Eel River Valley Groundwater Basin

Humboldt County, California

Groundwater Sustainability Plan Alternative

Prepared in Collaboration with:

County of Humboldt

SHN Consulting Engineers & Geologists, Inc.

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December 2016
016219

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Prepared in Collaboration with:

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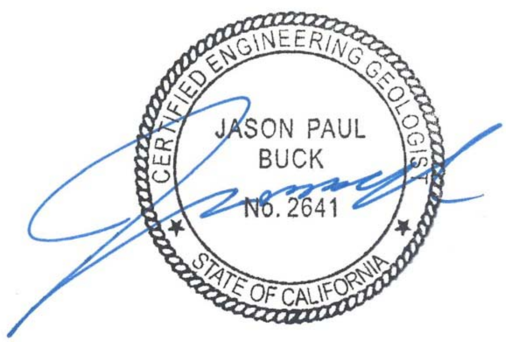

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QA/QC: LKS

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Executive Summary (Reg. § 354.4)

Humboldt County has prepared a Groundwater Sustainability Plan Alternative (GSP Alternative) for the Eel River Valley Groundwater Basin (Basin) in collaboration with stakeholders representing agricultural, municipal, and environmental interests, as the local response to the Sustainable Groundwater Management Act (SGMA). Stakeholders have actively participated through the Eel River Valley Groundwater Working Group (Working Group) which was convened in October 2015.

This GSP Alternative was prepared in accordance with the implementing regulations at California Code of Regulations, Title 23, §350 et seq. and provides information demonstrating that the Basin has operated within its sustainable yield over a period of at least 10 years. The GSP Alternative is intended to accomplish the same goals as a full GSP, but does not require the formation and administration of a Groundwater Sustainability Agency and supports more streamlined planning efforts, which allows a more cost-effective use of limited resources.

Groundwater within the Eel River Valley is a highly valuable resource with multiple beneficial uses, including agricultural water supply, municipal and domestic water supply, industrial water supply, and freshwater replenishment to surface waters. The Eel River Valley is the center of Humboldt County's dairy and beef cattle economy; dairy producers and ranchers pump groundwater for pasture irrigation and livestock watering. The population within the Basin is approximately 21,558 people, with nearly half of this population residing with the City of Fortuna. The Sustainability Goal for the Basin is to maintain high quality and abundant groundwater resources in support of existing and long-term community needs without causing undesirable results.

The Basin has a total area of 72,957 acres. Usable groundwater is found within floodplain alluvium and the underlying Wildcat series formations. The Basin is bisected by the Eel River and its tributary, the Van Duzen River, both of which provide habitat for anadromous salmonids and other fish and aquatic species. The Basin is a coastal basin with drainage to the ocean.

The Department of Water Resources (DWR) designated the Basin as medium-priority in the initial prioritization which went into effect on January 1, 2015. DWR plans to a state-wide update to basin prioritizations in 2017. New, more detailed information regarding irrigated acreage and irrigation water use within the Basin has been obtained since the initial prioritization, indicating less water use than had been previously estimated, and there is a reasonable possibility that the new information could result in a reduced priority level. The applicability of this GSP Alternative will need to be re-evaluated if the Basin's priority level is reduced from medium to low and actions under SGMA become optional rather than mandatory.

This GSP Alternative is based on the best available information and best available science, and contains the functional equivalent of applicable elements of a GSP. The GSP Alternative was developed to be sufficiently thorough and reasonable, to the extent necessary, to assess whether the Basin is being sustainably managed. Professional judgment was used to incorporate content commensurate with the level of understanding of the Basin, with consideration for data gaps and the need for an acceptable level of uncertainty. The GSP Alternative includes a hydrogeologic conceptual model, description of current and historical groundwater conditions, water budget, and evaluation of potential undesirable results associated with groundwater use. Potential undesirable results include significant and unreasonable lowering of groundwater levels, reduced groundwater storage, seawater intrusion, degraded water quality, land subsidence, or depletion of interconnected surface waters causing adverse impacts to beneficial uses.

In July 2016, DWR awarded Humboldt County a Proposition 1 Sustainable Groundwater Planning Grant to complete the Eel River Valley Groundwater Basin Assessment (Basin Assessment). The Basin Assessment is a geologic and hydrogeologic investigation combined with initial management planning efforts in response to SGMA, to provide an improved understanding of the Basin and support local decision-making regarding groundwater management. This project will continue through 2017.

In summary, groundwater levels at the basin scale have been generally stable, including during the droughts of 1976-1977 and 1987-1992, and recent drought conditions from 2013 through 2015. Well elevation levels generally do not drop below a minimum elevation during droughts. This finding is supported by the hydrogeological conceptual model which documents highly favorable conditions for reliable recharge and a significant amount of water storage, on the order of two million acre-feet. Groundwater use is a small percentage of annual recharge and a small percentage of groundwater storage volume. Water use within the Basin over the next five years is projected to be closely comparable to existing conditions. The position of the seawater/freshwater transition zone mapped in 2016 is comparable to the extent measured in 1975. Existing data indicate acceptable water quality and the absence of a contaminant plume affecting water supplies. The underlying conditions for potential land subsidence are not present. Late-summer low-flows are a concern in the Lower Eel River and Lower Van Duzen River; however, the primary anthropogenic factors are upstream diversions, sedimentation and post-flood sediment deposits, and changing forest composition at the watershed scale. Multiple lines of evidence demonstrate that groundwater use within the Basin is not causing undesirable results associated with beneficial uses of interconnected surface waters.

The hydrogeologic conceptual model and water budget enhance our understanding of the Basin and the contributing factors that enable abundant groundwater resources. The results of the technical studies performed to date indicate low potential for stressed conditions, overdraft, or undesirable results. There is sufficient information to demonstrate that undesirable results are not present within the Basin and are unlikely to occur given the hydrogeologic conditions and water use patterns. However, there is insufficient information to develop a quantitative estimate of sustainable yield or establish minimum thresholds for undesirable results. Specifically, there is insufficient information on the dynamics of the groundwater/surface water system to accurately predict how sustainability indicators would respond to significant increases in water extraction or other changes in water budget conditions. Therefore, it would be inappropriate to formulate arbitrary estimates for sustainable yield or minimum thresholds without a valid scientific basis. Speculating on numerical values would likely be more confusing or misleading than helpful for management purposes, and is unnecessary to demonstrate sustainable groundwater management within the Basin.

Based on the data and evaluation detailed herein, Humboldt County concludes, with support from the Working Group, that the Basin is being managed sustainably for beneficial uses without undesirable results, and a GSP Alternative is the most appropriate compliance option for achieving the goals of SGMA. This GSP Alternative includes a goal-setting framework that is appropriate for Basin conditions and the current state of scientific data and understanding, along with a monitoring plan and commitments for annual reporting and a five-year assessment.

Table of Contents

Page

Table of Contents (continued)

Appendices

List of Illustrations

Report Figures (located in Appendix I)

List of Illustrations (continued)

Tables **Page**

Abbreviations and Acronyms

acre-ft	acre-feet
cfs	cubic feet per second
ft	feet
gpm	gallons per minute
km	kilometer
mg/L	milligrams per liter

Basin	Eel River Valley Groundwater Basin
Basin Assessment	Eel River Valley Groundwater Basin Assessment
BMP	best management practice
CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	California Code of Regulations
CSD	community services district
County	County of Humboldt
CPS	Cleanup Program Sites
CSD	Community Services District
CSZ	Cascadia Subduction Zone
DWR	State of California Department of Water Resources
ERRP	Eel River Recovery Project
ET	evapotranspiration
FWS	U.S. Fish and Wildlife Service
GAMA	California Groundwater Ambient Monitoring and Assessment
GIS	Geographic Information System
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
IG	infiltration gallery
HCRCD	Humboldt County Resource Conservation District
LUST	State of California Leaking Underground Storage Tank Program
MCL	maximum contaminant level
MW-#	monitoring well-number
NWI	National Wetlands Inventory
P	precipitation
PECG	Palmer Environmental Consulting Group, Inc.
R	groundwater recharge
RO	surface water runoff
RWQCB	North Coast Regional Water Quality Control Board
SGMA	Sustainable Groundwater Management Act
SGWP	Sustainable Groundwater Planning
SHN	SHN Engineers & Geologists
SMCL	secondary maximum contaminant level
SWRCB	State Water Resources Control Board
USGS	U.S. Geological Survey
Working Group	Eel River Valley Groundwater Working Group

1.0 Introduction

1.1 Purpose

This document is a Groundwater Sustainability Plan Alternative (GSP Alternative) for the Eel River Valley Groundwater Basin (Basin) submitted by the County of Humboldt for compliance with the Sustainable Groundwater Management Act (SGMA). This GSP Alternative provides information demonstrating that the Basin has operated within its sustainable yield over a period of at least 10 years. A site location map for the Basin is provided in Figure 1-1.

This GSP Alternative has been developed in accordance with 23 California Code of Regulations (CCR) §358.2 and the Alternative Elements Guide published by the Department of Water Resources (DWR) on December 5, 2016. A preparation checklist has been prepared to aid DWR in review of this document. A copy of the checklist is included in Appendix A.

1.2 Sustainable Groundwater Management Act

1.2.1 Overview

SGMA was passed by the California Legislature and signed by the Governor in September 2014, creating a new state-wide framework for groundwater resource management. Management responsibility under SGMA is delegated to the local level with state oversight by DWR and the State Water Resources Control Board (SWRCB). The SWRCB has jurisdiction for surface water diversions.

SGMA established a state policy of sustainable, local groundwater management:

> "It is the policy of the state that groundwater resources be managed sustainably for long-term reliability and multiple economic, social and environmental benefits for current and future beneficial uses. Sustainable groundwater management is best achieved locally through the development, implementation, and updating of plans and programs based on the best available science" (Water Code 113).

The stated legislative intent of SGMA (Section 10720.1) is as follows:

a) To provide for the sustainable management of groundwater basins.

b) To enhance local management of groundwater consistent with rights to use or store groundwater and Section 2 of Article X of the California Constitution. It is the intent of the Legislature to preserve the security of water rights in the state to the greatest extent possible consistent with the sustainable management of groundwater.

c) To establish minimum standards for sustainable groundwater management.

d) To provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater.

e) To avoid or minimize subsidence.

f) To improve data collection and understanding about groundwater.

g) To increase groundwater storage and remove impediments to recharge.

h) To manage groundwater basins through the actions of local governmental agencies to the greatest extent feasible, while minimizing state intervention to only when necessary to ensure that local agencies manage groundwater in a sustainable manner.

SGMA is based on designated alluvial groundwater basins, which are areas where usable groundwater is present within sediment deposits associated with the floodplain or delta of rivers and streams. DWR designates four priority levels (high, medium, low, and very-low) for groundwater basins throughout the state based on eight criteria developed to assess relative importance as a water supply source and potential for adverse effects. SGMA contains specific requirements for high- and medium-priority basins, while actions for low- and very-low priority basins are voluntary. The Basin was rated as medium priority in January 2015 under DWR's initial prioritization of groundwater basins in the state. DWR intends to update basin prioritizations in 2017.

SGMA identifies two compliance options for medium- and high-priority basins. One option is formation of a Groundwater Sustainability Agency (GSA) and adoption of a Groundwater Sustainability Plan (GSP). With this option, GSA formation is required by June 30, 2017, and GSP adoption is required by January 2022. Another option is for a local entity to submit a GSP Alternative, if an analysis of basin conditions demonstrates that the basin has operated within its sustainable yield over a period of at least 10 years [SGMA Section 10733.6(b)(3)]. GSP Alternatives must be submitted to DWR for review by January 1, 2017, and every five years thereafter.

The June 30, 2017, deadline for formation of a GSA under option one does not apply if a GSP Alternative has been submitted and is pending review with DWR. If the GSP Alternative is deemed inadequate, a GSA would need to be formed within six months from the date of disapproval. If a local entity does not assume compliance responsibility for a medium- or high-priority basin, then the SWRCB has the authority to prepare and implement a GSP, with fees charged to groundwater extractors for the costs of the State's intervention.

"**Sustainable yield**" is defined in SGMA as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result" (Section 10721).

