	→	Phase 2 →	→	→	⇢	⇢	⇢	Ongoing Monitoring ⇢	⇢	⇢	⇢	⇢	⇢	⇢	⇢
Project 2 – Initiate a Survey of Private Wells			→	→																
Project 3 – Evaluation of the Effects of Aggregate Pits on Groundwater Flow and Quality				→	→	→	→	→	→	→										
Prepare 5-Year Evaluation																				✓

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APPENDIX A

Joint Powers Agreement forming the Bedford-Coldwater Groundwater Sustainability Agency

JOINT POWERS AGREEMENT

by and among

THE CITY OF CORONA,
a California general law city,

ELSINORE VALLEY MUNICIPAL
WATER DISTRICT,
a municipal water district

and

TEMESCAL VALLEY WATER DISTRICT,
a California water district

for the formation of a joint powers authority and management of

THE BEDFORD-COLDWATER SUB-BASIN
OF THE ELSINORE BASIN

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JOINT POWERS AGREEMENT BY AND AMONG THE CITY OF CORONA, ELSINORE VALLEY MUNICIPAL WATER DISTRICT, AND TEMESCAL VALLEY WATER DISTRICT FOR THE FORMATION OF A JOINT POWERS AUTHORITY AND MANAGEMENT OF THE BEDFORD-COLDWATER SUB-BASIN OF THE ELSINORE BASIN

THIS JOINT POWERS AGREEMENT ("Agreement") is entered into as of February 28, 2017, by and between the CITY OF CORONA ("Corona"), a California General Law City organized and existing under the laws of the State of California, ELSINORE VALLEY MUNICIPAL WATER DISTRICT ("EVMWD"), a Municipal Water District organized under Water Code §§ 71000 et seq., and the TEMESCAL VALLEY WATER DISTRICT ("TVWD"), a California Water District organized under California Water Code §§ 34000 et seq., hereinafter collectively referred to as "Members", with reference to the following:

A. WHEREAS, in September 2014, the Governor signed three bills (SB 1168, SB 1319, and AB 1739) into law creating the Sustainable Groundwater Management Act of 2014 ("SGMA"); and

B. WHEREAS, SGMA generally requires the formation of one or more Groundwater Sustainability Agencies ("GSA" or "GSAs") responsible for implementing sustainable groundwater management and preventing "undesirable results" in groundwater basins and sub-basins designated as a medium or high priority basin by the California Department of Water Resources ("DWR") in its Bulletin 118 inventory of California groundwater basins; and

C. WHEREAS, DWR has designated the Bedford-Coldwater Sub-Basin (the "Sub-Basin"), as a medium priority groundwater basin under Bulletin 118; and

D. WHEREAS, each of the Members overlies a portion of the Sub-Basin and exercises water management, water supply or land use authority within a portion of the Sub-Basin; and

E. WHEREAS, the Members are local agencies that can exercise powers related to groundwater management within their jurisdictional boundaries and qualify individually to serve as a GSA within portions of the Sub-Basin per Water Code Section 10723; and

F. WHEREAS, under SGMA, a combination of local agencies may elect to form a joint powers authority ("JPA") to serve as the GSA for all or portions of the Sub-Basin through a joint powers agreement; and

G. WHEREAS, the Members intend by this Agreement to create a JPA to implement SGMA in the entire Sub-Basin, and are authorized to enter into this Agreement pursuant to the Joint Exercise of Powers Act, Government Code §§ 6500 et seq., for the purpose of acting as a separate public agency that can carry out all obligations, and exercise all powers, of a GSA in all areas of the Sub-Basin; and

H. WHEREAS, under SGMA, a GSA, including a JPA composed of one or more SGMA-eligible local agencies, must file a notice of intent with DWR by June 30, 2017 indicating the GSA's intent to undertake sustainable groundwater management within all or portions of a groundwater basin; and

I. WHEREAS, the governing boards of each of the three Members have formally agreed to: (1) enter into this Agreement; (2) form a JPA that can jointly exercise the powers common to the Members and fulfill all legal obligations imposed by SGMA; and (3) authorize the JPA to promptly file all necessary documentation with DWR so as to permit the JPA to become the exclusive GSA for the entire Sub-Basin; and

J. WHEREAS, the Members further intend by this Agreement to provide for the management and funding commitments reasonably anticipated to be necessary for the above purposes and for the purpose of ensuring that the Sub-Basin is sustainably managed in accordance with the timelines established by SGMA; and

K. WHEREAS, the Members understand that Corona has entered into a Water Enterprise Management Agreement and a Wastewater Enterprise Management Agreement, both dated as of February 6, 2002, with the Corona Utility Authority ("CUA") for the maintenance, management and operation of those utility systems (collectively "the CUA Management Agreements"). To the extent that this Agreement is deemed to be a "material contract" under either of the CUA Management Agreements, Corona enters into this Agreement on behalf of the CUA and subject to the terms of the applicable CUA Management Agreements.

ACCORDINGLY, IT IS AGREED BY ALL MEMBERS:

1. RECITALS: The foregoing recitals are incorporated as terms of this Agreement.

2. DEFINITIONS: Unless otherwise required by the context, the following terms shall have the following meanings:

a. "Administering Member" shall mean the Member designated by the Authority Board to provide administration, operation and staffing of the Authority so as to ensure the Authority complies with this Agreement and all legal requirements. The Board is not required to designate an Administering Member, and a Member so designated is not required to accept the designation.

b. "Administrator" shall mean the individual selected to act as the chief executive of the Authority, and the person responsible for its day to day operations. The Administrator may, but it is not required to be, an employee of one of the Members.

c. "Authority" and "JPA" as used herein shall, unless otherwise noted, mean the "Bedford-Coldwater Groundwater Sustainability Authority," the separate public agency created by this Agreement and Government Code Sections 6507 and 6508, and the entity charged by this Agreement with becoming the exclusive GSA for the Sub-Basin.

d. "Board" or "Board of Directors," shall, unless otherwise indicated, mean the Board of Directors of the Authority.

e. "DWR" shall mean the California Department of Water Resources.

f. "Effective Date" shall mean the date on which all Members have signed this Agreement.

g. “Fiscal Year” shall run from July 1 through June 30.

h. “Groundwater Sustainability Agency” or “GSA” shall mean a groundwater sustainability agency as defined in SGMA, Water Code § 10721.

i. “Groundwater Sustainability Plan,” “Plan,” or “GSP” shall have the same meaning as provided in SGMA, Water Code § 10721.

j. “Member” shall mean any of the individual signatories to this Agreement, and “Members” shall collectively mean two or more of the signatories to this Agreement.

k. “SGMA” shall mean the Sustainable Groundwater Management Act of 2014, as amended, and any regulations of DWR or the State Water Resources Control Board that implement SGMA.

l. “Special Projects” shall mean projects that are consistent with, and within the scope of activities, authorized by this Agreement, but which are undertaken by fewer than all the Members in the name of the Authority in accordance with the procedures outlined in Sections 10 and 14.

m. “Sub-Basin” shall mean the Bedford-Coldwater Sub-Basin of the Elsinore Groundwater Basin, Sub-Basin No. 8-004.2, as identified in the most recent modifications of Bulletin 118 by DWR.

n. “SWRCB” shall mean the California State Water Resources Control Board.

3. CERTIFICATION: Each Member, as a signatory to this Agreement, certifies and declares that it is a public agency, as defined by Government Code § 6500, that is authorized to enter into a joint powers agreement to contract with each other for the joint exercise of any common power under Article 1, Chapter 5, Division 7, Title 1 of the Government Code or any power otherwise granted to one or more of the Members by SGMA.

4. CREATION OF SEPARATE AGENCY: There is hereby created, per Government Code §§ 6507 and 6508, an agency separate from the parties to the Agreement, and which is responsible for the administration of this Agreement, to be known as the “**BEDFORD-COLDWATER GROUNDWATER SUSTAINABILITY AUTHORITY**.” Within thirty (30) days of the Effective Date of this Agreement, the Members, and/or the Authority shall: (a) cause a notice of this Agreement to be prepared and filed with the office of the California Secretary of State as required by Government Code § 6503.5; (b) file a copy of this Agreement with the State Controller per Government Code § 6503.6; and (c) file a copy of this Agreement with the Local Agency Formation Commission (“LAFCO”) for Riverside County per Government Code § 6503.6.

5. PURPOSES AND MEMBER RESPONSIBILITIES: The Authority is formed with the purpose and intent of jointly creating a separate legal entity to fulfill the role and legal obligations of a GSA required by SGMA, to include complying with SGMA and ensuring sustainable groundwater management throughout the Sub-Basin, so that the Members may collaboratively and cost effectively develop, adopt, and implement a GSP for the Sub-Basin in accordance with pertinent regulatory timelines. The geographic boundaries of the GSA that will be formed by the Authority, which will encompass the entire Sub-Basin, are as depicted in the map attached hereto as Exhibit "A," which is incorporated herein by reference. The Authority may also represent the Members, as appropriate, in discussions and transactions with other local agencies, to include (but not limited to) the development of inter-basin coordination agreements with other GSAs in Riverside County, and agreements with other local agencies or groundwater sustainability agencies as may be required to ensure compliance with SGMA for the Sub-Basin.

6. POWERS: The Members intend that the Authority provide for the joint exercise of powers common to the Members as such powers relate to the management of the Sub-Basin, and for the exercise of such additional powers as are conferred by law in order to meet the requirements of SGMA. The Members are each SGMA-eligible local agencies empowered by the laws of the State of California to exercise the powers specified in this Agreement, and such other powers as are granted to GSAs by SGMA. These common powers shall be exercised for the benefit of any one or more of the Members or otherwise in the manner set forth in this Agreement. Subject to the limitations set forth in this Agreement, the Authority shall have the powers to perform all acts necessary to accomplish its purposes as stated in this Agreement, as authorized by law, including but not limited to the following:

a. To make and/or assume contracts and to employ agents, employees, consultants and such other persons or firms as the Board may deem necessary, to the full extent of the Authority's power, including, but not limited to, engineering, hydrogeological, and other consultants, and with attorneys and accountants and financial advisors, for the purpose of providing any service required by the Authority to accomplish its purposes, or to otherwise take such actions as are necessary to ensure the Sub-Basin is managed in accordance with the requirements of SGMA;

b. To conduct all necessary research and investigations, and to compile appropriate reports and collect data from all available sources to assist in preparation and implementation of a GSP, and to support the development of such other agreements as may be necessary to ensure the Sub-Basin can be sustainably managed;

c. To cooperate, act in conjunction with, and contract with the United States, the State of California, or any agency thereof, the County of Riverside, or such other entities or persons as the Board may deem necessary to ensure that the Authority fulfills its obligations under SGMA;

d. To apply for, accept and receive licenses, permits, water rights, approvals, agreements, grants, loans, gifts, contributions, donations or other aid from any agency of the United States, the State of California or other public or private person or entity necessary for fulfilling the purposes of SGMA in the Sub-Basin;

e. To acquire by grant, purchase, lease, gift, devise, contract, construction, eminent domain or otherwise, and hold, use, enjoy, sell, let, and dispose of, real and personal property of every kind, including lands, water rights, structures, buildings, rights-of-way, easements, and privileges, and construct, maintain, alter, and operate any and all works or improvements, within or outside the agency, necessary or proper to carry out any of the purposes of the Authority as specified in this Agreement and/or the requirements of SGMA;

f. To enforce the requirements of SGMA within the Sub-Basin to the extent authorized by law including, but not limited to, the imposition and collection of civil penalties as authorized by SGMA;

g. To sue and be sued in its own name;

h. To provide for the prosecution of, defense of, or other participation in actions or proceedings at law or in public meetings in which the Members, pursuant to this Agreement or otherwise pertaining to management of the Sub-Basin, may have an interest, and to employ counsel or other expert assistance for that purpose;

i. To adopt an initial operating budget and initial Member contributions within ninety (90) days of the execution of this Agreement, and an annual budget and Member contributions, by March 31 of each subsequent Fiscal Year;

j. To incur debts, liabilities or obligations, subject to the limitations provided in this Agreement;

k. To impose fees authorized by SGMA (Water Code §§ 10730-10731), without any limitation on a Member's separate ability to impose fees within its jurisdiction, to fund the cost of furthering the purposes of this Agreement, complying with SGMA, and sustainably managing groundwater within the Sub-Basin;

l. To adopt rules, regulations, policies and procedures for governing the operation of the GSA and adoption and implementation of the GSP consistent with the powers and purposes of the Authority and as authorized by SGMA;

m. To investigate legislation and proposed legislation affecting SGMA and the Sub-Basin and make appearances regarding such matters;

n. Subject to the limitations imposed by this Agreement, to take such actions as are deemed necessary by the Board to achieve the purposes stated above and to provide for the sustainable management of the Sub-Basin; and

o. To adopt and revise bylaws, rules, ordinances, and resolutions in a manner authorized by law and not inconsistent with the terms of this Agreement.

Any power necessary or incidental to the foregoing powers shall be exercised by the Authority in the manner provided for under the legal authority applicable to the City of Corona except as otherwise provided by law or in this Agreement.

7. OBLIGATIONS OR LIABILITIES OF AUTHORITY: No debt, liability or obligation of the Authority shall constitute a debt, liability or obligation of any of the Members, except as otherwise provided in this Agreement or unless otherwise required by law.

8. DESIGNATION OF ADMINISTERING MEMBER/ADMINISTRATOR: The powers of the Authority provided in this Agreement shall be exercised in the manner provided by this Agreement. The Board may designate an Administering Member and/or an Administrator to provide all or a portion of the administrative (or other) services required by this Agreement, SGMA, or other legal authority. However, whether or not the Board decides to designate an Administering Member, each Member shall nevertheless be responsible, when requested by the Board, for designating staff from their agency to coordinate with the Board and other Members, and for otherwise ensuring the Authority has sufficient staffing and administrative support to comply with this Agreement and other legal obligations.

9. ORGANIZATION:

a. Additional Members: The Board may allow additional members to join the Authority. Additional Members must be local agencies capable of being designated as a GSA under SGMA. The Board may set whatever conditions it deems necessary as a precondition to addition of the new Member, to include requiring the additional Members to reimburse the other Members for a proportionate share of the costs already incurred by the existing Members.

b. Bylaws: The Board shall adopt bylaws governing the management of the Authority within 180 days of the Effective Date. The bylaws shall require the Board to develop a conflict of interest code for the Authority compliant with California law, and to otherwise ensure that the Board operates in a manner that is fully compliant with the Brown Act, the Joint Exercise of Powers Act, Government Code §§ 6500 et seq., SGMA, and all other applicable legal requirements.

c. Committees: The Board may create committees as authorized by law.

d. Governing Board: The Authority shall be governed by a Board of Directors which shall be composed of one (1) elected representative of each Member, appointed by each Member. The governing body of each Member shall determine in its sole discretion the person it will appoint to the Authority Board of Directors. The Board of Directors shall receive no compensation from the JPA for serving on the Board of the JPA.

e. Meetings: Regular meetings of the Board may be held quarterly, or as the Board determines necessary, on such dates and times and at such locations as the Board shall fix by resolution. Special meetings of the Board shall be called in accordance with Government Code § 54956. All meetings of the Board shall comply with the provisions of the Ralph M. Brown Act (Government Code §§ 54950 et seq.).

f. Officers: The officers of the Authority shall be a Chairperson, and Vice-Chairperson, and such other officers as the Board shall designate. The election of officers will take place at the first meeting of the JPA Board, and subsequently in the first Board meeting of each new Fiscal Year unless the time of election is otherwise designated in the Authority bylaws. The officers or persons who have charge of, handle or have access to any property of the Authority shall be designated in the bylaws, and such officers and persons shall comply with all applicable requirements of Government Code § 6505.1.

g. Quorum: Two-thirds (2/3) of the Board of Directors shall constitute a quorum in order to conduct business.

h. Rules: The Board may adopt such other rules, policies, and regulations as it deems proper consistent with all applicable laws, this Agreement, and the Authority's bylaws.

i. Term: The Authority Board Members shall serve without terms and at the pleasure of the legislative body which appointed them.

j. Treasurer: The Treasurer of the Board shall be formally designated by a resolution adopted by the Board of Directors stating the effective date of the appointment and the term of the appointment.

k. Voting: Each Director shall have one vote. A simple majority of the quorum shall be required for the adoption of a motion, resolution, contract authorization or other action of the Board, except that:

(1) A majority vote of less than a quorum may vote to adjourn;

(2) Any of the following actions shall require a unanimous vote of the entire Board:

(a) Adoption, modification or alteration of the GSP, or of the GSA boundaries;

(b) Adoption of assessments, charges or fees;

(c) Adoption or modification of ramp-downs or curtailments;

(d) Initiation/settlement of enforcement actions;

(e) Adoption of an initial budget;

(f) Adoption or modification of the annual budget, as further described in Section 14, below;

(g) Initiation/termination or settlement of any litigation or threatened litigation that involves the Authority;

(h) Admission of additional Members to the Authority;

(i) Appointment, employment, or dismissal of the Authority's Administrator and/or Legal Counsel;

(j) Designating an Administrator or Administering Member;

(k) Setting the amounts of any contributions or fees to be made or paid to the Authority by any Member, including extraordinary costs as defined in Section 15;

(l) Acquisition by grant, purchase, lease, gift, devise, contract, construction, or otherwise, and hold, use, enjoy, sell, let, and dispose of, real and personal property of every kind, including lands, water rights, structures, buildings, rights-of-way, easements, and privileges, and construct, maintain, alter, and operate any and all works or improvements, within or outside the agency, necessary or proper to carry out any of the purposes of the Authority;

(m) Replacement of the annual special audit required by Government Code § 6505(f) with an audit covering a two year period;

(n) Amendments or modifications of this Agreement;

(o) Adoption or modification of bylaws or other binding rules governing the operations of the JPA Board;

(p) Adoption of ordinances;

(q) Issuance of bonds or other indebtedness;

(r) Allocating funding received from grants, loans, or from other alternative sources, in a manner that does not result in equal sharing of alternative funding among the Members;

(s) To apply for, accept and receive licenses, permits, water rights, approvals, agreements, grants, loans, gifts, contributions, donations or other aid from any agency of the United States, the State of California or other public or private person or entity necessary for fulfilling the purposes of SGMA in the Sub-Basin.

10. SPECIAL PROJECTS AND PROJECT COMMITTEES:

a. With the prior approval of the entire Board, Members may undertake Special Projects in the name of the Authority, utilizing the legal powers granted to the Authority under SGMA, the Joint Exercise of Powers Act, or other applicable legal authorities. All Members shall be given the opportunity to participate in Special Projects, but shall not be required to participate.

b. A Member considering a new project, other than a groundwater extraction project, where the project is reasonably likely to affect groundwater management in the Sub-Basin shall consult with the other Members before individually undertaking the project to determine whether that individual project might otherwise be better accomplished as an Authority Special Project.

c. Members electing to participate in a Special Project shall enter into a Special Project Agreement in accordance with Section 14.a(4) of this Agreement. Such Special Project Agreement shall provide that: (a) no Special Project undertaken pursuant to such agreement shall conflict with the terms of this Agreement or the GSP; (b) the Members to the Special Project Agreement shall indemnify, defend and hold harmless the Authority, and Members of the Authority who are not participating in the Special Project, against any costs liabilities, or expenses of any kind arising as a result of the Special Project; (c) all benefits and liabilities attributable to a Special Project shall solely be the benefits and liabilities of the Members that have entered into the Special Project Agreement, and non-participating Members shall have no rights, and incur no obligations or liabilities, in the Special Project.

11. FISCAL AGENT, DEPOSITORY AND ACCOUNTING: The "Treasurer" appointed by the Board is designated as the fiscal agent and depository for the Authority per Government Code §§ 6505.5 and 6505.6. The Treasurer of the Authority shall be the treasurer of one of the Authority's Members, or a certified public accountant designated by the Board, or an officer or employee designated per Government Code § 6505.6. The Treasurer shall be the depositary and have custody of all money of the Authority, from whatever source, subject to the applicable provisions of any indenture or resolution providing for a trustee or other fiscal agent. All funds of the Authority shall be held in the operating fund established by Section 14, or such other separate accounts as may be necessary, in the name of the Authority and not commingled with the funds of any Member or any other person or entity. Full books and accounts shall be maintained for the Authority in accordance with generally accepted accounting principles applicable to governmental entities per Government Code §§ 6505 et seq., and any other applicable laws of the State of California.

12. ACCOUNTABILITY, REPORTS AND AUDITS: There shall be strict accountability of all funds, and an auditor designated by the Board shall report any and all receipts and disbursements to the Board with such frequency as shall reasonably be required by the Board. The Authority will utilize the services of an outside independent certified public accountant to make an annual audit of the accounts and records of the Authority as required by Government Code § 6505, unless the Members, elect to conduct the audit for a two (2) year period. In each case, the minimum requirements of the audit shall be those prescribed by the State Controller for special districts pursuant to Government Code § 26909, and shall conform to generally accepted accounting principles. The outside independent certified public accountant selected by the Authority as auditor shall be formally designated by a resolution adopted by the Board of Directors stating the effective date of the appointment and the term of the appointment.

13. OPERATING BUDGET AND EXPENDITURES: The Board shall adopt a budget as specified in the bylaws and as set forth in Section 14, below. Unless otherwise required by this Agreement or applicable law, the Authority's Treasurer shall draw checks or warrants or make payments as specified in the bylaws of the Authority. The Authority may, consistent with the bylaws, invest any money in the treasury that is not needed for its immediate necessities.

14. CONTRIBUTIONS/BUDGETS: Unless otherwise provided in this Agreement, the Members shall equally share in the costs of the JPA. The Authority shall establish an operating fund. The fund shall be used to pay all administrative, operating and other expenses incurred by the Authority, and shall be funded by equal Member's contributions for payment of costs of the Authority. The Board may direct that any surplus funds be returned to the Members, per Government Code § 6512, in proportion to the contributions made by each Member.

a. Authority Budgets: Authority budgets shall be established as follows:

(1) General Operating Budget. No more than ninety (90) days following the first meeting of the Board, and annually thereafter in the month of March or other mutually agreed upon timeframe, a general operation budget (the "Operating Budget") shall be adopted by the Board. The Operating Budget shall be prepared in sufficient detail to constitute an operating outline for the purpose of establishing rates and/or contributions to be billed to and paid by the Members. The operating rates and/or contributions to be billed to and paid by each Member shall be based upon an equal contribution by each Member. The Operating Budget shall outline anticipated revenues and planned expenditures to be made during the ensuing Budget year by functional category such as operations and maintenance, administration, projects, programs, planning, study and any applicable contributions to operate related reserves. For the purpose of the Operating Budget, operating shall mean any financial activity related to exchange transactions, as defined by applicable generally accepted accounting principles ("GAAP") associated with the principal activity of the JPA. The Operating Budget shall be adopted by unanimous approval of the Board. The rates and contributions approved by the Board shall be paid by the Members pursuant to Section 14.c below.

(2) Non-Operating Budget. No more than ninety (90) days following the first meeting of the Board, and annually thereafter in the month of March or other mutually agreed upon timeframe, a non-operating budget (the "Non-Operating Budget") shall be adopted by the Board. The Non-Operating Budget shall be prepared in sufficient detail to constitute a non-operating outline for the purpose of establishing rates and/or contributions to be billed to and paid by the Members. These rates and/or contributions shall be based upon equal contributions by each Member. At a minimum, the Non-Operating Budget shall outline anticipated revenues and planned expenditures for non-operating financial activities for the ensuing Fiscal Year, inclusive of any amount necessary for servicing debt. For the purpose of the budget, Non-Operating shall mean any financial activity related to non-exchange transactions, as defined by applicable GAAP. Examples of non-exchange transactions include investment income, contributed capital from Members for capital debt service, interest expense, and return of capital to Members. The Non-Operating Budget shall be adopted by unanimous approval of the Board. The rates and contributions approved by the Board shall be paid by the Members pursuant to Section 14.c below.

(3) Capital Project Budget. No more than ninety (90) days following the first meeting of the Board, and annually thereafter in the month of March, or other mutually agreed upon timeframe, a capital project budget (the "Capital Project Budget") shall, if applicable, be adopted by the Board. The Capital Project Budget, if applicable, shall be prepared in sufficient detail to constitute a capital project outline to assess contributions to be paid by the Members and expenditures to be paid by the Members during the ensuing year for capital projects needed for major repair, replacement, expansion and efficiency of any capital improvements constructed or installed by or on behalf of the Authority. These contributions shall be based upon equal contribution by each Member, subject to unequal contribution amounts for Special Projects, as addressed in Sections 10 and 14.a.(4). The Capital Project Budget shall be adopted by unanimous approval of the Board. The contributions approved by the Board shall be paid by the Members pursuant to Section 14.c below.

(4) Special Project Budgets. In addition to the Operating Budgets, the Non-Operating Budgets, and the Capital Project Budget, the Board may budget at any time for the study, implementation or construction of any Special Project, program or study proposed to be undertaken by the Authority for matters not deemed to be of general benefit to all Members. A Special Project budget and written Special Project Agreement of the Members who consented to participation in the Special Project shall be established for each Special Project, which budget and agreement shall determine the respective obligations, functions, and rights of the Members involved and of the Authority. The directors of the Board representing the Members who will be involved in financing and implementing the Special Project shall be and constitute a "Special Project Committee," for purposes of administration and implementation of the Special Project. No Special Project shall be acquired or constructed by the Board without the consent of each of the governing boards of the participating Members. Ratification of the Special Project budget by each of the participating Members shall constitute consent for the acquisition and construction of the Special Project. Notwithstanding the foregoing, no debt shall be incurred by the Authority for a Special Project without the unanimous consent of the Board. Any rates and contributions approved by the Special Project Committee and approved by the participating Members shall be paid by the participating Members pursuant to Section 14.c below.

Where the Board has approved one or more Special Projects, annually thereafter in the month of March (or other mutually agreed upon timeframe), a Special Project budget shall be developed by each Special Project Committee if required by the applicable Special Project Agreement, Each Special Project budget shall include, without limitation, the following:

(i) Administrative expenses;

(ii) Studies and planning costs;

(iii) Engineering and construction costs;

(iv) The allocation of costs, including debt service costs, if any, among participating Members;

(v) Annual maintenance and operating expenses for the project; and

(vi) A formula for allocating annual maintenance and operating expenses, if any.

All actions by a Special Project Committee shall be deemed actions of the Authority and shall be taken in the name of the Authority, provided, only the participating Members shall have rights and obligations in the Special Project as herein provided.

b. Failure to Obtain Budget Approvals. In the event a budget acceptable to the Board is not approved prior to the start of a Fiscal Year the Authority shall continue to operate at the level of expenditure as authorized below:

(1) General Operating Budget. The Operating Budget shall be at the expenditure level authorized by the last approved Operating Budget increased by the Consumer Price Index ("CPI") with a minimum increase of no less than two percent (2%). The CPI shall mean the change in CPI for Urban Wage Earners and Clerical Workers for the Los Angeles County, Orange County, and Riverside County areas for the all items category for the 12-month period ending the February prior to the beginning of the Fiscal Year budgeted as determined by the U.S. Department of Labor, Bureau of Labor Statistics, or other mutually agreeable source if such a CPI is no longer available. This factor will be applied to the Operating Budget until such time as a new Operating Budget is approved by the Authority. Any shortfall in revenues will be made up from available reserves dedicated by the Board for such a purpose, and if insufficient to cover the shortfall, any available reserve funds not designated by the Board for other purposes or otherwise legally restricted for other purposes by external parties. Reserves shall mean any available cash or investments.

(2) Non-Operating Budget. The Non-Operating Budget shall automatically be established at the required level necessary to meet annual debt service requirements including any revenue coverage covenants. Each Member shall contribute to the Authority such amounts which will yield during each Fiscal Year net revenues payable to the Authority sufficient for the Authority to satisfy all covenants in any indentures, loan agreements or other documents entered into by the Authority and to enter into such other agreements as are necessary for the Authority to secure financing to pay the acquisition price for any facilities authorized by the Authority.

(3) Capital Project Budget. The Capital Project Budget shall automatically be established at the required level necessary to implement capital projects previously approved by the Authority.

c. Payments of Amounts Due. The payments owed for contributions from each Member to the Authority shall be due, payable, and delivered by the Members to the Authority within forty-five (45) days after receipt of a billing therefor from the Authority. To the extent permitted by state law, unpaid and past due contributions shall bear interest at ten percent (10%) per annum, calculated daily, from the date due to the date payment is received by the Authority.

15. ASSESSMENTS FOR EXTRAORDINARY COSTS: In the event the Authority should experience an unanticipated need to pay for extraordinary costs (e.g., those costs that are unanticipated and not otherwise funded through the budget), including, but not limited to the costs of litigation or indemnification as provided in this Agreement, and to the extent that such costs cannot otherwise be reasonably funded through use of reserves on hand or through the other revenue sources authorized by this Agreement, the Board may allocate the additional costs to the Members, whether such extraordinary costs are actually incurred or estimated to be necessary. Unless otherwise specifically allocated to one or more Members by the unanimous vote of the Board, all allocations of extraordinary costs shall be shared equally by each Member. The Members agree that they will then contribute their proportionate share of the extraordinary costs within a reasonable period of time as determined by the Board, or as otherwise specified in the Bylaws.

16. STAFFING: The Board shall provide for staffing of the Authority in accordance with procedures established in the bylaws. Such staffing shall ensure the Authority is able to accomplish all requirements imposed by SGMA, this Agreement, and/or any other requirements imposed by law. Legal counsel shall be appointed by the Board and shall serve at the pleasure of the Board. Legal counsel may be an attorney that also performs work for one of the Members, provided appropriate waivers suitable to the Board, and counsel for all of the Members, are first obtained.

17. DISPUTE RESOLUTION: The Members desire to informally resolve all disputes related to this Agreement and/or SGMA, whenever possible, at the lowest possible level, and triggering of the dispute resolution procedures described herein shall only occur where the Members and/or the Board have reached impasse and are unable to resolve matters without invoking formal dispute resolution procedures. Should informal resolution of any dispute prove unsuccessful, the Parties agree to neutral facilitation/mediation of the dispute as a next step prior to filing a lawsuit or otherwise seeking judicial intervention. The appointed facilitator/mediator, who need not be a licensed attorney, shall be a person who is not a current or former employee or agent of any Member, and someone who has knowledge of the rules governing public agencies, and who has experience with the management of groundwater resources in Southern California. The facilitator shall be compensated by the Authority.

The facilitator shall be a third party neutral assigned by the Center for Collaborative Policy ("CCP") of Sacramento State University, or such other neutral as is unanimously decided upon by the Members involved in the dispute. In the event that the Members involved in the dispute are unable to agree upon the facilitator or mediator, then each Member involved in the dispute shall provide the name of one recommended facilitator or mediator to the Authority's legal counsel. The facilitator/mediator shall then be selected by the Authority's legal counsel, based upon whichever recommended facilitator/mediator is the most qualified facilitator/mediator for the type of dispute involved. The selected facilitator/mediator shall diligently seek to achieve a consensus based solution to the dispute. Upon the request of one of the Members involved in the dispute, the facilitator shall render a recommended resolution of the dispute after five facilitated negotiation sessions between the Members involved in the dispute where an acceptable resolution has not yet been reached. The facilitator/mediator's recommended resolution shall not be admissible in any judicial proceedings. Where facilitation/mediation as described herein is unable to successfully resolve the dispute, then a Member involved in the dispute, upon providing 60 days-notice to the other Members and the Authority, may initiate judicial proceedings in the Superior Court for Riverside County.

This Section shall not bar a Member or Member(s) from initiating legal action in another appropriate forum with jurisdiction over the matter as necessary to comply with an applicable statute of limitation, provided such legal action, where authorized, is stayed pending completion of the dispute resolution process described herein. Members involved in a dispute governed by this Section are encouraged to enter a tolling agreement, if legally authorized, in order to allow sufficient time for completion of the process required by this Section.

18. WITHDRAWAL:

a. Notice to Members: Any Member may withdraw from the Authority by delivery of written notice to withdraw to each of the Members at least two years prior to the date of withdrawal ("Withdrawal Notice Period"), unless the Members unanimously agree to allow the withdrawing Member to withdraw sooner than two years, in which case the date of withdrawal shall be the date unanimously agreed upon by the Board. The withdrawing Member shall continue to be a full Member during the pendency of the Withdrawal Notice Period and shall retain all rights and obligations during such period unless otherwise agreed to by unanimous vote of the Board.

b. Effect of Withdrawal: Should a Member choose to withdraw from the Authority in accordance with the terms of this Agreement, that Member retains any legal right it has under SGMA to serve as the GSA for the groundwater basin underlying its jurisdictional boundaries, provided such withdrawal will not cause the Authority (or its remaining Members) to default on financial obligations or to otherwise fail to comply with the legal obligations imposed by SGMA. The Authority and the non-withdrawing Members shall retain whatever legal rights they have under SGMA, and the withdrawal of the Member shall have no effect on the continuance of this Agreement among the remaining Members. The withdrawing Member shall not take any action after withdrawal that would be reasonably anticipated to frustrate the ability of the Authority to comply with SGMA. After providing written notice of withdrawal, the withdrawing Member shall act at all times in good faith in the best interests of the Authority until such time as the withdrawal process is complete.

c. Continuing Fiscal Obligations: Any Member that withdraws as provided herein shall remain proportionately liable during the Withdrawal Notice Period for its proportionate share of the budget. If the Members elect to incur extraordinary costs in accordance with Section 15, the withdrawing Member shall be proportionately liable during the Withdrawal Notice Period for the obligations or debts approved and incurred by the Authority for those extraordinary costs, unless the Members agree otherwise. Any Member that withdraws shall remain proportionately liable for any unfunded capital expenditures or debt service obligations incurred or approved by the Board prior to the date of written notice of withdrawal of such Member until such time as the obligation is fully satisfied.

d. Continuing Claims Obligations: Members will remain obligated to contribute their proportionate share (based upon the membership roll as of the date of the claim), including without limitation legal defense costs, for any occurrences incurred during the Member's membership, but not presented as a claim against the Authority until after the Member's withdrawal.

e. Divisions of Property Assets: The real and/or personal property assets contributed by the withdrawing Member or the value of the real and/or personal property assets at the date of withdrawal will be returned to the withdrawing Member to the extent such assets are not required for the Authority to meet its continuing obligations as a GSA under SGMA. If such real and/or personal property assets are needed to meet the continuing obligations of the Authority to comply with SGMA, then the remaining Members of the Authority and the withdrawing Member shall negotiate a purchase or lease of such assets for a price not to exceed the fair market value of those assets.

19. TERM AND TERMINATION: This Agreement shall become effective, and the Authority shall come into existence, on the Effective Date. The Agreement, and the Authority, shall thereafter continue in full force and effect until the governing bodies of the Members unanimously elect to terminate the Agreement. Upon unanimous election to terminate this Agreement, the Board shall continue to act as a board to wind up and settle the affairs of the Authority. The Board shall adequately provide for the known debts, liabilities and obligations of the Authority, and shall then distribute the assets of the Authority among the Members, as follows:

a. The assets contributed by each Member, or the value thereof as of the date of termination, shall be distributed to that Member.

b. The remaining assets shall then be distributed to each Member in equal proportions.

The distribution of assets shall be made in-kind to the extent possible by returning to each Member those assets contributed by such parties to the Authority; however, no party shall be required to accept transfer of an asset in kind.

Notwithstanding any other provision by the Board for payment of all known debts, liabilities and obligations of the Authority, each Member shall remain liable for any and all such debts, liabilities, and obligations in equal proportions, or in the proportion specified by unanimous action of the Board if alternative proportions are so specified for particular actions or activities that give rise to such debts, liabilities, and obligations.

Termination of this Agreement shall not occur, and the Members shall continue to fund the operations of the Authority as a GSA for the Sub-Basin, until the Authority determines by a unanimous vote of the Board that: (a) a GSA is no longer required for the Sub-Basin; or (b) one or more of the individual Members will undertake the legal obligations of a GSA previously performed by the Authority, and such termination of the Authority will not result in the Sub-Basin being placed in a probationary status by the SWRCB.

20. INDEMNIFICATION/CONTRIBUTION: Members, directors, officers, agents and employees of the Authority shall use ordinary care and reasonable diligence in the exercise of their powers, and in the performance of their duties pursuant to this Agreement. The Authority shall hold harmless, defend and indemnify the Members, the Authority Board, and the Members' directors, agents, officers and employees from and against any liability, claims, actions, costs, damages or losses of any kind, including death or injury to any person and/or damage to property (including property owned by any Member), arising out of the activities or omissions of the Authority, or its agents, officers and employees related to this Agreement or SGMA ("Claims").

a. To the extent authorized by California law, no Member shall be liable for the actions or omissions of any other Member or the Authority related to this Agreement.

b. The indemnification obligations described herein shall continue beyond the term of this Agreement as to any acts or omissions occurring during this Agreement or any extension of this Agreement.

c. To the extent that the Authority is unable or unwilling (because of comparative fault of Member(s), or other good faith legal basis) to hold harmless, defend and/or indemnify any Member to this Agreement as provided in this Section, such Member shall be entitled to contribution from the other Members in equal proportion to the extent one Member pays more than its equal share of such obligation. Provided, however, that where one or more Members is determined by a court (or in a settlement approved by a court) to be responsible for a greater proportion for the Claims, each Member will only be responsible for contribution to the other Member (or Members) up to the extent of the contributing Member's proportional responsibility.

21. INSURANCE: The Authority shall obtain insurance for the Board members and general liability insurance containing liability in such amounts as the Board shall determine will be necessary to adequately insure against the risks of liability (including compliance with the indemnification provisions in Section 20 above) that may be incurred by the Authority. The Members, their officers, directors and employees, shall be named as additional insureds.

22. CLAIMS: All claims against the Authority, including, but not limited to, claims by public officers and employees for fees, salaries, wages, mileage, or any other expenses, shall be filed within the time and in the manner specified in Chapter 2 (commencing with Section 910) of Part 3, Division 3.6 of Title I of the Government Code, which describes the appropriate content of a claim.

23. ENTIRE AGREEMENT REPRESENTED: This Agreement represents the entire agreement among the parties as to its subject matter and no prior oral or written understanding shall be of any force or effect. No part of this Agreement may be modified without the written consent of all of the parties.

24. HEADINGS: Section headings are provided for organizational purposes only and do not in any manner affect the scope, meaning or intent of the provisions under the headings.

25. NOTICES: Except as may be otherwise required by law, any notice to be given shall be written and shall be either personally delivered sent by facsimile transmission, emailed or sent by first class mail, postage prepaid and addressed as follows:

MEMBERS:

City of Corona
Attn: General Manager,
Department of Water and Power
Address: 755 Public Safety Way
Corona, CA 92880

Elsinore Valley Municipal Water District
Attn: General Manager
Address: 31315 Chaney Street
Lake Elsinore, CA 92530

Temescal Valley Water District
Attn: General Manager
Address: 22646 Temescal Canyon Rd
Corona, CA 92883

Notice delivered personally is deemed to be received upon delivery. Notice sent by first class mail shall be deemed received on the fourth day after the date of mailing. Any party may change the above address by giving written notice pursuant to this Section.

26. CONSTRUCTION: This Agreement reflects the contributions of all parties and accordingly the provisions of Civil Code § 1654 shall not apply to address and interpret any uncertainty.

27. NO THIRD PARTY BENEFICIARIES INTENDED: Unless specifically set forth, the parties to this Agreement do not intend to provide any other party with any benefit or enforceable legal or equitable right or remedy.

28. WAIVERS: The failure of any party to insist on strict compliance with any provision of this Agreement shall not be considered a waiver of any right to do so, whether for that breach or any subsequent breach.

29. CONFLICT WITH LAWS OR REGULATIONS/SEVERABILITY: This Agreement is subject to all applicable laws and regulations. If any provision of this Agreement is found by any court or other legal authority, or is agreed by the parties, to be in conflict with any code or regulation governing its subject, the conflicting provision shall be considered null and void. If the effect of nullifying any conflicting provision is such that a material benefit of the Agreement to any party is lost, the Agreement may be terminated at the option of the affected party. In all other cases the remainder of the Agreement shall continue in full force and effect.

30. FURTHER ASSURANCES AND OBLIGATION OF GOOD FAITH DEALING: Each party agrees to execute any additional documents and to perform any further acts which may be reasonably required to affect the purposes of this Agreement. Moreover, consent or approval, where reasonably requested in furtherance of the purposes of this Agreement or compliance with SGMA, shall not be unreasonably withheld by a Member.

31. COUNTERPARTS: This Agreement may be signed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

32. AMENDMENT: This document may only be amended with a vote by all of its Members.

33. CUA ASSIGNMENT: To the extent that this Agreement is deemed to be a "material contract" under either of the CUA Management Agreements, the Members have no right to terminate this Agreement, either or without cause, based upon the existence or non-existence of either or both of the CUA Management Agreements. Therefore, if an applicable CUA Management Agreement expires or terminates for any reason, the Members shall remain fully obligated to perform under this Agreement contracting directly with the CUA or another third party contracted by the CUA for the maintenance, management and operation of the applicable utility systems.

CITY OF CORONA SIGNATURE PAGE
FOR
JOINT POWERS AGREEMENT BY AND AMONG THE CITY OF CORONA, ELSINORE VALLEY MUNICIPAL WATER DISTRICT AND TEMESCAL VALLEY WATER DISTRICT FOR THE FORMATION OF A JOINT POWERS AUTHORITY AND MANAGEMENT OF THE BEDFORD-COLDWATER SUB-BASIN OF THE ELSINORE BASIN

EACH OF THE UNDERSIGNED, having read and considered the above provisions, indicate their agreement by their authorized signatures.

CITY OF CORONA,
a California General Law City organized and
existing under the laws of the State of California

By: ______________________
Dick Haley
Mayor

Attest:

____
Lisa Mobley
City Clerk

Approved as to Form:

____
Dean Derleth
City Attorney

Consent:

____
Darrell Talbert
Executive Director
Corona Utility Authority

ELSINORE VALLEY MUNICIPAL WATER DISTRICT SIGNATURE PAGE FOR JOINT POWERS AGREEMENT BY AND AMONG THE CITY OF CORONA, ELSINORE VALLEY MUNICIPAL WATER DISTRICT AND TEMESCAL VALLEY WATER DISTRICT FOR THE FORMATION OF A JOINT POWERS AUTHORITY AND MANAGEMENT OF THE BEDFORD-COLDWATER SUB-BASIN OF THE ELSINORE BASIN

EACH OF THE UNDERSIGNED, having read and considered the above provisions, indicate their agreement by their authorized signatures.

ELSINORE VALLEY MUNICIPAL WATER DISTRICT, a Municipal Water District organized under Water Code §§ 71000

By:______________________________
Harvey R. Ryan
President, Board of Directors

ATTEST

Terese Quintanar

____
Terese Quintanar
Secretary to the Board

APPROVED AS TO FORM

John E. Brown

____
John E. Brown
General Counsel

TEMESCAL VALLEY WATER DISTRICT SIGNATURE PAGE FOR JOINT POWERS AGREEMENT BY AND AMONG THE CITY OF CORONA, ELSINORE VALLEY MUNICIPAL WATER DISTRICT AND TEMESCAL VALLEY WATER DISTRICT FOR THE FORMATION OF A JOINT POWERS AUTHORITY AND MANAGEMENT OF THE BEDFORD-COLDWATER SUB-BASIN OF THE ELSINORE BASIN

EACH OF THE UNDERSIGNED, having read and considered the above provisions, indicate their agreement by their authorized signatures.

TEMESCAL VALLEY WATER DISTRICT,
a California Water District organized under
California Water Code §§ 34000 et seq.

By: CW Colladay
C.W. Colladay
President, Board of Directors

Attest:

Paul Rodriguez
Board Secretary

Approved as to Form:
David R. Saunders
Dave Saunders
General Counsel

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APPENDIX B

Bedford-Coldwater GSA Notice of Decision to become a Groundwater Sustainability Agency

April 20, 2017

Mark Nordberg, GSA Project Manager
Senior Engineering Geologist
California Department of Water Resources
901 P Street, Room 213A
P.O. Box 942836
Sacramento, CA 94236

Re: Notice of Election to Become a Groundwater Sustainability Agency for the Bedford-Coldwater Subbasin (Basin No. 8-.004.02)

Pursuant to California Water Code section 10723.8 of the Sustainable Groundwater Management Act (SGMA), the Bedford-Coldwater Joint Powers Authority (JPA) provides this notice of election to serve as the Groundwater Sustainability Agency (GSA) for the entire Bedford-Coldwater Subbasin (Basin No. 8-004.02) (the "Subbasin"). The JPA was formed by way of joint powers agreement among Elsinore Valley Municipal Water District, Temescal Valley Water District, and the City of Corona. The Board of Directors of the JPA approved a resolution forming the JPA on March 29, 2017.

Along with this letter and a copy of the joint powers agreement, we have also uploaded to the DWR SGMA Portal–GSA Formation Notification System a map and GIS shapefiles depicting the boundaries of the Subbasin from Bulletin 118 and the service area boundaries of the members of the JPA.

The GSA and its management area cover the entire 7,025-acre Subbasin. For planning purposes, minor portions of the Subbasin are located outside the service area boundaries of the member agencies of the JPA. The first of these areas comprises approximately 114 acres of steep, remote canyons within the Cleveland National Forest. To the JPA's knowledge, no pumping is currently occurring in the portion of the Subbasin within these canyons and it is likely that no pumping has historically or will ever occur there due to their inaccessibility and relative lack of groundwater.

A second small area consisting of approximately 44 acres outside of the JPA's boundaries is the eastern end of Dawson Canyon, which is located in the central, eastern side of the Subbasin. To the JPA's knowledge, there are only two de minimis, domestic pumpers in this area. The remote canyon has little potential for significant groundwater extraction. Notwithstanding, the GSA intends to ensure through the groundwater sustainability planning process that sustainability is reached within the SGMA statutory timeframe in the Dawson Canyon and all other areas of the Subbasin, including within the above-indicated U.S. Forest Service lands.

The JPA members have worked with the County of Riverside and the Riverside County Flood Control & Water Conservation District ("Flood Control") to obtain their support for the JPA to secure GSA status over the entire Subbasin. Support letters from the County of Riverside and Flood Control are attached. In the unlikely event that any pumping in the United States Forest Service or Dawson Canyon areas outside of the JPA's service area were to ever occur or exceed de minimis thresholds, the JPA will work with the County and Flood Control to regulate such pumping, as may be appropriate.

We have also uploaded to the DWR SGMA portal all of the other information needed to form a GSA, including copies of the JPA's Government Code section 6066 notice, the JPA resolution approving the formation of the GSA, and the list of interested parties.

Please do not hesitate to contact me with any questions you may have about this matter.

Sincerely,

Margie Armstrong
Interim Administrator
Bedford-Coldwater Joint Powers Authority

RESOLUTION NO. 2017-01

RESOLUTION OF INTENT OF THE BOARD OF DIRECTORS OF THE BEDFORD-COLDWATER GROUNDWATER SUSTAINABILITY AUTHORITY, A JOINT POWERS AUTHORITY, TO BECOME THE GROUNDWATER SUSTAINABILITY AGENCY FOR THE BEDFORD COLDWATER SUB-BASIN OF THE ELSINORE GROUNDWATER BASIN

WHEREAS, in September 2014. the Sustainable Groundwater Management Act ("SGMA") was signed into law, with an effective date of January 1, 2015, and codified at California Water Code, Section 10720 et seq; and

WHEREAS, the legislative intent of SGMA is to, among other goals, provide for sustainable management of alluvial groundwater basins and sub-basins defined by the California Department of Water Resources ("DWR"), to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide specified local agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, Water Code section 10723(a) authorizes a "local agency" with water supply, water management or local land use responsibilities, or a combination of local agencies with such responsibilities overlying a groundwater basin, to decide to become a Groundwater Sustainability Agency (GSA) under SGMA; and

WHEREAS, Elsinore Valley Municipal Water District ("EVMWD"), the City of Corona ("Corona") and Temescal Valley Water District ("TVWD") jointly requested the Elsinore Basin be split into two distinct groundwater areas; and

WHEREAS, on October 11, 2016, the California Water Commission approved the subject request and established two sub-basins within the Elsinore Basin; the southerly Elsinore Valley Sub-Basin (Bulletin 118 Basin No. #8-004.1) and the northerly Bedford Coldwater Sub-Basin (#8-004.2); and

WHEREAS, Bedford Coldwater Groundwater Sustainability Authority (Authority) is a "local agency" comprised of EVMWD, Corona, and TVWD (each a "Member") with "water management" responsibilities within the Bedford-Coldwater Sub Basin (DWR Bulletin 118, No. 8-004.2) (the "Sub-Basin") of the Elsinore Groundwater Basin (DWR Bulletin 118, No. 8-004); and

WHEREAS, sustainable groundwater management of groundwater basins designated by DWR as high and medium priority basins is required by SGMA; and

WHEREAS, the boundaries of the Authority overlie the Sub-Basin, which is not adjudicated and is designated by DWR as a high priority basin; and

WHEREAS, California Water Code Section 10723.8 requires that a local agency deciding to serve as a GSA notify DWR within 30 days of the local agency's decision to become a GSA authorized to undertake sustainable groundwater management within a basin; and

WHEREAS, California Water Code Section 10723.8 mandates that 90 days following the posting by DWR of the local agency's decision to become a GSA, that entity shall be presumed to be the exclusive GSA for the area within the basin the agency is managing as described in the notice, provided that no other GSA formation notice covering the same area has been submitted to DWR; and

WHEREAS, the Authority intends to manage all portions of the Sub-Basin subject to SGMA under a groundwater sustainability plan (GSP); and

WHEREAS, in accordance with Section 10723(b) of the California Water Code, and Section 6066 of the California Government Code, a notice of public hearing was published in two general circulation newspapers in Riverside County regarding the Authority's intent to consider becoming a GSA for the Sub-Basin.

NOW, THEREFORE, THE AUTHORITY BOARD OF DIRECTORS HEREBY FINDS, DETERMINES, RESOLVES, AND ORDERS AS FOLLOWS:

SECTION 1. The above recitals, and each of them, are true and correct, and are incorporated as terms of this resolution.

SECTION 2. The Authority Board of Directors hereby decides and determines that the Authority shall become the GSA for all of those portions of the Sub-Basin that are required to be managed under SGMA.

SECTION 3. Authority staff, or staff of one of the Authority Members on behalf of the Authority, shall submit to DWR, within thirty (30) days of the approval of this Resolution, all documentation and information required by Water Code section 10723.8 to support the Authority's formation of a GSA over the Sub-Basin.

SECTION 4. The approval of this Resolution and the actions described herein are exempt from the requirements of the California Environmental Quality Act (CEQA) since: (1) they are not a "project" for purposes of CEQA (CEQA Guidelines 14 Cal. Code Regs. §15378 (b)(5)) because the approval will not will not result in direct or indirect physical changes in the environment; and (2) it can be seen with certainty that there is no possibility that the approval in question may have a significant effect on the environment. (CEQA Guidelines, 14 Cal. Code Regs. §15061(b)(3).) Staff is directed to file and post within ten (10) business days a Notice of Exemption for this approval with the Clerk of the Board of Supervisors of Riverside County.

SECTION 5. The Board Secretary shall certify the adoption of this resolution.

PASSED, APPROVED AND ADOPTED this 29th day of March, 2017, by the following vote:

AYES:
NOES:
ABSENT:

Chairperson

ATTEST:

Secretary

THE PRESS-ENTERPRISE

1825 Chicago Ave, Suite 100
Riverside, CA 92507
951-684-1200
951-368-9018 FAX

PROOF OF PUBLICATION
(2010, 2015.5 C.C.P)

Publication(s): The Press-Enterprise

PROOF OF PUBLICATION OF

Ad Desc.: /

I am a citizen of the United States. I am over the age of eighteen years and not a party to or interested in the above entitled matter. I am an authorized representative of THE PRESS-ENTERPRISE, a newspaper in general circulation, printed and published daily in the County of Riverside, and which newspaper has been adjudicated a newspaper of general circulation by the Superior Court of the County of Riverside, State of California, under date of April 25, 1952, Case Number 54446, under date of March 29, 1957, Case Number 65673, under date of August 25, 1995, Case Number 267864, and under date of September 16, 2013, Case Number RIC 1309013; that the notice, of which the annexed is a printed copy, has been published in said newspaper in accordance with the instructions of the person(s) requesting publication, and not in any supplement thereof on the following dates, to wit:

03/15, 03/22/2017

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Date: March 22, 2017
At: Riverside, California

Legal Advertising Representative, The Press-Enterprise

TEMESCAL VALLEY WATER DISTRICT
22646 TEMESCAL CYN RD
ATTN: MEL MCCULLOUGH
CORONA, CA 92883

Ad Number: 0010914773-01

P.O. Number:

Ad Copy:

NOTICE OF PUBLIC HEARING TO CONSIDER THE ELECTION BY THE BEDFORDCOLDWATER GROUNDWATER SUSTAINABILITY AUTHORITY TO BECOME THE GROUNDWATER SUSTAINABILITY AGENCY FOR THE BEDFORD COLDWATER SUBBASIN OF THE ELSINORE BASIN

NOTICE IS HEREBY GIVEN pursuant to Section 10723(b) of the California Water Code and Section 6066 of the California Government Code that the Board of Directors ("Board") of the Bedford-Coldwater Groundwater Sustainability Authority will hold a public hearing to consider the proposed decision by Bedford-Coldwater Groundwater Sustainability Authority to become the Groundwater Sustainability Agency ("GSA") for the BedfordColdwater Subbasin (#8-004.02) of the Elsinore Basin (#8-004) on Wednesday, March 29, 2017 at 4 p.m., in the Boardroom of Temescal Valley Water District's headquarters, located at 22646 Temescal Canyon Road, Temescal Valley, California 92883.

The purpose of the public hearing will be to hear comments from the public regarding the Bedford-Coldwater Groundwater Sustainability Authority's proposed formation of a GSA within its boundaries in the Bedford-Coldwater Subbasin (#8-004.02).

At the end of the public hearing, the Board may adopt, revise or modify a Resolution of Intent to become the GSA and to submit notification to the California Department of Water Resources ("DWR"), which shall post the notice pursuant to Section 10723.8(b) of the California Water Code. The notification submitted to DWR will include a description of the proposed boundaries of the GSA and the Subbasin that the Bedford-Coldwater Groundwater Sustainability Authority intends to manage pursuant to the Sustainable Groundwater Management Act ("SGMA").

The draft Resolution of Intent is on file and available for inspection during regular business hours at the office of the Temescal Valley Water District at 22646 Temescal Canyon Road, Temescal Valley, California 92883.

To publish March 15, 2017 and March 22, 2017.

PROOF OF PUBLICATION

CITY OF CORONA

NOTICE OF PUBLIC HEARING TO CONSIDER THE ELECTION BY THE BEDFORD-COLDWATER GROUNDWATER SUSTAINABILITY AUTHORITY TO BECOME THE GROUNDWATER SUSTAINABILITY AGENCY FOR THE BEDFORD COLDWATER SUBBASIN OF THE ELSINORE BASIN

NOTICE IS HEREBY GIVEN pursuant to Section 10723(b) of the California Water Code and Section 6066 of the California Government Code that the Board of Directors ("Board") of the Bedford-Coldwater Groundwater Sustainability Authority will hold a public hearing to consider the proposed decision by Bedford-Coldwater Groundwater Sustainability Authority to become the Groundwater Sustainability Agency ("GSA") for the Bedford-Coldwater Subbasin (#8-004.02) of the Elsinore Basin (#8-004) on WEDNESDAY, MARCH 29, 2017 AT 4 P.M., in the Boardroom of Temescal Valley Water District's headquarters, located at 22646 Temescal Canyon Road, Temescal Valley, California 92883.

The purpose of the public hearing will be to hear comments from the public regarding the Bedford-Coldwater Groundwater Sustainability Authority's proposed formation of a GSA within its boundaries in the Bedford-Coldwater Subbasin (#8-004.02).

At the end of the public hearing, the Board may adopt, revise or modify a Resolution of Intent to become the GSA and to submit notification to the California Department of Water Resources ("DWR"), which shall post the notice pursuant to Section 10723.8(b) of the California Water Code. The notification submitted to DWR will include a description of the proposed boundaries of the GSA and the Subbasin that the Bedford-Coldwater Groundwater Sustainability Authority intends to manage pursuant to the Sustainable Groundwater Management Act ("SGMA").

The draft Resolution of Intent is on file and available for inspection during regular business hours at the office of the Temescal Valley Water District at 22646 Temescal Canyon Road, Temescal Valley, California 92883.

Published: March 15, 2017 and March 22, 2017.

JOB CC17-025

SENTINEL WEEKLY NEWS

"Adjudicated for City of Corona, Corona Judicial Dist., Riverside County, California"

SWN-2511 JOB CC17-025

MARCH 15, 22, 2017

THIS SPACE RESERVED FOR CLERK / RECORDING STAMP

Sentinel Weekly News

Adjudicated for the City of Corona, California

1307-C West 6th St., Suite 139
Corona, CA. 92882
Tel: (951) 737-9784 / Fax: (951) 737-9785
E-mail: SentinelWeekly@aol.com

PROOF OF PUBLICATION

(2010, 2015.5 C.C.P.)

STATE OF CALIFORNIA
COUNTY OF RIVERSIDE

I am a Citizen of the United States. I am over the age of eighteen years and not a party to or interested in the above entitled matter. I am an Authorized Representative of *SENTINEL WEEKLY NEWS* (formerly known as The Lake Mathews Sentinel), a Newspaper of General Circulation, printed and published weekly in the City of Corona, County of Riverside, and which Newspaper has been Adjudicated a Newspaper of General Circulation by the Superior Court of the County of Riverside, State of California, under the date of March 30, 1995, Case Number 262254; and under the date of December 7, 1999, Case Number 334071; and the Notice, of which the annexed is a printed copy, has been published in said Newspaper in accordance with the instructions of the Person(s) requesting publication, and not in any supplement thereof on the following dates to wit:

(1) ***March 22, 2017***

(2)

(3)

(4)

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

/S/ ______________________________
Authorized Representative

DATED: __ ***MARCH 22, 2017*** __

APPENDIX C

GSP Elements Guide

Article 5.			Plan Contents for Bedford-Coldwater Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.			**Introduction to Plan Contents**					
			This Article describes the required contents of Plans submitted to the Department for evaluation, including administrative information, a description of the basin setting, sustainable management criteria, description of the monitoring network, and projects and management actions.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
SubArticle 1.			**Administrative Information**					
§ 354.2.			**Introduction to Administrative Information**					
			This Subarticle describes information in the Plan relating to administrative and other general information about the Agency that has adopted the Plan and the area covered by the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.4.			**General Information**					
			Each Plan shall include the following general information:					
(a)			An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.	17:25	ES			
(b)			A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.	225:230	10			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
§ 354.6.			**Agency Information**					
			When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:					
(a)			The name and mailing address of the Agency.	29:31	1.3			
(b)			The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.	29:30	1.3.1			
(c)			The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.	29:30	1.3.1			
(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.	30	1.3.2			
(e)			An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.	30:31	1.3.3			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.8, 10727.2, and 10733.2, Water Code.					

Article 5.			Plan Contents for Bedford-Coldwater Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.8.			**Description of Plan Area**					
			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.	27, 35:47	2.1	Figure 1-1		
	(2)		Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.	35:36, 49	2.1.2	Figure 2-2		
	(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.	35:36, 48:49	2.1.2	Figure 2-1, 2-2		
	(4)		Existing land use designations and the identification of water use sector and water source type.	36, 38	2.1.3, 2.1.5	Figure 2-8, 2-9		
	(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 the best available information.	36:37, 50:53	2.1.2	Figures 2-3,2-4, 2-5, 2-6		
(b)			A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.	35:49	2.1	Figure 2-1, 2-2		
(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.	37:38	2.1.4			
(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.	37:38	2.1.4			
(e)			A description of conjunctive use programs in the basin.	37:38	2.1.4			

Article 5.			Plan Contents for Bedford-Coldwater Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(f)			A plain language description of the land use elements or topic categories of applicable general plans that includes the following:					
	(1)		A summary of general plans and other land use plans governing the basin.	38, 55:56	2.1.5	Figure 2-8, 2-9		
	(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	38	2.1.5			
	(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.	38	2.1.5			
	(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.	38	2.1.5			
	(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.	38	2.1.5			
(g)			A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.					none determined to be appropriate
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10720.3, 10727.2, 10727.4, 10733, and 10733.2, Water Code.					
§ 354.10.			**Notice and Communication**					
			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.	61:62, 157, 164:166, 168:169, 178, 288:300	3.10, 6.2.4, 6.3.4, 6.5.4, 6.6.4, 6.7.4, Appendix D			
(b)			A list of public meetings at which the Plan was discussed or considered by the Agency.	301:354	Appendix E			
(c)			Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.	355:389	Appendix F			

Article 5.			**Plan Contents for Bedford-Coldwater Basin**	**GSP Document References**				
				Page Numbers of Plan	**Or Section Numbers**	**Or Figure Numbers**	**Or Table Numbers**	**Notes**
(d)			A communication section of the Plan that includes the following:					
	(1)		An explanation of the Agency's decision-making process.	256:263	Appendix B			
	(2)		Identification of opportunities for public engagement and a discussion of how public input and response will be used.	288:300	Appendix D			
	(3)		A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.	288:300	Appendix D			
	(4)		The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.	288:300	Appendix D			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.8, 10728.4, and 10733.2, Water Code					
SubArticle 2.			**Basin Setting**					
§ 354.12.			**Introduction to Basin Setting**					
			This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.14.			**Hydrogeologic Conceptual Model**					
(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.	57:73	3	Figures 3-1:3-10		
(b)			The hydrogeologic conceptual model shall be summarized in a written description that includes the following:					
	(1)		The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.	58:59, 64:68	3.4, 3.5	Figures 3-1:3-5		
	(2)		Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.	68	3.5, 3.6, 3.9	Figure 3-5		
	(3)		The definable bottom of the basin.	60:61, 69	3.7	Figure 3-6		

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	(4)		Principal aquifers and aquitards, including the following information:					
		(A)	Formation names, if defined.	60, 68	3.6.1	Figure 3-5		
		(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.	58:61, 68, 390:506	3.4, 3.5, 3.6, 3.7, 3.8, 3.9, Appendix G	Figure 3-5		
		(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.	58:61, 68, 390:506	3.4, 3.5, 3.6, 3.7, 3.8, 3.9, Appendix G	Figure 3-5		
		(D)	General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.	79:80	4.4, 4.5			
		(E)	Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.	62:63	3.11			
	(5)		Identification of data gaps and uncertainty within the hydrogeologic conceptual model	63	3.12			
(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.	61, 70:72	3.8	Figure 3-7:3-9		
(d)			Physical characteristics of the basin shall be represented on one or more maps that depict the following:					
	(1)		Topographic information derived from the U.S. Geological Survey or another reliable source.	64		Figure 3-1		
	(2)		Surficial geology derived from a qualified map including the locations of cross-sections required by this Section.	68		Figure 3-5		
	(3)		Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.	67		Figure 3-4		
	(4)		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.	73		Figure 3-10		
	(5)		Surface water bodies that are significant to the management of the basin.	65		Figure 3-2		
	(6)		The source and point of delivery for imported water supplies.	35:36, 54	2.1.2.1	Figure 2-7		
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10733, and 10733.2, Water Code.					

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§ 354.16.			**Groundwater Conditions**					
			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:					
(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.	96:97		Figure 4-7, Figure 4-8		
	(2)		Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.	91:95		Figure 4-2, Figure 4-6		
(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.	139		Figure 5-6		
(c)			Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.	8.3	4.8			
(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.	79:83, 100:102	4.4, 4.5, 4.6, 4.7	Figure 4-11:4-13		
(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 the best available information.	76:78, 98:99	4.3	Figure 4-9, 4-10		
(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 the best available information.	83:89, 103:108	4.9	Figures 4-14:4-19		
(g)			Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.	83:89, 109:111	4.9	Figures 4-20:4-22		
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, and 10733.2, Water Code.					

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§ 354.18.			**Water Budget**					
(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.	112, 114:119, 138:139	5.1, 5.5	Figure 5-5, 5-6		
(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.	121:122, 138	5.6	Figure 5-5	Table 5-3	
	(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.	126:129, 139	5.7.1	Figure 5-6	Table 5-4	
	(3)		Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.	126, 129:130, 139	5.7.2	Figure 5-6	Table 5-4	
	(4)		The change in the annual volume of groundwater in storage between seasonal high conditions.	126, 130:131, 139, 513:520	5.8, Appendix J	Figure 5-6	Table 5-4	
	(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.					Not applicable
	(6)		The water year type associated with the annual supply, demand, and change in groundwater stored.	112:113, 134	5.2	Figure 5-1		
	(7)		An estimate of sustainable yield for the basin.	131:133	5.9		Table 5-5	
(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.	124:126, 139	5.7	Figure 5-6	Table 5-4	

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	(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.	124:126, 138, 390:506, 513:520	5.7, Appendix G, Appendix J	Figure 5-5	Table 5-4	
		(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.	124:126, 138, 390:506, 513:520	5.7, Appendix G, Appendix J	Figure 5-6	Table 5-4	
		(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.	124:126, 131:134, 139	5.7, 5.9	Figure 5-6, 5-1	Table 5-4	
	(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.	117:119, 121:125, 140:141, 143	5.5.3, 5.6, 5.7	Figures 5-7, 5-8, 5-10		
		(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.	114:120, 124:125, 140:141, 143	5.5, 5.7	Figures 5-7, 5-8, 5-10	Table 5-2	

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		(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.	114:125, 140:141, 143, 390:506, 513:520	5.5, 5.6, 5.7, Appendix G, Appendix J	Figures 5-7, 5-8, 5-10		
(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.	112:113, 139, 390:506, 513:520	5.2, Appendix G, Appendix J	Figure 5-6		
	(2)		Current water budget information for temperature, water year type, evapotranspiration, and land use.	112:114, 139, 390:506, 513:520	5.2,5.3, Appendix G, Appendix J	Figure 5-6		
	(3)		Projected water budget information for population, population growth, climate change, and sea level rise.	117:119, 140:141, 390:506, 513:520	5.5.3, Appendix G, Appendix J	Figure 5-7, 5-8		
(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.	114:131, 390:506	5.5, 5.6, 5.7, 5.8, Appendix G			
(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.	112, 390:506	5.1, Appendix G			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10727.6, 10729, and 10733.2, Water Code.					

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§ 354.20.			**Management Areas**					
(a)			Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.	114, 135, 509:512	5.4, Appendix I	Figure 5-2		
(b)			A basin that includes one or more management areas shall describe the following in the Plan:					
	(1)		The reason for the creation of each management area.	114, 509:512	5.4, Appendix I			
	(2)		The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.	145:183	6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7			
	(3)		The level of monitoring and analysis appropriate for each management area.	189:200	7			
	(4)		An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.	144:183	6			
(c)			If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.	114, 135	5.4	Figure 5-2		
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
SubArticle 3.			**Sustainable Management Criteria**					
§ 354.22.			**Introduction to Sustainable Management Criteria**					
			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.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					

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§ 354.24.			**Sustainability Goal**					
			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.	145	6.1.1			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10727, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.26.			**Undesirable Results**					
(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.	145, 148, 156:157, 162:163, 167, 173	6.1.1, 6.2.1, 6.3.1, 6.5.1, 6.6.1, 6.7.1			

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(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.	145:146, 149, 157, 163, 168, 173:178	6.1.2, 6.2.2, 6.3.2, 6.5.2, 6.6.2, 6.7.2			
	(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.	146:147, 149, 157, 164, 168, 178	6.1.3, 6.2.3, 6.3.3, 6.5.3, 6.6.3, 6.7.3			
	(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.	145:147, 150, 157, 164:166, 178	6.1, 6.2.4, 6.3.4, 6.5.4, 6.6.4, 6.7.4			
(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.	150, 157:159, 166, 169:172, 179	6.2.5, 6.3.5, 6.5.5, 6.6.5, 6.7.5			
(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.	162	6.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10733.2, and 10733.8, Water Code.					

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§ 354.28.			**Minimum Thresholds**					
(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.	152:156, 159:161, 164:166, 169:172, 179:181	6.2.6, 6.3.6, 6.5.4, 6.6.5, 6.7.6			
(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.	150, 157:159, 166, 169:172, 179	6.2.5, 6.3.5, 6.5.5, 6.6.5, 6.7.5			
	(2)		The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.	152:156, 159:161, 172, 179:181	6.2.6, 6.3.6, 6.5.6, 6.6.6, 6.7.6			
	(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.	152:156, 159:161, 172, 179:181	6.2.6, 6.3.6, 6.5.6, 6.6.6, 6.7.6			
	(4)		How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.	152:156, 159:161, 172, 179:181	6.2.6, 6.3.6, 6.5.6, 6.6.6, 6.7.6			
	(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.	152:156, 159:161, 172, 179:181	6.2.6, 6.3.6, 6.5.6, 6.6.6, 6.7.6			
	(6)		How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.	152:156, 159:161, 172, 179:181	6.2.6, 6.3.6, 6.5.6, 6.6.6, 6.7.6			

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(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.	74:75, 92:95, 147:156, 184	4.1.3, 6.2	Figure 4-3:4-6, 6-1		
		(B)	Potential effects on other sustainability indicators.	160	6.3.6.1			
	(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.	156:161	6.3			
	(3)		Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:					
		(A)	Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.	162	6.4			
		(B)	A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.	162	6.4			
	(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 based 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.	162:166	6.5			

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	(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 an 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.	166:172	6.6			
		(B)	Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.	99, 166:172	6.6	Figure 4-10		
	(6)		Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:					
		(A)	The location, quantity, and timing of depletions of interconnected surface water.	172:182, 185:188	6.7	Figures 6-2:6-5		
		(B)	A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.	179, 185:188	6.7.5	Figures 6-2:6-5		
(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.	156:161	6.3			
(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.	162	6.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10733, 10733.2, and 10733.8, Water Code.					

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§ 354.30.			**Measurable Objectives**					
(a)			Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.	155:156, 161, 166, 172, 182	6.2.7, 6.3.7, 6.5.5, 6.6.6, 6.7.7			
(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.	155:156, 161, 166, 172, 182	6.2.7, 6.3.7, 6.5.5, 6.6.6, 6.7.7			
(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.	155:156, 161, 166, 172, 182	6.2.7, 6.3.7, 6.5.5, 6.6.6, 6.7.7			
(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.	161, 182	6.3.7, 6.7.7			
(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.	145:147	6.1			
(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.	155:156, 161, 166, 172, 182	6.2.7, 6.3.7, 6.5.5, 6.6.6, 6.7.7			
(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 a finding of inadequacy of the Plan.	155:156, 161, 166, 172, 182	6.2.7, 6.3.7, 6.5.5, 6.6.6, 6.7.7			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					

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SubArticle 4.			**Monitoring Networks**					
§ 354.32.			**Introduction to Monitoring Networks**					
			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.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.34.			**Monitoring Network**					
(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.	189:195	7.1		Table 7-1	
(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.	189:195	7.1		Table 7-1	
	(2)		Monitor impacts to the beneficial uses or users of groundwater.	189:195	7.1		Table 7-1	
	(3)		Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.	189:195	7.1		Table 7-1	
	(4)		Quantify annual changes in water budget components.	189:195	7.1		Table 7-1	

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(c)			Each monitoring network shall be designed to accomplish the following for each sustainability indicator:					
	(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 monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.	191:192, 199, 203	7.1.1	Figure 7-1	Table 7-2	
		(B)	Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.	191:192, 199, 203	7.1.1	Figure 7-1	Table 7-2	
	(2)		Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.	192:193	7.1.2			
	(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.	193	7.1.3			
	(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.	193:194, 199, 203	7.1.5	Figure 7-2	Table 7-2	
	(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.	193	7.1.4			

Article 5.			Plan Contents for Bedford-Coldwater Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(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.	194:195	7.1.6			
		(B)	Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.	194:195	7.1.6			
		(C)	Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.	194:195	7.1.6			
		(D)	Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.	194:195	7.1.6			
(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.	189:195, 202:203	7.1	Figure 7-1, 7-2		
(e)			A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.	189:195	7.1		Table 7-1	
(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.	189:195	7.1			
	(2)		Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.	189:195	7.1			
	(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.	189:195	7.1			
	(4)		Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.	189:195	7.1			

				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(g)			Each Plan shall describe the following information about the monitoring network:					
	(1)		Scientific rationale for the monitoring site selection process.	189:195	7.1			
	(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.	195:197	7.2			
	(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.	189:195	7.1			
(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.	189:195	7.1			
(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.	195:197	7.2			
(j)			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 a monitoring network related to those sustainability indicators.	189:195	7.1			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, 10728, 10733, 10733.2, and 10733.8, Water Code					
§ 354.36.			**Representative Monitoring**					
			Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:					
(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.	198	7.3			

Article 5.			**Plan Contents for Bedford-Coldwater Basin**	**GSP Document References**				
				Page Numbers of Plan	**Or Section Numbers**	**Or Figure Numbers**	**Or Table Numbers**	**Notes**
(b)			(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.	198	7.3			
	(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.	198	7.3			
(c)			The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.	198	7.3			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2 and 10733.2, Water Code					
§ 354.38.			**Assessment and Improvement of Monitoring Network**					
(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.	200:201	7.5		Table 7-3	
(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.	200:201	7.5		Table 7-3	
(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.	201			Table 7-3	
	(2)		Local issues and circumstances that limit or prevent monitoring.	200:201	7.5		Table 7-3	
(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.	200:201	7.5		Table 7-3	
(e)			Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:					
	(1)		Minimum threshold exceedances.	189:195	7.1			
	(2)		Highly variable spatial or temporal conditions.	189:195	7.1			
	(3)		Adverse impacts to beneficial uses and users of groundwater.	189:195	7.1			
	(4)		The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.	189:195	7.1			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10728.2, 10733, 10733.2, and 10733.8, Water Code					

Article 5.			Plan Contents for Bedford-Coldwater Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.40.			**Reporting Monitoring Data to the Department**					
			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.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10728, 10728.2, 10733.2, and 10733.8, Water Code.					
SubArticle 5.			**Projects and Management Actions**					
§ 354.42.			**Introduction to Projects and Management Actions**					
			This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 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.	204:218	8			
(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.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
		(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.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
	(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.					Not applicable
	(3)		A summary of the permitting and regulatory process required for each project and management action.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	

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				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(4)		The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
	(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.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
	(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.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
	(7)		A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
	(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.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
	(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.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
(c)			Projects and management actions shall be supported by best available information and best available science.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
(d)			An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.	204:218	8.1,8.2,8.3, 8.4,8.5,8.6, 8.7,8.8		Tables 8-1:8-8	
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					

APPENDIX D

BCGSA Stakeholder Outreach Plan

STAKEHOLDER OUTREACH PLAN

BEDFORD COLDWATER GROUNDWATER SUBBASIN (#8-004.02) of the ELSINORE BASIN (#8-004)

RIVERSIDE COUNTY, CALIFORNIA

SUSTAINABLE GROUNDWATER MANAGEMENT ACT
(SGMA) PROGRAM

Prepared For:

BEDFORD COLDWATER
GROUNDWATER SUSTAINABILITY AUTHORITY

Acting as a Groundwater Sustainability Agency

Prepared By:

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October 2018
Updated October 2021

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LIST OF ACRONYMS AND ABBREVIATIONS

BCGSA	Bedford Coldwater Groundwater Sustainability Authority acting as a Groundwater Sustainability Agency
CASGEM	California Statewide Groundwater Elevation Monitoring
Corona	City of Corona
DAC	disadvantaged community
DWR	California Department of Water Resources
EVMWD	Elsinore Valley Municipal Water District
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
JPA	Joint Powers Authority
SGMA	Sustainable Groundwater Management Act
TVWD	Temescal Valley Water District

1.0 INTRODUCTION

The Sustainable Groundwater Management Act (SGMA), effective January 1, 2015, was enacted in California to regulate and sustainably manage groundwater basins throughout the state. SGMA provides a framework to guide local public agencies and newly created Groundwater Sustainability Agencies (GSAs) in the management of their underlying groundwater basins, especially those considered critically affected as defined by the Department of Water Resources (DWR).

The Bedford Coldwater Groundwater Sustainability Authority (BCGSA) was formed as a result of a Joint Powers Agreement to create a Joint Powers Authority (JPA). The JPA consists of the City of Corona (Corona), Elsinore Valley Municipal Water District (EVMWD), and Temescal Valley Water District (TVWD) acting as the Groundwater Sustainability Agency (GSA) for the Bedford Coldwater Groundwater Subbasin (Subbasin), a subbasin of the Elsinore Groundwater Basin. The BCGSA will be responsible for creating a Groundwater Sustainability Plan (GSP) to achieve long-term groundwater sustainability in the Subbasin. Under SGMA Regulations (California Water Code [Water Code] Section 10723.2), the BCGSA must consider all beneficial users and users of groundwater throughout the GSP development process. The BCGSA, comprised of three local agencies, will strive to achieve sustainable groundwater management in the region in the best interests of the stakeholders and local community.

This Stakeholder Outreach Plan (Outreach Plan) outlines the communication methods and strategies the BCGSA will employ to most effectively engage and involve stakeholders throughout GSP development and SGMA implementation per California Water Code.

2.0 OBJECTIVES

The purpose of this Outreach Plan is to involve stakeholders and understand their values throughout development of the GSP for the Subbasin. The objectives of the Outreach Plan are to:

- Identify and include interested stakeholders, including: affected governments, agencies, land use and environmental organizations, interested parties, and members of the public
- Provide multiple forums for stakeholder involvement
- Encourage stakeholder input throughout the GSP development process
- Receive and understand information about stakeholders' values and interests
- Incorporate comments and feedback received during GSP development
- Abide by SGMA Regulations and ensure broad public participation and transparency

3.0 STAKEHOLDER IDENTIFICATION

SGMA Regulations require GSAs to consider the interests of all beneficial users and users of groundwater (Water Code Section 10723.2), and establish and maintain a list of persons interesting in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents (Water Code Section 10723.4). Per Water Code Section 10723.8(a)(4), a list of interested parties was developed and provided to DWR during formation of the BCGSA. The BCGSA will continue to expand this list throughout the GSP development process. An initial list of stakeholders is presented in Table 1.

Table 1 – List of Stakeholders in the BCGSA Area

Category	Identified Stakeholders
Holders of overlying groundwater rights – Agricultural users	None identified
Holders of overlying groundwater rights – Domestic well owners	• Golf Club at Glen Ivy • Shea Homes, Inc. • Other small producers
Municipal well operators	• City of Corona Department of Water and Power • Elsinore Valley Municipal Water District • Temescal Valley Water District
Industrial well operators	• Coldwater Aggregates
Public water systems	• Western Municipal Water District • Eastern Municipal Water District • City of Corona Department of Water and Power • Elsinore Valley Municipal Water District • Temescal Valley Water District
Local land use planning agencies	• Riverside County, Planning Department • City of Corona
Regulatory Agencies	• Riverside County Flood Control and Water Conservation District • California Regional Water Quality Control Board – Santa Ana Region (8)
Environmental Groups	• The Nature Conservatory
Surface water users, if there is a hydrologic connection between surface and groundwater bodies	• Santa Ana Watershed Protection Agency • City of Corona Department of Water and Power • Elsinore Valley Municipal Water District • Temescal Valley Water District
The Federal Government	• United States Forest Service • United States Fish and Wildlife Service
California State Agencies	• California Department of Water Resources • California Department of Fish and Wildlife Groundwater Program
California Native American Tribes	• Soboba Band of Luiseño Indians • Rincon Band of Luiseño Indians • Agua Caliente Band of Cahuilla Indians • Temecula Band of Luiseño Indians
Disadvantaged communities (DAC), including, but not limited to, those served by private domestic wells or small community water systems	None identified
Entities listed in Water Code Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the groundwater sustainability agency	Elsinore Valley Municipal Water District is the entity responsible for the California Statewide Groundwater Elevation Monitoring (CASGEM) program

3.1 Tribal Lands in the Basin

There are no tribal entities with land within the Basin. The list of stakeholders includes four California Native American tribes in the region, though not with land in the Basin, in order to continue the long history of coordination with tribal entities between the GSA agencies. The tribes have been contacted for stakeholder meetings as well as for consultation during the California Environmental Quality Act (CEQA) process for two new monitoring wells. The tribes have indicated no specific interest in the Basin, however the BCGSA will continue to consult with the tribes throughout GSP implementation and CEQA permitting.

3.2 Private Well Owners

The BCGSA believes there are very few active private wells, none of which are used for potable water supply in the Basin. While the BCGSA is aware of a small number of private wells, a systematic well inventory identifying all active private wells has not been completed to date. The GSP includes a project to address this data gap with a survey and inventory of active private wells throughout the Basin (Project 2, Section 8.7). This project was designed to locate and characterize the construction and use of existing private wells so that they can be included in sustainable management of the Basin.

4.0 OUTREACH ACTIVITIES

The BCGSA will implement the following outreach activities to maximize stakeholder involvement during development and implementation of the GSP. A summary of SGMA stakeholder outreach requirements and Water Code sections (Dobbin, 2015) are included in Table A.1 of Appendix A.

4.1 Public Notices and Meetings

SGMA establishes public notice requirements for GSAs to ensure that the general public and other stakeholders, are aware of actions by their local GSA. Table 2 outlines the three sections of the Water Code that require public notice, including before establishing a GSA, before adopting or amending a GSP, and before imposing or increasing a fee.

Table 2 – SGMA Requirements for Public Notice

Public Notice Requirement	Water Code Section
“Before deciding to become a groundwater sustainability agency, and after publication of notice pursuant to Section 6066 of the Government Code, the local agency or agencies shall hold a public hearing in the county or counties overlying the basin.”	10723(b)
“A groundwater sustainability agency may adopt or amend a groundwater sustainability plan after a public hearing, held at least 90 days after providing notice to a city or county within the area of the proposed plan or amendment.”	10728.4
“Prior to imposing or increasing a fee, a groundwater sustainability agency shall hold at least one public meeting, at which oral or written presentations may be made as part of the meeting.”	10730(b)(1)

The BCGSA will satisfy these requirements by publishing notices in local news outlets for Riverside County (*The Press-Enterprise)* and the City of Corona (*Sentinel Weekly News)*, as well as posting on the BCGSA website.

In accordance with Water Code Section 10723(b), the following notices were provided to the public during formation of the BCGSA:

- On March 15, 2017 and March 22, 2017, a notice of public hearing was published in *The Press-Enterprise* and *Sentinel Weekly News* to inform the public of the intent to hold a public hearing to consider the proposed decision by Bedford-Coldwater Groundwater Sustainability Authority to become the GSA for the Bedford-Coldwater Subbasin of the Elsinore Basin.

- On March 29, 2017, the Bedford-Coldwater Groundwater Sustainability Authority held a public hearing in the Boardroom of the Temescal Valley Water District's headquarters to hear comments from the public regarding the Bedford-Coldwater Groundwater Sustainability Authority's proposal to form a GSA within the Bedford-Coldwater Subbasin.

4.1.1 Public Meetings

To promote broad public participation and stakeholder involvement (Water Code Section 10727.8(a)), the BCGSA will conduct at least two public meetings during development of the GSP. Each meeting will be open to stakeholders and will include agency representatives. These meetings will be an opportunity for stakeholders to ask questions and provide input on sections of the GSP.

Public meetings will be held in the Boardroom of the Temescal Valley Water District's headquarters, located at 22646 Temescal Canyon Road, Temescal Valley, California 92883. More information including date and time of upcoming meetings will be provided on the BCGSA website. Throughout stakeholder outreach, the BCGSA will evaluate if additional accommodations will be necessary (e.g., evening meetings, translation for hearing impaired or non-English speaking individuals, etc.) in order to include as many stakeholders as possible.

As of this 2021 update, two public meetings have been held: November 7, 2019 in the Temescal Valley Water District boardroom, and July 15, 2021 online via Zoom. Since the start of the COVID-19 pandemic, to encourage participation and ensure the safety of all participants, all public and JPA Board meetings have been conducted through online formats.

Stakeholders will continue to be encouraged to participate in meetings and engage with BCGSA members following adoption of the GSP through email updates and website postings. Public meetings will be held as needed prior to significant updates made to the GSP throughout GSP implementation. Meeting information will be made available on the BCGSA website.

4.1.2 JPA Board Meetings

Representatives of each agency comprising the BCGSA will be present during quarterly Board meetings with the JPA. The dates, times, and location of these meetings will be posted on the BCGSA website. Time is designated during these meetings for the BCGSA to provide the JPA with updates on the progress of GSP development and SGMA implementation. There will be opportunity for the public to pose questions and comments at the start of each meeting. This public comment period will continue throughout GSP implementation.

4.2 GSA Website

The BCGSA will develop a website to facilitate the sharing of information about GSP development and SGMA implementation with stakeholders. Information will include maps, a calendar of upcoming meetings and important dates, meeting summaries, groundwater information, relevant documents, mailing list signup, and other SGMA/GSA related information. The BCGSA website is located at: www.bedfordcoldwatergsa.com

The website will be updated regularly. There will be a designated page where users are encouraged to request more information, ask questions, or be added to the list of stakeholders. Links to the BCGSA website will be provided on the homepages of member agency websites.

Prior to initiating the development of a GSP, SGMA Regulations require that GSAs make a written statement describing the manner in which interested parties may participate in the development and implementation of the GSP available to the public and to DWR (Water Code Section 10727.8(a)). A section of the BCGSA website will allow the public to access this statement, the Outreach Plan, and any other written requirements.

4.3 Direct Mailings/Email

The BCGSA will maintain and continue to update a list of stakeholders. The list will be updated as persons request information though the website and from attendance at public meetings. Information distributed to those on the list who are interested in receiving BCGSA updates may include, plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents (Water Code Section 10723.4).

4.4 Outreach Implementation Timeline

Stakeholder engagement opportunities will be tracked and available on the BCGSA website throughout the GSP development process. Figure 1 shows the required stakeholder engagement opportunities throughout the four phases of GSP development as described by DWR (DWR, 2018). Forms of stakeholder engagement may include public meetings, information distributed to the BCGSA list of stakeholders, or DWR open public comment periods online via the SGMA Portal found at https://sgma.water.ca.gov/portal/#intro.

Phase 1 (years 2015 to 2017) is the GSA Formation and Coordination phase and includes one stakeholder input requirement. This requirement was completed by holding a public hearing to form the GSA from the Bedford Coldwater Groundwater Sustainability Authority.

Phase 2 (year 2017 to 2022) is the GSP Preparation and Submission part of the GSP development process. During this phase, stakeholders will be provided with opportunities to provide input on sections of the GSP by attending public meetings or reaching out on the BCGSA website.

Phase 3, occurring at any point after completion of Phase 2, consists of GSP review and evaluation. Once the GSP is submitted, any person may provide comments to DWR regarding a proposed or adopted GSP via the SGMA Portal found on DWR’s website.

Phase 4 (year 2022+) is the Implementation and Reporting phase following adoption of the GSP. Active stakeholder involvement and public meetings are encouraged by DWR during this phase.

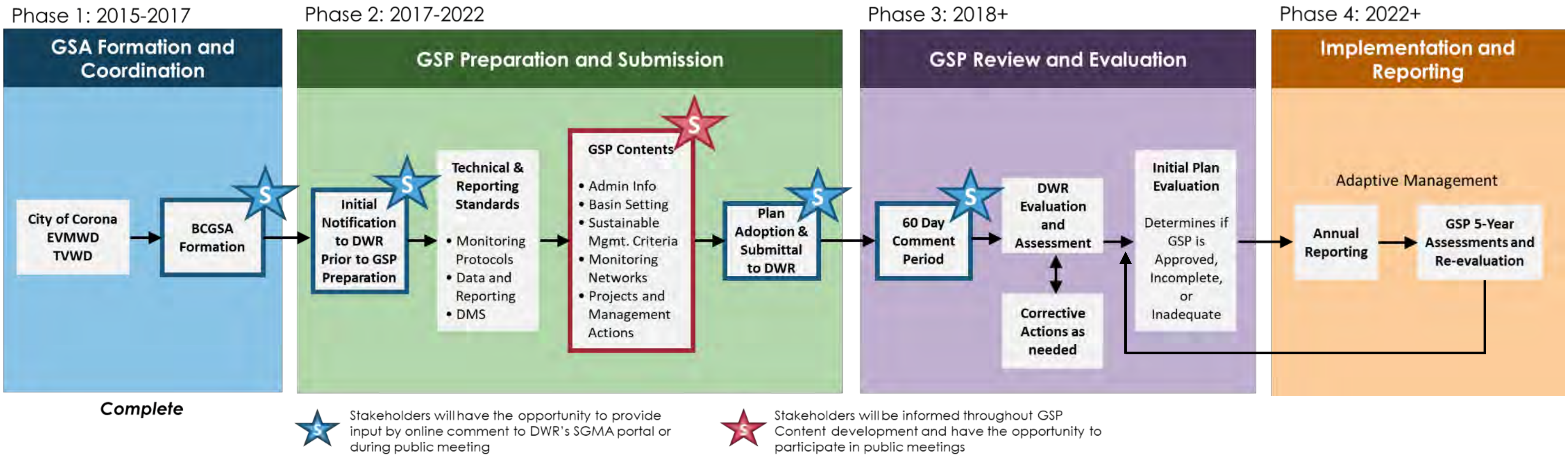


Figure 1 – Stakeholder Input Timeline (adapted from DWR, 2018)

5.0 EVALUATION

GSAs are encouraged to continually evaluate the effectiveness and monitor the progress of stakeholder engagement. The BCGSA will monitor the effectiveness of the Outreach Plan throughout GSP development and implementation by actively revising and updating the Outreach Plan to reflect any changing needs of stakeholders. The stakeholders list will be updated as needed to ensure all interested groups and beneficial users are included.

5.1 Public Meeting Participation and Attendance

Recording attendance and participation at public meetings is one method the BCGSA will use to implement the Outreach Plan and identify any adjustments that may be required. A record of attendance will be taken at each public meeting, and written feedback request forms will be available to each attendee. The forms will allow a clear pathway for the BCGSA to receive direct feedback on how to improve engagements with the public, if necessary, and to ensure individual interests are documented and considered.