"**Undesirable results**" is defined by SGMA as one or more of the following effects caused by groundwater conditions occurring throughout the basin:

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

Groundwater levels, groundwater storage, seawater intrusion, water quality, land subsidence, and beneficial uses of interconnected surface water are the six "**sustainability indicators**" under SGMA. The implementing regulations for SGMA are contained in the CCR, Title 23, §350 et seq. These regulations describe the required content for a GSP and GSP Alternative and the evaluation criteria to be used by DWR.

1.2.2 Requirements for Groundwater Sustainability Plan Alternative

The GSP Alternative is intended to accomplish the same goals as a GSP, but does not require the formation and administration of a GSA, which allows for a more cost-effective use of limited resources. According to 23 CCR §358.2(d), the GSP Alternative must contain elements that are functionally equivalent to certain required elements of a GSP. Further, the elements of the GSP Alternative must demonstrate the ability of the GSP Alternative to achieve the objectives of SGMA. DWR's criteria for evaluating a GSP Alternative are contained in 23 CCR §355.4. The evaluation criteria are based on a "substantial compliance" standard which allows DWR to use discretion and flexibility in reviewing the adequacy of a GSP Alternative, as long as supporting information is sufficiently detailed and the analyses sufficiently thorough and reasonable such that any discrepancy would not materially affect achievement of the sustainability goal for the basin.
If DWR changes the prioritization of a basin from high or medium to low or very-low, then presumably a GSP or GSP Alternative could be withdrawn or suspended.

2.0 Description of Plan Area (Reg. § 354.8)

2.1 Overview of the Eel River Valley Groundwater Basin

Groundwater within the Eel River Valley is a highly valuable resource with multiple beneficial uses, including agricultural water supply, municipal and domestic water supply, industrial water supply, and freshwater replenishment to surface waters.

The Eel River Valley is the center of Humboldt County's dairy and beef cattle economy; dairy producers and ranchers pump groundwater for pasture irrigation and livestock watering. The Humboldt County Farm Bureau represents agricultural interests. In addition, the Humboldt County Agricultural Commissioner, Humboldt County Resource Conservation District (HCRCD), and University of California-Cooperative Extension have close involvement with the agricultural community.

The population within the Basin is approximately 21,558 people, with approximately half of this population residing within the City of Fortuna (DWR, 2015). A map depicting the jurisdictional boundaries of agencies with water management responsibilities is provided in Figure 2-1. Public water suppliers utilizing groundwater within the basin include City of Fortuna, Scotia Community Services District (CSD), City of Rio Dell, Riverside CSD, Loleta CSD, Palmer Creek CSD, Hydesville Community Services District, Bear River Band of the Rohnerville Rancheria, and Del Oro Water Company. Del Oro Water Company is an investor-owned public utility company that provides water to the City of Ferndale and surrounding area. The City of Rio Dell and Scotia CSD's obtain surface water from the Eel River, and the City of Rio Dell utilizes groundwater as a secondary/emergency source. Based on a query of DWR's database for well completion logs in October 2015, Humboldt County Public Works estimates that there are approximately 350 domestic water wells within the Basin. The densities of irrigation, municipal, domestic, and industrial wells per square mile are depicted on Figure 2-2.

The Basin has a total area of 72,957 acres (based on DWR's adjustment to the boundary in October 2016). Usable groundwater is found within floodplain alluvium and the underlying Wildcat series formations. Significant geologic and groundwater studies were performed by Ogle (1953), Evenson (1959), DWR (1973), and the U.S. Geological Survey (USGS; 1978). The Basin is bisected by the Eel River and its tributary, the Van Duzen River, both of which provide habitat for anadromous salmonids and other fish and aquatic species. The Basin is a coastal basin with drainage to the ocean and encompasses the slough channels of the Eel River estuary. The Basin has not been adjudicated and is not adjacent to another groundwater basin subject to SGMA. Establishment of management areas within the Basin has been determined to be unwarranted.

2.2 Eel River Valley Groundwater Working Group

On April 27, 2015, the County of Humboldt and the University of California-Cooperative Extension co-sponsored a workshop entitled "Groundwater in the Eel River Valley: Responding to the New State Groundwater Legislation." A summary of feedback from this workshop is contained in Appendix B. Based on feedback from this workshop, the Humboldt County Board of Supervisors directed the Public Works Department to convene the Eel River Valley Groundwater Working Group (Working Group) with representatives from agricultural, municipal, and environmental interests. The purpose of the Working Group is to guide the local response to SGMA for the Eel River Valley. The Working Group was asked to:

1. Provide information and viewpoints regarding groundwater issues in the Eel River Valley.
2. Support the collection and analysis of technical data and information to understand conditions and trends.
3. Discuss selection and formation of a GSA, if applicable.
4. Discuss the framework and sustainable management criteria for a GSP Alternative or future GSP.

The Working Group has convened eight meetings between October 2015 and December 2016. Presentations and minutes are available on the County website (www.humboldtgov.org/groundwater). Humboldt County plans to continue sponsoring the Working Group as the method for sharing information with the public and soliciting stakeholder participation in management activities and decision-making.

Representatives from all the water purveyors within the Eel River Valley have participated in the Working Group with the exception of the Bear River Band of the Rohnerville Rancheria. The Bear River Band has provided water system information but has not responded to written invitations to participate in the Working Group.

2.3 Notice and Communication

The Working Group has been the primary means of sharing information and soliciting input from stakeholders. In addition, the Humboldt County Public Works Department has participated in public discussions regarding the Basin at the following meetings:

- January 20, 2015 – Presentation at the Humboldt County Fish and Game Advisory Commission meeting.
- February 5, 2015 – Presentation at the Humboldt County Farm Bureau board meeting.

- February 24, 2015 – Staff report at the Humboldt County Board of Supervisors meeting.
- May 20, 2015 – Presentation at the Eel River Forum meeting in Fortuna.
- June 25, 2015 – Presentation at the Buckeye Conservancy meeting in Eureka.
- April 1, 2016 – Presentation at the Eel Russian River Commission meeting in Santa Rosa.
- September 8, 2016 – Presentation at the Humboldt County Farm Bureau board meeting.
- October 6, 2016 – Staff report at the Humboldt County Board of Supervisors meeting.
- December 13, 2016 – Staff report at the Humboldt County Board of Supervisors meeting.

2.4 Proposition 1 Sustainable Groundwater Planning Grant

In July 2016, DWR awarded Humboldt County a Proposition 1 Sustainable Groundwater Planning Grant to complete the Eel River Valley Groundwater Basin Assessment (Basin Assessment). The Basin Assessment is a geologic and hydrogeologic investigation combined with initial management planning efforts in response to SGMA. The purpose of the project is to provide Humboldt County, cities and districts, water users, and other stakeholders with an improved understanding of the Basin to support local decision-making regarding groundwater management. The project was designed to provide data and evaluation needed to determine whether the Basin is being managed sustainably for beneficial uses without undesirable results, and to support the determination whether a GSP or GSP Alternative is the most appropriate compliance option.

Humboldt County Public Works retained SHN Engineers and Geologists, Fisch Drilling, and HCRCD to assist with the Basin Assessment. Field work was initiated in August 2016 and included installation of nine new monitoring wells, collection of water level measurements in more than 60 wells, testing of aquifer characteristics, and collection of water surface and flow measurements in the Eel River. Data collection and analysis under the grant will continue in 2017. The term of the grant ends on June 30, 2017, but Humboldt County intends to request an amendment to extend the term until December 31, 2017.

2.5 Agency Description and Legal Authority

Humboldt County is a political subdivision of the State of California. Humboldt County serves as the monitoring entity for the California Statewide Groundwater Elevation Monitoring (CASGEM) program in collaboration with DWR. The majority of the Eel River Valley is unincorporated, where Humboldt County is the land use authority. Humboldt County is the contract administrator for the North Coast Resource Partnership, which is the integrated regional water management planning group for the seven-county North Coast region. Humboldt County is not a water purveyor or distributor but has regulating authority for well installation. The Basin does not have an existing district or other public agency charged with groundwater management, and neither a groundwater management plan nor groundwater use ordinance are in effect.

Three Humboldt County departments have roles related to groundwater management:

- The Environmental Services Division of the **Department of Public Works** implements the County's role as the monitoring entity for the state CASGEM program, and serves as the grant administrator for the North Coast Resource Partnership. The Department of Public Works has taken the lead role coordinating the Working Group and the region's response to SGMA.

- The **Department of Planning and Building** implements the County's role as land use authority and develops a variety of state-mandated plans. The Water Resources element of the General Plan contains county-wide policies regarding groundwater.
- The Environmental Health Division of the **Department of Health and Human Services** administers the County's well permit program and provides oversight for certain subsurface contamination sites.

On December 13, 2016, the Humboldt County Board of Supervisors adopted Resolution No. 16-142 (Appendix C) which resolved that the County of Humboldt has the legal authority to submit and implement a GSP Alternative for the Basin in accordance with 23 CCR §354.6(d) and §358.2(c)(3). The resolution authorized the Public Works Department to prepare and submit a GSP Alternative.

The primary contact for the GSP Alternative is:

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2.6 Water Use Rate Estimates

HCRCD (2016) performed an irrigation water use study to estimate irrigation water use rates and the amount of irrigated lands within the Basin. The Technical Memorandum (provided in Appendix D) describes the methods and assumptions and presents the detailed results. In summary, the HCRCD estimated that there were 13,558 acres irrigated with groundwater in 2016, of which more than 85% was applied to grazed pasture or hay and alfalfa production. Other crop types include corn and quinoa. Approximately 73% of the irrigated land is situated in the Ferndale area, with the remainder distributed within several geographic areas. A summary of irrigation water use rates is provided in Table 2-1.

Table 2-1
Irrigation Groundwater Use Rate by Water Year (2007-2016)[1]

Water Year	Total Acre-Feet	Acre-Feet per Acre	Estimate of Water Use in Last 10 Years
Dry Irrigation Season (April 15-October 1)	16,680	1.2	2008, 2009, 2013, 2014, 2015
Normal Irrigation Season (May 15-October 1)	13,600	1.0	2007, 2012, 2016
Wet Irrigation Season (June 1-October 1)	10,265	0.8	2010, 2011

1. Source: Table 5 in HCRCD (2016)

In addition, HCRCD (2016) compares their results with other published values. A summary of this comparison is provided in Table 2-2.

Table 2-2 Irrigation Groundwater Use Rate by Water Year (2007-2016)			
Source	**Irrigated Land (Acres)**	**Water Use Volume (Acre-Feet)**	**Water Use Rate (Acre-Feet per Acre)**
DWR (1968)	11,700	18,800	1.0 to 1.7
USGS (1978)	17,300	17,300	1.0
DWR (2003)	-	49,000	-
DWR (2012)	26,800	24,400	0.9 (implied)
RCD (2016)	13,558	10,265 to 16,680 (varies seasonally)	0.8 to 1.2
1. HCRCD (2016).			

Table 2-3 provides a summary of municipal water use from water suppliers in the Basin.

Table 2-3 Municipal Water Use, 2005-2015 (Acre-Feet per Year)													
Supplier	**Water Source**	**System Cap. (MGD)[1]**	**Connec-tions**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**
City of Fortuna	Wells (5)	8.25	4,403	1,445	1,595	1,654	1,540	1,333	1,399	1,423	1,439	N/A	N/A
City of Rio Dell	IG[2] (Eel River)	0.432	1,220	254	294	351	315	304	305	327	330	365	280
Town of Scotia	IG (Eel River)	N/A	317	346	363	325	362	422	432	421	430	471	N/A
Del Oro Water Co.	Well	0.324	775	46	41	33	29	12	11	19	26	44	58
Loleta CSD[3]	Well	0.232	258	23	23	21	20	20	20	20	19	21	25
Riverside CSD	Well	0.20	95	24	N/A	35	32	32	33	32	N/A	26	26
Palmer Creek CSD	Wells (2)	0.21	114	3	3	3	3	3	3	4	N/A	N/A	N/A
Hydesville CSD	Wells (2)	0.60	420	97	107	118	124	161	153	126	138	148	162
Bear River	Well	0.2	50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	**---**	**---**	**7,652**	**2,238**	**2,426**	**2,540**	**2,425**	**2,287**	**2,356**	**2,372**	**2,382**	**1,075**	**551**

1. System Capacity (million gallons per day)
2. IG: Infiltration Gallery
3. CSD: Community Services District

2.7 Water Resource Monitoring and Management Programs

2.7.1 California Statewide Groundwater Elevation Monitoring

Long-term monitoring has been performed by DWR at seven wells in the Basin, with some records dating back to the late 1950s. The network includes five wells near Ferndale and single wells in Loleta and Fortuna. The groundwater elevation data collected by DWR meet the CASGEM requirements. In 2014, the County of Humboldt became the designated monitoring entity for groundwater basins within the County in accordance with the CASGEM program. Humboldt County Public Works serves an administrative role to develop a monitoring plan and make the required submittals. Three of the seven wells monitored by DWR in the Basin are reported under the CASGEM program.