5.2 Comment and Response Database

The BCGSA will maintain a database in order to ensure that comments voiced during public meetings and throughout stakeholder engagement are addressed. The database will track comments (and other information including name, date, and venue), assign responsibility for response preparation, and track distribution of responses. A copy of the information contained in the database will be included in the GSP as required by GSP Regulations Section 354.10.

6.0 REFERENCES

California Department of Water Resources (DWR), 2018. “Guidance Document for Groundwater Sustainability Plan, Stakeholder Communication and Engagement.” Sustainable Groundwater Management Program. January.

Dobbin, Kristin, et al., 2015. “Collaborating for Success: Stakeholder Engagement for Sustainable Groundwater Management Act Implementation.” Community Water Center. July.

Water Code Sections can be found online at California Legislative Information. <https://leginfo.legislature.ca.gov/faces/home.xhtml>

APPENDIX A

Summary of Statutory Requirements

Table A.1 – Summary of Statutory Requirements for Stakeholder Engagement in SGMA

Timeframe	Requirement	California Water Code Section
During GSA Formation	"Before electing to be a groundwater sustainability agency… the local agency or agencies shall hold a public hearing"	10723 (b)
	"A list of interested parties [shall be] developed [along with] an explanation of how their interests will be considered"	10723.8(a)(4)
During GSP Development and Implementation	"A groundwater sustainability agency may adopt or amend a groundwater sustainability plan after a public hearing"	10728.4
	"Prior to imposing or increasing a fee, a groundwater sustainability agency shall hold at least one public meeting"	10730(b)(1)
	"The groundwater sustainability agency shall establish and maintain a list of persons interested in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents"	10723.4
	"Any federally recognized Indian Tribe… may voluntarily agree to participate in the preparation or administration of a groundwater sustainability plan or groundwater management plan… A participating Tribe shall be eligible to participate fully in planning, financing, and management under this part"	10720.3(c)
	"Prior to initiating the development of a groundwater sustainability plan, the groundwater sustainability agency shall make available to the public and the department a written statement describing the manner in which interested parties may participate in the development and implementation of the groundwater sustainability plan"	10727.8(a)
Throughout SGMA Implementation	"The groundwater sustainability agency shall consider the interests of all beneficial uses and users of groundwater"	10723.2
	"The groundwater sustainability agency shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin"	10727.8(a)

APPENDIX E

Public Meeting Summaries

MEETING SUMMARY
Public Meeting

Bedford Coldwater Groundwater Sustainability Authority
6:30 PM, November 7, 2019
22646 Temescal Valley Road, Temescal Valley, CA 92883

Attendees
Craig Kessler, SoCal Golf Association
Kevin Fitzgerald, SoCal Golf Association
Rachel Gray, Eastern Municipal Water District
Kristian Aifelor, City of Corona Department of Water and Power
Sonny Gowan, ECS/Glen Ivy
Arean Park, KOK/Tom's Farms
Mike Buckantz, Associates Environmental
Jim St. Martin, Chandler's Sand and Gravel
Trevor Wood, Chandler's Sand and Gravel
Pakiza Chatha, California Department of Water Resources
Ray Alvarez, Glen Ivy Hot Springs
Brandon Barnett, KWC Engineers
Charley Land, California Department of Fish and Wildlife
Ian Achimore, Santa Ana Watershed Project Authority
Jacque Casillas, City of Corona
Phil Williams, Elsinore Valley Municipal Water District
Margie Armstrong, Elsinore Valley Municipal Water District
Tom Moody, City of Corona
Jeff Pape, Temescal Valley Water District
Victor Harris, Stantec
Kelly Shugart, Stantec

Agenda
1. Welcome and Introductions
2. Introduction to the Sustainable Groundwater Management Act (SGMA)
3. Bedford Coldwater Groundwater Sustainability Authority
4. Open Discussion
5. Next Steps

Victor Harris presented on the above topics followed by an open discussion. Comments from stakeholders were mostly addressed by Victor Harris, Tom Moody, and Jeff Pape are summarized below.

General comments from Jeff Pape, TVWD:
- It will be helpful for the BCGSA to know details about stakeholders' wells in the Subbasin: Has anyone had to lower pumps? Any water quality issues?
- We are interested in obtaining the earliest well data available for warm water and cold water wells.

General comments from Tom Moody, City of Corona

- The BCGSA is interested in gaining information about the geology where wells have been drilled in order to better understand the hydrogeology and the water entering those wells.
- We want to understand where recharge is occurring in the Subbasin and that we have recharge occurring in the correct location for future modelling efforts.
- We are interested in the native safe yield at each of the wells in the Subbasin so the BCGSA can know how much can be pumped safely without damaging the aquifer.

Stakeholder Comment: Will future development go into recharge in the Subbasin?

Response: The BCGSA will need to do a water study, but yes, it's possible.

Stakeholder Comment: Does water withdrawn in the basin stay in the basin or is it transported out?

Response: Most of the water stays in or very near the basin, but not 100% of it. Any exports out of the Subbasin is another aspect we need to understand. TVWD imports 100% of its potable water, about 3,000 acre-feet.

Stakeholder Comment: Is any of the water used for recharge?

Response: Recycled water is percolated into the ground.

Stakeholder Comment: What should we worry about for future projects?

Response: We will try to plan for known development as part of the Master Plan, for example, recycled water is required for landscape irrigation. If something deviates from the Master Plan, we will need to work it out with the developer.

Stakeholder Comment: For future projects, will developments need to be equipped with a reservoir or way to capture rainwater?

Response: It's possible; we want to minimize runoff and maybe look into xeriscaping. Future developments could be required to do stormwater management. Knowing how much runoff we are saving could go into offsetting extractions.

Stakeholder Comment: There is a creek passing through my client's land and they are experiencing erosion. Would it be possible to use [BCGSA] budget to create a reservoir to hold water on that land?

Response: If it promotes general sustainability, it could be a possibility.

Stakeholder Comment: Will you develop regulations for new and existing developments?

Response: There could be guidance setup for minimizing runoff, for example. The BCGSA will continue to review and update the GSP regularly. As regulations change, we will need to see how our plan fits and update, as needed.

Stakeholder Comment: Can you speak more to fees?

Response: Extraction fees are a possible authority, but it is more about compliance. It would be an enforcement amount. Fees could potentially used as funding for new projects or enforcement.

Stakeholder Comment: Is the GSA's authority a one-size fits all or will you look at each user individually concerning compliance with policies? Not everything would fit for the spa, for example, like landscaping policies.

Response: Policies will need to be practical and equitable for everyone.

Stakeholder Comment: How do you plan on gathering data?

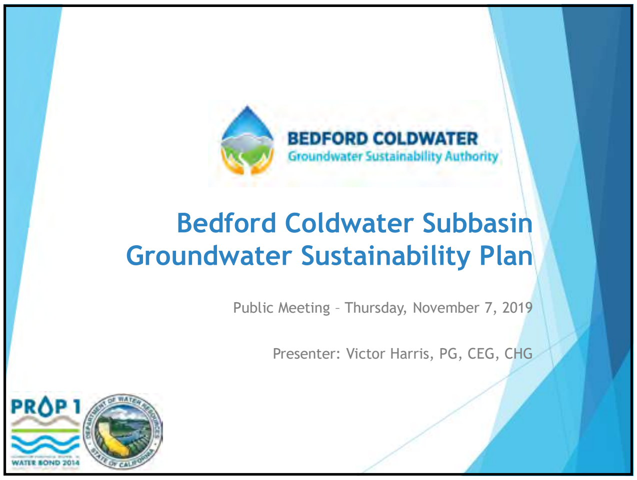
> **Response:** We will be asking users for any data they have. Lots of wells are de minimus, less than 2 acre-feet per year, or hard rock wells and are exempt. We are in contact with most of the larger producers and hope to have good relationships with everyone in the basin. We really want to know the geology and to understand the basin.

Stakeholder Comment: Are you reaching out to other stakeholders?

> **Response:** We have contacted all we are aware of in the basin. Do you have suggestions on how to reach others? We will be reaching out during a data gathering period and will publish our list of stakeholders. We will be careful of confidentiality, especially with the mining operations. We need to understand the basin without hurting business. We will be asking everyone for their information.

DWR Comment: How can stakeholders stay engaged?

> **Response:** Attend meetings which are posted on the BCGSA website. A listserv is a good way to keep people engaged and send notifications automatically. We will also add the presentation slides to the website.



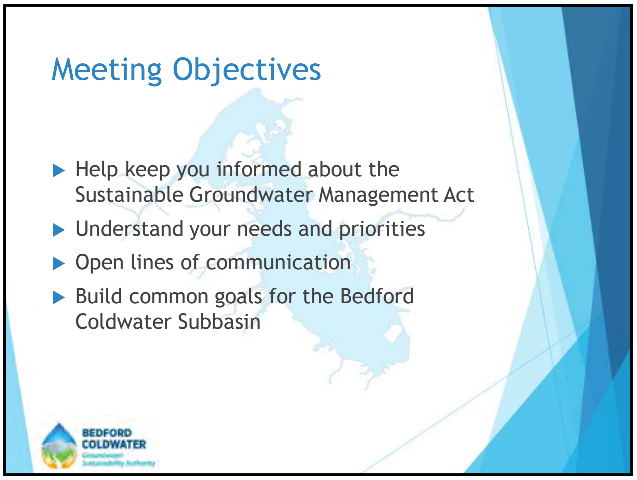
Bedford Coldwater Subbasin Groundwater Sustainability Plan

Public Meeting – Thursday, November 7, 2019

Presenter: Victor Harris, PG, CEG, CHG

Agenda

1. Welcome and Introductions
2. Introduction to the Sustainable Groundwater Management Act (SGMA)
3. Bedford Coldwater Groundwater Sustainability Authority
4. Open Discussion
5. Next Steps



Meeting Objectives

- Help keep you informed about the Sustainable Groundwater Management Act
- Understand your needs and priorities
- Open lines of communication
- Build common goals for the Bedford Coldwater Subbasin

Introduction to the Sustainable Groundwater Management Act

The Sustainable Groundwater Management Act (SGMA)

- Sustainable Groundwater Management Act (SGMA) was passed by the California legislature in 2014
  - Created a framework for sustainable groundwater management in California
- **Sustainable Groundwater Management** = *"Management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results."*

"…groundwater management in California is best accomplished locally."
– Governor Jerry Brown, September 2014

SGMA

- Requires the formation of Groundwater Sustainability Agencies (GSAs) – generally agencies overlying the groundwater basin
- GSAs are responsible for preparing Groundwater Sustainability Plans (GSPs) and be submitted by:
  - January 2020 for critically over drafted basins
  - January 2022 for remaining high and medium priority basins
- Creates a single sustainability goal for the basin or subbasin
  - Achieved within 20 years of GSP implementation
  - Maintained without causing undesirable results

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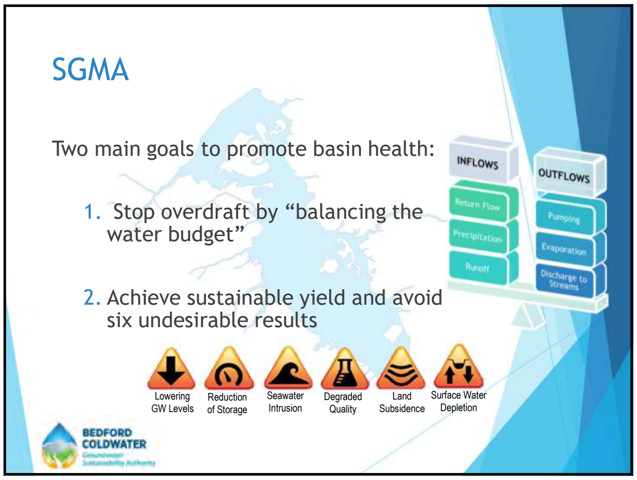
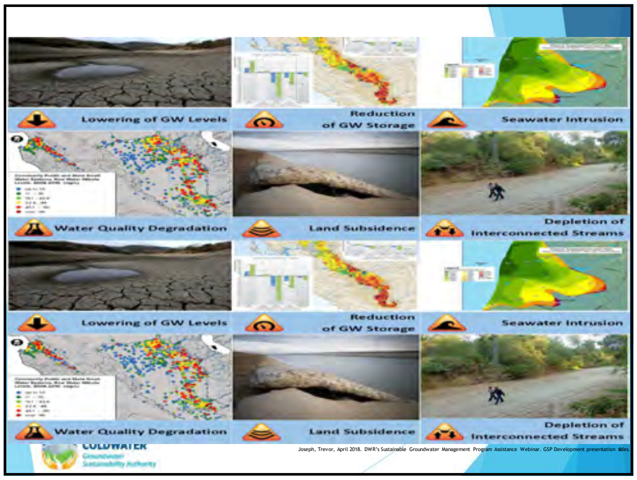
Groundwater Sustainability Authority



SGMA

Two main goals to promote basin health:

1. Stop overdraft by "balancing the water budget"
2. Achieve sustainable yield and avoid six undesirable results



Joseph, Trevor, April 2018. DWR's Sustainable Groundwater Management Program Assistance Webinar. GSP Development presentation slides.

Basin Prioritization

- Four groundwater basin categories: High, medium, low, and very low
- Based on components in California Water Code Section 10933(b)
  - Population overlying basin or subbasin
  - Number of wells that draw from the basin
  - Irrigated acreage overlying the basin
  - Reliance on groundwater for primary source of water

Groundwater Sustainability Plans Required for High and Medium Priority Basins by 2020/22

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Groundwater Sustainability Agencies

- SGMA Required Groundwater Sustainability Agencies (GSAs) be formed
- Expanded the role of DWR to support local implementation of sustainable groundwater management by GSAs
- Allows for intervention by the State Water Resources Control Board (SWRCB) at points throughout the process of achieving sustainable groundwater management

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Powers and Authority of a GSA

- Adopt rules, regulations, ordinances and resolutions to achieve groundwater sustainability
- Conduct investigations for the purpose of:
  - Determining the need for groundwater management
  - Preparing and adopting a GSP and implementing rules and regulations
  - Proposing and updating fees
  - Monitor compliance and enforcement
  - Inspection of property or facilities to ascertain compliance
- Require registration of a groundwater extraction facility
- Require measurement and recording of groundwater extraction (costs borne by owner or operator)
- Require groundwater extraction facilities to file an annual report

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Powers and Authority of a GSA (continued)

- Acquire land, water rights, rights-of-way, structures, or other property
- Appropriate and acquire surface or groundwater (or rights thereof)
- Transport, reclaim, purify, desalinate or treat wastewater or polluted water
- Additional authorities
  - Regulate or limit groundwater extractions
  - Limit construction of new wells, or reactivation of older wells
  - Authorize transfers and carryover of groundwater extraction allocations

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12

Groundwater Sustainability Plan

- ***GSP development must be a transparent and open process encouraging stakeholder and public input***
- Establish minimum thresholds for each sustainability indicator to avoid undesirable results

Bedford Coldwater Groundwater Sustainability Authority

Bedford Coldwater Groundwater Sustainability Authority

- Joint Powers Authority (JPA) formed by three local agencies in February 2017 for management of the Subbasin
  - City of Corona
  - Elsinore Valley Municipal Water District
  - Temescal Valley Water District
- JPA signed a resolution in March 2017 to become the GSA for the Subbasin
- Governed by a representative Board member from each agency

Bedford Coldwater GSA
Basin and Agency Boundaries

Bedford Coldwater Subbasin Prioritization

- Bedford Coldwater Subbasin classified as a *very low priority* subbasin
- Groundwater use <9,500 acre-feet per year and no documented impacts to the subbasin

DWR SGMA Basin Prioritization Tool

BEDFORD COLDWATER Groundwater Sustainability Authority

2017 Prop 1 SGWP Grant

- BCGSA was awarded funding by the Department of Water Resources (DWR) of the State of California through the Proposition 1 Sustainable Groundwater Planning (SGWP) Grant
- SGWP Grant provides funding to assist in financing the planning and/or selected project activities that will improve sustainable groundwater management
- BCGSA submits quarterly progress reports to DWR under the conditions of the grant

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GSP Development

The First Step is a Conceptual Model

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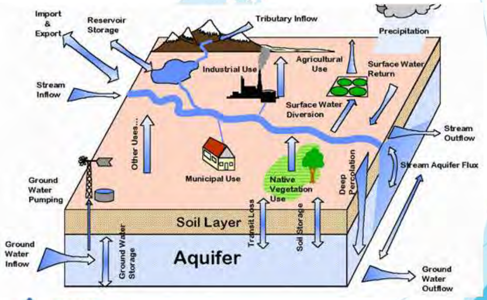
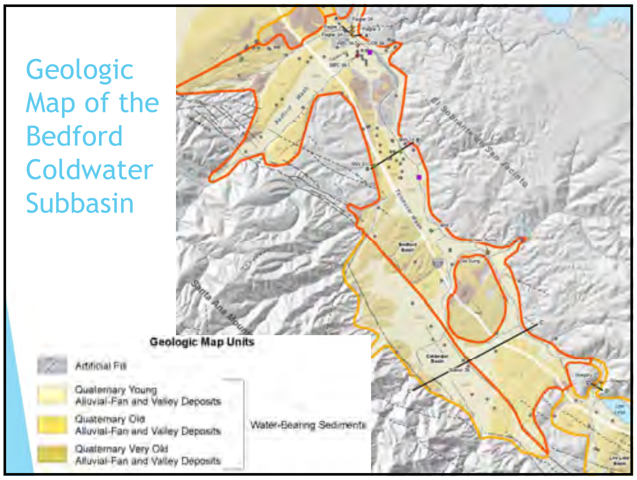
GSP Development

A Water Budget is Key to the Conceptual Model



BEDFORD COLDWATER Groundwater Sustainability Authority

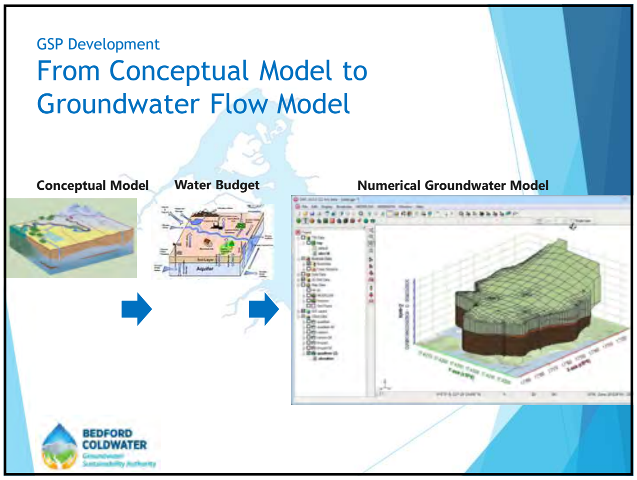


Geologic Map of the Bedford Coldwater Subbasin

Geologic Map Units

- ▨ Artificial Fill
- 🟨 Quaternary Young Alluvial-Fan and Valley Deposits
- 🟨 Quaternary Old Alluvial-Fan and Valley Deposits
- 🟨 Quaternary Very Old Alluvial-Fan and Valley Deposits

Water-Bearing Sediments



GSP Development

From Conceptual Model to Groundwater Flow Model

BEDFORD COLDWATER Groundwater Sustainability Authority

Potential Projects for BCGSA

- Drill new, or locate suitable existing wells for groundwater monitoring
- Surface water instrumentation and monitoring
- Baseline groundwater quality sampling

BEDFORD COLDWATER Groundwater Sustainability Authority

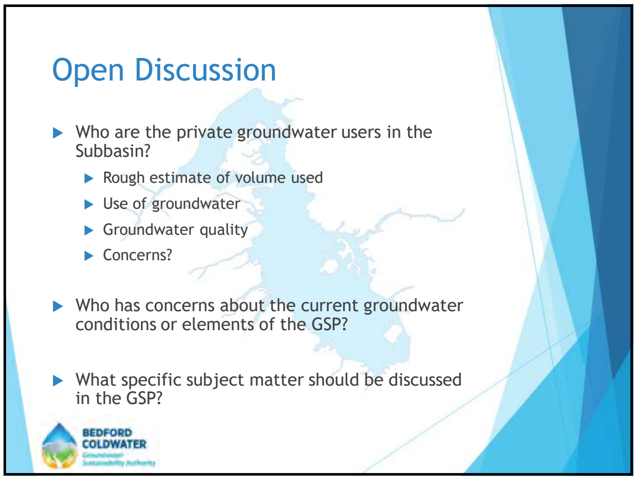
GSP Development Timeline

July 2019
- Begin Draft GSP development

July 2020
- Draft GSP available for public review

December 2020
- Final Draft GSP submitted to DWR

BEDFORD COLDWATER Groundwater Sustainability Authority



Open Discussion

- Who are the private groundwater users in the Subbasin?
  - Rough estimate of volume used
  - Use of groundwater
  - Groundwater quality
  - Concerns?
- Who has concerns about the current groundwater conditions or elements of the GSP?
- What specific subject matter should be discussed in the GSP?

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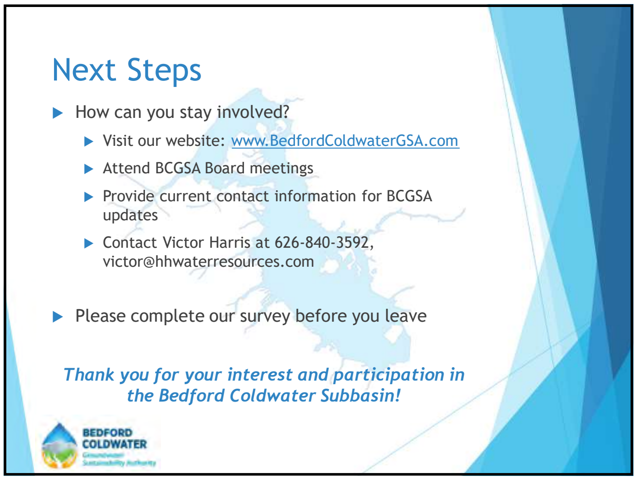
Groundwater Sustainability Authority



Next Steps

- How can you stay involved?
  - Visit our website: www.BedfordColdwaterGSA.com
  - Attend BCGSA Board meetings
  - Provide current contact information for BCGSA updates
  - Contact Victor Harris at 626-840-3592, victor@hhwaterresources.com
- Please complete our survey before you leave

Thank you for your interest and participation in the Bedford Coldwater Subbasin!

BEDFORD COLDWATER
Groundwater Sustainability Authority

BEDFORD COLDWATER
Groundwater Sustainability Authority

BCGSA Stakeholder Survey

Meeting Date: November 7, 2019

Organization or Business Name: Chandler's Sand & Gravel

Stakeholder Name: Jim St. Martin

Email: JSTMARTIN@CHANDLERSCORP.COM **Phone:** 949.933.3905

Question:	**Response:**
1. Are you familiar with SGMA regulations?	No
2. Are you currently engaged in activity or discussions regarding groundwater management in this region?	No
3. Do you own or manage/operate land in this region?	Yes
4. Do you manage water resources? If yes, what is your role?	Management
5. What is your primary interest in land or water resources management?	Still Learning
6. Do you have concerns about groundwater management? If yes, what are they?	
7. Do you have recommendations regarding groundwater management? If yes, what are they?	
8. Private groundwater users: Primary use? Rough estimate of volume used? General groundwater quality?	
9. Who else would you recommend we contact who may have interest in water resources in the Bedford Coldwater Sub-basin?	
10. Please note any other comments or concerns regarding development of the Groundwater Sustainability Plan for the Bedford Coldwater Sub-basin.	

How helpful was this meeting in understanding SGMA and water resources in the Bedford Coldwater Sub-basin?

Please circle response: 1 Not helpful 2 3 Neutral [✓ 4] 5 Very helpful

Please provide suggestions for improvement of stakeholder outreach:

BEDFORD COLDWATER
Groundwater Sustainability Authority

BCGSA Stakeholder Survey

Meeting Date: November 7, 2019

Organization or Business Name: Chandley's Sand & Gravel

Stakeholder Name: Trevor Wood

Email: Twood@ChandlersCorp.com **Phone:** 36 308-8312

Question:	Response:
1. Are you familiar with SGMA regulations?	yes
2. Are you currently engaged in activity or discussions regarding groundwater management in this region?	Yes
3. Do you own or manage/operate land in this region?	Yes
4. Do you manage water resources? If yes, what is your role?	Yes - Plant Manager Maitri Road Recycling
5. What is your primary interest in land or water resources management?	effects on business
6. Do you have concerns about groundwater management? If yes, what are they?	↑
7. Do you have recommendations regarding groundwater management? If yes, what are they?	—
8. Private groundwater users: Primary use? Rough estimate of volume used? General groundwater quality?	
9. Who else would you recommend we contact who may have interest in water resources in the Bedford Coldwater Sub-basin?	
10. Please note any other comments or concerns regarding development of the Groundwater Sustainability Plan for the Bedford Coldwater Sub-basin.	

How helpful was this meeting in understanding SGMA and water resources in the Bedford Coldwater Sub-basin?

Please circle response: 1 Not helpful, 2, 3 Neutral, [✓ 4], 5 Very helpful

Please provide suggestions for improvement of stakeholder outreach:

still learning

PROP 1
WATER BOND 2014

BEDFORD COLDWATER
Groundwater Sustainability Authority

BCGSA Stakeholder Survey

Meeting Date: November 7, 2019

Organization or Business Name: Santa Ana Watershed Project Authority

Stakeholder Name: Ian Achimore

Email: iachimore@ sawpa.org **Phone:**

Question:	**Response:**
1. Are you familiar with SGMA regulations?	yes
2. Are you currently engaged in activity or discussions regarding groundwater management in this region?	yes
3. Do you own or manage/operate land in this region?	no
4. Do you manage water resources? If yes, what is your role?	From a salt management perspective
5. What is your primary interest in land or water resources management?	water quality, TDS
6. Do you have concerns about groundwater management? If yes, what are they?	
7. Do you have recommendations regarding groundwater management? If yes, what are they?	
8. Private groundwater users: Primary use? Rough estimate of volume used? General groundwater quality?	
9. Who else would you recommend we contact who may have interest in water resources in the Bedford Coldwater Sub-basin?	
10. Please note any other comments or concerns regarding development of the Groundwater Sustainability Plan for the Bedford Coldwater Sub-basin.	

How helpful was this meeting in understanding SGMA and water resources in the Bedford Coldwater Sub-basin?

Please circle response: 1 Not helpful 2 3 Neutral 4 [✓ 5 Very helpful]

Please provide suggestions for improvement of stakeholder outreach:

PROP 1
GOVERNOR EDMUND G. BROWN JR.
WATER BOND 2014

BEDFORD COLDWATER
Groundwater Sustainability Authority

Board Members:
Paul Rodriguez, TVWD
Jacque Casillas, City of Corona
Phil Williams, EVMWD

MEETING SUMMARY
Public Meeting to Review the Bedford Coldwater Basin Draft Groundwater Sustainability Plan (GSP)

Bedford Coldwater Groundwater Sustainability Authority
6:00 PM, July 15, 2021
Online Zoom Meeting

Attendees
Rachel Gray, Eastern Municipal Water District
Kristian Alfelor, City of Corona Department of Water and Power
Sonny Gowan, ECS/Glen Ivy
Jim St. Martin, Chandler's Sand and Gravel
Mike Weil, California Department of Water Resources
Brent Miles, Glen Ivy Hot Springs
Phil Williams, Elsinore Valley Municipal Water District
Margie Armstrong, Elsinore Valley Municipal Water District
Ganesh Krishnamurthy, Elsinore Valley Municipal Water District
Parag Kalaria, Elsinore Valley Municipal Water District
Paul Rodriguez, Temescal Valley Water District
Melissa Estrada-Maravilla, City of Corona
Jesus Gastelum, Elsinore Valley Municipal Water District
Sodavy Ou, West Yost Associates
Jerry Sincich, Temescal Valley Municipal Advisory Council (MAC)
Craig Deleo, Temescal Driving Range
Eric Werner, Werner Corporation
Tom Moody, City of Corona
Jeff Pape, Temescal Valley Water District
Chad Taylor, Todd Groundwater
Maureen Reilly, Todd Groundwater
Terese Quintanar, Elsinore Valley Municipal Water District
Victor Harris, H & H Water Resources
Kelly Shugart, Stantec

Agenda
1. Groundwater Sustainability Plan (GSP) Background
2. Introduction to the Bedford Coldwater Basin
3. SGMA Requirements
4. Recommended Actions and Projects
5. Schedule and Timeline
6. Questions, Comments, and Open Discussion

The second Stakeholders Meeting of the Bedford-Coldwater Groundwater Sustainability Authority was held via teleconference. Participants joined by accessing Zoom web meeting. The meeting began at 6:00 p.m. and was recorded.

Mr. Victor Harris made introductions of those attending and explained methods for participants to indicate the desire to speak or ask questions. Mr. Harris explained that the purpose of the meeting was to present a summary of the recently completed Bedford Coldwater Groundwater Sustainability Plan (GSP), and invite questions or comments from basin stakeholders. He presented and explained a PowerPoint presentation and welcomed questions and comments at the completion of the presentation. The PowerPoint is attached to this summary for reference.

After the PowerPoint presentation, the following questions were posed by stakeholders:

Stakeholder Question: Are there any new regulations that would prohibit private well owners from replacing or installing new wells?

> **Response:** The BCGSA and GSP has not introduced new regulations regarding well installations and will adopt the Riverside County well guidance. Well regulations can be found on the Riverside County website.

Stakeholder Question: Are you willing to discuss the GSP with local citizens groups in the Temescal Valley?

> **Response:** Yes.

Because of the relatively few questions or concerns voiced by attendees, Mr. Harris invited additional comments or questions during the public review period (ending September 6, 2021) via email or telephone contact (contact information was provided in the presentation). He also requested responses to a questionnaire distributed immediately after the meeting via email to invitees.

The meeting ended at approximately 7:00 pm.

BEDFORD COLDWATER
Groundwater Sustainability Authority

Bedford Coldwater Subbasin Groundwater Sustainability Plan

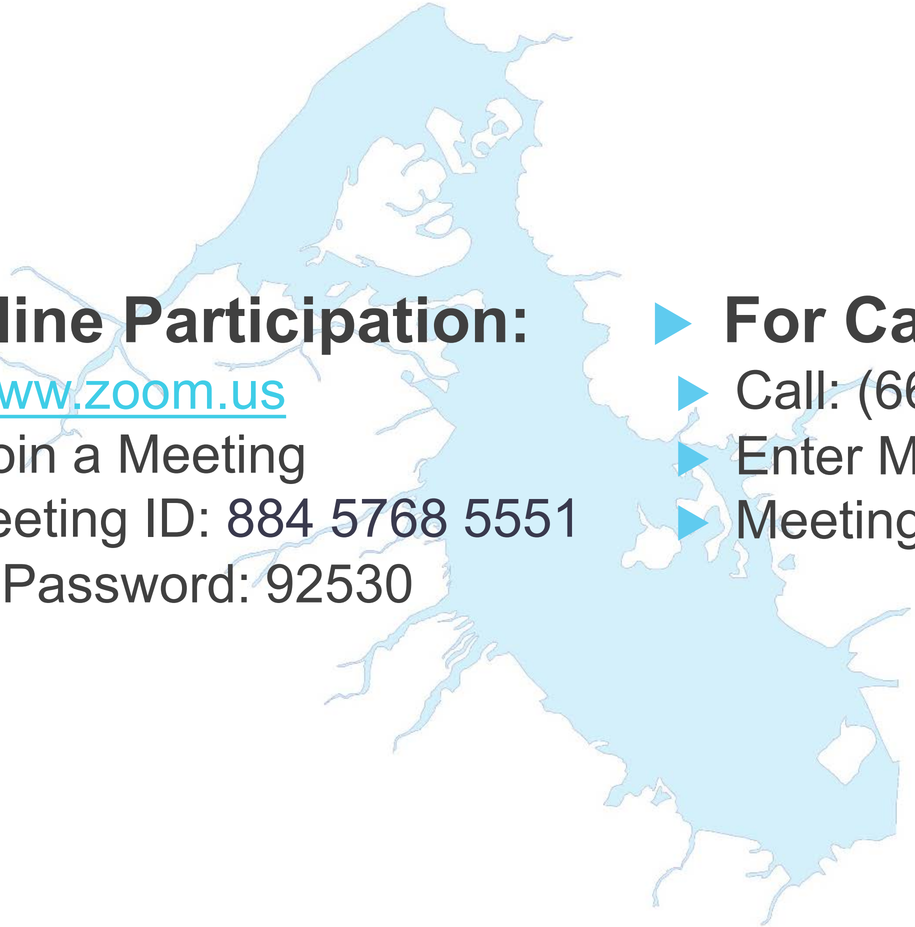
Public Meeting – Thursday, July 15, 2021

Presenter: Victor Harris, PG, CEG, CHG
BCGSA Administrator

PROP 1
GOVERNOR EDMUND G. BROWN, JR.
WATER BOND 2014
RELIABILITY | RESTORATION | RESILIENCE

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

Meeting Information



- **For Online Participation:**
  - Go to: www.zoom.us
  - Select Join a Meeting
  - Enter Meeting ID: 884 5768 5551
  - Meeting Password: 92530

- **For Call-in Only:**
  - Call: (669) 900-9128
  - Enter Meeting ID: 884 5768 5551
  - Meeting Password: 92530

BEDFORD COLDWATER
Groundwater Sustainability Authority

Agenda

1. Groundwater Sustainability Plan (GSP) Background
2. Introduction to the Bedford Coldwater Basin
3. SGMA Requirements
4. Recommended Actions and Projects
5. Schedule and Timeline
6. Questions, Comments, and Open Discussion

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Sustainability Authority

Acknowledgements

- Bedford-Coldwater Groundwater Sustainability Authority (BCGSA) Board and Staff
- California Department of Water Resources (DWR) Funding


Jacque Casillas, Director


Paul Rodriguez, Chairman


Phil Williams, Vice-Chairman

First Stakeholder Meeting Questions and Input

- November 7, 2019, Temescal Valley Water District
  - Introduction to Sustainable Groundwater Management Act (SGMA), BGSA, and GSP development

Issues Discussed:

- Protection of water quality
- Future projects
- New regulations
- Fees
- How to stay engaged

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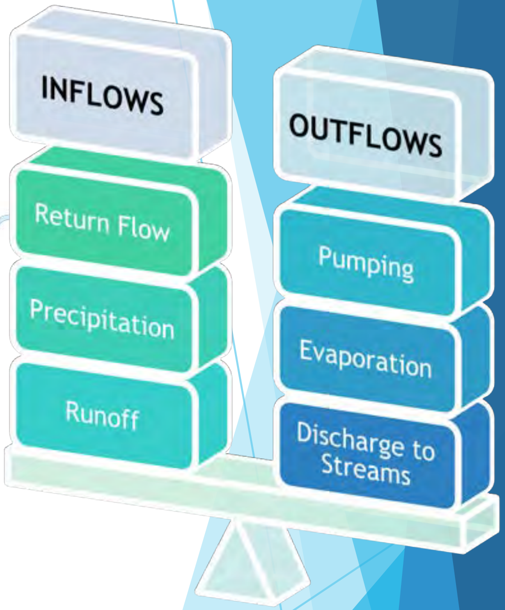
Sustainability Authority

SGMA Background

- Sustainable Groundwater Management Act (SGMA) was passed by the California legislature in 2014
  - Stop overdraft and achieve sustainable yield
- Requires the formation of Groundwater Sustainability Agencies (GSAs) overlying the groundwater basin
- GSAs are responsible for preparing Groundwater Sustainability Plans (GSPs)



> *"...groundwater management in California is best accomplished locally."*
>
> – Governor Jerry Brown, September 2014

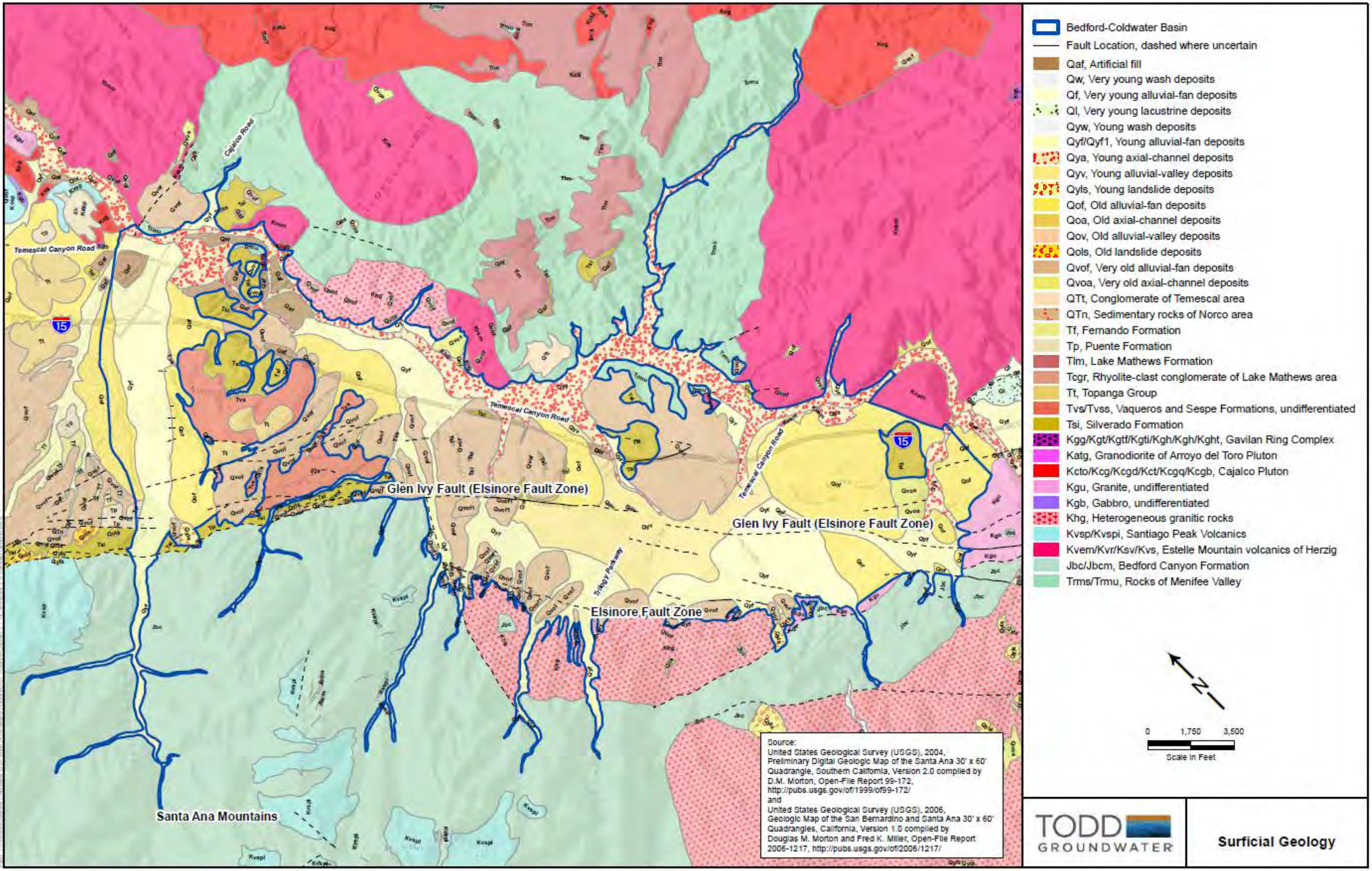
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Bedford-Coldwater Subbasin

- Coldwater Management Area
- Bedford Management Area

BEDFORD COLDWATER
Groundwater Sustainability Authority

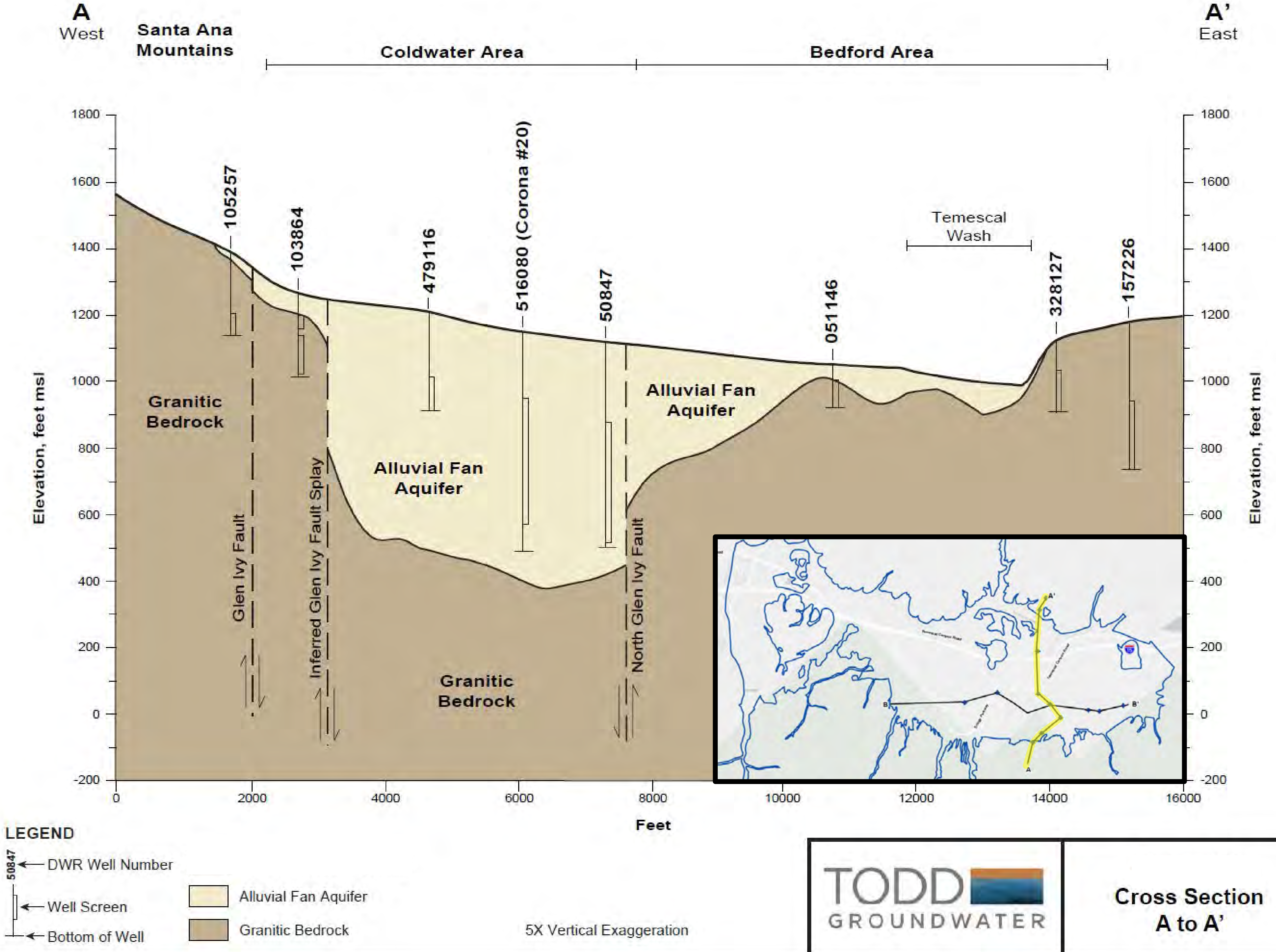
Geology of the Basin



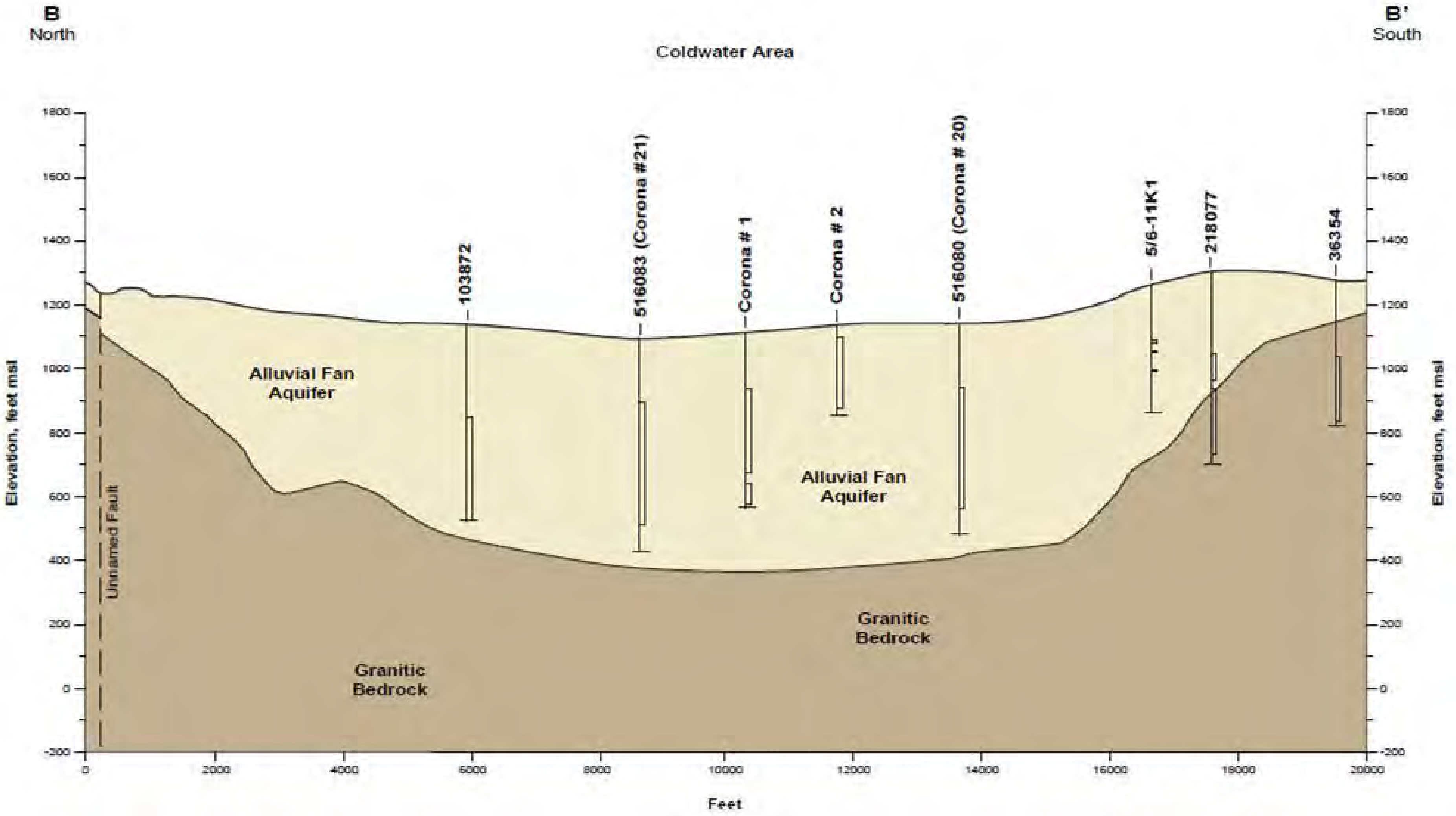
Source:
United States Geological Survey (USGS), 2004, Preliminary Digital Geologic Map of the Santa Ana 30' x 60' Quadrangle, Southern California, Version 2.0 compiled by D.M. Morton, Open-File Report 99-172, http://pubs.usgs.gov/of/1999/of99-172/
and
United States Geological Survey (USGS), 2006, Geologic Map of the San Bernardino and Santa Ana 30' x 60' Quadrangles, California, Version 1.0 compiled by Douglas M. Morton and Fred K. Miller, Open-File Report 2006-1217, http://pubs.usgs.gov/of/2006/1217/

TODD GROUNDWATER

Surficial Geology



Cross Section A to A'



LEGEND

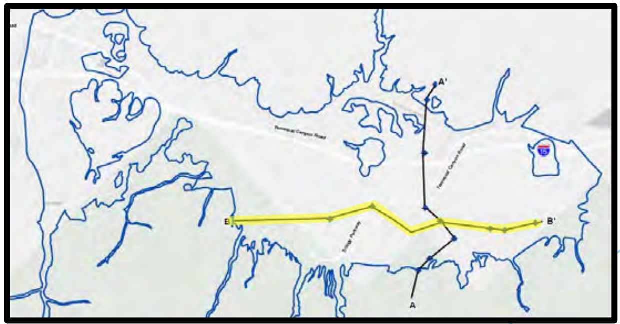
36354 ← DWR Well Number

← Well Screen

← Bottom of Well

▭ Alluvial Fan Aquifer

▨ Granitic Bedrock

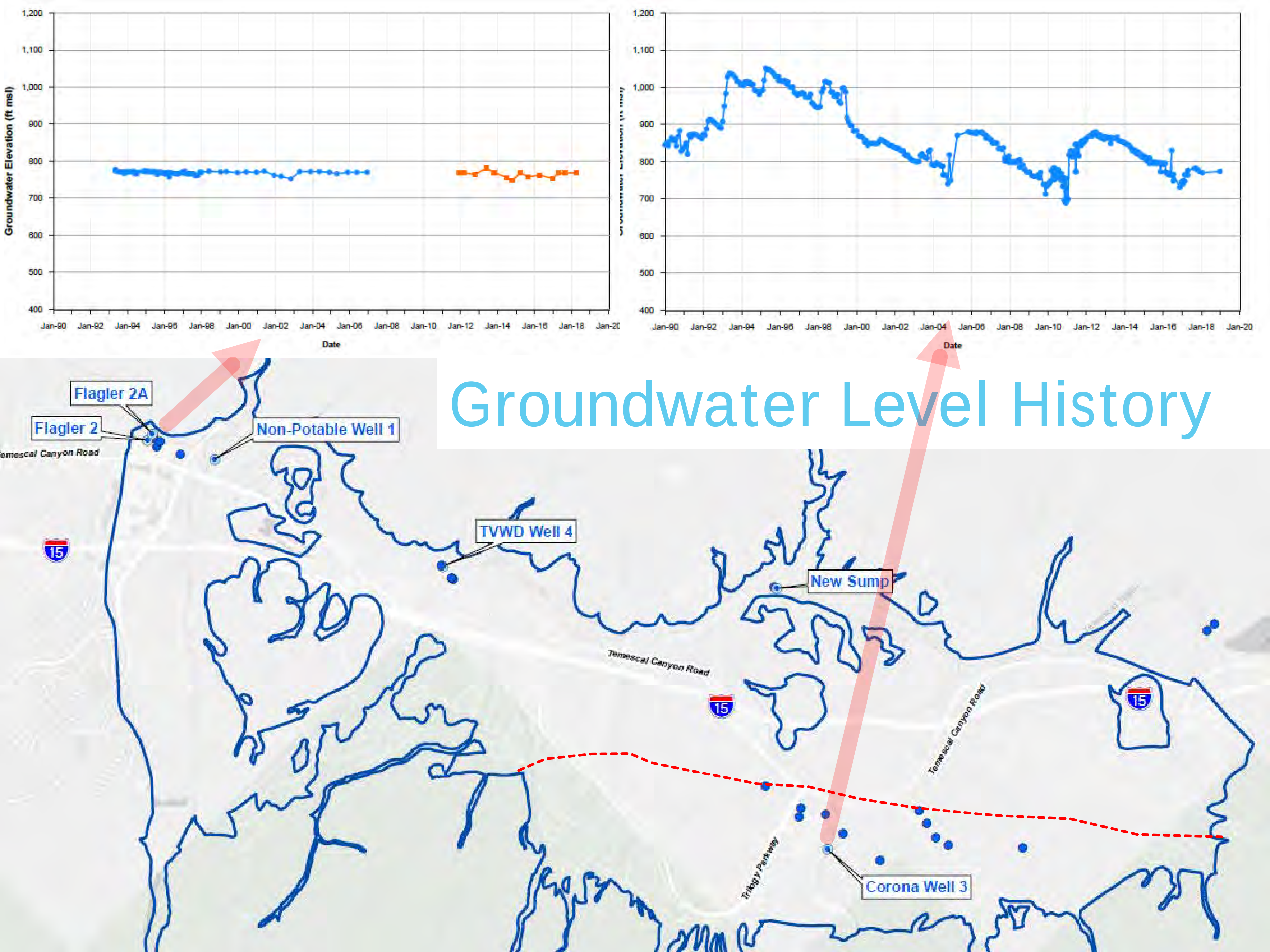


February 2020

TODD GROUNDWATER

Cross Section B to B'

Groundwater Level History



SGMA Terminology

- **Sustainability Criteria** = Quantitative ways the GSA can define, measure, and track sustainable management
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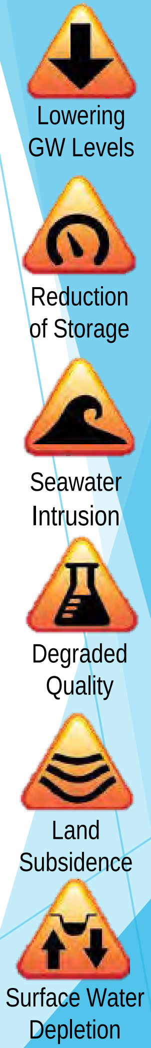
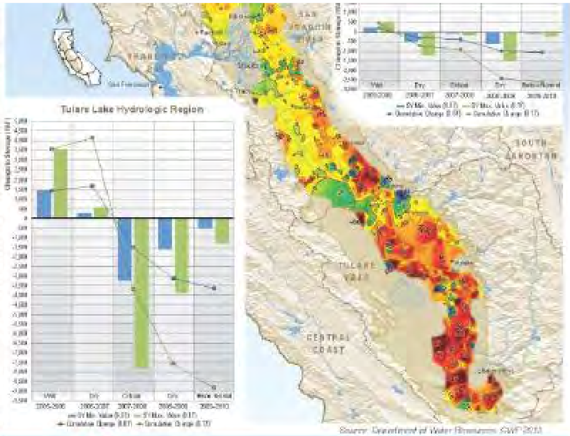
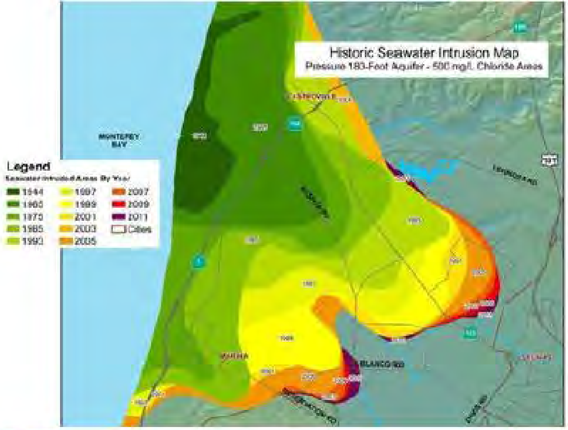


BEDFORD COLDWATER
Groundwater Sustainability Authority

Six Undesirable Results

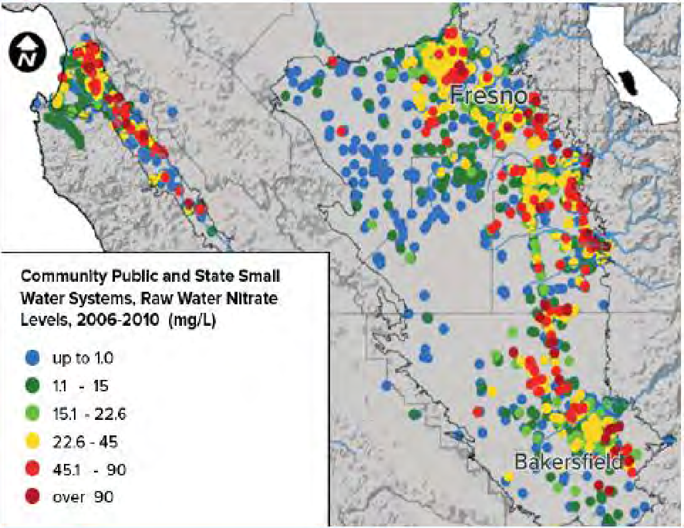




Lowering of GW Levels

Reduction of GW Storage

Seawater Intrusion



Water Quality Degradation

Land Subsidence

Depletion of Interconnected Streams

Joseph, Trevor, April 2018. DWR's Sustainable Groundwater Management Program Assistance Webinar. GSP Development presentation slides.

Consequences of Undesirable Results

- Increased pumping costs
- Entrained air in discharge/accelerated corrosion
- Loss of production
- Loss of groundwater-dependent habitat
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- Loss of groundwater in storage
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Sustainability Authority

Sustainability Goal for the Bedford-Coldwater Basin

- Provide a long-term, reliable and efficient groundwater supply for municipal, industrial, and other uses;
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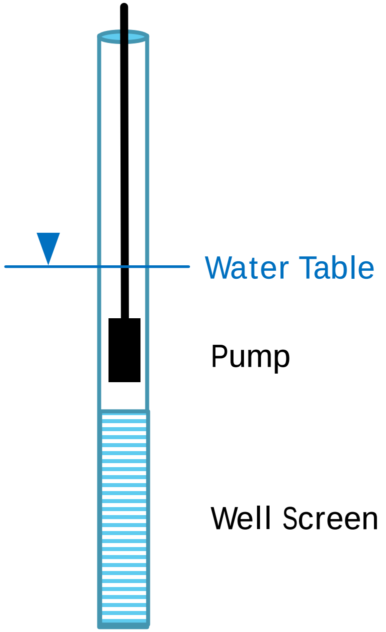
Groundwater
Sustainability Authority

Minimum Thresholds for Sustainability



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Monitoring Network


Flaggler 2A


New Sump


Corona 3

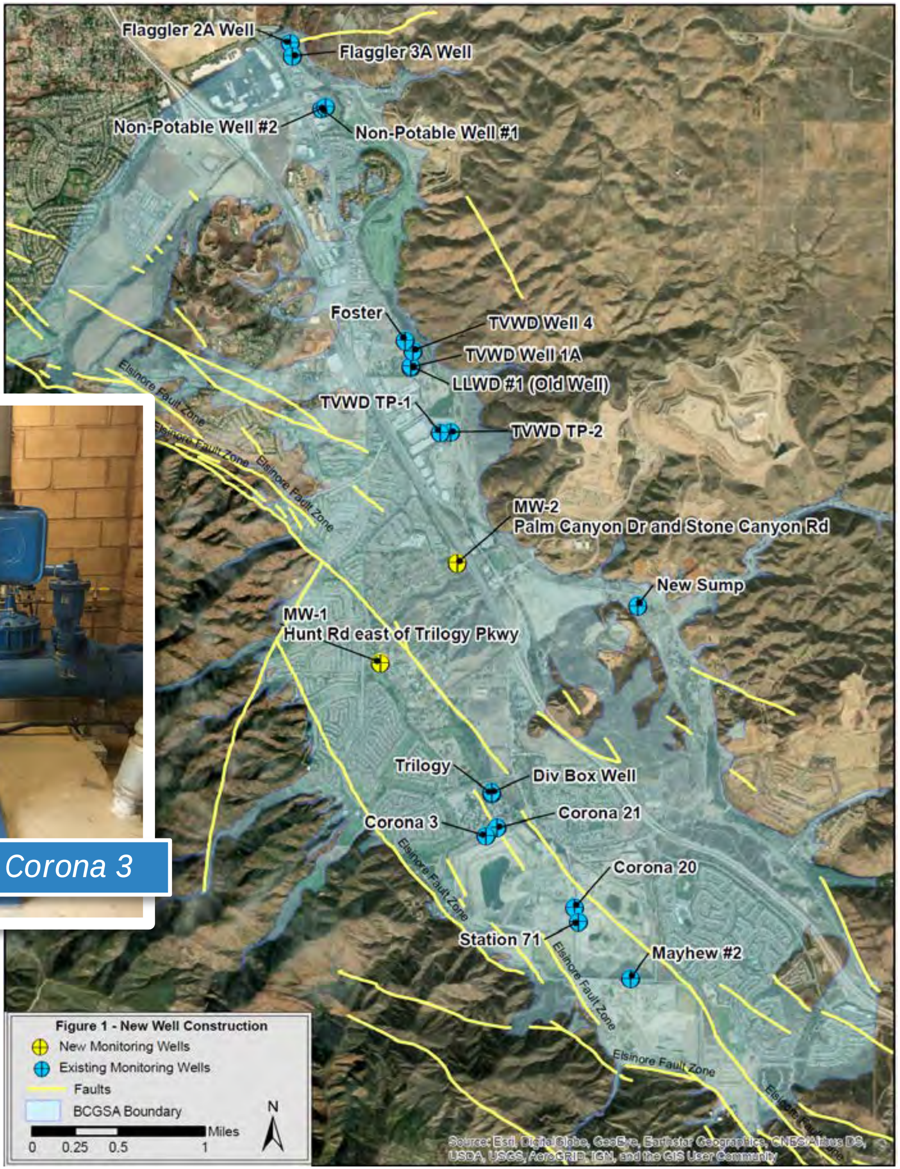

Figure 1 - New Well Construction

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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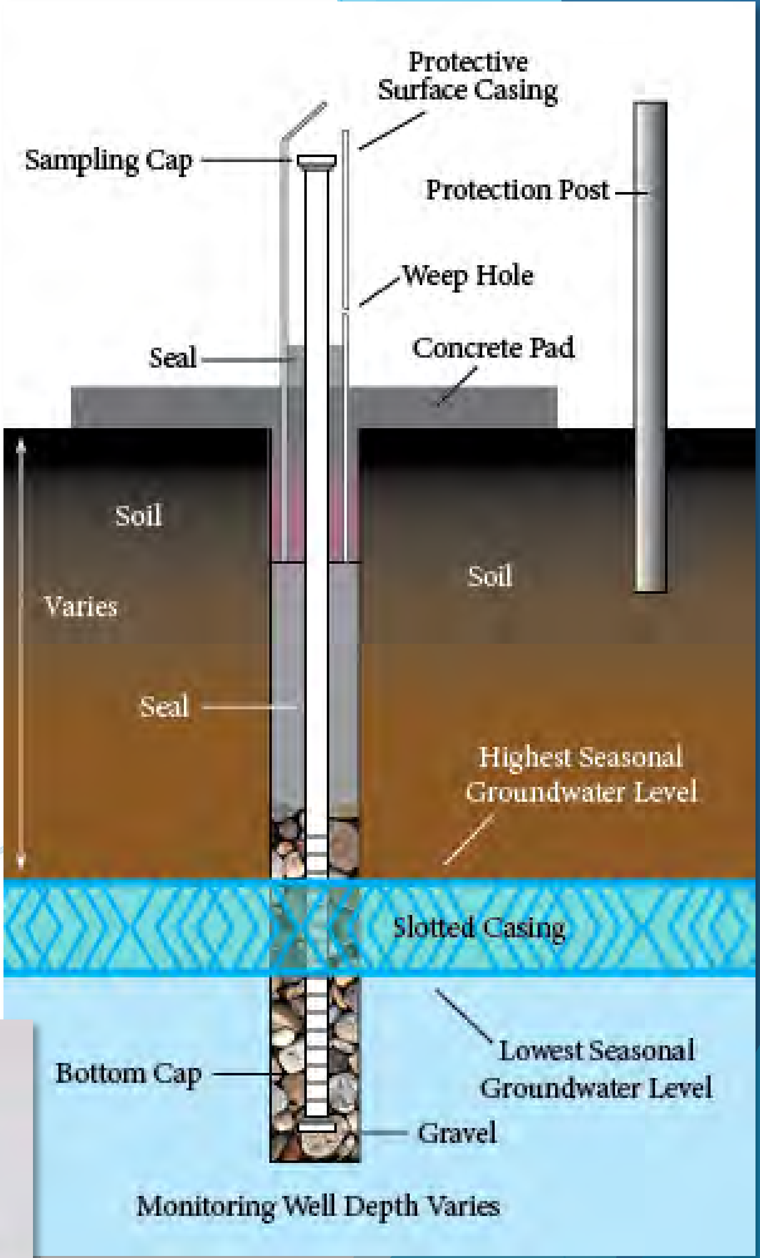
Groundwater Sustainability Authority

Monitoring Well Construction and Transducer Installation



BEDFORD COLDWATER
Groundwater Sustainability Authority

Management Action 1

- Provide for Collection, Compilation, and Storage of Information Required for Annual Reports and Submit Annual Reports

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- ✓ Change in Groundwater in Storage
- ✓ Progress in Plan Implementation

BEDFORD COLDWATER
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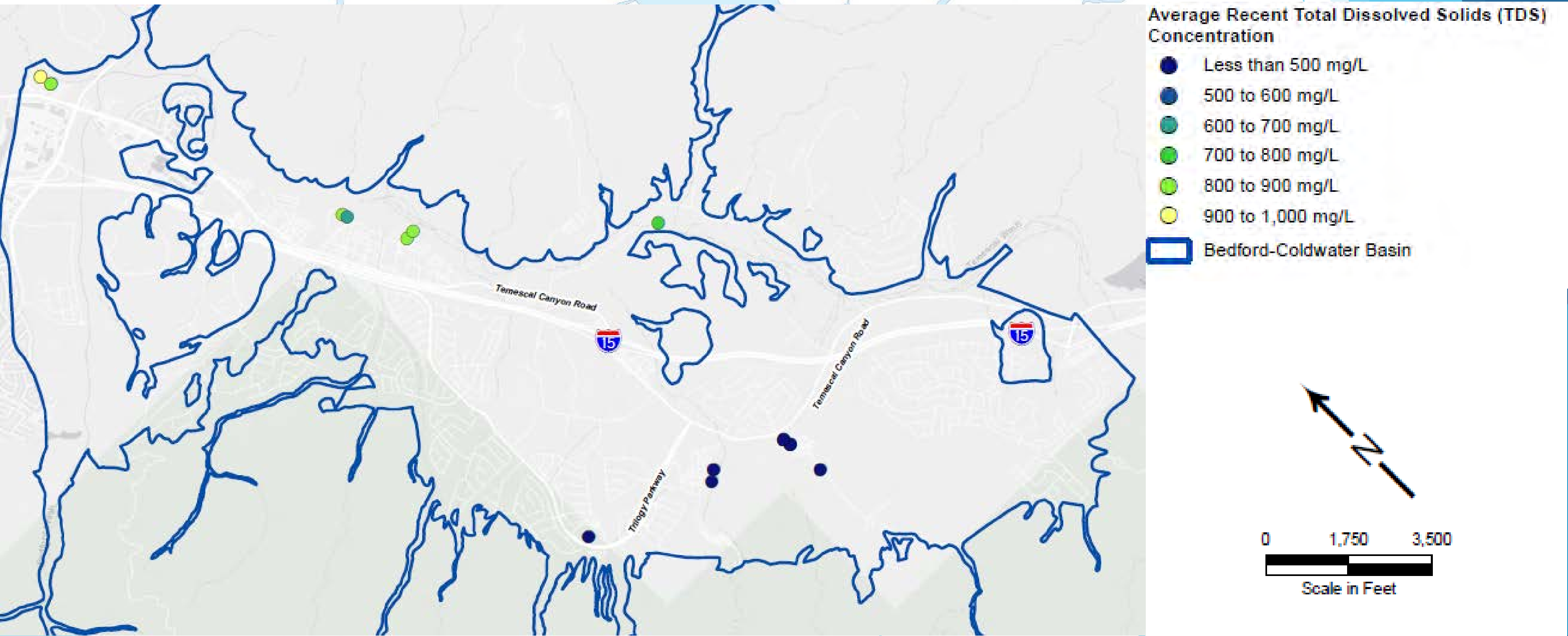
Management Action 2

- Routinely Record Groundwater Levels and Take Action if Necessary

BEDFORD COLDWATER
Groundwater Sustainability Authority

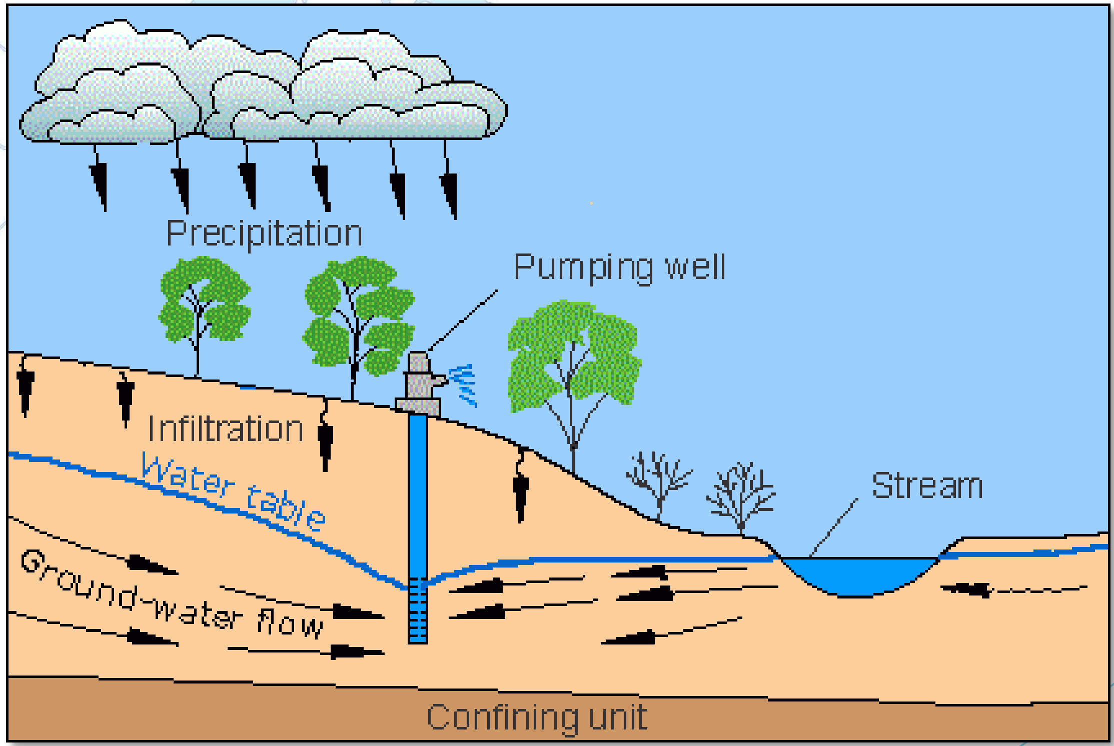
Management Action 3

- Monitor Selected Groundwater Quality Constituents and Coordinate with the Regional Water Quality Control Board



Management Action 4

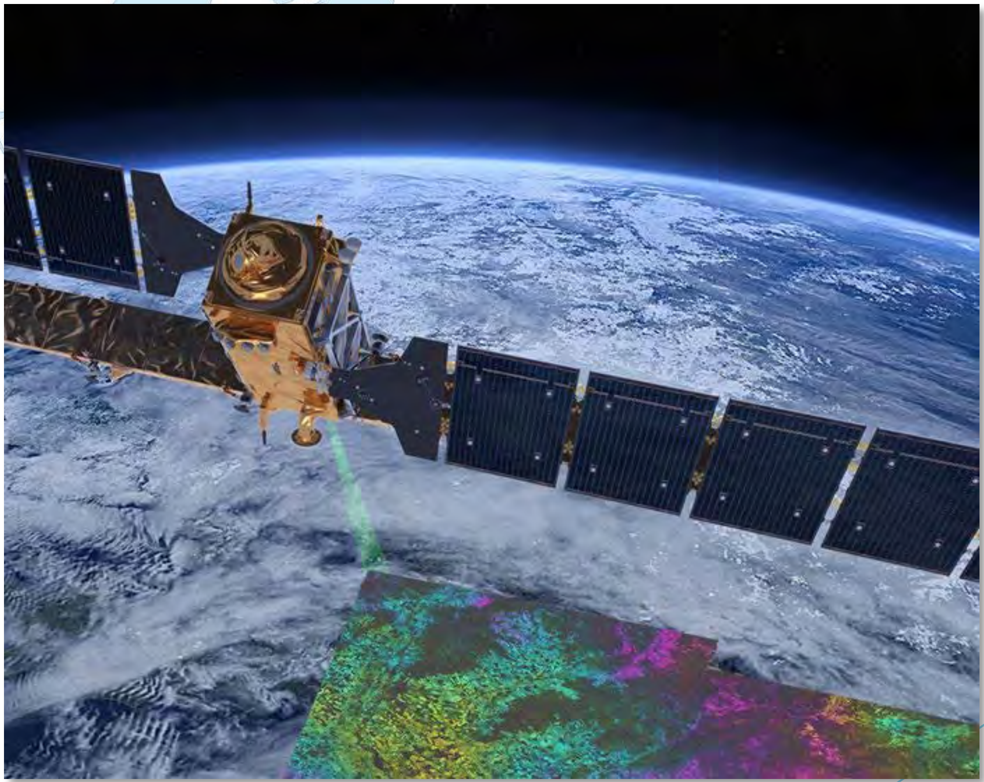
- Track Trends in Groundwater Levels Near Temescal Wash and Take Action as Necessary



BEDFORD COLDWATER
Groundwater Sustainability Authority

Management Action 5

- Review InSAR* Data on the DWR Dataviewer During 5-Year Updates



* Interferometric Synthetic Aperture Radar

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Groundwater Sustainability Authority

Project 1

- Investigate Groundwater / Surface Water Interaction at Temescal Wash

BEDFORD COLDWATER
Groundwater Sustainability Authority

Project 2

- Initiate a Survey of Active Private Wells

BEDFORD COLDWATER
Groundwater Sustainability Authority

Project 3

- Evaluation of Interaction of Aggregate Pits and Groundwater Flow

BEDFORD COLDWATER
Groundwater
Sustainability Authority

Benefits of the GSP

- Ensures long-term sustainability of the Basin
- Evaluates and prepares for climate change
- Protects groundwater-dependent ecosystems
- Protects all groundwater users in the Basin
- Provides for transparent and open Basin management
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BEDFORD COLDWATER
Groundwater
Sustainability Authority

GSP Implementation Schedule

	2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Select GSP Administrator	✓																			
Action 1 – Provide for Collection, Compilation, and Storage of Information Required For Annual Reports and Submit Annual Reports	✓				✓				✓				✓				✓			
Action 2 – Routinely Record Groundwater Levels and Take Action if Necessary	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
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Project 1 – Investigate Groundwater/Surface Water Interaction at Temescal Wash		→	→	→	→	→	→													
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Project 3 – Evaluation of the Effects of Aggregate Pits on Groundwater Flow and Quality				→	→	→	→	→	→	→										
Prepare 5-Year Evaluation																				✓

BEDFORD COLDWATER
Groundwater Sustainability Authority

Survey

Please submit your survey to victor@hhwaterresources.com

Meeting Date: July 15, 2021

Organization or Business Name: ____

Stakeholder Name: ____

Email:____ **Phone:** ____

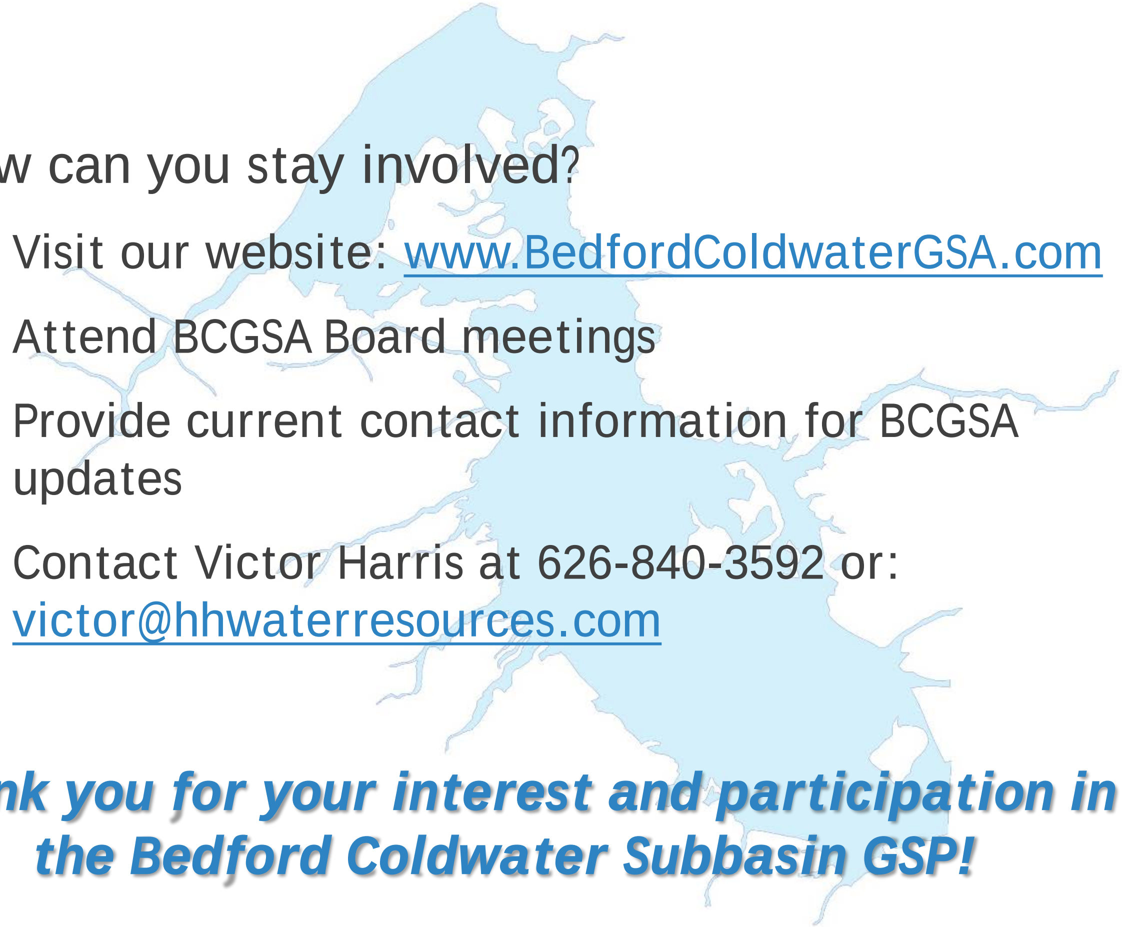
Question:	**Response:**
1. Has this presentation increased your knowledge about the Groundwater Sustainability Plan (GSP)?	
2. Do you own or operate a water well in the vicinity of the basin? Do you plan to in the future?	
3. Is the timeline for GSP implementation clear?	
4. Do you have any concerns or suggestions about implementing the GSP in the Bedford-Coldwater Subbasin?	
5. Please note any other comments or questions regarding implementation of the GSP in the Bedford-Coldwater Subbasin or the GSP document itself. ***(Reminder: written comments are due on the Draft GSP by September 6, 2021. Please email this survey and any addtional comments to victor@hhwaterresources.com).***	

How helpful was this meeting in understanding development of the draft GSP for the Bedford-Coldwater Subbasin?

Please circle response:	**1** **Not helpful**	**2**	**3** **Neutral**	**4**	**5** **Very helpful**

Please provide suggestions for improvement of stakeholder outreach:

Open Discussion



- How can you stay involved?
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    - Attend BCGSA Board meetings
    - Provide current contact information for BCGSA updates
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BEDFORD COLDWATER
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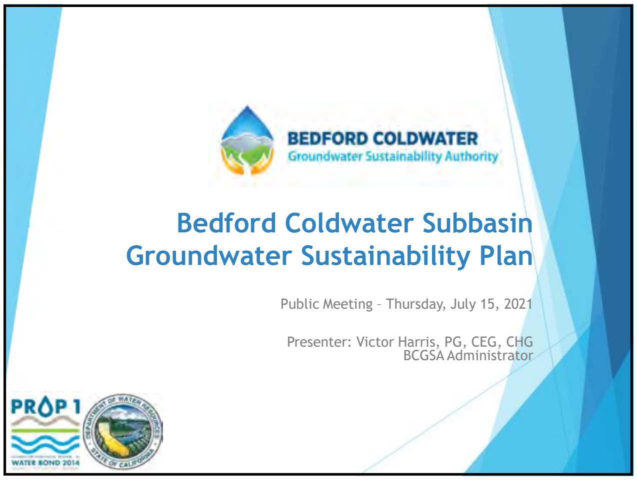


BEDFORD COLDWATER
Groundwater Sustainability Authority

Bedford Coldwater Subbasin Groundwater Sustainability Plan

Public Meeting – Thursday, July 15, 2021

Presenter: Victor Harris, PG, CEG, CHG
BCGSA Administrator

1

Agenda

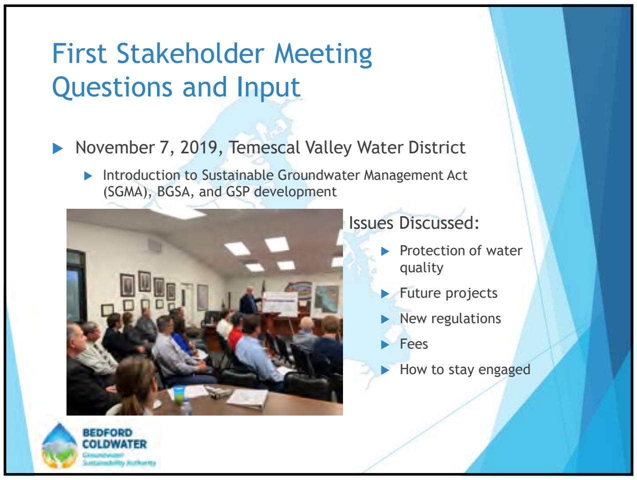
1. Groundwater Sustainability Plan (GSP) Background
2. Introduction to the Bedford Coldwater Basin
3. SGMA Requirements
4. Recommended Actions and Projects
5. Schedule and Timeline
6. Questions, Comments, and Open Discussion

2

Acknowledgements

- Bedford-Coldwater Groundwater Sustainability Authority (BCGSA) Board and Staff
- California Department of Water Resources (DWR) Funding

3



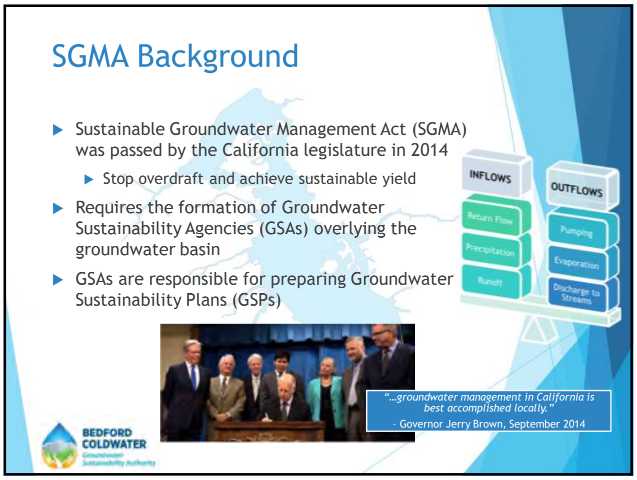
First Stakeholder Meeting Questions and Input

- November 7, 2019, Temescal Valley Water District
  - Introduction to Sustainable Groundwater Management Act (SGMA), BGSA, and GSP development

Issues Discussed:

- Protection of water quality
- Future projects
- New regulations
- Fees
- How to stay engaged

4

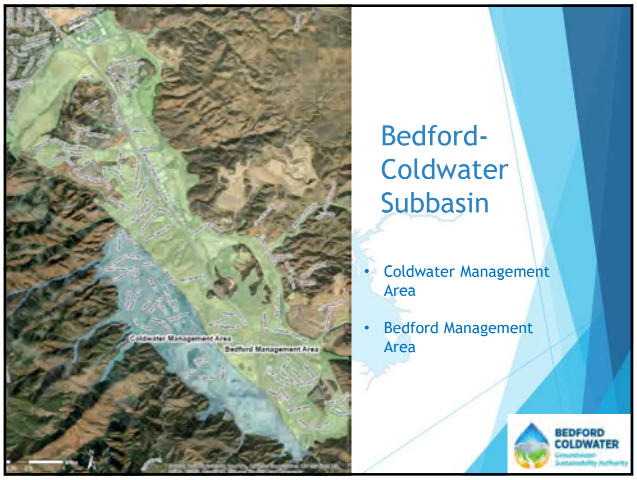


SGMA Background

- Sustainable Groundwater Management Act (SGMA) was passed by the California legislature in 2014
  - Stop overdraft and achieve sustainable yield
- Requires the formation of Groundwater Sustainability Agencies (GSAs) overlying the groundwater basin
- GSAs are responsible for preparing Groundwater Sustainability Plans (GSPs)

"…groundwater management in California is best accomplished locally."
- Governor Jerry Brown, September 2014

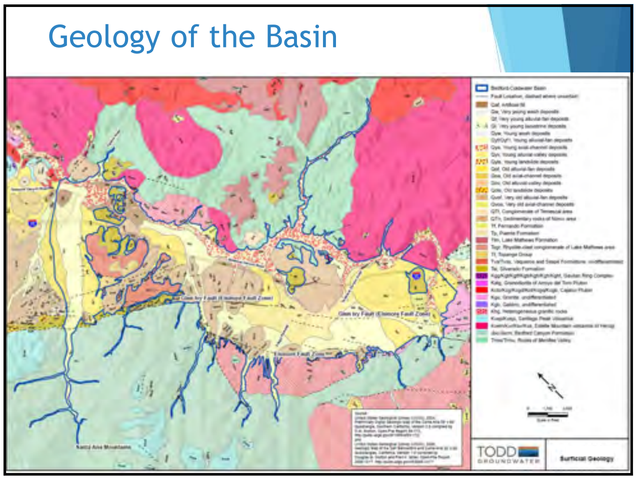
BEDFORD COLDWATER Groundwater Sustainability Authority



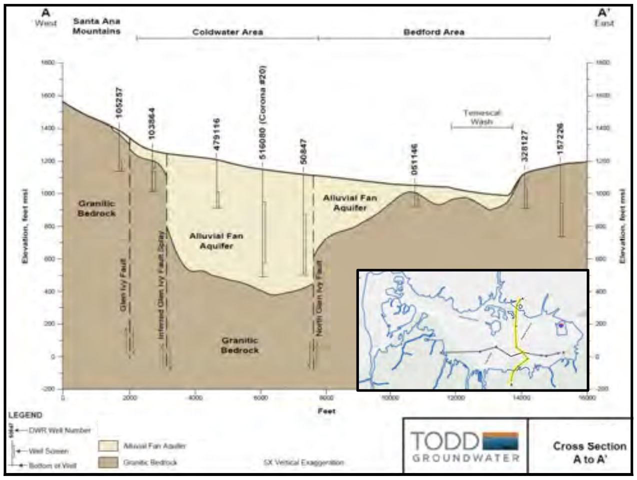
Bedford-Coldwater Subbasin

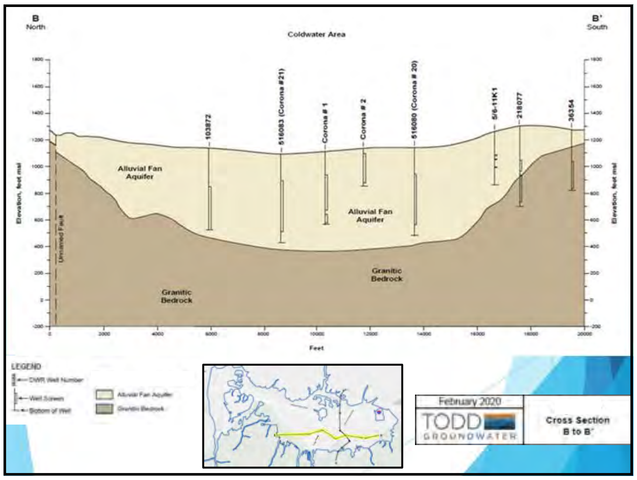
- Coldwater Management Area
- Bedford Management Area

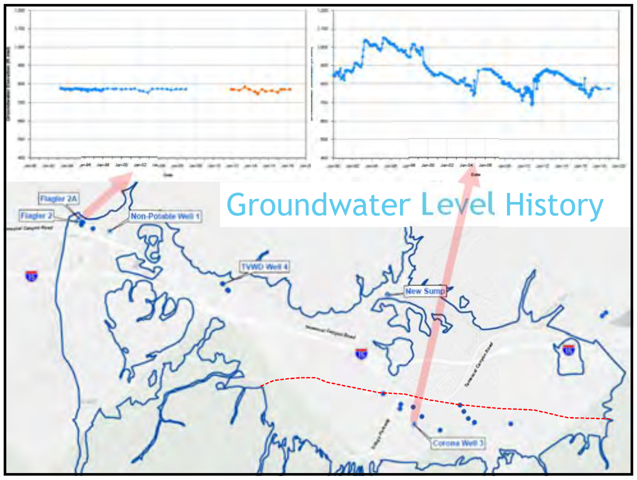
BEDFORD COLDWATER Groundwater Sustainability Authority



Geology of the Basin







Groundwater Level History

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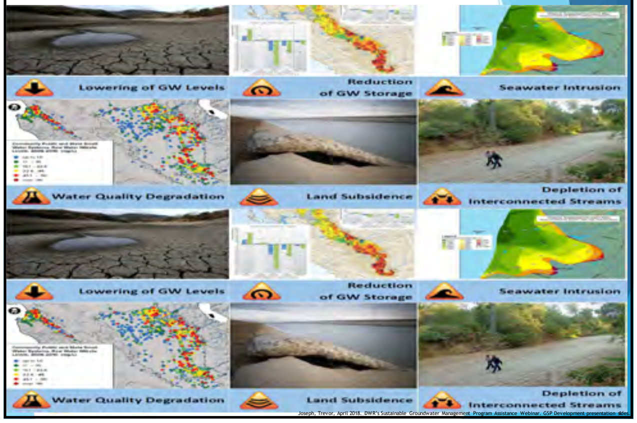
Lowering GW Levels
Reduction of Storage
Seawater Intrusion
Degraded Quality
Land Subsidence
Surface Water Depletion

BEDFORD COLDWATER
Groundwater Sustainability Authority

Six Undesirable Results



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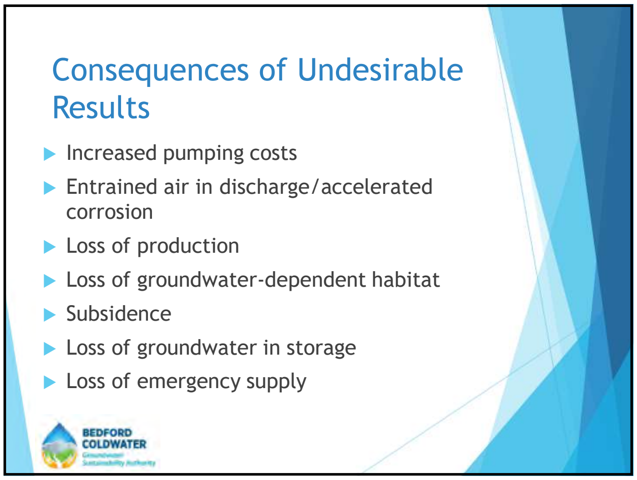

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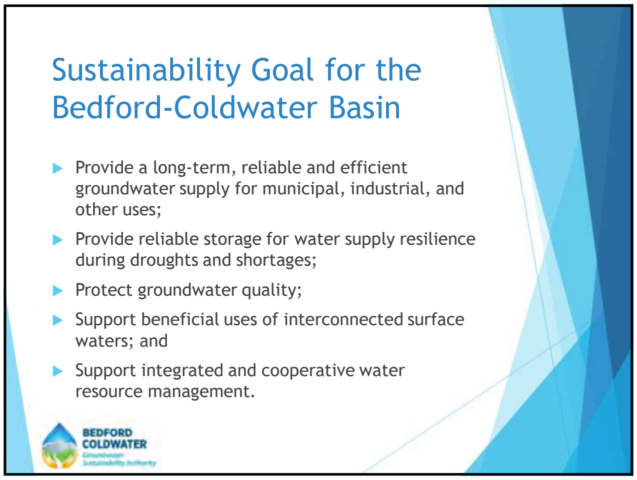

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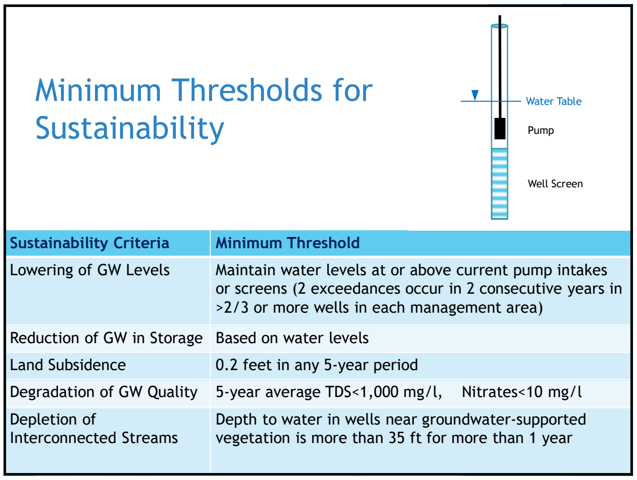

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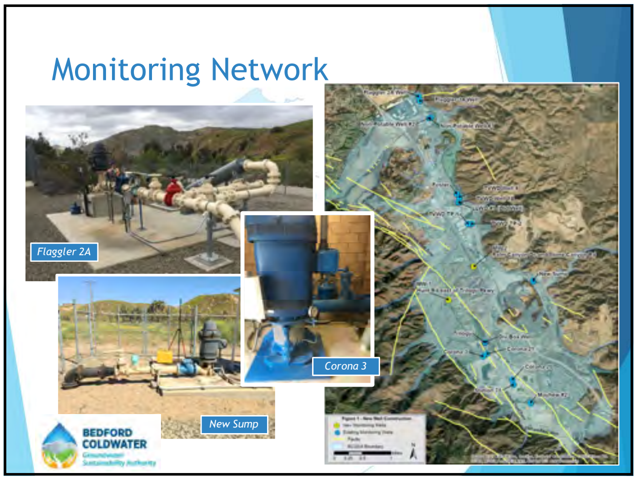
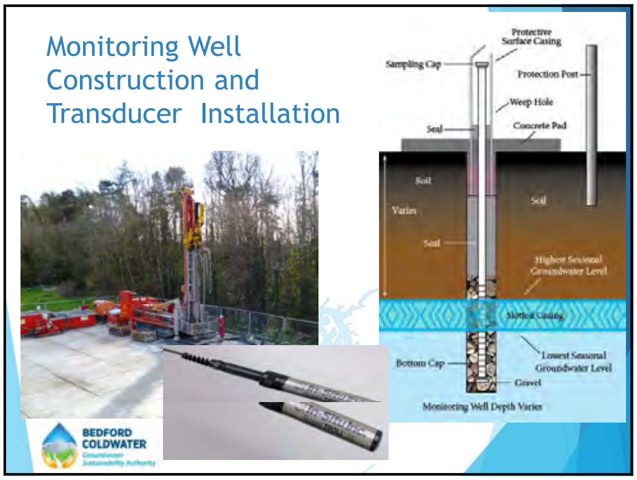
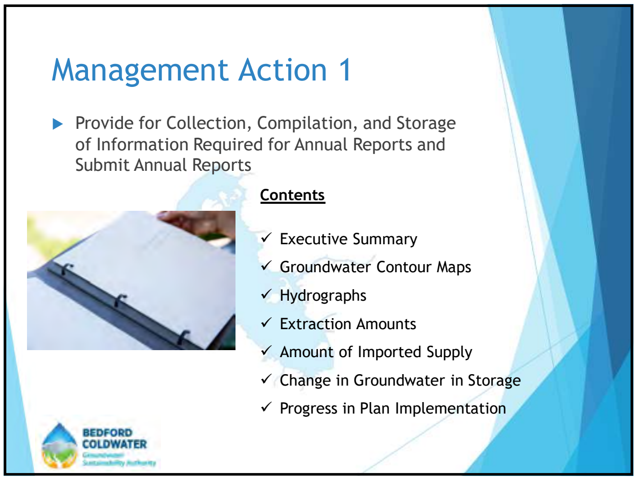


Monitoring Network



Monitoring Well Construction and Transducer Installation

17



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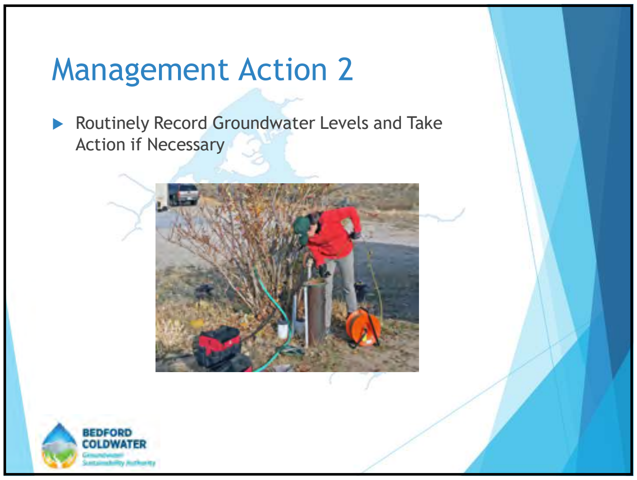
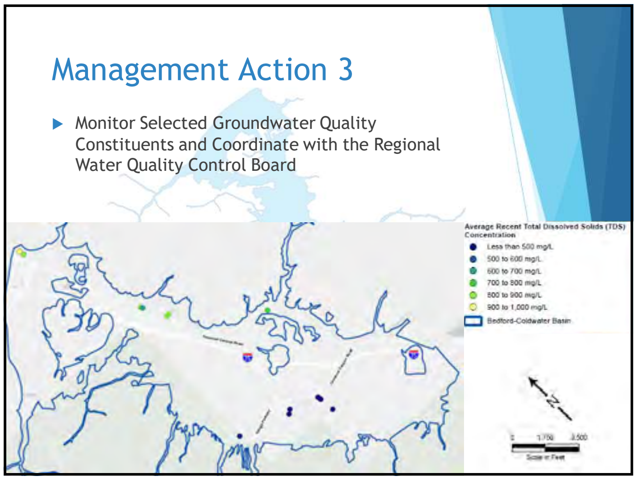


Management Action 2

- Routinely Record Groundwater Levels and Take Action if Necessary

19



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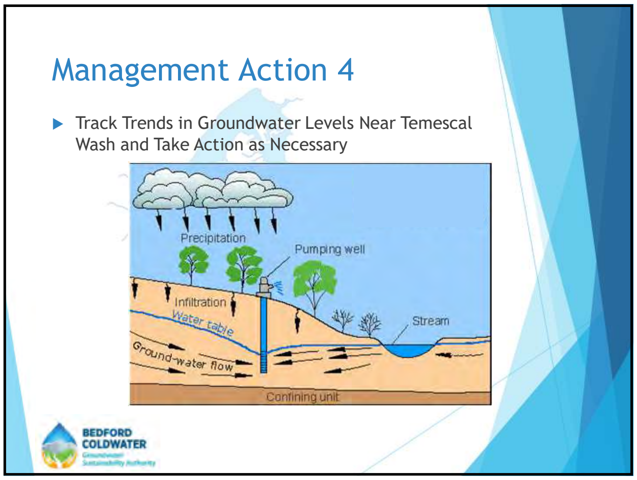
20



Management Action 4

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Management Action 5

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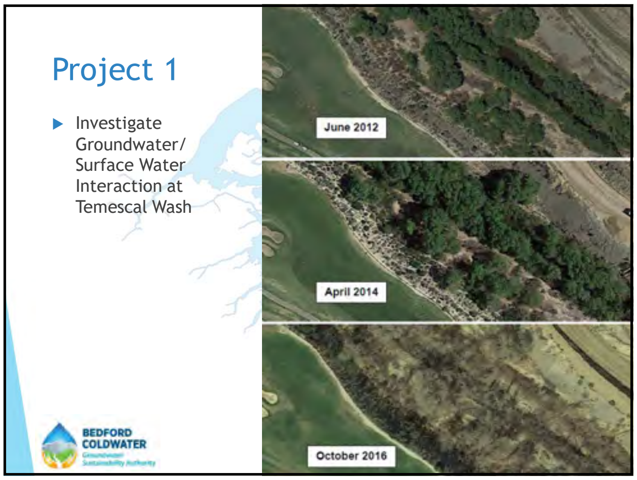
* Interferometric Synthetic Aperture Radar



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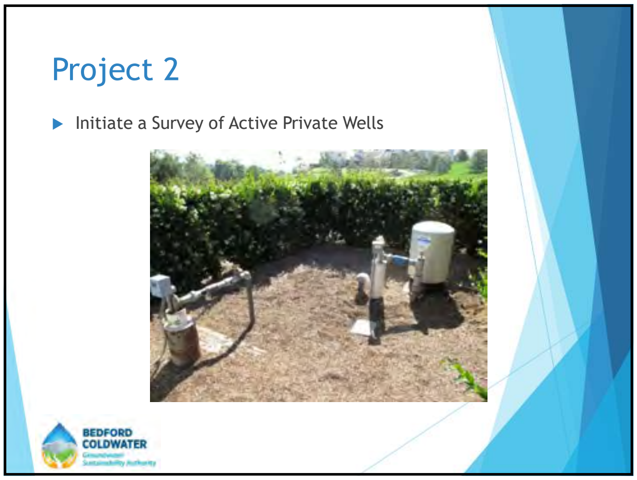

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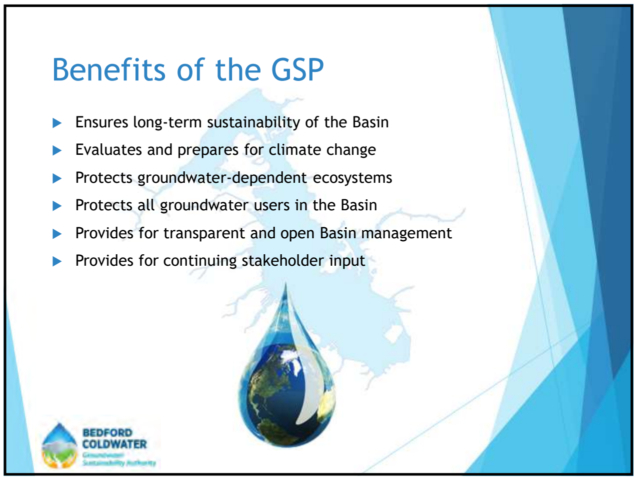

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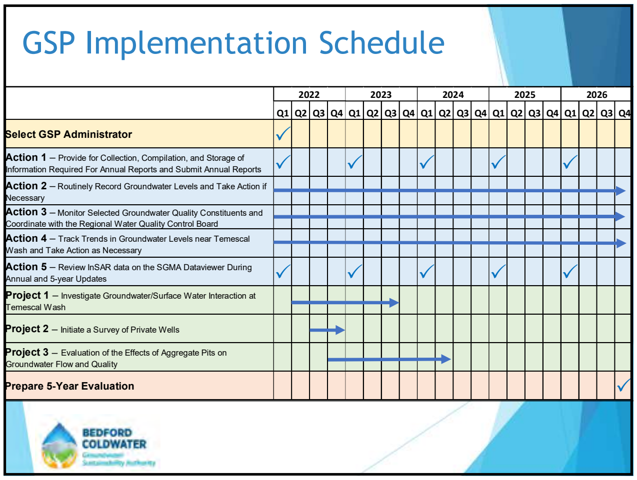

GSP Implementation Schedule

	2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Select GSP Administrator	✓																			
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Action 5 – Review InSAR data on the SGMA Dataviewer During Annual and 5-year Updates	✓				✓				✓				✓				✓			
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Project 2 – Initiate a Survey of Private Wells			→	→																
Project 3 – Evaluation of the Effects of Aggregate Pits on Groundwater Flow and Quality				→	→	→	→	→	→	→										
Prepare 5-Year Evaluation																				✓

Open Discussion

- How can you stay involved?
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BEDFORD COLDWATER
Groundwater Sustainability Authority

BCGSA Stakeholder Survey

Meeting Date: July 15, 2021

Organization or Business Name: ____

Stakeholder Name: ____

Email:____ **Phone:** ____

Question:	**Response:**
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How helpful was this meeting in understanding development of the draft GSP for the Bedford-Coldwater Subbasin?

Please circle response:	1	2	3	4	5
	Not helpful		Neutral		Very helpful

Please provide suggestions for improvement of stakeholder outreach:

PROP 1
GOVERNOR EDMUND G. BROWN, JR.
WATER BOND 2014

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

APPENDIX F

Draft GSP Comments and Responses

The Nature Conservancy
Audubon | CALIFORNIA
Local Government Commission
Leaders for Livable Communities
Union of Concerned Scientists
Science for a healthy planet and safer world
CLEAN WATER ACTION | CLEAN WATER FUND

September 6, 2021

Bedford Coldwater Groundwater Sustainability Authority
c/o Temescal Valley Water District
22646 Temescal Valley Road
Temescal Valley, CA 92883

Submitted via email: victor@hhwaterresources.com

Re: Public Comment Letter for the Bedford-Coldwater Basin Draft GSP

Dear Victor Harris,

On behalf of the above-listed organizations, we appreciate the opportunity to comment on the Draft Groundwater Sustainability Plan (GSP) for the Bedford-Coldwater Basin being prepared under the Sustainable Groundwater Management Act (SGMA). Our organizations are deeply engaged in and committed to the successful implementation of SGMA because we understand that groundwater is critical for the resilience of California's water portfolio, particularly in light of changing climate. Under the requirements of SGMA, Groundwater Sustainability Agencies (GSAs) must consider the interests of all beneficial uses and users of groundwater, such as domestic well owners, environmental users, surface water users, federal government, California Native American tribes and disadvantaged communities (Water Code 10723.2).

As stakeholder representatives for beneficial users of groundwater, our GSP review focuses on how well disadvantaged communities, tribes, climate change, and the environment were addressed in the GSP. While we appreciate that some basins have consulted us directly via focus groups, workshops, and working groups, we are providing public comment letters to all GSAs as a means to engage in the development of GSPs across the state. Recognizing that GSPs are complicated and resource intensive to develop, the intention of this letter is to provide constructive stakeholder feedback that can improve the GSP prior to submission to the State.

Based on our review, we have significant concerns regarding the treatment of key beneficial users in the Draft GSP and consider the GSP to be **insufficient** under SGMA. We highlight the following findings:

1. Beneficial uses and users **are not sufficiently** considered in GSP development.
    a. Human Right to Water considerations **are not sufficiently** incorporated.
    b. Public trust resources **are not sufficiently** considered.
    c. Impacts of Minimum Thresholds, Measurable Objectives and Undesirable Results on beneficial uses and users **are not sufficiently** analyzed.
2. Climate change **is not sufficiently** considered.
3. Data gaps **are not sufficiently** identified and the GSP **does not have a plan** to eliminate them.

4. Projects and Management Actions **do not sufficiently consider** potential impacts or benefits to beneficial uses and users.

Our specific comments related to the deficiencies of the Draft Bedford-Coldwater Basin GSP along with recommendations on how to reconcile them, are provided in detail in **Attachment A.**

Please refer to the enclosed list of attachments for additional technical recommendations:

Attachment A	GSP Specific Comments
Attachment B	SGMA Tools to address DAC, drinking water, and environmental beneficial uses and users
Attachment C	Freshwater species located in the basin
Attachment D	The Nature Conservancy's "Identifying GDEs under SGMA: Best Practices for using the NC Dataset"

Thank you for fully considering our comments as you finalize your GSP.

Best Regards,

Ngodoo Atume
Water Policy Analyst
Clean Water Action/Clean Water Fund

Samantha Arthur
Working Lands Program Director
Audubon California

E.J. Remson
Senior Project Director, California Water Program
The Nature Conservancy

J. Pablo Ortiz-Partida, Ph.D.
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Union of Concerned Scientists

Danielle V. Dolan

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Melissa M. Rohde

Melissa M. Rohde
Groundwater Scientist
The Nature Conservancy

Attachment A

Specific Comments on the Bedford-Coldwater Basin Draft Groundwater Sustainability Plan

1. Consideration of Beneficial Uses and Users in GSP development

Consideration of beneficial uses and users in GSP development is contingent upon adequate identification and engagement of the appropriate stakeholders. The (A) identification, (B) engagement, and (C) consideration of disadvantaged communities, drinking water users, tribes, groundwater dependent ecosystems, streams, wetlands, and freshwater species are essential for ensuring the GSP integrates existing state policies on the Human Right to Water and the Public Trust Doctrine.

A. Identification of Key Beneficial Uses and Users

Disadvantaged Communities, Drinking Water Users, and Tribes

The identification of Disadvantaged Communities (DACs), drinking water users, and tribes is **insufficient**, due to lack of clarity around tribal lands in the basin. The GSP states that there are no tribal lands in the basin, but includes four tribes in the list of stakeholders presented in Appendix D, Table 1.

The GSP indicates that there are no DACs in the basin (Section 2.1.2). The GSP includes a map of the density of domestic wells in the basin (Figure 2-4). The GSP should be further improved by including a map of individual domestic well locations and by indicating the population dependent on groundwater for their source of drinking water.

The missing elements regarding tribes and domestic wells are required for the GSA to fully understand the specific interests and water demands of these beneficial users, to support the development of water budgets using the best available information, and to support the development of sustainable management criteria and projects and management actions that are protective of these users.

RECOMMENDATIONS

- Describe the occurrence of tribal lands in the basin. If tribes have interests in the basin, describe them in detail.
- Include a map of individual domestic well locations and a table of well data showing screen depths. Indicate the population dependent on groundwater for their source of drinking water.

Interconnected Surface Waters

The identification of Interconnected Surface Water (ISW) is **insufficient**.

The GSP describes the use of aerial photos to analyze stream reaches during the dry season. However, this analysis is insufficient to determine interconnected reaches. The GSP states: “the reach of Temescal Wash that passes through the Bedford-Coldwater Basin does not appear to gain flow from groundwater seepage into the channel, at least during the dry season. Water levels in wells near the creek further suggest that the water table is usually below the creek bed elevation." Both of these sentences appear to discount the time periods when the stream reaches *may* be interconnected. The regulations [23 CCR §351(o)] define ISW 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". "At any point" has both a spatial and temporal component. Even short durations of interconnections of groundwater and surface water can be crucial for surface water flow and supporting environmental users of groundwater and surface water.

Therefore, potential ISWs are not being identified, described, nor managed in the GSP. Until a disconnection can be proven, include all potential ISWs in the GSP. This is necessary to assess whether surface water depletions caused by groundwater use are having an adverse impact on environmental beneficial users of surface water.

RECOMMENDATIONS

- Provide a map showing all the stream reaches in the basin, with reaches clearly labeled. Consider any segments with data gaps as potential ISWs and clearly mark them as such on maps provided in the GSP.
- Provide depth-to-groundwater contour maps using the best practices presented in Attachment D, to aid in the determination of ISWs. Specifically, ensure that the first step is contouring groundwater elevations, and then subtracting this layer from land surface elevations from a digital elevation model (DEM) to estimate depth to groundwater contours across the landscape. This will provide accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.
- Use seasonal data over multiple water year types to capture the variability in environmental conditions inherent in California's climate, when mapping ISWs.
- Reconcile ISW data gaps with specific measures (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features in the Monitoring Network section of the GSP.

Groundwater Dependent Ecosystems

The identification of Groundwater Dependent Ecosystems (GDEs) is **insufficient**, due to a lack of comprehensive, systematic analysis of the basin's GDEs.

The GSP uses TNC's GDE Pulse Tool to describe trends in plant growth (e.g., NDVI) and plant moisture (e.g., NDMI), and provided a map of change in NDMI (Figure 4-16) plotted on NC dataset polygons. Additionally, the GSP provides general discussion of riparian vegetation and depth to groundwater. However, the depth to groundwater data was not directly used to verify the NC dataset polygons.

In particular, we found that some mapped features in the NC dataset were improperly disregarded based on the following:

- GDEs were disregarded based on the presence or proximity of surface water. However, partial reliance on surface water does not necessarily prove that the plants and animals do not access groundwater. Many GDEs often simultaneously rely on multiple sources of water (i.e., both groundwater and surface water), or shift their reliance on different sources on an interannual or inter-seasonal basis. Additionally, adverse impacts can occur to GDEs due to pumping that further separates groundwater from surface water.

- Mapped features in the NC dataset were disregarded if Normalized Difference Vegetation Index (NDVI) and Normalized Difference Moisture Index (NDMI) data downloaded from GDE Pulse did not correlate with groundwater. This is an incorrect method, since a lack of a relationship does not preclude that groundwater is providing some of the ecosystem's water needs. If the ecosystem is tapping into shallow groundwater then the ecosystem should be categorized as a GDE. If there are no data to characterize groundwater conditions in the shallow principal aquifer, then the GDE should be retained as a potential GDE and data gaps reconciled in the Monitoring Network section of the GSP.

RECOMMENDATIONS

- Develop and describe a systematic approach for analyzing the basin's GDEs. For example, provide a map of the NC Dataset. On the map, label polygons retained or removed from the NC dataset (and the removal reason if polygons are not considered potential GDEs). Discuss how local groundwater data was used to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer. Refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer.

- Use depth to groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons. We recommend that a baseline period (10 years from 2005 to 2015) be established to characterize groundwater conditions over multiple water year types. Refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer.

- Provide depth-to-groundwater contour maps, noting the best practices presented in Attachment D. Specifically, ensure that the first step is contouring groundwater elevations, and then subtracting this layer from land surface elevations from a DEM to estimate depth-to-groundwater contours across the landscape.

- If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons as "Potential GDEs" in the GSP until data gaps are reconciled in the monitoring network.

- Please provide a complete inventory, map, or description of fauna (e.g., birds, fish, amphibian) and flora (e.g., plants) species in the basin and note any threatened or endangered species (see Attachment C in this letter for a list of freshwater species located in the Bedford-Coldwater basin). The GSP provides a habitat map of the federally listed bird species gnatcatcher, but this is the only species referenced under the GDE discussion. The GSP mentions the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP), but provides few details.

Native Vegetation and Managed Wetlands

Native vegetation and managed wetlands are water use sectors that are required[1,2] to be included into the water budget. The integration of native vegetation into the water budget is **sufficient**. We commend the GSA for including the groundwater demands of this ecosystem in the historical, current and projected water budgets. Managed wetlands are not mentioned in the GSP, so it is not known whether or not they are present in the basin.

RECOMMENDATION

- State whether or not there are managed wetlands in the basin. If there are, ensure that their groundwater demands are included as separate line items in the historical, current, and projected water budgets.

B. Engaging Stakeholders

Stakeholder Engagement during GSP development

Stakeholder engagement during GSP development is **insufficient**. SGMA's requirement for public notice and engagement of stakeholders[3] is not fully met by the description in the Stakeholder Outreach Plan included in the GSP (Appendix D). We note the following deficiencies with the overall stakeholder engagement process:

- The opportunities for public involvement and engagement are described in very general terms. They include attendance at public meetings, stakeholder email list, and updates to the GSP website.

- Domestic well owners are specifically mentioned in the Stakeholder Engagement Plan as holders of overlying groundwater rights, however no information is provided other than stating that their participation is invited in the GSP development process.

- The Stakeholder Outreach Plan does not include a plan for continual opportunities for engagement through the implementation phase of the GSP for tribes and environmental stakeholders.

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[1] "'Water use sector' refers to 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." [23 CCR §351(al)]

[2] "The water budget shall quantify the following, either through direct measurements or estimates based on data: (3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow." [23 CCR §354.18]

[3] "A communication section of the Plan shall include a requirement that the GSP identify how it encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin." [23 CCR §354.10(d)(3)]

RECOMMENDATIONS

- Include a more detailed and robust Stakeholder Outreach Plan that describes active and targeted outreach to engage domestic well owners, environmental stakeholders, and tribal stakeholders during the remainder of the GSP development process and throughout the GSP implementation phase. Refer to Attachment B for specific recommendations on how to actively engage stakeholders during all phases of the GSP process.

- Describe the occurrence of tribal lands in the basin. The GSP states that there are no tribal lands in the basin, but includes four tribes in the list of stakeholders presented in Table 1. If tribes have interests in the basin, describe them in detail.

- Describe efforts to consult and engage with tribes within the basin. Refer to the DWR guidance entitled *Engagement with Tribal Governments* for specifics on how to consult with tribes.[4]

C. Considering Beneficial Uses and Users When Establishing Sustainable Management Criteria and Analyzing Impacts on Beneficial Uses and Users

The consideration of beneficial uses and users when establishing sustainable management criteria (SMC) is **insufficient**. The consideration of potential impacts on all beneficial users of groundwater in the basin are required when defining undesirable results[5] and establishing minimum thresholds.[6,7]

Disadvantaged Communities and Drinking Water Users

The GSP has aligned the minimum thresholds for contaminants of concern to maximum contaminant levels (MCLs), but has done so by averaging monitored concentrations over a 5-year period and over the entire basin. The TDS water quality minimum threshold basin-wide is defined as 5-year average concentrations not exceeding the 1,000 mg/L Secondary MCL for TDS. The nitrate water quality minimum threshold basin-wide is defined as 5-year average concentrations not exceeding the 10 mg/L drinking water MCL for nitrate as nitrogen. The monitored concentrations are totaled from each well and then divided by the total number of wells to achieve a single value representing average conditions over the entire Basin.

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[4] DWR Guidance Document for Engagement with Tribal Governments https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Guidance-Doc-for-SGM-Engagement-with-Tribal-Govt_ay_19.pdf

[5] “The description of undesirable results shall include [...] 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.” [23 CCR §354.26(b)(3)]

[6] “The description of minimum thresholds shall include [...] how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.” [23 CCR §354.28(b)(4)]

[7] “The description of minimum thresholds shall include [...] 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 the basis for the difference.” [23 CCR §354.28(b)(5)]

The GSP acknowledges that the method of averaging concentrations (p. 6-25) "is slightly different than the suggested methods to determine sustainability, [but] the GSA desired a single quantitative value to guide management." Despite this explanation, we still disagree with averaging monitored concentrations over time and space. This is not an adequate methodology since concentrations averaged over 5-years and over the entire basin can not detect impacts to beneficial users of groundwater.

The GSP discounts domestic wells in the setting of SMC, based on the rationale that there are very few private wells in the basin, known private wells are for non-potable use, and responsibility for potential undesirable results to shallow wells is shared between a GSA and a well owner. Therefore, potential impacts on all beneficial users of groundwater in the basin have not been considered when defining undesirable results and establishing minimum thresholds.

RECOMMENDATIONS

Chronic Lowering of Groundwater Levels

- Consider and evaluate the impacts of selected minimum thresholds and measurable objectives on drinking water users within the basin. Further describe the impact of passing the minimum threshold for drinking water users. For example, provide the number of domestic wells that would be de-watered at the minimum threshold.

Degraded Water Quality

- Set minimum thresholds for degraded water quality that are compared to individually monitored concentrations, not those that are averaged over time or space.

- Describe direct and indirect impacts on drinking water users when defining undesirable results for degraded water quality. For specific guidance on how to consider domestic water users, refer to "Guide to Protecting Water Quality Under the Sustainable Groundwater Management Act."[8]

- Evaluate the cumulative or indirect impacts of proposed minimum thresholds for TDS and nitrate on drinking water users.

- Provide distinct maps for PFOS, PFOA and sulfate contamination plumes as required in SGMA regulations[9].

Groundwater Dependent Ecosystems and Interconnected Surface Waters

The GSP uses 2014-2016 groundwater elevations as minimum thresholds for the depletion of interconnected surface water SMC (using groundwater elevations as proxy). We are concerned that this will not avoid undesirable results to environmental beneficial users. The true impacts to ecosystems under this scenario are not fully discussed in the GSP. If minimum thresholds are set to historic low groundwater levels and the subbasin is allowed to operate just above or close to those levels over many years, there is a risk of causing catastrophic damage to ecosystems that are more adverse than what was occurring at the height of the 2012-2016 drought. This is because California ecosystems, which are adapted to our Mediterranean climate, have some

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[8] Guide to Protecting Water Quality under the Sustainable Groundwater Management Act https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1559328858/Guide_to_Protecting_Drinking_Water_Quality_Under_the_Sustainable_Groundwater_Management_Act.pdf?1559328858.

[9] "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." [23 CCR §354.16(d)]

drought strategies that they can utilize to deal with short-term water stress. However, if the drought conditions are prolonged, the ecosystem can collapse.

The GSP states (p. 6-37) that “undesirable results did occur in the Bedford-Coldwater Basin during the recent drought, because vegetation die-back occurred along about 3.9 miles of the channel, or about 57 percent of the total length of Temescal Wash in the Basin.” The basin’s ecosystems could be further damaged or even destroyed if groundwater conditions are maintained just above those levels in the long-term, since the subbasin would be permitted to sustain extreme dry conditions over multiple seasons and years.

RECOMMENDATIONS

- Define chronic lowering of groundwater SMC directly for environmental beneficial users of groundwater. GDEs are discussed only in relation to the depletions of interconnected surface water SMC (using groundwater elevations as proxy for depletions of interconnected surface waters), but not directly for the chronic lowering of groundwater SMC.

- When defining undesirable results for chronic lowering of groundwater levels and depletions of interconnected surface waters, provide specifics on what biological responses (e.g., extent of habitat, growth, recruitment rates) would best characterize a significant and unreasonable impact to GDEs. Undesirable results to environmental users occur when ‘significant and unreasonable’ effects on beneficial users are caused by groundwater conditions in the subbasin. Thus, potential impacts on environmental beneficial uses and users need to be considered when defining undesirable results[10] in the subbasin. Defining undesirable results is the crucial first step before the minimum thresholds[11] can be determined.

2. Climate Change

The SGMA statute identifies climate change as a significant threat to groundwater resources and one that must be examined and incorporated in the GSPs. The GSP Regulations[12] require integration of climate change into the projected water budget to ensure that projects and management actions sufficiently account for the range of potential climate futures.

The integration of climate change into the projected water budget is **insufficient**. The GSP does incorporate climate change into the projected water budget using DWR change factors for 2070. However, the GSP did not consider the 2070 extremely wet and extremely dry climate scenarios in the projected water budget. The GSP should clearly and transparently incorporate the extremely wet and dry scenarios provided by DWR into projected water budgets or select more appropriate extreme scenarios

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[10] “The description of undesirable results shall include [...] 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”. [23 CCR §354.26(b)(3)]

[11] The description of minimum thresholds shall include [...] how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.” [23 CCR §354.28(b)(4)]

[12] “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.” [23 CCR §354.18(e)]

for their basins. While these extreme scenarios may have a lower likelihood of occurring, their consequences could be significant, therefore they should be included in groundwater planning.

We acknowledge and commend the inclusion of climate change into key inputs (precipitation, evaporation, and surface water flow) of the projected water budget. Additionally, the sustainable yield is calculated based on the projected pumping for future projections that include climate change. However, if the water budgets are incomplete, including the omission of extremely wet and dry scenarios, then there is increased uncertainty in virtually every subsequent calculation used to plan for projects, derive measurable objectives, and set minimum thresholds. Plans that do not adequately include climate change projections may underestimate future impacts on vulnerable beneficial users of groundwater such as ecosystems and domestic well owners.

RECOMMENDATIONS

- Integrate extreme wet and dry scenarios into the projected water budget to form the basis for development of sustainable management criteria and projects and management actions.
- Incorporate climate change scenarios into projects and management actions.

3. Data Gaps

The consideration of beneficial users when establishing monitoring networks is **insufficient**. Without adequate monitoring and identification of data gaps, beneficial users of groundwater including GDEs, surface water users, and drinking water users will remain unprotected by the GSP. The Plan therefore fails to meet SGMA's requirements for the monitoring network[13]. We recommend the following steps to ensure that the monitoring network is protective of all beneficial users of groundwater.

RECOMMENDATIONS

- Provide maps that overlay monitoring well locations with the locations of GDEs and domestic wells to clearly identify potentially impacted areas. Ensure that existing and proposed representative monitoring sites adequately cover portions of the basin with GDEs and domestic wells.
- Provide a detailed plan for the investigation of shallow groundwater/surface water interaction at Temescal Wash as discussed in Section 8.6, instead of leaving this for a future project. Reconcile data gaps in the monitoring network by evaluating how the gathered data will be used to identify and map GDEs and ISWs.

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[13] "The monitoring network objectives shall be implemented to accomplish the following: [...] (2) Monitor impacts to the beneficial uses or users of groundwater." [23 CCR §354.34(b)(2)]

- Determine what ecological monitoring can be used to assess the potential for significant and unreasonable impacts to GDEs or ISWs due to groundwater conditions in the subbasin. The GSP mentions biological surveys in Section 8.6, but no details are given.

4. Addressing Beneficial Users in Projects and Management Actions

The consideration of beneficial users when developing projects and management actions is **insufficient**, due to lack of identification of benefits or impacts of identified projects and management actions to key beneficial users of groundwater such as GDEs, surface water users, and drinking water users. Therefore, potential project and management actions may not protect these beneficial users. Groundwater sustainability under SGMA is defined not just by sustainable yield, but by the avoidance of undesirable results for all beneficial users.

RECOMMENDATIONS

Because GDEs, aquatic habitats, surface water users, and drinking water users were not sufficiently identified in the GSP, please consider including the following related to potential project and management actions in the GSP:

- Recharge ponds, reservoirs and facilities for managed stormwater recharge can be designed as multiple-benefit projects to include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. For guidance on how to integrate multi-benefit recharge projects into your GSP refer to the "Multi-Benefit Recharge Project Methodology Guidance Document"[14].

- For domestic well owners, include discussion of a drinking water well impact mitigation program to proactively monitor and protect drinking water wells through GSP implementation. Refer to Attachment B for specific recommendations on how to implement a drinking water well mitigation program.

- For domestic well owners, include a discussion of whether potential impacts to water quality from projects and management actions could occur and how the GSA plans to mitigate such impacts.

- Develop management actions that incorporate climate and water delivery uncertainties to address future water demand and prevent future undesirable results.

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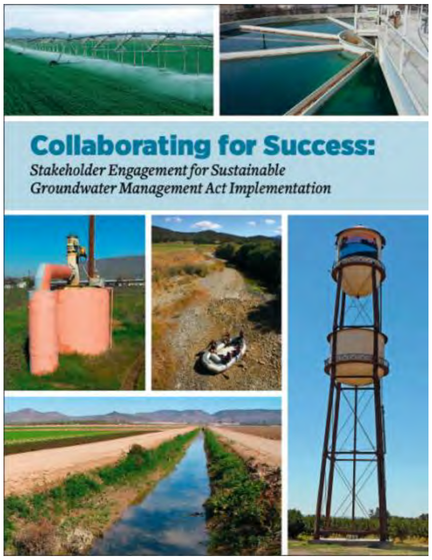
[14] The Nature Conservancy. 2021. Multi-Benefit Recharge Project Methodology for Inclusion in Groundwater Sustainability Plans. Sacramento. Available at: https://groundwaterresourcehub.org/sgma-tools/multi-benefit-recharge-project-methodology-guidance/

Attachment B

SGMA Tools to address DAC, drinking water, and environmental beneficial uses and users

Stakeholder Engagement and Outreach



Collaborating for Success:
Stakeholder Engagement for Sustainable Groundwater Management Act Implementation

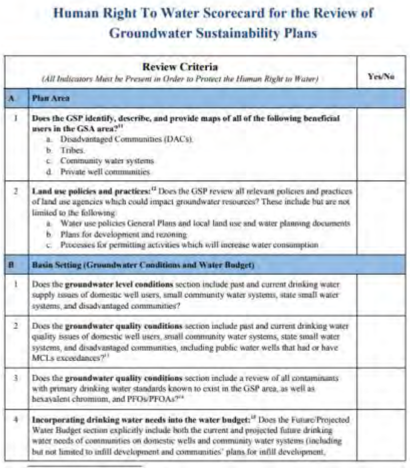
Clean Water Action, Community Water Center and Union of Concerned Scientists developed a guidance document called Collaborating for success: Stakeholder engagement for Sustainable Groundwater Management Act Implementation. It provides details on how to conduct targeted and broad outreach and engagement during Groundwater Sustainability Plan (GSP) development and implementation. Conducting a targeted outreach involves:

- Developing a robust Stakeholder Communication and Engagement plan that includes outreach at frequented locations (schools, farmers markets, religious settings, events) across the plan area to increase the involvement and participation of disadvantaged communities, drinking water users and the environmental stakeholders.

- Providing translation services during meetings and technical assistance to enable easy participation for non-English speaking stakeholders.

- GSP should adequately describe the process for requesting input from beneficial users and provide details on how input is incorporated into the GSP.

The Human Right to Water

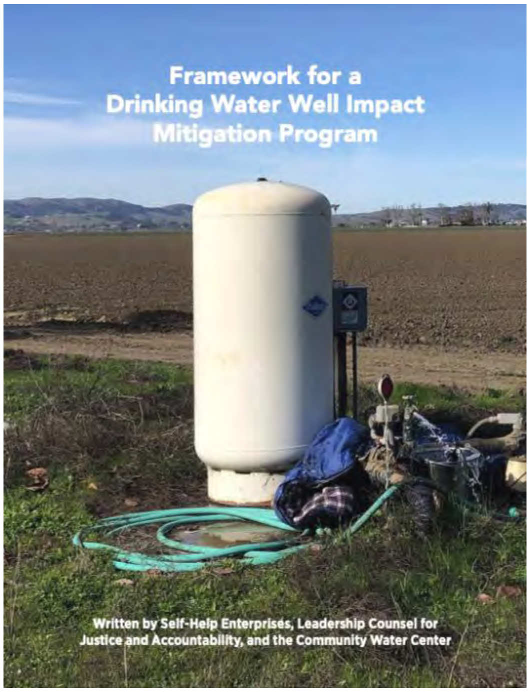


Human Right To Water Scorecard for the Review of Groundwater Sustainability Plans

	Review Criteria *(All Indicators Must be Present in Order to Protect the Human Right to Water)*	Yes/No
A	**Plan Area**	
1	**Does the GSP identify, describe, and provide maps of all of the following beneficial users in the GSA area?**[11] a. Disadvantaged Communities (DACs). b. Tribes. c. Community water systems. d. Private well communities.	
2	**Land use policies and practices:**[12] Does the GSP review all relevant policies and practices of land use agencies which could impact groundwater resources? These include but are not limited to the following: a. Water use policies General Plans and local land use and water planning documents b. Plans for development and rezoning c. Processes for permitting activities which will increase water consumption	
B	**Basin Setting (Groundwater Conditions and Water Budget)**	
1	Does the **groundwater level conditions** section include past and current drinking water supply issues of domestic well users, small community water systems, state small water systems, and disadvantaged communities?	
2	Does the **groundwater quality conditions** section include past and current drinking water quality issues of domestic well users, small community water systems, state small water systems, and disadvantaged communities, including public water wells that had or have MCLs exceedances?[13]	
3	Does the **groundwater quality conditions** section include a review of all contaminants with primary drinking water standards known to exist in the GSP area, as well as hexavalent chromium, and PFOs/PFOAs?[14]	
4	**Incorporating drinking water needs into the water budget:**[15] Does the Future/Projected Water Budget section explicitly include both the current and projected future drinking water needs of communities on domestic wells and community water systems (including but not limited to infill development and communities' plans for infill development.	

The Human Right to Water Scorecard was developed by Community Water Center, Leadership Counsel for Justice and Accountability and Self Help Enterprises to aid Groundwater Sustainability Agencies (GSAs) in prioritizing drinking water needs in SGMA. The scorecard identifies elements that must exist in GSPs to adequately protect the Human Right to Drinking water.

Drinking Water Well Impact Mitigation Framework

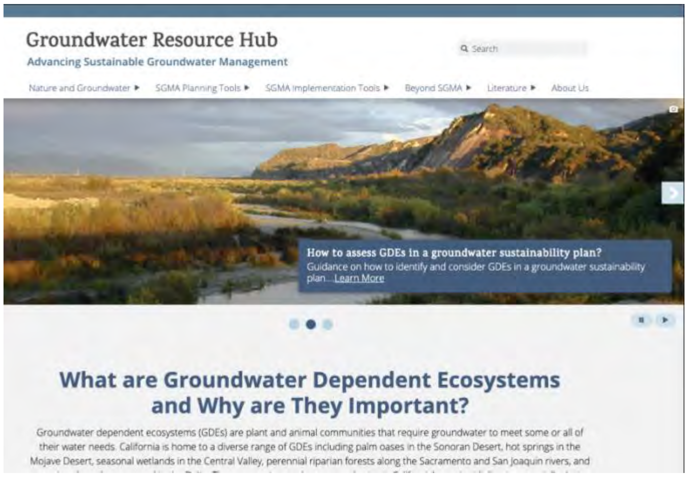


Framework for a Drinking Water Well Impact Mitigation Program

Written by Self-Help Enterprises, Leadership Counsel for Justice and Accountability, and the Community Water Center

The Drinking Water Well Impact Mitigation Framework was developed by Community Water Center, Leadership Counsel for Justice and Accountability and Self Help Enterprises to aid GSAs in the development and implementation of their GSPs. The framework provides a clear roadmap for how a GSA can best structure its data gathering, monitoring network and management actions to proactively monitor and protect drinking water wells and mitigate impacts should they occur.

Groundwater Resource Hub



How to assess GDEs in a groundwater sustainability plan?
Guidance on how to identify and consider GDEs in a groundwater sustainability plan... Learn More

What are Groundwater Dependent Ecosystems and Why are They Important?

Groundwater dependent ecosystems (GDEs) are plant and animal communities that require groundwater to meet some or all of their water needs. California is home to a diverse range of GDEs including palm oases in the Sonoran Desert, hot springs in the Mojave Desert, seasonal wetlands in the Central Valley, perennial riparian forests along the Sacramento and San Joaquin rivers, and

The Nature Conservancy has developed a suite of tools based on best available science to help GSAs, consultants, and stakeholders efficiently incorporate nature into GSPs. These tools and resources are available online at GroundwaterResourceHub.org. The Nature Conservancy's tools and resources are intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

Rooting Depth Database

The [Plant Rooting Depth Database]() provides information that can help assess whether groundwater-dependent vegetation are accessing groundwater. Actual rooting depths will depend on the plant species and site-specific conditions, such as soil type and availability of other water sources. Site-specific knowledge of depth to groundwater combined with rooting depths will help provide an understanding of the potential groundwater levels are needed to sustain GDEs.

How to use the database

The maximum rooting depth information in the Plant Rooting Depth Database is useful when verifying whether vegetation in the Natural Communities Commonly Associated with Groundwater (NC Dataset) are connected to groundwater. A 30 ft depth-to-groundwater threshold, which is based on averaged global rooting depth data for phreatophytes[1], is relevant for most plants identified in the NC Dataset since most plants have a max rooting depth of less than 30 feet. However, it is important to note that deeper thresholds are necessary for other plants that have reported maximum root depths that exceed the averaged 30 feet threshold, such as valley oak (*Quercus lobata*), Euphrates poplar (*Populus euphratica*), salt cedar (*Tamarix spp.*), and shadescale (*Atriplex confertifolia*). The Nature Conservancy advises that the reported max rooting depth for these deeper-rooted plants be used. For example, a depth-to groundwater threshold of 80 feet should be used instead of the 30 ft threshold, when verifying whether valley oak polygons from the NC Dataset are connected to groundwater. It is important to re-emphasize that actual rooting depth data are limited and will depend on the plant species and site-specific conditions such as soil and aquifer types, and availability to other water sources.

The Plant Rooting Depth Database is an Excel workbook composed of four worksheets:

1. California phreatophyte rooting depth data (included in the NC Dataset)
2. Global phreatophyte rooting depth data
3. Metadata
4. References

How the database was compiled

The Plant Rooting Depth Database is a compilation of rooting depth information for the groundwater-dependent plant species identified in the NC Dataset. Rooting depth data were compiled from published scientific literature and expert opinion through a crowdsourcing campaign. As more information becomes available, the database of rooting depths will be updated. Please Contact Us if you have additional rooting depth data for California phreatophytes.

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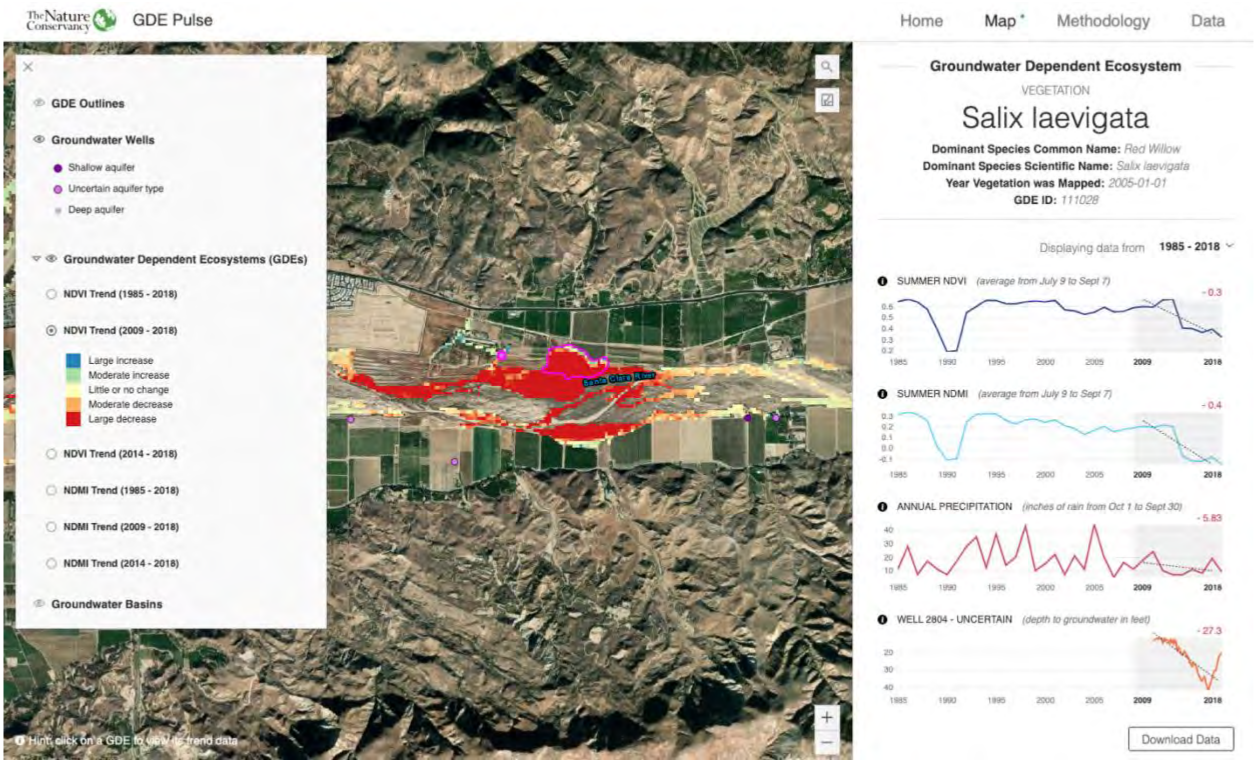
[1] Canadell, J., Jackson, R.B., Ehleringer, J.B. et al. 1996. Maximum rooting depth of vegetation types at the global scale. Oecologia 108, 583–595. https://doi.org/10.1007/BF00329030

GDE Pulse



Groundwater Dependent Ecosystem

VEGETATION

Salix laevigata

Dominant Species Common Name: Red Willow
Dominant Species Scientific Name: Salix laevigata
Year Vegetation was Mapped: 2005-01-01
GDE ID: 111028

Displaying data from **1985 - 2018**

GDE Pulse is a free online tool that allows Groundwater Sustainability Agencies to assess changes in groundwater dependent ecosystem (GDE) health using satellite, rainfall, and groundwater data. Remote sensing data from satellites has been used to monitor the health of vegetation all over the planet. GDE pulse has compiled 35 years of satellite imagery from NASA's Landsat mission for every polygon in the Natural Communities Commonly Associated with Groundwater Dataset. The following datasets are available for downloading:

Normalized Difference Vegetation Index (NDVI) is a satellite-derived index that represents the greenness of vegetation. Healthy green vegetation tends to have a higher NDVI, while dead leaves have a lower NDVI. We calculated the average NDVI during the driest part of the year (July - Sept) to estimate vegetation health when the plants are most likely dependent on groundwater.

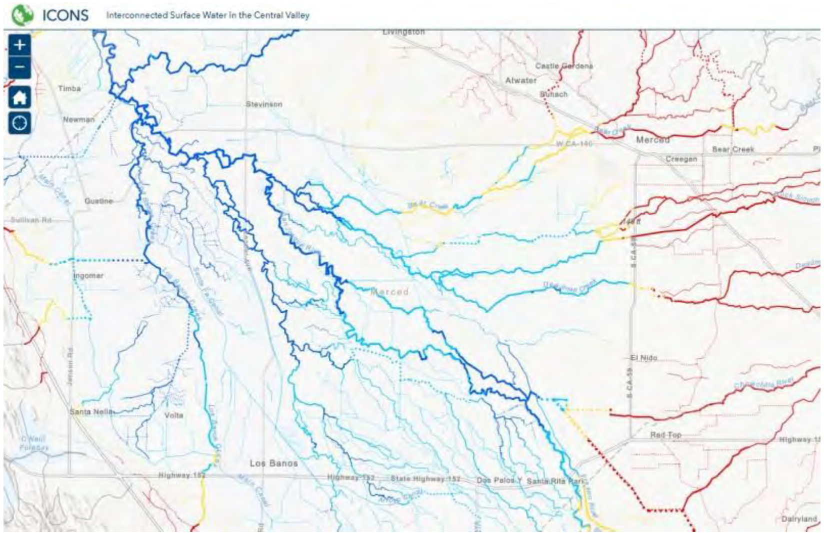
Normalized Difference Moisture Index (NDMI) is a satellite-derived index that represents water content in vegetation. NDMI is derived from the Near-Infrared (NIR) and Short-Wave Infrared (SWIR) channels. Vegetation with adequate access to water tends to have higher NDMI, while vegetation that is water stressed tends to have lower NDMI. We calculated the average NDVI during the driest part of the year (July–September) to estimate vegetation health when the plants are most likely dependent on groundwater.

Annual Precipitation is the total precipitation for the water year (October 1st – September 30th) from the PRISM dataset. The amount of local precipitation can affect vegetation with more precipitation generally leading to higher NDVI and NDMI.

Depth to Groundwater measurements provide an indication of the groundwater levels and changes over time for the surrounding area. We used groundwater well measurements from nearby (<1km) wells to estimate the depth to groundwater below the GDE based on the average elevation of the GDE (using a digital elevation model) minus the measured groundwater surface elevation.

ICONOS Mapper

Interconnected Surface Water in the Central Valley



[ICONS](#) maps the likely presence of interconnected surface water (ISW) in the Central Valley using depth to groundwater data. Using data from 2011-2018, the ISW dataset represents the likely connection between surface water and groundwater for rivers and streams in California's Central Valley. It includes information on the mean, maximum, and minimum depth to groundwater for each stream segment over the years with available data, as well as the likely presence of ISW based on the minimum depth to groundwater. The Nature Conservancy developed this database, with guidance and input from expert academics, consultants, and state agencies.

We developed this dataset using groundwater elevation data available online from the California Department of Water Resources (DWR). DWR only provides this data for the Central Valley. For GSAs outside of the valley, who have groundwater well measurements, we recommend following our methods to determine likely ISW in your region. The Nature Conservancy's ISW dataset should be used as a first step in reviewing ISW and should be supplemented with local or more recent groundwater depth data.

Attachment C

Freshwater Species Located in the Bedford-Coldwater Subbasin

To assist in identifying the beneficial users of surface water necessary to assess the undesirable result "depletion of interconnected surface waters", Attachment C provides a list of freshwater species located in the Bedford-Coldwater Subbasin. To produce the freshwater species list, we used ArcGIS to select features within the California Freshwater Species Database version 2.0.9 within the basin boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015[1]. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife's BIOS[2] as well as on The Nature Conservancy's science website[3].

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
BIRDS				
Icteria virens	Yellow-breasted Chat		Special Concern	BSSC - Third priority
Vireo bellii pusillus	Least Bell's Vireo	Endangered	Endangered	
Anas platyrhynchos	Mallard			
Ardea alba	Great Egret			
Ardea herodias	Great Blue Heron			
Butorides virescens	Green Heron			
Egretta thula	Snowy Egret			
Himantopus mexicanus	Black-necked Stilt			
Megaceryle alcyon	Belted Kingfisher			
Oxyura jamaicensis	Ruddy Duck			
Pelecanus erythrorhynchos	American White Pelican		Special Concern	BSSC - First priority
Phalacrocorax auritus	Double-crested Cormorant			
Podilymbus podiceps	Pied-billed Grebe			
Setophaga petechia	Yellow Warbler			BSSC - Second priority
CRUSTACEANS				
Crangonyx spp.	Crangonyx spp.			
Hyalella spp.	Hyalella spp.			
HERPS				
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC
Anaxyrus boreas boreas	Boreal Toad			

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[1] Howard, J.K. et al. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLoSONE, 11(7). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710

[2] California Department of Fish and Wildlife BIOS: https://www.wildlife.ca.gov/data/BIOS

[3] Science for Conservation: https://www.scienceforconservation.org/products/california-freshwater-species-database

Anaxyrus californicus	Arroyo Toad	Endangered	Special Concern	ARSSC
Pseudacris cadaverina	California Treefrog			ARSSC
Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC
Spea hammondii	Western Spadefoot	Under Review in the Candidate or Petition Process	Special Concern	ARSSC
Taricha torosa	Coast Range Newt		Special Concern	ARSSC
Thamnophis hammondii hammondii	Two-striped Gartersnake		Special Concern	ARSSC
Thamnophis sirtalis sirtalis	Common Gartersnake			
INSECTS & OTHER INVERTS				
Alotanypus spp.	Alotanypus spp.			
Argia spp.	Argia spp.			
Baetis adonis	A Mayfly			
Baetis spp.	Baetis spp.			
Cheumatopsyche spp.	Cheumatopsyche spp.			
Chironomidae fam.	Chironomidae fam.			
Coenagrionidae fam.	Coenagrionidae fam.			
Cricotopus bicinctus				Not on any status lists
Cricotopus trifascia				Not on any status lists
Dicrotendipes spp.	Dicrotendipes spp.			
Eukiefferiella spp.	Eukiefferiella spp.			
Hetaerina spp.	Hetaerina spp.			
Hydropsyche spp.	Hydropsyche spp.			
Hydroptila spp.	Hydroptila spp.			
Hydroptilidae fam.	Hydroptilidae fam.			
Labrundinia spp.	Labrundinia spp.			
Libellulidae fam.	Libellulidae fam.			
Limnophyes spp.	Limnophyes spp.			
Micrasema spp.	Micrasema spp.			
Microtendipes spp.	Microtendipes spp.			
Nectopsyche spp.	Nectopsyche spp.			
Ochrotrichia spp.	Ochrotrichia spp.			
Parametriocnemus spp.	Parametriocnemus spp.			
Paraphaenocladius spp.	Paraphaenocladius spp.			
Paratendipes spp.	Paratendipes spp.			
Pentaneura spp.	Pentaneura spp.			
Phaenopsectra spp.	Phaenopsectra spp.			
Polypedilum spp.	Polypedilum spp.			

Procladius spp.	Procladius spp.			
Pseudochironomus spp.	Pseudochironomus spp.			
Rheotanytarsus spp.	Rheotanytarsus spp.			
Simulium spp.	Simulium spp.			
Sperchon spp.	Sperchon spp.			
Tanytarsus spp.	Tanytarsus spp.			
Thienemannimyia spp.	Thienemannimyia spp.			
Tinodes spp.	Tinodes spp.			
Tipulidae fam.	Tipulidae fam.			
Tribelos spp.	Tribelos spp.			
Tricorythodes spp.	Tricorythodes spp.			
MOLLUSKS				
Ferrissia spp.	Ferrissia spp.			
Lymnaea spp.	Lymnaea spp.			
Menetus opercularis	Button Sprite			CS
Physa spp.	Physa spp.			
Planorbidae fam.	Planorbidae fam.			
PLANTS				
Baccharis salicina				Not on any status lists
Cyperus erythrorhizos	Red-root Flatsedge			
Mimulus guttatus	Common Large Monkeyflower			
Mimulus pilosus				Not on any status lists
Phacelia distans	NA			
Plagiobothrys acanthocarpus	Adobe Popcorn-flower			
Platanus racemosa	California Sycamore			
Pluchea odorata odorata	Scented Conyza			
Pluchea sericea	Arrow-weed			
Rorippa palustris palustris	Bog Yellowcress			
Rumex salicifolius salicifolius	Willow Dock			
Salix gooddingii	Goodding's Willow			
Salix laevigata	Polished Willow			
Salix lasiandra lasiandra				Not on any status lists
Veronica anagallis-aquatica	NA			

Attachment D

The Nature Conservancy

July 2019

IDENTIFYING GDEs UNDER SGMA
Best Practices for using the NC Dataset

The Sustainable Groundwater Management Act (SGMA) requires that groundwater dependent ecosystems (GDEs) be identified in Groundwater Sustainability Plans (GSPs). As a starting point, the Department of Water Resources (DWR) is providing the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) online[1] to help Groundwater Sustainability Agencies (GSAs), consultants, and stakeholders identify GDEs within individual groundwater basins. To apply information from the NC Dataset to local areas, GSAs should combine it with the best available science on local hydrology, geology, and groundwater levels to verify whether polygons in the NC dataset are likely supported by groundwater in an aquifer (Figure 1)[2]. This document highlights six best practices for using local groundwater data to confirm whether mapped features in the NC dataset are supported by groundwater.

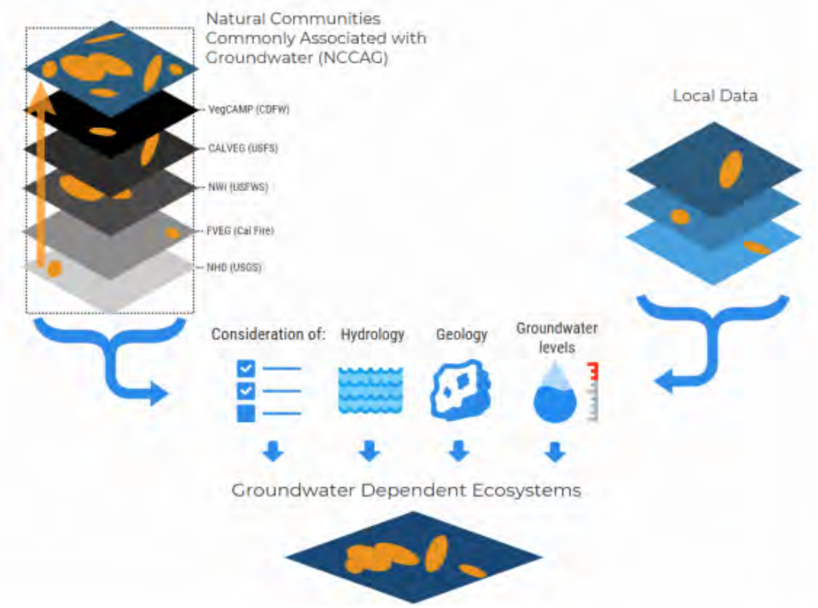

Figure 1. Considerations for GDE identification.
Source: DWR[2]

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[1] NC Dataset Online Viewer: https://gis.water.ca.gov/app/NCDatasetViewer/

[2] California Department of Water Resources (DWR). 2018. Summary of the "Natural Communities Commonly Associated with Groundwater" Dataset and Online Web Viewer. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Statewide-Reports/Natural-Communities-Dataset-Summary-Document.pdf

The NC Dataset identifies vegetation and wetland features that are good indicators of a GDE. The dataset is comprised of 48 publicly available state and federal datasets that map vegetation, wetlands, springs, and seeps commonly associated with groundwater in California[3]. It was developed through a collaboration between DWR, the Department of Fish and Wildlife, and The Nature Conservancy (TNC). TNC has also provided detailed guidance on identifying GDEs from the NC dataset[4] on the Groundwater Resource Hub[5], a website dedicated to GDEs.

BEST PRACTICE #1. Establishing a Connection to Groundwater

Groundwater basins can be comprised of one continuous aquifer (Figure 2a) or multiple aquifers stacked on top of each other (Figure 2b). In unconfined aquifers (Figure 2a), using the depth-to-groundwater and the rooting depth of the vegetation is a reasonable method to infer groundwater dependence for GDEs. If groundwater is well below the rooting (and capillary) zone of the plants and any wetland features, the ecosystem is considered disconnected and groundwater management is not likely to affect the ecosystem (Figure 2d). However, it is important to consider local conditions (e.g., soil type, groundwater flow gradients, and aquifer parameters) and to review groundwater depth data from multiple seasons and water year types (wet and dry) because intermittent periods of high groundwater levels can replenish perched clay lenses that serve as the water source for GDEs (Figure 2c). Maintaining these natural groundwater fluctuations are important to sustaining GDE health.

Basins with a stacked series of aquifers (Figure 2b) may have varying levels of pumping across aquifers in the basin, depending on the production capacity or water quality associated with each aquifer. If pumping is concentrated in deeper aquifers, SGMA still requires GSAs to sustainably manage groundwater resources in shallow aquifers, such as perched aquifers, that support springs, surface water, domestic wells, and GDEs (Figure 2). This is because vertical groundwater gradients across aquifers may result in pumping from deeper aquifers to cause adverse impacts onto beneficial users reliant on shallow aquifers or interconnected surface water. The goal of SGMA is to sustainably manage groundwater resources for current and future social, economic, and environmental benefits. While groundwater pumping may not be currently occurring in a shallower aquifer, use of this water may become more appealing and economically viable in future years as pumping restrictions are placed on the deeper production aquifers in the basin to meet the sustainable yield and criteria. Thus, identifying GDEs in the basin should done irrespective to the amount of current pumping occurring in a particular aquifer, so that future impacts on GDEs due to new production can be avoided. A good rule of thumb to follow is: *if groundwater can be pumped from a well - it’s an aquifer*.

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[3] For more details on the mapping methods, refer to: Klausmeyer, K., J. Howard, T. Keeler-Wolf, K. Davis-Fadtke, R. Hull, A. Lyons. 2018. Mapping Indicators of Groundwater Dependent Ecosystems in California: Methods Report. San Francisco, California. Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/iGDE_data_paper_20180423.pdf

[4] “Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans” is available at: https://groundwaterresourcehub.org/gde-tools/gsp-guidance-document/

[5] The Groundwater Resource Hub: www.GroundwaterResourceHub.org

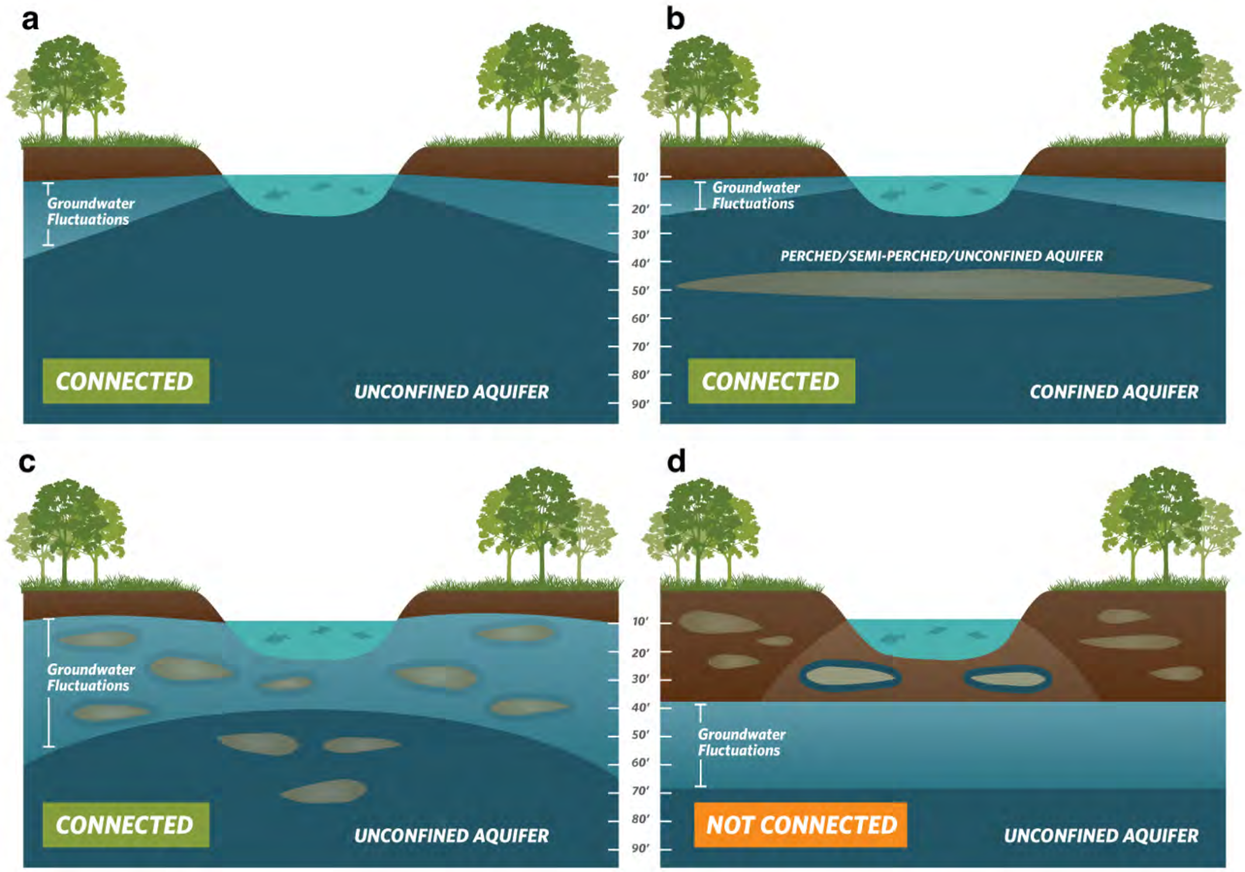

Figure 2. Confirming whether an ecosystem is connected to groundwater. Top: (a) Under the ecosystem is an unconfined aquifer with depth-to-groundwater fluctuating seasonally and interannually within 30 feet from land surface. (b) Depth-to-groundwater in the shallow aquifer is connected to overlying ecosystem. Pumping predominately occurs in the confined aquifer, but pumping is possible in the shallow aquifer. Bottom: (c) Depth-to-groundwater fluctuations are seasonally and interannually large, however, clay layers in the near surface prolong the ecosystem's connection to groundwater. (d) Groundwater is disconnected from surface water, and any water in the vadose (unsaturated) zone is due to direct recharge from precipitation and indirect recharge under the surface water feature. These areas are not connected to groundwater and typically support species that do not require access to groundwater to survive.

BEST PRACTICE #2. Characterize Seasonal and Interannual Groundwater Conditions

SGMA requires GSAs to describe current and historical groundwater conditions when identifying GDEs [23 CCR §354.16(g)]. Relying solely on the SGMA benchmark date (January 1, 2015) or any other single point in time to characterize groundwater conditions (e.g., depth-to-groundwater) is inadequate because managing groundwater conditions with data from one time point fails to capture the seasonal and interannual variability typical of California's climate. DWR's Best Management Practices document on water budgets[6] recommends using 10 years of water supply and water budget information to describe how historical conditions have impacted the operation of the basin within sustainable yield, implying that a baseline[7] could be determined based on data between 2005 and 2015. Using this or a similar time period, depending on data availability, is recommended for determining the depth-to-groundwater.

GDEs depend on groundwater levels being close enough to the land surface to interconnect with surface water systems or plant rooting networks. The most practical approach[8] for a GSA to assess whether polygons in the NC dataset are connected to groundwater is to rely on groundwater elevation data. As detailed in TNC's GDE guidance document[4], one of the key factors to consider when mapping GDEs is to contour depth-to-groundwater in the aquifer that is supporting the ecosystem (see Best Practice #5).

Groundwater levels fluctuate over time and space due to California's Mediterranean climate (dry summers and wet winters), climate change (flood and drought years), and subsurface heterogeneity in the subsurface (Figure 3). Many of California's GDEs have adapted to dealing with intermittent periods of water stress, however if these groundwater conditions are prolonged, adverse impacts to GDEs can result. While depth-to-groundwater levels within 30 feet[4] of the land surface are generally accepted as being a proxy for confirming that polygons in the NC dataset are supported by groundwater, it is highly advised that fluctuations in the groundwater regime be characterized to understand the seasonal and interannual groundwater variability in GDEs. Utilizing groundwater data from one point in time can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Time series data on groundwater elevations and depths are available on the SGMA Data Viewer[9]. However, if insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network (see Best Practice #6).

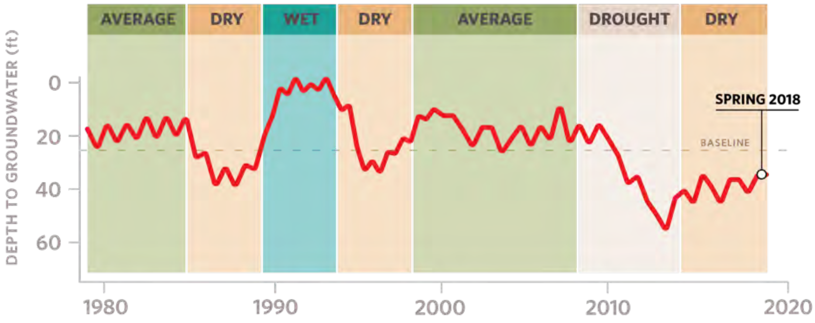

Figure 3. Example seasonality and interannual variability in depth-to-groundwater over time. Selecting one point in time, such as Spring 2018, to characterize groundwater conditions in GDEs fails to capture what groundwater conditions are necessary to maintain the ecosystem status into the future so adverse impacts are avoided.

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[6] DWR. 2016. Water Budget Best Management Practice. Available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf

[7] Baseline is defined under the GSP regulations as "historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin." [23 CCR §351(e)]

[8] Groundwater reliance can also be confirmed via stable isotope analysis and geophysical surveys. For more information see The GDE Assessment Toolbox (Appendix IV, GDE Guidance Document for GSPs[4]).

[9] SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer

BEST PRACTICE #3. Ecosystems Often Rely on Both Groundwater and Surface Water

GDEs are plants and animals that rely on groundwater for all or some of its water needs, and thus can be supported by multiple water sources. The presence of non-groundwater sources (e.g., surface water, soil moisture in the vadose zone, applied water, treated wastewater effluent, urban stormwater, irrigated return flow) within and around a GDE does not preclude the possibility that it is supported by groundwater, too. SGMA defines GDEs as "ecological communities and species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" [23 CCR §351(m)]. Hence, depth-to-groundwater data should be used to identify whether NC polygons are supported by groundwater and should be considered GDEs. In addition, SGMA requires that significant and undesirable adverse impacts to beneficial users of surface water be avoided. Beneficial users of surface water include environmental users such as plants or animals[10], which therefore must be considered when developing minimum thresholds for depletions of interconnected surface water.

GSAs are only responsible for impacts to GDEs resulting from groundwater conditions in the basin, so if adverse impacts to GDEs result from the diversion of applied water, treated wastewater, or irrigation return flow away from the GDE, then those impacts will be evaluated by other permitting requirements (e.g., CEQA) and may not be the responsibility of the GSA. However, if adverse impacts occur to the GDE due to changing groundwater conditions resulting from pumping or groundwater management activities, then the GSA would be responsible (Figure 4).

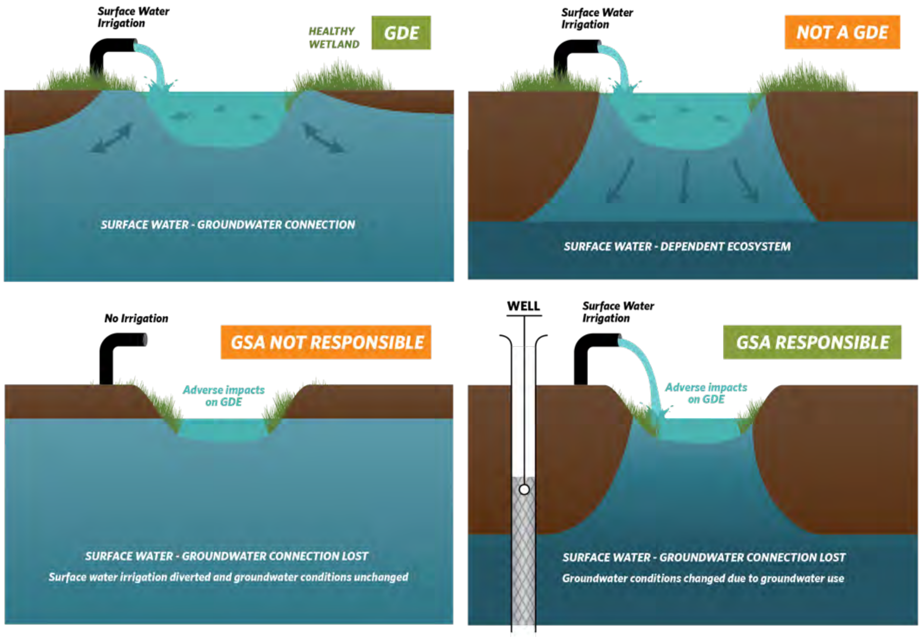

Figure 4. Ecosystems often depend on multiple sources of water. Top: (Left) Surface water and groundwater are interconnected, meaning that the GDE is supported by both groundwater and surface water. (Right) Ecosystems that are only reliant on non-groundwater sources are not groundwater-dependent. Bottom: (Left) An ecosystem that was once dependent on an interconnected surface water, but loses access to groundwater solely due to surface water diversions may not be the GSA's responsibility. (Right) Groundwater dependent ecosystems once dependent on an interconnected surface water system, but loses that access due to groundwater pumping is the GSA's responsibility.

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[10] For a list of environmental beneficial users of surface water by basin, visit: https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/

BEST PRACTICE #4. Select Representative Groundwater Wells

Identifying GDEs in a basin requires that groundwater conditions are characterized to confirm whether polygons in the NC dataset are supported by the underlying aquifer. To do this, proximate groundwater wells should be identified to characterize groundwater conditions (Figure 5). When selecting representative wells, it is particularly important to consider the subsurface heterogeneity around NC polygons, especially near surface water features where groundwater and surface water interactions occur around heterogeneous stratigraphic units or aquitards formed by fluvial deposits. The following selection criteria can help ensure groundwater levels are representative of conditions within the GDE area:

- Choose wells that are within 5 kilometers (3.1 miles) of each NC Dataset polygons because they are more likely to reflect the local conditions relevant to the ecosystem. If there are no wells within 5km of the center of a NC dataset polygon, then there is insufficient information to remove the polygon based on groundwater depth. Instead, it should be retained as a potential GDE until there are sufficient data to determine whether or not the NC Dataset polygon is supported by groundwater.

- Choose wells that are screened within the surficial unconfined aquifer and capable of measuring the true water table.

- Avoid relying on wells that have insufficient information on the screened well depth interval for excluding GDEs because they could be providing data on the wrong aquifer. This type of well data should not be used to remove any NC polygons.

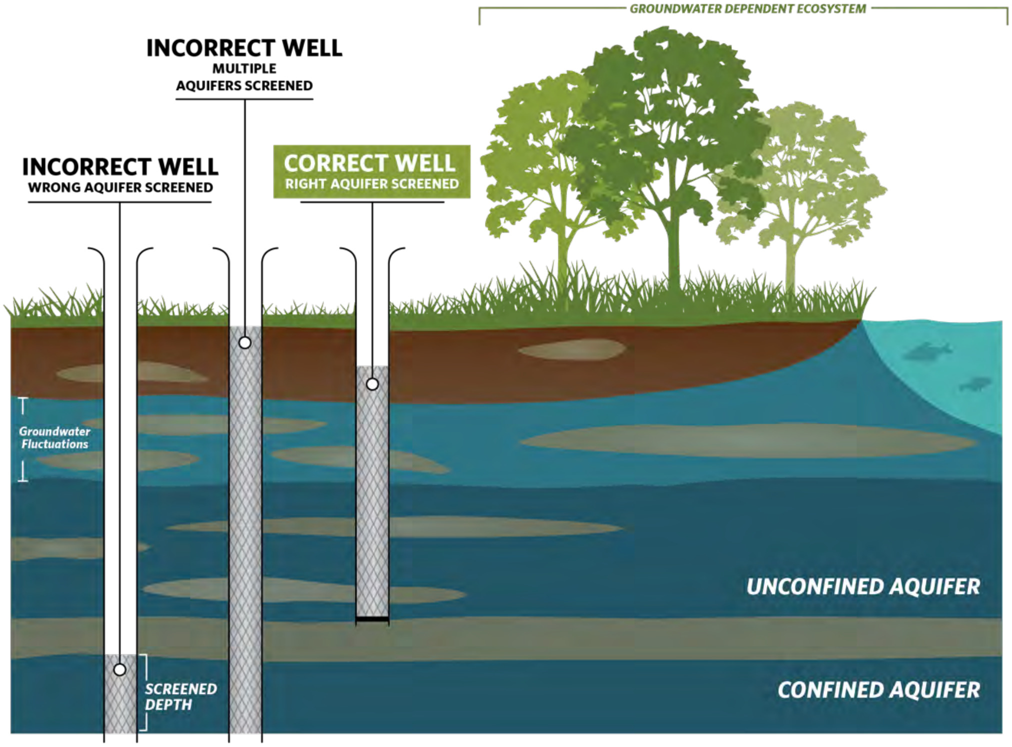

Figure 5. Selecting representative wells to characterize groundwater conditions near GDEs.

BEST PRACTICE #5. Contouring Groundwater Elevations

The common practice to contour depth-to-groundwater over a large area by interpolating measurements at monitoring wells is unsuitable for assessing whether an ecosystem is supported by groundwater. This practice causes errors when the land surface contains features like stream and wetland depressions because it assumes the land surface is constant across the landscape and depth-to-groundwater is constant below these low-lying areas (Figure 6a). A more accurate approach is to interpolate groundwater elevations at monitoring wells to get groundwater elevation contours across the landscape. This layer can then be subtracted from land surface elevations from a Digital Elevation Model (DEM)[11] to estimate depth-to-groundwater contours across the landscape (Figure b; Figure 7). This will provide a much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.

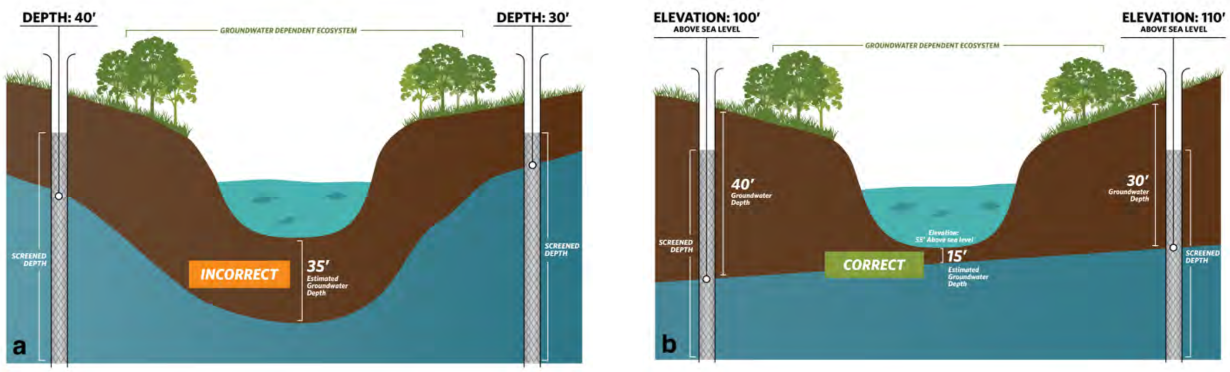

Figure 6. Contouring depth-to-groundwater around surface water features and GDEs. (a) Groundwater level interpolation using depth-to-groundwater data from monitoring wells. (b) Groundwater level interpolation using groundwater elevation data from monitoring wells and DEM data.

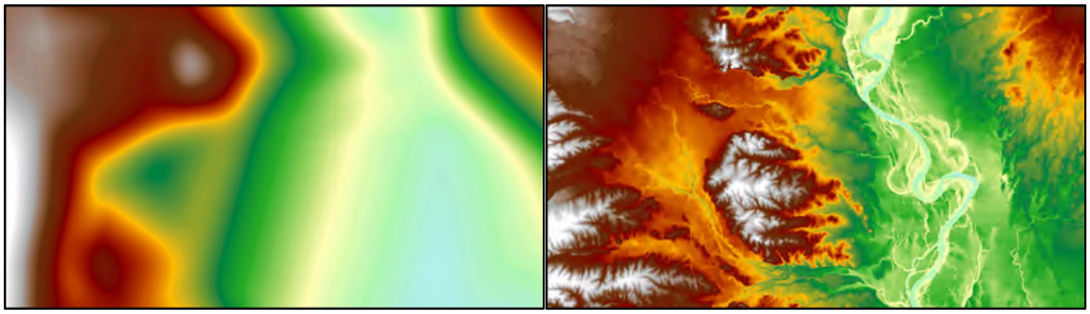

Figure 7. Depth-to-groundwater contours in Northern California. (Left) Contours were interpolated using depth-to-groundwater measurements determined at each well. (Right) Contours were determined by interpolating groundwater elevation measurements at each well and superimposing ground surface elevation from DEM spatial data to generate depth-to-groundwater contours. The image on the right shows a more accurate depth-to-groundwater estimate because it takes the local topography and elevation changes into account.

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[11] USGS Digital Elevation Model data products are described at: https://www.usgs.gov/core-science-systems/ngp/3dep/about-3dep-products-services and can be downloaded at: https://iewer.nationalmap.gov/basic/

BEST PRACTICE #6. Best Available Science

Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decisions, and using the data collected through monitoring programs to revise decisions in the future. In many situations, the hydrologic connection of NC dataset polygons will not initially be clearly understood if site-specific groundwater monitoring data are not available. If sufficient data are not available in time for the 2020/2022 plan, The Nature Conservancy strongly advises that questionable polygons from the NC dataset be included in the GSP until data gaps are reconciled in the monitoring network. Erring on the side of caution will help minimize inadvertent impacts to GDEs as a result of groundwater use and management actions during SGMA implementation.

KEY DEFINITIONS

Groundwater basin is an aquifer or stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom. *23 CCR §341(g)(1)*

Groundwater dependent ecosystem (GDE) are ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. *23 CCR §351(m)*

Interconnected surface water (ISW) 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. *23 CCR §351(o)*

Principal aquifers are aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. *23 CCR §351(aa)*

ABOUT US

The Nature Conservancy is a science-based nonprofit organization whose mission is *to conserve the lands and waters on which all life depends*. To support successful SGMA implementation that meets the future needs of people, the economy, and the environment, TNC has developed tools and resources (www.groundwaterresourcehub.org) intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

BEDFORD COLDWATER
Groundwater Sustainability Authority

Board Members:
Paul Rodriguez, TVWD
Jacque Casillas, City of Corona
Phil Williams, EVMWD

November 1, 2021

To: Ngoro Atume – Clean Water Action/Clean Water Fund
Dr. J. Pablo Ortiz-Partida – Union of Concerned Scientists
Samantha Arthur – Audubon California
Danielle V. Dolan – Local Government Commission
E.J. Remson – The Nature Conservancy (TNC)
Melissa M. Rohde – The Nature Conservancy
Via email

RE: Public Comment Letter for the Bedford-Coldwater Basin Draft GSP Dated September 6, 2021

The Bedford-Coldwater Groundwater Sustainability Agency (BCGSA) appreciates your thorough review of our Groundwater Sustainability Plan (GSP). Throughout the process, the BCGSA has encouraged and welcomed public input, including the comment letter you submitted September 6, 2021. We have reviewed your comments and are editing the Bedford-Coldwater GSP in response to them. In addition, detailed responses to your comments are provided below. Your September 6 comment letter is attached for reference.

1. Comment: "Beneficial uses and users are not sufficiently considered in GSP development"

Beneficial uses and users have been considered throughout the GSP. We are adding text to Chapter 2 of the GSP to more completely document groundwater users in the Basin.

A. Comment: "Human Right to Water considerations are not sufficiently incorporated."

Disadvantaged Communities, Drinking Water Users, and Tribes

There are no disadvantaged communities (DACS) or tribal lands in the Basin, and the BCGSA believes there are very few active private wells, none of which are used for potable water supply in the Basin. We have clarified and added text in the Executive Summary and Chapters 2, 5 and 6 in response to your comment.

DACs

No DACs or severely disadvantaged communities (SDACs) have been identified in the Basin.

Tribal Lands

The comment takes issue with the statement that there are no tribal lands in the Basin when tribal entities were included in the list of stakeholders. The list of interested parties was developed to encourage public participation from any and all local and regional agencies, entities, and individuals. The list included tribes with land in the region even though they do not have land within the Basin. The BCGSA agencies have a long history of coordination with the regional tribal entities, and they always inform these entities of upcoming planning and/or infrastructure projects. The regional tribal entities take an interest in planning and infrastructure projects within the Basin and surrounding areas because there are important cultural resource sites within these areas. The BCGSA agencies and regional tribal entities coordinate to assess infrastructure project sites prior to groundbreaking to identify and protect potential cultural resources.

Comment: "The identification of…drinking water users …is not sufficient"
While the BCGSA is aware of a small number of private wells in the Basin, a systematic well inventory identifying all active private wells has not been completed to date. This has been identified as a data gap in the GSP, as described in Section 6.2.7.1. The GSP also includes a project to address this data gap with a survey and inventory of active private wells throughout the Basin (Project 2, Section 8.7). This project was designed to locate and characterize the construction and use of existing private wells so that they can be included in sustainable management of the Basin. The BCGSA solicited information from private well owners during public meetings and through email and postal outreach but received little response.

Comment: "The identification of Interconnected Surface Water (ISW) is insufficient"
The comment claims that brief periods of interconnection can be ecologically significant, and we have not proven that those do not occur.

- If connection is due to surface flow creating losing stream conditions, then the gaged inflows document when surface flow is available that might establish connection. However:
    - Surface inflow from the Lee Lake Management Area in the Elsinore Subbasin is not affected by groundwater management in the Bedford-Coldwater Basin.
    - Any habitat value from those periods results from surface inflow, not groundwater discharge.
- Groundwater discharge is not flashy, the way stream flow is. Thus, although air photos represent only moments in time, they are more likely to detect groundwater discharge than surface flow events.
- Revisiting the Google Earth air photos including wet and dry seasons, we see groundwater emerging into a dry channel starting around the golf course in 2002 to 2004, 2012, and 2018. Throughflow (probably continuous from the Lee Lake Management Area in the Elsinore Subbasin) appeared to happen in 2005 to 2006, November 2009, and June 2012. However:
    - Perennial pools could easily be hidden from view by tree canopy. In the absence of perennial pools, the years with groundwater discharge-supported water in channel are probably too infrequent to support fish. Perennial pools can be important refugia for fish and other aquatic species. A channel survey for pools is needed.
    - The years with throughflow or groundwater discharge to a dry channel were years with significant wastewater discharges from Eastern Municipal Water District and/or Elsinore Valley Municipal Water District (verified by wastewater discharges before 2012 and gaged flow at Lee Lake after 2012). The possible open water in February 2018 upstream of Cajalco Road was the only event in a year without Lee Lake outflow.

The comment from the reviewers does not give examples of aquatic species and life history stages for which brief periods of groundwater-supported flow every few years are "essential".

We discussed the possible existence of aquatic species in the Bedford-Coldwater portion of the Temescal Wash with the Natural Resources Manager of the Riverside County Resource Conservation District and none were identified.

The conclusion "Therefore, potential ISWs are not being identified, described nor managed in the GSP" is an exaggeration. "Potential ISW" is a TNC term, not a Sustainable Groundwater Management Act (SGMA) term. There is extensive description and analysis of surface flow, riparian vegetation, and wetlands in the GSP. The GSP is managing groundwater dependent ecosystems (GDEs) by not allowing depth to water near Temescal Wash to drop more than 35 feet below the ground surface, which is much more restrictive than the water level minimum threshold.