2.7.2 Streamflow Gauging Stations

USGS maintains streamflow gauging stations on the Lower Eel River at Scotia and Fernbridge, and on the Van Duzen River at Bridgeville. The Fernbridge station measures gage height only (not discharge). Fernbridge is generally considered the upstream extent of the estuary, with average salinity near 0.5 parts per thousand. Humboldt County Public Works operates a gauging station on Francis Creek, a tributary to the Salt River.

2.7.3 Urban Water Management Plans

The City of Fortuna has prepared an Urban Water Management Plan (City of Fortuna; 2016).

2.7.4 Water Agency Monitoring and Reporting

Water agencies collect various water quality data as required by state and federal regulations and publish annual consumer confidence reports.

2.7.5 Fisheries Monitoring and Reporting

Since 1997, commercial gravel operators have conducted fisheries monitoring activities to track habitat conditions for listed salmonids within the Lower Eel River and Lower Van Duzen River, based on federal, state, and county permitting requirements (Stillwater Sciences, 2015). These habitat monitoring activities record the distribution, characteristics, and trends of habitat units (pools, riffles, flatwaters) within the river channel.

The Eel River Recovery Project (ERRP) began citizen-assisted monitoring of the Eel River fall Chinook run in 2012 (Higgins, 2016). These monitoring activities include dive surveys, pool depth measurements, and water quality monitoring (temperature and dissolved oxygen).

2.8 General Plans and Well Permits

2.8.1 General Plans

The Humboldt County Planning and Building Department is projecting to complete the County's General Plan Update in late 2017 or early 2018. The General Plan includes Land Use and Water Resources Elements. The Land Use Element provides policies to guide growth and development of land through 2025. Existing land use designations are depicted on Figure 2-3. According to data and projections from the California Department of Finance, the current annual population growth rate within Humboldt County is 0.6 percent, and the anticipated average annual growth rate over the next 20 years is 0.4 percent, which is lower than the 0.8 percent annual growth experienced in the past 30 years. This level of growth is not expected to have a significant effect on water demands in the Basin or affect the ability of stakeholders to maintain sustainable groundwater management.

The draft version of the Water Resources Element (tentatively approved by the Board of Supervisors in 2015) contains goals, policies, standards, and implementation measures related to groundwater, as summarized in Table 2-4.

Table 2-4
Groundwater-Related Provisions in the Draft Humboldt County General Plan

Goals, Policies, and Implementation Measures	Description
Goal WR-G1	**Water Supply, Quality, and Beneficial Uses.** High quality and abundant surface and groundwater resources that satisfy the water quality objectives and beneficial uses identified in the Water Quality Control Basin Plan for the North Coast Region.
Goal WR-G5	**Watershed Management.** A system of water resource management that recognizes watersheds as natural systems producing multiple economic, social, and environmental benefits that can be sustained in perpetuity and optimized with education, sound data, cooperative public processes, adaptive management, and science-based leadership.
Goal WR-G6	**Public Water Supply.** Public water systems able to provide adequate water supply to meet existing and long-term community needs in a manner that protects other beneficial uses and the natural environment.
Policy WR-P1	**Sustainable Management**. Ensure that land use decisions conserve, enhance, and manage water resources on a sustainable basis to assure sufficient clean water for beneficial uses and future generations.
Policy WR-P2	**Protection for Surface and Groundwater Uses**. Impacts on Basin Plan beneficial water uses shall be considered and mitigated during discretionary review of land use permits that are not served by municipal water supplies.

Table 2-4 Groundwater-Related Provisions in the Draft Humboldt County General Plan	
Goals, Policies, and Implementation Measures	**Description**
Policy WR-P12	**Groundwater Quality Protection**. Commercial and industrial discretionary uses shall be evaluated for their potential to contaminate groundwater resources, and mitigated as necessary.
Policy WR-P13	**Saltwater Intrusion**. Discretionary projects involving groundwater withdrawals in proximity to coastal areas with a potential to create saltwater intrusion shall demonstrate that groundwater supplies will not be adversely affected by saltwater intrusion.
Policy WR-P18	**Watershed and Community Based Efforts**. Support the efforts of local community watershed groups to protect, restore, and monitor water resources and work with local groups to ensure decisions and programs take into account local priorities and needs.
Policy WR-P23	**Conservation and Re-use Strategy**. Promote the use of water conservation and re-use as a strategy to lower the cost, minimize energy consumption, and maximize the overall efficiency and capacity of public and private water systems…. Encourage and support conservation for agricultural activities that increase the efficiency of water use for crop irrigation and livestock…. Avoid water reuse that could adversely affect the quality of groundwater or surface water.
Implementation Measure WR-IM12	**Sustainable Groundwater Plans**. Support the development of Sustainable Groundwater Plans consistent with California Water Code.
Implementation Measure WR-IM21	**Long-term Water Supply Planning**. Work with Humboldt Bay Municipal Water District and other public water suppliers in the development and implementation of long-term plans for water supply, storage, and delivery necessary to first meet existing water demands and, secondly, to meet planned growth within the designated service areas, consistent with the sustainable yield of water resources.

2.8.2 Well Permits

The Environmental Health Division of the Humboldt County Department of Health and Human Services administers permits for the construction, repair, and destruction of water wells. Standards and requirements are contained in Section 631-1 of the Humboldt County Code. The County's well permit ordinance will be updated in 2017. The Environmental Health Division is considering the addition of a new provision to address groundwater quantity.

3.0 Basin Setting

The Basin, as defined by DWR, occurs at the downstream end of the Eel River watershed. The main stem Eel River originates in headwaters near Potter Valley and Lake Pillsbury in Mendocino County, and flows more than 120 miles to the northwest where it flows into the ocean near Ferndale in Humboldt County. The watershed drains a substantial portion of northwestern California. Downstream of Scotia, the Eel River flows into a structurally controlled, alluvial-filled valley that forms the subject groundwater basin.

The boundaries of the Eel River groundwater basin are shown on Figure 3-1, defined by DWR based on unpublished mapping by Thomas Dibblee (2008). The groundwater basin extends upstream from the estuary at the mouth of the Eel River upstream to encompass the alluvial-filled valley, and the lower reaches of the Eel and Van Duzen river valleys.

3.1 Hydrogeologic Conceptual Model (Reg. § 354.14)

This section discusses the geologic and hydrogeologic setting of the Basin. Information in this section is derived from the results of the current study, as well as published geologic literature (Ogle, 1953; McLaughlin and others, 2000; Dibblee, 2008), periodic evaluations by DWR of groundwater resources (Evenson, 1959; DWR, 1965, 1978), and an evaluation of groundwater conditions conducted by the USGS in 1975 (USGS, 1978).

3.1.1 Geologic Setting

The Basin occurs in a structurally controlled valley within a complex geologic setting directly north of the Mendocino Triple Junction, the intersection of three crustal plates (the Gorda, North American, and Pacific plates). The Eel River Valley is about 20 miles north of the triple junction (Figure 3-2). The region is dominated by northeast-southwest directed compression associated with collision of the Gorda and North American tectonic plates. The Gorda plate is being actively subducted beneath North America north of Cape Mendocino along the southern portion of the Cascadia Subduction Zone (CSZ). Crustal deformation in the over-riding North American plate associated with the subduction of the Gorda plate is expressed as a 90-kilometer (km) wide fold-and-thrust belt within the accretionary margin of the North American plate (Carver, 1987).

A major element of this fold and thrust belt is a broad structural downwarp (synclinal fold), referred to as the "Eel River syncline" that is coincident with the lower reaches of the Eel River (Figure 3-3). The folding affects a series of Plio-Pleistocene age sedimentary units referred to as the "Wildcat Group," as shown on geologic cross-sections in Figure 3-4. The result is a geologic basin formed in the consolidated basement rocks of the region (Wildcat Group and underlying Franciscan Formation) that fills with large quantities of unconsolidated alluvial deposits from the Eel and Van Duzen rivers, as well as streams flowing from the surrounding uplands.

The geologic setting of the Basin is described on published geologic maps by Ogle (1953) and McLaughlin and others (2000). DWR defined the latest iteration of the Basin on an unpublished geologic map by Dibblee (2008) that does not follow unit conventions typically used in the region and is not incorporated herein. The consolidated rocks of the Wildcat Group were defined by Ogle (1953), whose nomenclature and mapping remain in wide use. The Wildcat Group consists of five sedimentary formations (from oldest to youngest: the Pullen, Eel River, Rio Dell, Scotia Bluffs, and Carlotta Formations) that were deposited in the ancestral Eel River basin. The formations represent a shallowing (upward-coarsening) sequence ranging from inner-shelf, fine-grained sandstone, siltstone, and mudstone (Pullen, Eel River, and Rio Dell Formations), to near-shore sands and gravels (Scotia Bluffs and Carlotta Formations). This upward coarsening of lithologies represents the transition (regression) form a deep-water offshore environment to a near-shore marine or terrestrial alluvial environment. Wildcat Group units unconformably overlie the regional bedrock material, the Franciscan Complex.

The Eel River has the largest mean annual sediment load of any river on the conterminous U.S. Pacific coast (Meade and others, 1990). The Eel River watershed is associated with high rainfall in an area with steep slopes underlain by geologically young, unstable bedrock. Sediment transport and loading in the lower valley are high, such that alluvial material is readily available to fill the structural basin associated with the Eel River syncline. In addition, large floods occurred in 1955 and 1964, both of which were profound geomorphic events that produced large amounts of sediment. These events impacted fluvial conditions along the Eel River for decades (and are still likely affecting the system).

Figures 3-5, 3-6, and 3-7 show shallow geologic cross-sections highlighting stratigraphy within the alluvial aquifer (based on wells), as well as the Carlotta Formation and secondary aquifers (Hookton Formation, terraces, and so on). Because the primary rivers within the system (Eel and Van Duzen) both exit relatively confined stream canyons before entering the wide, low-gradient Eel River Valley, a broad floodplain is present spanning the width of the valley. Alluvium within the valley contains a wide variety of materials ranging from coarse gravels near active stream channels to fine-grained flood deposits (silts, clays) in floodplain settings far removed from the active channels. Evenson (1959) identified an area in the southwest part of the Eel River Valley dominated by fine sediments derived from periodic Eel River floods, as well as fine material washed from the Wildcat Range bordering the south side of the basin (Figure 3-5).

3.1.2 Basin Boundaries

For this conceptual model, we use the basin boundaries as defined by DWR, which generally follow well-defined geologic features that define clear basin margins. The Basin is bounded on the south side by the Wildcat Range, a mountainous area formed by north-dipping sediments of the Wildcat Group in the southern limb of the Eel River syncline. Specifically, the basin includes the portions of the Wildcat Range underlain by the uppermost (coarse-grained) subunits within the Wildcat Group (primarily the Carlotta and Scotia Bluffs formations). The northern side of the basin is bounded by the Little Salmon fault, a prominent, active, northwest-trending, northeast-dipping thrust fault that accommodates triple-junction related crustal shortening. Paleoseismic studies indicate the Little Salmon fault is the most significant fault within the on-land fold-and-thrust belt; therefore, it clearly represents a significant geologic boundary. The western edge of the groundwater basin abuts the estuary where the Eel River flows into the ocean (that is, the saltwater-freshwater interface along the coast). The eastern limits of the basin are defined by the extent of recharge areas within the two major rivers that enter the basin, the Eel and Van Duzen rivers. The base of the Basin occurs within the upper (coarse grained) units of the Wildcat Group, primarily the Carlotta Formation. The base of the Basin is not well constrained, as the Carlotta Formation is several thousand feet thick in places and exploration of groundwater potential has not penetrated to that depth.