The GSA recognizes that there is limited data on groundwater/surface water interaction and have identified this as a data gap. As noted in Section 8 of the GSP, a management action is described to monitor water levels in the vicinity of Temescal Wash, and a specific project is proposed to gather more information on potential groundwater/surface water interaction (including dedicated monitoring wells) along Temescal Wash.

Comment: "The identification of Groundwater Dependent Ecosystems is insufficient, due to a lack of comprehensive, systematic analysis of the basin's GDWs."

- The comment incorrectly states that some GDEs were disregarded based on the proximity or presence of surface water. This is an incorrect representation of the GSP, which stated that at "wetland" polygons where depth to groundwater is clearly too large to have groundwater discharge, any "wetland" vegetation is likely seasonally supported by rainfall and local ponding of runoff.
- The comment states that the lack of correlation between groundwater levels and normalized difference vegetation index (NDVI) changes is not evidence that NDVI is unrelated to groundwater levels. This fails to explain how an uncorrelated variable can be a causal factor in NDVI.
- The last bullet of "Recommendations" requests a "complete inventory" of fauna and flora in the Basin. The GSP discusses thirteen animal species by name and the five most abundant woody riparian vegetation species by name. All of the species discussed in the MSHCP and USARHCP that historically or presently occur along Temescal Wash were reviewed for potential groundwater dependence. A longer list of species associated with riparian or wetland areas—particularly ones not a focus in the HCPs—would not change the analysis results.
- The last bullet of "Recommendations" incorrectly states that "The GSP mentions the Western Riverside County Multispecies Habitat Conservation Plan but provides few details." In fact, Sections 4.9.4 and 4.9.4.1 each include a full paragraph describing the Multiple Species Habitat Conservation Plan (MSHCP) content that relates to Temescal Wash and the Basin. Also, Section 6.7.2.3 includes a full paragraph describing all species mentioned in the MSHCP whose habitat areas overlap the Basin. Furthermore, the comment neglected to note that the GSP also reviewed and discussed the Upper Santa Ana River Habitat

Conservation Plan (HCP), the Temescal Creek Native Fish Restoration Project, interviews with Resource Conservation District (RCD) staff (two additional long paragraphs in (Section 6.7.2.3), and review of U.S. Fish and Wildlife Service (USFWS) critical habitat maps (Section 4.9.4.1). In summary, the comment grossly mischaracterizes the evaluation of plant and animal species as inadequate when in fact, the consideration of relevant species was ample and the analysis went far beyond simply listing species, which by itself is of little value.

B. Comment: "Public trust resources are not sufficiently considered."

The GSA encouraged stakeholder engagement throughout the GSP process. Outreach efforts included website updates, individual phone calls, email, and postal mail. Domestic well owners were invited to participate but none indicated concern about the development of the GSP. As noted above there are no tribes in the Basin, although tribes in the region were invited to public meetings and consulted for the monitoring well construction project. We are updating our outreach plan to include continuing engagement during GSP implementation.

C. Comment: "Impacts of Minimum Thresholds, Measurable Objectives and Undesirable Results on beneficial uses and users are not sufficiently analyzed."

DACs and drinking water users

Aside from the production wells of the BCGSA agencies, there is only one small community water system in the Basin, the Glen Ivy Hot Springs. The Glen Ivy well is regulated as a small community water system and is included in the sustainable management criteria. This well is also included as a monitoring well in the GSP and water levels and quality in the well will continue to be assessed as part of GSP implementation. As indicated in prior responses, there are no DACs or SDACs in the Basin and there are no known private domestic potable wells in the Basin. Project 2 (Section 8.7) will identify all active private wells in the Basin so that they can be included in sustainable management.

Distinct maps for perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and sulfate contamination are unavailable due to lack of available data and not required by SGMA.

Groundwater Dependent Ecosystems and Interconnected Surface Waters

The comment letter characterizes the sustainable management criteria (SMC) for interconnected surface water as observed groundwater elevations from the 2014-2016 drought. This is incorrect. The SMC is not defined in terms of historical groundwater elevations during 2014-2016. The minimum threshold (MT) for ISW is very clearly stated in Section 6.7.6:

> "The Minimum Threshold for depletion of interconnected surface water is the amount of depletion that occurs when the depth to water in wells near areas supporting phreatophytic riparian trees is greater than 35 feet for a period exceeding one year."

It should be noted that this MT is much more restrictive than the MT for chronic declines in groundwater levels (see GSP Table 6.1).

2. Comment: "Climate change is not sufficiently considered."

The comment states that "the GSP did not consider the 2070 extremely wet and extremely dry climate scenarios in the projected water budget." The comment appears to be referring to two alternative sets of monthly climate multipliers provided in the files of climate change factors downloadable from the SGMA Data Portal. Those sets of factors are labeled Drier/Extreme-Warming (DEW) and Wetter/Moderate-Warming (WMW). There is no requirement to use anything but the expected factors. In fact, the California Department of Water Resources (DWR) document "Guidance for Climate Change Data Use during Groundwater Sustainability Plan Development" does not even mention the alternative data sets. Rather, Section 4.5 of the guidance document states that uncertainty in climate change predictions is represented by inter-annual variability in the 50-year future simulations. It also states that the evaluation of sustainability will be based on the "central tendency" of the climate change factors, which is represented by the primary climate factor data set. The DEW and WMW data sets are for optional research purposes. Therefore, the climate change analysis in the GSP is adequate.

Our interpretation is that DWR is requesting two water budgets only (2030 and 2070) and that "uncertainty" is represented by the interannual variability represented by the 50 years of analysis. In other words, the climate change scenario is itself an expression of uncertainty relative to the future baseline scenario. Also, projects are evaluated on the "central tendency", which is based on the expected climate change factors (the ones used in the GSP climate change analysis). There is no requirement for additional analysis of alternative climate change factor sets such as those identified in the comment.

3. Comment: "Data gaps are not sufficiently identified and the GSP does not have a plan to eliminate them."

Data gaps in the monitoring network have been identified and projects and management actions to address those data gaps are included in the GSP. The existing Project 1 (Section 8.6) has been more clearly defined to include the siting and installation of shallow monitoring wells to eliminate the data gap for interconnected surface water, as described in response 4 below.

4. Comment: "Projects and Management Actions do not sufficiently consider potential impacts or benefits to beneficial uses and users."

Please see previous responses regarding the identification of beneficial users and uses, including the project already in the GSP to locate all private (including domestic) wells (Project 2, Section 8.7).

Regarding interconnected surface water and GDEs, Project 1 (Section 8.6) was clarified and expanded to add more detail in a phased approach involving well siting and permitting review, followed by construction of shallow monitoring wells along Temescal Wash where possible. A survey for perennial pools along the entire length of Temescal Wash in the Basin will also be conducted. The new wells along Temescal Wash will greatly increase the knowledge of groundwater conditions near the wash, and appropriate reduction in pumping to protect GDEs, if required (Management Action 4).

Once again, thank you for your detailed review of the Bedford-Coldwater GSP. We hope these responses to your comments are helpful.

Sincerely,

Victor Harris
BCGSA Administrator

Attachment: "Public Comment Letter for the Bedford-Coldwater Basin Draft GSP" dated September 6, 2021

APPENDIX G

Bedford-Coldwater GSP Numerical Groundwater Model Documentation Report

BEDFORD COLDWATER
Groundwater Sustainability Authority

BEDFORD-COLDWATER BASIN GROUNDWATER SUSTAINABILITY PLAN

GROUNDWATER MODEL DOCUMENTATION REPORT

November 2021

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1. INTRODUCTION

The groundwater model was developed to support the Groundwater Sustainability Plan (GSP) for the Bedford-Coldwater Subbasin of the Elsinore Groundwater Basin (DWR Groundwater Basin 8-004.02) and is prepared in accordance with Sustainable Groundwater Management Act (SGMA). For convenience, DWR Basin 8-004.02 will be referred to as the Bedford-Coldwater Subbasin (Basin) in this memo.

1.1. SCOPE AND OBJECTIVE

SGMA effectively requires that groundwater modeling be used to demonstrate that a GSP will achieve sustainable basin operation. Various numerical model that has been developed, periodically updated, and used for various scenarios since the 1990s. The objective of this model was to simulate the surface water and groundwater model for the entire Basin that updates key parameters the Basin boundary, discretization, geologic layering, aquifer parameter distribution. The assessment and final model focuses on applicability to SGMA GSP regulations including consistency with DWR Best Management Practices for surface water and groundwater modeling (DWR, 2016). This comprehensive groundwater model serves as a quantitative tool for computing Basin-wide and management area specific water budgets as required by the SGMA GSP regulations.

1.2. SUMMARY OF PREVIOUS MODELS

The Basin Model (Bedford-Coldwater Model) incorporates the hydrologic, geologic and groundwater data to develop a numerical groundwater model to evaluate local water budgets and assess sustainability criteria. An earlier groundwater model was developed for use on the Coldwater Basin Recharge Feasibility Study (MWH, 2004). The Bedford-Coldwater Model builds on earlier data from the 2004 MWH model, and expands the previous model in order to cover the rest of the Basin. This report documents the setup and calibration of the model, including the steps used to process to incorporate this data into the groundwater model.

2. BASIN GEOLOGY AND STRUCTURE

The following summarizes the hydrogeologic conceptual model (HCM) and groundwater conditions from the GSP (see Sections 3 and 4). The HCM and groundwater conditions create a foundation of the technical aspects of the Basin's hydrogeology necessary for model development. This section references figure and text in Sections 3 and 4 of the GSP.

2.1. BEDFORD COLDWATER BASIN

The Basin is a subbasin of the Elsinore Basin and covers approximately 11 square miles in western Riverside County (**Figure 1**). The Basin is located between the Santa Ana Mountains to the west and the Perris Plain on the east. The Basin is separated from the Temescal Subbasin to the northwest by a groundwater divide near Bedford Wash. A jurisdictional boundary separates the Basin with the Elsinore Valley Subbasin to the south. The Basin is thin in some areas, which impedes groundwater flow especially at the northern and southern boundaries.

2.1.1. Physiography

Ground surface elevations along the valley floor are generally flat. Elevations range from approximately 1,000 feet above mean sea level (msl) at the northern boundary to approximately 1,200 feet above msl to the south, as shown by 200-foot contours on **Figure 1**. The tributary watersheds reach up to more than 5,600 feet msl at the highest peak in the Santa Ana Mountain watersheds west of the Basin. Watersheds east of the Basin are significantly lower in elevation and rise only to about 1,800 feet.

Annual precipitation varies from below 12 inches to more than 26 inches over the Study Area. The long-term average annual rainfall is between 12 and 14 inches per year on the Basin floor and increases to more than 20 inches along the top of the local watersheds in the Santa Ana Mountains to the west.

2.1.2. Hydrology

The Basin covers a portion of the Santa Ana River watershed. Main tributaries to the Santa Ana River include Temescal Wash which flows through the Basin from the southeast to northwest and the Bedford Wash flowing toward the northeast along the northern boundary of the Basin. These waterways are ephemeral and are dry much of the year, flowing mainly during the winter. Water enters the basin as surface runoff and subsurface inflow from watersheds draining into the basin. The overall watershed tributary to the Basin was divided into 15 sub-watersheds for the purpose of simulating inflow to the model, as shown on **Figure 2**.

2.1.3. Management Areas

Two management areas have been designated for the Basin. These are:

- Bedford Management Area (Bedford MA) consists of the eastern areas of the Basin including Temescal Wash, and the Bedford area extends from the Elsinore Valley Subbasin to the south to the Temescal Subbasin to the north.
- Coldwater Management Area (Coldwater MA) consists of the western areas of the Basin and is more than 800 feet thick (Todd and AKM, 2008). The Coldwater Area does not share a boundary with either the Elsinore Valley or the Temescal Subbasins.

The Glen Ivy fault separates the Bedford area from the Coldwater area, resulting in differing geology, water use, water quality, and sources of water between the two areas. The fault offsets the aquifer units in the Bedford MA from the units in the Coldwater MA by up to approximately 250 feet (Todd, 2019), with the total basin thickness greater on the west side of the fault (Coldwater MA) relative to the east side of the fault (Bedford MA). These differences serve as the basis for defining two management areas in the Basin for the purpose of facilitating implementation of the GSP. The Bedford and Coldwater MAs will be used in the water budget analysis for the surface water and groundwater modeling results.

The Bedford MA is the area east of the Glen Ivy fault and west of the Estelle Mountain area. Alluvial sediments are up to 500 feet thick in the Bedford MA (Todd and AKM, 2008). Land uses are primarily urban residential and commercial/industrial in the Bedford MA. Temescal Wash flows from the southeast to northwest along the full length of the Bedford MA along the northern boundary of the Basin.

The Coldwater MA is the area located in a deep basin area located west the Glen Ivy fault and east of the Santa Ana Mountains. Alluvial sediments are more than 800 feet thick in the Coldwater MA (Todd and AKM, 2008). The City of Corona and Elsinore Valley Municipal Water District established a production agreement in 2008 to ensure the sustainable use of groundwater in the Coldwater area (EVMWD, 2008). Glen Ivy Hot Springs is a community water system with one well in the Coldwater MA, it is estimated the water system serves 750 people.

2.2. REGIONAL GEOLOGY

The Basin is located within one of the structural blocks of the Peninsular Ranges of Southern California. The Basin occurs in a linear low-lying block, referred to as the Elsinore-Temecula trough, between the Santa Ana Mountains on the west and the Perris Plain on the east (Norris and Webb 1990). The trough extends from Corona to the southeast some 30 miles and was formed along an extensive northwest-southeast trending fault zone including the Elsinore, Chino, and related faults. The Elsinore fault zone, including the Glen Ivy Fault, bound the Basin on the west and trend along the mountain front.

2.2.1. Geologic Units

The Bedford-Coldwater Basin is composed of alluvial fan, recent alluvial along Temescal Wash and older sedimentary rocks. These deposits are sourced from the Santa Ana Mountains to the west of the Basin and the Peninsular Ranges to the east of the Basin. Alluvial deposits along Temescal Wash and local tributaries define the eastern boundary of the Basin. The alluvial fan deposits in the Coldwater area extend into the Bedford area and appear to have been disrupted by faulting (GSP, Section 3, Figure 3-5).

Both older and recent alluvial fans have been deposited along the mountain front on the western edge of the Basin. Although these deposits are relatively thick, the entire unit is heterogeneous. These aquifers from less than 40 feet up to 500 feet in the Bedford area (eastern portion of the Basin) and up to 800 feet in thickness in the deepest portions of the Coldwater area (western portion of the Basin). Alluvial thicknesses tend to increase toward the center of the basin away from the faults (MWH, 2004, Todd and AKM 2008).

Underlying much of the Basin is the Bedford Canyon Formation (a slightly metamorphosed sedimentary formation composed of interlayered argillite, slate, graywacke, conglomeratic graywacke, impure quartzite, and small masses of limestone and quartz-rich metasandstone) and adjacent granitic rocks are the primary source materials for these alluvial deposits. In the northern Bedford area, a variety of

Tertiary sedimentary units crop out including the Silverado (Paleocene), Vaqueros (Miocene), Topanga (Miocene), and Puente (Miocene) formations (GSP, Section 3, Figure 3-5).

These uplands surrounding the Basin are composed principally of granitic, volcanic and older sedimentary rocks of Jurassic and Cretaceous age. The Coldwater MA is surrounded by the metamorphic, volcanic and granitic basement rocks of the Santa Ana Mountains to the south and west. Around the Bedford MA is an area of sedimentary units of Tertiary age that crop out along the mountain front generally lying east of the Glen Ivy Fault within the Elsinore Fault Zone. This zone of sedimentary units broadens to the north and contains numerous mapped formations of Cretaceous and Tertiary age.

2.2.2. Faults

The Glen Ivy Fault is associated with the right lateral strike-slip-dominated Elsinore Fault Zone that extends approximately 200 km from Baja California north to the Corona area. Bedrock faulting in the area largely controls depth to bedrock and the resultant alluvial thickness (MWH, 2004). The units in the Basin are truncated by the Glen Ivy fault that separates the Bedford area from the Coldwater area.

The location and effect of the Glen Ivy fault on the units of the Basin are shown on cross sections presented in GSP Section 3 (Figures 3-6 through 3-8). As shown on these cross sections, the Glen Ivy fault and related faults offset the units approximately by as much as 250 feet. This offset is inferred from well logs that extend to bedrock near the fault. Groundwater flow in the Basin is strongly affected by the Glen Ivy fault (Todd and AKM 2008, WEI 2015b) and the fault appears to be a nearly complete barrier to subsurface flow (MWH, 2004)

2.2.3. Pull-Apart Basin

The Elsinore Fault Zone forms a complex series of pull-apart basins (Morton and Weber 2003). The deep portion of the Basin in the Coldwater MA is one of these pull-apart basins. Pull-apart basins are topographic depressions that form at releasing bends or steps in basement strike-slip fault systems. This initial deposition into the Basin is composed of rapid deposition of landslide and debris flow deposits which are extremely poorly sorted with a mixture of clay, sand, gravel and boulders as seen on the well logs at the lower depths. Since the movement on the faults is right-lateral, the oldest sediments will be located at the lower levels in the northern part of the Basin. As the pull-apart basin forms, progressively younger sediments will be deposited from north to south. Because of this type of deposition, the lower units of the pull-apart basin can be chaotic.

Pull-apart basins are topographic depressions that form at releasing bends or steps in basement strike-slip fault systems. Traditional plan view models of pull-apart basins usually show a rhombic to spindle-shaped depression developed between two parallel master vertical strike-slip fault segments. The basin is bounded longitudinally by a transverse system of oblique-extensional faults, termed “basin sidewall faults” (**Figure 3**). Basins commonly display a length to width ratio of 3:1 (Wu et.al., 2012).

The Coldwater area of the Basin is located within a pull-apart basin between the Glen Ivy fault and the Elsinore Fault Zone located at the base of the Santa Ana Mountains. Based on the geology, the Glen Ivy fault limits deep groundwater flow, resulting in a limitation of the hydraulic connection between the Coldwater ad Bedford areas. At depth, the offset geologic units place the alluvial deposits in the Coldwater area against the Tertiary Bedford Canyon Formation. When groundwater levels in the Coldwater area are low, there is reduced groundwater flow across the fault. This is especially apparent during the recent periods when the groundwater levels in the Coldwater area were especially low. During these low water periods in the Coldwater area, groundwater levels are higher across the fault in the Bedford area resulting in minor inflows from Bedford into the Coldwater area. This is shown in some recent groundwater level data (GSP Sections 3 and 4). However, at shallower depths, the fault offset is across alluvial deposits. During periods, or areas, when groundwater levels in the Coldwater area are high, groundwater elevation data suggests these areas appear to be well-connected when groundwater elevations in the Basin are high (MWH, 2004, Todd and AKM 2008), indicating more compartmentalization with depth.

2.2.4. Definable Basin Bottom

The Basin bottom is defined by bedrock, which is shallow around the perimeter and deep in the center. Depth to bedrock ranges in depth from 10 feet to over 700 feet (Todd and AKM, 2008 and WEI, 2015b). The depth to the bottom of the alluvial materials in the Basin and the contact with the bedrock bottom of the Basin are shown in the contours presented in GSP, Section 3 (Figures 3-9). Aquifer thickness is greatest in the Coldwater portion of the Basin west of the Glen Ivy fault. Additional cross sections showing these relationships are provided in the GSP, Section 3 (Figures 3-6 through 3-8).

2.3. GROUNDWATER CONDITIONS

Understanding the groundwater conditions is important in development of the surface water and groundwater models. A summary of the discussion of the groundwater conditions and water balance based on the model results is provided in GSP Sections 4 and 5 is provided below.

2.3.1. Aquifer

The Basin is defined by the lateral extents of the alluvial material described above. This material is bounded by bedrock in the Santa Ana Mountain on the west and the Peninsular Ranges to the east. The southern and northern boundaries of the Basin are formed by areas of thin alluvial material over shallow bedrock in narrow valleys (Todd and AKM, 2008 and WEI, 2015b). The northeastern side of the valley is flanked primarily by granitic rocks of Cretaceous age. Erosion of these units has filled in the trough over time resulting in quaternary-age alluvial fan, channel, and other deposits making up the permeable portions of the groundwater Basin (Todd and AKM, 2008). The Basin is thin in some areas, which impedes groundwater flow. This is especially relevant at the northern and southern boundaries of the Basin. With the exception of the Glen Ivy fault described above, there are no other known aquifer characteristics impeding or impacting flow in the Basin.

The Basin aquifer is truncated by the Glen Ivy Fault that separates the Bedford area from the Coldwater area. The location and effect of the Glen Ivy Fault on the units of the Basin are shown on cross sections in GSP, Section 3 (Figures 3-6 through 3-8). As shown on these cross sections, the Glen Ivy Fault offsets the units by up to 250 feet. As noted above, these faults may sometimes impede groundwater flow, backing up groundwater west of the fault within the Coldwater MA and limiting flow into the Bedford MA (Todd 2019). However, there is insufficient groundwater elevation monitoring information to assess the extent of this potential barrier to flow and it is therefore not considered a complete barrier to groundwater flow in the Basin.

2.3.2. Recharge and Discharge Areas

Recharge to the Basin occurs primarily from infiltration of runoff, and to a lesser extent from deep percolation of precipitation and urban return flows, wastewater recharge, and subsurface inflow from outside the Basin. Most of the Basin recharge comes from the infiltration of runoff from precipitation in the Santa Ana Mountains west of the Basin and the Peninsular Ranges east of the Basin. Large amounts of runoff from the mountains flows into unlined channels and the shallow subsurface at the edges of the Basin and then on into and through the Basin. The amount of water available for recharge varies annually with changes in rainfall and runoff. Runoff into the Basin is subject to evapotranspiration, infiltration, and continued surface flow to and in the Temescal Wash. The watersheds contributing to the Basin include multiple drainages, all of which flow across the Basin in generally east-west orientations. Wet years generate large amounts of water that exceeds the recharge capacity of the Basin (Todd and AKM 2008).

Return flows are those portions of applied water (e.g., landscape irrigation) that are not consumed by evapotranspiration and returned to the groundwater system through deep percolation or infiltration. Return flows associated with urban, industrial, and agricultural water uses all have the potential to contribute to recharge to the Basin (Todd and AKM 2008). Discharge from wastewater treatment and subsurface inflow occur to a limited extent in the Basin. Recharge associated with wastewater is associated with discharge at the wastewater treatment facilities. Subsurface inflow occurs along the Basin boundaries. This is not considered to be a significant source of recharge to the Basin (Todd and AKM 2008).

Sand and gravel mining has been the predominant industrial land use in the southern half of the Coldwater MA, an activity that continues today. Localized sand and gravel operations are also located along Temescal Wash in the Bedford MA. In addition, berms along washes, diversions of surface water, and the presence of large gravel pits enhance groundwater recharge of runoff in Coldwater area (Todd and AKM, 2008).

Discharge from the Basin is almost entirely from groundwater pumping, evapotranspiration, and mining operations. There is some limited discharge across the northern Basin boundary with the Temescal Subbasin, but the thin alluvial material in this area limits the volume and timing of subsurface outflow along this boundary (Todd and AKM, 2008).

2.3.3. Primary Groundwater Uses

The primary groundwater uses in the Basin are municipal pumping, with limited private pumping for small water system, commercial, industrial and residential users. Groundwater use estimates are included in GSP Section 5 (Water Budget). Groundwater in the principal aquifer in the Bedford area is primarily used for non-potable municipal and irrigation water supply. The principal aquifer in the Coldwater area is mostly used for municipal water supply. Most of the pumping in this area is from wells owned and operated by the BCGSA agencies, with some additional pumping by small community water system and small commercial users. There has historically also been non-potable pumping in this area to support agricultural, recreational, small residential, and industrial water uses.

Gravel operations in the Coldwater MA extract water for industrial use to support sand and gravel mining. Their pumping amounts have ranged from about 100 AFY to 300 AFY, except for a period of increased production from 1975 through 1980 when production averaged about 450 AFY (Todd and AKM 2008).

3. RAINFALL-RUNOFF-RECHARGE MODEL

A rainfall-runoff-recharge model developed by Todd Groundwater was used to prepare estimates of groundwater recharge from rainfall, irrigation, bedrock inflow, and pipe leaks. It also generated the estimates of groundwater use for agricultural irrigation and flows in ungauged streams tributary to or within the basin. Several commercially available software programs were used to prepare model input and evaluate model output, such as Microsoft Excel and ArcGIS. Finally, the rainfall-runoff-recharge model and several pre-processing utility programs were developed in the Fortran 90 programming language by Todd Groundwater.

3.1. APPROACH

The rainfall-runoff-recharge model is built around a soil moisture balance of the root zone, which is simulated continuously using daily time steps for the 29-year calibration period. Numerous variables are involved in the physical processes of rainfall, interception, runoff, infiltration, root zone soil moisture storage, evapotranspiration, irrigation, shallow groundwater storage, recharge of deeper regional aquifers from shallow groundwater, and lateral flow of shallow groundwater into streams. Accordingly, the groundwater basin and tributary watersheds were divided into small recharge zones over which the most influential variables were relatively homogeneous. The daily water balance was then simulated for each zone, and the results aggregated geographically to cells in the groundwater model grid and temporally to the model stress periods.

The rainfall-runoff-recharge model provides several benefits to the groundwater modeling effort:

- It represents the hydrological processes with governing equations that reflect the actual physical processes, at least in a simplified way. This allows sensitivity or suspected errors to be traced to specific assumptions and processes.
- It enforces the principle of conservation of mass on the recharge and stream flow values. Beginning with rainfall, all water mass is accounted for as it moves through the hydrological system.
- It allows additional data sets to be included in model calibration. In tributary watersheds with gauged stream flow data, measured flows can be compared with simulated flows, which consist of the sum of direct runoff and shallow-groundwater seepage to streams. Simulated irrigation frequency can be compared with actual grower practices, and applied irrigation amounts can be compared with water delivery data recorded by the District. Simulated urban irrigation amounts can be compared with seasonal variations in measured urban water use, which are primarily related to urban irrigation.
- It provides estimates of stream flow in ungauged tributary streams, as well as runoff from valley floor areas within the active model domain.
- It provides estimates of inflow from bedrock and/or upland areas adjacent to the active model domain and constrains the amounts of inflow according to the water balance for each tributary watershed.
- It simulates the effects of runoff from impervious surfaces in urban areas, either to storm drainage systems or to adjacent pervious soils.
- It simulates changes in land use over the 29-year calibration period and the resulting changes in recharge and irrigation demand.

- It combines and parses all of these flows—plus estimated recharge from leaky water and sewer pipes—into recharge values by model cell and stress period in the format required by MODFLOW.

The following sections describe the input data sets and the assumptions and governing equations used to simulate each hydrologic process included in the rainfall-runoff-recharge model.

3.2. LAND USE AND RECHARGE ZONES

Recharge zones were developed by intersecting and editing numerous maps in GIS. The starting point was a map of the Bedford-Coldwater Basin and the boundaries of all surrounding watersheds that flow into it. The Basin area was divided into the Bedford MA and Coldwater MA. The Basin and tributary watersheds were then divided into numerous polygons reflecting land use as of 1990 and changes in land use since then. Land use was delineated into 13 categories based on DWR land use maps for Riverside County from 1993 and 2000, a statewide crop map developed by LandIQ for DWR in 2014 and Google Earth historical aerial imagery available for 1990-2018. The primary change in land use has been urbanization of undeveloped (natural vegetation) areas. Polygons were delineated to represent the locations of changes in land use so that a single, fixed set of polygons could accurately represent the evolution of land use by changing the use type of a polygon beginning in the year that land use changed. Additional divisions of polygons were made on the basis of soil texture, annual rainfall and watershed. This resulted in a total of 224 polygons ranging in size from 2 to 4,529 acres. A map of the zones and their land uses in 1990 and 2018 is shown in **Figure 4.**

Land use in each zone was assigned to one of thirteen categories. The only agricultural crop in the Basin is citrus, which occupied about 1,900 acres in 1990 and was almost entirely converted to residential during the 1990s. Natural land cover categories are grassland, shrubs/trees, dense riparian, sparse riparian and open water. Developed land uses are residential, low-density residential, turf, commercial, industrial, quarry and vacant. The natural and developed land uses were mapped by inspection of Google Earth aerial photography. The categories are listed in **Table 1** along with their total acreages in 1990, 2018 and 2068 (estimated) in the groundwater basin management areas and tributary watersheds.

Table 1. Bedford-Coldwater Basin Land Use (acres)

	Bedford Area			Coldwater Area			Tributary Watersheds		
Land Use	**1990**	**2018**	**2068**	**1990**	**2018**	**2068**	**1990**	**2018**	**2068**
Citrus	1,242	0	0	677	32	32	0	0	0
Grassland	1,700	1,454	385	171	87	33	16,703	16,429	16,174
Shrubs/Trees	226	110	30	173	138	82	13,777	13,693	13,693
Dense riparian	217	120	120	8	27	27	0	0	0
Sparse riparian	291	291	291	0	0	0	0	0	0
Open water	0	0	0	0	0	0	0	0	0
Low-density residential	159	175	132	66	88	88	0	0	0
Residential	179	1,023	2,255	76	405	547	0	94	327
Turf	7	225	288	0	170	226	0	85	107
Commercial	0	30	528	24	33	50	0	0	0
Industrial	232	469	469	0	0	0	0	0	0
Quarry	295	204	104	441	588	0	365	555	555
Vacant	648	1,030	494	38	105	0	0	0	0

Each land use category is further divided into irrigated, non-irrigated and impervious subareas. These are not explicitly mapped but are expressed as percentages of total zone area. Based on examination of aerial photographs and historical water use patterns, the percent impervious cover in urban land use areas was estimated to be 15 percent for low-density residential, 45 percent for residential, 70 percent for commercial and 80 percent for industrial. The corresponding percent irrigated area for those categories was estimated to be 14, 18, 10 and 0 percent, respectively.

3.3. RAINFALL

The distribution of average annual rainfall over the basin and tributary watersheds was obtained from PRISM climate modeling (http://www.prism.oregonstate.edu/). Each recharge zone was assigned an average annual rainfall value based on its location, as shown in **Figure 5**.

The surface hydrology model requires daily rainfall as one of two transient inputs. Daily rainfall for the Elsinore station was used for this purpose, with missing values supplied by correlation with rainfall at the Riverside Fire Station and Claremont-Pomona Stations, both of which also have long periods of record. Daily rainfall for each recharge zone was calculated as Elsinore daily rainfall multiplied by the ratio of zonal average-annual rainfall to Elsinore average-annual rainfall.

3.4. INTERCEPTION

Plant leaves intercept some of the rain that falls from the sky, and the amount is roughly proportional to the total leaf area of the vegetation canopy. The estimated interception on each day of rain ranged from zero for industrial, idle and vacant land uses, to 0.03 inch for turf and 0.06 inch for trees in full leaf. These estimates were inferred from published results of interception studies (Viessman and others, 1977). For each day of the simulation, rainfall reaching the land surface (throughfall) is calculated as rainfall minus interception. Interception storage is assumed to completely evaporate each day and is not carried over from one day to the next.

3.5. RUNOFF AND INFILTRATION

Most throughfall infiltrates into the soil, but direct runoff occurs when net rainfall exceeds a certain threshold. The threshold at which runoff commences and the percent of additional rainfall that runs off are significantly influenced by a number of variables, including soil texture, soil compaction, leaf litter, ground slope, and antecedent moisture. These factors can be highly variable within a recharge zone, and data are not normally available for them. Also, the intercept and slope of the rainfall-runoff relationship depend on the time increment of analysis. Most analytical equations for infiltration and runoff apply to spatial scales of a few square meters over periods of minutes to hours (Viessman and others, 1977). They are suitable for detailed analysis of individual storm events. The curve number approach to estimating runoff also applies to single, large storm events. It is not suitable for continuous simulation of runoff over the complete range of rainfall intensities (Van Mullen and others, 2002). The approach used in the rainfall-runoff-recharge model is similar but less complex than the approach used in popular watershed models such as HSPF (Bicknell and others, 1997).

In the rainfall-runoff-recharge model, daily infiltration is simulated as a three-segment linear function of throughfall, and throughfall in excess of infiltration is assumed to become runoff. The general shape of the relationship of daily infiltration to daily net rainfall is shown in **Figure 6** (upper graph). Below a specified runoff threshold, all daily throughfall is assumed to infiltrate. Above that amount, a fixed percentage of throughfall is assumed to infiltrate, which is the slope of the second segment of the infiltration function. Finally, an upper limit is imposed that represents the maximum infiltration capacity of the soil. The runoff threshold, the percentage of excess net rainfall that infiltrates, and the maximum daily infiltration capacity were assumed to vary by land use and were among the variables adjusted for model calibration. The runoff threshold ranged from 0.2 inches per day (in/d) for unpaved areas in industrial and commercial zones to 1.0 in/d for turf and natural vegetation areas. The infiltration percentage for excess rainfall ranged from 60 percent in commercial and industrial areas to 94 percent in areas of natural vegetation. The maximum daily infiltration was set to 2.5 in/d in upland tributary areas and 4 in/d for zones overlying the Basin. These values were selected on the basis of calibration, although results were not very sensitive to this parameter.

The above parameter values are for soils that are relatively dry. Infiltration rates decrease as soils become more saturated. This phenomenon led to the development of the Antecedent Runoff Condition adjustment factor for rainfall-runoff equations (Rawls and others, 1993). However, application of the concept has been focused on individual storm events. For the purpose of the rainfall-runoff-recharge model, the adjustment provides a means of simulating empirical observations that a given amount of rainfall produces less runoff at the beginning of the rainy season when soils are relatively dry than at the end of the rainy season when soils are relatively wet. This effect is included in the recharge model as a multiplier that decreases the estimated infiltration as soil saturation increases. This multiplier is applied to the runoff threshold, the infiltration slope and the maximum infiltration rate. The multiplier decreases from 1.0 when the soil is dry to a user-selected value between 1.0 and 0.60 when the soil is fully saturated (lower graph in **Figure 6**). A low value has the effect of decreasing infiltration (and potential groundwater recharge) toward the end of the rainy season or in very wet years, and also to increase simulated peak runoff during large storm events. The multiplier under saturated conditions was assumed to be 0.75 for the Bedford-Coldwater rainfall-runoff-recharge model.

Runoff from impervious surfaces was assumed to equal 100 percent of rainfall. Runoff that flows into a storm drain system (known as “connected impervious runoff”) contributes to stream flow but not groundwater recharge. However, runoff from some impervious surfaces flows onto adjacent areas of pervious soils (“disconnected impervious runoff”). The surface hydrology model treats this type of runoff as if it were a large increment of additional rainfall where it flows over or ponds on the pervious soils. The excess water can quickly saturate the soil and initiate deep percolation. The model incorporates this process by means of a variable representing the fraction of impervious runoff that becomes deep percolation. Data and literature values are not available for this variable. It was estimated to be 20 percent in residential, commercial and industrial areas and 80 percent in low-density residential areas.

3.6. ROOT ZONE DEPTH AND MOISTURE CONTENT

The storage capacity of the root zone equals the product of the vegetation root depth and the available water capacity of the soil. The available water capacity for each recharge zone was a depth-weighted average for the dominant soil type, as reported in the soil survey (Natural Resources Conservation Service, 2015). Root depth is a complex variable. Except for cropland, vegetation cover typically consists of a mix of species with different root depths. At a very local scale, roots are deepest directly beneath a plant and shallower between plants. Root density and water extraction also typically decrease with depth within the root zone. To complicate matters, root depth is somewhat facultative for some plants, which means that roots will tend to grow deeper in soils with low available water capacity, such as sands. Finally, root depth in upland watershed areas can be restricted by shallow bedrock.

The root depth selected for each recharge zone essentially represents an average of all these factors. Simulated recharge and stream base flow are both quite sensitive to vegetation root depth, and values were adjusted during the joint calibration of the rainfall-runoff-recharge model and the groundwater flow model. Separate root depths were specified for irrigated and non-irrigated vegetation in each recharge zone. Root depths for turf and crops were required to be the same in all zones. In upland watersheds root depth can be affected by the depth to bedrock, which is often shallow. Outflow from individual tributaries flowing into the basin is not gaged, and uniform rooting depths for grass and shrubs/trees were used throughout all of the watersheds.

3.7. EVAPOTRANSPIRATION

Evapotranspiration is affected by meteorologic conditions, plant type, plant maturity, and soil moisture availability. All of these factors are included in the rainfall-runoff-recharge model. The evaporative demand created by meteorological conditions is represented by reference evapotranspiration (ETo). Numerous equations have been developed over the years relating ETo to solar radiation, air temperature, relative humidity and wind speed. For the purposes of this study, daily values of ETo were obtained from a microclimate station in Temecula (about 20 miles south of the Basin) that is part of the California Irrigation Management Information System (CIMIS) network.

Vegetation factors are lumped into multipliers called crop coefficients. Reference ET is the amount of water evapotranspired from a broad expanse of turf mowed to a height of 4-6 inches with ample irrigation. ETo is multiplied by a crop coefficient to obtain the actual ET of a different crop or vegetation type at a particular stage in its growth and development. Although primarily used for agricultural crops, crop coefficients can also be applied to urban landscape plants and natural vegetation. The only agricultural crop in the Basin is citrus trees, which have a crop coefficient that ranges from 0.5 in winter to 0.91 in mid-summer (U.N. Food and Agriculture Organization, 2006). Irrigated landscaping was assumed to consist primarily of turf, for which a crop coefficient of 0.8 was used in all months (Snyder and others, 2007). Non-irrigated natural grassland consists of annual grasses that go dormant in summer once soil moisture has been depleted. A crop coefficient of 1.0 was assigned in all months, but actual ET decreases to zero as the grasses lower soil moisture to the wilting point in summer. Natural shrubs/trees were assigned a crop coefficient of 0.8 year-round. Those perennial species have deeper roots and do not tend to fully deplete root zone soil moisture during a single dry season (Blaney and others, 1963). Many riparian phreatophytes are deciduous, and a crop coefficient of 0.75 was assigned for winter months to reflect a reduced leaf area index. Their tall stature and linear distribution within an arid landscape raises the crop coefficient in summer months, and a coefficient of 1.10 was assigned to reflect those factors.

3.8. IRRIGATION

Evapotranspiration gradually depletes soil moisture, and for irrigated areas the rainfall-runoff-recharge model triggers an irrigation event whenever soil moisture falls below a specified threshold. The amount of applied irrigation water is equal to the volume required to refill soil moisture storage to field capacity, divided by the assumed irrigation efficiency. An irrigation threshold equal to 70 percent of maximum soil moisture storage was used for citrus, and a threshold of 0.8 was used for urban landscaping. This variable primarily affects the frequency of irrigation; a higher threshold results in more frequent irrigation but approximately the same total amount of water applied annually. Ten percent of water applied to citrus was assumed to percolate past the root zone, and 15 percent was assumed for urban irrigation. This reflects nonuniformity of applied water, such as uneven overlap of sprinkler spray areas.

There are additional sources of irrigation inefficiency, such as evaporation of sprinkler spray mist and sprinkler overspray or runoff onto impervious surfaces in urban areas. Thus, total irrigation efficiency is less than 90 percent for citrus and 85 percent for urban landscaping. Total efficiency was used to estimate applied water, but only the deep percolation component was used to estimate deep percolation. Urban irrigation in the Basin is supplied by municipal water purveyors, and irrigation use is included in their metered deliveries. The rainfall-runoff-recharge model was only used to estimate groundwater pumping for citrus irrigation.

Because irrigation is assumed to completely refill soil moisture storage and is less than 100 percent efficient, simulated soil moisture exceeds capacity immediately following an irrigation event. The excess is assumed to become deep percolation beneath the root zone.

3.9. DEEP PERCOLATION FROM ROOT ZONE TO SHALLOW GROUNDWATER

The surface hydrology model updates soil moisture storage each day to reflect inflows and outflows. Rainfall infiltration and applied irrigation water are added to the ending storage of the previous day, and ET is subtracted. If the resulting soil moisture storage exceeds the root zone storage capacity, all of the excess is assumed to percolate down from the root zone to shallow groundwater on that day. In modeling parlance, this is known as a "bathtub model"; vertical unsaturated flow and preferential flow through cracks and root tubes in the soil are not considered.

3.10. MOVEMENT OF SHALLOW GROUNDWATER TO DEEP RECHARGE AND STREAM BASE FLOW

A shallow groundwater storage component may not be part of all groundwater systems, but its presence is sometimes indicated by groundwater hydrographs and stream base flow. In upland watersheds, for example, the shallow groundwater reservoir is what supplies base flow to streams. Without it, simulated stream flow consists of large flows occurring only on rainy days. Physically, it represents the overall permeability and storage capacity of deep soil horizons and bedrock fractures beneath hillsides bordering a gaining stream. It allows the integration of shallow and deep, fast and slow flow paths between the point of rainfall infiltration and the stream. In valley floor areas with flat terrain and deep deposits of unconsolidated basin fill, the presence of a shallow groundwater system is sometimes evident in a lack of response of deep well hydrographs to rainfall recharge events or even wet versus dry years. The shallow zone in that case attenuates the pulses of recharge percolating beneath the root zone into a relatively steady recharge flux, and there may be little outflow to streams.

In the surface hydrology model, the only inflow to shallow groundwater storage is deep percolation from the root zone. There are two outflows: laterally to a nearby creek and downward to the regional groundwater flow system. Outflow to streams is specified as a certain percentage of current groundwater storage, which results in a first-order logarithmic recession of stream base flow, consistent with gaged stream flows. Outflow to the regional groundwater system is simulated as a constant downward flux. This is consistent with flow across confining layers in which the vertical head gradient is near unity. Both outflows are calculated and subtracted from shallow groundwater storage each day. They continue until the storage has been exhausted, resuming whenever a new influx of deep percolation from the root zone arrives. There is no assumed maximum capacity of shallow groundwater storage.

The two parameters defining shallow groundwater flow are the recession constant for flow to streams and the constant downward flow rate for deep recharge. Both of these are obtained by calibration. The recession constant can generally be calibrated by matching simulated to measured stream base flow in gaged watersheds. The deep recharge rate can be used to adjust the long-term partitioning of shallow groundwater mass into base flow versus recharge.

The shallow groundwater component of the surface hydrology model is simple but adequate to capture the fundamental behaviors of logarithmic stream base flow recession and attenuated deep recharge. Other watershed models invoke more complex systems of storage and flow to simulate these processes. For example, the Precipitation and Runoff Modeling System (PRMS) developed by the U.S. Geological Survey includes a total of seven storage components between the point where a raindrop reaches the ground and the stream into which it ultimately flows (Markstrom and others, 2015). This larger number of components and parameters enables relatively detailed matching of observed stream flow hydrographs but is unnecessarily complex for the purposes of groundwater modeling.

3.11. EVAPOTRANSPIRATION BY RIPARIAN VEGETATION

In locations where the water table is shallow, some plants (phreatophytes) can extract water directly from the water table to meet evaporative demand. The rainfall-runoff-recharge model was used to estimate the amount that would be drawn from the water table if a shallow water table were present. The potential use of groundwater by phreatophytes was assumed to equal the ET demand of the vegetation minus the amount that could be supplied by soil moisture. In practice, this was accomplished by temporarily simulating the vegetation as if it were irrigated using the rainfall-runoff-recharge model, then using the simulated irrigation rates as the maximum rate of withdrawal by roots from the water table. This rate of groundwater use is thought to decrease with increasing depth to the water table because fewer shrub and tree roots are able to reach the water table and the energetics of withdrawing the water become less favorable. The use of groundwater decreases from the maximum rate when the water table is at the land surface to zero when the water table is 15 feet or more below the ground surface. These calculations are applied at model cells where aerial photographs indicate the presence of dense, lush riparian vegetation, which is a sign of phreatophytic water use. These calculations were also made using the MODFLOW evapotranspiration (EVT) module.

3.12. GROUNDWATER INFLOW

Groundwater inflow into the basin from adjacent uplands—also called mountain front recharge—is difficult to estimate. If the basin is bounded by igneous or metamorphic rocks with very limited groundwater flow through fractures, it can be reasonable to assume that inflow from bedrock is negligibly small. If the bedrock is fractured, the total amount of inflow across the long “no-flow” boundaries on the east and west sides of the Basin can be cumulatively significant. Subsurface inflow across those boundaries was estimated using the rainfall-runoff-model results for the tributary watersheds. By this method, the estimates must be consistent with conservation of mass in the watersheds; that is, with the estimates of rainfall, ET, and surface outflow. The resulting estimates are still highly uncertain, however, because groundwater outflow from the watersheds—and surface outflow, too, for that matter—are both small compared to the two largest flows in the watershed water balances: rainfall and evapotranspiration. Thus, a small error in the estimate of either of those flows can result in a large error in groundwater outflow.

Ultimately, groundwater flows produced by the rainfall-runoff-recharge model were calibrated based on their effects on simulated groundwater levels at nearby wells within the basin and on the simulated amount of stream base flow exiting the watersheds. The initial groundwater inflow estimates were generally too high. The estimates were lowered primarily by increasing the estimated root depth of natural vegetation in the watersheds, which is highly uncertain due to the effects of shallow bedrock on rooting depth.

Groundwater inflow from tributary watersheds was smoothed over time to reflect attenuation of recharge pulses that occur during wet months and wet years as they gradually flow through long, relatively slow flow pathways. Smoothing was accomplished by a moving average of simulated groundwater recharge in the tributary areas over the preceding 2-10 years. This range represents local variability that was indicated by rates of recession in stream base flow and groundwater levels near the basin boundary during prolonged droughts. The final estimate of average annual groundwater inflow during the calibration period was 5,400-7,200 AFY under normal climatic conditions.

3.13. CALIBRATION OF RAINFALL-RUNOFF-RECHARGE MODEL

Parameters in the rainfall-runoff-recharge model were jointly calibrated with the groundwater model. The total amount of dispersed recharge and annual variations in recharge influence simulated groundwater levels, and parameters in the rainfall-runoff-recharge model were adjusted to improve the fit between measured and simulated groundwater hydrographs. The rainfall-runoff-recharge model was also calibrated based on a comparison of measured and simulated daily stream flow at two gage locations: Coldwater Canyon Creek and Temescal Wash at the Lee Lake dam. Coldwater Canyon Creek flows into the adjacent Bedford-Coldwater Basin and is the only gaged stream draining the eastern slopes of the Santa Ana Mountains. Characteristics and model parameters for that watershed were assumed to also apply to similar watersheds along the western edge of the Basin. Unfortunately, the gage began operation in 2019, which is after the 1990-2018 model simulation period. Nevertheless, the general pattern of flow peaks and base flow recession simulated in prior years was similar to the gaged pattern in 2019-2020, as shown in **Figure 7**.

4. NUMERICAL GROUNDWATER MODEL DEVELOPMENT

The numerical model incorporated the hydrogeological data from the basin and hydrologic model and is capable of simulating historical and future conditions. The following section describes the development of each of the components in the MODFLOW model.

4.1. GENERAL APPROACH

The Bedford-Coldwater Model is a numerical groundwater model, which is a mathematical description of the hydrogeological conceptual model (Bear and Verruijt, 1987). The advantage of a numerical model is that, once in a mathematical format, the model quantitatively combines data on basin geometry, aquifer properties, recharge, and discharge to simulate changes in groundwater elevations and calculate the water balance over time.

The Bedford-Coldwater Model is setup to represent the physical features that influence groundwater flow including the geology, hydrology and climate. Each of these features is mapped onto a model grid that represents the vertical and horizontal distribution of parameters over the Basin based on the hydrogeological conceptual model. The parameters can also be varied through time over a defined base period to represent seasonal variations in precipitation, streamflow and groundwater pumping. A more detailed discussion of how each of these parameters was developed and entered into the Bedford-Coldwater Model is summarized below.

- Model Setup - representation of the physical groundwater basin
- Boundary Conditions – representation of the inflows and outflows from outside of the model
- Aquifer Properties – representation of the flow characteristics of the aquifer
- Initial Conditions – representation of groundwater conditions prior to the model period

The model development was focused on the HCM with emphasis on defining boundary conditions and flow paths. Aquifer parameters were assigned on a subregional basis within each MA and varied by model layer to represent reasonable aquifer properties for the geologic unit being simulated.

4.2. MODEL SETUP

The model also incorporates spatial distribution of the physical features of the Basin and the temporal distribution of time-varying parameters such as precipitation and recharge. The following describes the basic components required to construct a numerical model.

4.2.1. Model Code Selection

The model setup utilizes the MODFLOW modeling code developed by the United States Geological Survey (USGS). The Bedford-Coldwater Model uses MODFLOW-NWT (Niswonger *et al*, 2011), which is a standalone version of MODFLOW-2005 (Harbaugh, 2005) that includes an advanced mathematical solver that provides a more robust solution to complex conditions such as rewetting of dry model cells, unconfined conditions and groundwater-surface water interactions. These features improve the ability of the Model to evaluate complex groundwater-surface water interactions, potential conjunctive use, and other projects to increase future groundwater levels in the Basin.

4.2.2. Base Period

The update Bedford-Coldwater Model is setup using water years that run from October through to the following September to capture the cause and effect relationship on groundwater levels of wintertime rain and subsequent summertime groundwater pumping. The model simulates the 29-year base period from October 1989 through September 2018 to represent Water Years (WY) 1990 through 2018. This retains the starting date of prior models, which coincides with the beginning of some key data sets and also the beginning of the period of rapid land use conversion from agricultural to urban. The ending year is the most recent year for which all necessary model input data were available. The 29-year simulation period is desirable for model calibration purposes because it includes a wide range of hydrologic and water use conditions, including wet periods, droughts, changes in groundwater pumping and implementation of lake management measures.

To simulate this base period, the model is subdivided into time intervals termed stress periods. For each water year, monthly stress periods were defined to provide the ability of the model to evaluate temporal at a monthly scale. For the base period, a total of 348 stress periods were defined. Time-dependent parameters, such as groundwater pumping or precipitation recharge, are assigned to for each stress period.

Conditions during the stress period are constant, but parameters can be varied from stress period to stress period. A stress period can be subdivided into shorter time periods, or timesteps, to allow for more temporal resolution within each stress period to help with model convergence. For the Bedford-Coldwater Model, each stress period was simulated using three (3) timesteps. MODFLOW calculates the groundwater elevations and water balance for each time step. The model results provide the groundwater elevations for the final timestep of each stress period, and the summation of the water balance changes for all timesteps for each stress period.

4.2.3. Model Domain and Grid

MODFLOW requires the application of a rectangular grid that encompasses the entire area, or domain, that will be modeled. The model grid forms the mathematical framework for the model. Each grid cell has to be populated with aquifer properties. Physical features such as streams and wells are mapped onto the model grid. Using this information, the MODFLOW model calculates a groundwater elevation at each model grid cell for each timestep. The density of model grid cells is what defines the resolution of the model in resolving drawdown and other hydrologic effects.

The Basin covers about 11 square miles of the Santa Ana River Watershed that underlies the Elsinore Valley in western Riverside County. The extent of the model domain for the Bedford-Coldwater Model is shown on **Figure 8**. The Basin has two management areas that are defined within the model domain for water budget zone budgets (**Figure 9**). These include:

- **Bedford Management Area (Bedford MA)** occupies roughly the eastern two-thirds of the Basin. It is separated from the Coldwater MA by the Glen Ivy Fault, which is a partial barrier to groundwater flow. The Bedford MA connects to the Elsinore Subbasin in the south and the Temescal Basin at the north end of the Basin.,
- **Coldwater Management Area (Coldwater MA)** is the part of the Basin west of the Glen Ivy Fault. Because of downward movement on that side of the fault, Basin thickness is much greater than in the Bedford MA. A large open-pit mine is located in the southern part of this MA. Several streams enter the Coldwater MA from watersheds on the eastern slopes of the Santa Ana Mountains.

The Bedford-Coldwater Model consists of 250 rows, 365 columns and 3 layers. The rows and columns have a uniform spacing of 100 feet. Each 100-foot square represents a model cell. MODFLOW calculates one groundwater level for the center point of each grid cell for each timestep. The total number of grid cells in the Bedford-Coldwater Model is 273,750 cells, of which 87,882 are active cells where MODFLOW calculates a groundwater levels. The active areas represent the area within the groundwater basin where groundwater elevations are simulated.

Areas outside of the Basin are represented as no-flow cells where MODFLOW does not perform calculations. The high percentage of no-flow cells in the model grid is due to both the elongate shape of the Basin, the inclusion of narrow watersheds off of the main Basin, and because the distribution of active cells varies from layer to layer. The bottom of the lowest model layer is a no-flow boundary condition, representing the older bedrock formations that are assumed to be relatively impermeable.

4.2.4. Model Layers

The model layers represent the geologic the geologic units that compose the Principal Aquifer of the Basin based on the geology and HCM presented in summarized in **Section 2**. Model layers provide vertical resolution for the model to simulate variations in groundwater elevation, aquifer stresses, and water quality with depth. The model layers are based on an evaluation of the following data sets:

- Surficial geology,
- Faulting,
- Lithologic borehole logs.
- Well construction logs, and
- Previously completed local hydrogeologic conceptualizations and cross sections.

This information was collected and translated into a unified GIS compatible database structure for cross section construction and geographic evaluation. This approach allows any hydrostratigraphic structures relevant to groundwater flow in the Basin to be easily translated from GIS for use in other formats.

For the Bedford-Coldwater Model, three model layers were defined to simulate hydrogeologic character of the primary water-bearing sediments within the groundwater basin. The model layers are numbered from 1 through 3 from top to bottom. The top of Model Layer 1 represents the topography that is based on topographic elevation points every 10 meters were extracted from the National Elevation Dataset (http://ned.usgs.gov) throughout the model domain **Figure 10**.

The model layers represent the geologic units within each of the hydrologic areas. **Figures 11 through 13** show the areal extent and thickness of each of the model layers over the entire model domain. **Figures 14 and 15** show cross sections of the model grid along row 127 and column 230, respectively, to illustrate the shapes and relative thicknesses of the layers. The following provides a summary of the geologic units represented by each model layer in accordance with the HCM for the three hydrologic areas.

In the Bedford MA, three model layers were defined that represent the following geologic units:

- Model Layer 1 – Temescal Wash alluvium and shallow soils
- Model Layer 2 – Tertiary sedimentary units primarily the Bedford Canyon Formation
- Model Layer 3 - Weathered bedrock

The alluvium along Temescal Wash is the primary water supply unit in the Bedford MA (Todd and AKM 2008) where the larger wells are completed. The alluvial deposits are a mix of interlayered gravels, sands, silts, and clays resulting from alluvial fan and fluvial processes. Model Layer 1 ranges up to 80 feet thick along the Temescal Wash. Alluvial aquifer materials are present in other parts of this hydrologic area, but their extent and production capacity are uncertain. In these areas, Model Layer 1 represents a relatively thin layer, with a minimum thickness of five feet, that overlies the Bedford Canyon Formation that is rarely saturated.

Model Layer 2 represent the Bedford Canyon Formation that is composed of alternating slate and fine-grained sandstone, underlies alluvial deposits in this hydrologic area and is generally less than 200 feet deep (Todd and AKM 2008). It is reported to have limited groundwater production potential (Todd and AKM 2008). The bottom of Model Layer 2 is defined based on depth to bedrock data in the Bedford MA that ranges from 25 feet to approximately 500 feet (Todd and AKM 2008). Model Layer 3 represents the weathered and fractured bedrock formations underlying Model Layer 2. These basement rocks have limited produce significant groundwater except in fractures (Todd and AKM 2008).

In the Coldwater MA for the areas outside of the deep basin area that are upgradient of the Wildomar and Glen Ivy Faults, three model layers were defined that represent the following geologic units:

- Model Layer 1 – Coldwater Basin alluvial fill sediments.
- Model Layer 2 - Older Alluvial deposits
- Model Layer 3 - Weathered Bedrock

The alluvium (both young and old) that fills the deep basin in the Coldwater Basin, represented by Model Layers 1 and 2, forms the majority of the Basin aquifer. These alluvial deposits may be more than 800 feet thick locally and are composed of interfingered gravels, sands, silts, and clays (MWH 2004, Todd and AKM 2008). Groundwater is generally unconfined in these aquifer units.

Model Layer 3 represents the weathered and fractured bedrock formations underlying Model Layer 2. Domestic wells competed along the margins and along the narrow canyons that extend from the main part of the groundwater basin are completed in weathered bedrock. Model Layer 3 is represented by a uniform thickness of 75 feet in the weathered bedrock based on well logs of domestic wells along the basin margin.

4.2.5. Faults

The Basin is dominated by the Glen Ivy Fault zone that forms a partial barriers to groundwater flow in the between the Bedford and Coldwater MAs based on water level differences and on analysis of sources of groundwater recharge across the fault (MWH 2004, Todd and AKM 2008). The location of the faults applied for the Bedford-Coldwater Model are shown on **Figure 16**. For the Bedford-Coldwater Model, all faults extended across Model Layers 1 through 3.

The faults were simulated using the Horizontal Flow Boundary (HFB) Package in MODFLOW that allows by defining a conductance parameter to be placed between adjacent model cells that can act to limit groundwater flow. All of the faults were simulated as a 10-foot wide zone. The lowest fault hydraulic conductivities were applied for the faults bordering the Back Basin where the hydraulic conductivity ranged from 0.0001 to 0.00001 ft/d. The fault hydraulic conductivities were based on an initial estimate that was refined during model calibration.

4.2.6. Aquifer Conditions

Groundwater conditions for each model layer can be defined as unconfined, fully-confined, or convertible between confined and unconfined based on the relation of the simulated groundwater level to the top of the model layer. Unconfined conditions exist when groundwater levels are below the top of the physical aquifer layer whereas confined conditions exist when groundwater levels are above the top of the physical aquifer layer. For the Bedford-Coldwater Model, Model Layer 1 is defined as unconfined. Model Layers 2 and 3 are defined as convertible between confined and unconfined conditions.

Because of the historical changes in groundwater levels, areas within the Basin can be temporarily unsaturated. Prior MODFLOW versions set a dewatered cell to a no-flow condition for the rest of the simulation if the cell is dewatered. An important advantage of using MODFLOW-NWT compared to previous MODFLOW versions is that groundwater heads will be calculated for dry cells, whereas standard MODFLOW excludes these calculations (Niswonger et. al., 2011). This resaturation capability of MODFLOW-NWT was utilized for the Bedford-Coldwater Model.

In MODFLOW-NWT, cells can be reset to active using the rewetting option without setting a dewatered cell to no flow condition. MODFLOW-NWT will calculate a head in a dry cell while not allowing water to flow out of a dry cell that provides a continuous solution for groundwater flow. Inflow to a dry cell, either from adjacent cells, overlying cells, or an external source simulated by one of the stress packages, automatically flows downward to an underlying cell if there are deeper layers. A cell with head below the cell bottom has no water in storage, so changes in storage also are zero for these cells. The model accounts for this situation by setting the storage coefficient for a dry cell to zero. This allows for the continuous solution of head not to affect the overall water balance results (Niswonger et. al., 2011).

Because groundwater heads are calculated for dry cells using this approach, it is necessary for the model user to interpret the head in a cell relative to the cell bottom. If the head in a cell is at or below the cell-bottom altitude, then the water table is not contained within this cell (Niswonger et. al., 2011).

4.3. BOUNDARY CONDITIONS

Model boundary conditions represent the hydrologic budget by simulating where groundwater enters and exits the basin. Boundary condition data must be entered for each stress period at each model grid cell where a boundary condition is defined in the model. MODFLOW NWT provides a number of boundary condition options to numerically represent the different physical processes included in the hydrologic budget. The physical distribution and volumes of groundwater inflow and outflow for each budget component needs to be accounted for geographically within the model domain. A discussion of each boundary condition of the groundwater budget is provided below.

4.3.1. Surface Recharge

The surface recharge includes the contributions from precipitation and return flows within the Bedford-Coldwater Model. The surface recharge is applied using zones that are defined by the geology and land use. Surface recharge is applied using the MODFLOW recharge package and using the methods outlined below. This summary discusses implementation of surface recharge into the Bedford-Coldwater Model.

4.3.2. Streams

The groundwater model dynamically simulates groundwater recharge from stream percolation and groundwater discharge into streams. Percolation from streams is a function of stream flow and—where the water table is equal to or higher than the stream bed elevation—the difference in water level between the creek and water table.

The MODFLOW stream flow routing (SFR2) package is used to simulate these processes. Each stream in the basin is simulated as a sequence of reaches, each of which is a model grid cell along the alignment of the channel. Flow is specified at the upstream end of each stream segment and routed down the reaches, with flow to or from the aquifer calculated on the basis of wetted channel area, channel bed hydraulic conductivity and the difference in elevation between the stream surface and the simulated groundwater level at that reach. By this means conservation of mass is applied concurrently to the stream and the aquifer. Streams can dry up completely as they cross the basin; and conversely, groundwater discharge can create stream flow in a segment that is dry farther upstream. The stream flow routing module allows for a network of channel segments, with multiple inflows or diversions at the start of each segment.

The Bedford-Coldwater Model includes a network of 43 stream segments containing a total of 1,363 stream reaches (**Figure 17**). Twenty-two segments are used to simulate eleven streams that drain watersheds in the Santa Ana Mountains along the west side of the Basin. Streams that flow across the Coldwater MA onto the Bedford MA where they connect up with Temescal Wash are divided into multiple segments to represent varying underlying geologic conditions. Temescal Wash is composed of thirteen segments that represent reaches along Temescal Wash. Five segments represent the short sections of five streams that drain watersheds in the Estelle Mountain and other upland areas east of Temescal Wash. Three segments represent internal drainage within the Basin the receive valley floor runoff in the northern Bedford MA.

In general, most stream reaches are more than 20 feet above the water table and are not hydraulically coupled to groundwater. Percolation from those reaches is independent of groundwater levels and not affected by pumping. Reaches where groundwater appears to be hydraulically coupled to surface water primarily include most of the length of Temescal Wash, and the lower ends of some larger tributaries as they approach the wash. All streams in the Coldwater MA are detached from the groundwater except for limited areas in the small canyons along the western basin margin.

Stream bed permeability was estimated by model calibration. Calibrated values ranged from 0.1 to 1.0 feet per day (ft/d). The relationships of stream width and depth to stream flow were divided into two categories. For small tributary streams, the relationships were patterned after measured data at the Coldwater Canyon gage. Inflows for Temescal Wash are coordinated with output from the Elsinore Valley numerical model and the USGS gauge located downstream of Lee Lake just south of the basin boundary with the Basin.

To develop estimates of surface and subsurface inflows from these tributary areas to the groundwater basin, a rainfall-runoff-recharge model is used to simulate the entire watershed tributary to the Basin. This model simulates all near-surface hydrologic processes, including rainfall, runoff, infiltration, evapotranspiration, effects of impervious areas and irrigation, soil moisture storage and percolation to stream base flow and deep groundwater recharge. The calculated runoff is included in the SFR2 Package.

4.3.3. Mountain Front Recharge

Groundwater inflow into the basin from adjacent uplands—also called mountain front recharge—were calculated by the rainfall-runoff-recharge model (see Section 3). Mountain front recharge represents subsurface inflow of groundwater from the low-permeability rocks adjacent from the surrounding watershed to the groundwater Basin. the MODFLOW General Head Boundary (GHB) package was applied along the basin margin in Model Layer 3 which represents the weathered bedrock. The distribution of the GHB cells is shown on **Figure 18.**

The GHB package is a head dependent boundary condition; therefore, the amount of groundwater flowing into or out of this boundary was influenced by the relative hydraulic gradient between the basin and the boundary condition. To have the GHB package input the bedrock inflows determined by the rainfall-runoff-recharge model (see Section 3), the GHB was set up to act as a rate limited flux boundary. To do this, the reference head was a considerable distance away (one mile) from the recharge location, so it is well above the groundwater levels in the model. The conductance and elevation terms for the GHB package were back-calculated to get the appropriate flux. By setting the head at distance, the variability due to the changing heads in the groundwater model produces a variation of 1 to 2 percent in the GHB flux compared to the rainfall-runoff-recharge model values. The advantage of this approach is that the bedrock inflow can more easily be distributed to a large number of cells along the basin margin to maintain simulation stability. In addition, this approach allows the Bedford-Coldwater Model to simulate a consistent groundwater gradient flowing away from the margins to be consistent with the HCM.

4.3.4. Evapotranspiration

Evapotranspiration (ET) represents groundwater outflow from evaporation to the atmosphere and uptake by plants from the saturated zone. This is distinct from ET associated with soil moisture before it reaches the groundwater aquifer that is sustained by the total available precipitation not accounted for by runoff or recharge (see Section 3).

The MODFLOW Evapotranspiration (EVT) package is used simulate ET directly from the groundwater aquifer. ET is defined over the entire model domain; however, ET only occurs in areas of shallow groundwater. In the Basin, this is generally limited to riparian areas adjacent to streams. ET includes uptake from both phreatophytes (plants that require groundwater) and mesophytes (plants that can utilize groundwater) either directly from the saturated zone or from the overlying capillary fringe (Meinzer, 1927; Robinson, 1958; and Lewis and Burgy, 1964). ET from the capillary fringe is replenished with groundwater from the underlying aquifer, so it is also considered a loss of groundwater (Lubczynski, 2011).

The MODFLOW EVT package that the ET rate decreases with increasing depth to the water table because fewer shrub and tree roots are able to reach the water table and the energetics of withdrawing the water become less favorable. In the groundwater model, the consumptive use of groundwater due to ET decreases from the maximum rate when the water table is at the land surface and diminishes linearly down to zero when the water table reaches the extinction depth for that location.

In the Bedford-Coldwater Model, three ET zones were defined as shown on **Figure 19**. The first zone represents locations where aerial photographs indicate the presence of dense, lush riparian vegetation indicates areas of shallow groundwater where the plants (phreatophytes) can regularly uptake water directly from the water table to meet evaporative demand. These occur along the Temescal Wash and in the upper portions of some of the canyons along the basin margin. The extinction depth for these locations was set at 15 feet below the ground surface. Over most of the remaining model domain, the extinction depth was set at 7.5 feet to represent the vegetation in these areas. The third area represents areas where quarry lakes exist where the extinction depth was set at 3.0 feet to represent evaporation off of ponded water that periodically exists in these quarry areas. ET rates applied in the Bedford-Coldwater Model use the ET data from the rainfall-runoff-recharge model (see Section 3).

4.3.5. Groundwater Pumping

Groundwater pumpage is the most significant groundwater outflow component for the basin. Groundwater users in the Basin are required to report their pumping to Western Municipal Water District, which is one of several agencies responsible for administering adjudication decrees in the Upper Santa Ana River Watershed area. Thirty-eight wells within the Basin produced groundwater in one or more years during 1990-2018, and the reported annual pumping amounts were obtained from WMWD. **Figure 20** shows the locations of pumping in the Basin. Locations of agricultural pumping are distributed based on the estimated agriculture pumping requirements calculated using the rainfall-runoff model (**Figure 21**).

Annual production by all of the wells generally increased from 1990 to about 1999; however, from 2000 through 2007 annual production stabilized at about have the 1990-1999 rates, as shown in **Figure 22**. All pumping wells are included as analytical elements that are simulated by the MODFLOW well package in the model. **Table 2** presents the overall trend in average annual groundwater pumping over time along with the assigned model layer for each well. In 2008, the City of Corona and Elsinore Valley Water District came to an agreement to limit groundwater pumping

The citrus groves in the Basin were presumed to be irrigated by groundwater, although that pumping does not appear to be included in the WMWD production records. The amount of irrigation was estimated using the rainfall-runoff-recharge model and was assigned to hypothetical well locations at the center of each citrus recharge polygon. Some rural residences might be served by on-site domestic wells. The amount of pumping at those wells is assumed to be negligibly small in the context of the overall groundwater budget. Small domestic wells are not included in the WMWD database and are not included in the model.

4.3.6. Recycled Water Recharge Ponds

Reclaimed wastewater is percolated in ponds at the TVWD Water Reclamation Facility (WRF) (**Figure 23**). However, most of the reclaimed water is recycled for irrigation. Annual or monthly data describing the partitioning of reclaimed water into irrigation, pond percolation and discharge to Temescal Wash were obtained from TVWD and the City of Corona.

Discharges from the TVWD Water Reclamation Facility (WRF) to Temescal wash were discontinued in 2013. All of the plant outflow is recycled for irrigation during spring, summer, and fall (assumed April through November), and most or all of it is percolated in ponds at the WRF when irrigation demand is low (December through March). In recent years more of the outflow from the TVWD WRF has been percolated in ponds than has been recycled for irrigation. This proportion was assumed to reverse, such that all outflow would be recycled for irrigation during April through November and all would be percolated in ponds during November through March.

The MODFLOW Well Package was used to simulate recharge at the WRF recharge ponds. The wells were simulated as recharge wells. The volume of flow was distributed evenly over the area of the ponds. Prior to 2008, the recycled water recharge was applied to recharge located just south of the TVWD WRF. Starting 2008, recycled water recharge was applied to new recharge ponds located just north of the TVWD WRF. The simulated recharge locations are shown on **Figure 24**.

4.3.7. Quarries

Sand and gravel mining has been the predominant industrial land use in the southern half of the Coldwater MA, an activity that continues today. Localized sand and gravel operations are also located along Temescal Wash in the Bedford MA (**Figure 23**). In addition, berms along washes, diversions of surface water, and the presence of large gravel pits enhance groundwater recharge of runoff in Coldwater area (Todd and AKM, 2008).

Discharge from the Coldwater MA quarry operations is from groundwater pumping, evapotranspiration, and other mining operations (MWH, 2004, Todd and AKM 2008). Losses also occur when the sand and gravel from the gravel pits, which contains groundwater used for washing, is transported from the Coldwater Basin. The estimated losses from gravel operations range from about 300 acre-feet per year (ft/yr to more than 900 acre-ft/yr (MWH, 2004). The average losses are approximately 700 acre-ft/yr (MWH, 2004). Quarry outflows were simulated using a combination of the EVT and Drain Packages. The ET rate and drain conductance were varied during model calibration to simulate the average annual losses from the MWH (2004) report that are listed above. The location of the boundary conditions for the Coldwater MA quarry operations are shown on **Figure 24**.

Quarry recharge represents inflows of surface water into existing quarries where it is allowed to recharge into the groundwater. In the Coldwater MA, streamflow from Mayhew Creek and some other smaller streams are directed into existing quarry areas where the water is contained and allowed to percolate. Coldwater Creek has been redirected around an existing quarry. Although Coldwater Creek is not currently directed into a quarry, there have been historic instances where flood flows have gone into the quarries, especially prior to 2005. A portion of the estimated streamflow from the rainfall-runoff-recharge model for each stream is recharged to groundwater at the quarry location. This recharge from streamflow directed into the quarries is simulated using the MODFLOW well package. A portion of the monthly streamflow assigned from the rainfall-runoff model was moved from the SFR2 Package to the Well Package to simulate quarry inflow recharge.

In the Bedford area, the Mobile Sand quarry located just north of the Temescal WRF is open to potential outflows to Temescal Wash. To estimate groundwater outflows from the quarry pit during high groundwater levels, the MODFLOW model applies a boundary condition based on the observed water level in the pit to estimate the volume of quarry outflow. This is a head-dependent boundary condition that is able to calculate either quarry recharge or outflow based on groundwater conditions. This was simulated using the MODFLOW river package. Since we can estimate the water surface based on topography, the River Package can allow the quarry pit ponds to alternative from recharge to discharge based on monthly hydrologic conditions.

Quarry recharge in the Bedford MA is from streamflow from Brown and McBride Creeks flow into the Mobile Sand quarry located just north of the TVWD WRF. In addition, streamflow from Temescal Wash can flow into the quarry location especially during high and flood flows. The quarry pit at this location is below the water table and is consistently flooded. To estimate the recharge, the MODFLOW model applies a boundary condition based on the observed water level in the pit to estimate the volume of quarry recharge. Similar to the Coldwater MA quarry recharge, recharge from streamflow directed into the quarries is simulated using the MODFLOW well package. A portion of the monthly streamflow assigned from the rainfall-runoff model was moved from the SFR2 Package to the Well Package to simulate quarry inflow recharge.

4.3.8. Subsurface Flow with Adjacent Groundwater Basins

To simulate potential subsurface groundwater and outflow with adjacent groundwater basins, a specified head boundary was defined using the MODFLOW constant head package. Constant head boundaries allow sufficient inflow or outflow at that model cell to achieve the specified head. Where the

Basin adjoins the Elsinore Valley and Temescal Basins, at the north and south ends of the model respectively, represent a very small percentage of the overall perimeter of the Basin.

Along the Elsinore Subbasin boundary, a constant head boundaries were set along a limited length of the boundary near Temescal Wash and another unnamed stream (**Figure 24**). The constant head along Temescal Wash was set at 1046.5 feet in Model Layer 2 and 3. Along the unnamed stream, the constant head was set at 1068.0 feet in Model Layer 2 and 3.

Along the Temescal Subbasin boundary, a similar set of constant head boundaries were set along a limited length of the boundary near Temescal Wash and another unnamed stream (**Figure 24**). The constant head along Temescal Wash was set at 765.0 feet in Model Layers 1, 2 and 3 for the first three years, and then set to 775.0 feet for the following twenty-six years. The constant head boundaries were based on an initial estimate that was refined during model calibration.

4.4. AQUIFER PROPERTIES

Aquifer properties represent the physical and hydrogeologic characteristics of the aquifers within the Basin that control groundwater flow. Aquifer properties must be assigned to each active grid cell in the model. The conceptual model provides the framework necessary to define aquifer properties.

4.4.1. Aquifer Characteristics

The groundwater model represents the basin fill materials in terms of their ability to store and transmit groundwater. Horizontal and vertical hydraulic conductivity define the permeability of the aquifer, which is its ability to transmit groundwater flow. The ability to store water consists of two components. At the water table, storage of water associated with filling or draining the empty (air-filled) interstices between mineral grains is represented by the specific yield of the aquifer. In deep aquifers, there is a much smaller ability to store and release groundwater that derives from the compressibility of the water and aquifer materials (specific storativity). Thus, the initial response to pumping from a deep aquifer is a large drop in water level (head) within that aquifer. With sufficient time, however, the decrease in head creates downward movement of groundwater that eventually accesses the storage capacity at the water table. In other words, the storage response of the aquifer depends partly on the duration of pumping and observation. For groundwater management purposes, storage responses over periods of months to decades are usually the most relevant.

Aquifer characteristics can be estimated in two ways. The first is by means of an aquifer test in which one well is pumped while water levels are measured at a nearby well. This approach typically measures horizontal hydraulic conductivity over distances of tens to hundreds of feet and storage responses over periods of 1-3 days. The second approach is to calibrate a groundwater flow model such that the aquifer characteristics reproduce measured historical water levels throughout the basin given estimates of historical recharge and pumping. The latter approach produces estimates of aquifer characteristics averaged over spatial scales of thousands to tens of thousands of feet and time scales of months to decades. The estimates account for preferential flow through localized sand and gravel lenses in the basin fill materials and for delayed water-table responses to deep pumping. Also, model calibration provides estimates of vertical hydraulic conductivity across the layers of alluvial deposits, which is rarely measured by aquifer tests. The temporal and spatial scales represented by the model calibration approach are better for addressing most long-term groundwater management questions.

4.4.2. Zone Approach

Because of the limited data for aquifer properties for the Basin, a zoned distribution pattern was used that applied aquifer properties over subregional areas with similar geologic conditions. Although the units are heterogeneous, the approach was to get a representative average value for each aquifer property for limited number of zones around the basin. This was to avoid the patchwork quilt type of aquifer property distribution that does not show any relation to the underlying geologic conditions that define the aquifer property.

Figures 25 shows the distribution of aquifer characteristics after calibration of hydraulic conductivity and specific storage, respectively. The initial estimates of hydraulic conductivity and specific yield were from available local data, which incorporated major geologic features such as relatively permeable sediments in the upper parts of alluvial fans.

4.4.3. Hydraulic Conductivity

Hydraulic conductivity represents the ability of the water to flow through the aquifer, and is defined horizontally within a model layer to represent groundwater flow through the aquifer and vertically between adjacent model layers to represent groundwater exchange between aquifers.

The definition of the horizontal hydraulic conductivity is based on an assessment of lithologic description, available aquifer test data and model calibration. Since each model layer represents a thick interval composed of varying lithologies, the horizontal hydraulic conductivity represents an average value over the entire vertical thickness that includes the finer-grained layers in addition to any specific sand and gravel zone. For the Bedford-Coldwater Model, horizontal hydraulic conductivity is defined using regionalized blocks based on the geologic character of the unit and refined during calibration.

The hydraulic conductivity used in the Bedford-Coldwater Model varies within a reasonable value range for the aquifer characteristics for each aquifer to achieve the model calibration. The horizontal hydraulic conductivities used in the Bedford-Coldwater Model are listed in **Table 3.**

4.4.4. Vertical Conductance

In general, groundwater flow within an aquifer is dominantly horizontal whereas flow between adjacent aquifers is essentially vertical. The application of vertical hydraulic conductivity recognizes the inherent isotropy present in natural geologic formations. Vertical groundwater flow is equivalent to Ohm's Law for serial electrical flow through different resistivity layers. Based on this analogy, vertical groundwater flow, similar to serial electrical flow, is limited by the lowest conductivity (or highest resistivity) layer encountered. Therefore, vertical groundwater flow is defined by the lowest-permeability, continuous layer that controls the exchange of groundwater between aquifer or model layers.

In MODFLOW, vertical groundwater flow between model layers is calculated using vertical conductance (VCONT) that is calculated as the conductance of two one-half cells in a series with continuous saturation between them (Harbaugh, 2005). This calculation is performed within MODFLOW and requires the input of a vertical hydraulic conductivity (Kz) for each layer. In general, Kz values were set to allow relatively free exchange between layers. The vertical hydraulic conductivity values used in the model to calculate the VCONT are summarized in **Table 3**.

4.4.5. Specific Yield and Specific Storage

Aquifer storage defines the ability of the aquifer to take in or release water. Under unconfined conditions, water released from or put into aquifer storage represents the physical draining of groundwater from interstitial pore space within the aquifer. Unconfined storage is defined by specific yield, which is typically consistent with the effective porosity of the aquifer. Under confined conditions, water released from or put into aquifer storage is derived from the compressibility of water as a result of changes in the aquifer pressure within the interstitial pore space.

MODFLOW 2005 requires the use of specific storage, which is in the units of feet^{-1}. Reasonable ranges for the specific yield and specific storage were varied within a reasonable range during the model calibration and the values are listed in **Table 3**, respectively.

4.5. INITIAL CONDITION

The model also requires that groundwater levels be specified at the start of the simulation. They were estimated based on contouring of available water level data. As the initial heads may be dynamic and not representative of stable initial conditions, the first stress period representing pre-1990 conditions were run as steady-state to facilitate the calculation of a stable hydrologic system.

The transient model was used to develop the initial groundwater elevations that serve as the starting condition for the transient model. For this, groundwater pumping was applied to represent the long-term average pumping prior to 1990. The surface recharge component used to estimate groundwater recharge was set to a predevelopment condition to reduce the effect of urbanization. The results of the transient model provided a reasonable groundwater elevation data representing the late 1980’s to obtain an appropriate starting condition. This was an iterative process and the transient model used to develop the initial head was updated during the transient model calibration to incorporate significant changes in the model setup. **Figure 26** provides the starting head for Layers 2, which provides a reasonable representation of the groundwater conditions for Layers 1 and 3.

5. HISTORICAL MODEL RESULTS

The Bedford-Coldwater Model was calibrated using the developed calibration criteria to reduce uncertainty by matching model results to observed data. An extensive calibration process was designed to better constrain the range of aquifer properties and boundary conditions for the model, thereby reducing uncertainty in the results.

5.1. CALIBRATION METHODOLOGY

For the Bedford-Coldwater Model, the simulation is setup using a 29-year base period that covers Water Year (WY) 1990 to WY2018. This aspect of the calibration is important to demonstrate that the model has the capability to simulate historical changes in groundwater elevations, and is therefore capable of forecasting future changes in groundwater elevations. This capability is necessary for the model to serve as a useful groundwater management tool.

5.1.1. Approach

The transient calibration is a process that compares the simulated groundwater levels from the model to observed groundwater level measurements. During calibration, boundary condition parameters and aquifer properties are varied within the reasonable range defined by the hydrogeological conceptual model. Different combinations are tested to determine the set of parameters and properties that produce an acceptable correlation simulated to measured groundwater elevations over time. Other data sets, such as key water budget components, surface water conditions, or hydrogeological conceptual model, may be used to further constrain the calibration.

There are multiple combinations of aquifer properties and boundary conditions that can be used to match a single set of groundwater elevation data. Calibrating to multiple data sets under differing stresses (i.e. recharge and discharge rates) reduces this “non-uniqueness”, thereby reducing the uncertainty. Performing a comprehensive calibration over a 29-year base period infers the calibration has been performed over wet, dry, and normal years with varying degrees of pumping. To that end, the Bedford-Coldwater Model was primarily calibrated using groundwater levels. The measures of calibration are primarily from a statistical analysis along with a visual assessment groundwater level trends from hydrographs. The groundwater elevation maps and water budget data considered during the model calibration are assessed in context with the model results, so are discussed in the next section.

5.1.2. Calibration Methodology

Joint calibration of the rainfall-runoff-recharge model, the surface water budget models and the groundwater flow model applied heuristic methods (i.e. trial-and-error adjustments) to selected variables, as informed by the timing and location of model residuals. In accordance with the principle of parsimony in modeling (DWR, 2016), calibration began with a small number of broad zones for hydraulic conductivity and storage. Zones were subdivided during calibration if a pattern of residuals at multiple wells warranted it. Although storage and hydraulic conductivity are not necessarily correlated, in practice they often are to some degree. Thus, for simplicity, similar zonation patterns were used for both variables.

In practice, most of the calibration effort focused on adjustments to horizontal and vertical hydraulic conductivity, the locations and conductances of faults, stream bed vertical hydraulic conductivity, and several tributary watershed parameters: root depths of natural vegetation, rainfall-runoff thresholds and slopes, and the leakage and recession rates for shallow groundwater. Variables that were not adjusted during calibration include land use, crop root depths, pumping locations, and groundwater pumping.

Model performance during the calibration process was evaluated primarily by visual inspection of superimposed measured and simulated water-level hydrographs. Adjustments to model inputs and parameters were made only if two or more wells in a given area exhibited similar patterns of discrepancies between measured and simulated water levels. The process of manually calibrating a groundwater model also produces considerable insight into the groundwater flow system and the factors that influence it. Water levels for some wells were easy to reproduce with the model, while others were more difficult.

5.1.3. Primary and Alternative Calibration

In this report, we provide two sets of calibration results. Primarily, this was done to provide two variations for simulating the quarry operations in the Coldwater MA. These two calibration versions include:

- Primary Calibration – the Primary Calibration is the version of the historical model that is carried forward as the final model calibration that is used as the based for the projected future scenarios.
- Alternative Calibration – the Alternative Calibration is presented to demonstrate that uncertainty regarding the quarry operations, primarily in the Coldwater MA, may indicate a data gap. The Alternative Scenario is presented for informational purposes to document this work for future model updates, but it is not used for the projected future scenarios.

Quarry outflows represents outflows associated with active or passive quarry operations to account for observed water conditions within the deeper quarry pits. In the Coldwater area, excavations occur within the large quarry pits following periods of high groundwater levels for the period from 1990 to 2010. Based on available information, no additional pumping to maintain quarry water levels was assumed to occur. However, during model calibration, it was necessary to assume that additional pumping or other groundwater removal occurred during these operational periods to maintain the observed groundwater levels.

For the Primary Calibration, quarry outflows were simulated using a combination of the EVT and Drain Packages (**see Section 4.3.7**). From 1990 to 2010, the quarry outflows were allowed to be higher assuming some limited additional pumping may have occurred. However, after 2010, no additional pumping to maintain quarry water levels has occurred and that is supported by the historical model calibration. The ET rate and drain conductance were varied during model calibration to simulate the average annual losses from the MWH (2004) report. However, the calibration results (see following discussion) did not fully capture the high and low observed groundwater near the Coldwater MA quarries.

For the Alternative Calibration, a different simulation method was applied at the quarry locations. The emphasis of the Alternative calibration was to apply a boundary condition that would more forcefully simulate the observed groundwater levels. For the Alternative Calibration, the quarry operations were simulated using the MODFLOW river package. The River Package can allow the quarry pit ponds to alternate from recharge to discharge based on monthly hydrologic conditions. We estimated the water surface based on a review of Google Earth satellite images of the quarries and other local reports.

5.2. STATISTICAL CALIBRATION

The calibration was evaluated using a statistical comparison of difference (or residual) between measured and simulated groundwater elevations. The calibration was done for the entire Subbasin. In addition, a breakdown of the calibration results for each of the management areas is also provided.

5.2.1. Primary Calibration Results

For the Basin, the calibration is based on observed groundwater elevations from 3,736 measurements in 27 wells over the 29-year base period from October 1989 through September 2018 (WY1990-2018). The locations of these wells are shown on **Figures 27 and 28** for the Bedford MA and Coldwater MA, respectively.

Next, a more rigorous calibration was performed involving a statistical analysis to compare the difference or residual between measured and simulated groundwater elevations. An initial comparison is made with a scatter plot (**Figure 29**) that depicts this relationship of observed versus simulated groundwater elevations. As indicated on **Figure 29**, the scatter along the correlation line is minor in comparison to the range of the data. The correlation coefficient for the data on this graph is 0.905. The correlation coefficient ranges from 0 to 1 and is a measure of the closeness of fit of the data to a 1 to 1 correlation. A correlation of 1 is a perfect correlation. The correlation coefficient of 0.905 indicates a strong correlation between simulated and observed groundwater elevations.

A more detailed statistical analysis is provided that compares the difference, or residual, between measured and simulated groundwater elevations. **Table 4** summarizes statistical measures used to assess the calibration. A brief summary of the statistical measures used to evaluate the calibration results shown on **Table 4** is summarized below:

- The residual mean is computed by dividing the sum of the residuals by the number of residual data values. The closer this value is to zero, the better the calibration especially as related to the water balance and estimating the change in aquifer storage. The residual mean is 16.0 feet.
- The absolute residual mean is the arithmetic average for the absolute value of the residual so it provides a measure of the overall error in the model. The absolute residual mean is 42.1 feet.
- The residual standard deviation evaluates the scatter of the data. A lower standard deviation indicates a closer fit between the simulated and observed data. The standard deviation for the calibrated model is 31.5 feet.
- The Root Mean Square (RMS) Error is the square root of the arithmetic mean of the squares of the residuals is provides another measure of the overall error in the model. The RMS Error for the calibrated model is 45.0 feet.
- The scaled absolute residual the ratio of the absolute residual mean is divided by the range of observed groundwater elevations. This ratio helps to put the variation of the residuals into perspective with respect to the scale of the groundwater basin. This ratio for the Bedford-Coldwater Model is 0.077, which puts the statistical variability at less than 8 percent of the range. A ratio below 0.15 is generally considered a well calibrated (ESI 2011).

It should be noted that some degree of difference (or residual) between the observed and simulated groundwater elevations is expected. Residuals may be due in part to localized effects or data quality issues. For example, residuals can result from using groundwater elevations from pumping wells as calibration targets. MODFLOW calculates the groundwater elevation for the center of a model cell rather than at the well location itself. MODFLOW also does not consider the impact of well efficiency on groundwater elevations at pumping wells. In addition, the timing of the observed groundwater elevations does not exactly match the model stress periods. Since the several calibration locations being pumping wells, the statistical parameters are considered reasonable indicating that the model is well calibrated. **Table 5 (following text)** provides a summary statistics for each of the 59 wells used in the calibration process.

Table 4. Summary of Primary Calibration for the Bedford-Coldwater Model

Calibration Measure	Complete GW Basin	Bedford MA	Coldwater MA
Units	**Feet**	**Feet**	
Residual Mean	16.0	1.0	26.5
Residual Standard Deviation	42.1	11.2	97.0
Absolute Residual Mean	31.5	8.1	47.8
Root Mean Square (RMS) Error	45.0	10.9	22.4
Scaled Absolute Residual Mean	0.077	0.034	0.084
Number of Locations	27	13	14
Number of Observations	3,736	1,535	2,201

The statistical comparison is also consistent when evaluated by management area (MA). **Table 4** includes the statistical calibration results for the Bedford-Coldwater Model by MA. The residual mean varies from 1.0 feet in the Bedford MA to 26.5 in the Coldwater MA. The standard deviation ranges from 11.2 feet in the Bedford MA to 97.0 feet in the Coldwater MA. The absolute residual mean ranges from 8.1 feet in the Bedford MA to 47.8 feet in the Coldwater MA. The scaled absolute residual mean ranges from 0.034 in the Bedford MA to 0.084 in the Coldwater MA.

The higher variability indicated in Coldwater MA is primarily attributed to the greater number of groundwater levels from active pumping that increases the variability of the observed data over the calibration period. Conversely, the Bedford MA has less variability because of less groundwater pumping and narrow range in groundwater levels over the calibration period. The statistical results are of high quality and indicate that each MA is well calibrated.

5.2.2. Alternative Calibration Results

For the Alternative Calibration, the boundary conditions were adjusted to simulate the observed groundwater levels more forcefully with no limitations on the effect on the water budget. For the Alternative Calibration, the quarry operations were simulated using the MODFLOW river package. The River Package can allow the quarry pit ponds to alternative from recharge to discharge based on monthly hydrologic conditions. We estimated the water surface based on a review of Google Earth satellite images of the quarries and other local reports.

A comparison of the statistical analysis for the Coldwater MA between the Primary and Alternative Calibration is provided in **Table 6**. A brief summary of the statistical measures used to evaluate the calibration results for the Coldwater MA are summarized on **Tables 4 and 6** below:

- The residual mean for the Alternative Calibration is -4.3 feet compared to 26.5 feet for the Primary Calibration.

- The absolute residual mean for the Alternative Calibration is 87.2 feet compared to 97.0 feet for the Primary Calibration.
- The residual standard deviation for the Alternative Calibration is 29.7 feet compared to 47.8 feet for the Primary Calibration.
- The Root Mean Square (RMS) Error for the Alternative Calibration is 20.1 feet compared to 22.4 feet for the Primary Calibration 45.0 feet.
- The scaled absolute residual ratio for the Alternative Calibration is 0.055 feet compared to 0.084 for the Primary Calibration.

The water budget results were considered to be unrealistically high for quarry operations, so they are not provided and the Primary Calibration is the selected calibration results for the GSP. However, the Alternative Calibration indicates that a significantly improved model calibration but this is currently limited by potential uncertainty regarding the historical quarry operations. Therefore, the Alternative Calibration suggests that the quarry operations present a potentially significant data gap moving forward. Therefore, an improved understanding quarry operations may help to enhance future model calibration.

Table 6. Summary of Alternative Calibration for the Bedford-Coldwater Model

Calibration Measure	Complete GW Basin	Bedford MA	Coldwater MA
Units	Feet	Feet	
Residual Mean	-1.6	2.2	-4.3
Residual Standard Deviation	30.9	11.4	87.2
Absolute Residual Mean	21.3	9.2	29.7
Root Mean Square (RMS) Error	30.9	11.3	20.1
Scaled Absolute Residual Mean	0.044	0.038	0.055
Number of Locations	27	13	14
Number of Observations	3,736	1,533	2,201

5.2.3. Comparison to Previous Model Calibration for Coldwater MA

The primary performance measure is to improve upon the calibration from the previous models. Previous groundwater models have been developed for the Coldwater MA; however, no previous groundwater model exist for the Bedford MA. In the MWH (2004) report, the model calibration results listed in the report was a general goal of a residual mean of less than 40-feet over the 1977 to 2010 simulation period. Both the Primary and Alternative Calibration both have residual means that are

- The residual mean of 26.5 feet for the Primary Calibration (**Table 4**) for the 2021 GSP Model is an improvement of 34 percent compared to the 2004 MWH Model.
- The residual mean of -4.3 feet for the Alternative Calibration (**Table 6**) for the 2021 GSP Model is an improvement of 89 percent compared to the 2004 MWH Model.

Overall, the results of the calibration showed significant improvement in the calibration over the 2004 MWH model. Although the data points used for both versions of the models are the same, the number of observations did vary. This indicates that the changes implemented for the Bedford-Coldwater Model were successful and resulted in improved model performance.

5.3. GROUNDWATER LEVEL TRENDS

Hydrographs provide a detailed time history of groundwater elevations for specific wells. This time history data includes the impact of varying climatic and pumping stresses on the groundwater basin. Comparing hydrographs of model results versus observed data provides a measure of how well the model handles these changing conditions through time. Groundwater elevation data for 26 hydrographs from different parts of the basin are included on **Figures 30 through 36** for the hydrograph evaluation. Locations of these well used for the hydrographs are shown on **Figures 27 and 28**.

For calibration purposes, the hydrographs were inspected to evaluate how well the model results matched the overall magnitude and trend of the observed groundwater elevation data over time. For the transient model, it was considered more important to honor the overall trend of the data. A hydrograph was considered a good match if the model simulated the trend, but the groundwater elevations were offset. The following is a discussion of the overall groundwater trends, comparison of simulated to measured data, and other hydrogeological inferences made from the historical simulation results shown on the **Figures 30 through 36** hydrographs.

5.3.1. Bedford MA Hydrographs

Hydrographs from twelve wells located in different areas within the Bedford MA are shown on **Figures 30 through 32**. Well locations are shown in **Figure 27**. To facilitate a comparison of the relative groundwater trends observed in these wells, a consistent vertical scale of 250 feet is used on **Figures 30 through 32**.

The North Temescal Wash Area is located along Temescal Wash in the northern portion of the Bedford MA. **Figures 30 and 31** show hydrographs for 8 wells located within this area. Groundwater levels in this area are generally characterized as having relatively stable trends over time. Also, depth to groundwater in many parts of this area are relatively shallow ranging from 5 to 50 feet. Data from Corona #4 prior to 1992 show that groundwater levels were lower during this period. Groundwater levels were relatively stable. From 2012 through 2018 groundwater levels become more variable reflecting changes in groundwater pumping and climatic conditions.

Hydrographs for four monitoring wells are located in the mid-Temescal Wash (**Figure 32**). Locations of these wells are shown on **Figure 27**. Three of these wells are located area near the TVWD WRF (TVWD#01A, TVWD#04, and LLWD_#01-Old). These wells show very stable water levels over the period of record. In this area, groundwater levels are stabilized by the level of Temescal Wash and the presence of two flooded gravel mine pits in the mined area north of TVWD WRF.

The New Sump well, also shown on **Figure 32**, a is located further upstream from the TVWD WRF near the confluence with Dawson Creek which flows in from the upland areas to the east. Groundwater levels show more variability due to pumping at this location and the narrow constricted configuration of the aquifer at this location.

For all twelve wells, the comparison of simulated to measured groundwater levels shows a close correlation which is consistent with the statistical data presented on Tables 4 and 5.

5.3.2. Coldwater MA Hydrographs

Hydrographs from thirteen wells located in different areas within the Coldwater MA are shown on **Figures 33 through 36**. Well locations are shown in **Figure 27**. To facilitate a comparison of the relative groundwater trends observed in these wells, a consistent vertical scale of 600 feet is used on **Figures 33 through 36** to capture the full range and variability of groundwater levels in the Coldwater MA.

Figures 33 shows hydrographs for four wells located within in the Coldwater Creek area of the Coldwater MA. These wells are located near the Chandler gravel mining operations which is the northernmost gravel pit (**Figure 23**). It is in the Coldwater MA that the difference between the Primary and Alternative Calibration are most apparent. The measured groundwater levels for the four hydrographs on **Figure 33** shows a consistent pattern that is summarized below:

- From 1989 through 1992, groundwater levels are relatively low, with elevations ranging between 800 to 900 feet above mean sea level (msl). This is considered to represent a period of active mining operations and deepening of the pits to near or below the water table.
- During the period from 1993 through 1999, groundwater levels rapidly rise in 1993 due to flood events where flood flows are either directed into or breached berms to flood the mining areas. The result is a major recharge event during high rainfall events in 1993, 1995, 1997 and 1998. As a result, groundwater levels rise 150 to 200 feet to reach elevations between 1,000 and 1,050 feet elevation msl.
- From 2000 through 2004, groundwater levels decline between 100 to 200 feet with elevations ranging between 750 to 850 feet above mean sea level (msl). This is a period of active mining in the large, deep mining areas.
- In 2005, another large flooding event occurred that results in major recharge event with groundwater rising about 100 feet to reach elevations between 850 and 900 feet elevation msl.
- From 2006 through 2010, groundwater levels decline between 100 to 150 feet with elevations ranging between 750 to 800 feet above mean sea level (msl). This is a period of active mining in the large, deep mining areas.
- In 2010 and 2011, another large flooding event occurred that results in major recharge event with groundwater rising about 100 feet to reach elevations between 850 and 900 feet elevation msl.
- From 2011 through 2016, groundwater levels decline between 100 to 150 feet with elevations ranging between 750 to 800 feet above mean sea level (msl). This is a period of active mining in the large, deep mining areas and mine reclamation.
- From 2016 to 2018, groundwater levels rise about 50 feet to an elevation of about 800 feet msl. This represents a period where mining operations are occurring well above the water table. Deeper areas of the mine have undergone reclamation and are no longer active.

During model calibration, this pattern of groundwater elevation changes was not fully obtained by using reported pumping volumes, streamflow from the rainfall-runoff model, and local ET rates. The general form was achieved, but not the full extent, especially the high groundwater levels in the 1990s. The Alternative Calibration applied a boundary condition to more forcefully drive the simulation to simulate the measured groundwater levels; however, this resulted in significantly higher groundwater extraction or loss rates to achieve the decline from the high groundwater level periods in the 1990s, 2005 and 2011 to the corresponding low groundwater levels in 2004, 2010, and 2016. Because of the water budget issue, the model calibration used the Primary Calibration; however, the Alternative Calibration indicates a potentially significant data gap in understanding the effects of mining operations on groundwater levels.

Figures 34 and 35 show hydrographs for six wells located within in the Mayhew area of the Coldwater MA which is located south of the wells shown in **Figure 33**. A similar pattern of groundwater level change is shown in these areas; however, the mining operations in these areas are more typically above the groundwater table such that the difference between the Primary and Alternative Calibration is less significant than for the wells in **Figure 33**. These wells show relatively strong agreement between measured and simulated groundwater levels over the simulation period.

Figure 36 shows hydrographs for four wells located north of the Coldwater MA and north of the wells shown in **Figure 33**. The pattern in the change in groundwater levels shows a similar pattern but the magnitude of the changes is much less. These wells are located further away from the mining areas which suggests much of these changes are related to mining operations. The Primary and Alternative Calibrations show a general match to the pattern and magnitude of the groundwater level changes over the simulation period, but show some offset in simulating the groundwater elevation.

5.4. EVALUATION OF GROUNDWATER FLOW

The Bedford-Coldwater Model simulates monthly groundwater elevations for 348 months from October 1989 through September 2018. In general, the overall groundwater flow directions remain generally consistent over this time with some variations observed near the major groundwater pumping centers. To evaluate the range of groundwater elevations, we have selected a few key time periods. These include:

- **Figure 37** - End of Historical Simulation Period – September 2018
- **Figure 38** - Period of consistently high groundwater levels – March 1995
- **Figure 39** - Period of consistently low groundwater levels – October 2010

The high and low conditions represent a combination of climatic conditions and groundwater pumping demands. Groundwater maps for Layers 1 for each of the above time periods is presented. In general, groundwater levels in Layers 1, 2 and 3 are generally consistent. For the purposes of evaluating groundwater flow directions, we have selected Layer 1 as representative of these three layers.

Figure 37 shows the groundwater level contours and flow directions for Layer 1 at the end of the historical simulation period representing September 2018 conditions. On each of these maps, large blue arrows to better illustrate the groundwater flow directions. The groundwater contour represents a line of equal groundwater elevation, or equipotential. Groundwater flow occurs at right angles to the contour lines with the direction flow from the higher to lower groundwater elevation. In general, groundwater flow in the Bedford MA is generally towards or along Temescal Wash. Along the Glen Ivy Fault groundwater flow directions are generally parallel to the fault in the southern area, but flow is away from the fault in the northern areas of the Bedford MA.

In the Coldwater MA, groundwater flow is generally from the marginal areas towards the primary pumping wells located within the area of the large gravel mining operations (**Figure 37**). The thinner aquifer along the basin margins has limited capacity to store the recharge that occurs along the basin margins from runoff, stream recharge and bedrock inflows. This, along with the higher elevations, creates higher groundwater elevations along the margins that drives groundwater flow into the center of the basin.

The tightly-spaced contours along the Glen Ivy Fault (**Figure 37**) that separates the Bedford and Coldwater MA represent the flow restriction formed by the faults that limits inflows into the deep basin and maintains higher, relatively stable groundwater levels upgradient of the faults. Within the deep basin, the groundwater levels are several hundred feet lower than on the areas upgradient faults.

Figures 38 show the groundwater elevations during March 1995. During this period, widespread high groundwater levels were observed reflecting a period of high precipitation and below average groundwater pumping rates occurring in the basin. Even in this case, the general groundwater flow directions remain generally consistent with September 2018 (**Figure 37**). The main differences are increased groundwater levels in the Coldwater MA and northern Bedford MA reflect increased recharge from creek reaching this area along with lower pumping. Steeper groundwater levels are observed along the basin margins reflecting the higher recharge rates due to the high precipitation levels.

Figure 39 shows the groundwater elevations during October 2010. During this period, widespread low groundwater levels were observed reflecting several preceding dry years. In general the groundwater flow directions remain generally consistent with September 2018 (**Figures 37**). The main differences are lower groundwater levels in the Coldwater MA due to groundwater pumping with limited recharge. In the Bedford MA, groundwater levels are also generally lower across the area due to lower recharge. .

The groundwater flow is consistent with the hydrogeological conceptual model. These maps are included to demonstrate that the model provides reasonable simulation of groundwater elevation and flow direction even during the more extreme climatic periods during the base period. This further demonstrates that the model is well calibrated and can accurately simulate wet and dry weather periods.

5.5. MODEL-BASED HYDROLOGIC BUDGET

GSP regulations (§354.18(c)(2)(B)) indicate a need to identify an average hydrologic study period that cover as least 10 years that includes a range of hydrologic conditions (e.g. wet, normal, dry and critically dry) for purposes of the groundwater analyses in the basin-wide water budgets. In order to select a consistent study period, the Bedford-Coldwater GSA is using a 29-year base period covering Water Years (WY) 1990 through 2018. Water years used for the Bedford-Coldwater Model run from October through to the following September to capture the cause and effect relationship on groundwater levels of wintertime rain and subsequent summertime groundwater pumping. Additional analysis of the historical water budget is provided in Section 5 ("Water Budget") of the GSP.

The model-derived groundwater budget for the entire Basin is presented in **Table 7**. Over the entire simulation period, groundwater inflows average about 9,300 AFY. Surface recharge from precipitation and return flows accounts for about 24 percent of the total recharge and average about 2,200 acre-feet per year (AFY). Groundwater-surface water interactions represent about 50 percent of the total recharge and average about 4,600 AFY. Mountain front recharge represents inflows from bedrock units into the basin from the surrounding watersheds. This accounts for about 15 percent of the total recharge and average about 1,350 AFY. Recharge from wastewater recharge ponds accounts for about 7 percent or 650 AFY. Groundwater inflow from the adjacent Temescal and Elsinore Valley Basins account about 4 percent of the total recharge and average about 370 AFY. Net recharge from quarry operations accounts for about 1 percent of the total recharge and averages about 100 AFY.

Outflows from the entire Basin, **Table 7**, average about 11,323 AFY. Groundwater pumping is the primary groundwater outflow accounting for about 63 percent of the outflow and averages about 7,100 AFY over the entire historical period. Quarry operations in both the Bedford MA and Coldwater MA account for about 21 percent of the outflow and averages about 2,400 AFY. Evapotranspiration (ET) accounts for about 7 percent of the outflow and averages about 780 AFY. Groundwater outflow from the adjacent Temescal and Elsinore Valley Basins account about 2 percent of the total recharge and average about 230 AFY.

Similar groundwater budget tables are presented for the each of the management areas defined within the Bedford-Coldwater GSA. These include:

- **Table 8** for the Bedford MA
- **Table 9** for the Coldwater MA

The difference between the model-derived inflows and outflows represents the change in groundwater in storage over the simulation period. **Table 10** summarizes the change in groundwater in storage for the entire Basin and for each of the individual subareas and are graphically illustrated on **Figure 40**. The overall change in storage over the simulation period for the entire Basin average a decline of about 2,000 AFY for a cumulative decline over the simulation period of about 59,000 AFY. OF this, the majority of the decline is experienced in the Coldwater MA where the majority of the groundwater pumping occurs. Most of the decline in groundwater in storage occurs prior 2002 when pumping rates were higher and quarry operations appear to be more active with respect to groundwater resources. Since 2008, EVWMD and the City of Corona have had an operating agreement for pumping within the Coldwater MA. As a results, the average change in groundwater in storage from 2005 through 2015 is an increase of 22 AFY for a cumulative increase of 240 acre-feet (**Table 10**).

6. SIMULATION OF FUTURE CONDITIONS

GSP regulations §354.18(c)(3) require simulation of several future scenarios to determine their effects on water balances, yield and sustainability indicators. The following scenarios to simulate future conditions include:

- **Baseline Scenario** - This represents a continuation of existing land and water use patterns, imported water availability, and climate.
- **Growth Plus Climate Change Scenario** - This scenario implements anticipated changes in land use and associated water use, such as urban expansion, and anticipated effects of future climate change on local hydrology (rainfall recharge and stream percolation) and on the availability of imported water supplies.

The historical period used for model calibration consisted of only 29 years (water years 1990-2018). The Sustainable Groundwater Management Act requires that future simulations cover a 50-year period. To obtain 50 years of hydrology, rainfall, reference ET and streamflow were assumed to repeat the 1993-2017 sequence twice. Rainfall during that period equaled 99 percent of the long-term average. Surface and subsurface inflows from tributary watersheds simulated using the rainfall-runoff-recharge model were also replicated to obtain 50 years of data. The initial conditions for the future baseline simulation equaled the ending water levels of the calibration simulation, or September 2018. Thus, the future simulation period nominally covers water years 2019 to 2068.

The future Baseline Scenario and Growth Plus Climate Change Scenario serve as a reference conditions against which to compare alternative management scenarios. Additional data and assumptions used in the future baseline simulation are described in Section 5 of the GSP ("Water Budget"). Inputs and results of other scenarios related to specific management actions recommended in the GSP are also described in Section 8 ("Management Actions").

6.1. BASELINE SCENARIO

The simulation is of a 50-year period, as required by SGMA regulations. For the simulations of future conditions, the hydrology is assumed to repeat the 1993 to 2017 calibration period twice to obtain 50 years of data. Specific assumptions and data included in the future baseline scenario are outlined below.

6.1.1. Baseline Assumptions

Municipal, commercial, and industrial (M&I) and private pumping were assumed to remain at existing levels. Initial estimates were obtained by calculating average pumping for each calendar month during 2010 through 2018 and applying those averages in every year of the future simulation. This approach omits additions to and withdrawals from Coldwater MA storage accounts by the three municipal agencies with wells in that MA. Municipal use of imported water was also assumed to remain at existing levels. From the standpoint of the groundwater budget, total municipal water use was used only to estimate pipe leaks. Use of imported water by the Temescal Valley Water District (TVWD) was obtained from that agency's 2015 Urban Water Management Plan (RMC/Woodard Curran 2017), and imported water use in the parts of the City of Corona (Corona) and Elsinore Valley Municipal Water District (EVMWD) service areas within the Basin were assumed to be the same on a per-acre basis for developed areas. Updated pumping volumes were input into the model with the MODFLOW well package.

Land use and water use were assumed to remain at their current patterns and levels throughout the 50-year period. Land use remains the same as actual, existing conditions. In the model these are represented by 2014 land use mapped by remote sensing methods and obtained from DWR, adjusted for subsequent urbanization identified in Google Earth imagery. These data were used in the rainfall-runoff-recharge model for estimated hydrologic parameters for MODFLOW model input.

Rainfall and reference evapotranspiration (ET_0) used historical monthly data for the 1993-2017 hydrologic period used in the model. The surface recharge was input using the MODFLOW recharge package and ET from groundwater rates are input using the MODFLOW EVT package.

Small stream inflows and bedrock inflow simulated for 1993 to 2017 of the calibration simulation were repeated twice to obtain 50 years of data Stream flows are entered in the MODFLOW model using the SFR2 package and the bedrock inflow is input using GHB package. Wastewater percolation and recycled water discharges to TVWD WRF recharge ponds and Temescal Wash were assumed to continue as under the current levels.

Initial water levels are simulated water levels for September 2018 from the historical calibration simulation. That year represents relatively recent, non-drought conditions. These simulated water levels are internally consistent throughout the model flow domain and reasonably matched measured water levels at wells with available data.

6.1.2. Baseline Water Budget Results

GSP regulations (§354.18(c)(2)(B)) require a 50-year simulation period of average hydrologic conditions (e.g. wet, normal, dry and critically dry) for purposes of the analyses in the projected-future basin-wide water budgets. The Future Baseline Scenario generally assumes a continuous of current groundwater operations and historical hydrology over the 50-year simulation period. Additional analysis of the historical water budget is provided in Section 5 (“Water Budget”) of the GSP.

The model-derived groundwater budget for the entire Basin is presented in **Table 11**. Over the entire simulation period, groundwater inflows average about 10,100 AFY. Surface recharge from precipitation and return flows accounts for about 23 percent of the total recharge and average about 2,300 acre-feet per year (AFY). Groundwater-surface water interactions represent about 44 percent of the total recharge and average about 4,500 AFY. Groundwater-surface water interactions primarily account for recharge from streams, including wastewater and recycled water discharge to streams. Mountain front recharge represents inflows from bedrock units into the basin from the surrounding watersheds. This accounts for about 12 percent of the total recharge and average about 1,250 AFY. Recharge from wastewater recharge ponds accounts for about 19 percent or 1,850 AFY. Net recharge from quarry operations accounts for about 2 percent of the total recharge and averages about 160 AFY. Groundwater inflow from the adjacent Temescal and Elsinore Valley Basins account about 1 percent of the total recharge and average about 80 AFY.

Outflows from the entire Basin, **Table 11**, average about 9,200 AFY. Groundwater pumping is the primary groundwater outflow accounting for about 47 percent of the outflow and averages about 4,400 AFY over the entire historical period. Quarry operations in both Bedford and Coldwater MA account for about 26 percent of the outflow and averages about 2,400 AFY. Groundwater-surface water interactions represent about 11 percent of the total outflows and average about 1,000 AFY. ET accounts for about 10 percent of the outflow and averages about 900 AFY. Groundwater outflow from the adjacent Temescal and Elsinore Valley Basins account about 6 percent of the total recharge and average about 530 AFY.

Similar groundwater budget tables are presented for the each of the management areas defined within the Bedford-Coldwater GSA. These include:

- **Table 12** for the Bedford MA
- **Table 13** for the Coldwater MA

The difference between the model-derived inflows and outflows represents the change in groundwater in storage over the simulation period. **Table 14** summarizes the change in groundwater in storage for the entire Basin and for each of the individual subareas and are graphically illustrated on **Figure 51**. The overall change in storage over the simulation period for the entire Basin average is an increase of about 850 AFY for a cumulative increase over the 50-year simulation period of about 43,000 AFY. Of this, the majority of the increase is experienced in the Coldwater MA where the most significant changes to groundwater pumping occurs. The rate of the change in groundwater in storage increases from 140 AFY during the implementation period of the GSP (2018-2041). During the sustainability period of the GSP (2042-2068) the rate of the change in groundwater in storage increases from 830 AFY (**Table 14**).

6.1.3. Baseline Groundwater Flow Evaluation

A contour map of simulated groundwater elevations from the Baseline Scenario at the end of the simulation period (September 2068) is presented in **Figure 42**. In the Bedford MA, groundwater conditions remain generally consistent with September 2018 (**Figures 37**) with hydraulic gradients generally directed towards or along Temescal Wash. Only minor variations in groundwater levels are observed in the Bedford MA primarily related to shifts in groundwater pumping. This is consistent with the historical data which shows the Bedford MA with minimal change in groundwater in storage over time.

In the Coldwater MA, groundwater levels are generally about 100 feet or more higher in the center of the Coldwater MA. This is primarily due to the use of lower pumping rates in the Baseline that are consistent with present day pumping practices. The City of Corona and Elsinore Valley Municipal Water District established a production agreement in 2008 to ensure the sustainable use of groundwater in the Coldwater area (Corona and EVMWD, 2008). Prior to 2008, groundwater pumping in the Coldwater MA was much higher. Therefore, the Baseline Scenario results indicated that continued application of the 2008 agreement are anticipated to result in significant increases in groundwater levels over the 50-year simulation period.

6.2. GROWTH AND CLIMATE CHANGE SCENARIO

The growth plus climate change scenario incorporated anticipated effects of climate change, urban development and associated changes in water and wastewater management. The input parameters for the growth plus climate change scenario were input using the same MODFLOW packages as listed in the Baseline Scenario setup. Specific assumptions and data included in the growth plus climate change scenario are outlined below.

6.2.1. Growth and Climate Change Assumptions

For the growth plus climate change scenario, average annual groundwater pumping in the Coldwater MA was assumed to equal average historical pumping during 2010 through 2017, with an increase proportional to the estimated amount of irrigation return flow from future increased use of imported water. In the Bedford MA average annual groundwater pumping was assumed to be equal to 2020 production volumes. Municipal pumping in Coldwater was distributed among wells in proportion to their averages during 2010 to 2017 and in Bedford it was distributed as recorded in 2020. All remaining municipal water use was assumed to be obtained from imported water. Projected water use for irrigated turf in the rainfall-runoff-recharge model indicated that the combined effect of the warmer and drier climate will be to increase annual irrigation demand by about 10 percent.

A map of the zones and their land uses projected for 2068 is shown in **Figure 42.** The categories are listed in **Table 1** (**Section 3.2**) along with their total acreages in the groundwater basin management areas and tributary watersheds. Projected land use in 2068 was developed on the basis of population projections, land use designations in the Temescal Canyon Area Plan (Riverside County 2018), assumed urban infill, and topography. A comparison of land use acreage by land use category and management area for 1990, 2018, and 2068 was developed. Conversion of grassland to residential land use was the dominant change in both management areas and also occurred in tributary watershed areas.

Rainfall and reference evapotranspiration (ETo) were adjusted to 2070 conditions using monthly multipliers developed by DWR based on climate modeling studies. The climate in 2070 is expected to be drier and warmer than it presently is. The multipliers were applied to historical monthly data for the 1993-2017 hydrologic period used in the model. DWR prepared a unique set of multipliers for each 4-km^2 cell of a grid covering the entire state. Fourteen grid cells overlie the Basin and its tributary watershed areas. For each recharge analysis polygon in the rainfall-runoff-recharge model, multipliers from the nearest grid cell were used.

Bedrock inflow and surface inflow from tributary streams along the perimeter of the Basin were re-simulated using the rainfall-runoff-recharge model to reflect the effects of urban development in some of the tributary watersheds and of climate change. Urbanization also increased surface runoff within the Basin, which was routed to small streams and Temescal Wash.

Wastewater generation was assumed to double by 2068, in proportion to the increase in total urban water use. Wastewater disposal was assumed to change, however. In recent years more of the outflow from the TVWD WRF has been percolated in ponds than has been recycled for irrigation. This proportion was assumed to reverse, such that all outflow would be recycled for irrigation during April through November and all would be percolated in ponds during November through March. The small discharge from Corona WRF-3 to Temescal Wash at the northern end of the Basin was assumed to be eliminated, consistent with the City of Corona's plans to decommission that WRF.

Water pipe leak rates in the EVMWD and City of Corona service areas were assumed to decrease to 5 percent of delivered water from the rates reported in the 2015 Urban Water Management Plans (7.0 percent and 6.6 percent, respectively). The leak rate in the TVWD service area was assumed to continue at the low rate reported in 2015 (two percent).

In the growth plus climate change scenario, gravel mining operations were assumed to have ended and the mine areas to have been converted to stormwater control facilities with groundwater recharge capacity during high runoff periods.

6.2.2. Growth and Climate Change Scenario Water Budget Results

GSP regulations (§354.18(c)(2)(B)) require a 50-year simulation period of average hydrologic conditions (e.g. wet, normal, dry and critically dry) for purposes of the analyses in the projected-future basin-wide water budgets. The Growth with Climate Change Scenario includes planned changes in the groundwater operations in the basin along with projected climate change based on data provided by DWR. Additional analysis of the historical water budget is provided in Section 5 ("Water Budget") of the GSP.

The model-derived groundwater budget for the entire Basin is presented in **Table 15**. Over the entire simulation period, groundwater inflows average about 11,400 AFY. Surface recharge from precipitation and return flows accounts for about 26 percent of the total recharge and average about 2,900 acre-feet per year (AFY). Groundwater-surface water interactions represent about 39 percent of the total recharge and average about 4,500 AFY. Net recharge from quarry operations accounts for about 4 percent of the total recharge and averages about 470 AFY. Groundwater-surface water interactions primarily account for recharge from streams, including wastewater and recycled water discharge to streams. Mountain front recharge represents inflows from bedrock units into the basin from the surrounding watersheds. This accounts for about 11 percent of the total recharge and average about 1,250 AFY. Recharge from wastewater recharge ponds accounts for about 19 percent or 2,200 AFY. Groundwater inflow from the adjacent Temescal and Elsinore Valley Basins account about 1 percent of the total recharge and average about 80 AFY.

Outflows from the entire Basin, **Table 15**, average about 10,600 AFY. Groundwater pumping is the primary groundwater outflow accounting for about 48 percent of the outflow and averages about 5,000 AFY over the entire historical period. Quarry operations in both Bedford and Coldwater MA account for about 23 percent of the outflow and averages about 2,500 AFY. Groundwater-surface water interactions represent about 13 percent of the total outflows and average about 1,400 AFY. ET accounts for about 11 percent of the outflow and averages about 1,200 AFY. Groundwater outflow from the adjacent Temescal and Elsinore Valley Basins account about 4 percent of the total recharge and average about 470 AFY.

Similar groundwater budget tables are presented for the each of the management areas defined within the Bedford-Coldwater GSA. These include:

- **Table 16** for the Bedford MA
- **Table 17** for the Coldwater MA

The difference between the model-derived inflows and outflows represents the change in groundwater in storage over the simulation period. **Table 18** summarizes the change in groundwater in storage for the entire Subbasin and for each of the individual subareas and are graphically illustrated on **Figure 52**. The overall change in storage over the simulation period for the entire Basin average is an increase of about 850 AFY for a cumulative increase over the 50-year simulation period of about 42,600 AFY. Of this, the majority of the increase is experienced in the Coldwater MA where the most significant changes to groundwater pumping occurs. The rate of the change in groundwater in storage increases from 150 AFY during the implementation period of the GSP (2018-2041). During the sustainability period of the GSP (2042-2068) the rate of the change in groundwater in storage increases from 800 AFY (**Table 18**).

6.2.3. Future Growth and Climate Change Groundwater Map

A contour map of simulated groundwater elevations from the Growth and Climate Change Scenario at the end of the simulation period (September 2068) is presented in **Figure 45**. In the Bedford MA, groundwater conditions remain generally consistent with September 2018 (**Figures 37**) with hydraulic gradients generally directed towards or along Temescal Wash. Only minor variations in groundwater levels are observed in the Bedford MA primarily related to shifts in groundwater pumping. Furthermore, the groundwater conditions remain generally consistent with September 2068 Baseline Scenario results (**Figures 42**). The Growth and Climate Change Scenario adds an additional 1,200 AFY in groundwater pumping; however, a similar increase in groundwater recharge, primarily from urban return flows, generally balances these results.

As with the Baseline Scenario, groundwater levels for the Growth and Climate Change Scenario are generally about 100 feet in the center of the Coldwater MA due to the use of lower pumping rates compared to the historical pumping. The City of Corona and Elsinore Valley Municipal Water District established a production agreement in 2008 to ensure the sustainable use of groundwater in the Coldwater area (Corona and EVMWD, 2008). Prior to 2008, groundwater pumping in the Coldwater MA was much higher. Therefore, the Growth and Climate Change Scenario results indicated that continued application of the 2008 agreement are anticipated to result in significant increases in groundwater levels over the 50-year simulation period.

7. SGMA REQUIREMENTS

As noted in the SGMA Modeling Best Management Practices (BMP) guidelines (DWR, 2016), the description of the model application should include detailed information on the model conceptualization, assumptions, data inputs, boundary conditions, calibration, sensitivity and uncertainty analysis, and there applicable modeling elements such as model limitations. A DWR requirement for using model results in future water budget reporting for Annual Reports is to report the model accuracy. The following information addresses these reporting requirements.

7.1. MODEL DATA GAPS

When evaluating model results, it is important to consider the strengths and limitations of the numerical model. The horizontal and vertical resolution used to construct the model dictates the range of scales that the model can evaluate. The Bedford-Coldwater Model is designed as a regional or basin-wide model to evaluate long-term, regional trends and the overall groundwater inflow and outflow to the basin. Within that scale, conditions are averaged. However, this model may not contain the site-specific details necessary to evaluate some localized conditions due to geologic complexity or unique localized effects. For these areas, a more localized model may be required if such a detailed analysis is necessary. The regional model can provide a broader regional context to support the development of these localized models.

The groundwater flow model is an appropriate tool for evaluating groundwater conditions at the basin and subarea scale over periods of months to decades. Given its reasonable calibration under a wide range of historical hydrologic and water management conditions, it should produce reliable results under a similar range of future conditions. However, some aspects of the model and some types of applications may be less reliable. Limitations in model accuracy and in types of applications include the following:

- Understanding of water use and groundwater interaction with deep mining operations that intersect the groundwater present a data gap that presented challenges during the calibration. These issues were most prominent in the Coldwater MA, but also influenced some localized areas around the TVWD WRF in the Bedford MA. The Alternative Calibration indicates that calibration is limited by uncertainty regarding the historical quarry operations. A better understanding of quarry operations could provide an improved understanding to help enhance future model calibration.
- As with any regional model, the model cannot simulate details of water levels and flow at spatial scales smaller than one model cell. It cannot, for example, simulate drawdown within a pumping well. It can only simulate the average effect of that pumping on the average water level of the cell in which the well is located.
- The monthly stress periods of the model preclude simulation of brief hydrologic stresses. For example, the model cannot simulate the effects of daily pumping cycles on water levels, or the amount of recharge associated with peak stream flow events.
- Surface and subsurface inflows from tributary watersheds around the perimeter of the basin remain uncertain. The new rainfall-runoff-recharge model simulates watershed hydrology explicitly but flows from the watersheds to the groundwater basin are small compared to rainfall and ET. Accurate data for those variables within the watershed areas are not available, and a small error in rainfall or ET can result in a large error in simulated watershed outflow.

- Model calibration is better in some parts of the basin than others. For any future model application that focuses on a particular subarea, it would be prudent to evaluate the quality of model calibration for that area before conducting simulations of alternative conditions.

7.2. MODEL ACCURACY

A numerical model mathematically describes the conceptual model by solving the mass balance and motion equations that govern groundwater flow and chemical transport (Bear and Verruijt 1987). To solve these equations, an iterative method is used to solve the matrix equations. For these iterative techniques, the procedure is repeated until the convergence criteria are met. The convergence criteria may be groundwater elevation change, mass balance difference, or both. Convergence defines whether the model is mathematically stable and capable of producing reliable results.

For this model, the Newton (NWT) Solver Package was used (Niswonger *et al*, 2011). The convergence criteria for NWT included both a maximum change in groundwater elevation and a maximum mass balance differential for a cell. For this model, the convergence parameter for groundwater elevation was set at 0.001 feet and 50 cubic feet per day for mass balance differential. Convergence is evaluated at the grid cell level. If a single cell does not meet the requirement, then the solution procedure is repeated. The model was able to successfully converge using the set convergence parameters.

The primary method to check whether the model is numerically stable is to evaluate the differential in mass balance. Iterative techniques provide an approximate solution for the model; therefore, there is always a mass balance differential. This differential should be small, and typically a differential of less than 1.00 percent is considered as a good solution. The mass balance differential for Bedford-Coldwater Model is 0.03%. These values further indicate that numerical model that is accurately simulating the flow of groundwater in the Basin.

The model calibration and comparison of the hydrologic budget results demonstrate that the model is consistent with the conceptual model to produce these results. The calibration correlation coefficient of 0.905 demonstrates a strong comparison between measured and simulated groundwater elevations. Other statistical calibration parameters show that the scaled ratio of the parameter to the range of observed groundwater levels is about 10 percent. Based on these parameters, the accuracy of the Bedford-Coldwater Model is considered to range between 10 to 15 percent.

7.3. LIMITATIONS TO CALIBRATION

All inputs to a model are estimates that are subject to errors or uncertainty, but some are better known than others. Also, some have relatively pronounced effects on simulation results. For example, the amount of water pumped by municipal wells is metered and is considered highly accurate compared to most model inputs. Accordingly, the amount of municipal pumping was not adjusted during calibration.

Data gaps with the water use with quarry operations and the groundwater interactions with the deep mining operation pits presented a challenge for calibration. Variables were selected for adjustment during calibration based on their relative uncertainty, the sensitivity of results to that variable, and whether the variable might logically be connected to an observed pattern of residuals based on hydrologic processes.

The measured water levels that serve as the basis for calibration are themselves subject to uncertainty stemming from wellhead elevation errors, effects of recent pumping at the measured well, and wells that for unknown reasons have water levels inconsistent with water levels at nearby wells. Almost all of the wells used to monitor water levels are active water supply wells. If a well was pumping shortly before the water level is measured, the water level will be much lower (by feet to tens of feet) than if the well had been idle for a day or more. In some hydrographs, pumping-affected water levels stand out as obvious anomalies. A number of those points were removed from the calibration data set. In other cases, water levels fluctuate over a wide range seasonally and between measurements, and pumping effects could not be systematically identified and eliminated.

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TABLES

Table 2 - Annual Groundwater Pumping Volumes by Well (acre-feet per year)

Well_Name	HA	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Corona #04	Bedford	291	253	305	269	33	332	173	103	215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Flager #02	Bedford	620	940	1,001	279	54	418	289	606	606	202	656	560	420	643	578	523	16	147	495	517	19	0	0	0	0	0	0	0	0	0	0
Flager #03	Bedford	679	614	392	432	117	337	61	111	287	1	1	141	533	705	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Flagler #02A	Bedford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	289	420	444	36	0	0	37	207
Flagler #03A	Bedford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	475	458	699	16	0	0	42	202
Foster	Bedford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	220	275	169	185
New Sump	Bedford	501	479	570	379	57	128	185	328	429	45	336	575	439	435	239	342	33	2	241	358	295	388	57	12	198	200	13	288	680	414	278
Non Potable #01	Bedford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	245	0	0	0	0	0	0	258	28	1	1	1	450	368	185	243	380
Non Potable #02	Bedford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	177	131	151	253	268	327	0	0	1	1	1	0	0	0	0	0
Old Ranch	Bedford	0	1	19	18	248	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Old Sand Plant	Bedford	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rose #02	Bedford	84	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rose #03	Bedford	56	16	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rose #04	Bedford	153	52	7	168	238	206	8	18	0	0	31	30	4	12	6	1	4	3	3	3	1	1	1	1	1	1	440	295	476	385	410
Rose #09	Bedford	236	130	475	523	887	0	0	262	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TVWD 1	Bedford	172	51	166	183	230	34	207	0	0	0	31	30	4	29	6	1	4	3	3	3	1	1	1	1	1	1	442	163	445	354	425
TVWD TP1	Bedford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	324	205
TVWD TP2	Bedford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	174	96
Coldwater City Park	Coldwater	110	160	680	1,020	1,300	260	1,300	19	16	16	17	1	1	15	17	17	18	17	0	0	0	0	0	0	0	0	0	0	0	0	0
Corona #01	Coldwater	1,278	1,062	1,001	1,174	1,663	1,285	1,685	1,680	1,629	1,614	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corona #02	Coldwater	157	0	0	394	1,152	1,059	1,191	1,256	1,016	1,067	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corona #03	Coldwater	1,155	1,024	1,107	1,192	1,368	1,072	1,391	1,297	1,349	1,110	770	506	4	1	237	380	978	1,316	1,083	999	897	952	491	559	83	392	881	460	3	0	0
Corona #20	Coldwater	0	0	0	0	0	0	0	0	0	0	1,489	0	0	0	0	0	338	801	430	361	186	238	186	57	212	196	19	0	0	0	0
Corona #21	Coldwater	0	0	0	0	0	0	0	0	0	2,461	4,364	3,493	2,528	2,579	2,345	2,401	1,506	1,609	2,004	1,955	2,018	1,942	761	662	1,432	1,658	1,254	1,508	764	178	0
Div Box Well	Coldwater	0	0	0	0	388	419	563	468	125	125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mayhew #01	Coldwater	921	662	678	212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mayhew #02	Coldwater		0	0	235	853	1,108	356	727	436	649	737	587	462	318	348	219	596	493	377	432	383	413	457	436	467	747	400	286	575	174	748
Noble #1 Maitri Rd	Coldwater	147	135	112	90	75	69	65	81	95	101	170	37	139	172	207	348	16	23	0	0	507	477	497	547	558	547	535	556	586	565	522
SantaAna #1 UpperCyn	Coldwater	81	44	80	88	86	100	111	113	5	83	110	12	45	0	0	0	0	0	0	0	0	0	27	102	41	26	44	34	66	45	45
SantaAna #2 LowerCyn	Coldwater	9	9	11	12	18	18	9	14	3	30	22	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	2	8	9	8
Smith #2	Coldwater	32	32	32	32	32	32	38	40	41	37	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Smith Lower #1	Coldwater	35	35	35	35	35	35	33	35	30	27	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Smith Upper #2	Coldwater	5	5	5	5	5	5	3	3	2	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Station #26	Coldwater	164	165	116	89	14	3	30	109	77	20	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Station #71	Coldwater	632	476	306	500	858	577	881	930	1,226	690	318	551	378	399	241	185	30	139	216	131	120	100	0	111	238	388	24	97	92	0	175
Station #72	Coldwater	344	302	303	332	369	345	322	288	200	126	337	456	422	353	276	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Warm Sprg	Coldwater	73	73	73	73	73	62	72	73	73	72	67	72	75	72	71	73	72	71	72	72	68	0	0	0	0	0	0	54	57	56	57
Well #1	Coldwater	83	89	71	57	37	26	31	40	47	53	62	8	3	2	2	11	555	620	608	569	0	0	0	0	0	0	0	0	0	0	0
Subtotals																																
Bedford	Bedford	2,792	2,570	2,935	2,251	1,864	1,455	923	1,428	1,537	248	1,055	1,336	1,400	1,824	1,078	1,046	188	306	995	1,149	643	648	87	780	1,080	1,347	1,397	1,334	2,061	2,142	2,389
Coldwater	Coldwater	5,226	4,273	4,610	5,540	8,326	6,475	8,081	7,173	6,370	8,284	8,550	5,723	4,057	3,911	3,744	3,634	4,110	5,089	4,791	4,520	4,179	4,122	2,419	2,475	3,032	3,955	3,157	2,998	2,152	1,027	1,555
Total		8,018	6,843	7,545	7,791	10,190	7,930	9,004	8,601	7,907	8,532	9,605	7,059	5,457	5,735	4,822	4,680	4,298	5,395	5,786	5,669	4,822	4,770	2,506	3,255	4,112	5,302	4,554	4,332	4,213	3,169	3,944

Table 3 - Aquifer Properties for MODFLOW Zones by Model Layer

Horizontal Hydraulic Conductivity (feet/day)

Zone	Name	MA	Model Layer 1	Model Layer 2	Model Layer 3
1	Mayhew Area	Coldwater	5	2	1
2	Mid Wash	Bedford	100	10	1
3	Bedford Canyon	Bedford	5	2	1
4	Midlands South	Bedford	2	2	1
5	North Wash	Bedford	100	10	1
6	South Wash	Bedford	40	5	1
7	Coldwater Creek	Coldwater	10	2	1
8	North Area	Coldwater	2.5	2	1
9	Midlands North	Bedford	2	1	1

Vertical Hydraulic Conductivity (feet/day)

Zone	Name	MA	Model Layer 1	Model Layer 2	Model Layer 3
1	Mayhew Area	Coldwater	1	0.2	0.5
2	Mid Wash	Bedford	5	5	0.5
3	Bedford Canyon	Bedford	2.5	0.2	0.1
4	Midlands South	Bedford	0.4	0.2	0.1
5	North Wash	Bedford	5	5	5.0E-01
6	South Wash	Bedford	4	0.5	5.0E-01
7	Coldwater Creek	Coldwater	1	0.2	0.5
8	North Area	Coldwater	0.25	0.2	5.0E-01
9	Midlands North	Bedford	0.4	0.1	1.0E-01

Specific Storage (1/feet)

Zone	Name	MA	Model Layer 1	Model Layer 2	Model Layer 3
1	Mayhew Area	Coldwater	1.0E-04	2.0E-05	1.0E-05
2	Mid Wash	Bedford	2.0E-04	1.0E-04	1.0E-05
3	Bedford Canyon	Bedford	1.0E-04	2.0E-05	1.0E-05
4	Midlands South	Bedford	1.0E-04	2.0E-05	1.0E-05
5	North Wash	Bedford	5.0E-04	1.0E-04	1.0E-05
6	South Wash	Bedford	1.0E-03	1.0E-04	1.0E-05
7	Coldwater Creek	Coldwater	1.0E-03	2.0E-05	1.0E-05
8	North Area	Coldwater	2.0E-03	1.0E-05	1.0E-05
9	Midlands North	Bedford	1.0E-04	1.0E-05	1.0E-05

Specific Yield (percentage)

Zone	Name	MA	Model Layer 1	Model Layer 2	Model Layer 3
1	Mayhew Area	Coldwater	0.05	0.03	0.02
2	Mid Wash	Bedford	0.15	0.1	0.02
3	Bedford Canyon	Bedford	0.05	0.03	0.02
4	Midlands South	Bedford	0.05	0.03	0.02
5	North Wash	Bedford	0.15	0.1	0.02
6	South Wash	Bedford	0.11	0.1	0.02
7	Coldwater Creek	Coldwater	0.08	0.05	0.02
8	North Area	Coldwater	0.05	0.02	0.02
9	Midlands North	Bedford	0.05	0.01	0.02

Table 5 - Statistical Calibration by Well

Well ID	Model Layer	Count	Residual Mean (feet)	Absolute Residual Mean (feet)	Standard Deviation (feet)	Management Area
B_Well	1	106	47.7	47.7	12.8	Coldwater
Corona#01	1	152	31.8	43.2	38.6	Coldwater
Corona#02	1	108	48.7	59.0	42.6	Coldwater
Corona#03	1	378	15.8	35.5	40.4	Coldwater
Corona#04	1	183	-5.9	12.7	16.6	Bedford
Corona#20	1	181	-35.7	44.3	45.3	Coldwater
Corona#21	1	99	18.8	26.6	28.0	Coldwater
Div_Box_Well	1	71	46.8	46.8	21.4	Coldwater
Flager#02	1	276	5.9	6.4	4.6	Bedford
Flager#03	1	145	8.5	10.7	8.2	Bedford
Flagler#02A	1	133	0.4	4.9	7.6	Bedford
Flagler#03A	1	196	-3.3	5.2	7.4	Bedford
Flagler#04	1	90	5.3	6.9	5.8	Bedford
LLWD_#01-Old	1	11	-2.6	5.5	5.6	Bedford
Mayhew#01	1	261	36.4	52.8	52.7	Coldwater
Mayhew#02	1	15	43.0	64.4	65.1	Coldwater
New_Sump	1	352	0.9	9.8	13.4	Bedford
Non-Potable#01	1	64	-2.1	6.3	7.5	Bedford
Non-Potable#02	1	62	-3.8	7.3	10.1	Bedford
OLD_SUMP	1	1	3.6	3.6	NA	Bedford
Station#22	1	58	58.0	58.7	38.2	Coldwater
Station#26	1	154	92.7	93.0	28.6	Coldwater
Station#71	1	309	4.9	40.2	50.5	Coldwater
Station#72	1	214	46.6	55.0	44.3	Coldwater
Trilogy	1	95	-7.3	32.8	35.1	Coldwater
TVWD#01A	1	11	-1.1	4.5	5.2	Bedford
TVWD#04	1	11	-3.0	5.0	4.8	Bedford
Basin Average		**3736**	**16.02**	**31.6**	**42.49**	
Bedford Average		**1535**	**0.21**	**6.83**	**8.05**	
Coldwater Average		**2201**	**32.02**	**50.00**	**38.84**	

Table 7 - Bedford/Coldwater GW Basin Water Balance (in acre-feet per year) - Historical

	INFLOWS							OUTFLOWS							
Simulation Year	Surface Recharge	GW-SW	Mountain Front Recharge	Net Quarry Ops	WRF Perc Ponds	Boundary Inflow	Total Inflow	Wells	Net Quarry Ops	GW-SW	ET	Boundary Outflow	Total Outflow	Annual Storage Change	Cumulative Storage Change
1990	1,027	1,194	1,656	74	0	1,173	5,125	10,621	5,276	1,086	446	57	17,486	-12,361	-12,361
1991	1,954	6,303	1,660	7	0	1,218	11,142	10,130	2,014	747	445	59	13,395	-2,253	-14,614
1992	1,576	4,486	1,654	18	0	776	8,510	9,579	1,012	520	342	46	11,498	-2,988	-17,602
1993	7,001	19,899	1,641	418	0	206	29,167	11,724	1,214	1,588	1,090	370	15,986	13,181	-4,421
1994	961	1,366	1,645	314	0	399	4,684	11,391	1,006	1,011	537	117	14,062	-9,378	-13,799
1995	3,167	9,420	1,973	121	20	245	14,946	10,957	1,297	1,123	686	105	14,169	777	-13,022
1996	939	562	2,012	111	40	384	4,049	11,610	1,252	582	428	48	13,921	-9,871	-22,893
1997	1,007	345	1,721	11	62	685	3,831	10,893	1,112	234	267	33	12,539	-8,707	-31,601
1998	4,730	13,989	1,467	36	107	253	20,582	10,377	1,471	838	674	287	13,647	6,935	-24,666
1999	864	342	1,355	1	210	242	3,014	11,517	1,558	413	369	117	13,974	-10,960	-35,626
2000	1,154	527	1,047	14	309	415	3,466	9,543	2,383	117	501	33	12,577	-9,111	-44,737
2001	1,975	5,127	989	85	373	497	9,047	7,351	2,713	194	721	30	11,009	-1,962	-46,699
2002	734	73	1,161	56	473	928	3,425	6,803	2,751	94	740	24	10,412	-6,987	-53,686
2003	2,286	5,187	957	29	691	645	9,795	5,714	2,425	154	872	41	9,205	590	-53,096
2004	1,047	316	731	37	891	562	3,582	5,313	5,314	83	807	30	11,547	-7,965	-61,061
2005	9,460	23,787	1,390	1	1,029	124	35,791	5,075	2,336	2,387	1,654	631	12,083	23,708	-37,353
2006	1,872	3,870	1,855	38	854	87	8,577	5,978	1,989	2,174	977	783	11,901	-3,324	-40,676
2007	600	1,045	1,805	0	801	143	4,393	6,168	1,972	1,114	1,183	184	10,622	-6,229	-46,906
2008	582	695	1,680	0	525	313	3,795	5,829	3,525	666	813	44	10,877	-7,082	-53,988
2009	1,642	2,582	1,588	72	291	148	6,323	5,157	4,159	639	868	200	11,023	-4,700	-58,688
2010	3,801	8,513	1,214	14	285	80	13,906	4,919	3,743	953	1,226	541	11,382	2,524	-56,165
2011	4,804	10,308	1,241	30	0	75	16,459	3,162	1,875	1,584	1,256	869	8,746	7,713	-48,452
2012	1,086	1,174	1,452	18	487	94	4,310	3,124	1,689	1,187	759	355	7,114	-2,804	-51,256
2013	848	931	1,460	22	1,575	165	5,002	3,982	2,455	831	625	74	7,966	-2,964	-54,220
2014	1,108	792	1,429	25	1,646	399	5,399	5,090	2,438	568	564	49	8,708	-3,309	-57,529
2015	1,370	757	1,094	178	1,462	192	5,053	4,560	2,241	450	816	278	8,345	-3,292	-60,821
2016	1,083	565	463	252	386	92	2,841	4,244	1,232	257	306	324	6,362	-3,521	-64,342
2017	3,793	8,905	506	404	3,438	80	17,126	4,046	3,736	662	1,088	599	10,131	6,995	-57,348
2018	876	931	659	353	2,862	72	5,753	2,812	3,062	433	916	460	7,682	-1,929	-59,276
Average Water Budget over Simulation Period (1990-2018)															
Average	2,184	4,620	1,362	94	649	369	9,279	7,161	2,388	782	758	234	11,323	-2,044	
Total	63,346	133,989	39,506	2,740	18,818	10,696	269,094	207,669	69,249	22,689	21,977	6,787	328,370	-59,276	
Average Water Budget over Early Historical period (1993-2002)															
Average	2,253	5,165	1,501	117	159	426	9,621	10,217	1,676	619	601	116	13,230	-3,608	
Total	22,533	51,651	15,011	1,167	1,594	4,255	96,212	102,166	16,758	6,194	6,014	1,164	132,296	-36,084	
Average Water Budget over Late Historical period (2005-2015)															
Average	2,470	4,950	1,473	36	814	166	9,910	4,822	2,584	1,141	977	364	9,888	22	
Total	27,172	54,452	16,208	399	8,956	1,821	109,007	53,044	28,421	12,553	10,742	4,007	108,768	240	
Average Water Budget over Long Historical period (1993-2015)															
Average	2,306	4,852	1,431	71	527	317	9,504	7,228	2,301	825	802	228	11,383	-1,879	
Total	53,037	111,605	32,908	1,632	12,132	7,283	218,597	166,237	52,918	18,984	18,435	5,242	261,816	-43,220	
Average Water Budget over Current period (2008-2018)															
Average	1,908	3,287	1,162	124	1,178	156	7,815	4,266	2,741	748	840	345	8,940	-1,125	
Total	20,992	36,152	12,786	1,368	12,957	1,711	85,966	46,925	30,154	8,230	9,236	3,792	98,337	-12,371	

Table 8 - Bedford MA Water Balance (in acre-feet per year) - Historical

Simulation Year	INFLOWS							OUTFLOWS						Annual Storage Change	Cumulative Storage Change
	Surface Recharge	GW-SW	Quarry Recharge	Mountain Front Recharge	WRF Perc Ponds	Boundary Inflow	Total Inflow	Wells	GW-SW	Quarry Outflow	ET	Boundary Outflow	Total Outflow		
1990	693	863	74	980	0	1,493	4,103	4,309	731	973	394	57	6,464	-2,361	-2,361
1991	1,270	2,248	7	981	0	1,514	6,020	4,056	559	1,153	369	59	6,196	-176	-2,537
1992	1,000	1,344	18	979	0	1,054	4,395	3,216	409	1,012	306	46	4,988	-593	-3,130
1993	4,800	3,920	418	977	0	423	10,538	3,230	1,495	1,214	768	370	7,076	3,462	332
1994	644	1,042	314	978	0	637	3,614	2,939	950	1,006	531	117	5,544	-1,930	-1,598
1995	2,085	2,422	121	1,185	20	427	6,260	2,349	1,080	1,297	609	105	5,441	819	-779
1996	654	494	111	1,194	40	563	3,057	2,554	563	1,252	427	48	4,845	-1,787	-2,566
1997	733	206	11	1,046	62	849	2,907	2,607	233	1,112	267	33	4,252	-1,345	-3,911
1998	3,219	3,159	36	897	107	354	7,772	1,462	832	1,471	545	287	4,597	3,174	-736
1999	647	341	1	833	210	342	2,375	1,861	413	1,558	369	117	4,318	-1,944	-2,680
2000	785	146	14	629	309	499	2,381	2,086	117	1,373	195	33	3,804	-1,423	-4,103
2001	1,274	1,731	85	592	373	556	4,611	2,040	193	1,108	294	30	3,664	947	-3,155
2002	475	72	56	693	473	977	2,746	2,212	94	1,145	268	24	3,743	-998	-4,153
2003	1,401	1,655	29	547	691	654	4,978	1,641	152	1,447	341	41	3,622	1,356	-2,796
2004	707	153	37	393	891	562	2,743	1,440	83	1,490	311	20	3,344	-601	-3,398
2005	6,337	4,947	1	848	1,029	124	13,287	902	2,377	2,279	1,037	553	7,149	6,138	2,740
2006	1,232	2,135	38	1,119	854	87	5,466	954	2,170	1,982	773	743	6,622	-1,157	1,584
2007	411	1,031	0	1,080	801	143	3,466	1,167	1,114	1,972	497	166	4,917	-1,451	133
2008	397	682	0	1,019	525	313	2,936	1,136	666	1,542	350	20	3,714	-778	-646
2009	1,023	1,205	72	969	291	148	3,707	795	637	1,290	418	150	3,291	416	-230
2010	2,511	2,888	14	706	285	80	6,483	669	949	1,654	626	457	4,355	2,128	1,898
2011	3,209	3,069	30	765	0	75	7,148	235	1,580	1,583	919	762	5,080	2,069	3,967
2012	768	1,172	18	894	487	94	3,434	632	1,187	1,689	759	270	4,537	-1,103	2,864
2013	604	931	22	897	1,575	165	4,194	1,032	831	2,455	625	-11	4,932	-738	2,126
2014	762	664	25	894	1,646	399	4,390	1,308	568	2,438	564	-46	4,831	-440	1,686
2015	954	577	178	686	1,462	192	4,049	1,202	450	2,241	429	171	4,493	-444	1,242
2016	744	403	252	297	386	92	2,174	1,191	257	1,232	292	207	3,178	-1,005	237
2017	2,521	2,847	404	341	3,438	80	9,631	1,625	660	3,736	585	463	7,069	2,562	2,800
2018	584	727	353	382	2,862	72	4,980	1,444	433	3,062	359	357	5,655	-675	2,125
Average Water Budget over Simulation Period (1990-2018)															
Average	1,464	1,485	94	821	649	447	4,960	1,803	751	1,647	491	195	4,887	73	
Total	42,446	43,072	2,740	23,800	18,818	12,970	143,845	52,295	21,784	47,766	14,227	5,649	141,721	2,125	
Average Water Budget over Early Historical period (1993-2002)															
Average	1,532	1,353	117	902	159	563	4,626	2,334	597	1,254	427	116	4,728	-102	
Total	15,317	13,532	1,167	9,022	1,594	5,627	46,261	23,341	5,970	12,537	4,272	1,164	47,284	-1,023	
Average Water Budget over Late Historical period (2005-2015)															
Average	1,655	1,755	36	898	814	166	5,324	912	1,139	1,920	636	294	4,902	422	
Total	18,208	19,300	399	9,877	8,956	1,821	58,560	10,033	12,529	21,124	6,999	3,235	53,920	4,640	
Average Water Budget over Long Historical period (1993-2015)															
Average	1,549	1,506	71	863	527	377	4,893	1,585	815	1,591	518	194	4,703	190	
Total	35,633	34,641	1,632	19,840	12,132	8,664	112,542	36,455	18,735	36,599	11,922	4,459	108,170	4,372	
Average Water Budget over Current period (2008-2018)															
Average	1,280	1,379	124	714	1,178	156	4,830	1,024	747	2,084	539	255	4,649	181	
Total	14,077	15,164	1,368	7,849	12,957	1,711	53,127	11,269	8,219	22,920	5,926	2,800	51,135	1,992	

Table 9 - Coldwater MA Water Balance (in acre-feet per year) - Historical

	INFLOWS						OUTFLOWS							
Simulation Year	Surface Recharge	GW-SW	Mountain Front Recharge	Net Quarry Ops	Boundary Inflow	Total Inflow	Wells	Net Quarry Ops	GW-SW	ET	Boundary Outflow	Total Outflow	Annual Storage Change	Cumulative Storage Change
1990	334	331	676	0	0	1,341	6,312	4,303	355	52	320	11,342	-10,000	-10,000
1991	684	4,055	678	0	0	5,418	6,074	861	188	76	296	7,495	-2,077	-12,077
1992	576	3,141	675	0	0	4,393	6,363	0	111	37	277	6,787	-2,395	-14,472
1993	2,201	15,979	665	0	0	18,845	8,493	0	93	323	217	9,126	9,719	-4,753
1994	317	324	667	0	0	1,308	8,451	0	61	6	238	8,756	-7,448	-12,201
1995	1,082	6,998	788	0	0	8,868	8,608	0	43	77	182	8,909	-42	-12,243
1996	285	68	818	0	0	1,171	9,056	0	19	2	179	9,255	-8,084	-20,327
1997	274	139	675	0	0	1,088	8,285	0	1	1	164	8,451	-7,363	-27,690
1998	1,511	10,831	570	0	0	12,912	8,915	0	5	129	101	9,151	3,761	-23,929
1999	217	1	522	0	0	740	9,656	0	0	0	100	9,756	-9,017	-32,946
2000	369	381	419	0	0	1,169	7,457	1,010	0	306	84	8,857	-7,688	-40,634
2001	702	3,396	397	0	0	4,494	5,312	1,605	2	427	59	7,404	-2,909	-43,544
2002	259	1	468	0	0	728	4,591	1,606	0	472	49	6,718	-5,990	-49,533
2003	884	3,532	410	0	0	4,826	4,073	977	2	531	9	5,592	-766	-50,300
2004	340	163	338	0	10	850	3,873	3,824	0	496	0	8,193	-7,344	-57,643
2005	3,122	18,840	542	0	77	22,582	4,173	57	10	617	0	4,857	17,724	-39,919
2006	641	1,735	736	0	40	3,152	5,024	7	4	204	0	5,238	-2,087	-42,005
2007	189	14	725	0	18	945	5,001	0	0	685	0	5,687	-4,741	-46,747
2008	185	13	661	0	24	883	4,693	1,983	0	463	0	7,139	-6,256	-53,002
2009	619	1,377	619	0	51	2,667	4,361	2,869	2	450	0	7,681	-5,015	-58,017
2010	1,290	5,625	508	0	83	7,506	4,250	2,089	4	601	0	6,943	562	-57,455
2011	1,595	7,239	476	0	106	9,416	2,927	292	4	337	0	3,560	5,856	-51,598
2012	317	1	558	0	85	961	2,492	0	0	0	0	2,492	-1,531	-53,129
2013	244	1	562	0	85	892	2,950	0	0	0	0	2,950	-2,058	-55,187
2014	346	127	536	0	95	1,104	3,783	0	0	0	0	3,783	-2,679	-57,866
2015	416	180	408	0	107	1,111	3,358	0	0	387	0	3,745	-2,633	-60,499
2016	339	162	166	0	117	784	3,053	0	0	14	0	3,067	-2,282	-62,782
2017	1,272	6,058	165	0	136	7,631	2,421	0	2	503	0	2,926	4,705	-58,077
2018	292	205	277	0	123	896	1,368	0	0	557	0	1,924	-1,028	-59,105
Average Water Budget over Simulation Period (1990-2018)														
Average	721	3,135	542	0	40	4,437	5,358	741	31	267	78	6,475	-2,038	
Total	20,901	90,917	15,706	0	1,158	128,682	155,373	21,483	905	7,750	2,275	187,786	-59,105	
Average Water Budget over Early Historical period (1993-2002)														
Average	722	3,812	599	0	0	5,132	7,882	422	22	174	137	8,638	-3,506	
Total	7,216	38,118	5,989	0	0	51,323	78,824	4,221	224	1,742	1,372	86,384	-35,061	
Average Water Budget over Late Historical period (2005-2015)														
Average	815	3,196	576	0	70	4,656	3,910	663	2	340	0	4,916	-260	
Total	8,964	35,152	6,331	0	772	51,219	43,011	7,297	24	3,743	0	54,075	-2,856	
Average Water Budget over Long Historical period (1993-2015)														
Average	757	3,346	568	0	34	4,705	5,643	710	11	283	60	6,706	-2,001	
Total	17,404	76,965	13,068	0	782	108,218	129,782	16,319	250	6,513	1,381	154,245	-46,027	
Average Water Budget over Current period (2008-2018)														
Average	629	1,908	449	0	92	3,077	3,241	658	1	301	0	4,201	-1,123	
Total	6,915	20,988	4,937	0	1,012	33,852	35,655	7,233	11	3,310	0	46,210	-12,358	

Table 10 - Change in Groundwater in Storage (in acre-feet per year) - Historical

Simulation Year	Net Change in Groundwater in Storage		Annual Change in Groundwater in Storage	Cumulative Storage Change
	Coldwater Hydrologic Area	Bedford Hydrologic Area		
1990	-10,000	-2,361	-12,361	-12,361
1991	-2,077	-176	-2,253	-14,614
1992	-2,395	-593	-2,988	-17,602
1993	9,719	3,462	13,181	-4,421
1994	-7,448	-1,930	-9,378	-13,799
1995	-42	819	777	-13,022
1996	-8,084	-1,787	-9,871	-22,893
1997	-7,363	-1,345	-8,707	-31,601
1998	3,761	3,174	6,935	-24,666
1999	-9,017	-1,944	-10,960	-35,626
2000	-7,688	-1,423	-9,111	-44,737
2001	-2,909	947	-1,962	-46,699
2002	-5,990	-998	-6,987	-53,686
2003	-766	1,356	590	-53,096
2004	-7,344	-622	-7,965	-61,062
2005	17,724	5,984	23,708	-37,354
2006	-2,087	-1,237	-3,324	-40,677
2007	-4,741	-1,488	-6,229	-46,906
2008	-6,256	-826	-7,082	-53,989
2009	-5,015	314	-4,700	-58,689
2010	562	1,961	2,524	-56,165
2011	5,856	1,856	7,713	-48,453
2012	-1,531	-1,273	-2,804	-51,257
2013	-2,058	-907	-2,964	-54,221
2014	-2,679	-630	-3,309	-57,530
2015	-2,633	-659	-3,292	-60,822
2016	-2,282	-1,243	-3,526	-64,348
2017	4,705	2,287	6,992	-57,356
2018	-1,028	-881	-1,909	-59,264
Average Water Budget over Simulation Period (1990-2018)				
Average	-2,038	-6	-2,044	
Total	-59,105	-160	-59,264	
Average Water Budget over Early Historical period (1993-2002)				
Average	-3,506	-102	-3,608	
Total	-35,061	-1,023	-36,084	
Average Water Budget over Late Historical period (2005-2015)				
Average	-260	281	22	
Total	-2,856	3,096	239	
Average Water Budget over Long Historical period (1993-2015)				
Average	-2,001	122	-1,879	
Total	-46,027	2,807	-43,220	
Average Water Budget over Current period (2008-2018)				
Average	-1,123	0	-1,123	
Total	-12,358	0	-12,358	

Table 11 - Bedford/Coldwater GW Basin Water Balance (in acre-feet per year) - Projected Future Baseline Scenario

	INFLOWS							OUTFLOWS							
Simulation Year	Surface Recharge	GW-SW	Mountain Front Recharge	Net Quarry Ops	WRF Perc Ponds	Boundary Inflow	Total Inflow	Wells	Net Quarry Ops	GW-SW	ET	Boundary Outflow	Total Outflow	Annual Storage Change	Cumulative Storage Change
2019	7,126	16,193	1,580	107	1,856	71	26,933	4,319	2,911	1,486	1,278	660	10,654	16,279	16,279
2020	1,173	1,667	1,581	151	1,856	88	6,515	4,330	2,546	1,285	975	602	9,736	-3,221	13,058
2021	3,514	7,565	1,578	128	1,856	83	14,723	4,318	2,647	1,410	1,142	662	10,179	4,544	17,602
2022	905	1,120	1,587	173	1,856	91	5,732	4,333	2,358	1,008	923	524	9,146	-3,414	14,188
2023	1,089	1,008	1,592	185	1,856	91	5,822	4,330	2,220	795	850	451	8,646	-2,824	11,364
2024	4,977	10,445	1,436	118	1,856	77	18,908	4,326	2,652	1,357	1,159	669	10,163	8,744	20,108
2025	852	1,005	1,335	167	1,856	91	5,306	4,333	2,392	957	906	539	9,128	-3,822	16,287
2026	1,189	1,122	1,040	184	1,856	90	5,480	4,326	2,225	632	739	430	8,351	-2,871	13,416
2027	2,199	5,764	979	159	1,856	84	11,040	4,321	2,383	807	782	519	8,812	2,228	15,644
2028	526	652	1,097	194	1,856	92	4,417	4,335	2,179	580	656	409	8,158	-3,742	11,902
2029	2,586	5,375	887	159	1,856	84	10,947	4,315	2,293	615	764	492	8,479	2,468	14,370
2030	923	760	678	194	1,856	88	4,500	4,329	2,152	429	618	386	7,915	-3,415	10,955
2031	9,183	19,552	1,292	82	1,856	63	32,029	4,316	2,934	2,000	1,620	760	11,630	20,399	31,354
2032	1,672	2,232	1,673	136	1,856	83	7,652	4,324	2,667	1,633	1,152	701	10,476	-2,824	28,530
2033	457	1,082	1,612	183	1,856	91	5,281	4,332	2,320	1,051	847	474	9,023	-3,743	24,787
2034	473	934	1,498	194	1,856	91	5,047	4,321	2,161	865	665	389	8,402	-3,355	21,432
2035	1,529	2,031	1,426	182	1,856	84	7,108	4,324	2,183	774	709	424	8,413	-1,305	20,126
2036	3,554	8,626	1,055	133	1,856	80	15,304	4,324	2,577	1,055	966	614	9,535	5,768	25,895
2037	4,546	10,266	1,117	110	1,856	79	17,975	4,319	2,767	1,460	1,206	718	10,470	7,505	33,400
2038	985	1,013	1,313	168	1,856	91	5,426	4,326	2,400	963	922	529	9,139	-3,713	29,687
2039	726	780	1,322	189	1,856	91	4,965	4,334	2,207	718	755	423	8,436	-3,472	26,215
2040	973	652	1,296	199	1,856	92	5,066	4,332	2,094	507	698	374	8,005	-2,938	23,277
2041	1,240	549	980	195	1,856	92	4,911	4,331	2,065	372	614	359	7,740	-2,829	20,448
2042	920	477	405	205	1,856	92	3,955	4,329	2,015	244	543	331	7,461	-3,507	16,942
2043	3,490	8,003	461	152	1,856	80	14,042	4,327	2,363	560	773	510	8,533	5,509	22,450
2044	7,064	15,871	1,102	99	1,856	71	26,063	4,328	2,855	1,696	1,396	739	11,014	15,050	37,500
2045	1,172	1,713	1,539	150	1,856	87	6,518	4,330	2,578	1,354	1,005	613	9,880	-3,362	34,138
2046	3,514	7,700	1,843	126	1,856	83	15,122	4,318	2,669	1,546	1,195	675	10,403	4,719	38,856
2047	901	1,306	2,055	167	1,856	91	6,377	4,349	2,427	1,221	1,008	545	9,550	-3,173	35,683
2048	1,080	1,183	1,799	182	1,887	93	6,224	4,398	2,340	966	936	485	9,125	-2,902	32,781
2049	5,091	10,927	1,443	116	1,897	77	19,551	4,399	2,763	1,525	1,247	696	10,631	8,921	41,702
2050	819	1,088	1,339	169	1,897	93	5,405	4,406	2,481	1,048	953	557	9,445	-4,040	37,662
2051	1,187	1,346	1,043	184	1,897	92	5,748	4,400	2,314	722	781	450	8,667	-2,919	34,743
2052	2,200	6,108	982	156	1,887	85	11,418	4,388	2,475	894	830	564	9,152	2,266	37,009
2053	481	713	1,105	196	1,897	93	4,485	4,407	2,257	641	687	441	8,432	-3,948	33,061
2054	2,625	5,771	891	158	1,897	85	11,427	4,389	2,401	699	808	532	8,829	2,597	35,659
2055	910	944	678	193	1,897	90	4,712	4,403	2,245	510	657	421	8,236	-3,524	32,135
2056	9,323	20,087	1,301	78	1,887	65	32,740	4,383	3,030	2,213	1,713	797	12,136	20,604	52,739
2057	1,661	2,378	1,688	137	1,897	85	7,846	4,396	2,729	1,723	1,190	733	10,772	-2,926	49,813
2058	414	1,141	1,622	186	1,897	93	5,352	4,405	2,389	1,113	872	492	9,271	-3,920	45,893
2059	428	981	1,508	197	1,897	93	5,104	4,394	2,233	919	683	400	8,630	-3,526	42,367
2060	1,523	2,348	1,429	178	1,887	85	7,450	4,392	2,285	839	745	467	8,728	-1,278	41,090
2061	3,639	8,910	1,050	133	1,897	81	15,710	4,397	2,669	1,154	1,007	648	9,875	5,835	46,925
2062	4,601	10,532	1,112	111	1,897	81	18,333	4,392	2,854	1,569	1,254	746	10,815	7,517	54,442
2063	952	1,078	1,323	175	1,687	93	5,309	4,411	2,274	1,032	948	546	9,211	-3,902	50,540
2064	685	837	1,331	193	1,887	93	5,026	4,401	2,257	777	779	434	8,649	-3,623	46,917
2065	940	738	1,309	201	1,897	93	5,178	4,404	2,165	562	721	387	8,239	-3,061	43,856
2066	1,204	656	986	195	1,897	93	5,032	4,404	2,150	419	637	384	7,995	-2,963	40,893
2067	881	565	401	206	1,897	94	4,043	4,402	2,104	275	564	353	7,698	-3,654	37,238
2068	3,528	8,291	458	152	1,887	82	14,398	4,394	2,464	620	810	534	8,822	5,576	42,815
Average Water Budget over Simulation Period (2019-2068)															
Average	2,273	4,442	1,243	162	1,868	86	10,073	4,357	2,422	992	914	532	9,217	856	
Total	113,627	222,085	62,156	8,086	93,385	4,313	503,652	217,845	121,121	49,597	45,687	26,587	460,838	42,815	
Average Water Budget over Implementation Period (2022-2041)															
Average	2,029	3,748	1,261	165	1,856	86	9,146	4,326	2,362	929	877	509	9,003	142	
Total	40,583	74,968	25,213	3,304	37,120	1,728	182,915	86,528	47,231	18,577	17,549	10,183	180,069	2,846	
Average Water Budget over Sustainability Period (2042-2068)															
Average	2,268	4,507	1,193	163	1,878	87	10,095	4,383	2,437	994	916	536	9,267	828	
Total	61,232	121,692	32,204	4,396	50,698	2,344	272,566	118,350	65,788	26,840	24,743	14,481	250,200	22,366	
Average Water Budget over GSP Period (2019-2021)															
Average	3,937	8,475	1,580	128	1,856	80	16,057	4,322	2,701	1,394	1,132	641	10,190	5,867	
Total	11,812	25,425	4,740	385	5,568	241	48,171	12,967	8,103	4,181	3,395	1,923	30,569	17,602	

Table 12 - Bedford MA Water Balance (in acre-feet per year) - Projected Future Baseline Scenario

	INFLOWS							OUTFLOWS							
Simulation Year	Surface Recharge	GW-SW	Quarry Recharge	Mountain Front Recharge	WRF Perc Ponds	Boundary Inflow	Total Inflow	Wells	GW-SW	Quarry Outflow	ET	Boundary Outflow	Total Outflow	Annual Storage Change	Cumulative Storage Change
2019	4,825	3,730	107	1,008	1,856	71	11,597	1,310	1,479	2,911	1,125	514	7,339	4,258	4,258
2020	799	1,440	151	1,008	1,856	88	5,341	1,307	1,284	2,546	828	494	6,459	-1,118	3,140
2021	2,312	2,389	128	1,007	1,856	83	7,775	1,309	1,407	2,647	992	558	6,913	862	4,001
2022	622	1,070	173	1,010	1,856	91	4,823	1,305	1,008	2,358	766	439	5,876	-1,053	2,948
2023	758	887	185	1,012	1,856	91	4,791	1,303	795	2,220	685	369	5,373	-582	2,367
2024	3,335	2,923	118	905	1,856	77	9,214	1,312	1,351	2,652	1,005	571	6,891	2,323	4,689
2025	598	1,004	167	846	1,856	91	4,562	1,305	957	2,392	751	461	5,867	-1,305	3,385
2026	769	798	184	653	1,856	90	4,351	1,304	632	2,225	587	358	5,106	-754	2,630
2027	1,428	2,282	159	613	1,856	84	6,421	1,306	806	2,383	643	442	5,580	841	3,471
2028	354	652	194	668	1,856	92	3,816	1,303	580	2,179	508	344	4,914	-1,099	2,372
2029	1,695	1,843	159	518	1,856	84	6,155	1,306	614	2,293	615	416	5,245	910	3,283
2030	619	624	194	377	1,856	88	3,758	1,303	429	2,152	467	317	4,668	-910	2,372
2031	6,177	4,284	82	788	1,856	63	13,251	1,313	1,990	2,934	1,455	654	8,346	4,905	7,277
2032	1,101	1,682	136	1,015	1,856	83	5,873	1,309	1,632	2,667	1,012	638	7,258	-1,385	5,893
2033	299	1,082	183	973	1,856	91	4,485	1,303	1,051	2,320	701	442	5,817	-1,332	4,560
2034	314	934	194	918	1,856	91	4,308	1,302	865	2,161	532	364	5,225	-917	3,643
2035	964	1,276	182	877	1,856	84	5,238	1,304	773	2,183	568	388	5,216	22	3,666
2036	2,336	2,744	133	628	1,856	80	7,777	1,309	1,051	2,577	811	564	6,312	1,465	5,131
2037	3,023	2,732	110	699	1,856	79	8,499	1,310	1,457	2,767	1,061	662	7,257	1,243	6,374
2038	697	1,013	168	819	1,856	91	4,645	1,305	963	2,400	767	504	5,939	-1,294	5,079
2039	509	780	189	823	1,856	91	4,248	1,303	718	2,207	601	411	5,240	-991	4,088
2040	661	594	199	819	1,856	92	4,220	1,303	507	2,094	533	364	4,801	-581	3,507
2041	861	494	195	624	1,856	92	4,121	1,303	372	2,065	456	343	4,538	-417	3,091
2042	621	397	205	270	1,856	92	3,442	1,302	244	2,015	378	309	4,247	-805	2,286
2043	2,305	2,556	152	313	1,856	80	7,263	1,307	559	2,363	606	466	5,300	1,963	4,248
2044	4,780	3,528	99	720	1,856	71	11,053	1,313	1,690	2,855	1,233	674	7,764	3,289	7,537
2045	798	1,486	150	981	1,856	87	5,359	1,307	1,354	2,578	859	587	6,685	-1,326	6,211
2046	2,312	2,433	126	1,168	1,856	83	7,978	1,309	1,543	2,669	1,044	655	7,220	758	6,970
2047	620	1,256	167	1,281	1,856	95	5,275	1,310	1,221	2,427	851	545	6,354	-1,078	5,891
2048	754	1,053	182	1,131	1,887	103	5,110	1,325	965	2,340	767	485	5,882	-772	5,119
2049	3,417	3,052	116	918	1,897	77	9,477	1,333	1,519	2,763	1,091	681	7,388	2,090	7,209
2050	580	1,088	169	855	1,897	102	4,691	1,327	1,048	2,481	795	557	6,208	-1,517	5,692
2051	771	992	184	663	1,897	111	4,618	1,326	722	2,314	628	450	5,440	-823	4,869
2052	1,431	2,460	156	623	1,887	98	6,655	1,328	893	2,475	688	564	5,948	707	5,576
2053	327	713	196	681	1,897	120	3,934	1,325	641	2,257	538	441	5,200	-1,267	4,309
2054	1,725	2,082	158	528	1,897	100	6,488	1,329	698	2,401	656	532	5,617	872	5,181
2055	614	781	193	384	1,897	110	3,979	1,325	510	2,245	503	421	5,005	-1,026	4,155
2056	6,274	4,461	78	802	1,887	65	13,566	1,334	2,202	3,030	1,546	769	8,880	4,686	8,841
2057	1,097	1,783	137	1,031	1,897	103	6,047	1,330	1,722	2,729	1,048	733	7,562	-1,515	7,326
2058	274	1,141	186	985	1,897	149	4,631	1,325	1,113	2,389	724	492	6,044	-1,413	5,912
2059	287	981	197	931	1,897	160	4,452	1,324	919	2,233	548	400	5,425	-973	4,940
2060	961	1,531	178	884	1,887	139	5,581	1,325	839	2,285	601	467	5,517	64	5,004
2061	2,398	2,849	133	628	1,897	113	8,018	1,330	1,151	2,669	850	648	6,649	1,369	6,373
2062	3,058	2,844	111	699	1,897	103	8,712	1,332	1,566	2,854	1,106	746	7,604	1,108	7,481
2063	679	1,078	175	833	1,687	154	4,607	1,340	1,032	2,274	790	546	5,981	-1,375	6,106
2064	484	837	193	837	1,887	171	4,409	1,324	777	2,257	622	434	5,414	-1,006	5,100
2065	643	666	201	835	1,897	173	4,415	1,325	562	2,165	554	387	4,992	-577	4,523
2066	840	592	195	636	1,897	166	4,325	1,325	419	2,150	476	384	4,755	-429	4,094
2067	599	473	206	274	1,897	161	3,609	1,324	275	2,104	396	353	4,451	-842	3,252
2068	2,334	2,704	152	318	1,887	121	7,516	1,328	618	2,464	639	534	5,583	1,933	5,185
Average Water Budget over Simulation Period (2019-2068)															
Average	1,521	1,661	162	776	1,868	102	6,090	1,315	990	2,422	760	498	5,986	104	
Total	76,037	83,075	8,086	38,820	93,385	5,077	304,480	65,768	49,519	121,121	38,010	24,878	299,295	5,185	
Average Water Budget over Implementation Period (2022-2041)															
Average	1,356	1,485	165	779	1,856	86	5,728	1,305	927	2,362	726	453	5,773	-46	
Total	27,119	29,699	3,304	15,588	37,120	1,728	114,557	26,109	18,550	47,231	14,525	9,052	115,468	-911	
Average Water Budget over Sustainability Period (2042-2068)															
Average	1,518	1,697	163	748	1,878	115	6,119	1,323	993	2,437	761	528	6,041	78	
Total	40,982	45,817	4,396	20,209	50,698	3,108	165,210	35,732	26,798	65,788	20,539	14,260	163,116	2,094	
Average Water Budget over GSP Period (2019-2021)															
Average	2,645	2,520	128	1,008	1,856	80	8,237	1,309	1,390	2,701	982	522	6,904	1,334	
Total	7,936	7,559	385	3,023	5,568	241	24,712	3,926	4,170	8,103	2,945	1,566	20,711	4,001	

Table 13 - Coldwater MA Water Balance (in acre-feet per year) - Projected Future Baseline Scenario

	INFLOWS							OUTFLOWS						
Simulation Year	Surface Recharge	GW-SW	Mountain Front Recharge	Net Quarry Ops	Boundary Inflow	Total Inflow	Wells	Net Quarry Ops	GW-SW	ET	Boundary Outflow	Total Outflow	Annual Storage Change	Cumulative Storage Change
2019	2,301	12,463	572	0	145	15,481	3,009	0	7	153	0	3,169	12,312	12,312
2020	374	227	573	0	108	1,282	3,023	0	0	146	0	3,169	-1,887	10,425
2021	1,202	5,176	571	0	104	7,053	3,009	0	3	151	0	3,162	3,891	14,315
2022	283	50	577	0	85	994	3,028	0	0	157	0	3,185	-2,191	12,124
2023	331	121	580	0	82	1,113	3,026	0	0	165	0	3,192	-2,079	10,045
2024	1,642	7,522	530	0	98	9,792	3,015	0	6	153	0	3,174	6,618	16,664
2025	254	0	490	0	78	822	3,028	0	0	155	0	3,183	-2,362	14,302
2026	420	323	386	0	72	1,201	3,022	0	0	151	0	3,173	-1,972	12,330
2027	771	3,482	366	0	77	4,696	3,015	0	1	139	0	3,155	1,541	13,870
2028	172	0	429	0	65	666	3,031	0	0	147	0	3,179	-2,512	11,358
2029	891	3,533	369	0	76	4,868	3,009	0	1	149	0	3,159	1,709	13,066
2030	304	137	301	0	70	812	3,026	0	0	151	0	3,177	-2,365	10,701
2031	3,006	15,268	504	0	105	18,883	3,003	0	11	164	0	3,178	15,704	26,405
2032	571	549	658	0	62	1,841	3,015	0	2	140	0	3,156	-1,315	25,091
2033	157	0	638	0	33	828	3,028	0	0	145	0	3,174	-2,345	22,745
2034	159	0	579	0	25	764	3,019	0	0	133	0	3,152	-2,388	20,357
2035	565	756	549	0	35	1,905	3,021	0	0	141	0	3,162	-1,257	19,100
2036	1,217	5,882	428	0	51	7,577	3,015	0	3	155	0	3,173	4,404	23,505
2037	1,523	7,535	418	0	56	9,531	3,009	0	3	145	0	3,157	6,374	29,879
2038	288	0	493	0	24	806	3,021	0	0	155	0	3,176	-2,370	27,509
2039	217	0	499	0	11	728	3,031	0	0	154	0	3,185	-2,458	25,051
2040	312	57	477	0	10	856	3,029	0	0	165	0	3,193	-2,337	22,714
2041	380	55	356	0	16	806	3,028	0	0	158	0	3,186	-2,379	20,334
2042	299	79	134	0	22	535	3,027	0	0	165	1	3,193	-2,658	17,676
2043	1,185	5,447	148	0	44	6,823	3,020	0	1	168	1	3,190	3,633	21,309
2044	2,284	12,343	382	0	65	15,075	3,015	0	7	163	0	3,184	11,892	33,201
2045	374	227	558	0	26	1,184	3,023	0	0	146	0	3,169	-1,985	31,216
2046	1,202	5,267	675	0	20	7,164	3,009	0	3	151	0	3,164	4,000	35,216
2047	281	50	774	0	0	1,105	3,039	0	0	158	3	3,200	-2,095	33,121
2048	325	130	669	0	0	1,124	3,074	0	0	169	10	3,253	-2,129	30,991
2049	1,674	7,875	525	0	16	10,090	3,066	0	6	155	0	3,227	6,863	37,854
2050	239	0	484	0	0	724	3,079	0	0	158	9	3,246	-2,523	35,331
2051	415	354	380	0	0	1,150	3,073	0	0	154	20	3,246	-2,097	33,235
2052	768	3,649	359	0	0	4,776	3,061	0	1	142	13	3,217	1,559	34,794
2053	154	0	424	0	0	578	3,083	0	0	149	27	3,259	-2,681	32,113
2054	901	3,689	363	0	0	4,953	3,061	0	1	152	14	3,227	1,726	33,839
2055	295	164	295	0	0	754	3,077	0	0	154	20	3,251	-2,497	31,341
2056	3,048	15,626	500	0	28	19,202	3,049	0	11	167	0	3,228	15,974	47,315
2057	564	596	657	0	0	1,816	3,066	0	2	142	18	3,228	-1,411	45,904
2058	140	0	636	0	0	777	3,080	0	0	148	56	3,283	-2,507	43,398
2059	142	0	577	0	0	719	3,070	0	0	135	67	3,272	-2,553	40,845
2060	563	817	545	0	0	1,924	3,067	0	0	144	54	3,265	-1,341	39,503
2061	1,241	6,062	422	0	0	7,725	3,066	0	3	157	32	3,258	4,466	43,969
2062	1,542	7,688	413	0	0	9,643	3,060	0	3	148	22	3,234	6,409	50,378
2063	273	0	490	0	0	763	3,072	0	0	158	61	3,290	-2,527	47,851
2064	200	0	494	0	0	695	3,078	0	0	157	77	3,312	-2,617	45,234
2065	297	72	473	0	0	842	3,080	0	0	167	80	3,327	-2,484	42,750
2066	364	64	351	0	0	779	3,079	0	0	161	73	3,313	-2,533	40,216
2067	283	91	127	0	0	501	3,078	0	0	168	69	3,316	-2,815	37,401
2068	1,194	5,587	141	0	0	6,922	3,067	0	2	170	42	3,280	3,641	41,043
Average Water Budget over Simulation Period (2019-2068)														
Average	752	2,780	467	0	34	4,033	3,042	0	2	154	15	3,212	821	
Total	37,590	139,010	23,337	0	1,709	201,646	152,078	0	78	7,677	770	160,603	41,043	
Average Water Budget over Implementation Period (2022-2041)														
Average	673	2,263	481	0	57	3,474	3,021	0	1	151	0	3,173	301	
Total	13,464	45,269	9,625	0	1,131	69,489	60,419	0	27	3,024	0	63,470	6,019	
Average Water Budget over Sustainability Period (2042-2068)														
Average	750	2,810	444	0	8	4,013	3,060	0	2	156	29	3,246	767	
Total	20,250	75,875	11,995	0	221	108,341	82,618	0	41	4,204	770	87,633	20,708	
Average Water Budget over GSP Period (2019-2021)														
Average	1,292	5,955	572	0	119	7,939	3,014	0	3	150	0	3,167	4,772	
Total	3,877	17,865	1,716	0	357	23,816	9,041	0	10	450	0	9,501	14,315	

Table 14 - Change in Groundwater in Storage (in acre-feet per year) - Projected Future Baseline Scenario

Simulation Year	Net Change in Groundwater in Storage		Annual Change in Groundwater in Storage	Cumulative Storage Change
	Coldwater Hydrologic Area	Bedford Hydrologic Area		
2019	12,312	3,967	16,279	16,279
2020	-1,887	-1,334	-3,221	13,058
2021	3,891	654	4,544	17,602
2022	-2,191	-1,223	-3,414	14,188
2023	-2,079	-745	-2,824	11,364
2024	6,618	2,126	8,744	20,108
2025	-2,362	-1,460	-3,822	16,287
2026	-1,972	-898	-2,871	13,416
2027	1,541	687	2,228	15,644
2028	-2,512	-1,229	-3,742	11,902
2029	1,709	759	2,468	14,369
2030	-2,365	-1,050	-3,415	10,954
2031	15,704	4,695	20,399	31,353
2032	-1,315	-1,509	-2,824	28,529
2033	-2,345	-1,397	-3,743	24,786
2034	-2,388	-967	-3,355	21,431
2035	-1,257	-48	-1,305	20,126
2036	4,404	1,364	5,768	25,894
2037	6,374	1,131	7,505	33,399
2038	-2,370	-1,343	-3,713	29,686
2039	-2,458	-1,014	-3,472	26,215
2040	-2,337	-601	-2,938	23,276
2041	-2,379	-449	-2,829	20,448
2042	-2,658	-854	-3,512	16,936
2043	3,633	1,874	5,506	22,442
2044	11,892	3,158	15,050	37,491
2045	-1,985	-1,377	-3,362	34,129
2046	4,000	718	4,719	38,848
2047	-2,095	-1,078	-3,173	35,674
2048	-2,129	-772	-2,902	32,773
2049	6,863	2,058	8,921	41,693
2050	-2,523	-1,517	-4,040	37,654
2051	-2,097	-823	-2,919	34,734
2052	1,559	707	2,266	37,000
2053	-2,681	-1,267	-3,948	33,053
2054	1,726	872	2,597	35,650
2055	-2,497	-1,027	-3,524	32,126
2056	15,974	4,630	20,604	52,730
2057	-1,411	-1,515	-2,926	49,803
2058	-2,507	-1,413	-3,920	45,883
2059	-2,553	-973	-3,526	42,358
2060	-1,341	64	-1,278	41,080
2061	4,466	1,369	5,835	46,915
2062	6,409	1,108	7,517	54,432
2063	-2,527	-1,375	-3,902	50,530
2064	-2,617	-1,006	-3,623	46,908
2065	-2,484	-577	-3,061	43,846
2066	-2,533	-429	-2,963	40,884
2067	-2,815	-847	-3,662	37,222
2068	3,641	1,931	5,572	42,794
Average Water Budget over Simulation Period (2019-2068)				
Average	821	35	856	
Total	41,043	1,751	42,794	
Average Water Budget over Implementation Period (2022-2041)				
Average	301	-159	142	
Total	6,019	-3,173	2,846	
Average Water Budget over Sustainability Period (2042-2068)				
Average	767	61	828	
Total	20,708	1,638	22,346	
Average Water Budget over GSP Period (2019-2021)				
Average	4,772	1,096	5,867	
Total	14,315	3,287	17,602	