3.1.3 Principal Aquifers

Primary water-bearing units within the Basin include the Carlotta Formation within the upper Wildcat Group and the thick sequence of overlying unconsolidated alluvial deposits. The alluvial aquifer is unconfined, while the Carlotta Formation tends to occur as a confined or semi-confined aquifer. Other poorly-consolidated sedimentary materials in the area, including the Hookton Formation and a variety of uplifted alluvial terraces, are minor aquifers. Deeper units within the Wildcat Group tend to be too fine-grained to be significant groundwater producers.

3.1.3.1 Alluvium

The sediment-rich Eel River flows into the Eel River syncline and has deposited a thick section of unconsolidated alluvium over the down-warped Carlotta Formation. This up to 200 foot thick accumulation of alluvium consists of a variety of materials, tending to be coarser (sands, gravels) in near proximity to the active river channel and finer (silts, clays) beneath the extensive floodplain upon which agriculture and grazing occur. The alluvial aquifer is directly connected hydraulically to the Eel River. The unconsolidated alluvium is a highly productive aquifer that represents the primary water source for most agricultural wells. Most wells in the alluvial aquifer are less than about 70 feet deep and yield relatively high volumes.

3.1.3.2 Carlotta Formation

The Carlotta Formation consists of coarse-grained clastic sediments deposited in a near-shore or terrestrial setting. Based on its texture and regional distribution within the basin, it represents a principal aquifer within the Basin. Groundwater within the unit is typically confined, presumably by silt and clay interbeds or by the locally fine-grained Hookton Formation (which lies stratigraphically above the Carlotta). The Carlotta Formation is known to be in excess of 1,500 feet thick (locally as much as 4,000 feet thick per DWR [USGS, 1978]); however, only the upper part of the Carlotta Formation is exploited by water wells. Wells extracting groundwater from the Carlotta Formation tend to be relatively deep, on the order of 100 to 300 feet deep. Many of the wells that tap into the Carlotta Formation along the base of the foothills are flowing (artesian) wells. Most of the municipal wells in the area utilize the Carlotta Formation aquifer.

3.1.3.3 Aquitards

Well-defined, laterally continuous aquitards in the Basin have not been identified to date. Due to the variability of sediment textures within the alluvial aquifer (varying laterally from coarse-grained near the Eel River, to fine grained near the Wildcat Range front), it is unlikely that laterally persistent aquitards are present. Locally, coarse grained channel deposits may be surrounded by finer-grained floodplain deposits. The Carlotta Formation may contain fine-grained interbeds that form localized aquitards, but these are not well understood.

3.1.3.4 Aquifer Hydraulic Characteristics

Data regarding the hydraulic characteristics of the aquifers within the Basin are generally derived from DWR reports (1959, 1965, 1978).

The alluvial aquifer is a high production unit that is widely utilized for agricultural irrigation. The depth to groundwater is generally shallow, with the water table on the order of a few feet to as many as 20 feet deep. This aquifer is unconfined. Most wells in the alluvium are less than 50 feet in depth. These wells produce at rates that range from 400 to 1,200 gallons per minute (gpm). Specific capacities are typically on the order of 20 to 350 gpm per foot of drawdown (Johnson, 1978), although they may locally be as high as 600 gpm per foot of drawdown (DWR, 1965). Hydraulic conductivities of the alluvial aquifer as measured in new wells installed for this study range from 3 feet per day in the shallow fine-grained sediments west of Ferndale to as high as 420 feet per day in the old channel alluvium adjacent to the Eel River channel.

The Carlotta Formation also contains a large quantity of groundwater that is mostly undeveloped. Groundwater in the Carlotta Formation is confined or partially confined; many wells along the Wildcat range on the south side of the Eel River Valley that are tapped in the Carlotta Formation are flowing wells. Wells tapping the Carlotta Formation are associated with a high level of variability, with production rates on the order of 20 to 1,200 gpm. According to USGS (1978), specific capacities of most wells in the Carlotta Formation range from 15 to 100 gpm per foot of drawdown.

3.1.4 General Water Quality

The quality of groundwater in the Basin is generally good, with the exception of wells near the coast where chloride levels become relatively high. In general, shallow wells in the alluvial aquifer have a higher potential for dissolved solids than deeper wells in the Carlotta Formation. Water quality of groundwater emanating from the alluvial aquifer is adequate for irrigation and stock watering, and has been used as such for decades. Municipal water users typically tap into the deeper Carlotta Formation aquifer, where the potential for high concentrations of dissolved solids is lower. Water quality conditions in the basin are described in the various DWR reports (1959, 1965, 1978) and an analysis of current water quality conditions is provided in Section 3.2.4 below.

3.1.5 Groundwater Recharge Areas

Important recharge areas are shown on Figure 3-8. Surface flows from both the Eel and Van Duzen rivers recharge the alluvial aquifer, as they are directly hydrologically connected. Secondary streams draining the Wildcat Range south of the basin also contribute to the alluvial aquifer. A considerable amount of precipitation falls directly onto the Eel River Valley surface that infiltrates directly to the aquifer.

The Carlotta Formation aquifer is recharged by a variety of sources. The Van Duzen River reach directly upstream of the confluence with the Eel River flows through an area where the Carlotta Formation forms the channel substrate, providing a key recharge area. Additionally, the Carlotta Formation is exposed in several upland areas directly surrounding the basin. In these areas, tributary streams flowing over the Carlotta Formation provide direct surface flow recharge. Secondary aquifers, such as the Hookton Formation and alluvial terraces surrounding the Basin, are similarly recharged by precipitation and surface flows of tributary streams.

3.1.6 Groundwater Discharge Areas

Groundwater discharge areas within the Basin are primarily associated with springs and seeps emanating from upland areas surrounding the basin and the subsurface flow to the tidal estuary along the coast. Due to the high precipitation amounts during winter months, groundwater seeps and springs are common in the area. The city of Fortuna (within the study area) was previously known as "Springtown" due to the abundance of nearby springs. Springs in the area generally feed surface water flows of tributary streams that ultimately reach the primary water courses within the system (the Eel and Van Duzen rivers).

3.1.7 Surface Water Bodies

The Eel and Van Duzen rivers are the primary surface water bodies within the Basin. These are large river systems that drain significant areas of northwestern California (Figure 3-9). The Main stem Eel River is dammed near its headwaters (far from the groundwater basin) at Lake Pillsbury and some flow is diverted to the Russian River system by way of the Potter Valley diversion. Neither the South Fork Eel River nor the Van Duzen River is impounded.

Secondary surface water bodies include a log pond in Scotia and wastewater treatment facilities in the municipalities of Fortuna and Loleta. These sources are insignificant compared to the primary rivers in the groundwater basin.

3.1.8 Imported Water Supplies

There are no significant sources of imported water that enter the Basin.

3.1.9 Groundwater Storage

Previous estimates of groundwater storage (Evenson, 1959; DWR, 1965; USGS, 1978) have been calculated based on storage-unit boundaries, usable saturated thicknesses, and specific yields. Evenson (1959) estimated 125,000 acre-feet (acre-ft) of storage capacity using saturated thicknesses ranging from 10 to 40 feet. Wells used for analysis at that time generally did not penetrate through the shallow alluvial aquifer, so the derived estimates were generally lower than actual total storage. The 1965 DWR study estimated 136,000 acre-ft with a usable storage capacity of 100,000 acre-ft using sea level as a base of the storage (on the west side of the Eel River Valley) and 15 feet below sea level as the base of storage (on the east side of the Eel River Valley). The rationale for a base of 15 feet below sea level was that the Eel River would continue to supply water without impacting seawater intrusion. These estimates were derived from simple volumetric calculations and some judgment on the appropriate base of the storage in a "usable" context. We make similar estimations in Section 3.2.2 below as part of our estimate of seasonal change in groundwater storage.

When considering the total volume of water in storage in the Basin, evaluation of the size and saturated thickness of the alluvial and underlying Carlotta aquifers is appropriate. This is a much more significant number, even though the water wouldn't be considered available for total consumption. The Carlotta Formation extends to depths below 3,000 feet. Even when considering the freshwater/saltwater interface as a lower limit to the freshwater in storage, it is still reasonable to assume there is 500 to 600 feet of available water stored within the eastern two-thirds of the Eel River Valley. Within the Van Duzen watershed, the groundwater elevation climbs, so the corresponding depth to the seawater interface would drop such that the entire Carlotta Formation (approximately 1,000 feet thick within the Van Duzen area) might be of good quality. Using these assumptions and a conservative specific yield value of 10%, the estimated total groundwater storage within the eastern two-thirds of the Eel River Valley (16,000 acres) and the Van Duzen watershed area (10,000 acres) would equal approximately 2 million acre-feet.

3.1.10 Data Gaps in the Hydrogeologic Conceptual Model

Data gaps within the current hydrogeologic conceptual model include the following:

- The validity of the Little Salmon fault as a groundwater barrier is inferred but not well understood. The fault zone associated with the Little Salmon fault is complex and the single lineament shown on maps and in cross sections is a simplification. Similarly, the impacts of secondary faults within the basin (Goose Lake fault, for example) are not well understood.
- The stratigraphy within the Quaternary alluvium is complex. Lateral and vertical stratigraphic variations are the result of a dynamic geologic history influenced by tectonics, sea-level fluctuations and large river systems with high sedimentation rates. The size and configuration of the aquifer(s) associated with the alluvial unit, particularly at depth are not well understood. Similarly, the continuity of silt/clay layers (aquitards) across the basin is not well understood.
- Although the DWR database was reviewed for the current analysis, the location data for the well records is poorly constrained (grouped in sections). A complete and systematic spatial analysis of the well logs has not been conducted to date. Most well records are shallow. The sediments within both the Quaternary alluvium and the Carlotta formation range from clay to gravel, so it can be difficult to interpret the base of the alluvial aquifer, particularly using well driller's logs.
- Little is known about the hydrogeologic character of the Carlotta Formation. The relationship between the base of the alluvial aquifer and top of the Carlotta aquifer is not well understood; there is likely communication between the two in the central part of the basin. Further, there is little available information about aquitards within the unit and the potential for multiple aquifers within the unit. Finally, there is no data relative to the thickness of the water bearing part of the unit; the unit is up to 4,000 feet thick in places.

3.2 Current and Historical Groundwater Conditions (Reg. § 354.16)

The most comprehensive review of historical groundwater conditions in the Eel River basin is the "Groundwater Conditions in the Eureka Area, Humboldt County, California 1975" study published by USGS in 1978. No focused groundwater evaluations or studies aimed at the sustainability of the groundwater resources have been carried out since that time.

For evaluation of groundwater water elevations in the Basin, the CASGEM database was used (http://www.water.ca.gov/groundwater/casgem/). The hydrographs for the CASGEM wells provide the primary data available for analysis of current and historical groundwater elevations in the Basin.

For evaluation of groundwater quality in the Basin, the California Groundwater Ambient Monitoring and Assessment (GAMA) database was used (http://geotracker.waterboards.ca.gov/gama/). The GAMA database provides the primary water quality data available for analysis of current and historical groundwater quality conditions in the Basin.

In order to evaluate current groundwater conditions and begin filling in the data gaps, Humboldt County obtained a Proposition 1 Sustainable Groundwater Planning (SGWP) Grant for a variety of tasks related to assessment of groundwater conditions in the basin. Portions of the scope of work under the grant were completed during the months of August through November 2016, including the following:

1. Three different surface flow studies at up to 12 locations were conducted August 16, 23-24; and October 4, 2016, on the Eel and Van Duzen rivers by Thomas Gast and Associates. The field reports and findings from his work are provided in Appendix E and results from the August 23-24 study are shown on Figure 3-10.
2. Nine monitoring wells were installed by Fisch Drilling between October 26 and November 4, 2016. Six of the wells were paired with both deep and shallow screened intervals. Six were located within close proximity to the rivers for evaluation of the interaction between the surface water and groundwater in those locations, and three wells were located in the Eel River Valley. Details of the monitoring well installation, well logs, and the results of pneumatic slug testing are provided in Appendix F. Monitoring well locations are shown on Figure 3-11.
3. Thirteen pressure transducers were installed in the new monitoring wells, three were installed in select private wells, and four were installed in the river channels to monitor surface water and groundwater elevation changes over the 2017 water year. Approximately 6 weeks of data was downloaded from the transducers on December 10, 2016, and a preliminary analysis of this data along with the hydrographs is provided in Appendix F.
4. Depth to water measurements in 54 wells throughout the basin was performed by a team of staff from SHN, HCRCD, Humboldt County Public Works, and volunteer citizens, Don and Cheryl Laffranchi. Chloride sampling and testing in 27 of the wells within the seawater-freshwater transition zone were conducted during the last week of October and first week of November 2016.