Table 15 - Bedford/Coldwater GW Basin Water Balance (in acre-feet per year) - Projected Future Growth plus Climate Change Scenario

Simulation Year	INFLOWS							OUTFLOWS						Annual Storage Change	Cumulative Storage Change
	Surface Recharge	GW-SW	Mountain Front Recharge	Net Quarry Ops	WRF Perc Ponds	Boundary Inflow	Total Inflow	Wells	Net Quarry Ops	GW-SW	ET	Boundary Outflow	Total Outflow		
2019	8,073	16,119	1,632	299	2,139	71	28,334	5,021	2,866	1,737	1,553	607	11,784	16,549	16,549
2020	1,871	1,689	1,632	456	2,139	88	7,874	5,019	2,504	1,637	1,216	551	10,927	-3,053	13,497
2021	4,391	7,441	1,628	409	2,139	83	16,091	5,018	2,595	1,838	1,480	572	11,503	4,588	18,085
2022	1,545	1,258	1,637	490	2,139	91	7,160	5,027	2,405	1,396	1,143	476	10,445	-3,285	14,800
2023	1,743	1,172	1,642	510	2,139	91	7,298	5,028	2,321	1,142	1,076	398	9,965	-2,668	12,132
2024	5,728	10,357	1,470	380	2,139	77	20,151	5,016	2,658	1,837	1,543	605	11,660	8,492	20,624
2025	1,343	1,112	1,344	486	2,139	91	6,516	5,026	2,408	1,316	1,124	496	10,371	-3,855	16,768
2026	1,939	1,359	1,069	512	2,139	90	7,108	5,025	2,322	997	955	373	9,673	-2,564	14,204
2027	3,177	5,660	1,045	472	2,139	84	12,578	5,010	2,420	1,285	1,057	442	10,213	2,364	16,568
2028	910	824	1,185	528	2,139	92	5,678	5,021	2,292	940	853	361	9,466	-3,788	12,780
2029	3,419	5,353	975	475	2,139	84	12,445	5,009	2,358	1,033	1,055	401	9,856	2,589	15,370
2030	1,563	999	779	523	2,139	88	6,092	5,024	2,289	817	863	334	9,327	-3,235	12,134
2031	10,087	19,400	1,313	304	2,139	63	33,306	5,019	2,885	2,591	2,221	717	13,432	19,874	32,009
2032	2,152	2,186	1,613	432	2,139	83	8,606	5,021	2,590	2,048	1,442	644	11,744	-3,138	28,871
2033	838	1,097	1,503	518	2,139	91	6,187	5,022	2,348	1,284	987	418	10,059	-3,872	24,999
2034	842	950	1,400	542	2,139	91	5,965	5,020	2,244	1,049	770	320	9,403	-3,438	21,561
2035	2,277	2,241	1,322	513	2,139	84	8,577	5,012	2,301	1,067	884	367	9,630	-1,053	20,507
2036	4,385	8,461	1,048	416	2,139	80	16,529	5,017	2,562	1,470	1,292	535	10,877	5,652	26,159
2037	5,604	10,141	1,131	370	2,139	79	19,465	5,014	2,705	1,976	1,647	634	11,976	7,489	33,648
2038	1,490	1,153	1,327	488	2,139	91	6,689	5,026	2,415	1,356	1,138	487	10,423	-3,734	29,915
2039	1,144	912	1,343	528	2,139	91	6,159	5,023	2,288	1,038	927	359	9,635	-3,476	26,438
2040	1,555	817	1,324	515	2,139	92	6,442	5,030	2,237	819	887	276	9,249	-2,808	23,631
2041	1,869	796	1,026	529	2,139	92	6,452	5,018	2,213	726	821	286	9,064	-2,612	21,019
2042	1,517	642	482	542	2,139	93	5,415	5,029	2,197	548	751	271	8,796	-3,381	17,638
2043	4,321	7,838	537	448	2,139	80	15,364	5,021	2,427	958	1,105	424	9,935	5,429	23,066
2044	7,992	15,635	1,143	330	2,139	71	27,310	5,020	2,831	2,272	1,939	674	12,737	14,574	37,640
2045	1,874	1,766	1,570	454	2,139	87	7,891	5,019	2,532	1,804	1,303	569	11,226	-3,335	34,305
2046	4,391	7,564	1,856	406	2,139	83	16,439	5,019	2,616	2,008	1,556	587	11,786	4,653	38,958
2047	1,538	1,399	2,048	486	2,139	91	7,701	5,046	2,440	1,640	1,229	505	10,861	-3,159	35,799
2048	1,717	1,380	1,817	512	2,176	93	7,695	5,104	2,407	1,352	1,171	450	10,484	-2,789	33,010
2049	5,802	10,901	1,480	380	2,197	77	20,836	5,100	2,749	2,042	1,632	639	12,163	8,674	41,684
2050	1,267	1,175	1,358	495	2,197	93	6,585	5,110	2,481	1,413	1,163	521	10,687	-4,102	37,582
2051	1,912	1,614	1,072	517	2,197	92	7,403	5,109	2,402	1,100	999	399	10,008	-2,605	34,977
2052	3,151	5,993	1,043	471	2,176	85	12,920	5,086	2,494	1,385	1,104	487	10,557	2,363	37,339
2053	819	877	1,188	540	2,197	93	5,715	5,105	2,353	1,004	879	389	9,730	-4,015	33,324
2054	3,438	5,762	981	475	2,197	85	12,938	5,093	2,450	1,134	1,094	442	10,213	2,725	36,049
2055	1,522	1,214	783	529	2,197	90	6,334	5,108	2,370	903	902	374	9,657	-3,322	32,726
2056	10,185	20,021	1,321	294	2,176	65	34,062	5,102	2,969	2,827	2,323	764	13,985	20,077	52,803
2057	2,105	2,442	1,629	439	2,197	85	8,897	5,104	2,659	2,167	1,493	683	12,107	-3,210	49,593
2058	750	1,154	1,520	529	2,197	93	6,243	5,105	2,416	1,360	1,012	448	10,341	-4,097	45,495
2059	751	989	1,413	554	2,197	93	5,997	5,104	2,311	1,101	786	334	9,637	-3,639	41,856
2060	2,247	2,545	1,333	512	2,176	85	8,898	5,088	2,375	1,150	921	401	9,936	-1,037	40,819
2061	4,436	8,786	1,039	419	2,197	81	16,958	5,101	2,639	1,580	1,346	571	11,237	5,722	46,540
2062	5,639	10,443	1,122	372	2,197	81	19,854	5,098	2,795	2,086	1,698	669	12,346	7,508	54,049
2063	1,415	1,199	1,337	498	2,197	93	6,739	5,110	2,479	1,422	1,164	509	10,684	-3,945	50,103
2064	1,060	954	1,346	540	2,176	93	6,169	5,100	2,337	1,082	948	372	9,839	-3,670	46,433
2065	1,481	919	1,330	553	2,197	93	6,574	5,112	2,288	880	906	315	9,501	-2,927	43,506
2066	1,793	934	1,027	539	2,197	93	6,584	5,102	2,289	800	847	315	9,354	-2,770	40,736
2067	1,437	799	476	550	2,197	94	5,553	5,113	2,275	614	783	299	9,083	-3,530	37,206
2068	4,323	8,167	530	451	2,176	82	15,728	5,098	2,508	1,050	1,146	475	10,277	5,451	42,657
Average Water Budget over Simulation Period (2019-2068)															
Average	2,937	4,492	1,263	471	2,161	86	11,410	5,055	2,466	1,382	1,183	471	10,557	853	
Total	146,828	224,610	63,167	23,530	108,057	4,314	570,506	252,772	123,318	69,080	59,134	23,544	527,849	42,657	
Average Water Budget over Implementation Period (2022-2041)															
Average	2,680	3,812	1,275	477	2,139	86	10,470	5,020	2,413	1,309	1,134	446	10,323	147	
Total	53,609	76,249	25,495	9,532	42,790	1,728	209,402	100,408	48,262	26,185	22,684	8,930	206,469	2,934	
Average Water Budget over Sustainability Period (2042-2068)															
Average	2,922	4,560	1,214	475	2,180	87	11,437	5,085	2,485	1,396	1,193	477	10,636	801	
Total	78,884	123,112	32,780	12,835	58,849	2,345	308,804	137,306	67,091	37,684	32,201	12,885	287,166	21,638	
Average Water Budget over GSP Period (2019-2021)															
Average	4,778	8,416	1,631	388	2,139	80	17,433	5,019	2,655	1,737	1,417	577	11,405	6,028	
Total	14,335	25,249	4,892	1,164	6,418	241	52,299	15,058	7,965	5,211	4,250	1,730	34,214	18,085	

Table 16 - Bedford MA Water Balance (in acre-feet per year) - Projected Future Growth plus Climate Change Scenario

	INFLOWS							OUTFLOWS							
Simulation Year	Surface Recharge	GW-SW	Quarry Recharge	Mountain Front Recharge	WRF Perc Ponds	Boundary Inflow	Total Inflow	Wells	GW-SW	Quarry Outflow	ET	Boundary Outflow	Total Outflow	Annual Storage Change	Cumulative Storage Change
2019	5,577	3,665	299	1,082	2,139	71	12,833	1,895	1,730	2,866	1,388	453	8,332	4,501	4,501
2020	1,355	1,462	456	1,081	2,139	88	6,581	1,883	1,637	2,504	1,055	429	7,508	-927	3,574
2021	3,032	2,266	409	1,080	2,139	83	9,009	1,884	1,835	2,595	1,315	448	8,078	932	4,506
2022	1,125	1,210	490	1,083	2,139	91	6,138	1,880	1,396	2,405	972	372	7,025	-888	3,618
2023	1,285	1,052	510	1,085	2,139	91	6,163	1,882	1,142	2,321	895	298	6,538	-375	3,243
2024	3,966	2,841	380	965	2,139	77	10,368	1,888	1,831	2,658	1,375	485	8,238	2,130	5,373
2025	996	1,111	486	885	2,139	91	5,709	1,881	1,316	2,408	952	402	6,959	-1,250	4,123
2026	1,359	1,036	512	712	2,139	90	5,848	1,879	997	2,322	791	281	6,270	-422	3,701
2027	2,181	2,180	472	696	2,139	84	7,752	1,881	1,283	2,420	905	341	6,830	922	4,623
2028	656	824	528	764	2,139	92	5,003	1,879	940	2,292	691	276	6,078	-1,074	3,548
2029	2,383	1,824	475	605	2,139	84	7,511	1,880	1,032	2,358	891	304	6,466	1,045	4,593
2030	1,118	863	523	469	2,139	88	5,201	1,882	817	2,289	697	244	5,929	-728	3,865
2031	6,947	4,146	304	822	2,139	63	14,422	1,891	2,581	2,885	2,041	589	9,987	4,435	8,300
2032	1,550	1,641	432	1,005	2,139	83	6,851	1,884	2,046	2,590	1,289	563	8,373	-1,522	6,778
2033	595	1,097	518	943	2,139	91	5,383	1,879	1,284	2,348	828	370	6,709	-1,325	5,453
2034	600	950	542	903	2,139	91	5,226	1,878	1,049	2,244	626	280	6,076	-849	4,603
2035	1,580	1,486	513	868	2,139	84	6,670	1,878	1,067	2,301	730	309	6,284	385	4,989
2036	3,004	2,586	416	686	2,139	80	8,912	1,883	1,467	2,562	1,122	461	7,496	1,416	6,405
2037	3,878	2,612	370	751	2,139	79	9,829	1,886	1,973	2,705	1,487	556	8,607	1,223	7,627
2038	1,110	1,153	488	861	2,139	91	5,843	1,880	1,356	2,415	969	444	7,063	-1,220	6,407
2039	839	912	528	871	2,139	91	5,381	1,878	1,038	2,288	758	329	6,292	-910	5,497
2040	1,126	760	515	870	2,139	92	5,503	1,879	819	2,237	707	246	5,889	-386	5,111
2041	1,392	744	529	692	2,139	92	5,588	1,878	726	2,213	648	246	5,712	-123	4,988
2042	1,094	565	542	359	2,139	93	4,793	1,878	548	2,197	570	222	5,416	-623	4,365
2043	3,017	2,399	448	402	2,139	80	8,486	1,882	957	2,427	922	351	6,538	1,948	6,312
2044	5,514	3,300	330	790	2,139	71	12,145	1,892	2,266	2,831	1,763	585	9,336	2,808	9,121
2045	1,358	1,540	454	1,046	2,139	87	6,625	1,883	1,803	2,532	1,143	524	7,884	-1,259	7,862
2046	3,032	2,299	406	1,219	2,139	83	9,178	1,884	2,006	2,616	1,391	544	8,441	738	8,600
2047	1,121	1,350	486	1,319	2,139	91	6,507	1,888	1,640	2,440	1,059	487	7,514	-1,007	7,593
2048	1,274	1,250	512	1,185	2,176	93	6,490	1,910	1,352	2,407	987	438	7,093	-603	6,989
2049	4,026	3,023	380	981	2,197	77	10,683	1,919	2,037	2,749	1,462	600	8,767	1,916	8,905
2050	952	1,175	495	903	2,197	93	5,815	1,911	1,413	2,481	988	511	7,304	-1,489	7,416
2051	1,351	1,253	517	722	2,197	92	6,131	1,910	1,100	2,402	832	394	6,637	-506	6,910
2052	2,172	2,343	471	700	2,176	85	7,948	1,910	1,384	2,494	949	471	7,209	740	7,650
2053	601	877	540	772	2,197	98	5,086	1,909	1,004	2,353	715	389	6,371	-1,285	6,365
2054	2,407	2,078	475	615	2,197	85	7,858	1,911	1,133	2,450	928	431	6,854	1,004	7,369
2055	1,101	1,046	529	478	2,197	90	5,441	1,913	903	2,370	734	369	6,288	-848	6,521
2056	7,020	4,413	294	832	2,176	65	14,800	1,926	2,817	2,969	2,140	713	10,566	4,234	10,756
2057	1,529	1,838	439	1,022	2,197	85	7,109	1,915	2,166	2,659	1,338	681	8,759	-1,650	9,106
2058	542	1,154	529	962	2,197	130	5,514	1,909	1,360	2,416	850	448	6,983	-1,469	7,637
2059	546	989	554	919	2,197	142	5,347	1,908	1,101	2,311	640	334	6,294	-947	6,690
2060	1,567	1,722	512	882	2,176	112	6,972	1,906	1,150	2,375	765	401	6,597	375	7,065
2061	3,050	2,727	419	681	2,197	86	9,161	1,914	1,577	2,639	1,173	571	7,874	1,286	8,351
2062	3,906	2,762	372	746	2,197	81	10,064	1,917	2,083	2,795	1,534	666	8,995	1,068	9,419
2063	1,068	1,199	498	874	2,197	131	5,967	1,911	1,422	2,479	992	509	7,312	-1,345	8,074
2064	788	954	540	878	2,176	149	5,485	1,906	1,082	2,337	776	372	6,474	-989	7,086
2065	1,085	847	553	880	2,197	149	5,712	1,908	880	2,288	723	315	6,114	-402	6,684
2066	1,349	869	539	698	2,197	138	5,790	1,908	800	2,289	672	315	5,985	-195	6,489
2067	1,048	705	550	360	2,197	129	4,990	1,909	614	2,275	599	299	5,695	-705	5,784
2068	3,026	2,579	451	402	2,176	88	8,722	1,910	1,048	2,508	960	475	6,901	1,821	7,604
Average Water Budget over Simulation Period (2019-2068)															
Average	2,064	1,714	471	828	2,161	93	7,331	1,895	1,380	2,466	1,015	423	7,179	152	
Total	103,198	85,678	23,530	41,405	108,057	4,674	366,543	94,735	69,009	123,318	50,737	21,140	358,938	7,604	
Average Water Budget over Implementation Period (2022-2041)															
Average	1,884	1,551	477	827	2,139	86	6,965	1,881	1,308	2,413	969	370	6,941	24	
Total	37,689	31,029	9,532	16,534	42,790	1,728	139,301	37,625	26,161	48,262	19,376	7,395	138,819	482	
Average Water Budget over Sustainability Period (2042-2068)															
Average	2,057	1,750	475	801	2,180	100	7,364	1,905	1,394	2,485	1,022	460	7,267	97	
Total	55,545	47,256	12,835	21,628	58,849	2,705	198,818	51,447	37,646	67,091	27,603	12,415	196,202	2,617	
Average Water Budget over GSP Period (2019-2021)															
Average	3,321	2,465	388	1,081	2,139	80	9,474	1,887	1,734	2,655	1,253	443	7,973	1,502	
Total	9,964	7,394	1,164	3,243	6,418	241	28,423	5,662	5,202	7,965	3,758	1,330	23,918	4,506	

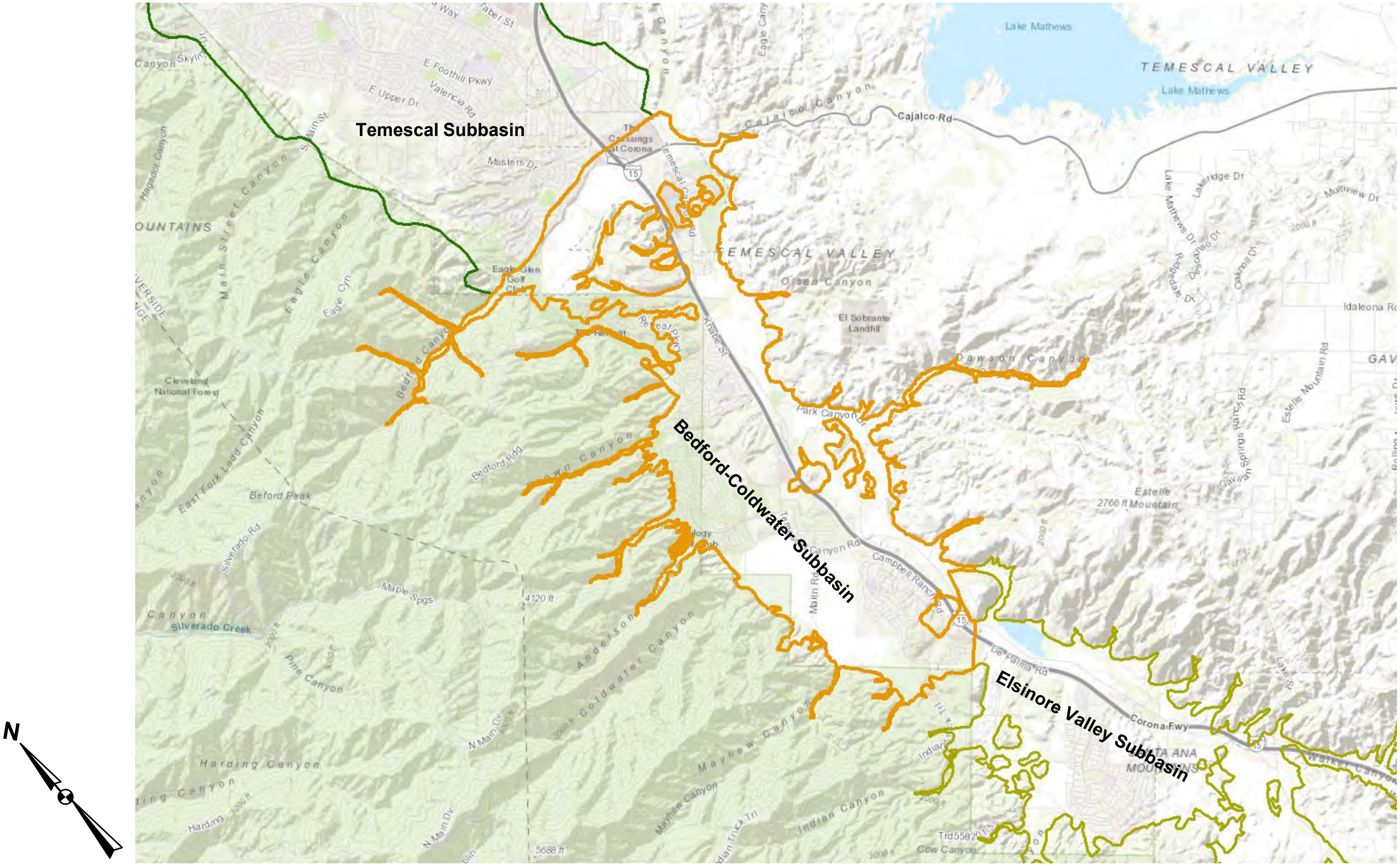
Table 17 - Coldwater MA Water Balance (in acre-feet per year) - Projected Future Growth plus Climate Change Scenario

	INFLOWS							OUTFLOWS						
Simulation Year	**Surface Recharge**	**GW-SW**	**Mountain Front Recharge**	**Net Quarry Ops**	**Boundary Inflow**	**Total Inflow**	**Wells**	**Net Quarry Ops**	**GW-SW**	**ET**	**Boundary Outflow**	**Total Outflow**	**Annual Storage Change**	**Cumulative Storage Change**
2019	2,496	12,454	550	0	154	15,655	3,126	0	6	166	0	3,298	12,357	12,357
2020	516	227	551	0	122	1,415	3,136	0	0	161	0	3,297	-1,882	10,475
2021	1,359	5,175	548	0	123	7,205	3,134	0	2	165	0	3,302	3,903	14,378
2022	420	49	554	0	103	1,126	3,147	0	0	170	0	3,317	-2,191	12,187
2023	458	120	557	0	100	1,235	3,146	0	0	181	0	3,327	-2,092	10,095
2024	1,762	7,516	505	0	120	9,903	3,128	0	5	168	0	3,301	6,602	16,697
2025	348	0	459	0	95	902	3,146	0	0	172	0	3,318	-2,416	14,280
2026	580	323	357	0	92	1,353	3,146	0	0	165	0	3,310	-1,958	12,323
2027	996	3,480	350	0	102	4,928	3,129	0	1	151	0	3,281	1,646	13,969
2028	255	0	421	0	85	760	3,142	0	0	162	0	3,304	-2,544	11,426
2029	1,036	3,529	370	0	97	5,032	3,128	0	1	164	0	3,293	1,739	13,164
2030	445	136	310	0	91	982	3,142	0	0	165	0	3,308	-2,326	10,838
2031	3,139	15,254	491	0	127	19,011	3,128	0	10	179	0	3,317	15,694	26,532
2032	602	545	608	0	81	1,836	3,136	0	2	153	0	3,291	-1,455	25,078
2033	243	0	560	0	48	852	3,143	0	0	159	0	3,302	-2,450	22,627
2034	242	0	497	0	40	778	3,143	0	0	144	0	3,287	-2,509	20,118
2035	698	755	455	0	58	1,965	3,134	0	0	154	0	3,288	-1,323	18,795
2036	1,380	5,875	362	0	74	7,691	3,134	0	3	170	0	3,307	4,384	23,179
2037	1,726	7,530	380	0	78	9,714	3,128	0	3	160	0	3,291	6,423	29,602
2038	380	0	466	0	44	890	3,146	0	0	170	0	3,316	-2,426	27,177
2039	305	0	472	0	30	807	3,145	0	0	169	0	3,313	-2,506	24,670
2040	428	57	454	0	30	969	3,151	0	0	180	0	3,331	-2,362	22,309
2041	477	52	334	0	40	903	3,140	0	0	172	0	3,312	-2,409	19,899
2042	422	77	123	0	49	671	3,151	0	0	180	1	3,332	-2,661	17,239
2043	1,305	5,439	134	0	73	6,951	3,140	0	1	183	1	3,325	3,627	20,865
2044	2,479	12,334	353	0	89	15,255	3,129	0	6	177	0	3,312	11,943	32,809
2045	516	226	523	0	45	1,311	3,136	0	0	160	0	3,296	-1,985	30,823
2046	1,359	5,265	637	0	43	7,304	3,134	0	2	166	0	3,303	4,001	34,824
2047	417	48	729	0	18	1,213	3,158	0	0	171	0	3,329	-2,116	32,709
2048	444	130	632	0	12	1,218	3,194	0	0	184	0	3,379	-2,161	30,547
2049	1,776	7,878	499	0	39	10,192	3,181	0	6	170	0	3,357	6,835	37,382
2050	314	0	455	0	9	779	3,199	0	0	175	0	3,374	-2,595	34,788
2051	560	361	350	0	4	1,276	3,199	0	0	167	0	3,366	-2,090	32,698
2052	979	3,650	343	0	16	4,988	3,177	0	1	154	0	3,332	1,655	34,353
2053	218	0	416	0	0	634	3,195	0	0	164	5	3,364	-2,730	31,622
2054	1,031	3,684	366	0	11	5,091	3,181	0	1	167	0	3,349	1,742	33,365
2055	420	168	305	0	5	898	3,195	0	0	168	0	3,364	-2,465	30,900
2056	3,165	15,608	488	0	51	19,313	3,176	0	10	183	0	3,369	15,944	46,844
2057	576	605	607	0	2	1,791	3,189	0	2	155	0	3,346	-1,556	45,288
2058	208	0	559	0	0	766	3,196	0	0	162	37	3,395	-2,629	42,660
2059	205	0	494	0	0	700	3,196	0	0	147	49	3,392	-2,692	39,968
2060	680	823	451	0	0	1,954	3,182	0	0	157	27	3,366	-1,412	38,556
2061	1,386	6,060	357	0	0	7,803	3,187	0	3	172	5	3,368	4,435	42,991
2062	1,733	7,681	376	0	3	9,793	3,181	0	3	163	0	3,347	6,446	49,437
2063	346	0	463	0	0	810	3,199	0	0	173	38	3,410	-2,601	46,837
2064	272	0	468	0	0	739	3,193	0	0	172	56	3,421	-2,682	44,155
2065	396	72	450	0	0	918	3,204	0	0	182	56	3,443	-2,525	41,630
2066	444	65	329	0	0	838	3,193	0	0	176	45	3,414	-2,575	39,055
2067	389	94	116	0	0	599	3,204	0	0	184	38	3,426	-2,827	36,228
2068	1,297	5,587	128	0	0	7,012	3,188	0	2	186	8	3,383	3,628	39,856
Average Water Budget over Simulation Period (2019-2068)														
Average	873	2,779	435	0	48	4,135	3,161	0	1	168	7	3,337	797	
Total	43,629	138,932	21,762	0	2,405	206,727	158,037	0	71	8,397	366	166,871	39,856	
Average Water Budget over Implementation Period (2022-2041)														
Average	796	2,261	448	0	77	3,582	3,139	0	1	165	0	3,306	276	
Total	15,920	45,220	8,961	0	1,535	71,636	62,783	0	25	3,307	0	66,115	5,521	
Average Water Budget over Sustainability Period (2042-2068)														
Average	864	2,809	413	0	17	4,104	3,180	0	1	170	14	3,365	739	
Total	23,338	75,856	11,152	0	470	110,816	85,859	0	37	4,598	366	90,859	19,957	
Average Water Budget over GSP Period (2019-2021)														
Average	1,457	5,952	550	0	133	8,092	3,132	0	3	164	0	3,299	4,793	
Total	4,371	17,856	1,649	0	400	24,275	9,396	0	9	492	0	9,897	14,378	

Table 18 - Change in Groundwater in Storage (in acre-feet per year) - Projected Future Growth plus Climate Change Scenario

Simulation Year	Net Change in Groundwater in Storage		Annual Change in Groundwater in Storage	Cumulative Storage Change
	Coldwater Hydrologic Area	Bedford Hydrologic Area		
2019	12,357	4,193	16,549	16,549
2020	-1,882	-1,171	-3,053	13,497
2021	3,903	685	4,588	18,085
2022	-2,191	-1,094	-3,285	14,800
2023	-2,092	-575	-2,668	12,132
2024	6,602	1,890	8,492	20,624
2025	-2,416	-1,439	-3,855	16,768
2026	-1,958	-607	-2,564	14,204
2027	1,646	718	2,364	16,568
2028	-2,544	-1,244	-3,788	12,780
2029	1,739	850	2,589	15,370
2030	-2,326	-910	-3,236	12,134
2031	15,694	4,181	19,874	32,008
2032	-1,455	-1,683	-3,138	28,870
2033	-2,450	-1,422	-3,872	24,998
2034	-2,509	-929	-3,438	21,560
2035	-1,323	270	-1,053	20,507
2036	4,384	1,268	5,652	26,159
2037	6,423	1,066	7,489	33,648
2038	-2,426	-1,308	-3,734	29,914
2039	-2,506	-970	-3,476	26,438
2040	-2,362	-446	-2,808	23,630
2041	-2,409	-203	-2,612	21,018
2042	-2,661	-726	-3,386	17,632
2043	3,627	1,800	5,426	23,058
2044	11,943	2,631	14,574	37,632
2045	-1,985	-1,350	-3,335	34,297
2046	4,001	652	4,653	38,950
2047	-2,116	-1,043	-3,159	35,791
2048	-2,161	-628	-2,789	33,002
2049	6,835	1,839	8,674	41,676
2050	-2,595	-1,508	-4,102	37,573
2051	-2,090	-515	-2,605	34,968
2052	1,655	707	2,363	37,331
2053	-2,730	-1,285	-4,015	33,316
2054	1,742	982	2,725	36,040
2055	-2,465	-858	-3,323	32,717
2056	15,944	4,132	20,077	52,794
2057	-1,556	-1,655	-3,210	49,584
2058	-2,629	-1,469	-4,097	45,487
2059	-2,692	-947	-3,639	41,847
2060	-1,412	375	-1,037	40,810
2061	4,435	1,286	5,722	46,532
2062	6,446	1,062	7,508	54,040
2063	-2,601	-1,345	-3,945	50,094
2064	-2,682	-989	-3,670	46,424
2065	-2,525	-402	-2,927	43,497
2066	-2,575	-195	-2,770	40,727
2067	-2,827	-710	-3,537	37,190
2068	3,628	1,819	5,447	42,637
Average Water Budget over Simulation Period (2019-2068)				
Average	797	56	853	
Total	39,856	2,781	42,637	
Average Water Budget over Implementation Period (2022-2041)				
Average	276	-129	147	
Total	5,521	-2,588	2,933	
Average Water Budget over Sustainability Period (2042-2068)				
Average	739	62	801	
Total	19,957	1,662	21,619	
Average Water Budget over GSP Period (2019-2021)				
Average	4,793	1,236	6,028	
Total	14,378	3,707	18,085	

FIGURES



Legend

🟧 Bedford-Coldwater Subbasin

🟨 Elsinore Valley Subbasin

🟩 Temescal Subbasin

0 0.5 1

Scale: Miles

November 2021

TODD GROUNDWATER

Figure 1
Location and Topography of Bedford-Coldwater Basin

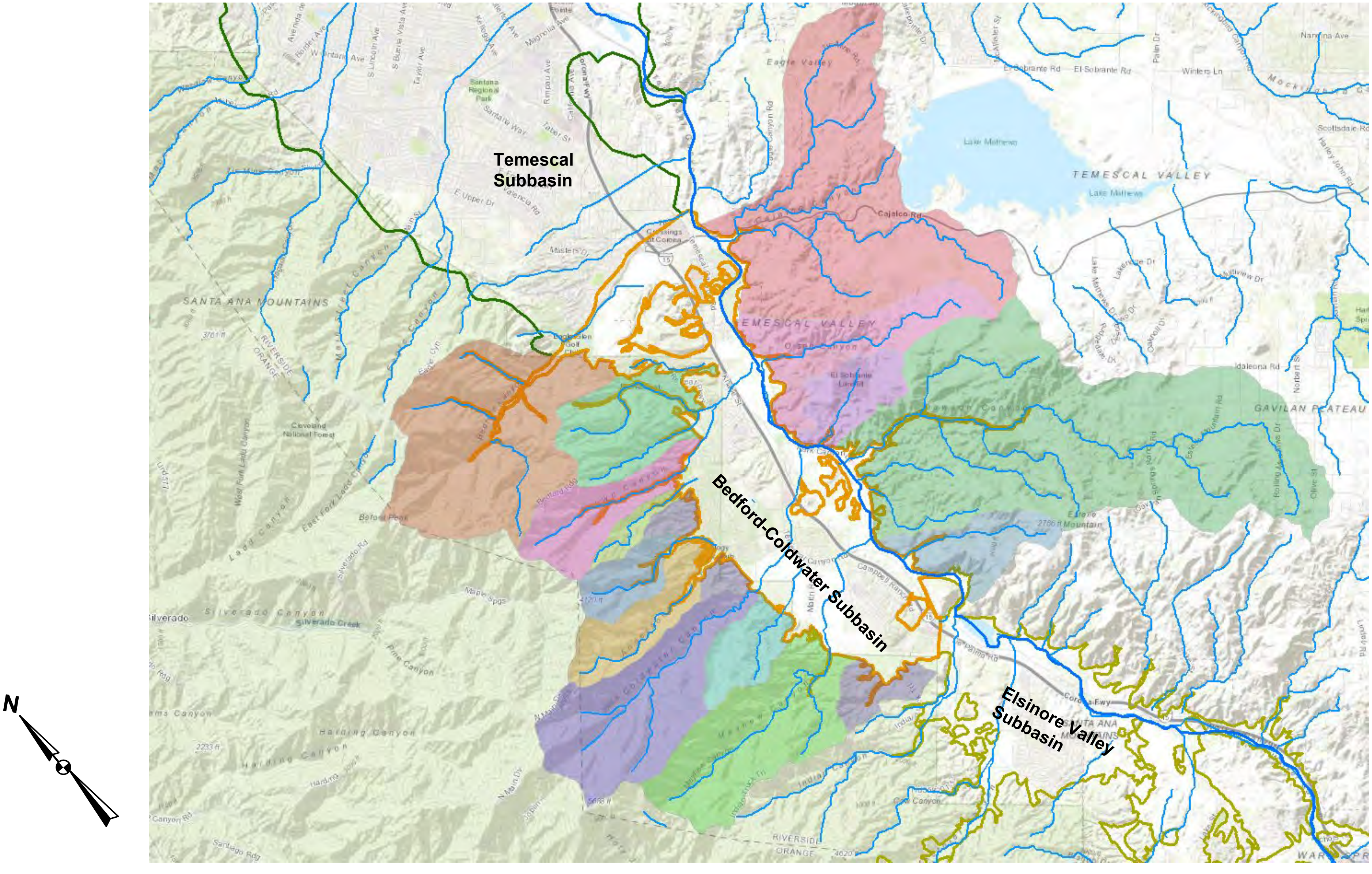


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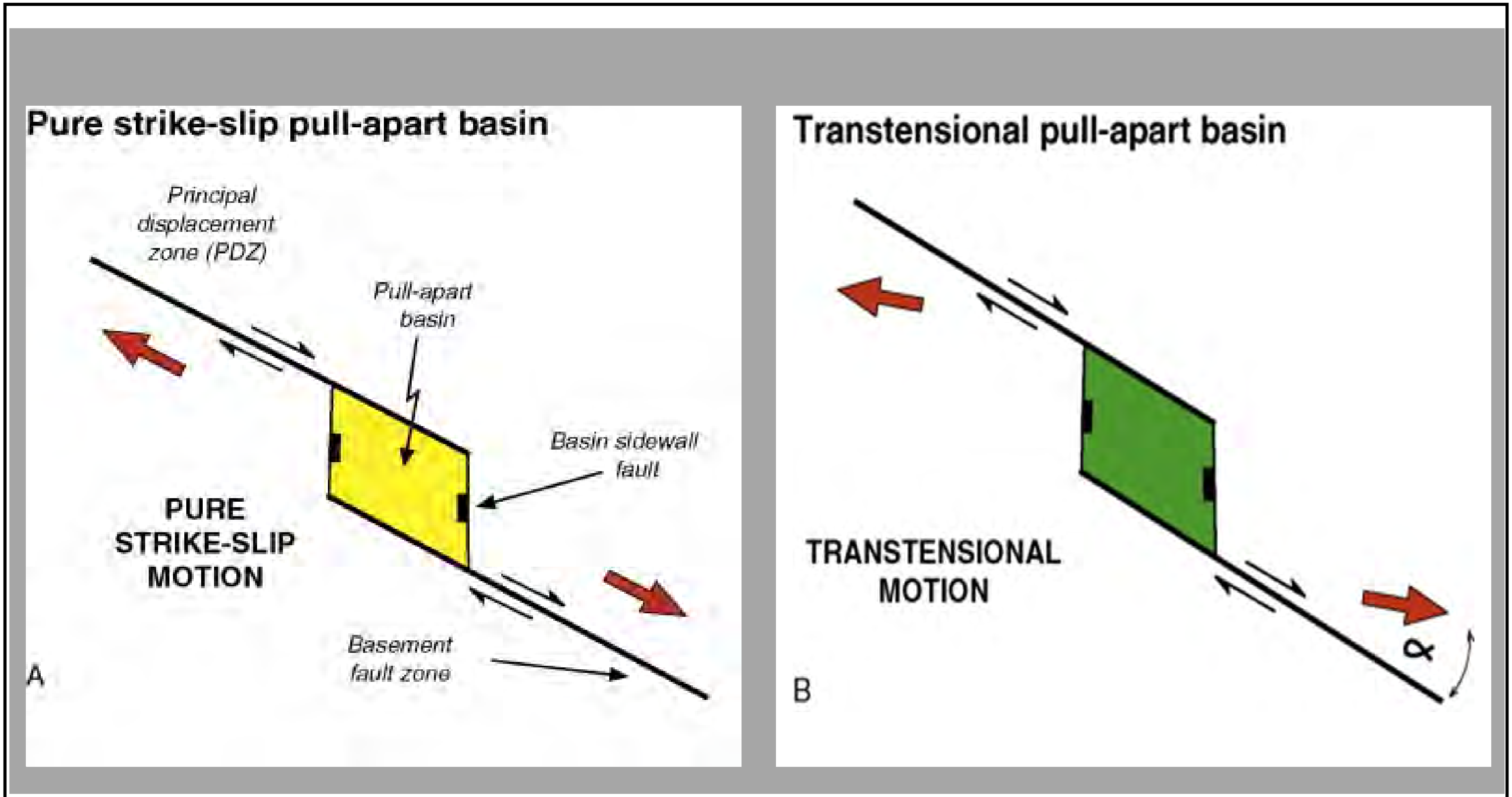
Figure 2
Local Watersheds that Drain into the Bedford-Coldwater Basin



Figures Source:

J. E. Wu, K. McClay, P. Whitehouse, T. Dooley, 2012, Regional Geology and Tectonics: Principles of Geologic Analysis

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Figure 3
Schematic Plan View Showing Faulting Associated with Pull-Apart Basins

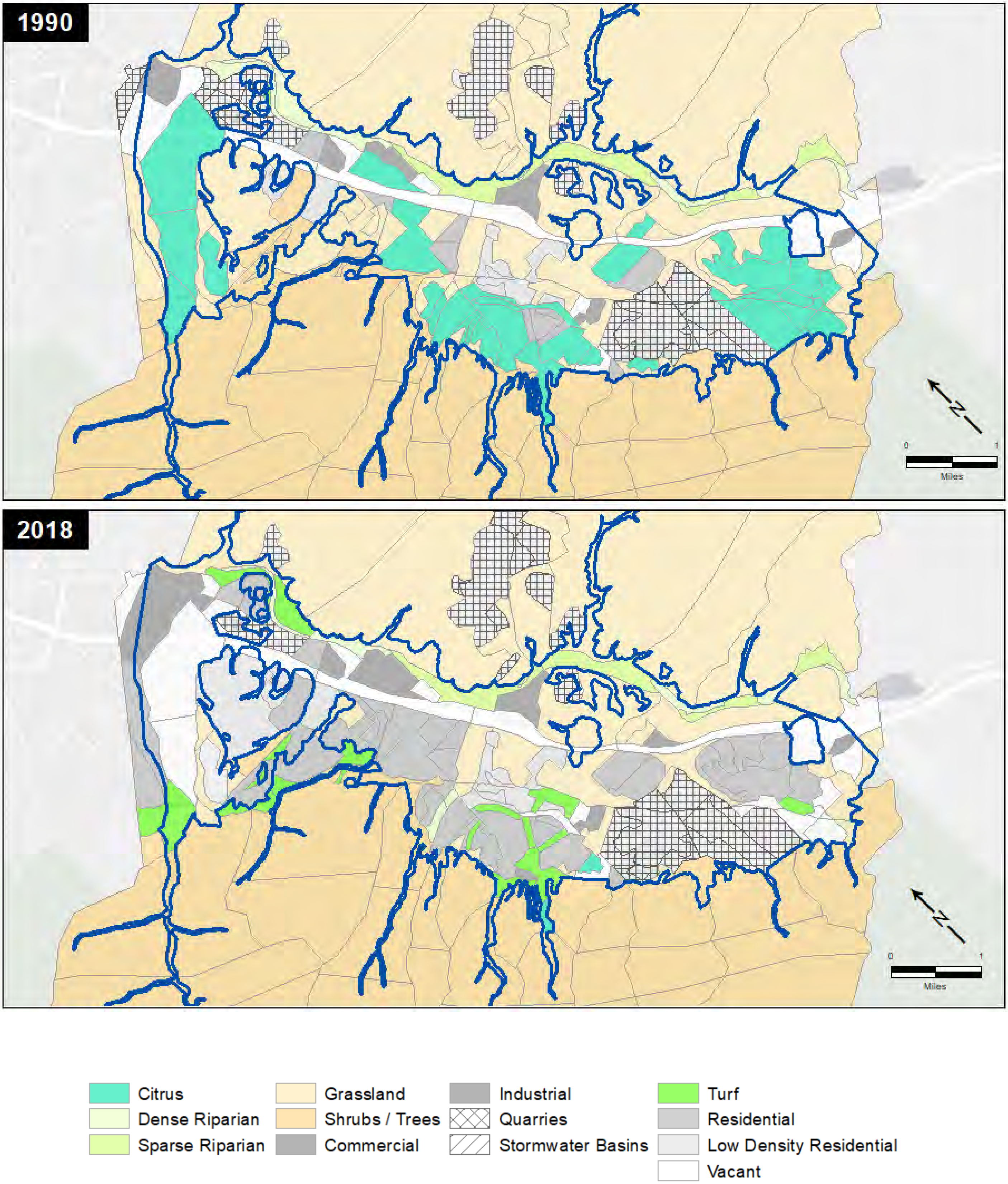

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Figure 4
1990 and 2018 Land
Use for Recharge Polygons

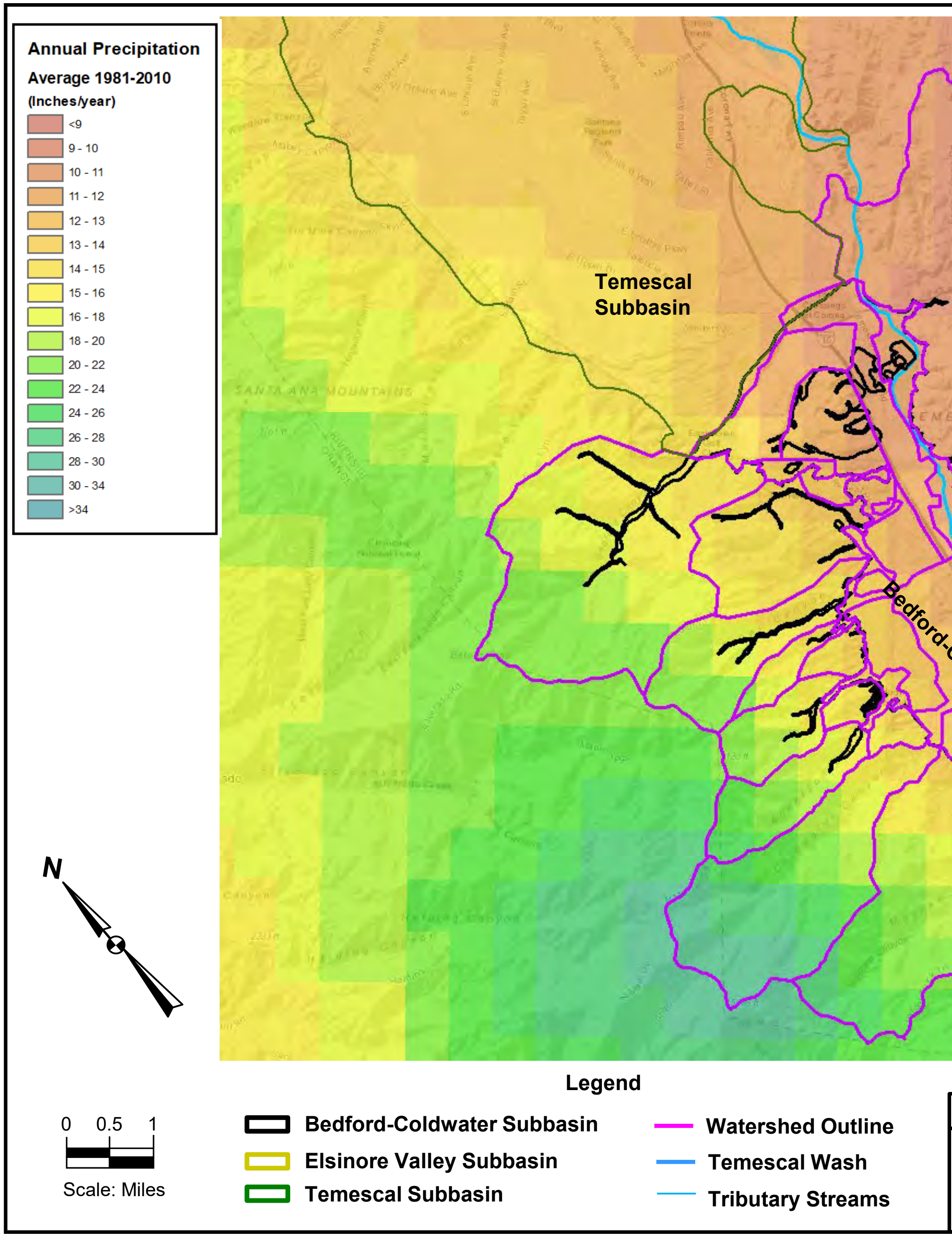

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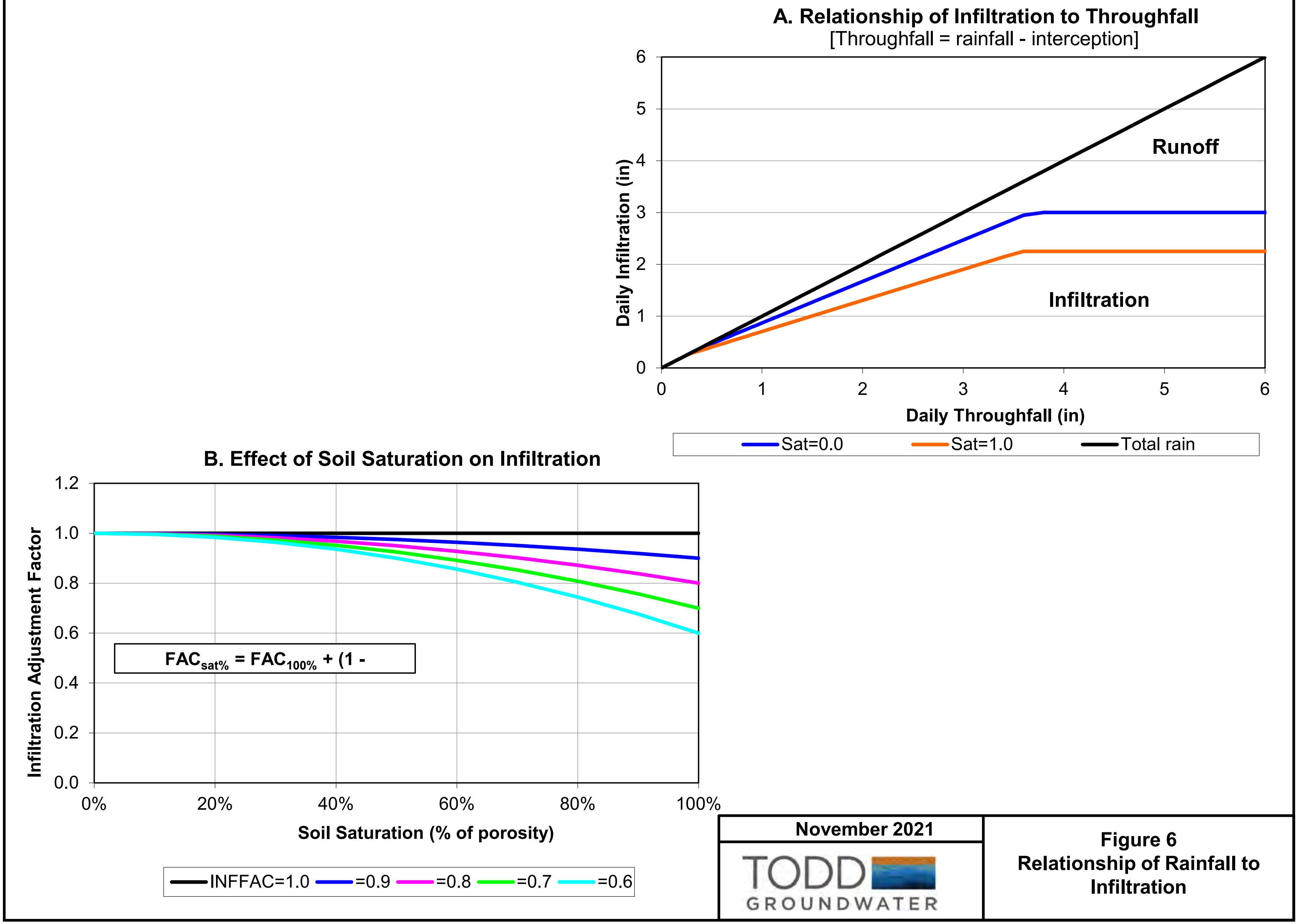
Figure 5
Average
Annual Rainfall



A. Relationship of Infiltration to Throughfall

[Throughfall = rainfall - interception]

B. Effect of Soil Saturation on Infiltration

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Figure 6
Relationship of Rainfall to Infiltration

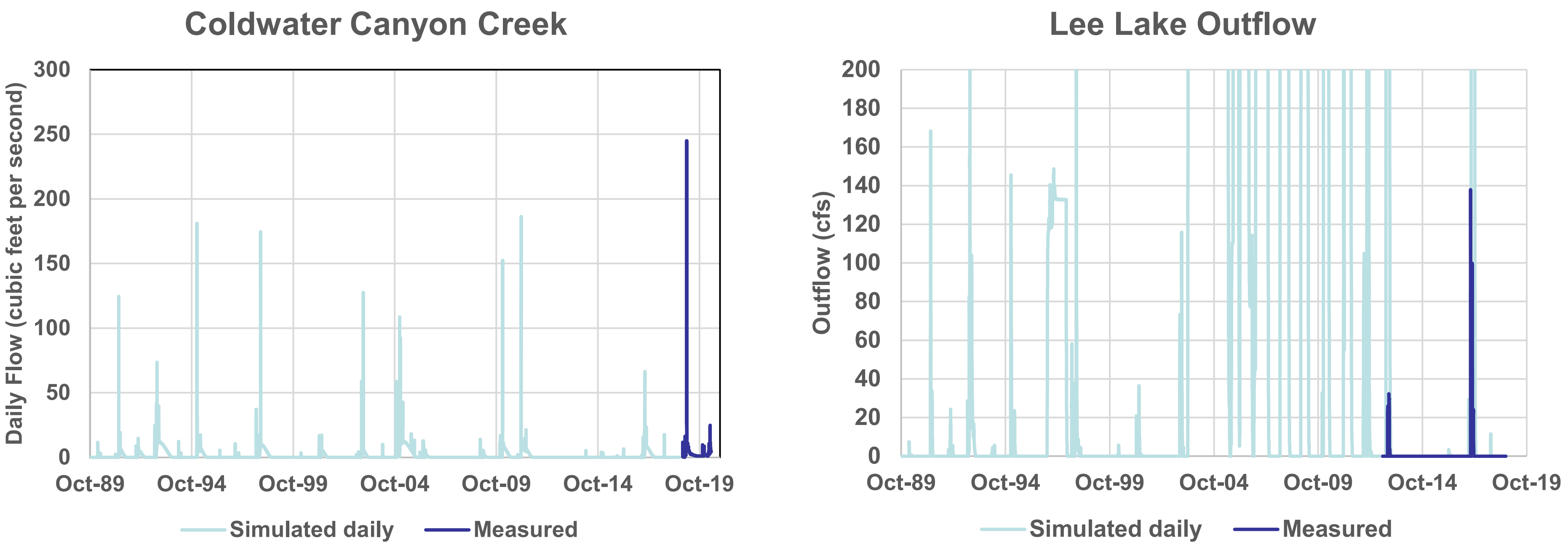

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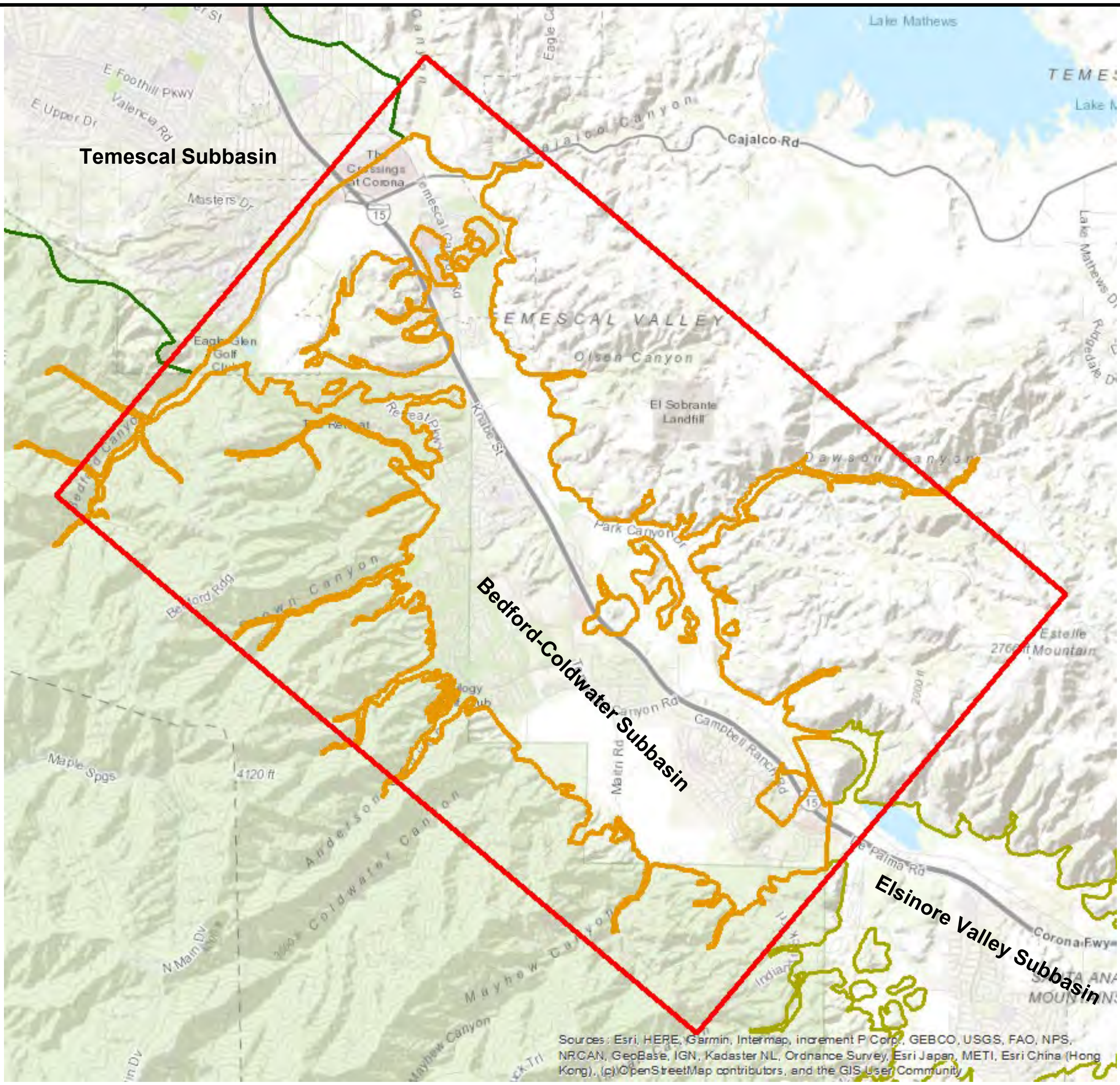
Figure 7
Rainfall to Runoff Calibration



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

N

Legend

- 🟥 MODFLOW Model Domain
- 🟨 Elsinore Valley Subbasin
- 🟧 Bedford-Coldwater Subbasin
- 🟩 Temescal Subbasin

0 0.5 1

Scale: Miles

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Figure 8
Location of MODFLOW Model Domain

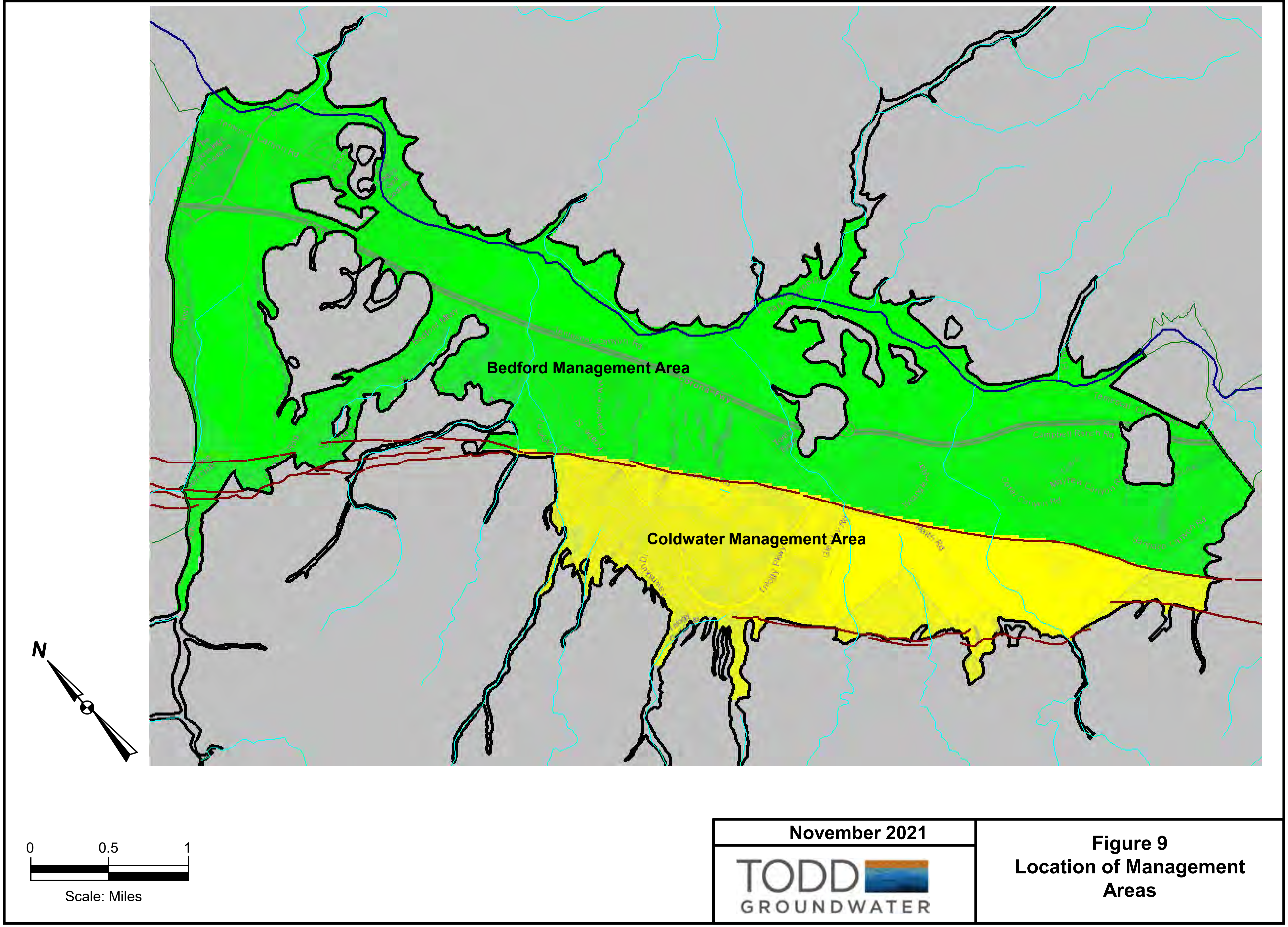

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Figure 9
Location of Management Areas

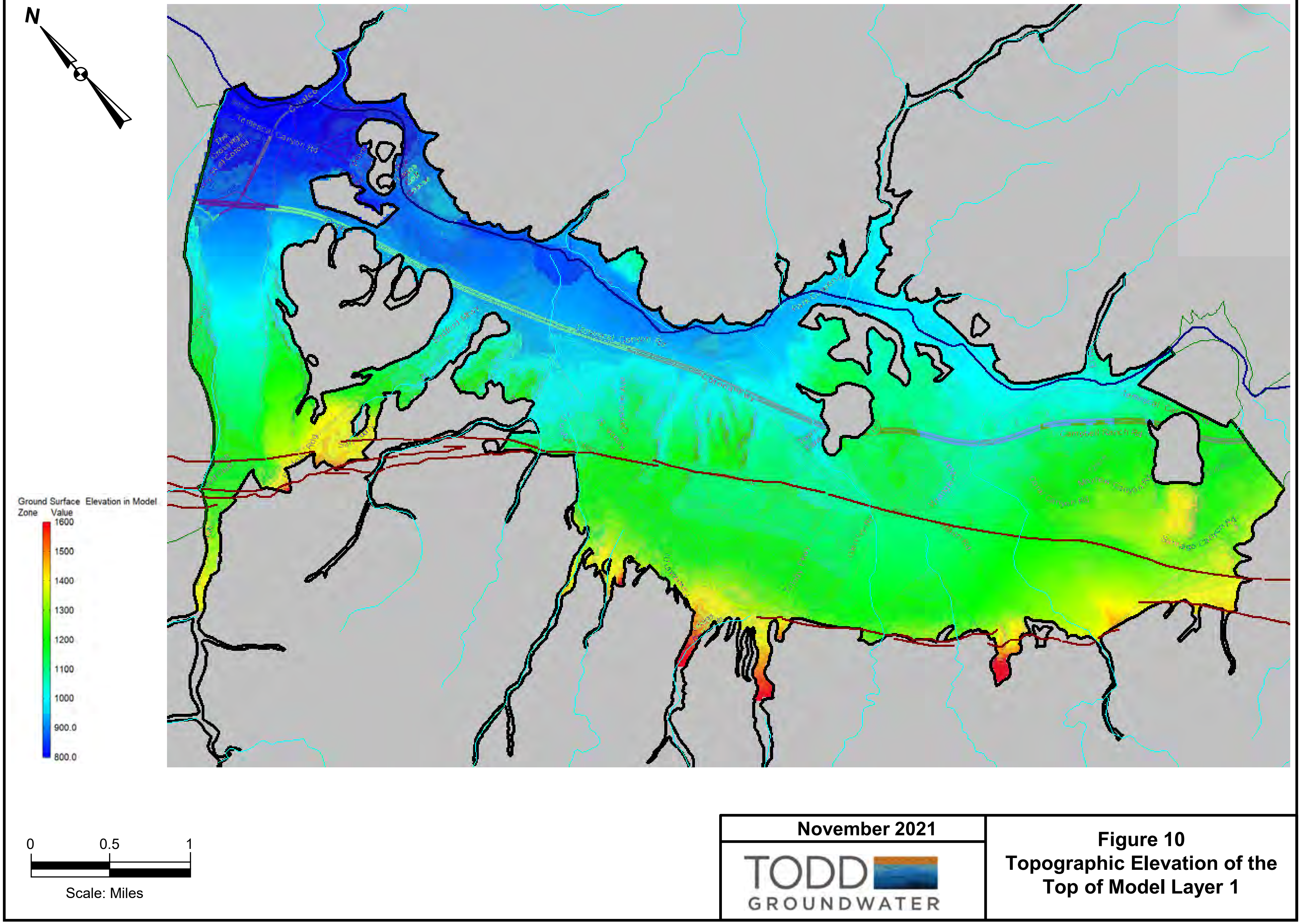

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Figure 10
Topographic Elevation of the Top of Model Layer 1

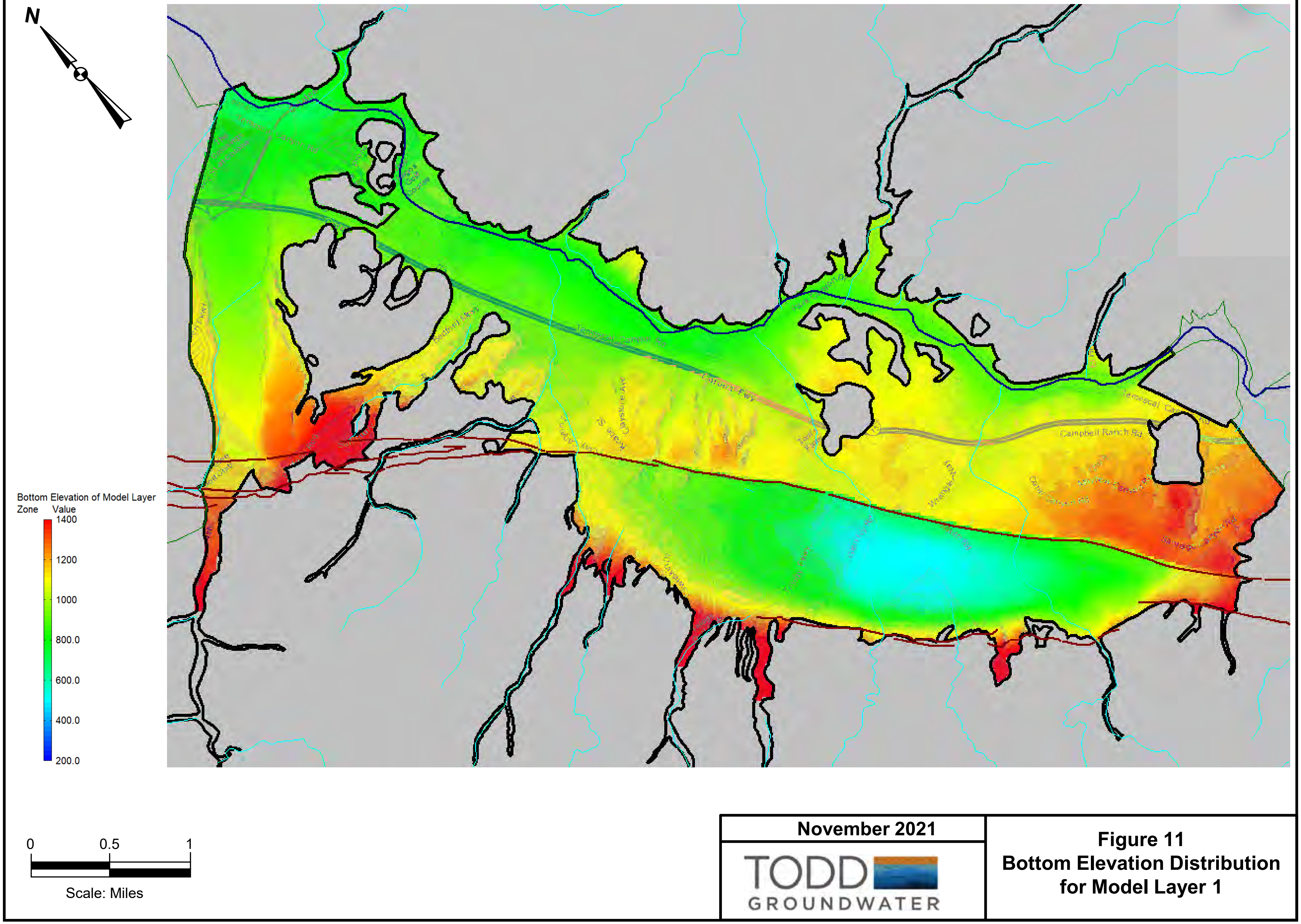

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Figure 11
Bottom Elevation Distribution for Model Layer 1

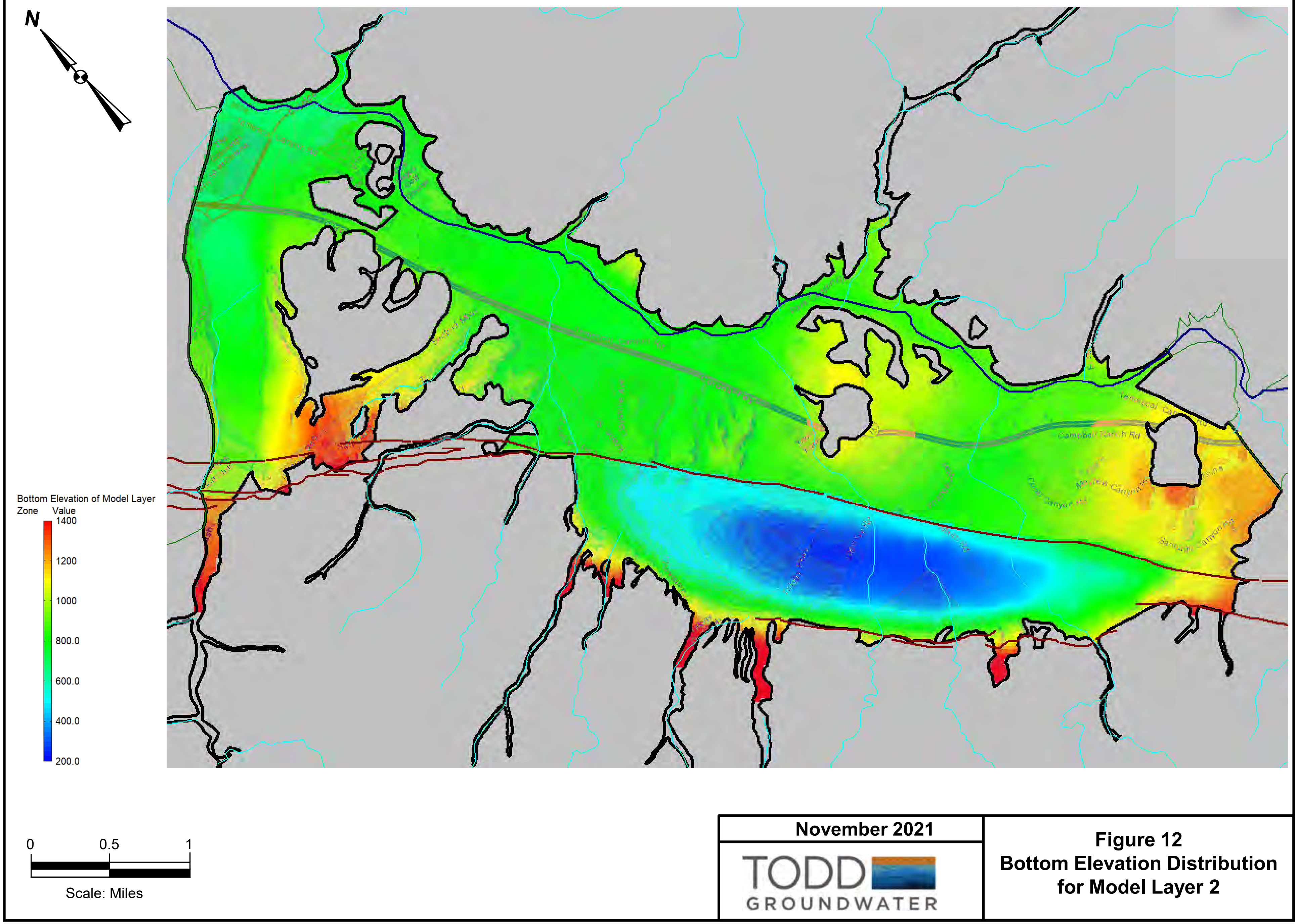

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Figure 12
Bottom Elevation Distribution for Model Layer 2

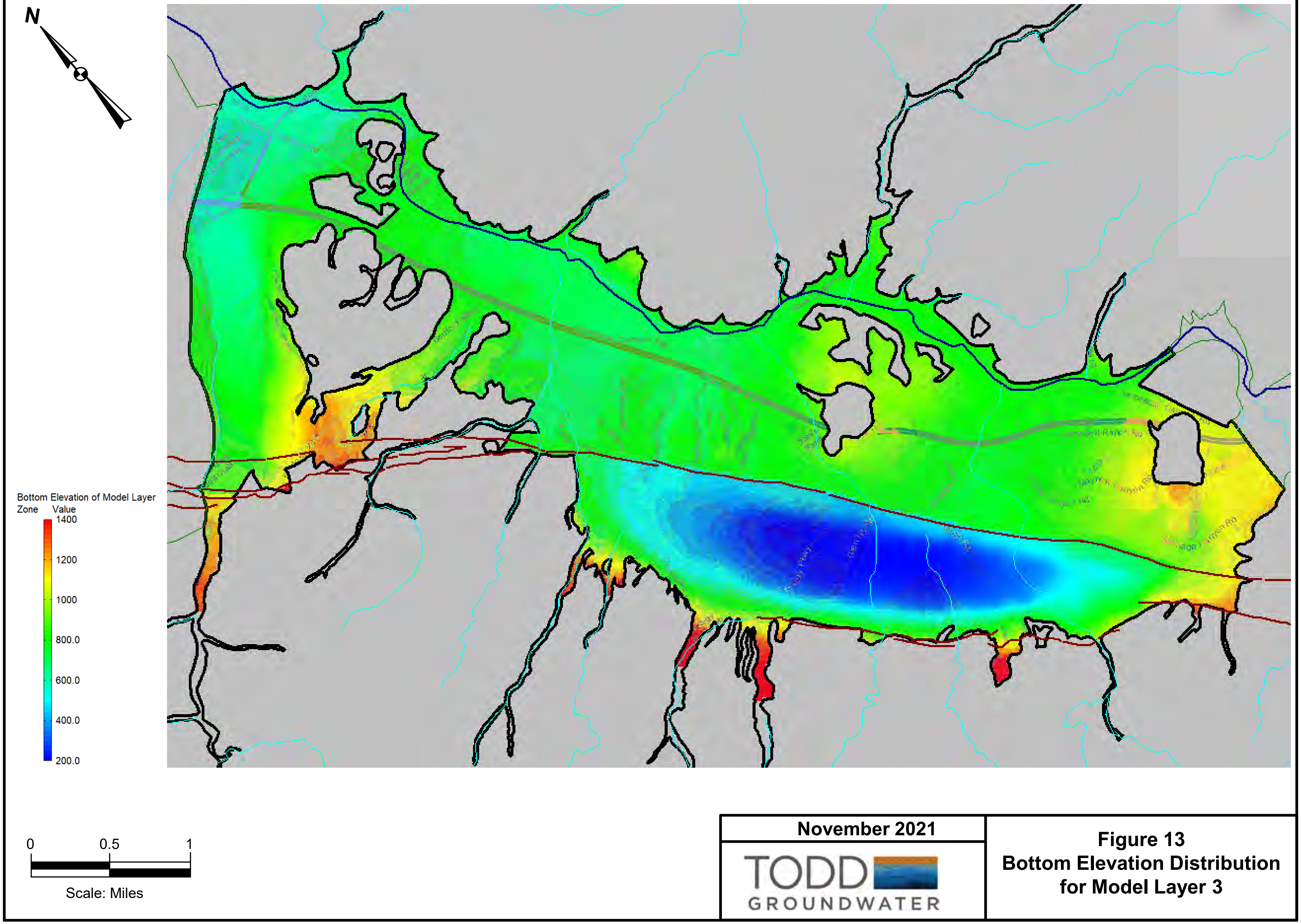

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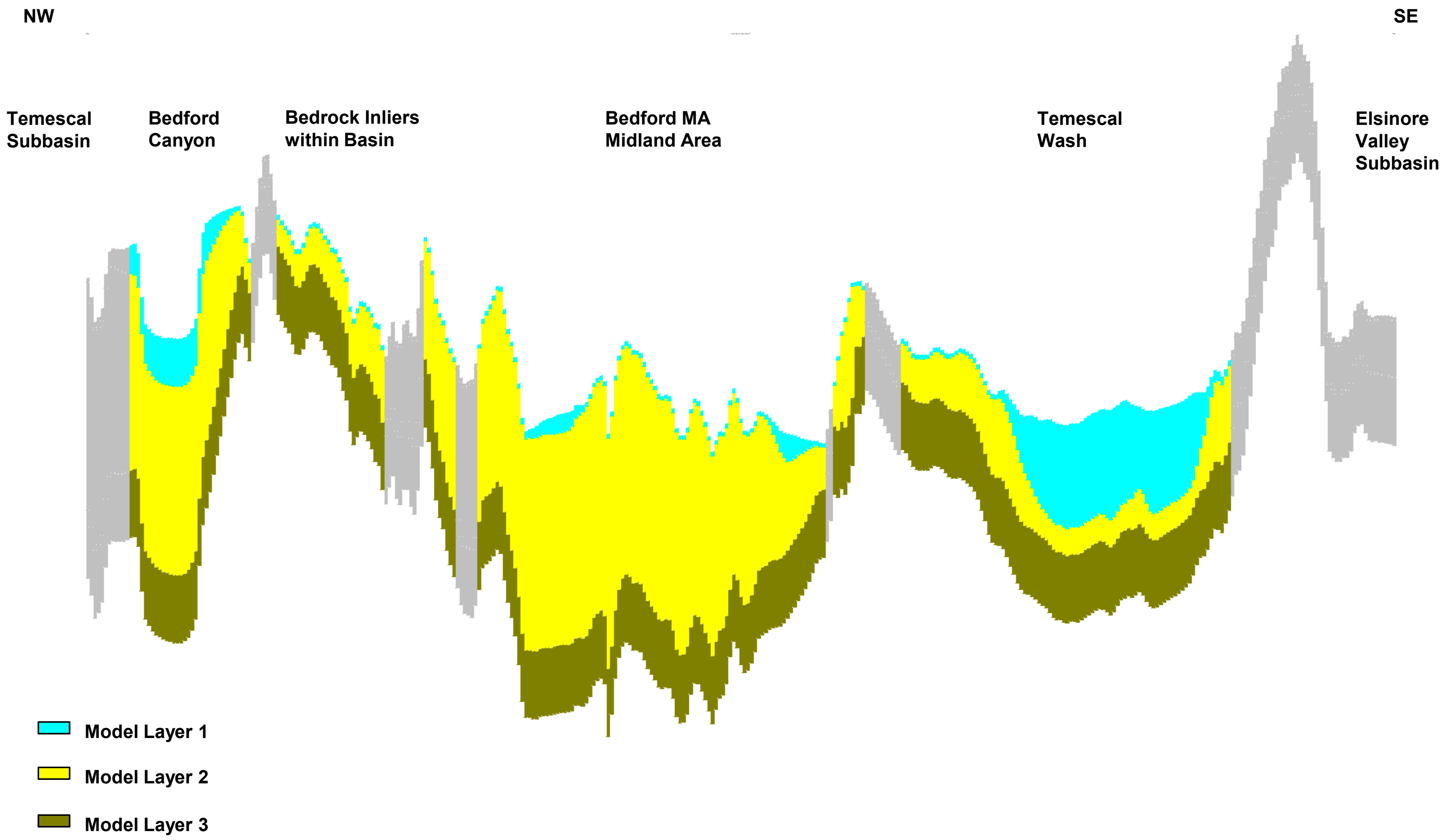
Figure 13
Bottom Elevation Distribution for Model Layer 3



Note: Cross Section taken from MODFLOW model along row 127

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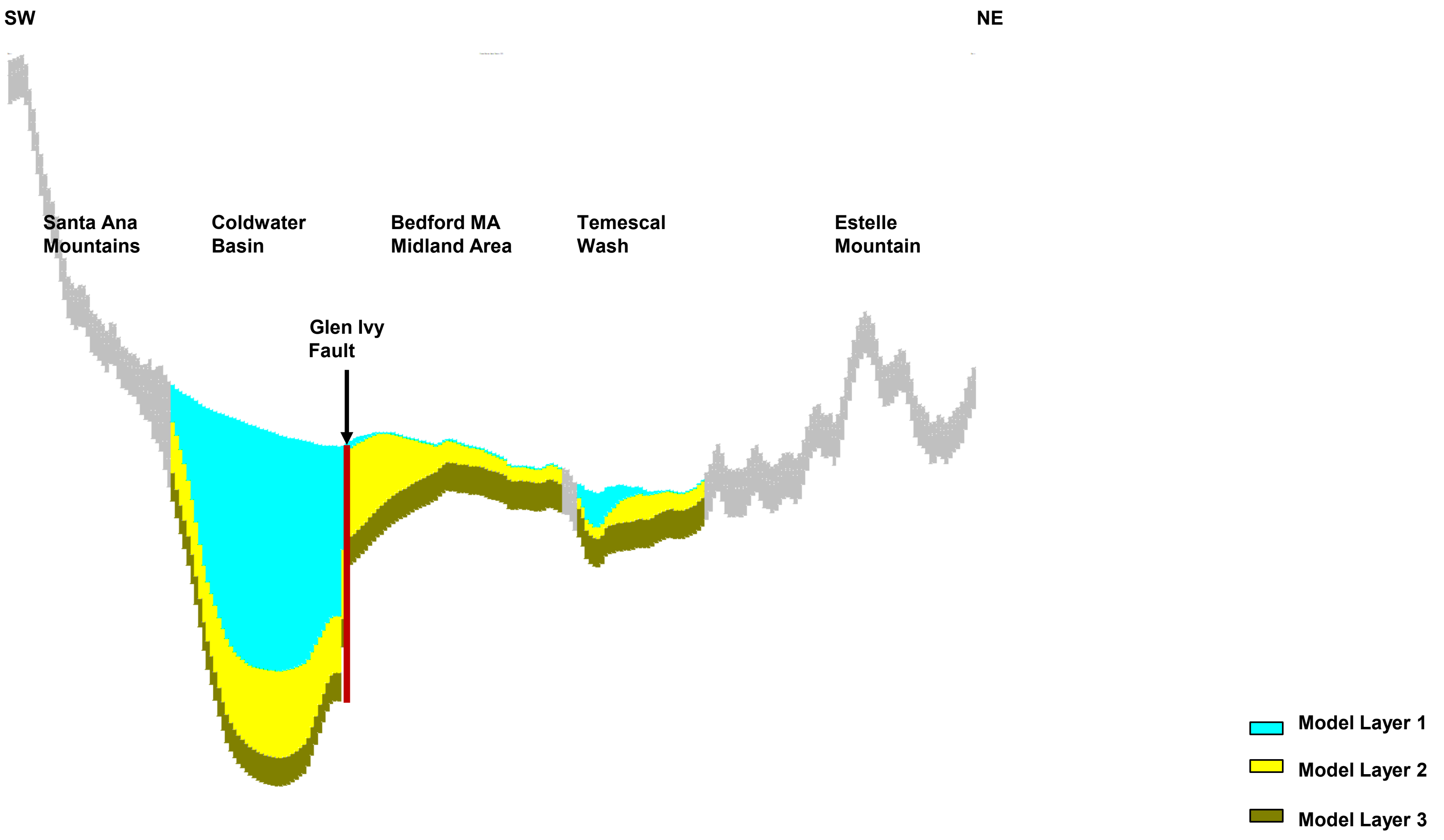
Figure 14
Schematic NW-SE Cross Section to Illustrate Relative Model Layer Thicknesses



Note: Cross Section taken from
MODFLOW model along column 230

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Figure 15
Schematic NE-SW Cross Section to Illustrate Relative Model Layer Thicknesses

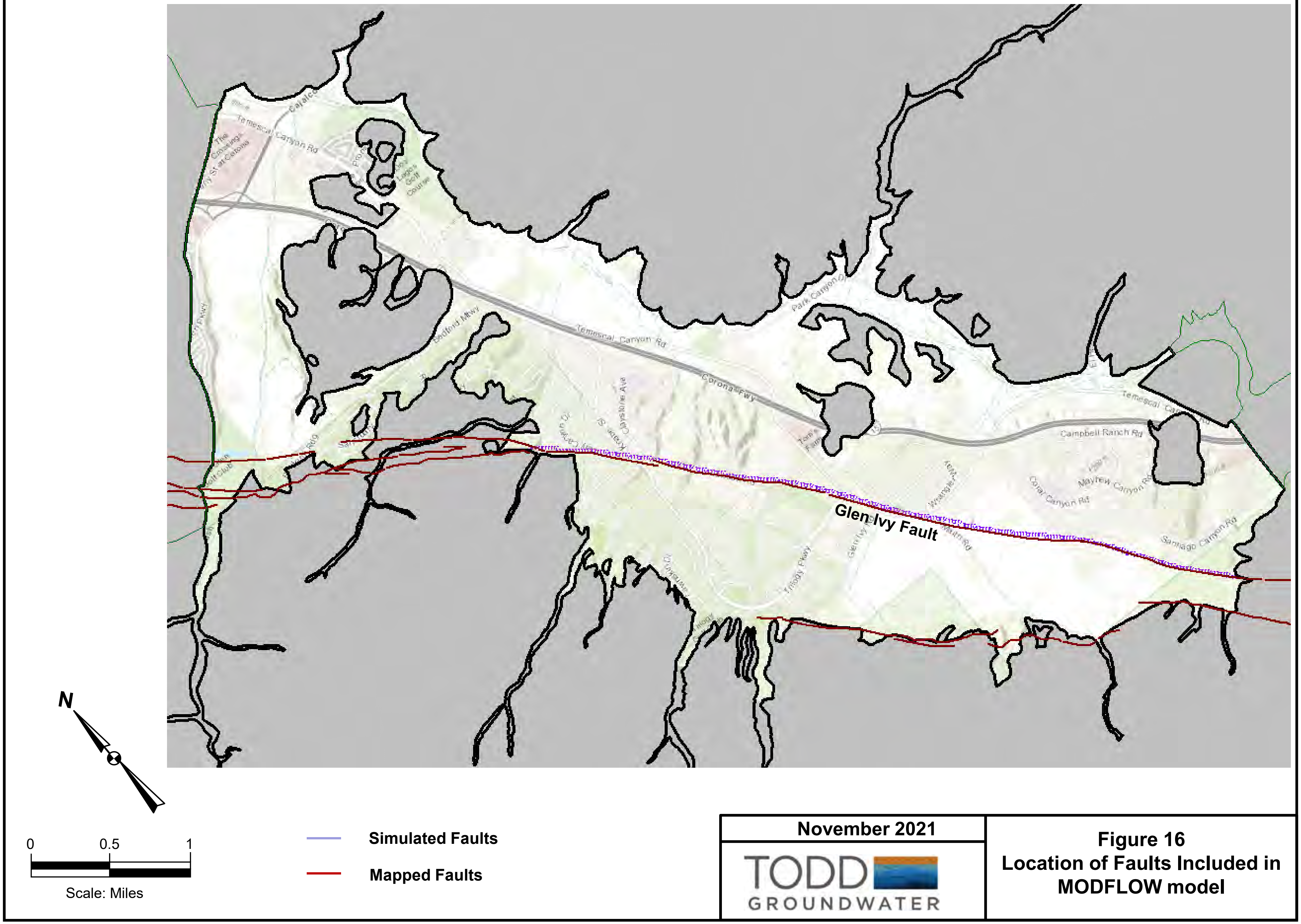

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Figure 16
Location of Faults Included in MODFLOW model

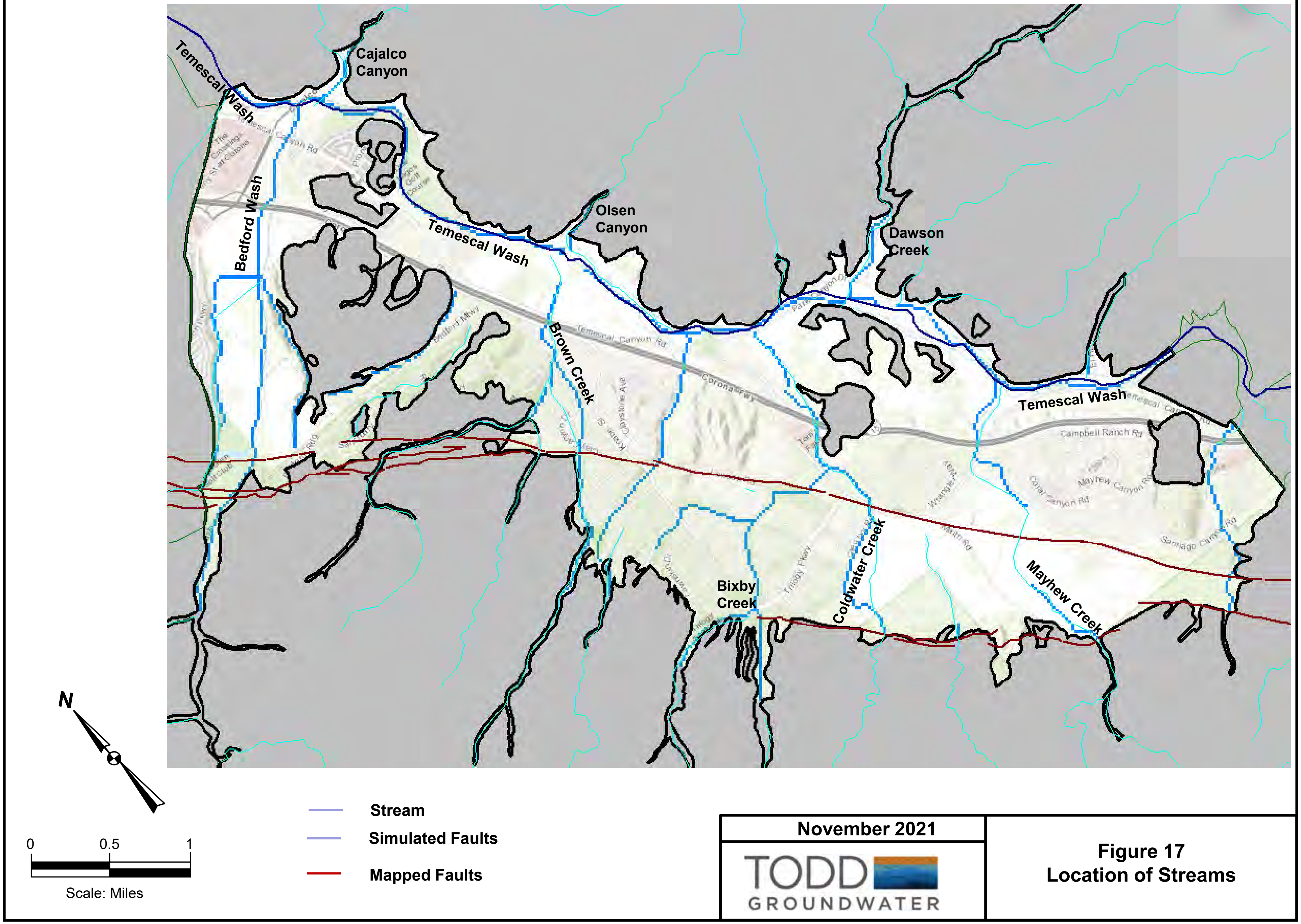

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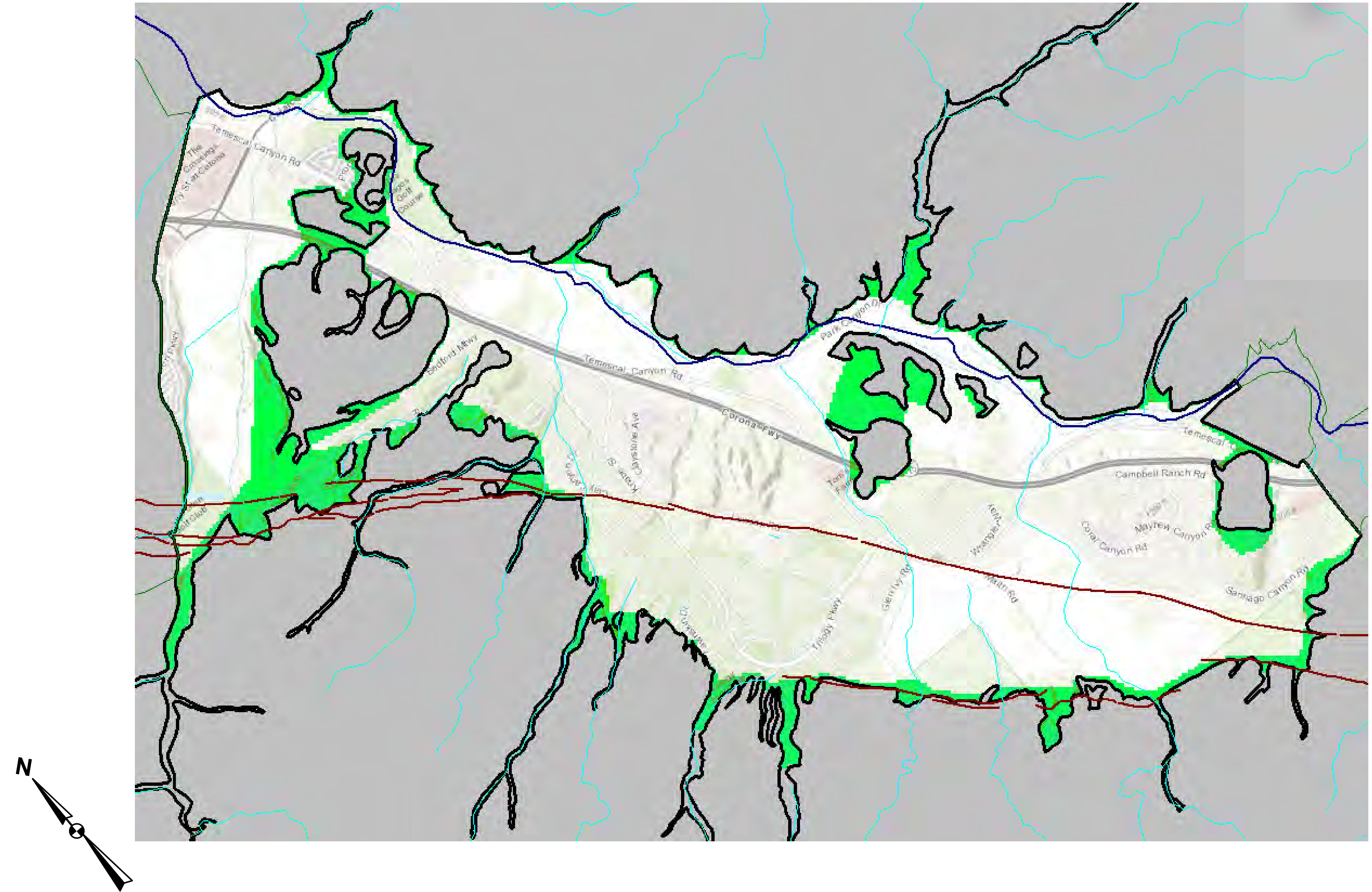
Figure 17
Location of Streams



0 0.5 1

Scale: Miles

🟩 Bedrock Inflow Area

Mapped Faults

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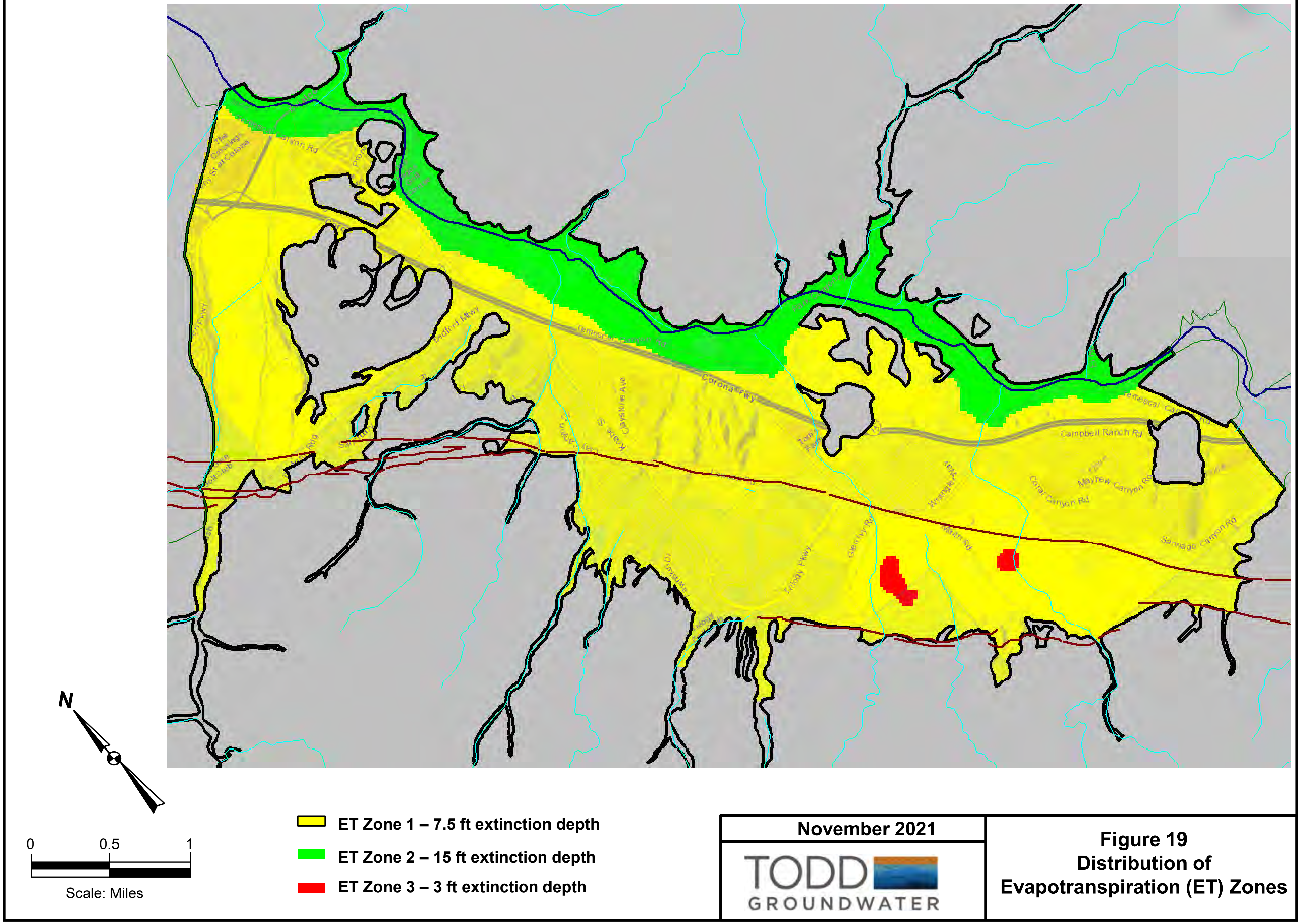
TODD GROUNDWATER

Figure 18
Distribution of General Head Boundary Used for Mountain Front Recharge



🟨 ET Zone 1 – 7.5 ft extinction depth

🟩 ET Zone 2 – 15 ft extinction depth

🟥 ET Zone 3 – 3 ft extinction depth

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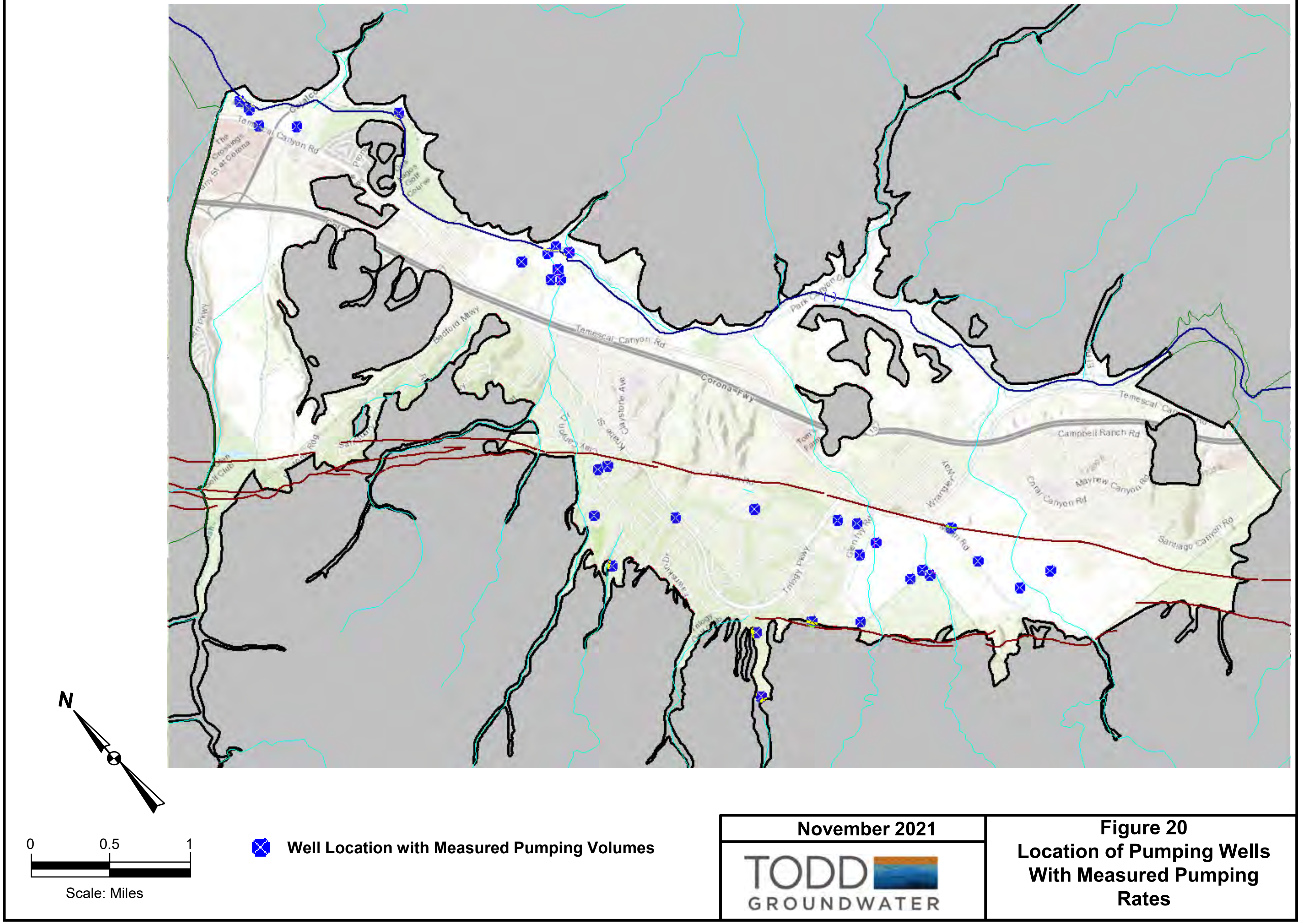
TODD GROUNDWATER

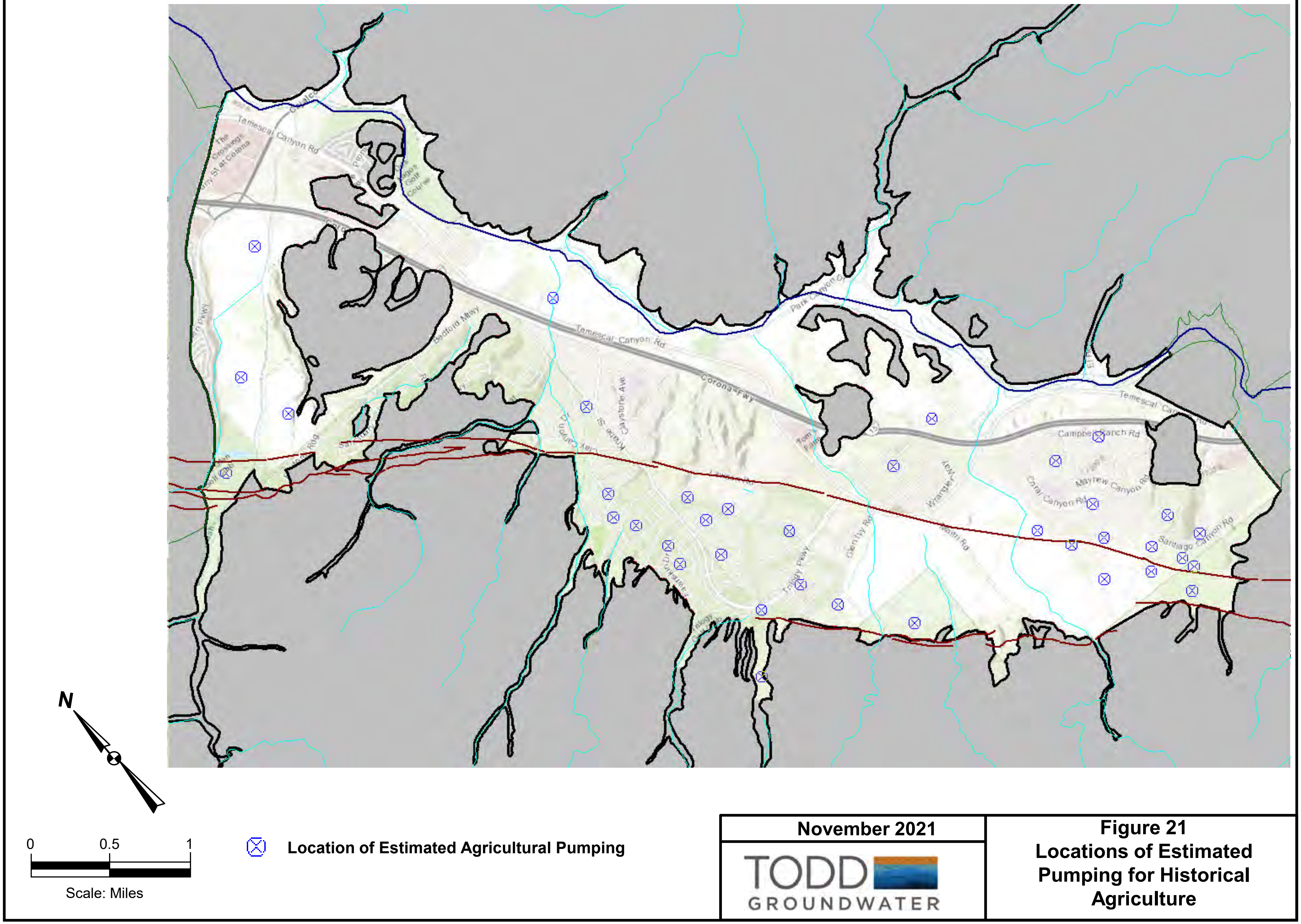
Figure 19
Distribution of
Evapotranspiration (ET) Zones



November 2021

TODD GROUNDWATER

Figure 20
Location of Pumping Wells With Measured Pumping Rates



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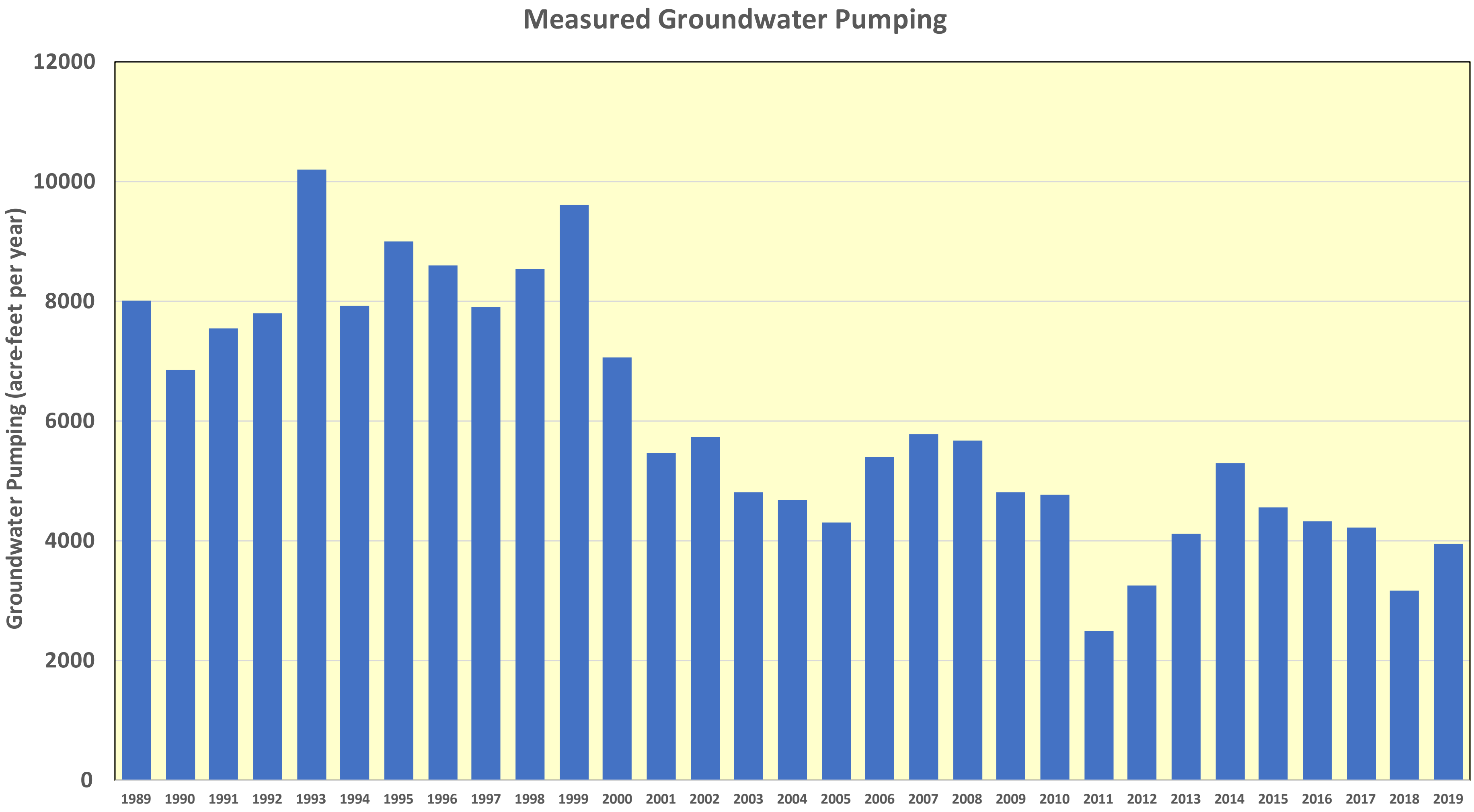
TODD GROUNDWATER

Figure 21
Locations of Estimated Pumping for Historical Agriculture



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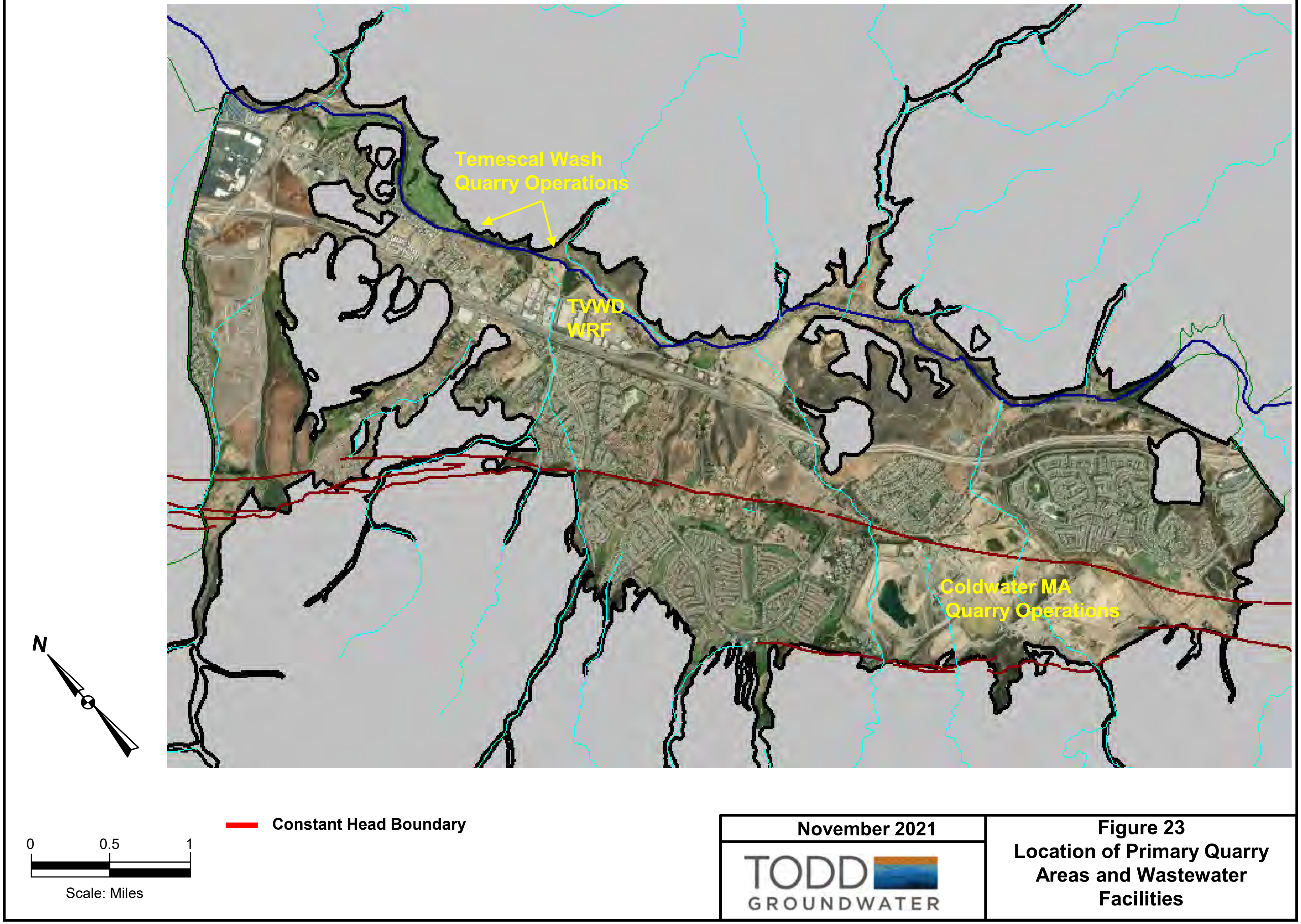
TODD GROUNDWATER

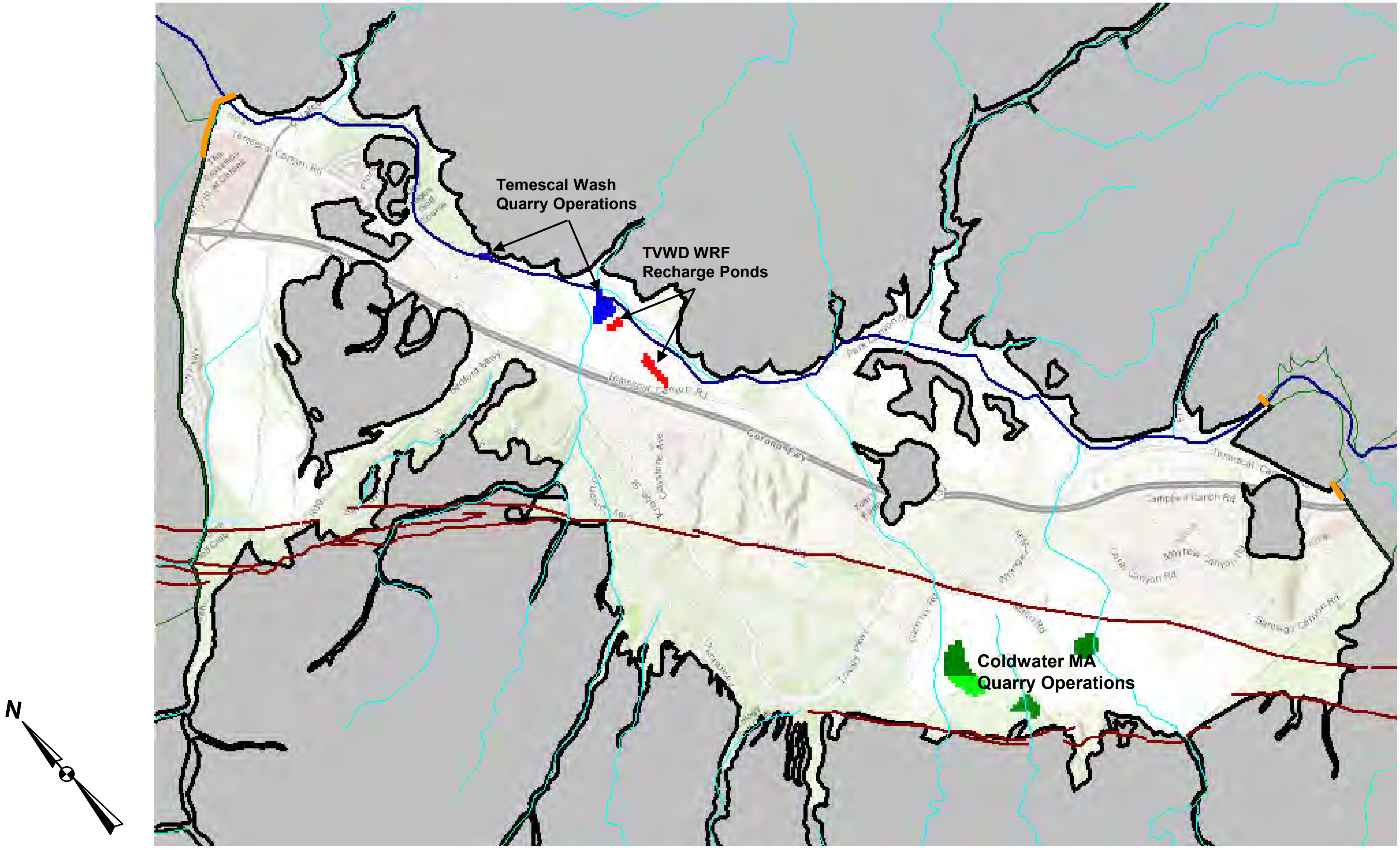
Figure 22
Annual Groundwater Pumping
in Bedford-Coldwater Basin



November 2021

TODD GROUNDWATER

Figure 23
Location of Primary Quarry Areas and Wastewater Facilities



🟧 Constant Head Boundary
🟥 WRF Recharge Pond as Well Package
🟦 Quarry Pond as River Package
🟩 Quarry surface as Drain Package
🟩 Quarry Pond as Combined Well and Drain Package

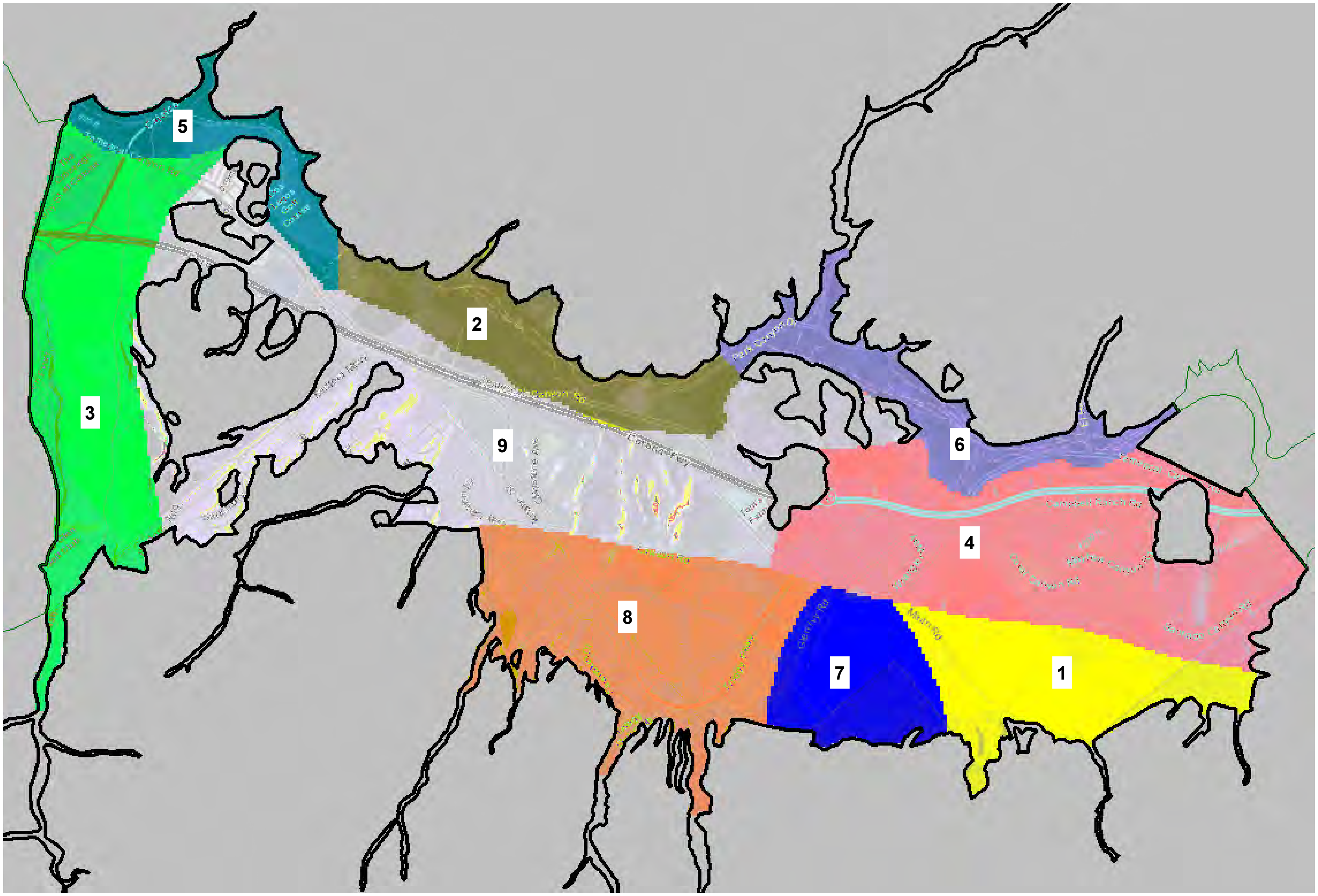
0 0.5 1

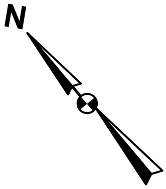
Scale: Miles

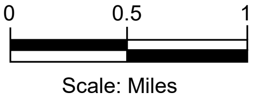
November 2021

TODD GROUNDWATER

Figure 24
Boundary Conditions Applied for Recharge Ponds, Quarries and Subsurface Flow







Note: Map Zone numbers relate to Aquifer Property Values on Table 3 in Report

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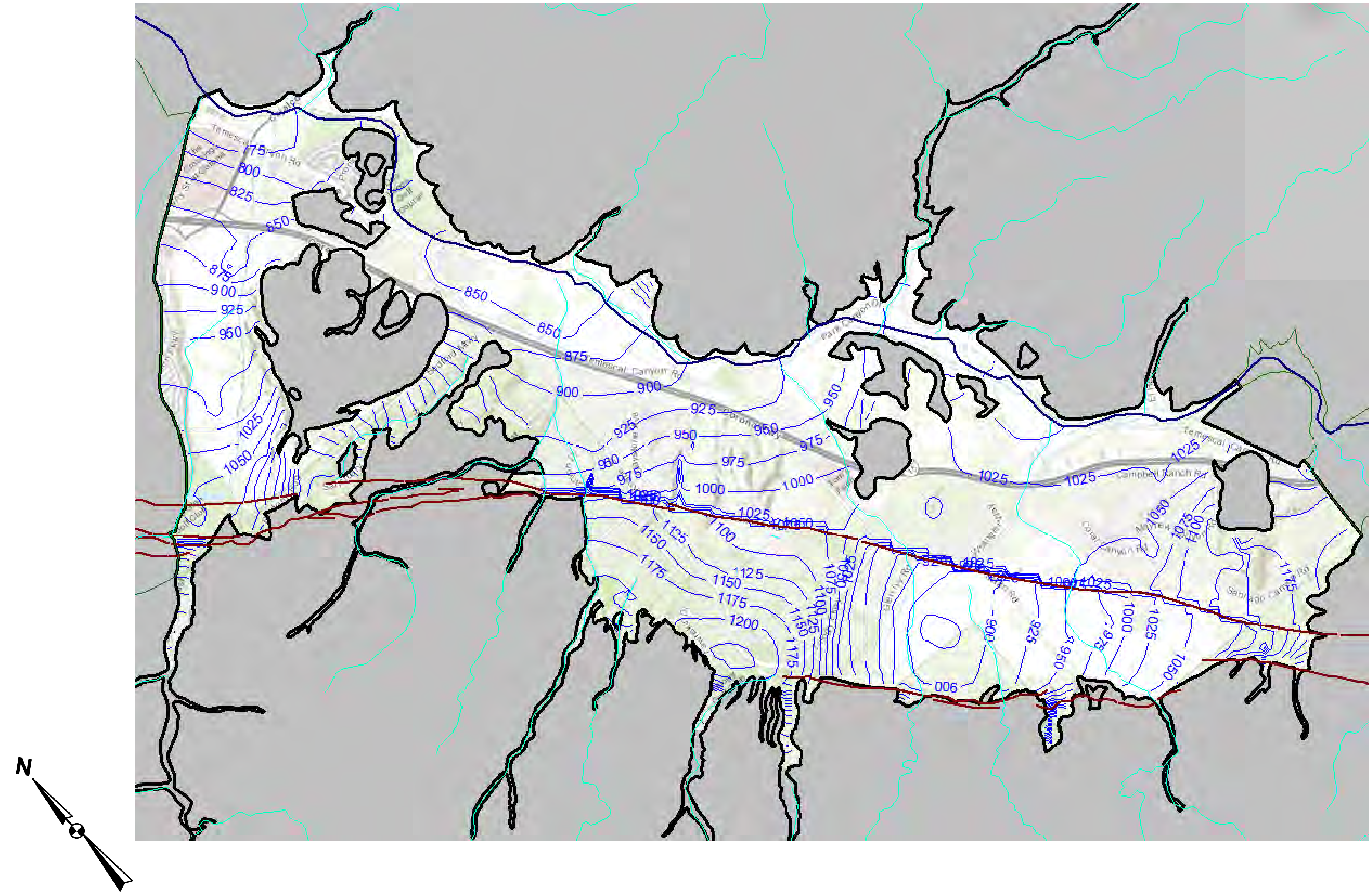
TODD GROUNDWATER

Figure 25
Distribution of Aquifer Property Zones for Layers 1, 2 and 3



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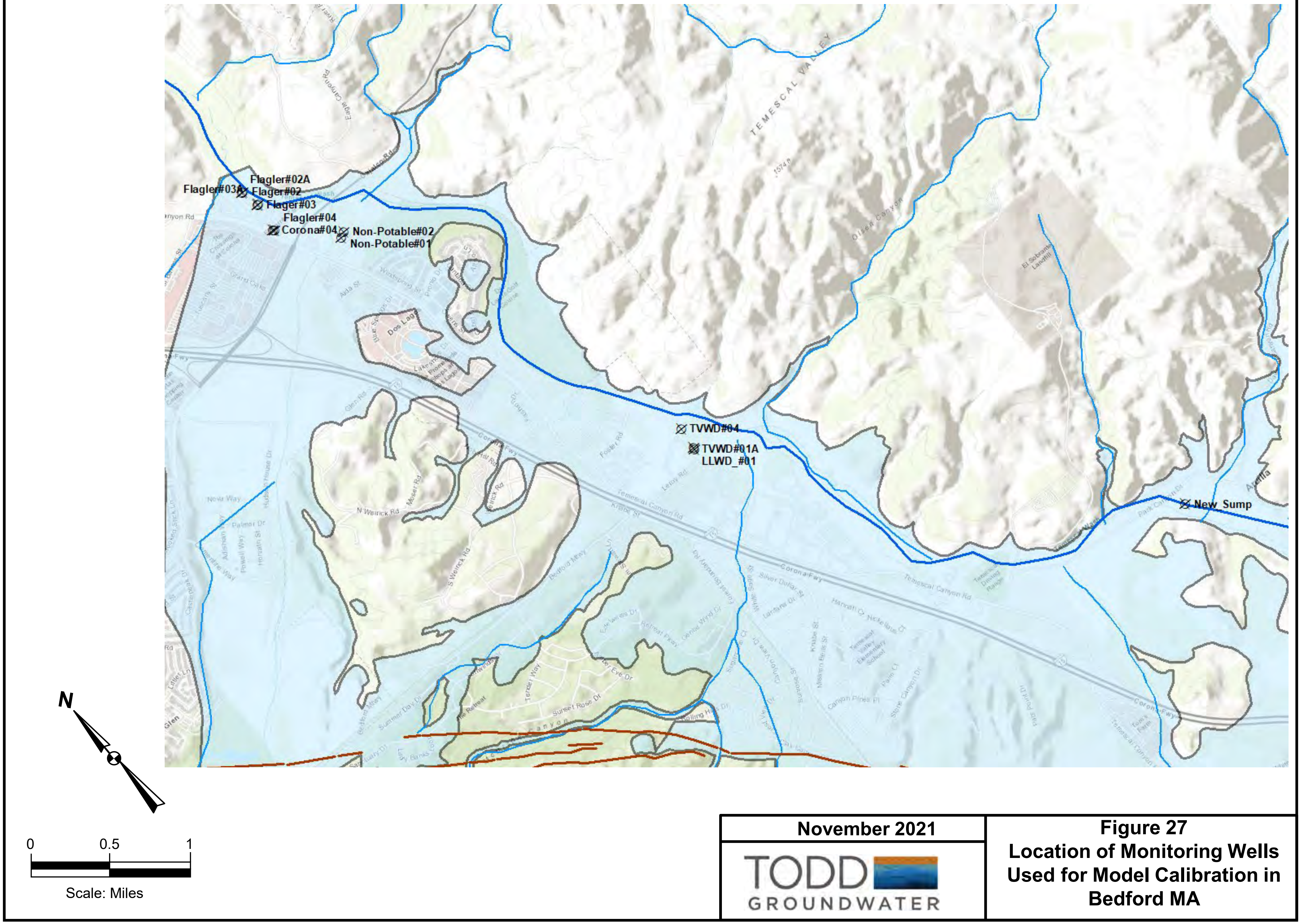
TODD GROUNDWATER

Figure 26
Initial Groundwater Conditions for Layer 2



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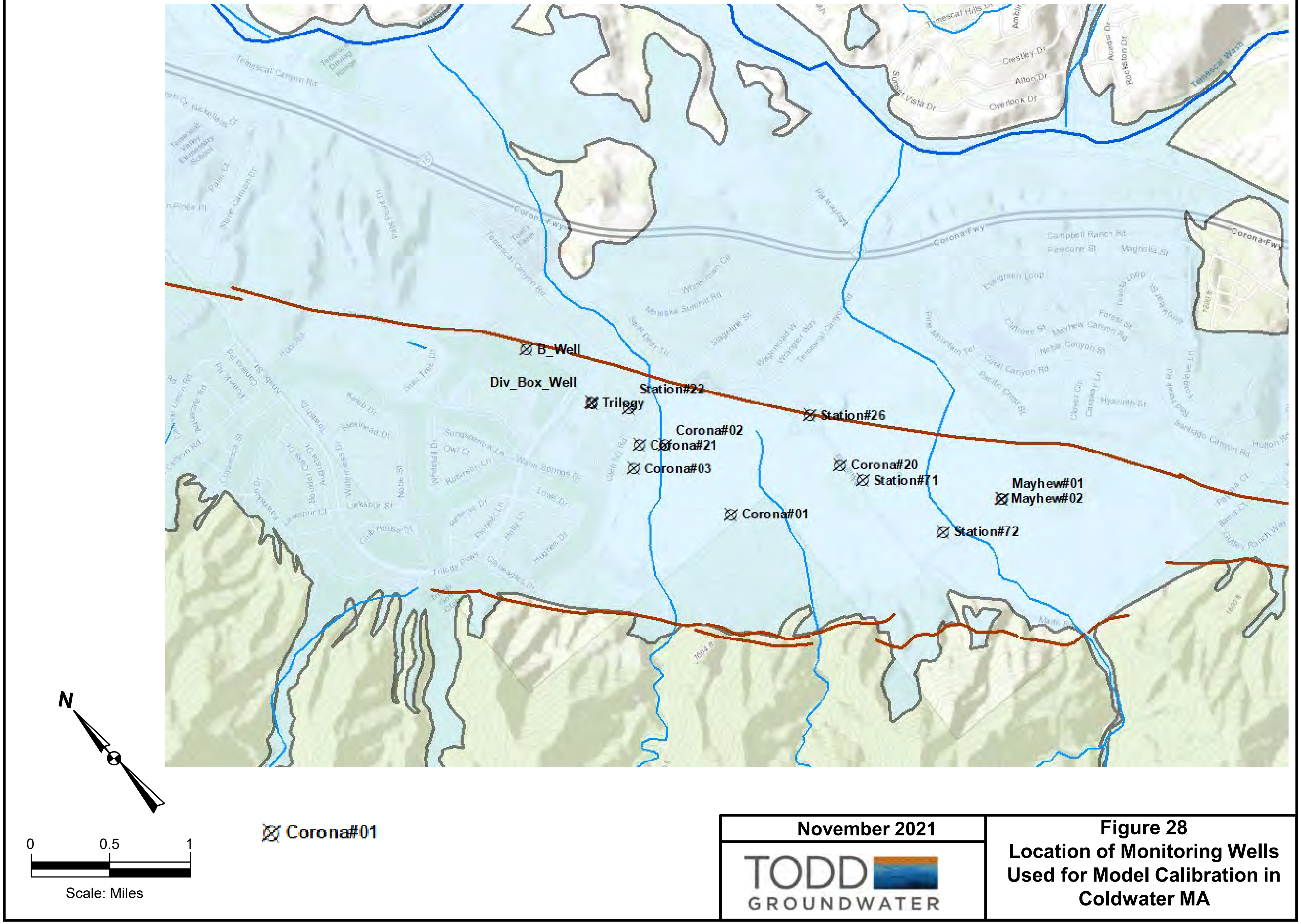
TODD GROUNDWATER

Figure 27
Location of Monitoring Wells Used for Model Calibration in Bedford MA



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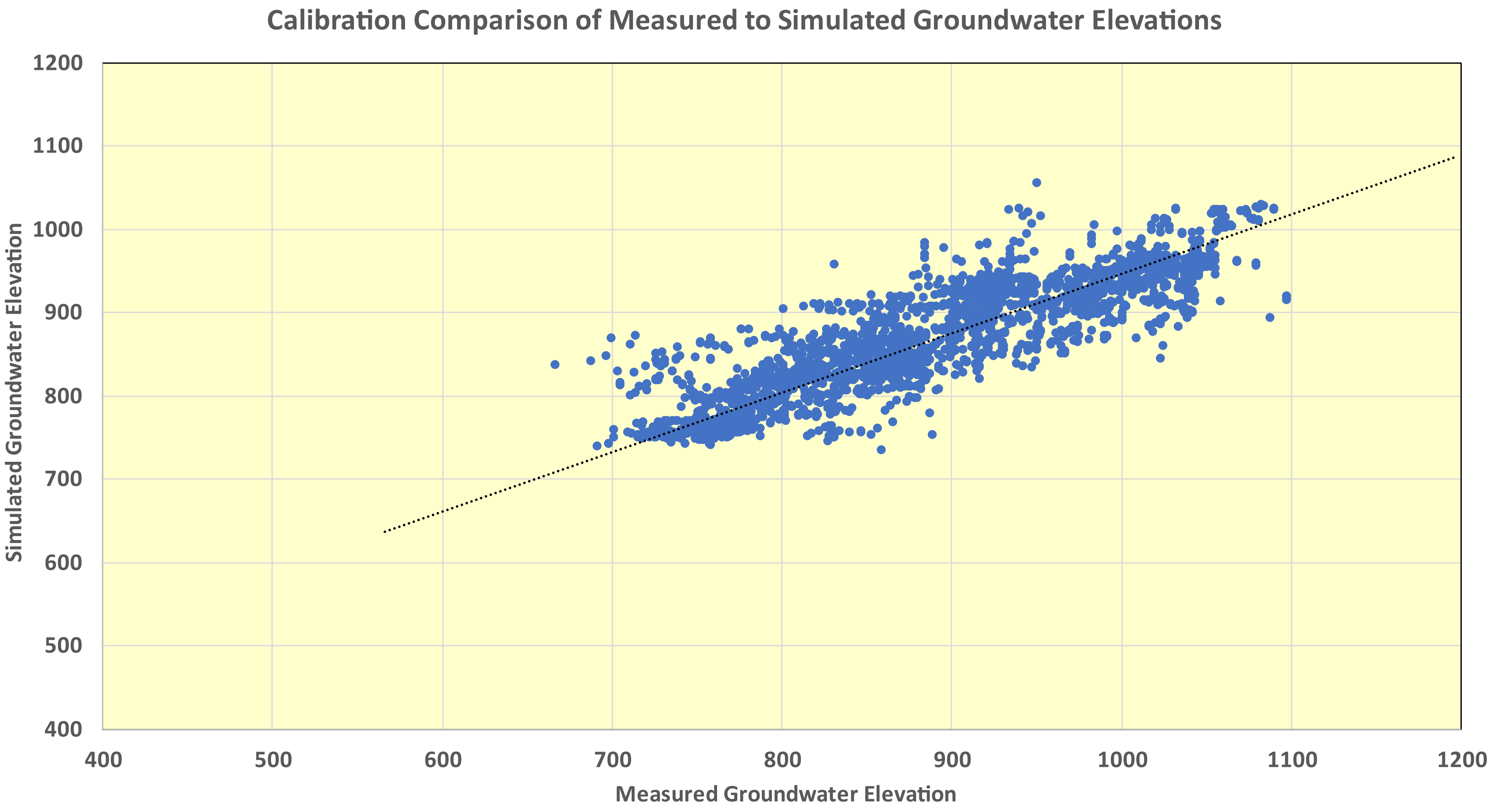
TODD
GROUNDWATER

Figure 28
Location of Monitoring Wells Used for Model Calibration in Coldwater MA



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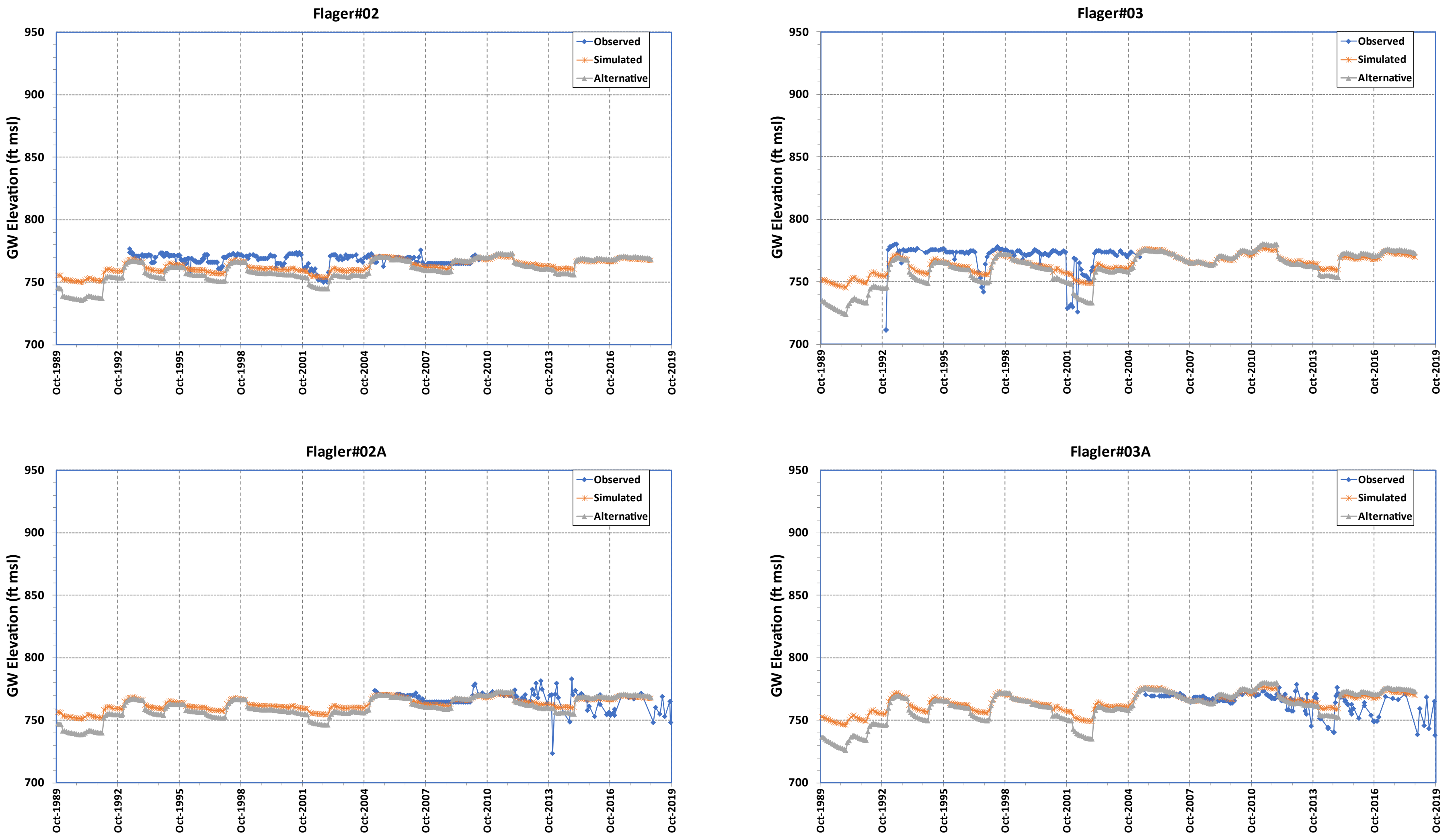
TODD GROUNDWATER

Figure 29
Scatter Plot Comparing Simulated to Measured Groundwater Levels



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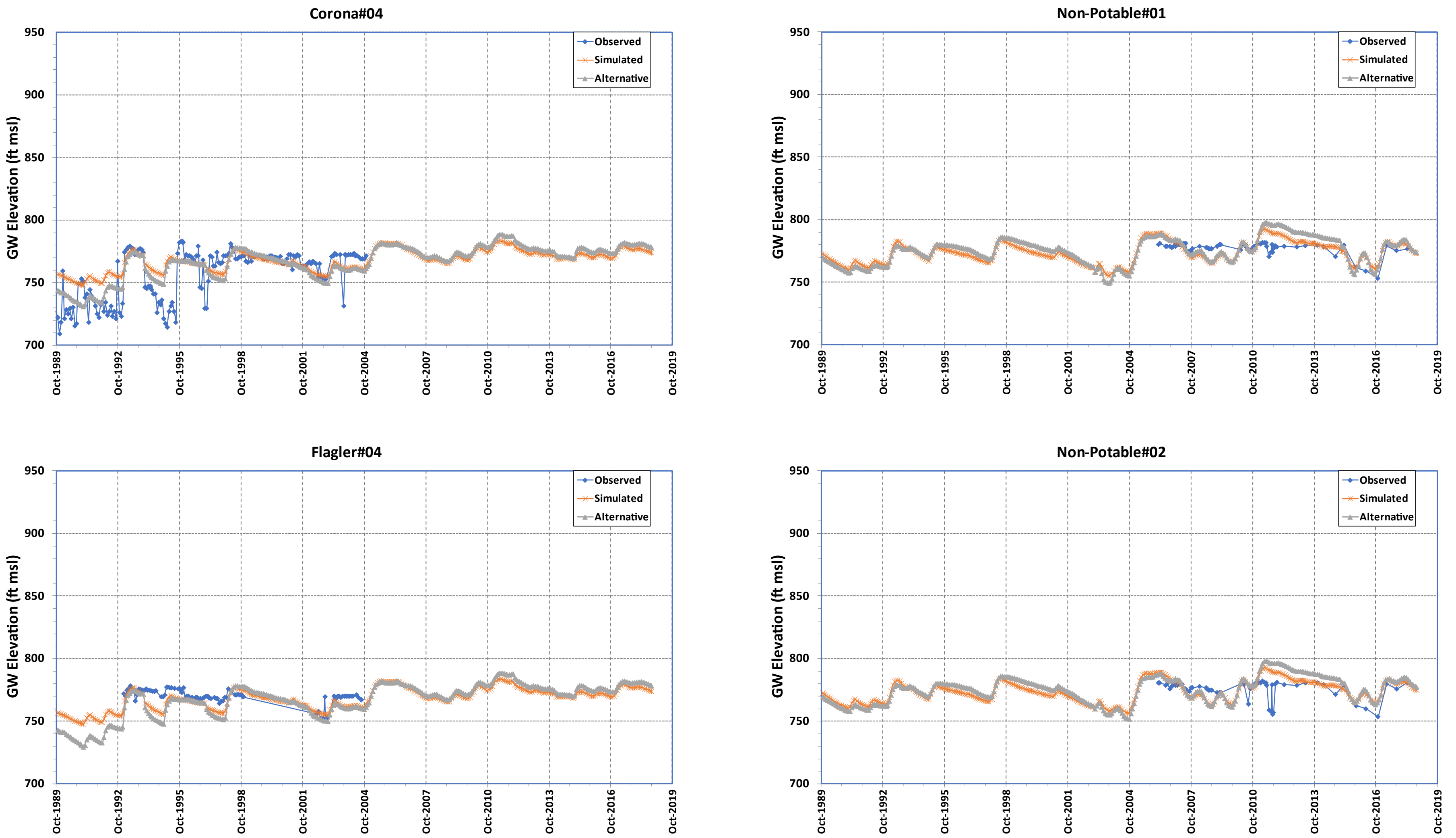
TODD GROUNDWATER

Figure 30
Calibration Hydrographs
Bedford MA
North Temescal Wash Area



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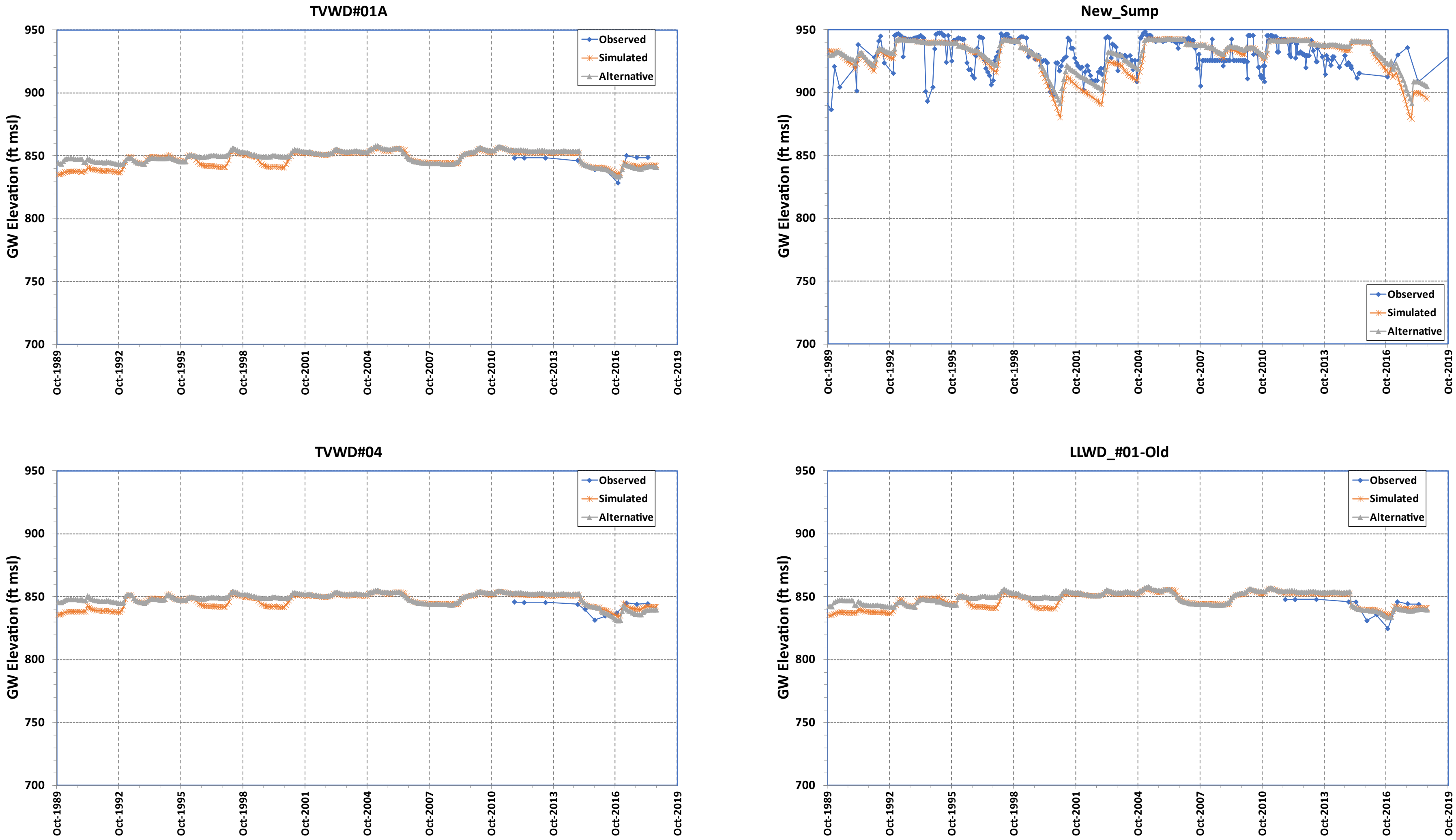
TODD GROUNDWATER

Figure 31
Calibration Hydrographs
Bedford MA
North Temescal Wash Area



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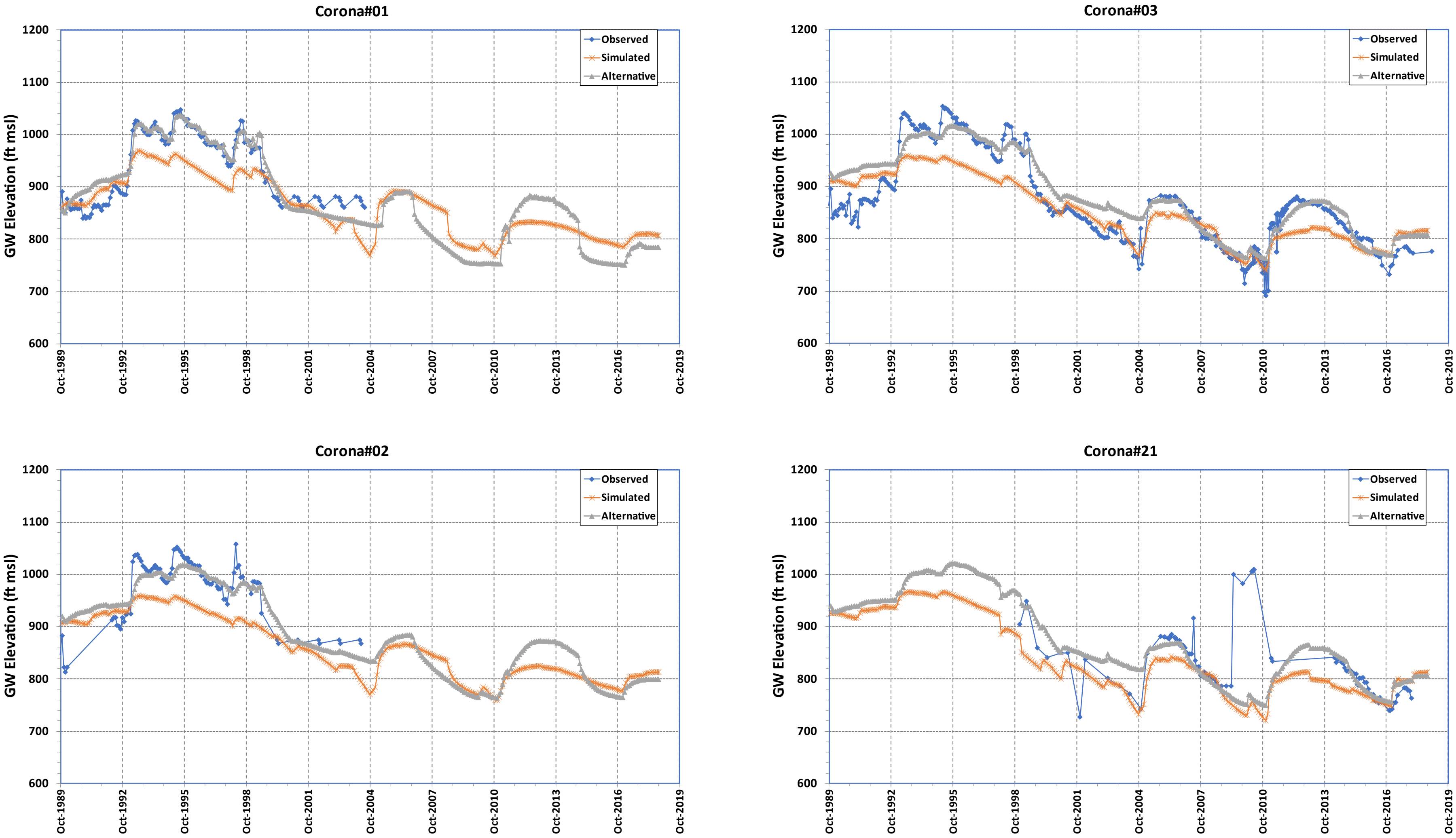
GROUNDWATER

Figure 32
Calibration Hydrographs
Bedford MA
Mid Temescal Wash Area



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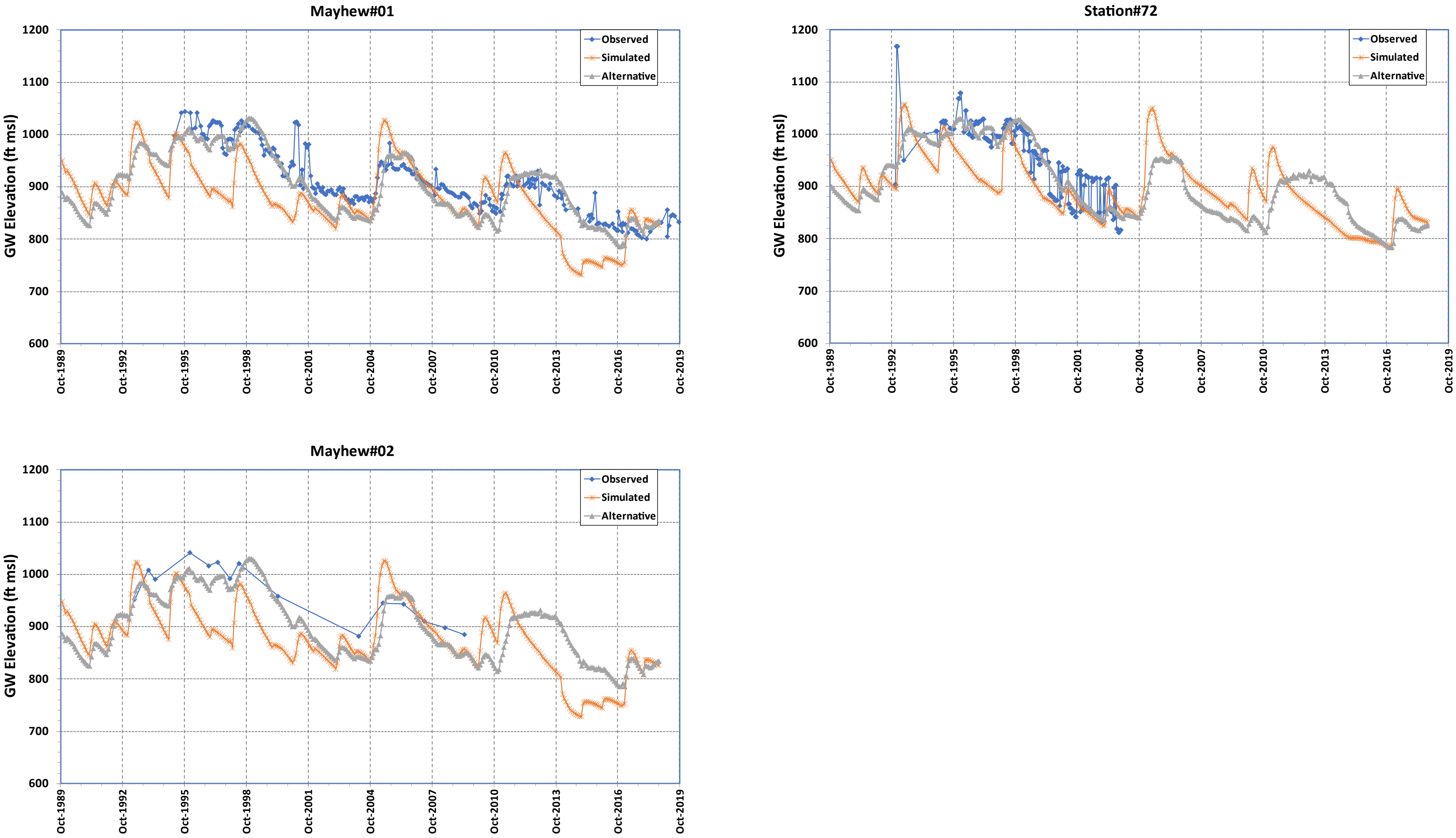
TODD GROUNDWATER

Figure 33
Calibration Hydrographs
Coldwater MA
Coldwater Quarry Area



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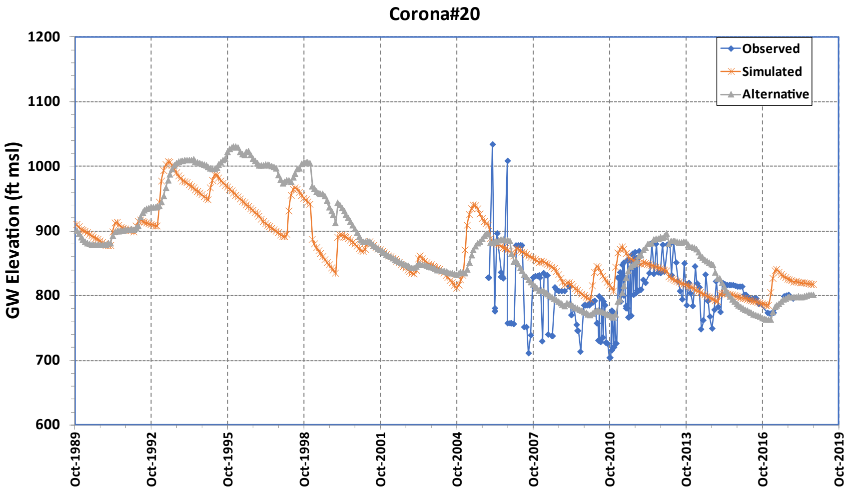
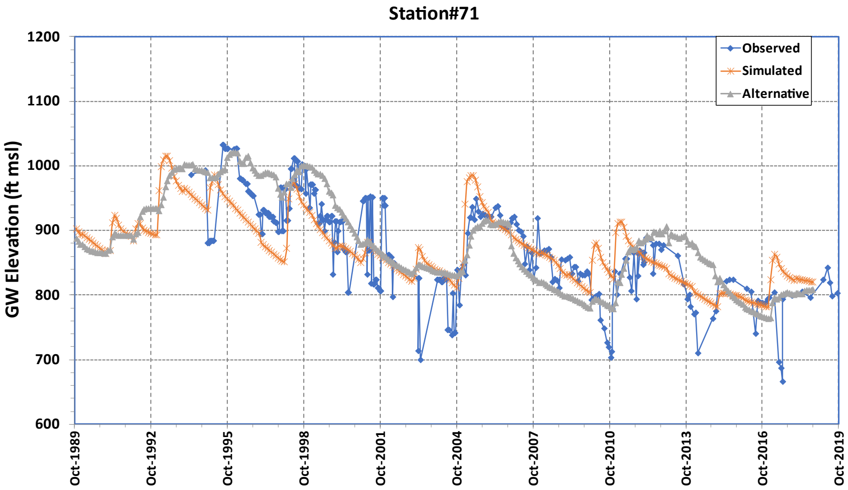
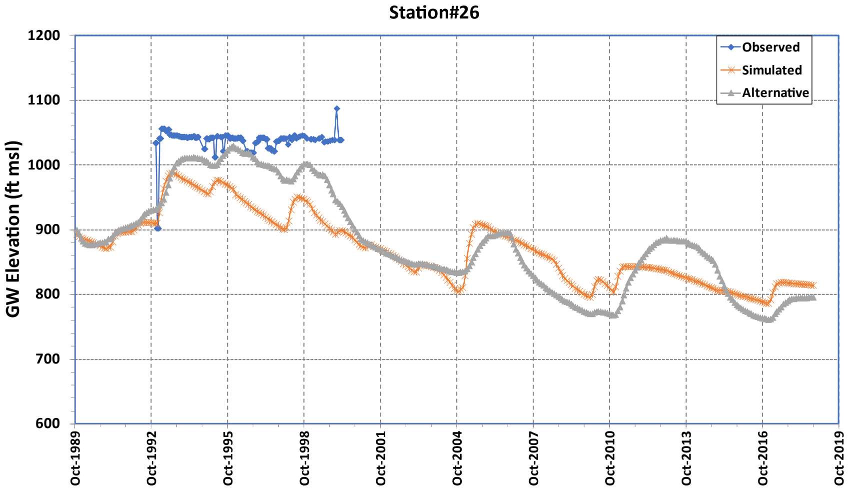
TODD GROUNDWATER

Figure 34
Calibration Hydrographs
Coldwater MA
Mayhew Quarry Area







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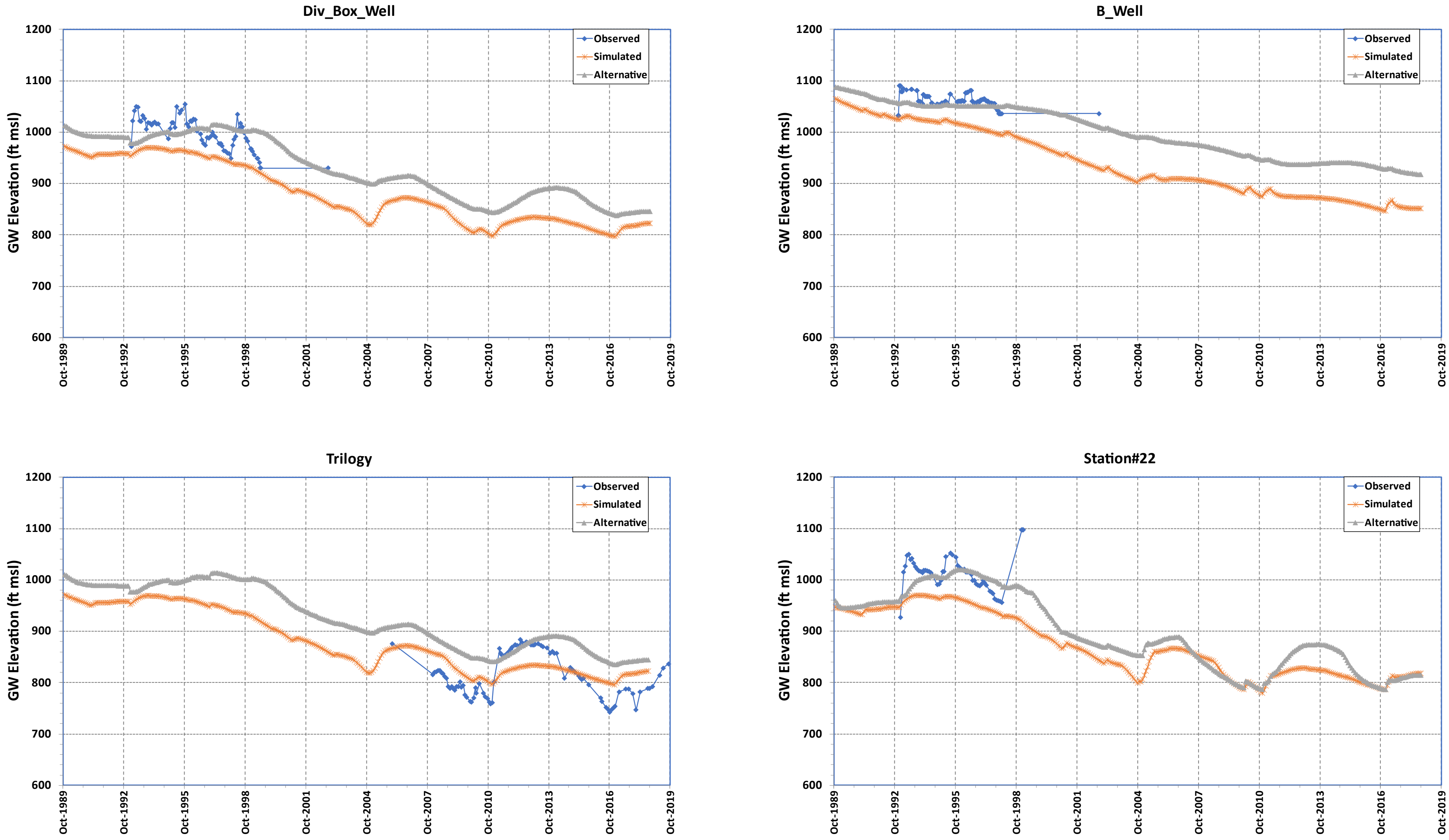
TODD GROUNDWATER

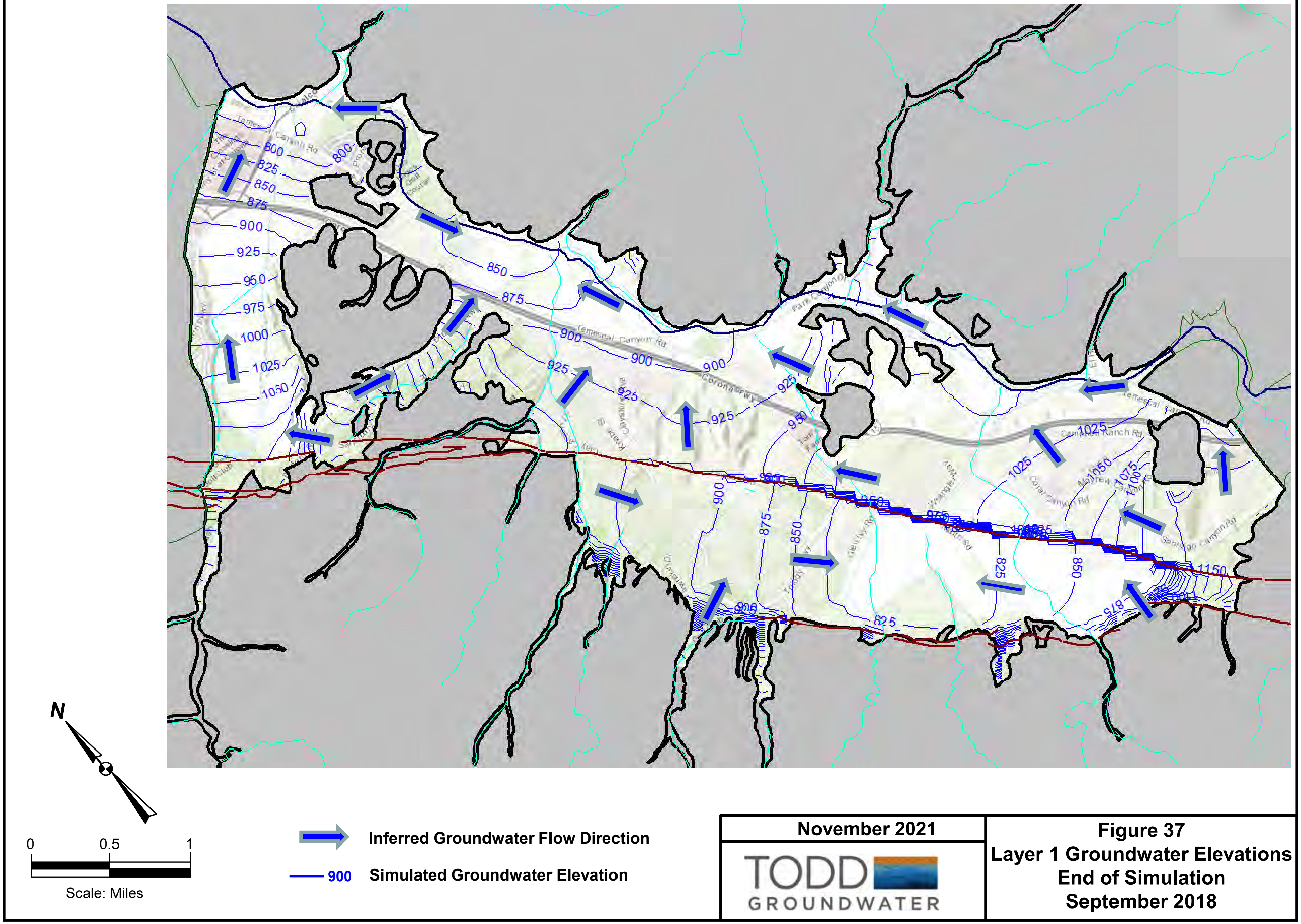
Figure 35
Calibration Hydrographs
Coldwater MA
Other Quarry Areas