The results of these studies are used to build upon the previous work that has been done characterizing the groundwater conditions within the Basin. An additional round of surface flow measurements, depth-to-water measurements, and chloride testing are planned for 2017. The continuous monitoring using the pressure transducers will continue through the low-flow season of 2017 and additional information will be available at the conclusion of those studies.

3.2.1 Groundwater Elevation Data

Beginning in November 2015, a volunteer member of the Working Group, Cheryl Laffranchi began collecting groundwater elevation data in 16 wells throughout the Eel River Valley and the Van Duzen watershed. Depth-to-water was collected every two months with the last round of sampling occurring on November 1, 2016. Using the March 1, 2016, elevations collected by Mrs. Laffranchi, along with the six CASGEM well elevations measured by DWR on March 29, 2016, an elevation contour map for the spring season in the Basin was prepared (Figure 3-12).

In fall 2016, groundwater elevations were recorded in 54 wells in a coordinated effort with members of the Working Group. Land owners, farmers, and municipal agencies provided access to their wells for the study. The area of focus was limited to the alluvial plains of the Eel River Valley, the Van Duzen River and Yager Creek, with one well in Metropolitan (an unincorporated community near Rio Dell). The wells measured included municipal wells, private wells, and newly-installed monitoring wells. Figure 3-13 shows the locations of wells measured for this study as well as the groundwater elevation contours developed from the data. Table F-3, in Appendix F, provides measurements and available information for each well.

Groundwater contours in both spring and fall 2016 indicate that flow is toward the ocean (westward) with gradients and directions consistent with topography. Flow gradients within the Eel River Valley are generally shallow with fall elevations ranging from approximately 20 feet along the eastern edge of the valley floor to 5 feet nearest the ocean. A much steeper groundwater gradient is observed within the Van Duzen watershed with elevations ranging from 120 feet within the Yager Creek down to 20 feet at the intersection with the Eel River Valley.

An additional round of groundwater elevation measurement is planned for spring 2017. Once complete, the fall 2016 and upcoming spring 2017 elevation data sets will represent the most comprehensive groundwater elevation mapping compiled since the previous groundwater study was completed by the USGS in 1975.

3.2.1.1 Eel River Valley Alluvial Aquifer

The alluvial aquifer within the Eel River Valley is the principal aquifer in the Basin and is the only aquifer that has a documented historical record of groundwater elevation data. Historical groundwater elevations within the Eel River Valley have been recorded in wells beginning as far back as 1951 by the USGS and since the mid-1960s water levels have been recorded on a semi-annual basis by DWR. Groundwater elevation data publicly available as part of DWR's CASGEM program provides the best opportunity to evaluate long term groundwater elevation trends. The locations of the CASGEM wells and hydrographs of the 7 wells currently being monitored are shown on Figure 3-14.

A review of the hydrographs of the CASGEM wells indicates that the groundwater elevations within the valley are stable. The range in elevations between the spring and fall seasons are generally less than 10 feet and on average, the wells within the western portion of the valley have slightly less range between the seasonal high and low levels (5 feet to 7 feet) than do the wells within the eastern side of the valley (8 feet to 10 feet). This is reflective of a consistent gradient towards the ocean.

The hydrograph data also shows that the fall elevations are particularly stable with only very slight deviations from what appears to be a baseline elevation. In fact, the severe drought conditions of 2013 and 2014 showed very little response in the lower elevations. The only two wells with distinguishable effect on the fall water levels were CASGEM wells 23178 and 36942. Of the wells currently being monitored, these two wells are the furthest east and are closest to the Eel River. The relative change in the lower level in these wells was only on the order of 2 feet below the most recent normal year.

The alluvial aquifer within the Eel River Valley is in contact with the ocean on the west and surrounded on the east and north sides by the Eel River. The boundary conditions provided by both the ocean and the Eel River play a critical role in the stability of the groundwater conditions observed in the valley.

The surface level of the ocean presents a physical limit to the level to which the groundwater elevation can fall. Effectively, the coastal margin of the unconfined alluvial aquifer forms a down gradient hinge point in the annual fluctuation of the groundwater surface. This is evident in comparing the spring 2016 and the fall 2016 contour maps (Figures 3-12 and 3-13). The relative change in groundwater elevations between the spring and fall is greatest at the eastern edge of the Eel River Valley, diminishing to no change at the ocean.

The Eel River is in close hydrologic connection with the alluvial aquifer, as discussed above in Section 3.1.5. Three new monitoring wells installed along the Eel River (MW-1, MW-2, and MW-3; Appendix F) encountered sediments with high hydraulic conductivity and their hydrographs show a very strong connection with the river level changes. The capacity for the Eel River to provide significant recharge to the adjacent alluvial aquifer sets up a condition where the base flow within the river channel provides a control on the groundwater elevations within the alluvial aquifer. Essentially, the elevations of the surface water and the groundwater remain at similar elevations through the year. This is evident in the pressure transducer data associated with MW-2 (Appendix F).

It cannot be understated how important the Eel River is to the stability of the groundwater conditions in the valley. This condition was recognized by the author of the 1975 USGS study and Figure 3-15, taken from the 19758USGS report, illustrates the controlling relationship that the river and the ocean play on the groundwater elevations within the alluvial aquifer. The presence of the Eel River maintains stable groundwater levels and maintains a seaward groundwater gradient which holds the seawater-freshwater interface steady in its position.

3.2.1.2 Van Duzen Watershed

The primary aquifer within the Van Duzen river watershed is the thin alluvial valley fill (channel deposits interbedded with flood plain deposits) and the underlying Carlotta Formation, which are known to be in good hydrologic connection. There are no monitoring wells within the Van Duzen watershed from which seasonal and long-term fluctuations can be evaluated.

Of the 16 wells monitored bimonthly by Mrs. Laffranchi, three of them are within the Van Duzen watershed. The seasonal fluctuation in the groundwater elevation ranged from 7 to 12 feet and all three wells showed complete recovery when comparing the November 2015 and 2016 measurements.

The groundwater contour maps for both spring and fall of 2016 (Figures 3-12 and 3-13) indicate a steep hydraulic gradient exists within the Van Duzen alluvial valley with measured elevations in fall ranging from approximately 130 feet in the Yager Creek drainage to 30 feet near the Van Duzen River's confluence with the Eel River. The relative change between the spring and fall groundwater elevations is on the order of approximately 5 to 10 feet.

The steep groundwater gradient within the alluvium/Carlotta Formation is persistent through the year and is a constant and steady source of discharge to the east bank of the Eel River. During the fall season, the losses from the Eel River to the alluvial aquifer within the valley is somewhat offset by the gains from the Van Duzen River and the underlying groundwater.

3.2.2 Seasonal Changes in Groundwater Storage

As discussed in Section 3.1.9, there is a significant amount of water available within the Basin, on the order of 2 million acre-feet; however, the total volume of this water is not "useable" without inducing undesirable impacts to the surface waters and/or causing the seawater interface to migrate landward. For the purposes of evaluating trends in the change in storage, sea level was used as a basal boundary to define the storage capacity. This is a practical lower limit as it relates to seawater intrusion and it simplifies the volume calculation. This lower limit was also used in the 1965 DWR estimate within the western portions of the valley.

Within the Basin, the only long-term data set available to evaluate change in storage over time are the hydrographs for the CASGEM wells. For this reason, our evaluation is focused on the Eel River Valley alluvial aquifer. Based on the similarities in groundwater elevation change between the fall and spring 2016 groundwater contour maps, we conclude that the alluvial aquifer is a good proxy for the Basin as a whole. It should be noted that because we are using a limited area and the sea level as an arbitrary lower boundary, the actual quantity of water is not important, but rather the trends in the annual and cumulative storage over time.

To facilitate the analysis, the Eel River Valley was broken into representative polygons based on position within the Basin and general compositional variations in the aquifer material. Each polygon was assigned to a representative CASGEM well within its area. The polygons and their representative CASGEM wells are shown on Figure 3-16. The area within approximately 1.5 miles of the coast was not considered as it is within the intertidal zone, the fluctuation is small, and the water quality is not good. The height of the spring groundwater elevations in each respective well was multiplied by the area of the associated polygon to derive a bulk volume. This volume was then multiplied by a specific yield estimated for each area to develop a quantity of water in storage. Figure 3-17 shows the change in storage year to year from 1989 to 2016 plotted with the yearly precipitation totals (water year) as measured in Scotia. As expected, the precipitation and storage track very closely with each other. Figure 3-18 plots the cumulative change over the same period with a net positive in 2016.

3.2.3 Seawater Intrusion Conditions

The principal aquifers within the Basin are in good hydrologic connection with the ocean along approximately 10 miles of coastline. The westernmost portion of the valley consists of a broad, low-lying coastal plain within intertidal/brackish marsh and wetlands. The tidal influence within the Eel River extends upstream of Fernbridge approximately 12 miles inland from the mouth.

3.2.3.1 Historical Conditions

In 1975, the USGS published the study "Groundwater Conditions in the Eureka Area, Humboldt County, California 1975"which included an assessment of the freshwater-seawater transition zone in the Lower Eel River groundwater basin. The study concluded that the position of the freshwater-seawater transition zone in the alluvial aquifer in 1975 was approximately the same as the position of the transition zone as documented in 1952 (USGS, 1978). The approximate location of the freshwater-seawater transition zone as mapped in 1975 is shown on Figure 3-19.

The 1975 study used a chloride concentration of 100 milligrams per liter (mg/L) as an indicator of poor-quality water (USGS, 1978). More specifically, the study applied the 100 mg/L concentration limit as an indication of the landward edge of the freshwater-seawater transition zone. The 1975 study referenced additional studies completed by the U.S. Bureau of Reclamation and DWR that also indicated that the landward limit of the transition zone in the alluvium remained fairly constant between 1952 and 1975 (USGS, 1978).

The majority of the wells sampled in the Eel River Valley in 1975 were shallow wells with depths less than 50 feet. The 1975 study showed that some localized temporary shifts in concentrations were observed in the shallow wells, where chloride concentrations varied season to season, and this variation was attributed to the change in groundwater levels from summer to winter. In summer, the naturally lower groundwater levels were considered likely to shift the edge of the transition zone landward, and then in the winter, the seasonal recharge would increase the freshwater head, and cause the edge of the transition zone to shift back seaward (USGS, 1978).

According to the study, almost all of the alluvial aquifer located north of the Eel River, between the Eel River and the Hookton Formation, is naturally degraded by seawater (USGS, 1978). This area adjoins the stretch of the Eel River that is tidally influenced and seawater in the alluvial aquifer is expected in these areas.

South of the Eel River, diluted seawater was detected in the alluvium along the coast where the land-surface altitude of the alluvium was less than 10 feet (USGS, 1978). Further inland from the coast, the chloride concentrations in the shallow groundwater averaged 100 mg/L along the approximate 10-foot land-surface altitude. In the Basin area south of the Eel River, a comparison was made between water from wells drilled at the same depth, with one located on the coast and one located to the east, and it was noted that chloride concentrations at a given depth decrease with distance from the coast (USGS, 1978). It was also noted that chloride concentrations increased with depth along the freshwater-seawater transition line (USGS, 1978).

According to the study, the substantial recharge from the stretch of the Eel River located above the tidal zone in the Eel River provides a seaward hydraulic gradient that sustains freshwater flows above sea level through the area south of the river. This freshwater head helps moderate the natural movement of seawater in the alluvium in this area (USGS, 1978).

Additional historical data collected since 1975 was available through the GAMA database. The GAMA database was queried to identify chloride data collected in the Eel River Valley since 1975. There was one well located in the vicinity of the freshwater-saltwater transition zone that was monitored for chlorides during the period of 1974 through 1989 (Well ID #03N02W35M002H). The data showed relative steady chloride concentrations less than 50 mg/L through the monitoring period.

3.2.3.2 Current Conditions

As part of the data collection effort for the current study, additional chloride samples were collected in select wells during the months of September, October, and November 2016. The sampling program included collecting samples from existing public and private wells, and from new monitoring wells installed as part of the current study. The wells selected for sampling were chosen on the basis of their proximity to the freshwater-seawater transition zone, and were intended to include only those wells screened in the upper aquifer zone. Two of the new wells installed were also located on the basis of proximity to the transition zone, and included paired wells, with varied screened intervals.