November 2021

TODD GROUNDWATER

Figure 36
Calibration Hydrographs
Coldwater MA
North of Quarry Area



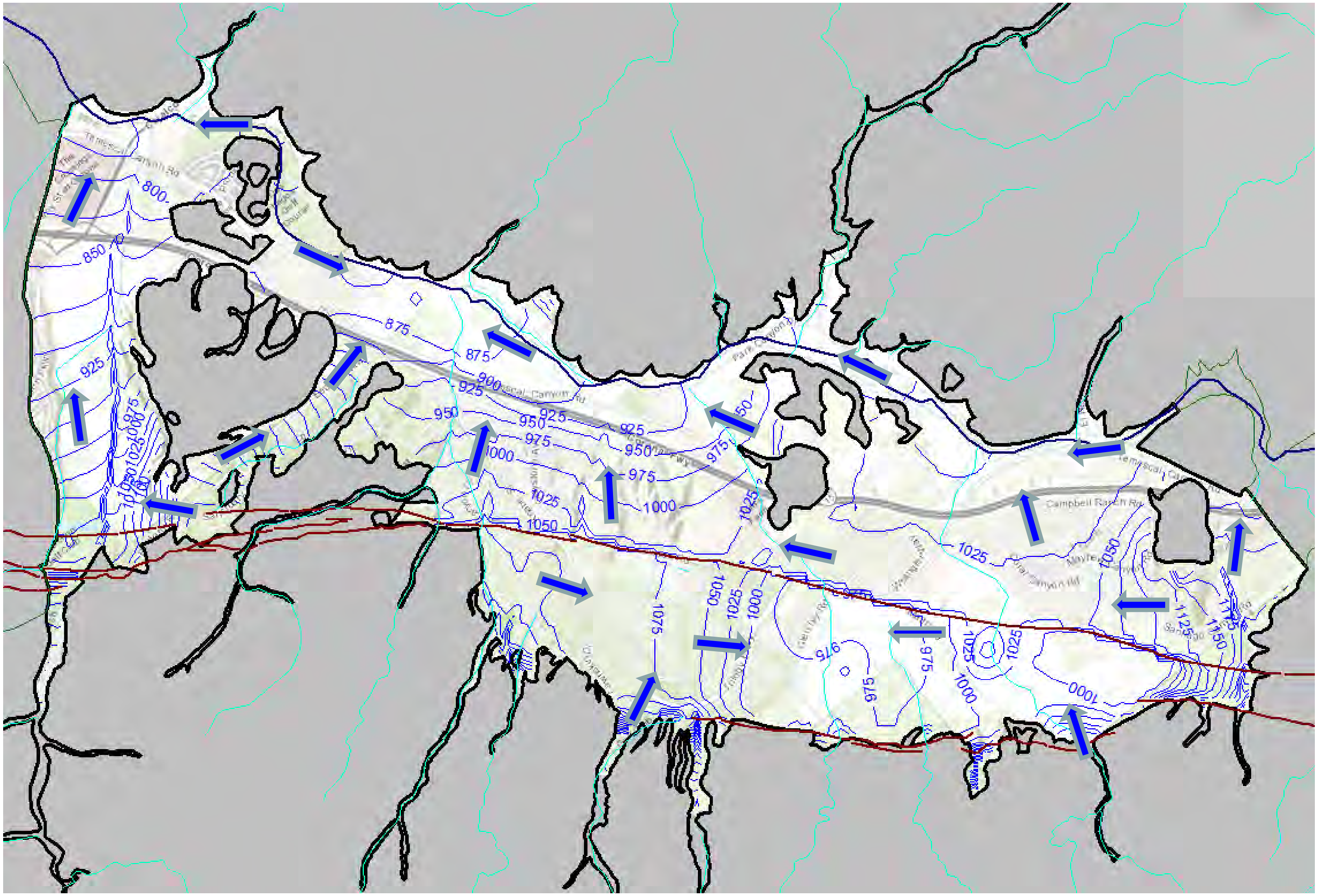
Inferred Groundwater Flow Direction

900 **Simulated Groundwater Elevation**

November 2021

TODD GROUNDWATER

Figure 37
Layer 1 Groundwater Elevations
End of Simulation
September 2018



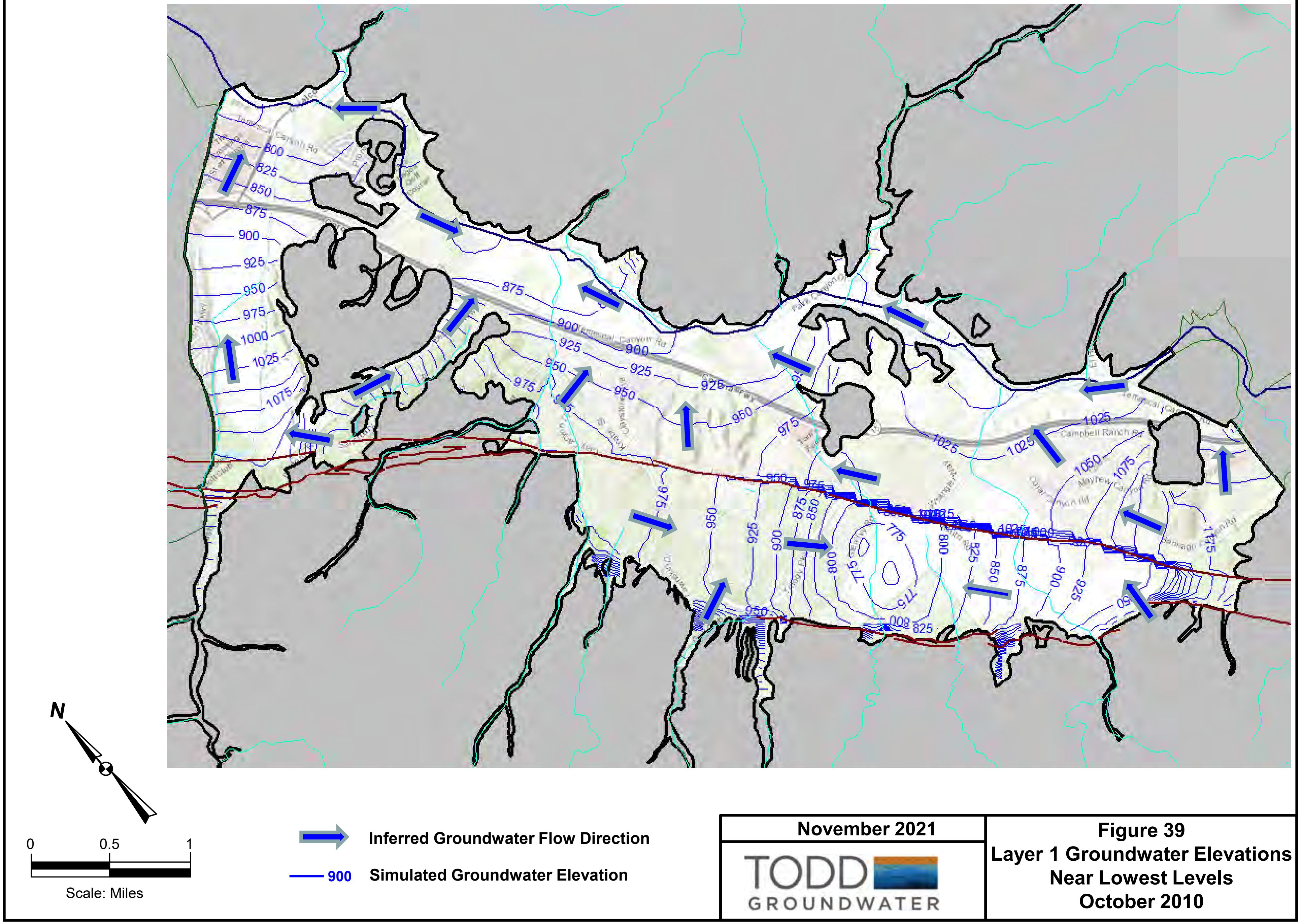
Inferred Groundwater Flow Direction

900 Simulated Groundwater Elevation

November 2021

TODD GROUNDWATER

Figure 38
Layer 1 Groundwater Elevations Near Highest Levels
March 1995



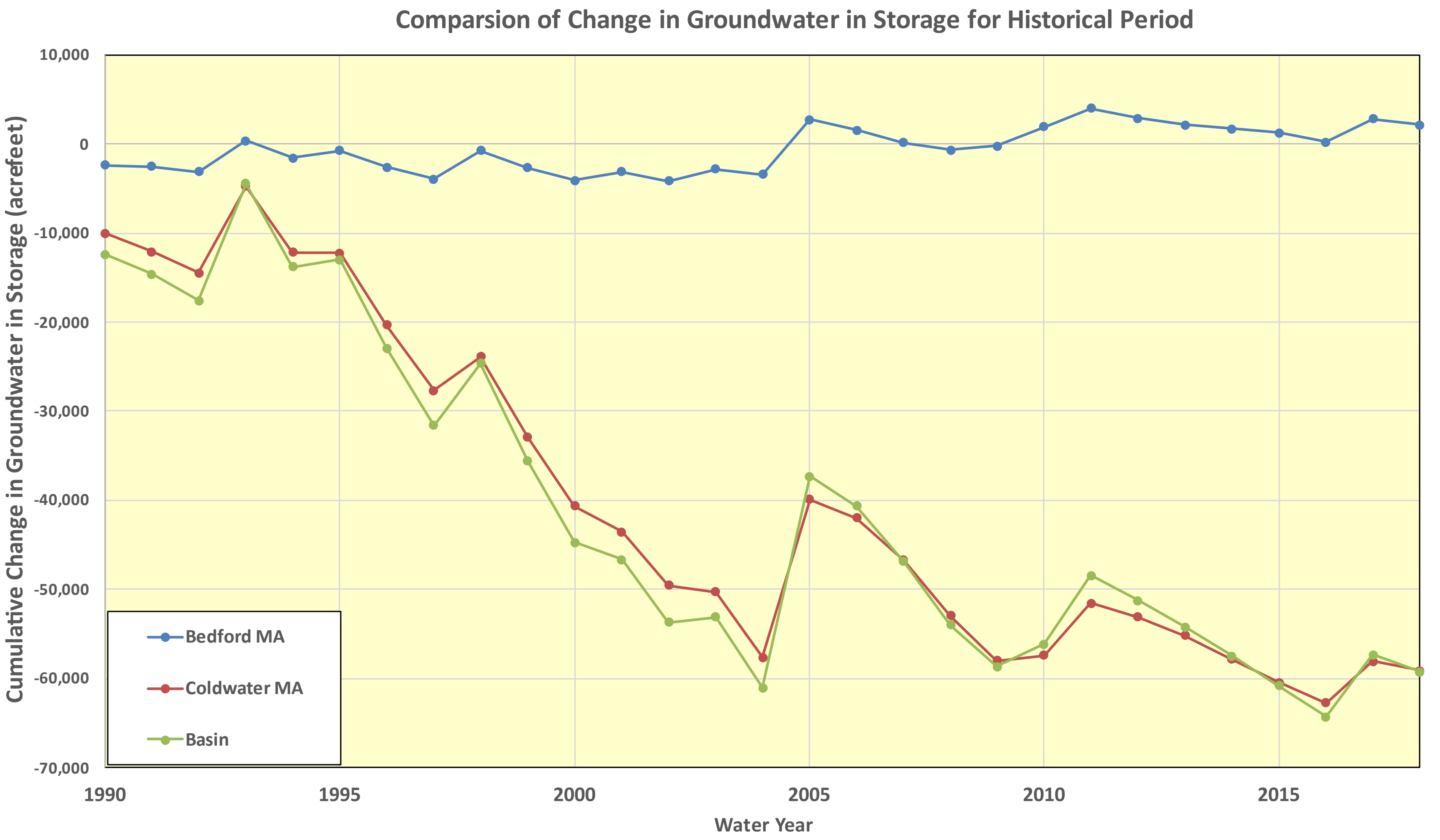
Inferred Groundwater Flow Direction

900 **Simulated Groundwater Elevation**

November 2021

TODD GROUNDWATER

Figure 39
Layer 1 Groundwater Elevations Near Lowest Levels October 2010



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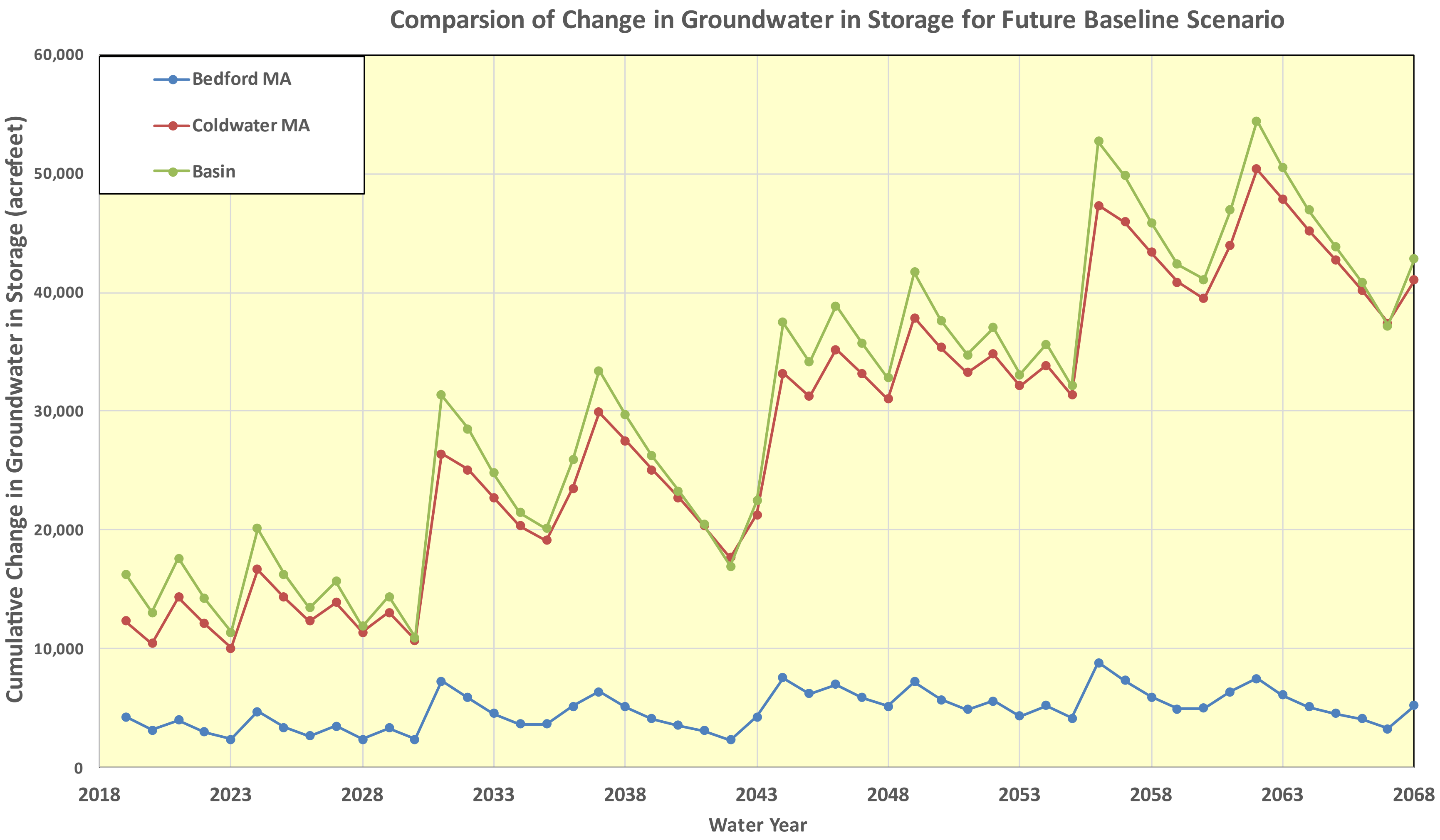
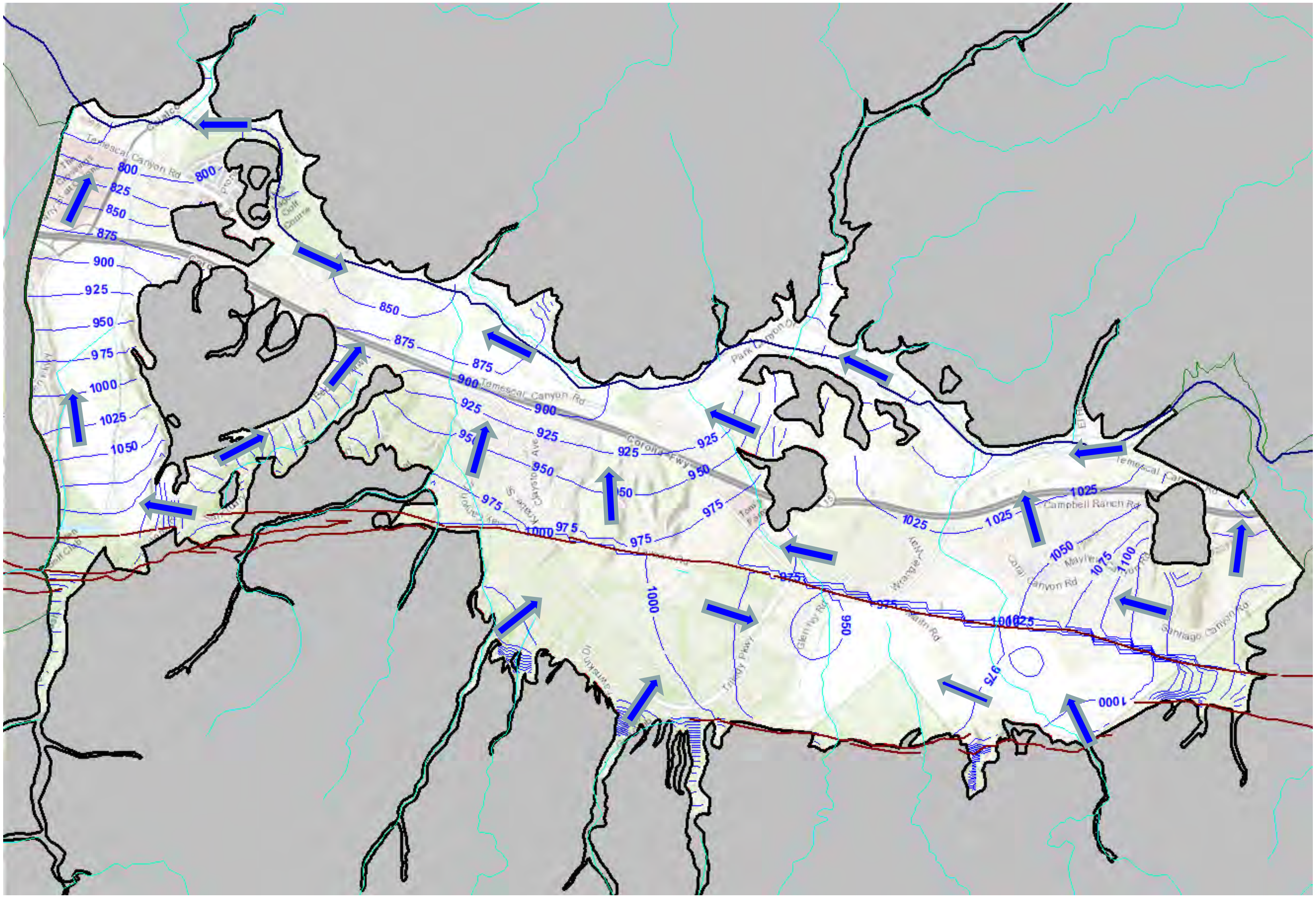
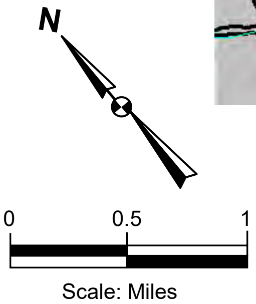
TODD GROUNDWATER

Figure 40
Simulated Change in Groundwater in Storage for Historical Simulation



November 2021	**Figure 41** **Simulated Groundwater Storage Change for Future Baseline Scenario**
TODD GROUNDWATER	

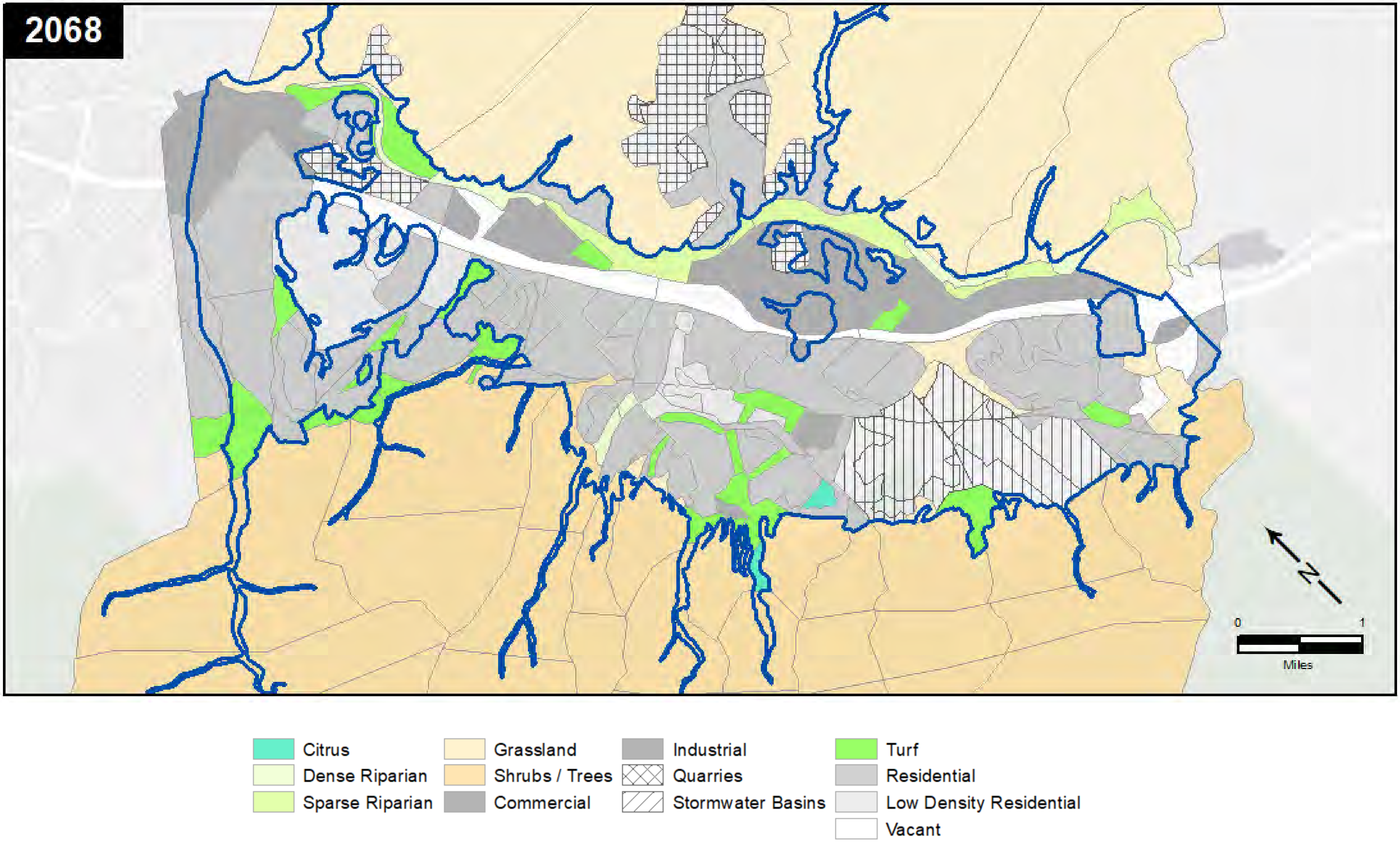




➡ Inferred Groundwater Flow Direction

— 900 Simulated Groundwater Elevation

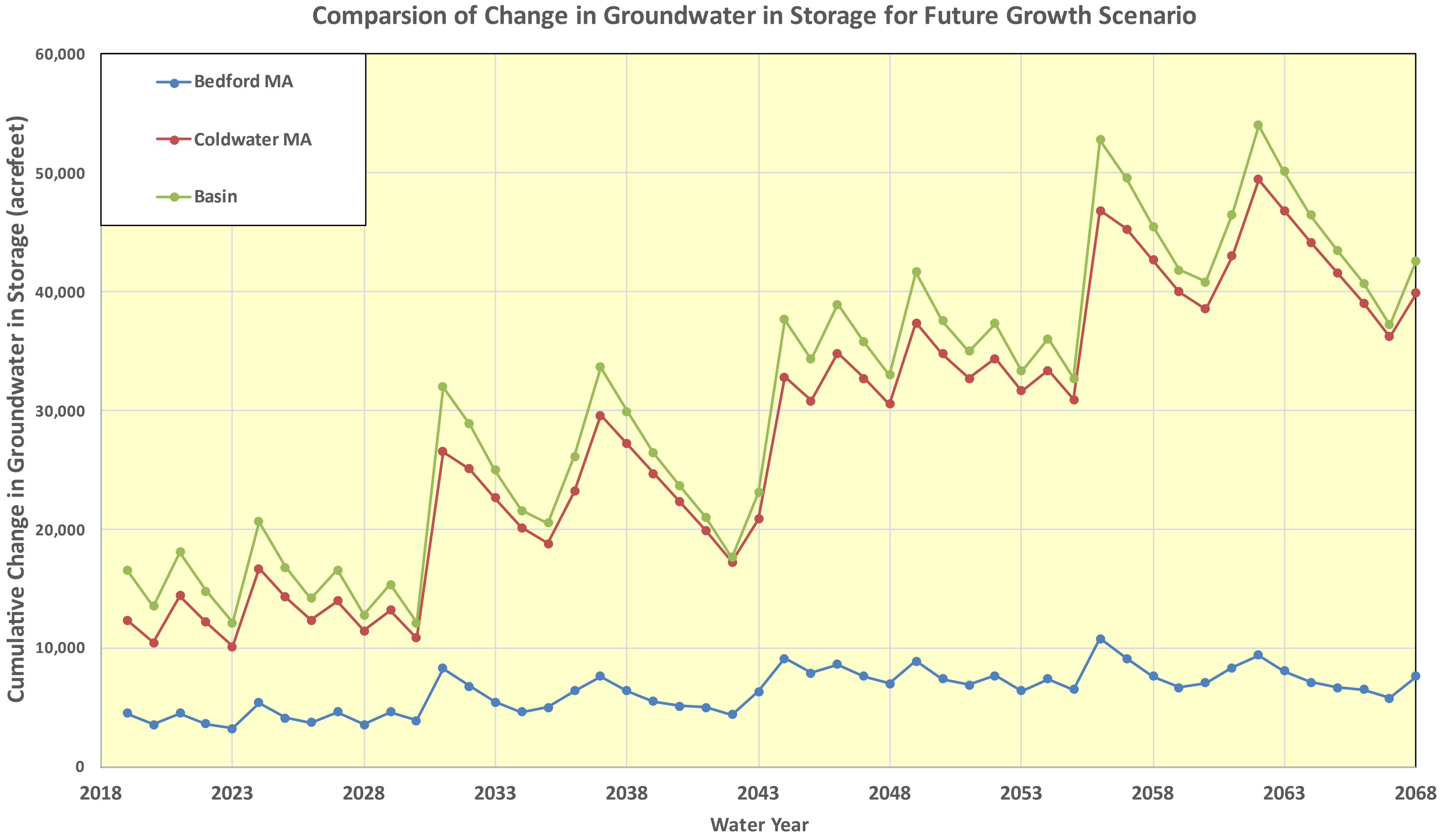
November 2021	Figure 42
TODD GROUNDWATER	Layer 1 Groundwater Elevations Future Baseline Scenario September 2068



November 2021

TODD GROUNDWATER

Figure 43
2018 Land
Use for Recharge Polygons
for Future Growth Scenario



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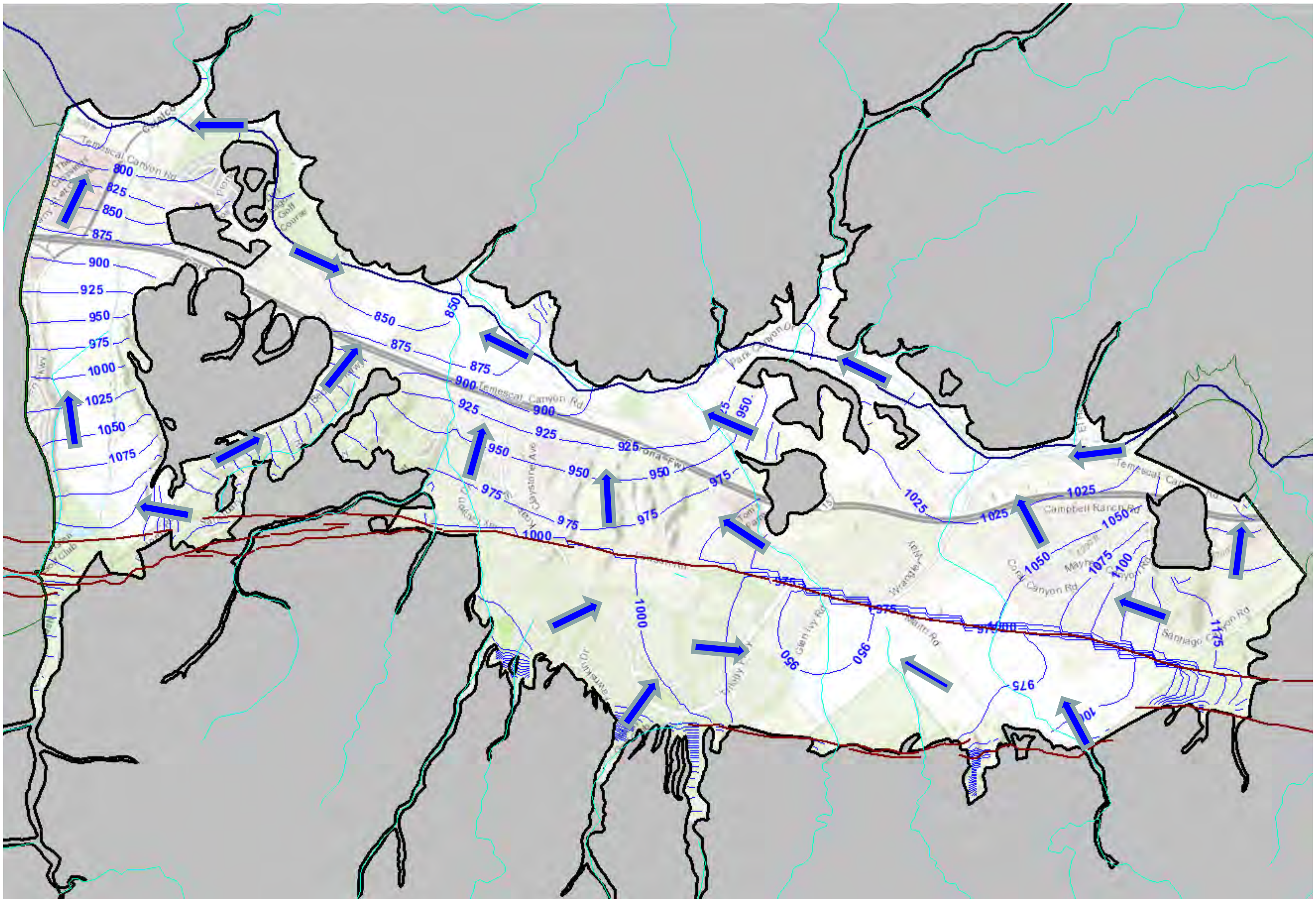
TODD GROUNDWATER

Figure 44
Simulated Groundwater Storage Change for Growth-Climate Change Scenario



Inferred Groundwater Flow Direction

900 Simulated Groundwater Elevation

November 2021

TODD GROUNDWATER

Figure 45
Layer 1 Groundwater Elevations
Future Growth Scenario
September 2068

APPENDIX H

Baseline Water Quality Sampling Results

Baseline Water Quality Data - February 2021

WELL NAME	Units	Type of Limit^1	Limit Concentration^1	Corona Well 21	Mayhew Well 2	New Sump	Corona Non-Potable Well 1	Station 71	TVWD Well 4	Flagler 2A Well	TVWD TP-1
				Coldwater	Coldwater	Bedford	Bedford	Bedford	Bedford	Bedford	Bedford
11-chloroeicosafluoro 3oxaundecane-1-sulfonic Acid	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
4,8-dioxa-3H-perfluorononanoic Acid (ADONA)	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
9-chlorohexadecafluoro-3-oxanone-1-sulfonic Acid	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
Arsenic	ug/L	MCL-CA	10 ug/L	<2	<2	<2	<2	<2	<2	2.1	<2.0
Bicarbonate	mg/L as CaCO3			190	150	270	240	150	280	280	230
Boron	ug/L	NL	1000 ug/L	<100	<100	260	250	<100	320	160	260
Calcium	mg/L	none		86	66	120	120	74	130	160	120
Carbonate	mg/L as CaCO3			<5	<5	<5	<5	<5	<5	<5.0	<5.0
Chloride	mg/L	SMCL	500 mg/L	30	43	180	170	49	180	140	170
Dissolved Oxygen	mg/L	none		7.9	6.7	1.2	6.1	5.7	5.7	6.4	4.0
E_ coli	MPN/100ml			<1	<1	<1	<1	<1	<1	<1.0	<1.0
Fluoride	mg/L	MCL-CA	2 mg/L	0.46	0.29	0.42	0.44	0.26	0.48	0.21	0.51
Heterotrophic Plate Count	CFU/mL			6	17		1	25	1900	6.0	14
Hexafluoropropylene oxide dimer acid (HFPO-DA)	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
Hydroxide	mg/L as CaCO3			<5	<5	<5	<5	<5	<5	<5.0	<5.0
Iron	ug/L	SMCL	300 ug/L	140	<100	<100	<100	<100	<100	<100	<100
Magnesium	mg/L	none		16	15	30	32	18	30	50	35
Manganese	ug/L	SMCL	50 ug/L	20	<20	<20	<20	24	38	<20	<20
N-EtFOSAA	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
Nitrate as N	mg/L	MCL-CA	10 mg/L	1.9	2.5	0.82	2.6	2.1	1.3	7.4	2.0
N-MeFOSAA	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
Perfluorobutanesulfonic Acid (PFBS)	ng/L	NL	500 ng/L	0.81	2.2	26	27	2.4	29	15	27
Perfluorodecanoic Acid (PFDA)	ng/L			0.19	<1.7	0.72	0.21	0.32	3.2	<1.7	0.36
Perfluorododecanoic Acid (PFDoDA)	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
Perfluoroheptanoic Acid (PFHpA)	ng/L			0.19	1	1.5	3.3	2.9	4.2	4.4	2.2
Perfluorohexanesulfonic Acid (PFHxS)	ng/L			<1.7	1.8	7.2	5	2.8	9.8	3.3	8.9
Perfluorohexanoic Acid (PFHxA)	ng/L			0.89	2.5	4.1	8.3	5.6	9.3	10	4.1
Perfluorononanoic Acid (PFNA)	ng/L			<1.7	0.21	3.8	2.3	0.87	2.3	0.65	1.2
Perfluorooctanesulfonic Acid (PFOS)	ng/L	RL	40 ng/L	<1.7	0.91	11	11	4.1	14	4.0	11
Perfluorooctanoic Acid (PFOA)	ng/L	RL	10 ng/L	0.34	2.9	11	14	7.8	25	11	18
Perfluorotetradecanoic Acid (PFTeDA)	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
Perfluorotridecanoic Acid (PFTrDA)	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
Perfluoroundecanoic Acid (PFUnA)	ng/L			<1.7	<1.7	<1.7	<1.7	<1.7	<1.8	<1.7	<1.7
pH (at Site, grab)	pH Units			7.4	7.2	6.8	7	7.3	7.3	7.1	7.0
Potassium	mg/L	none		1.6	1.8	3.8	3.3	1.8	3.3	3.7	6.1
Sodium	mg/L	US-HAL	200 mg/L	38	48	140	120	43	140	83	150
Specific Conductance	umhos/cm	SMCL	1600 UMHOS/CM	710	570	1200	1400	610	1300	1300	1300
Sulfate	mg/L	SMCL	500 mg/L	120	110	190	230	120	200	270	270
Temperature (at Site, grab)	°C			20	17	23	18	19	22	19	22
Total Alkalinity	mg/L as CaCO3	none		190	150	270	240	150	280	280	230
Total Coliform	MPN/100ml			<1	<1	46	<1	<1	<1	<1.0	<1.0
Total Dissolved Solids	mg/L	SMCL	1000 mg/L	440	410	820	910	430	850	930	900
Total Organic Carbon	mg/L			<0.3	0.31	1.6	0.59	0.61	1.2	0.30	1.0
Turbidity-at site	NTU			1.8	0.28	0.34	1.2	0.25	0.75	0.57	0.52

Notes:

---

[1]: Limits on constituent concentrations in water come from multiple sources, as indicated below (https://oehha.ca.gov/water/notification-levels-chemicals-drinking-water):

NL:	California drinking water Notification Levels
SMCL:	California Secondary Maximum Contiment Level,
AL:	Agricultural Limit
MCL:	California Secondary Maximum Contiment Level
US-HAL:	Federal Health Advisory Limit
RL:	California Response Level

APPENDIX I

Management Areas Designated in the Bedford Coldwater Subbasin to be Included in the Groundwater Sustainability Plan

INTRODUCTION

This memorandum summarizes the Management Areas (MAs) designated in the Bedford Coldwater Subbasin (Subbasin) to be included in the Groundwater Sustainability Plan (GSP) developed for the Bedford Coldwater Groundwater Sustainability Agency (BCGSA). As defined in the GSP Regulations, the purpose of MAs is to facilitate implementation of the GSP. The objective of this memorandum is to summarize the rational for creating each MA within the Bedford Coldwater Subbasin.

Management Areas will be described in Section 5 of the GSP, along with sustainability goals, characterization of undesirable results, and minimum thresholds and measurable objectives for each sustainability indicator. These indicators will be described for each MA. Consistent with the GSP Regulations, MAs will be presented in terms of:

- Reason for creation of each MA
- Descriptions, maps, and other information required by GSP Regulations to describe conditions in each MA
- Level of monitoring and analysis appropriate for each MA
- Explanation of how management of MAs will not cause undesirable results outside the MA

The purpose of dividing a basin into Management Areas is to facilitate implementation of the GSP in instances where a basin has distinctly different areas with unique management needs. As defined in the GSP Regulations, a MA is an area within a basin for which the GSP may identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors. Although a MA may have different minimum thresholds and be operated according to different measurable objectives than the basin as a whole, undesirable results must still be defined consistently throughout the Subbasin. The operation of each MA must also be managed in a way so as not to cause undesirable results outside of that MA.

The Bedford Coldwater Subbasin is a subbasin of the Elsinore Basin and covers approximately 11 square miles in western Riverside County. The Subbasin covers a portion of the Santa Ana River watershed. The main tributaries to the Santa Ana River include Temescal Creek, which flows through the Subbasin from the southeast to the northwest, and the Bedford Wash, which flows to the northeast along the northern boundary of the Subbasin. The Subbasin is located within the Elsinore-Temecula trough, a low-lying structural block between the Santa Ana Mountains to the west and the Perris Plain on the east. The Subbasin is separated from the Temescal Subbasin to the northwest by a groundwater divide near Bedford Wash. A jurisdictional boundary separates the Subbasin with the Elsinore Valley Subbasin to the south. The Subbasin is thin in some areas, which impedes groundwater flow especially at the northern and southern boundaries.

The Glen Ivy fault separates the Bedford area from the Coldwater area, resulting in differing geology, water use, water quality, and sources of water between the two areas. These differences serve as the basis for defining two management areas in the Subbasin for the purpose of facilitating implementation of the GSP.

The Bedford Coldwater Subbasin is divided into two MAs, Bedford and Coldwater, as defined in the following sections. The MAs will be used in the water budget analysis (presented in Section 5 of the GSP) and in numerical modeling. The MAs will be used to help define the sustainability criteria (undesirable results, minimum thresholds, management objectives) described in Section 6.

DEFINITION OF BEDFORD MANAGEMENT AREA

The Bedford MA is the area east of the Glen Ivy fault to the Estelle Mountain, as shown in Figure 1. The fault offsets the aquifer units in the Bedford MA from the units in the Coldwater MA by up to approximately 250 feet (Todd, 2019), with the west side of the fault (Coldwater MA) down dropped relative to the east side of the fault (Bedford MA). Alluvial sediments are up to 500 feet thick in the Bedford MA, and up to 800 feet deep in the Coldwater MA (Todd and AKM, 2008). Land uses are primarily urban residential and commercial/industrial in the Bedford MA. The only groundwater pumpers in the Bedford MA are the three member agencies of the BCGSA.

The 2017 Upper Temescal Valley Salt and Nutrient Management Plan (SNMP) separates the Bedford area from the Coldwater area and combines it with the Upper Temescal Valley groundwater management zone (GMZ; WEI, 2017).

DEFINITION OF COLDWATER MANAGEMENT AREA

The Coldwater MA is the area located within a down-dropped block between the Glen Ivy fault and the Santa Ana Mountains. Alluvial sediments are more than 800 feet thick in the Coldwater MA (Todd and AKM, 2008). In addition to a greater depth to bedrock, a factor distinguishing the Coldwater MA from the Bedford MA is that most of the groundwater pumping in the Subbasin occurs within this area. The City of Corona and Elsinore Valley Municipal Water District established a production agreement in 2008 to ensure the sustainable use of groundwater in the Coldwater area (EVMWD, 2008). Glen Ivy Hot Springs also has one well in the area that serves an estimated 750 people.

The Coldwater area is a separate groundwater management zone in the 2017 Upper Temescal Valley SNMP due to its distinct geologic structure and deep aquifer units (WEI, 2014).

REFERENCES

Corona and Elsinore Valley Municipal Water District (EVMWD), 2008. Agreement Concerning Water Production from Coldwater. December.

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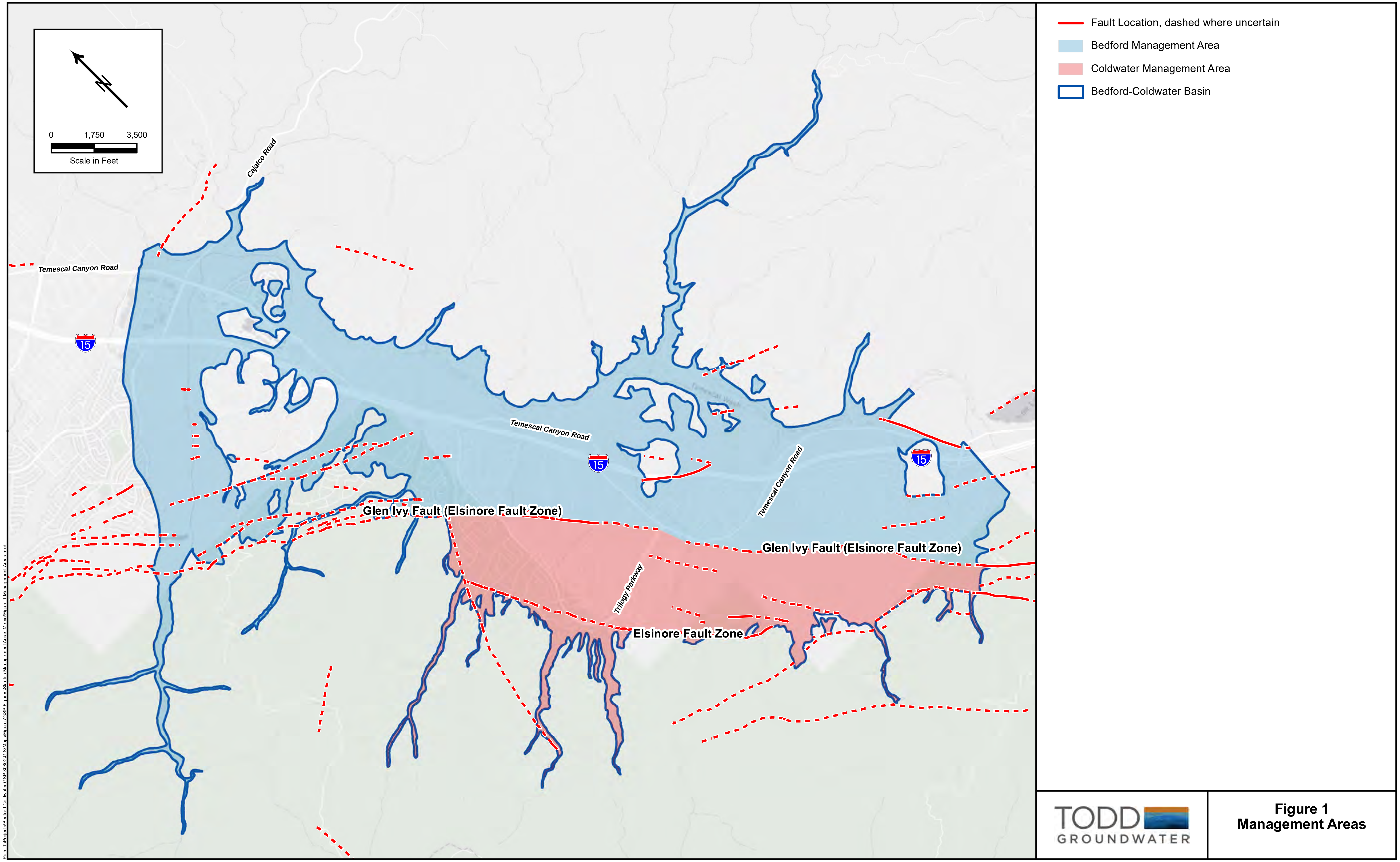

TODD GROUNDWATER

Figure 1
Management Areas

Path: T:\Projects\Bedford Coldwater GSP 80802\GIS\Maps\Figures\GSP Figures\Stantec Management Areas Memo\Figure 1 Management Areas.mxd

APPENDIX J

Detailed Annual Surface and Groundwater Budgets

Bedford-Coldwater Basin Surface Water Budget, Model Calibration Period (1990 to 2018)

Water Year	BEDFORD MANAGEMENT AREA (acre-feet per year)								COLDWATER MANAGEMENT AREA (acre-feet per year)			
	Outflow from Elsinore Subbasin to Bedford MA	Inflow from Coldwater MA	TVWD WRF Discharge into Wash	City of Corona WRF3 Discharge to Wash	Tributary and Local Runoff	Stream Percolation to Groundwater	Seepage from Groundwater to Streams	Surface Outflow to Temescal Basin	Tributary and Local Runoff	Stream Percolation to Groundwater	Inflow from Groundwater to Streams	Outflow to Bedford MA
1990	24,043	308	0	0	260	863	731	24,479	284	331	355	308
1991	5,398	2,308	7	0	4,043	2,248	559	10,066	6,175	4,055	188	2,308
1992	3,142	495	48	0	1,524	1,344	409	4,274	3,526	3,141	111	495
1993	63,144	8,156	134	0	24,997	3,920	1,495	94,005	24,042	15,979	93	8,156
1994	6,915	138	273	0	446	1,042	950	7,680	401	324	61	138
1995	8,510	2,462	402	0	7,184	2,422	1,080	17,215	9,416	6,998	43	2,462
1996	2,565	108	406	0	343	494	563	3,491	157	68	19	108
1997	1,392	132	414	0	435	206	233	2,401	270	139	1	132
1998	13,755	4,252	534	0	14,078	3,159	832	30,293	15,077	10,831	5	4,252
1999	4,682	87	840	0	503	341	413	6,184	88	1	0	87
2000	695	93	1,034	0	657	146	117	2,450	474	381	0	93
2001	3,940	668	690	0	2,890	1,731	193	6,651	4,063	3,396	2	668
2002	1,671	95	709	0	435	72	94	2,933	96	1	0	95
2003	6,056	2,067	844	0	3,968	1,655	152	11,433	5,597	3,532	2	2,067
2004	2,928	122	893	0	769	153	83	4,642	285	163	0	122
2005	49,649	13,308	1,029	0	32,278	4,947	2,377	93,695	32,138	18,840	10	13,308
2006	24,731	329	1,068	19	1,512	2,135	2,170	27,693	2,059	1,735	4	329
2007	12,768	22	1,335	50	480	1,031	1,114	14,737	35	14	0	22
2008	8,843	27	1,317	80	370	682	666	10,621	40	13	0	27
2009	6,339	164	1,455	111	947	1,205	637	8,447	1,539	1,377	2	164
2010	14,242	4,676	1,424	172	9,419	2,888	949	27,995	10,297	5,625	4	4,676
2011	23,939	6,872	1,397	194	12,566	3,069	1,580	43,480	14,107	7,239	4	6,872
2012	2,989	163	1,405	109	322	1,172	1,187	5,003	164	1	0	163
2013	1,873	87	0	205	-18	931	831	2,048	88	1	0	87
2014	0	140	0	150	159	664	568	352	267	127	0	140
2015	0	182	0	130	344	577	450	529	362	180	0	182
2016	0	111	0	137	159	403	257	261	273	162	0	111
2017	10,667	4,552	0	148	7,583	2,847	660	20,763	10,608	6,058	2	4,552
2018	2,082	95	0	162	205	727	433	2,250	299	205	0	95

Bedford Management Area Detailed Annual Water Budget, Model Calibration Period (1990 to 2018)

	Water Year and Type[1]																												
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
	D	**AN**	**AN**	**W**	**BN**	**W**	**D**	**D**	**W**	**D**	**D**	**N**	**D**	**AN**	**W**	**W**	**BN**	**D**	**D**	**BN**	**AN**	**W**	**BN**	**D**	**D**	**BN**	**D**	**W**	**D**
Inflows (AFY)																													
Subsurface inflow	1,493	1,514	1,054	423	637	427	563	849	354	342	499	556	977	654	562	124	87	143	313	148	80	75	94	165	399	192	92	80	72
Percolation from streams	863	2,248	1,344	3,920	1,042	2,422	494	206	3,159	341	146	1,731	72	1,655	153	4,947	2,135	1,031	682	1,205	2,888	3,069	1,172	931	664	577	403	2,847	727
Bedrock inflow	980	981	979	977	978	1,185	1,194	1,046	897	833	629	592	693	547	393	848	1,119	1,080	1,019	969	706	765	894	897	894	686	297	341	382
Dispersed recharge: non-irrigated land	46	126	102	2,629	63	894	82	123	1,800	127	156	381	13	579	165	4,227	424	-23	17	395	1,621	2,154	249	135	198	332	166	1,581	51
Dispersed recharge: irrigated land	556	1,050	801	2,072	477	1,082	459	493	1,296	390	504	773	340	691	400	1,961	654	282	227	473	736	905	365	305	390	438	387	742	347
Pipe leaks	91	94	96	100	104	110	114	117	124	130	125	120	122	131	142	149	154	153	153	155	154	150	155	164	174	184	191	198	187
Reclaimed water percolation	0	0	0	0	0	20	40	62	107	210	309	373	473	691	891	1,029	854	801	525	291	285	0	487	1,575	1,646	1,462	386	3,438	2,862
Quarry recharge	74	7	18	418	314	121	111	11	36	1	14	85	56	29	37	1	38	0	0	72	14	30	18	22	25	178	252	404	353
Total Inflow	4,103	6,020	4,395	10,538	3,614	6,260	3,057	2,907	7,772	2,375	2,381	4,611	2,746	4,978	2,743	13,287	5,466	3,466	2,936	3,707	6,483	7,148	3,434	4,194	4,390	4,049	2,174	9,631	4,980
Outflows (AFY)																													
Subsurface outflow	-57	-59	-46	-370	-117	-105	-48	-33	-287	-117	-33	-30	-24	-41	-20	-553	-743	-166	-20	-150	-457	-762	-270	11	46	-171	-207	-463	-357
Wells - M&I and domestic	-2,570	-2,935	-2,251	-2,252	-1,874	-1,486	-1,896	-1,662	-373	-1,055	-1,336	-1,400	-1,824	-833	-1,046	-188	-306	-995	-1,149	-643	-390	-59	-779	-1,079	-1,346	-947	-966	-1,876	-2,173
Wells - agricultural	-1,739	-1,121	-965	-978	-1,065	-863	-658	-945	-1,089	-806	-750	-640	-388	-808	-394	-714	-648	-172	13	-152	-279	-176	147	47	38	-255	-225	251	729
Groundwater discharge to streams	-731	-559	-409	-1,495	-950	-1,080	-563	-233	-832	-413	-117	-193	-94	-152	-83	-2,377	-2,170	-1,114	-666	-637	-949	-1,580	-1,187	-831	-568	-450	-257	-660	-433
Riparian evapotranspiration	-394	-369	-306	-768	-531	-609	-427	-267	-545	-369	-195	-294	-268	-341	-311	-1,037	-773	-497	-350	-418	-626	-919	-759	-625	-564	-429	-292	-585	-359
Quarry outflow	-973	-1,153	-1,012	-1,214	-1,006	-1,297	-1,252	-1,112	-1,471	-1,558	-1,373	-1,108	-1,145	-1,447	-1,490	-2,279	-1,982	-1,972	-1,542	-1,290	-1,654	-1,583	-1,689	-2,455	-2,438	-2,241	-1,232	-3,736	-3,062
Total Outflow	-6,464	-6,196	-4,988	-7,076	-5,544	-5,441	-4,845	-4,252	-4,597	-4,318	-3,804	-3,664	-3,743	-3,622	-3,344	-7,149	-6,622	-4,917	-3,714	-3,291	-4,355	-5,080	-4,537	-4,932	-4,831	-4,493	-3,178	-7,069	-5,655
Storage Change (AFY)																													
Total Inflows minus Total Outflows	-2,361	-176	-593	3,462	-1,930	819	-1,787	-1,345	3,174	-1,944	-1,423	947	-998	1,356	-601	6,138	-1,157	-1,451	-778	416	2,128	2,069	-1,103	-738	-440	-444	-1,005	2,562	-675

Notes:

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[1]: Water year types are described in Section 5 - Water Budget, and shown on Figure 5-1. Water year types are summarized above as follows D = Dry, Below Normal = BN, N = Normal, AN = Above Normal, W = Wet.

Coldwater Management Area Detailed Annual Water Budget, Model Calibration Period (1990 to 2018)

	Water Year and Type[1]																												
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
	D	**AN**	**AN**	**W**	**BN**	**W**	**D**	**D**	**W**	**D**	**D**	**N**	**D**	**AN**	**W**	**W**	**BN**	**D**	**D**	**BN**	**AN**	**W**	**BN**	**D**	**D**	**BN**	**D**	**W**	**D**
Inflows (AFY)																													
Subsurface inflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	77	40	18	24	51	83	106	85	85	95	107	117	136	123
Percolation from streams	331	4,055	3,141	15,979	324	6,998	68	139	10,831	1	381	3,396	1	3,532	163	18,840	1,735	14	13	1,377	5,625	7,239	1	1	127	180	162	6,058	205
Bedrock inflow	676	678	675	665	667	788	818	675	570	522	419	397	468	410	338	542	736	725	661	619	508	476	558	562	536	408	166	165	277
Dispersed recharge: non-irrigated land	10	30	59	978	-8	376	-34	-38	723	-14	32	265	-5	325	72	1,976	260	0	10	297	805	1,022	78	43	95	121	78	785	52
Dispersed recharge: irrigated land	305	635	496	1,202	303	685	298	291	766	209	309	402	226	520	228	1,105	339	147	134	283	446	535	201	161	207	249	213	436	193
Pipe leaks	19	20	21	22	22	21	21	21	22	23	29	35	37	40	40	41	42	42	41	40	39	38	39	41	44	46	48	50	47
Quarry runoff recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inflow	1,341	5,418	4,393	18,845	1,308	8,868	1,171	1,088	12,912	740	1,169	4,494	728	4,826	850	22,582	3,152	945	883	2,667	7,506	9,416	961	892	1,104	1,111	784	7,631	896
Outflows (AFY)																													
Subsurface outflow	-320	-296	-277	-217	-238	-182	-179	-164	-101	-100	-84	-59	-49	-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells - M&I and domestic	-4,148	-4,447	-5,368	-8,150	-6,285	-7,887	-6,968	-6,289	-8,104	-8,344	-5,711	-4,012	-3,911	-3,744	-3,634	-4,110	-5,089	-4,791	-4,520	-4,179	-4,122	-2,391	-2,372	-2,989	-3,927	-3,113	-2,961	-2,078	-973
Wells - agricultural	-2,164	-1,627	-995	-343	-2,166	-721	-2,088	-1,996	-811	-1,312	-1,746	-1,300	-680	-329	-239	-62	65	-211	-172	-182	-128	-536	-120	40	144	-245	-92	-343	-395
Groundwater discharge to streams	-355	-188	-111	-93	-61	-43	-19	-1	-5	0	0	-2	0	-2	0	-10	-4	0	0	-2	-4	-4	0	0	0	0	0	-2	0
Riparian evapotranspiration	-52	-76	-37	-323	-6	-77	-2	-1	-129	0	-306	-427	-472	-531	-496	-617	-204	-685	-463	-450	-601	-337	0	0	0	-387	-14	-503	-557
Quarry operations	-4,303	-861	0	0	0	0	0	0	0	0	-1,010	-1,605	-1,606	-977	-3,824	-57	-7	0	-1,983	-2,869	-2,089	-292	0	0	0	0	0	0	0
Total Outflow	-11,342	-7,495	-6,787	-9,126	-8,756	-8,909	-9,255	-8,451	-9,151	-9,756	-8,857	-7,404	-6,718	-5,592	-8,193	-4,857	-5,238	-5,687	-7,139	-7,681	-6,943	-3,560	-2,492	-2,950	-3,783	-3,745	-3,067	-2,926	-1,924
Storage Change (AFY)																													
Total Inflows minus Total Outflows	-10,000	-2,077	-2,395	9,719	-7,448	-42	-8,084	-7,363	3,761	-9,017	-7,688	-2,909	-5,990	-766	-7,344	17,724	-2,087	-4,741	-6,256	-5,015	562	5,856	-1,531	-2,058	-2,679	-2,633	-2,282	4,705	-1,028

Notes:

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[1]: Water year types are described in Section 5 - Water Budget, and shown on Figure 5-1. Water year types are summarized above as follows D = Dry, Below Normal = BN, N = Normal, AN = Above Normal, W = Wet.

Bedford Management Area Detailed Annual Water Budget, Baseline Period

	Water Year																																																	
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068
Inflows																																																		
Subsurface inflow	71	88	83	91	91	77	91	90	84	92	84	88	63	83	91	91	84	80	79	91	91	92	92	92	80	71	87	83	95	103	77	102	111	98	120	100	110	65	103	149	160	139	113	103	154	171	173	166	161	121
Percolation from streams	3,730	1,440	2,389	1,070	887	2,923	1,004	798	2,282	652	1,843	624	4,284	1,682	1,082	934	1,276	2,744	2,732	1,013	780	594	494	397	2,556	3,528	1,486	2,433	1,256	1,053	3,052	1,088	992	2,460	713	2,082	781	4,461	1,783	1,141	981	1,531	2,849	2,844	1,078	837	666	592	473	2,704
Bedrock inflow	1008	1008	1007	1010	1012	905	846	653	613	668	518	377	788	1015	973	918	877	628	699	819	823	819	624	270	313	720	981	1168	1281	1131	918	855	663	623	681	528	384	802	1031	985	931	884	628	699	833	837	835	636	274	318
Dispersed recharge: non-irrigated land	3,642	330	1,510	205	280	2,393	218	300	811	46	957	199	4,625	534	-6	23	418	1,529	2,081	289	160	228	378	193	1,524	3,601	330	1,510	205	291	2,507	232	333	844	51	1,018	226	4,753	563	0	27	444	1,623	2,147	302	166	241	389	202	1,584
Dispersed recharge: irrigated land	1,137	424	757	372	433	897	334	424	572	262	692	374	1,507	521	260	245	500	762	897	362	303	387	437	383	735	1,133	423	757	372	434	895	334	424	572	261	692	374	1,507	520	260	245	502	760	897	362	304	387	437	383	737
Pipe leaks	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	43	29	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	13
Reclaimed water percolation	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,856	1,887	1,897	1,897	1,897	1,887	1,897	1,897	1,897	1,887	1,897	1,897	1,897	1,887	1,897	1,897	1,687	1,887	1,897	1,897	1,897	1,887
Quarry recharge	107	151	128	173	185	118	167	184	159	194	159	194	82	136	183	194	182	133	110	168	189	199	195	205	152	99	150	126	167	182	116	169	184	156	196	158	193	78	137	186	197	178	133	111	175	193	201	195	206	152
Total Inflow	11,597	5,341	7,775	4,823	4,791	9,214	4,562	4,351	6,421	3,816	6,155	3,758	13,251	5,873	4,485	4,308	5,238	7,777	8,499	4,645	4,248	4,220	4,121	3,442	7,263	11,053	5,359	7,978	5,275	5,110	9,477	4,691	4,618	6,655	3,934	6,488	3,979	13,566	6,047	4,631	4,452	5,581	8,018	8,712	4,607	4,409	4,415	4,325	3,609	7,516
Outflows																																																		
Subsurface outflow	-514	-494	-558	-439	-369	-571	-461	-358	-442	-344	-416	-317	-654	-638	-442	-364	-388	-564	-662	-504	-411	-364	-343	-309	-466	-674	-587	-655	-545	-485	-681	-557	-450	-564	-441	-532	-421	-769	-733	-492	-400	-467	-648	-746	-546	-434	-387	-384	-353	-534
Wells - M&I and domestic	-1,310	-1,307	-1,309	-1,305	-1,303	-1,312	-1,305	-1,304	-1,306	-1,303	-1,306	-1,303	-1,313	-1,309	-1,303	-1,302	-1,304	-1,309	-1,310	-1,305	-1,303	-1,303	-1,303	-1,302	-1,307	-1,313	-1,307	-1,309	-1,310	-1,325	-1,333	-1,327	-1,326	-1,328	-1,325	-1,329	-1,325	-1,334	-1,330	-1,325	-1,324	-1,325	-1,330	-1,332	-1,340	-1,324	-1,325	-1,325	-1,324	-1,328
Wells - agricultural	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Groundwater discharge to streams	-1,479	-1,284	-1,407	-1,008	-795	-1,351	-957	-632	-806	-580	-614	-429	-1,990	-1,632	-1,051	-865	-773	-1,051	-1,457	-963	-718	-507	-372	-244	-559	-1,690	-1,354	-1,543	-1,221	-965	-1,519	-1,048	-722	-893	-641	-698	-510	-2,202	-1,722	-1,113	-919	-839	-1,151	-1,566	-1,032	-777	-562	-419	-275	-618
Riparian evapotranspiration	-1,125	-828	-992	-766	-685	-1,005	-751	-587	-643	-508	-615	-467	-1,455	-1,012	-701	-532	-568	-811	-1,061	-767	-601	-533	-456	-378	-606	-1,233	-859	-1,044	-851	-767	-1,091	-795	-628	-688	-538	-656	-503	-1,546	-1,048	-724	-548	-601	-850	-1,106	-790	-622	-554	-476	-396	-639
Quarry outflow	-2,911	-2,546	-2,647	-2,358	-2,220	-2,652	-2,392	-2,225	-2,383	-2,179	-2,293	-2,152	-2,934	-2,667	-2,320	-2,161	-2,183	-2,577	-2,767	-2,400	-2,207	-2,094	-2,065	-2,015	-2,363	-2,855	-2,578	-2,669	-2,427	-2,340	-2,763	-2,481	-2,314	-2,475	-2,257	-2,401	-2,245	-3,030	-2,729	-2,389	-2,233	-2,285	-2,669	-2,854	-2,274	-2,257	-2,165	-2,150	-2,104	-2,464
Total Outflow	-7,339	-6,459	-6,913	-5,876	-5,373	-6,891	-5,867	-5,106	-5,580	-4,914	-5,245	-4,668	-8,346	-7,258	-5,817	-5,225	-5,216	-6,312	-7,257	-5,939	-5,240	-4,801	-4,538	-4,247	-5,300	-7,764	-6,685	-7,220	-6,354	-5,882	-7,388	-6,208	-5,440	-5,948	-5,200	-5,617	-5,005	-8,880	-7,562	-6,044	-5,425	-5,517	-6,649	-7,604	-5,981	-5,414	-4,992	-4,755	-4,451	-5,583
Storage change																																																		
Inflows - outflows	4,258	-1,118	862	-1,053	-582	2,323	-1,305	-754	841	-1,099	910	-910	4,905	-1,385	-1,332	-917	22	1,465	1,243	-1,294	-991	-581	-417	-805	1,963	3,289	-1,326	758	-1,078	-772	2,090	-1,517	-823	707	-1,267	872	-1,026	4,686	-1,515	-1,413	-973	64	1,369	1,108	-1,375	-1,006	-577	-429	-842	1,933

Coldwater Management Area Detailed Annual Water Budget, Baseline Period

	Water Year																
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Inflows																	
Subsurface inflow	145	108	104	85	82	98	78	72	77	65	76	70	105	62	33	25	35
Percolation from streams	12,463	227	5,176	50	121	7,522	0	323	3,482	0	3,533	137	15,268	549	0	0	756
Bedrock inflow	572	573	571	577	580	530	490	386	366	429	369	301	504	658	638	579	549
Dispersed recharge: non-irrigated land	1,659	560	1,891	414	520	2,833	405	529	1,111	199	1,314	408	5,339	811	148	168	683
Dispersed recharge: irrigated land	617	213	396	183	214	476	168	215	292	129	355	186	814	265	126	121	256
Pipe leaks	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Quarry runoff recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inflow	15,481	1,707	8,163	1,334	1,540	11,485	1,165	1,550	5,353	848	5,671	1,127	22,054	2,371	970	919	2,303
Outflows																	
Subsurface outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells - M&I and domestic	-2,975	-2,980	-2,981	-2,981	-2,979	-2,980	-2,980	-2,981	-2,980	-2,981	-2,981	-2,981	-2,981	-2,981	-2,981	-2,981	-2,981
Wells - agricultural	-34	-43	-29	-48	-47	-34	-48	-42	-34	-51	-29	-45	-23	-34	-48	-39	-40
Groundwater discharge to streams	-7	0	-3	0	0	-6	0	0	-1	0	-1	0	-11	-2	0	0	0
Riparian evapotranspiration	-153	-146	-151	-157	-165	-153	-155	-151	-139	-147	-149	-151	-164	-140	-145	-133	-141
Quarry operations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow	-3,169	-3,169	-3,162	-3,185	-3,192	-3,174	-3,183	-3,173	-3,155	-3,179	-3,159	-3,177	-3,178	-3,156	-3,174	-3,152	-3,162
Storage change																	
Inflows - outflows	12,312	-1,462	5,000	-1,852	-1,652	8,311	-2,018	-1,623	2,198	-2,331	2,512	-2,050	18,876	-786	-2,203	-2,233	-859

	Water Year																
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052
Inflows																	
Subsurface inflow	51	56	24	11	10	16	22	44	65	26	20	0	0	16	0	0	0
Percolation from streams	5,882	7,535	0	0	57	55	79	5,447	12,343	227	5,267	50	130	7,875	0	354	3,649
Bedrock inflow	428	418	493	499	477	356	134	148	382	558	675	774	669	525	484	380	359
Dispersed recharge: non-irrigated land	1,917	2,522	489	337	447	606	410	1,892	4,139	561	1,891	414	526	2,934	406	550	1,132
Dispersed recharge: irrigated land	394	476	182	147	189	230	186	388	615	212	396	183	214	477	168	215	293
Pipe leaks	25	25	25	25	25	25	25	25	25	25	25	24	15	6	6	6	6
Quarry runoff recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inflow	8,696	11,031	1,215	1,019	1,205	1,287	857	7,943	17,571	1,609	8,274	1,444	1,553	11,833	1,064	1,505	5,439
Outflows																	
Subsurface outflow	0	0	0	0	0	0	-1	-1	0	0	0	-3	-10	0	-9	-20	-13
Wells - M&I and domestic	-2,981	-2,981	-2,981	-2,981	-2,980	-2,981	-2,981	-2,981	-2,981	-2,981	-2,981	-2,991	-3,027	-3,032	-3,032	-3,032	-3,027
Wells - agricultural	-34	-28	-40	-51	-48	-47	-46	-40	-34	-43	-29	-48	-47	-34	-48	-42	-34
Groundwater discharge to streams	-3	-3	0	0	0	0	0	-1	-7	0	-3	0	0	-6	0	0	-1
Riparian evapotranspiration	-155	-145	-155	-154	-165	-158	-165	-168	-163	-146	-151	-158	-169	-155	-158	-154	-142
Quarry operations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow	-3,173	-3,157	-3,176	-3,185	-3,193	-3,186	-3,193	-3,190	-3,184	-3,169	-3,164	-3,200	-3,253	-3,227	-3,246	-3,246	-3,217
Storage change																	
Inflows - outflows	5,523	7,874	-1,961	-2,166	-1,989	-1,898	-2,335	4,753	14,387	-1,560	5,110	-1,757	-1,701	8,606	-2,182	-1,741	2,222

	Water Year															
	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068
Inflows																
Subsurface inflow	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0
Percolation from streams	0	3,689	164	15,626	596	0	0	817	6,062	7,688	0	0	72	64	91	5,587
Bedrock inflow	424	363	295	500	657	636	577	545	422	413	490	494	473	351	127	141
Dispersed recharge: non-irrigated land	192	1,363	423	5,454	827	141	160	698	1,999	2,576	491	331	448	604	407	1,940
Dispersed recharge: irrigated land	129	355	186	814	265	126	121	257	393	476	182	147	189	230	186	388
Pipe leaks	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5
Quarry runoff recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inflow	751	5,776	1,073	22,428	2,350	910	864	2,322	8,881	11,158	1,169	979	1,188	1,255	817	8,062
Outflows																
Subsurface outflow	-27	-14	-20	0	-18	-56	-67	-54	-32	-22	-61	-77	-80	-73	-69	-42
Wells - M&I and domestic	-3,032	-3,032	-3,032	-3,026	-3,032	-3,032	-3,032	-3,027	-3,032	-3,032	-3,032	-3,027	-3,032	-3,032	-3,032	-3,027
Wells - agricultural	-51	-29	-45	-23	-34	-48	-39	-40	-34	-28	-40	-51	-48	-47	-46	-40
Groundwater discharge to streams	0	-1	0	-11	-2	0	0	0	-3	-3	0	0	0	0	0	-2
Riparian evapotranspiration	-149	-152	-154	-167	-142	-148	-135	-144	-157	-148	-158	-157	-167	-161	-168	-170
Quarry operations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow	-3,259	-3,227	-3,251	-3,228	-3,228	-3,283	-3,272	-3,265	-3,258	-3,234	-3,290	-3,312	-3,327	-3,313	-3,316	-3,280
Storage change																
Inflows - outflows	-2,508	2,549	-2,178	19,200	-878	-2,373	-2,408	-943	5,623	7,925	-2,122	-2,333	-2,139	-2,058	-2,499	4,781

Bedford Management Area Detailed Annual Water Budget, Growth And Climate Change 50-year Period

	Water Year																																																	
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068
Inflows																																																		
Subsurface inflow	71	88	83	91	91	77	91	90	84	92	84	88	63	83	91	91	84	80	79	91	91	92	92	93	80	71	87	83	91	93	77	93	92	85	98	85	90	65	85	130	142	112	86	81	131	149	149	138	129	88
Percolation from streams	3,665	1,462	2,266	1,210	1,052	2,841	1,111	1,036	2,180	824	1,824	863	4,146	1,641	1,097	950	1,486	2,586	2,612	1,153	912	760	744	565	2,399	3,300	1,540	2,299	1,350	1,250	3,023	1,175	1,253	2,343	877	2,078	1,046	4,413	1,838	1,154	989	1,722	2,727	2,762	1,199	954	847	869	705	2,579
Bedrock inflow	1082	1081	1080	1083	1085	965	885	712	696	764	605	469	822	1005	943	903	868	686	751	861	871	870	692	359	402	790	1046	1219	1319	1185	981	903	722	700	772	615	478	832	1022	962	919	882	681	746	874	878	880	698	360	402
Dispersed recharge: non-irrigated land	3,604	493	1,685	331	416	2,439	282	484	1,064	42	1,150	313	4,474	617	-16	18	592	1,619	2,304	372	175	319	530	269	1,705	3,547	493	1,685	332	437	2,567	302	540	1,116	54	1,238	360	4,609	661	-4	28	639	1,734	2,395	394	187	342	551	287	1,781
Dispersed recharge: irrigated land	1,854	743	1,229	675	751	1,409	596	756	998	495	1,115	686	2,354	814	491	463	869	1,267	1,455	619	545	689	743	706	1,193	1,848	747	1,229	675	753	1,404	596	756	1,001	492	1,115	686	2,355	813	491	463	873	1,261	1,455	619	546	688	743	706	1,195
Pipe leaks	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	113	84	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	50
Reclaimed water percolation	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,176	2,197	2,197	2,197	2,176	2,197	2,197	2,197	2,176	2,197	2,197	2,197	2,176	2,197	2,197	2,197	2,176	2,197	2,197	2,197	2,176
Quarry recharge	299	456	409	490	510	380	486	512	472	528	475	523	304	432	518	542	513	416	370	488	528	515	529	542	448	330	454	406	486	512	380	495	517	471	540	475	529	294	439	529	554	512	419	372	498	540	553	539	550	451
Total Inflow	12,833	6,581	9,009	6,138	6,163	10,368	5,709	5,848	7,752	5,003	7,511	5,201	14,422	6,851	5,383	5,226	6,670	8,912	9,829	5,843	5,381	5,503	5,588	4,793	8,486	12,145	6,625	9,178	6,507	6,490	10,683	5,815	6,131	7,948	5,086	7,858	5,441	14,800	7,109	5,514	5,347	6,972	9,161	10,064	5,967	5,485	5,712	5,790	4,990	8,722
Outflows																																																		
Subsurface outflow	-453	-429	-448	-372	-298	-485	-402	-281	-341	-276	-304	-244	-589	-563	-370	-280	-309	-461	-556	-444	-329	-246	-246	-222	-351	-585	-524	-544	-487	-438	-600	-511	-394	-471	-389	-431	-369	-713	-681	-448	-334	-401	-571	-666	-509	-372	-315	-315	-299	-475
Wells - M&I and domestic	-1,895	-1,883	-1,884	-1,880	-1,882	-1,888	-1,881	-1,879	-1,881	-1,879	-1,880	-1,882	-1,891	-1,884	-1,879	-1,878	-1,878	-1,883	-1,886	-1,880	-1,878	-1,879	-1,878	-1,878	-1,882	-1,892	-1,883	-1,884	-1,888	-1,910	-1,919	-1,911	-1,910	-1,910	-1,909	-1,911	-1,913	-1,926	-1,915	-1,909	-1,908	-1,906	-1,914	-1,917	-1,911	-1,906	-1,908	-1,908	-1,909	-1,910
Wells - agricultural	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Groundwater discharge to streams	-1,730	-1,637	-1,835	-1,396	-1,142	-1,831	-1,316	-997	-1,283	-940	-1,032	-817	-2,581	-2,046	-1,284	-1,049	-1,067	-1,467	-1,973	-1,356	-1,038	-819	-726	-548	-957	-2,266	-1,803	-2,006	-1,640	-1,352	-2,037	-1,413	-1,100	-1,384	-1,004	-1,133	-903	-2,817	-2,166	-1,360	-1,101	-1,150	-1,577	-2,083	-1,422	-1,082	-880	-800	-614	-1,048
Riparian evapotranspiration	-1,388	-1,055	-1,315	-972	-895	-1,375	-952	-791	-905	-691	-891	-697	-2,041	-1,289	-828	-626	-730	-1,122	-1,487	-969	-758	-707	-648	-570	-922	-1,763	-1,143	-1,391	-1,059	-987	-1,462	-988	-832	-949	-715	-928	-734	-2,140	-1,338	-850	-640	-765	-1,173	-1,534	-992	-776	-723	-672	-599	-960
Quarry outflow	-2,866	-2,504	-2,595	-2,405	-2,321	-2,658	-2,408	-2,322	-2,420	-2,292	-2,358	-2,289	-2,885	-2,590	-2,348	-2,244	-2,301	-2,562	-2,705	-2,415	-2,288	-2,237	-2,213	-2,197	-2,427	-2,831	-2,532	-2,616	-2,440	-2,407	-2,749	-2,481	-2,402	-2,494	-2,353	-2,450	-2,370	-2,969	-2,659	-2,416	-2,311	-2,375	-2,639	-2,795	-2,479	-2,337	-2,288	-2,289	-2,275	-2,508
Total Outflow	-8,332	-7,508	-8,078	-7,025	-6,538	-8,238	-6,959	-6,270	-6,830	-6,078	-6,466	-5,929	-9,987	-8,373	-6,709	-6,076	-6,284	-7,496	-8,607	-7,063	-6,292	-5,889	-5,712	-5,416	-6,538	-9,336	-7,884	-8,441	-7,514	-7,093	-8,767	-7,304	-6,637	-7,209	-6,371	-6,854	-6,288	-10,566	-8,759	-6,983	-6,294	-6,597	-7,874	-8,995	-7,312	-6,474	-6,114	-5,985	-5,695	-6,901
Storage change																																																		
Inflows - outflows	4,501	-927	932	-888	-375	2,130	-1,250	-422	922	-1,074	1,045	-728	4,435	-1,522	-1,325	-849	385	1,416	1,223	-1,220	-910	-386	-123	-623	1,948	2,808	-1,259	738	-1,007	-603	1,916	-1,489	-506	740	-1,285	1,004	-848	4,234	-1,650	-1,469	-947	375	1,286	1,068	-1,345	-989	-402	-195	-705	1,821
MODFLOW	4,501	-927	932	-888	-375	2,130	-1,250	-422	922	-1,074	1,045	-728	4,435	-1,522	-1,325	-849	385	1,416	1,223	-1,220	-910	-386	-123	-623	1,948	2,808	-1,259	738	-1,007	-603	1,916	-1,489	-506	740	-1,285	1,004	-848	4,234	-1,650	-1,469	-947	375	1,286	1,068	-1,345	-989	-402	-195	-705	1,821

Coldwater Management Area Detailed Annual Water Budget, Growth And Climate Change 50-year Period

	Water Year																																																	
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068
Inflows																																																		
Subsurface inflow	154	122	123	103	100	120	95	92	102	85	97	91	127	81	48	40	58	74	78	44	30	30	40	49	73	89	45	43	18	12	39	9	4	16	0	11	5	51	2	0	0	0	0	3	0	0	0	0	0	0
Percolation from streams	12,454	227	5,175	49	120	7,516	0	323	3,480	0	3,529	136	15,254	545	0	0	755	5,875	7,530	0	0	57	52	77	5,439	12,334	226	5,265	48	130	7,878	0	361	3,650	0	3,684	168	15,608	605	0	0	823	6,060	7,681	0	0	72	65	94	5,587
Bedrock inflow	550	551	548	554	557	505	459	357	350	421	370	310	491	608	560	497	455	362	380	466	472	454	334	123	134	353	523	637	729	632	499	455	350	343	416	366	305	488	607	559	494	451	357	376	463	468	450	329	116	128
Dispersed recharge: non-irrigated land	1,617	1,003	2,451	804	941	3,294	716	992	1,713	420	1,860	793	5,839	1,170	360	374	1,177	2,413	3,194	819	579	804	1,038	771	2,448	4,637	1,007	2,451	803	951	3,395	712	1,024	1,743	407	1,924	816	5,951	1,189	348	359	1,202	2,502	3,262	816	565	803	1,035	764	2,497
Dispersed recharge: irrigated land	832	304	533	273	297	624	232	319	420	187	475	277	1,060	332	186	178	354	544	636	244	212	274	305	275	521	828	304	533	273	297	623	232	319	421	186	475	277	1,060	332	186	178	356	540	636	244	215	274	305	275	521
Pipe leaks	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	44	26	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Quarry runoff recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inflow	15,655	2,254	8,878	1,830	2,063	12,107	1,550	2,131	6,113	1,161	6,379	1,655	22,819	2,784	1,203	1,137	2,847	9,315	11,867	1,620	1,341	1,667	1,818	1,344	8,664	18,289	2,153	8,977	1,916	2,048	12,442	1,417	2,067	6,181	1,017	6,468	1,579	23,167	2,743	1,101	1,040	2,840	9,467	11,966	1,531	1,256	1,608	1,743	1,258	8,740
Outflows																																																		
Subsurface outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	0	0	0	0	0	0	0	0	0	-5	0	0	0	0	-37	-49	-27	-5	0	-38	-56	-56	-45	-38	-8
Wells - M&I and domestic	-3,048	-3,049	-3,061	-3,044	-3,044	-3,062	-3,040	-3,050	-3,061	-3,048	-3,056	-3,045	-3,067	-3,054	-3,045	-3,047	-3,056	-3,051	-3,067	-3,044	-3,040	-3,042	-3,049	-3,040	-3,051	-3,057	-3,049	-3,061	-3,055	-3,091	-3,115	-3,093	-3,104	-3,109	-3,101	-3,109	-3,098	-3,115	-3,107	-3,098	-3,100	-3,104	-3,104	-3,120	-3,097	-3,088	-3,096	-3,102	-3,093	-3,099
Wells - agricultural	-78	-87	-73	-103	-103	-67	-106	-96	-68	-95	-72	-97	-61	-82	-98	-96	-78	-83	-61	-102	-105	-109	-91	-111	-89	-72	-87	-73	-103	-103	-67	-106	-96	-68	-95	-72	-97	-61	-82	-98	-96	-78	-83	-61	-102	-105	-108	-91	-111	-89
Groundwater discharge to streams	-6	0	-2	0	0	-5	0	0	-1	0	-1	0	-10	-2	0	0	0	-3	-3	0	0	0	0	0	-1	-6	0	-2	0	0	-6	0	0	-1	0	-1	0	-10	-2	0	0	0	-3	-3	0	0	0	0	0	-2
Riparian evapotranspiration	-166	-161	-165	-170	-181	-168	-172	-165	-151	-162	-164	-165	-179	-153	-159	-144	-154	-170	-160	-170	-169	-180	-172	-180	-183	-177	-160	-166	-171	-184	-170	-175	-167	-154	-164	-167	-168	-183	-155	-162	-147	-157	-172	-163	-173	-172	-182	-176	-184	-186
Quarry operations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow	-3,298	-3,297	-3,302	-3,317	-3,327	-3,301	-3,318	-3,310	-3,281	-3,304	-3,293	-3,308	-3,317	-3,291	-3,302	-3,287	-3,288	-3,307	-3,291	-3,316	-3,313	-3,331	-3,312	-3,332	-3,325	-3,312	-3,296	-3,303	-3,329	-3,379	-3,357	-3,374	-3,366	-3,332	-3,364	-3,349	-3,364	-3,369	-3,346	-3,395	-3,392	-3,366	-3,368	-3,347	-3,410	-3,421	-3,443	-3,414	-3,426	-3,383
Storage change																																																		
Inflows - outflows	12,357	-1,043	5,577	-1,487	-1,264	8,806	-1,768	-1,180	2,831	-2,143	3,086	-1,653	19,502	-507	-2,099	-2,151	-441	6,008	8,575	-1,695	-1,972	-1,664	-1,495	-1,989	5,339	14,978	-1,143	5,675	-1,413	-1,331	9,086	-1,957	-1,299	2,849	-2,347	3,119	-1,784	19,799	-603	-2,294	-2,352	-526	6,100	8,619	-1,879	-2,165	-1,835	-1,671	-2,168	5,357
MODFLOW	12,357	-1,882	3,903	-2,191	-2,092	6,602	-2,416	-1,958	1,646	-2,544	1,739	-2,326	15,694	-1,455	-2,450	-2,509	-1,323	4,384	6,423	-2,426	-2,506	-2,362	-2,409	-2,661	3,627	11,943	-1,985	4,001	-2,116	-2,161	6,835	-2,595	-2,090	1,655	-2,730	1,742	-2,465	15,944	-1,556	-2,629	-2,692	-1,412	4,435	6,446	-2,601	-2,682	-2,525	-2,575	-2,827	3,628

APPENDIX K

Bedford-Coldwater GSP Data Management System Description

TODD
GROUNDWATER

May 19, 2021

TECHNICAL MEMORANDUM

To:	Victor Harris, H&H Water Resources
From:	Maureen Reilly, PE and Chad Taylor, PG, CHG
Re:	Data Management System (DMS) Documentation, Bedford-Coldwater Groundwater Sustainability Plan

1. EXECUTIVE SUMMARY

The Bedford Coldwater Groundwater Basin Agency (BCGSA) was formed by the City of Corona (Corona), Elsinore Valley Municipal Water District (EVMWD), and Temescal Valley Water District (TVWD) through a Joint Powers Authority (JPA) to fulfill the role and legal obligations of a Groundwater Sustainable Agency (GSA) for the Bedford-Coldwater Subbasin (Basin) of the Elsinore Valley Groundwater Basin in accordance with the Sustainable Groundwater Management Act (SGMA). Foremost among the responsibilities is to develop, adopt, and implement a Groundwater Sustainability Plan (GSP) for the Basin.

As part of GSP development, the BCGSA has compiled data from various sources that are relevant to groundwater, geology, and water supply the Basin. These data focus on information that have been required and useful for the preparation of the GSP. The purpose of this Technical Memorandum (TM) is to document the Data Management System (DMS) developed as part of the GSP.

Corona, EVMWD, and TVWD have been collecting and compiling groundwater data including water levels, water quality, and water use for the GSP. As part of the GSP, the DMS has been redesigned to be practicable, usable, intuitive, and cost effective. The data (and data from the BCGSA and other sources) are being compiled in an Access database, geographic information system (GIS) geodatabase, and Excel workbooks. This DMS has been prepared to facilitate queries and other means of quickly checking and summarizing data and extracting relevant information for GSP preparation. This memo outlines the type of data available in the DMS and details how the data are stored. More information on available data is documented in the technical memorandum, “Bedford-Coldwater Basin Existing Data Transmittal” (Todd 2019).

2. DMS TYPES AND SOURCES

Data collected and compiled for the GSP have been stored in a variety of formats based on the type of data collected. Spatial information such as ArcGIS files, aerial imagery, and or other map sources, are stored in a Geodatabase. Tabular data are stored in subject-specific relational databases. Additional datasets are stored in files best suited for analysis. To be specific, climate data are stored in an Excel workbook to allow for cumulative departure calculations, scanned well documents are stored as images to preserve the detail on the hardcopy forms, and online datasets updated by other agencies are included by reference. Discussed below are the data formats and the type of data available within that format.

3. GEODATABASE

Spatial data are stored in a geodatabase, which allows spatial files to be easily accessed and transferred with all appropriate spatial information. Within the BC Geodatabase, consistent and feature dataset structures have been constructed to group associated data sets and maintain coordinate system assignments.

3.1 Jurisdiction Boundaries

The basin boundaries for the Bedford-Coldwater Basin, management areas, and neighboring basins are available as spatial coverages in the geodatabase. State, local, and federal boundaries within and surrounding the Bedford-Coldwater Basin were compiled from state and federal sources. These boundaries include all water districts and other local agencies near the basin as well as federally owned land. These boundaries are included in the *JurisdictionalAreas* feature dataset in the project geodatabase.

3.2 Surface Water Body Location and Watershed Mapping

Mapping data for surface water features have been provided from publicly available sources. These mapped data include locations of aqueducts, reservoirs, rivers, streams, drainages, lakes, and ponds. These data are presented in the project geodatabase in feature classes named *HydrologyArcs,* and *HydrologyPolygons*. DWR defined watershed coverages are also stored in the ArcHydro geodatabase names *Watershed*.

3.3 Mapping of Natural Communities Commonly Associated with Groundwater

GSP Regulations require identification of Groundwater Dependent Ecosystems (GDEs), which are defined as ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. A statewide database and mapping tool, developed by DWR, provides geographic information on Natural Communities Commonly Associated with Groundwater (NCAAG). While these do not necessarily represent GDEs, the dataset is a starting point in identifying GDEs. The mapping data for watersheds surrounding the Basin are included in the project geodatabase in the *Hydrology* feature dataset in feature classes named *GDE_NCCAGWetlands* and *GDE_NCCAGVegetation*.

3.4 Ground Surface Elevation Data

Ground surface elevation data are available from the USGS in the form of National Elevation Dataset (NED) GIS grid files (rasters) and raster and vector topographic map datasets. Both datasets have been compiled for the area surrounding and including the Basin. The 10-meter resolution NED data have been combined into a single raster.

3.5 Aerial Photographs

Aerial photographs of the area surrounding the Basin have been downloaded from the USGS National Aerial Imagery Program (NAIP) for 2004, 2005, 2006, 2009, 2010, 2012, 2014, and 2016. Selected historical aerial imagery of the Temescal Wash area from Google Earth and privately held aerial imagery archives have also been acquired. These aerial photographs are rectified GIS raster datasets whenever possible. Rectified GIS datasets are included in the project geodatabase, unrectified aerial imagery is stored separately.

3.6 Soil Maps

Soil information for the Basin and surrounding areas have been downloaded from the Natural Resources Conservation Service (NRCS 2018). Soil data are mapped and maintained by NRCS in a standardized format that is compatible with tools that NRCS makes freely available to the public. The soils data for the area surrounding the basin have been maintained in the standard NRCS formats to facilitate future use. These raw data are available for preparation of a various soil data presentations and analyses. The hydrologic soil group data from these datasets have been also mapped using the NRCS *Soil Data Development Toolbox.* These data are in the *Soils* feature dataset in the project geodatabase.

3.7 Land Use Maps

Land use map data have been collected from DWR, the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP), and Riverside County. The available land use maps are indicated below:

- DWR: 2014 statewide land use mapping specifically developed for SGMA and GSPs.
- FMMP: 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, and 2016
- Riverside County: 1993 and 2000

3.8 Geologic Mapping of Surficial Geology and Faults

Surficial geology in the area of the Bedford-Coldwater Basin has been mapped by the United States Geological Survey (USGS) in the 2004 *Preliminary Digital Geologic Map of the Santa Ana 30' x 60' Quadrangle* and the 2006 *Geologic Map of the San Bernardino and Santa Ana 30' x 60' Quadrangles*. This mapped geology has been digitized into GIS formats available from the USGS, and these complete datasets are included in the *Geology* feature dataset of the project geodatabase.

3.9 Subsidence - NASA JPL InSAR Dataset

Vertical ground surface displacement rates are derived from Interferometric Synthetic Aperture Radar (InSAR) data collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL), under contract with DWR. Changes in vertical displacement can be viewed through the DWR SGMA mapping tool. Data have been downloaded from the SGMA data viewer and stored in the project geodatabase.

3.10 Water Infrastructure

3.10.1 Imported Water

Imported water delivery pipelines and tie-in locations available from Corona, EVMWD, and TVWD are included in the GIS datasets in the *MunicipalWaterInfrastructure* feature dataset in the project geodatabase. TVWD did not provide pipeline location details but did indicate that imported water is delivered throughout their service area. Imported water delivery data are included in the *Corona Imported Water*, *EVMWD Imported Water*, and *TVWD Imported Water* tables in the project database.

3.10.2 Recycled Water and Wastewater

Corona and TVWD supplied waste discharge and recycled water use records and distribution locations. EVMWD does not deliver recycled water or discharge wastewater within the basin. Corona waste discharge and recycled water distribution and use locations are included in the GIS datasets in the *MunicipalWaterInfrastructure* feature dataset in the project geodatabase. TVWD waste discharge historically went either to Temescal Creek or ponds adjacent to their wastewater treatment facility and they provide recycled water throughout the Bedford portion of the basin and waste discharge. Recycled water use and wastewater discharge data are included in the *Corona Reclaimed Water Use*, *Corona Waste Discharge*, *TVWD All Waste Discharge*, and *TVWD Waste Discharge by Location* tables in the project database.

3.11 Climate Data

The CIMIS stations, NOAA stations, and other climate locations are available in the geodatabase as a point coverage. In addition, the PRISM isohyets are available as a raster.

3.12 Surface Water Gage Locations

The locations of USGS surface water gages are also stored in the Geodatabase. Three streamflow gage stations near the Bedford-Coldwater Basin that are maintained by the USGS were identified. These stations are located on Temescal Creek at about Main Street in Corona (USGS 11072100), Temescal Creek at Corona Lake (USGS 11071900), and San Jacinto River near Elsinore (USGS 11070500). Up to date surface water measurements are available from the USGS NWIS data repository.

4. ACCESS DATABASES

Tabular data are linked in relational databases by subject. The DMS include one access data base with stand-alone tables that pull together data from all sources for groundwater elevation, groundwater quality, and groundwater pumping. In addition, a table containing all know wells in Bedford-Coldwater links to the subject specific tables. The well table includes locational information as State Plane coordinates. These tables that include all sources of data are named with the prefix "ALL_". Additional tables from the individual agencies are included in the database for the records and are labels with the agency prefix (e.g. "EVMWD", "TVWD", "Corona"). Other tables are included to house subsets of data from other sources including the water master, EPA STORET, and data from outside the basin.

The types of data stored in the Access database are described below.

4.1 Well Information Table

Well locations and available information were collected from multiple sources, including previous investigations, USGS National Water Information System (NWIS), DWR California Groundwater Elevation Monitoring (CASGEM) program, and others. This data collection effort included available well locations, well construction information, and aquifer parameter information. Data from all the available sources for the basin and surrounding area were collected and reviewed and then the data were combined into a single unified dataset. The unified dataset retains detailed information from the source files. Well data from individual sources often use agency-specific identification numbers or names. This variation in identification number by source is problematic for organizing, relating, and querying data. A *UniqueID* field was added to the unified well dataset and assigned integer identification numbers for each well to serve as the primary field for joins, relating, and querying data. The unified well dataset includes wells with and without location data. In compiling these data, attempts were made to remove duplicate wells while compiling these data. In some cases of duplicate wells, it was not possible to determine which location is correct. In these instances, the duplicate records were maintained in the dataset. The unified well information dataset is included in the project database in the All_*Well Information Table* and the same information is presented in the project geodatabase in the *Well* feature class in the *Groundwater* feature dataset.

Well locations are not well tracked in California, and as a result it is always possible that wells are either completely missing from records or mis-located. While this is not a known data gap, there may be wells that are missing or mis-located in the data that has been compiled for this data collection task.

4.2 Groundwater Elevation Table

As with well locations, groundwater elevation records were collected from multiple sources, including previous investigations, Corona, USGS NWIS, DWR CASGEM, and others. Data from these sources were collected, reviewed, and compiled into a single unified groundwater elevation dataset. The dataset includes all information from each source and uses the *UniqueID* field for linking, joining, or relating to the *Well Information* table in the project database or *Well* feature class of the project geodatabase. Groundwater elevation data were not calculated for wells without reference elevation data; records for these wells include only depth to water measurements. In addition, there are temporal gaps in some of the data records between the completion of previous investigations and the start of data collection for publicly available records. This is discussed further in the data gaps section below.

Groundwater elevation data is presented in the *ALL_Groundwater Elevation Data* table of the project database, and this dataset has been structured according to the requirements of the CASGEM program in accordance with DWR's grant funding agreement with the BCGSA.

4.3 Groundwater Quality Table

The groundwater quality database combines water quality data from a variety of sources for a comprehensive repository of regional water quality data. The relational database includes locations for all wells with water quality data, a table of water quality data, a table with information on the water system that was sampled, and a table of constituents monitored with agency codes, reporting levels, and applicable water quality goals. Queries are included to extract data on the key constituents of concern. Data from all three agencies, regional monitoring (Regional Water Quality Control Board and the Division of Drinking Water), and special studies (SNMP) are included in the *All_Water_Quality* table. The wells are linked to the Well Information table by the Unique_ID and the source recorded in the dataset attribute field.

4.4 Groundwater Pumping Table

Groundwater production in the basin was compiled from all available sources in the table *ALL_BC_Annual_Pumping*. Annual groundwater pumping for all wells is tracked by the Santa Ana River Watermaster, along with production in the rest of the watershed. Western Municipal Water District (WMWD) currently coordinates groundwater use data collection. Complete records of historical groundwater use were requested from and provided by WMWD. These groundwater production data were reviewed and organized for inclusion in the project database in a table named Bedford-Coldwater Annual Pumping. These production records are related to well locations by the Unique ID in the *Well Information* and *Bedford-Coldwater Annual Pumping* tables.

Annual totals from the Watermaster were confirmed and monthly information included when available from each individual agency.

4.5 Aquifer Parameter and Well Construction Data

There are very few aquifer parameter estimates in and around the Bedford-Coldwater Basin. Some aquifer parameter estimates were collected and/or developed during preparation of the Corona Groundwater Management Plan (Todd 2008a) and the *Feasibility Study, Recycled*

Water Recharge, Bedford Subbasin (Todd 2008b). Most of the transmissivity and hydraulic conductivity parameter estimates from those studies were based on an empirical relationship between specific capacity and transmissivity wherein transmissivity is 1,500 times specific capacity in unconfined aquifers. However, there was a constant rate aquifer test performed on TVWD Well 1A with observations in TVWD Wells 3 and 4. The data from this test were analyzed as part of the *Feasibility Study, Recycled Water Recharge, Bedford Subbasin* (Todd 2008b). The TVWD Well 1A test data are included in excel workbooks in a directory named *Pumping Test Data* and a summary table of all available aquifer test data in included in the project database (*Well Construction + Aquifer Parameters*). The records in the *Well Construction + Aquifer Parameter* table relate to the *Well Information* table through the *UniqueID* fields.

4.6 Additional Water Sources

Additional data on imported water is stored as tables from the individual agencies in the Access database.

4.6.1 Imported Water

Corona, EVMWD, TVWD each use imported water and the measured data is stored in the database separate for each agency. There is no combined table for basin-wide imported water.

4.6.2 Recycled Water and Wastewater

Wastewater information from TVWD is stored in the database as *TVWD Waste Discharge by Location.* Corona's reclaimed water use by address is stored as a separate table, *Corona Reclaimed Water.*

5. OTHER FORMATS

5.1 Climate Data (precipitation, evaporation, temperature) - Excel

Climate data are compiled and stored as an Excel file. The workbook also calculates the cumulative departure of precipitation and local water year type by quintiles.

We identified three currently active climate monitoring stations near the Bedford-Coldwater Basin: the Lake Elsinore station maintained by the National Oceanic Atmospheric Administration (NOAA), the Santiago Peak station maintained by Orange County, and the UC Riverside California Irrigation Management Information System (CIMIS). The Lake Elsinore and UC Riverside stations include daily precipitation and evapotranspiration data; the Santiago Peak station collects monthly precipitation data. Monthly data for the Santiago Peak station is from January 1949 to current, with a slight lag on recent data. The Lake Elsinore station has daily data from January 1961 through current and the UC Riverside station has daily data from January 1986 through the present.

6. BEDFORD-COLDWATER GROUNDWATER MODEL

The groundwater model datasets prepared for the GSP are stored separately from the DMS. These data and files have been prepared using various datasets described above, as documented in the Bedford-Coldwater GSP Model Documentation Report (Todd 2021). The results of the historical and future model simulations are documented in the GSP. Model outputs including surface water budgets and groundwater budgets are also documented in detailed tables. While these data are valuable to understanding the basin, they represent simulated conditions and are stored separately from the observed data in the DMS which are documented here.

7. DATA MANAGEMENT STORAGE

The DMS will continue to be updated with more recent data for annual reports and the GSP 5-year update. It is expected that new datasets will be added as projects and management actions are enacted to fill data gaps. For example, shallow monitoring wells near Temescal Wash may be added at a later date.

The geodatabase, Access databases, and excel workbooks will be updated annually as part of the Annual GSP Report. The GSA will maintain a copy of the annually updated files.