A summary of the chloride data collected is presented in Table F-3 (Appendix F) and the sampled well locations are shown on Figure 3-20.

As shown in Table F-3, a few of the existing wells selected for the monitoring program extend into the deeper aquifer zone, and the wells in the deeper zones tended to have higher chloride levels than those in the shallow zones. For the paired wells, higher chloride levels were observed in the deeper zones than in the shallow zones, supporting the previous findings that chloride concentrations increase with depth along the freshwater-seawater transition zone.

As shown in Figure 3-20, the most recent chloride monitoring data generally correlates with the location of the freshwater-seawater transition boundary as identified in 1975. There were three samples located landward of the transition zone that had chloride concentrations greater than 100 mg/L. Two of these wells were located at depths greater than 100 feet and the third well is located north of the Eel River in the tidally-influenced zone.

Review of the recent chloride data in comparison to historical chloride data indicates that no substantial shift has occurred in the position of the freshwater-seawater transition zone in the Basin. As documented in the 1975 study, it appears the recharge from the Eel River into the alluvial aquifer provides enough of a freshwater head to maintain the historical location of the transition zone in general alignment with the approximate 10-foot land-surface altitude.

3.2.4 Groundwater Quality Issues

Data from the GAMA program was used to develop a summary of current and historical groundwater quality issues in the Basin. The dataset includes data monitored at municipal water supply wells and environmental monitoring wells from the period of 1952 through 2016.

3.2.4.1 Regulated Release Sites

Data presented on the State of California GeoTracker® website provides evidence of locations where known impacts to groundwater by historical chemical releases occur. Regulated release sites include those which fall under the State's Leaking Underground Storage Tank (LUST) program, and Cleanup Program Sites (CPS), with the former associated with petroleum hydrocarbon (gasoline, diesel, motor oil, kerosene, et cetera) releases, and the latter typically associated with hydrocarbons and pesticides, herbicides, insecticides, et cetera. Two military cleanup sites were noted west of Ferndale. Additionally, the population centers of Ferndale, Rio Dell, Fortuna, and Loleta operate waste water treatment plants, which release treated effluent to the Basin.

As of December 19, 2016, 90 LUST sites, 14 CPS sites, and 2 military cleanup sites were recorded in the Eel River Groundwater Assessment study area. Only 14 LUST sites currently remain open, with 1 site eligible for regulatory closure, and 7 CPS sites are currently open. Impacts to groundwater quality associated with open regulatory sites presented on the GeoTracker® website are typically limited in extent laterally and vertically, and are unlikely to pose regional scale threats to groundwater quality.

3.2.4.2 Municipal, Industrial, and Agricultural Uses

Constituents of concern for groundwater uses in the Basin include those chemical constituents that are regulated for municipal and agricultural water supply. For municipal supply uses, these constituents are listed in Table 3-2 of the North Coast Basin Plan (North Coast Regional Water Quality Control Board [RWQCB], 2011) and include inorganics, nitrates, pesticides, volatile organic compounds and semi-volatile organic compounds. For the purposes of this study, the identified constituents of concern selected for review included the inorganic chemicals listed in Table 3-2, and five other constituents evaluated for agricultural supply uses.

For the identified constituents of concern, water quality objectives including primary and secondary maximum contaminant levels (MCL) and agricultural use limits, as applicable, were identified using the Marshack Water Quality Goals database (Marshack, 2015). Table 3-1 summarizes the constituents of concern and applicable water quality objectives used for the analysis.

Table 3-1
Applicable Water Quality Objectives for Eel River Valley Groundwater Uses[1]
(mg/L[2], unless otherwise noted)

Chemical/Parameter	MCL[3]	Secondary MCL[4]	Agricultural Limits
Aluminum	1.0	0.2	5.0
Arsenic	**0.01**	**---[5]**	**1.0**
Barium	1.0	---	---
Boron	---	---	0.7
Cadmium	0.005	---	0.01
Chloride	**---**	**250**	**106**
Chromium	0.05	---	---
Lead	0.015	---	5.0
Mercury	0.002	---	---
Nitrate-N (as N)	**10**	**---**	**---**
Selenium	0.05	---	0.02
Silver	---	0.1	---
Sodium	**---**	**---**	**69**
Specific Conductance (umhos/cm)[6]	**---**	**900**	**700**
Total Dissolved Solids	**---**	**500**	**450**

1. Source: Marshack Database, 2015
2. mg/L: milligrams per liter
3. MCL: State of California Primary Maximum Contaminant Level
4. SMCL: State of California Secondary Maximum Contaminant Level
5. ---: not applicable
6. umhos/cm: microSiemens per centimeter

The GAMA dataset was queried to provide a compilation of the monitoring data for each constituent identified in Table 3-1 above. The water quality data compiled from the GAMA dataset was averaged for each 10-year period in the period of record. Appendix G includes a summary of the water quality analysis. Figures G-2 through G-7, included in Appendix G, present a summary of the data for each constituent compared to the relative to the water quality objectives.

As demonstrated in Figures G-2 through G-7 (Appendix G), the groundwater in the Eel River Valley appears to be of high quality and suitable for the intended municipal and agricultural uses. The average concentrations of arsenic, chloride, nitrate-N, sodium, specific conductance and total dissolved solids have all been below their respective water quality objectives for the last 40 years. Furthermore, the water quality trends in the dataset have not shown any significant increase in concentrations in the last ten-year period of record as compared to the entire data set.

3.2.5 Land Subsidence Conditions

There is no evidence that significant land subsidence has occurred within the Basin, and no land subsidence monitoring programs are known to exist. The majority of the sediments within the zone of groundwater fluctuation consist of granular deposits. Some thick deposits of silt and clay can be found within the vicinity of Ferndale, but these areas are not generally tapped for groundwater due to their poor water-bearing characteristics. The total fluctuation of groundwater elevations within the Lower Eel River as shown in the CASGEM hydrographs (Figure 3-14) is generally less than 10 feet. The granular nature of the sediments, the relative stability and consistency in the range of groundwater elevation fluctuations (particularly in the fall elevations), combined with the narrow range of annual groundwater fluctuation suggests that the conditions that could lead to land subsidence do not exist in the Basin.

3.2.6 Identification of Interconnected Surface Water Systems

The primary interconnected surface waters within the boundary of the Basin include the Eel River, Van Duzen River, Yager Creek, and Salt River. Additional surface waters within the basin include the coastal wetlands, springs, and tributary streams within the uplands.

3.2.6.1 Salt River and Coastal Wetlands

The Salt River watershed includes the upland tributary streams emanating from the Wildcat Range and the southern portion of the Eel River Valley (Figure 3-9). The Salt River has been significantly impacted by sediment to the point where many of its low-gradient tributary channels have been in-filled and no longer function to convey surface flow. A major restoration effort is underway, led by HCRCD, and portions of the lower reaches have been opened back up to allow tidal inundation. Most of the Salt River and its tributaries within the valley floor are underlain by fine-grained flood deposits and alluvial materials shed from the southern hillslopes. Infiltration of surface water into these materials is generally slow and flooding during the wet season is common. With the infilled channel conditions, and the frequent flooding, the surface flows associated with the Salt River above the intertidal reach is providing a higher recharge to the alluvial aquifer. The historical infilling has disconnected many of the upper tributary reaches from the alluvial aquifer and the lower portions of the river are controlled by the intertidal water levels.

3.2.6.2 Eel River

The Eel River drains the third largest watershed in California. Mean monthly flows recorded at the USGS gauging station in Scotia range from a high discharge in February of nearly 20,000 cubic feet per second (cfs) to a mean low flow in September of 140 cfs. On average, over 5,000,000 acre-feet flow into the Eel River Valley basin every year. The flows of the Eel River provide a significant component of the recharge to the alluvial aquifer as previously discussed.

The reach of the Eel River that winds past the Scotia, Rio Dell and Metropolitan areas flows over a bedrock channel with only a thin veneer of alluvial material. The bedrock within this reach is primarily composed of consolidated sandstone and mudstone of the lower Wildcat formation, which are not significant water bearing units. It is not until the Eel River enters into the valley, near the confluence of the Van Duzen River, where it transitions from a bedrock channel with thin alluvial cover to a low gradient alluvial plain with relatively thick deposits of channel sediments.

Both the Eel River and the Van Duzen River converge in an area where the topography flattens and the channel widens. Channel morphology is dynamic and a significant volume of gravel is redistributed every year (Figure 3-10).

As a result of the thick accumulations of gravels, there is a significant amount of water that flows through the gravel beneath the channel (underflow). Accurately capturing river flow volumes using surface flow measurement during low flow can be difficult in these reaches.

The Eel River traverses the perimeter of the valley for approximately 5 miles before it enters the intertidal zone near Fernbridge. The groundwater contour maps generated for the spring and fall of 2016 (Figures 3-12 and 3-13) indicate that groundwater consistently flows toward the Eel River from the Van Duzen drainage. This gaining stream condition on the right bank likely continues along the entire 5-mile traverse as there are additional sources of inputs from groundwater from upland sources along this stretch.

A review of the transducer data collected from monitoring wells MW-1, MW-2, and MW-3 along the west side of the river (or left bank) show a dynamic relationship between the river and the adjacent alluvial aquifer (Figures F-5, F-6 and F-7; Appendix F). High flows during precipitation drive groundwater gradients that discharge surface water to the aquifers. At the locations of monitoring wells MW-1 and MW-2, groundwater gradients temporarily reverse when the river levels subside and aquifers discharge to the river. It is expected that as the winter season continues the aquifers will fill up and a more consistent gaining stream condition will be observed.

3.2.6.3 Van Duzen River

The Van Duzen River and Yager Creek flow over a relatively thin veneer of alluvial deposits which overlie the Carlotta formation. The analysis of water level data collected from within monitoring well MW-9 in the Alton area indicate the surface water of the Van Duzen river is providing positive recharge to the shallow alluvial/Carlotta aquifer (Figure F-8; Appendix F). The aquifer elevations show a steep rise with the influx of surface water but appear to maintain the elevations more steadily after surface water levels have receded.

3.2.6.4 2016 Surface Flow Studies

Thomas Gast and Associates conducted three rounds of surface water discharge measurements to evaluate gaining and losing conditions along the Eel and Van Duzen Rivers. Two studies were conducted in August 2016 and one in early October prior to the winter rains. Details of the studies are provided in Appendix E including photos of the measured sections. The most comprehensive of the three studies was conducted on August 23-24, 2016, in which twelve locations within the basin were measured. The results of these measurements and pertinent features that relate to surface water flow conditions are shown on Figure 3-10.

Surface flow measurements along the Eel River show alternating gaining and losing reaches. The most significant change is between station E1 and E2 where a loss of 10 cfs is measured. This reach occurs over the general transition from shallow bedrock to thick alluvial deposits. An abrupt rise in flow between stations E2 and E3 is reflective of the inflow coming from the Van Duzen watershed (very little of which is surface water). Losing stream conditions between stations E3 and E4 are consistent with the strong left bank connection with the alluvial aquifer. An unknown volume of flow may be occurring as underflow within this reach. Gaining stream conditions are inferred from measurements between station E4 and Fernbridge (FB) associated with the inflow from upland sources north of the river and potential bank discharge from tidal fluctuations.

The flow measurements taken on the Van Duzen River and Yager Creek show predominantly losing stream conditions within the basin boundaries. This is consistent with the strong connection with shallow alluvium and the Carlotta Formation throughout this area. Both the lower reach on the Van Duzen River (stations VD2 to VD1) and the Yager Creek reach (stations Y1 to Y2) documented flows that went completely subsurface. Some of this flow is emerging in the Eel River channel and is reflective of the gaining stream measurements between stations E2 and E3.

Previous studies have recognized the important connection that the Eel River has with the alluvial aquifer of the Eel River Valley (DWR, 1965; USGS, 1978). Other than periodic flow studies, little work has been done to quantify the connections the rivers have with their underlying groundwater system. The distribution of new wells installed in 2016 will provide the opportunity to monitor these connections more directly. The continuous monitoring of these locations over the 2017 water year will provide valuable information on the timing and magnitude of the gradient changes through the transition from wet winter conditions to the drier summer and fall conditions.

3.2.6.5 Beneficial Uses and Impaired Surface Waters

Beneficial uses of surface waters are designated on Table 2-1 of the RWQCB Basin Plan (RWQCB, May 2011). Existing beneficial uses for the Lower Eel River and Van Duzen River Hydrologic Areas include:

- municipal and domestic supply;
- agricultural supply;
- industrial service supply;
- groundwater recharge;
- freshwater replenishment;
- navigation;
- water contact recreation;
- non-contact water recreation;
- commercial and sport fishing;
- warm freshwater habitat;
- cold freshwater habitat;
- wildlife habitat;
- rare, threatened or endangered species;
- marine habitat;
- migration of aquatic organisms;
- spawning, reproduction, and/or early development;
- shellfish harvesting; estuarine habitat; aquaculture; and
- Native American culture.

Potential beneficial uses include: industrial process supply and hydropower generation.

The RWQCB maintains a list of pollutant-impaired surface water bodies in accordance with Section 303(d) of the federal Clean Water Act. In 2014, the RWQCB approved Resolution No. R1-2014-0043 which approved the 2012 303(d) List for the North Coast Region. The Lower Eel River Hydrologic Area is listed for temperature and sedimentation/siltation and the Lower Van Duzen River Hydrologic Area is listed for sedimentation/siltation. The RWQCB received requests to consider identifying the Eel River as impaired due to reduced or altered instream flows; however, the RWQCB elected not to make such listings on the 2012 303(d) List.

3.2.6.6 Long-Term Flow Trends

Recent studies have identified declining streamflow trends in the mainstem Eel River gaging station at Scotia and most Eel River tributaries during the low-flow season (especially July through mid-October) over the 1953-2014 period (Asarian, 2015; Asarian and Walker, 2016). According to the Eel River Action Plan (Eel River Forum, 2016):

> "Low-flow conditions were a common and natural hydrologic condition in the Eel River even when the watershed was pristine and streamflows were unimpaired. Analysis of precipitation and streamflow data for the North Coast and in the Eel basin particularly suggests that the length and severity of low flow periods in the Eel River have increased more than can be explained by variations in rainfall.
>
> It is generally accepted that natural low-flow conditions in the Eel River have been compounded by human-caused factors, the most significant being: (1) sedimentation from timber harvest, landslides, and poorly constructed and maintained road networks that cumulatively has filled pools, reduced pool volumes and reduced hyporheic (sub-surface) flow, and increased transient rates of water out of watersheds, (2) conversion of pristine old growth forests to crowded, thirsty stands in a heavily roaded landscape (conversion of conifer-dominated forests to younger and more densely stocked deciduous-dominated forests that may increase evapotranspiration rates and thereby lower surface runoff) and (3) streamflow diversions which continue to increase as a result of (legal) appropriative and riparian water rights as well as unauthorized (illegal) diversions for marijuana production."

Impacts associated with surface water diversions for marijuana cultivation for three tributaries in the Eel River watershed are analyzed in Bauer *et al* (2015). This study concluded that water demand for marijuana cultivation has the potential to divert substantial portions of streamflow during low-flow periods.

3.2.7 Identification of Groundwater-Dependent Ecosystems

The U.S. Fish and Wildlife Service's (FWS) National Wetlands Inventory (NWI) program developed a wetland classification system (Cowardin et al. 1979) that is now the official FWS wetland classification system and the Federal standard for wetland classification. Throughout the United States, NWI locates and maps wetlands, riverine systems, and phreatophytic vegetation. These data are frequently used for strategic habitat conservation planning. Groundwater dependent ecosystems within the study area include freshwater emergent wetlands, forested/shrub wetlands, ponds and lakes, in addition to riverine and estuarine habitats (Figure 3-21).

3.3 Water Budget Information (Reg. § 354.18)

Palmer Environmental Consulting Group, Inc. (PECG) was retained to prepare a water budget for the Basin. The objective of the PECG Water Budget Study is to quantify the volume of water entering and leaving the basin, and to evaluate how these volumes compare with the water demand over the last 10 years. The PECG water budget report for the Basin, along with supporting figures and data tables, is included as Appendix H.

It is important to note that the water budget for the Basin and contributing watersheds is limited by the available data, particularly in the upper basin, and in areas of the Yager Creek and upper Van Duzen watersheds. Only limited recent and long-term data sets for groundwater levels, surface water flow, precipitation, temperature, and water use are available for these areas. In addition, the lower Eel River Valley is a highly-complex system that is influenced by shallow and deep groundwater flow systems, gaining and losing watercourses, large differences in precipitation and temperature between upland and lowland areas, and ocean tides. Insufficient data is available at this time to confidently utilize a computational groundwater model (i.e., Modflow) as these models are limited by the input data.

PECG utilized a Geographic Information System (GIS) water budget model based on the best available information to provide, long-term (i.e., 30-year) and yearly estimates of water budget parameters over the past 10-years (precipitation [P], evapotranspiration [ET], groundwater recharge [R], and surface water runoff [RO]). This information has been summarized for the Basin, as well as for the full watershed area of the contributing watercourses. This simplified approach is designed to reduce uncertainty and provide an estimated water budget that is commensurate with the quantity and quality of available data.

The water budget provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical and current water budget conditions, and the change in the volume of water stored. Specifically, the following items have been addressed in their report, which are consistent with the SGMA requirements:

- Total surface water entering and leaving a basin by water source type.
- 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.
- Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.
- The change in the annual volume of groundwater in storage between seasonal high conditions.
- 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.
- The water year type associated with the annual supply, demand, and change in groundwater stored.

The results of the analysis indicate that over the past 10-years, groundwater storage has ranged from 674,773 acre-ft/yr in 2006 to -387,708 acre-ft/yr in 2012. Over this 10-year period, there have been 5 dry water years (2008, 2009, 2013, 2014 and 2015), and the overall changes in groundwater storage has remained positive at an average of 81,167 acre-ft/ yr. This result is consistent with the long-term stable groundwater levels and change in groundwater storage as determined from in the CASGEM wells (Figure 3-14), and strongly suggests that groundwater storage in the basin is not being overdrawn. This was also concluded by Johnson (1978) that the lack of a downwards water level trend indicates that the basin is not being overdrawn.

The groundwater storage volumes already take into account current volumes of water used for irrigation, municipal and domestic supply, so the estimated available groundwater in the basin is 85,564 acre-ft/yr. As summarized in Table 3-2 (PECG, 2016; Appendix H), groundwater withdrawals account for only a small percentage of the overall water budget in the Eel River Valley Groundwater Basin.

Table 3-2
Groundwater Withdrawal Comparison to Water Budget Results

Groundwater Extraction Relative to Water Budget	Total Water Inflow	Total Recharge in Study Area	Total Recharge in lower Eel River Valley	Average Yearly Change in Groundwater Storage + Withdrawals
% of Groundwater Extraction	0.3%	4%	9%	17%

The analysis in Appendix H addresses historical and current water budget conditions, but does not develop quantified estimates for projected water budget conditions. Projected water budget conditions were not developed because (1) there are limited data to support meaningful quantifiable estimates, and (2) existing information is sufficient to conclude that water budget conditions within the next five years will be closely comparable to existing conditions. Support for this conclusion includes the low anticipated annual population growth of 0.4 to 0.6% (Section 2.8.1); the stability of irrigated land areas, irrigation water use, and municipal water use historically (Section 2.6); and the absence of significant expected changes in agricultural irrigation (Appendix D). Future water budget conditions will be driven by variability in precipitation and watershed-scale factors, but will not be significantly affected by changes in water use within the Basin.

The water budget model described in Appendix H is suitable for estimating groundwater storage volumes, but is not an appropriate tool for estimating sustainable yield, defined by SGMA as "the maximum quantity of water… that can be withdrawn annually from a groundwater supply without causing an undesirable result." As discussed in Section 4.0, there is sufficient information to demonstrate that undesirable results are not present within the Basin and are unlikely to occur given the hydrogeologic conditions and water use patterns. However, there is insufficient information to establish minimum thresholds for undesirable results, and there is insufficient information on the dynamics of the system to accurately predict how sustainability indicators would respond to significant increases in water extraction or other changes in water budget conditions. Predicting these effects would require a computational surface water-groundwater flow model and a flow study to determine the minimum instream flows necessary to maintain beneficial uses. This level of analysis is far beyond the scope of the ongoing Basin Assessment study. Therefore, Humboldt County, with support from the Working Group, determined that it would be inappropriate to formulate an arbitrary estimate for sustainable yield without a valid scientific basis. Speculating on a numerical value would likely be more confusing or misleading than helpful for management purposes, and is unnecessary to demonstrate sustainable groundwater management within the Basin.

4.0 Sustainable Management Criteria

4.1 Sustainability Goal *(Reg. § 354.24)*

The Sustainability Goal for the Basin is to maintain high quality and abundant groundwater resources in support of existing and long-term community needs without causing undesirable results.

4.2 Undesirable Results *(Reg. § 354.26)*

This section describes the evaluation that was performed for each of the six sustainability indicators to determine whether undesirable results caused by groundwater conditions throughout the Basin are present or likely to occur.

4.2.1 Groundwater Levels

The undesirable result associated with this sustainability indicator is chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply. Figure 3-14 (presented in Section 3.2.1.1) shows the locations of seven CASGEM wells with long-term groundwater elevation data collected by DWR, and hydrographs for each well. The earliest monitoring data were collected starting in the early 1950s. Monitoring has been performed biannually and depicts historic trends for spring and fall conditions. Overall, groundwater levels at the basin scale have been generally stable, including during the droughts of 1976-1977 and 1987-1992, and recent drought conditions from 2013 through 2015. Well elevation levels generally do not drop below a minimum elevation during droughts. This finding is supported by the hydrogeological conceptual model (presented in Section 3.1) which documents highly favorable conditions for reliable recharge. Groundwater use is a small percentage of annual recharge and a small percentage of groundwater storage volume. In addition, groundwater elevation monitoring performed in over 60 wells distributed across the Basin in fall 2016 did not identify any groundwater levels of concern. Further, water use within the Basin over the next five years is projected to be closely comparable to existing conditions (Section 3.3). This evidence is sufficient to demonstrate that undesirable results associated with groundwater levels are not present and unlikely to occur.

4.2.2 Groundwater Storage

The undesirable result associated with this sustainability indicator is significant and unreasonable reduction of groundwater storage. Technical evaluation of groundwater storage within the Basin is presented in Section 3.1.9. Groundwater storage is closely related to groundwater levels, and the information provided in Section 4.2.1 is sufficient to demonstrate that undesirable results associated with groundwater storage are not present and unlikely to occur.

4.2.3 Seawater Intrusion

The undesirable result associated with this sustainability indicator is significant and unreasonable seawater intrusion. As discussed in Section 3.2.3, the position of the seawater/freshwater transition zone mapped in 2016 is comparable to the extent measured by the USGS in 1975. This evidence is sufficient to demonstrate that undesirable results associated with seawater intrusion are not present and unlikely to occur.

4.2.4 Water Quality

The undesirable result associated with this sustainability indicator is significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies. As discussed in Section 3.2.4, water quality data collected as part of the GAMA Program indicates high quality groundwater conditions with respect to nutrients. Further, existing public agency records indicate there is an absence of a large-scale contaminant plume affecting water supplies. This evidence is sufficient to demonstrate that undesirable results associated with water quality are not present and unlikely to occur.

4.2.5 Land Subsidence

The undesirable result associated with this sustainability indicator is significant and unreasonable land subsidence that substantially interferes with surface land uses. Technical evaluation of land subsidence is presented in Section 3.2.5. The granular nature of the sediments, the relative stability and consistency in the range of groundwater elevation fluctuations, and the narrow range of annual groundwater fluctuation provide sufficient evidence to demonstrate that undesirable results associated with land subsidence are not present and unlikely to occur.

4.2.6 Beneficial Uses of Interconnected Surface Water

The undesirable result associated with this sustainability indicator is depletion of interconnected surface water that has significant and unreasonable adverse impacts on beneficial uses of the surface water. Beneficial uses for the Lower Eel River and Lower Van Duzen River are described in Section 3.2.6.5.

Evidence for this sustainability indicator includes the following:

- Groundwater levels have been generally steady since DWR began collecting data in the early 1950s.
- The cumulative rate of groundwater use has been steady since the 1960s (HCRCD, 2016).
- Groundwater extraction is generally dispersed across the valley and not concentrated along surface water interfaces.
- Results of the preliminary water balance indicate that groundwater use represents approximately 4% of annual recharge to the Basin (Section 3.3).
- The Lower Eel River normally maintains deep pools (depths of 7 to 14 feet) through the low-flow season, especially near the right bank where the river is receiving significant recharge from the east (Stillwater Sciences, 2015).
- There is little difference in the CASGEM well water levels between fall 2014, a drought year when flow in the Eel River went subsurface in late August, and fall 2016, a more normal water year. This lack of difference suggests that groundwater use within the Basin was not associated with the exceptionally low flow level in the Eel River in 2014.

- As described in Section 3.2.6.6, the primary anthropogenic causes of reduced streamflows in the Eel and Van Duzen Rivers are upstream diversions and changes in forest composition, both of which occur at the watershed scale. In addition, the stream channels are impacted by sediment deposits associated with the 1955 and 1964 floods.
- In 2014, the Regional Water Board elected not to list the Eel River as impaired for flow on the North Coast's 2012 303(d) List.

This evidence is sufficient to demonstrate that groundwater use within the Basin is not causing undesirable results associated with beneficial uses of interconnected surface waters, and such results are unlikely to occur.

4.2.7 Criteria for Undesirable Results

23 CCR §354.26(b) discusses the development of criteria to quantitatively define when and where the effects of groundwater conditions are causing undesirable results. However, criteria are not required when it is demonstrated that undesirable results are not present and are not likely to occur [23 CCR §354.26(d)]. Based on the preceding analysis for each of the six sustainability indicators, Humboldt County concludes that development of criteria for undesirable results is not required.

4.3 Minimum Thresholds *(Reg. § 354.28)*

"**Minimum threshold**" is defined in SGMA as "a numeric value for each sustainability indicator used to define undesirable results" [23 CCR §351(t)]. 23 CCR §354.28 discusses the development of minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each established monitoring site or representative monitoring site. The numeric value used to define minimum thresholds represents a point in a basin that, if exceeded, may cause undesirable results. However, minimum thresholds are not required when it is demonstrated that undesirable results are not present and not likely to occur [23 CCR §354.28(e)]. Based on the analysis in Section 4.2 for each of the six sustainability indicators, Humboldt County concludes that development of minimum thresholds for undesirable results is not required.

4.4 Measureable Objectives *(Reg. § 354.30)*

"**Measurable objectives**" are defined in SGMA as "specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin" [23 CCR §351(s)]. 23 CCR §354.30 specifies that measurable objectives shall be established using the same metrics and monitoring sites as are used to define the minimum thresholds. Based on the analysis in Section 4.2 and the conclusion in Section 4.3 that minimum thresholds are not required, Humboldt County concludes that development of measurable objectives are not required for this GSP Alternative.

Humboldt County proposes a different, but functionally equivalent, goal-setting framework that is appropriate for Basin conditions and the current state of scientific data and understanding. This framework is based on identifying measurable parameters and target conditions, where applicable. The framework is presented in Table 4-1.

Table 4-1 Goal-Setting Framework			
Sustainability Indicator	**Measureable Parameter**	**Evaluation**	**Target Conditions**
Groundwater levels	Water levels in selected wells	Comparison with historical trends	Continued stable trends
Groundwater storage	Water levels in selected wells (proxy)	Comparison with historical trends	Continued stable trends
Seawater Intrusion	Chloride Concentrations	Mapping of seawater/ freshwater transition zone (100 mg/L iso-concentration line)	No change in position of transition zone
Water Quality	N/A[1]	N/A	N/A
Land Subsidence	N/A[2]	N/A	N/A
Beneficial uses of interconnected surface water	N/A[3]	N/A	N/A

1. Existing drinking water and contaminant site programs are sufficient for ensuring suitable water quality. No additional monitoring or evaluation within the context of the GSP Alternative is warranted.
2. The underlying conditions for potential land subsidence are not present.
3. A measurable parameter has not been defined for this sustainability indicator due to incomplete data and information. The results of monitoring performed over the next five years will support re-evaluation of a measureable parameter for this indicator during preparation of the five-year update.

4.5 Monitoring Network

4.5.1 Description of Monitoring Network (Reg. § 354.34)

The monitoring network proposed for future use in evaluating groundwater conditions in the Eel River Valley includes a sub-set of the series of groundwater wells and river monitoring stations that were used for the current study. Figure 4-1 shows the proposed monitoring network.

One of the tasks under the SGWP grant obtained by the County included the installation of nine new monitoring wells in the Eel River Valley. These new wells provide a good distribution of sampling points along the river system and up into the Van Duzen watershed. Six wells are in locations within close proximity to the rivers for evaluation of river/aquifer connection, and three wells are located in the Eel River Valley. Six of the new wells are also paired wells with screened intervals in both the shallow and deep aquifer zones. These new wells will be included as part of the monitoring network. The County will also continue to support DWR in the monitoring of the CASGEM well network and its information will continue to provide data on the groundwater conditions within the Eel River Valley interior. The USGS Scotia gauging station (Station No. 11477000) and the USGS Bridgeville gauging station (Station No. 11478500) will both continue to be used to provide consistent surface flow monitoring data for the Eel and Van Duzen Rivers, respectively.

The proposed monitoring network, as shown in Figure 4-1, will be capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions. The County is proposing to conduct bi-annual depth-to-water measurement in the new monitor wells and will maintain a pressure transducer in one monitoring well for continuous data collection. The County is also proposing to conduct bi-annual chloride testing in two of the monitoring wells with a full suite of chloride testing conducted in all wells once every five years. Table 4-2 summarizes the proposed future monitoring program.

Table 4-2 Proposed Monitoring Network and Sampling Program Eel River Valley Groundwater Assessment			
Location	**Analysis**	**Frequency**	**Responsible Agency**
CASGEM[1] Wells	Depth-to-Water (feet)	Bi-annually	DWR[2]
River Stations	River Stage (feet)	Continuous	USGS[3]
County Monitoring Wells (All)	Depth-to-Water (feet)	Bi-annually	County
	Chlorides (mg/L)[4]	1X/5 Years	County
MW-2	Depth-to-Water (feet)	Continuous	County
MW-5/MW-7	Chlorides (mg/L)	Bi-annually	County

1. CASGEM: California Statewide Groundwater Elevation Monitoring
2. DWR: State of California Department of Water Resources
3. USGS: U.S. Geological Survey
4. mg/L: milligrams per liter

Additional work already scheduled to be completed by the County under the SGWP grant includes review of surface water and groundwater changes over the 2017 water year. The County currently has 20 transducers installed in 16 wells, and four of the well locations with transducers have paired transducer located in the adjacent river channels. This data will be reviewed at the end of the 2017 water year and will be used to build upon the previous work that has been done with regards to characterizing the groundwater and surface water interactions within the basin. The County is also planning on conducting another full suite of chloride monitoring in the spring 2017.

4.5.2 Monitoring Protocols for Data Collection and Monitoring (Reg. § 352.2)

On December 27, 2016, DWR published Best Management Practices (BMPs) for the Sustainable Management of Groundwater (DWR, 2016). The BMPs include a series of five documents that provide regulatory clarification, technical guidance, and general examples to assist GSAs and inform local agencies and stakeholders. The first BMP provides guidance on Monitoring Protocols, Standards and Sites; and the second BMP provides guidance on Monitoring Networks and Identification of Data Gaps.

The technical standards, data collection methods, and other procedures and protocols developed and used for the data collection efforts undertaken as part of the current study will be reviewed for adherence to the 2016 BMPs and modified as necessary to meet the objectives of the BMPs for future data collection efforts. Any changes in the technical standards, data collection methods, and other procedures and protocols used for future monitoring events will be detailed in the annual report and the next 5-year Alternative Plan submittal.

4.5.3 Representative Monitoring (Reg. § 354.36)

The County is proposing to conduct bi-annual depth-to-water measurements in the new monitoring wells and will maintain a transducer in one monitoring well for continuous data collection. Monitoring well MW-2 was selected as the representative well for continuous data collection as it is located immediately adjacent to the river near the confluence of the Van Duzen and the Eel River. The County is also proposing to conduct bi-annual chloride testing in two of the monitoring wells, with a full suite of chloride testing conducted in all wells once every five years. Monitoring wells MW-5 and MW-7 were selected as the representative wells for the bi-annual chloride testing. Both wells are located near the identified freshwater-seawater transition zone and are paired wells, with shallow and deep screened intervals.

4.5.4 Assessment and Improvement of Monitoring Network (Reg. § 354.38)

A thorough review and evaluation of the proposed monitoring network will be conducted following review of the 2017 water year data to determine if any additional monitoring network components are needed. For instance, additional continuous transducer monitoring actions may be added to the program, as needed or the chloride sampling program may be expanded to include additional wells based on new information. Review and evaluation of the proposed monitoring network will also be conducted as part of the annual reporting program. The annual report will identify any data gaps in the monitoring program and include a description of the steps taken to fill the data gaps, as necessary.

5.0 Projects and Management Actions to Achieve Sustainability Goal *(Reg. § 354.44)*

23 CCR §354.44 specifies that "Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal of the basin, including projects and management actions to respond to changing conditions in the basin."

Based on the evaluation presented herein, the Sustainability Goal for the Basin is being met and will continue to be met for at least the next five years. Therefore, Humboldt County concludes that periodic monitoring is sufficient, and projects or additional management actions are not needed to achieve the Sustainability Goal.

It's important to note that voluntary actions for water conservation within the Basin are expected to continue. For example, the U.S. Department of Agriculture – Natural Resources Conservation Service (NRCS) implements the Environmental Quality Incentives Program, and in 2014 NRCS received supplemental funding for drought assistance in California. NRCS has supported producers within the Basin to improve irrigation hardware and prepare irrigation management plans to optimize efficiency. In addition, the City of Fortuna has implemented various conservation measures and has seen a steady reduction in per capita water use over the last ten years (City of Fortuna, 2016).

The current monitoring network (described in Section 4.5) has been expanded with support from the Proposition 1 Sustainable Groundwater Planning Grant and volunteer participation by Working Group members and Basin stakeholders. Ongoing monitoring will provide relevant, high-quality data and information to support a continuously improving understanding of groundwater conditions and verification of sustainable groundwater management. Humboldt County will develop a data management system to compile the data and make it publicly available, and will continue to share information at meetings of the Working Group.

In the event of (1) a significant change in Basin conditions, or (2) significant new data or information that may warrant re-consideration of the findings of this GSP Alternative, Humboldt County will:

- Discuss the situation with the Working Group, DWR, and other stakeholders as appropriate.
- Determine what additional data, information, or analysis are needed.
- Determine what funding may be needed, and pursue funding sources or collaborative opportunities.
- Assess whether the evaluation can occur within the framework of the five-year assessment (Section 6.2) or whether an expedited timeline is warranted.
- Assess whether the goal-setting framework should be updated, and whether there is sufficient basis to establish minimum thresholds or measurable objectives.
- Develop an action plan for responding to the changing conditions or new data/information.

Based on the current understanding of groundwater conditions in the Basin, this level of planning is reasonable and appropriate for the GSP Alternative, and detailed plans for potential projects or management actions are unwarranted.

The total budget for the Basin Assessment currently in progress is $270,418, of which $250,00 is funded through the Proposition 1 grant and the remainder is funded through the County's General Fund. After completion of the Basin Assessment, the estimated cost to coordinate the Working Group and perform annual monitoring is approximately $15,000 to $20,000.

6.0 Annual Reports and Periodic Evaluations

6.1 Annual Reporting

Humboldt County will submit annual reports to DWR by April 1 of each year following approval of the GSP Alternative. The annual reports will include the required components for the preceding water year as specified at 23 CCR §356.2, including general information; a detailed description and graphical representation of basin conditions, as applicable; and a description of progress implementing the GSP Alternative.

6.2 Periodic Evaluations

Humboldt County will evaluate the GSP Alternative at least every five years and whenever the GSP Alternative is amended, and provide a written assessment to DWR. The five-year assessment will describe whether the Basin continues to meet its Sustainability Goal and include the information specified at 23 CCR §356.4, as applicable.

7.0 References (Reg. § 354.4)

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