Land Use Inventory for the Eel River Valley Groundwater Basin

Prepared for:
Eel River Valley Groundwater Basin GSP, 2022

HUMBOLDT COUNTY DPW

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1. Introduction

The Eel River Valley Groundwater Basin (ERVB), as defined by California Department of Water Resources (DWR), occurs at the downstream end of the Eel River watershed (Figure 1). This Land Use Inventory/Geodatabase Technical Memorandum used the best available information to develop an inventory of land use for the water balance in the ERVB for use in the Eel River Valley Groundwater Sustainability Plan (GSP). Multiple datasets and information are presented and evaluated in this technical memo to support development of an accurate land use inventory/geodatabase for the ERVB.

The purpose of this technical memorandum is to summarize the analysis completed to determine the number of acres for six different land use types with distinctive evapotranspiration rates within the ERVB groundwater basin: (1) irrigated lands, (2) impervious areas, (3) open water, (4) riparian areas, (5) areas with natural vegetation, and (6) urban landscapes. These land use categories are utilized by DWR and are applied in this Technical Memorandum for consistency with DWR's current standard practice. It's important to note that non-irrigated agricultural land will be grouped within the "natural vegetation" category. It is necessary to attribute all lands within the ERVB groundwater basin to the most appropriate land use category in order to complete the water budget. This technical memorandum also compares resulting values with DWR's 2018 land use database and discusses possible explanations for differences between the two land use databases.

1.1 Datasets Used in Land Use Analysis

The datasets applied in land use analysis include data sources from partner agencies and other partners. The data used for compiling the land use inventory was collected by the County of Humboldt (County), Humboldt County Resource Conservation District (HCRCD), DWR, Stillwater Sciences, and GHD. The following list summarizes the sources used by each agency for developing the separate parts of the land use inventory database. More information on the development of the database can be found in Section 2.1- ERVB Irrigated Land Use Acreages.

- Irrigated Acreage 2021 Geodatabase was developed by the County and HCRCD using the following sources:
  - Department of Water Resources (DWR) Groundwater Basin 1-10 boundary GIS polygon (updated October 2018)
  - 2020 NAIP aerial imagery
  - Interviews with agricultural producers
  - Consultations with current and previous owners of North Coast Pumphouse and Jeff Stackhouse, University California Cooperative Extension
  - ESRI Shapefiles from Irrigation Water Use Study, dated December 8, 2016 and included as an appendix in the County's Groundwater Sustainability Plan Alternative (Humboldt County, 2016)
- County and Municipal Parcel Geodatabase was developed by Julia Clark of GHD using the following sources:
  - Parcel data was received from the County of Humboldt in January 2021
  - Community Services District boundaries were downloaded from the county GIS data portal and dated August 2020
  - Del Oro Water Company and Riverside CSD boundaries were provided by Humboldt County in March 2021
  - Bear River Band Rancheria (BRB) parcels were identified by a former BRB employee
  - City boundaries were downloaded from the county GIS data portal and dated July 2019
  - A spatial dataset of building outlines was provided by the County in March 2021 as a GIS layer

- Groundwater Dependent Ecosystems Geodatabase was developed by Stillwater Sciences, and was divided into two sub-sections, Vegetation Communities and Special-Status Species, using the following sources:

  Vegetation Communities:

  – USDA (U.S. Department of Agriculture) 2014. Classification and Assessment with Landsat of Visible Ecological Groupings (CalVeg). Region 1: North Coast: Imagery date: 2000–2007. https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192 [Accessed March 2021].

  – USDA (U.S. Department of Agriculture) FSA Aerial Photography Field Office. 2020. National Agriculture Imagery Program. Mosaicked County Image for Humboldt, CA.

  – USDA (U.S. Department of Agriculture) FSA Aerial Photography Field Office. 2020. National Agriculture Imagery Program. Mosaicked County Image for Humboldt, CA.

  – H.T. Harvey & Associates. 2015. 2015 Quantitative habitat monitoring for the Salt River Ecosystem Restoration Project. Final Report. Prepared for Humboldt County Resource Conservation District, Eureka, California.

  – United States Department of Agriculture-Natural Resources Conservation Service (NRCS). 2016. Web Soil Survey. Available online at https://soilseries.sc.egov.usda.gov/OSD_Docs/F/FERNDALE.html/, accessed November 4, 2020.

  Special-Status Species

  – CDFW (California Department of Fish and Wildlife). 2020a. California Natural Diversity Database. RareFind 5 [Internet], Version 5.1.1. [accessed: November 2020].

  – eBird. 2021. eBird: An online database of bird distribution and abundance. Website [accessed November 2020]. eBird, Cornell Lab of Ornithology, Ithaca, New York.

  – TNC (The Nature Conservancy). Freshwater species list for Eel River Valley Groundwater Basins. https://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries. [Accessed March 2021]

  – NMFS (National Marine Fisheries Service). 2021. California Species List Tools. http://www.westcoast.fisheries.noaa.gov/maps_data/california_species_list_tools.html [Accessed May 2021]

  – Consortium of California Herbaria (CCH) (queried from CCH1 Berkeley Mapper and CalFlora 2021)

- The ET Land Use Geodatabase was developed by GHD using the following sources:
  – Polygons of irrigated areas provided by Humboldt County in November 2021
  – Polygons of groundwater dependent ecosystems (GDEs), provided by Stillwater Sciences in April 2021
  – Parcel dataset from the water/wastewater demand calculations created by GHD in March 2021
  – Image classification developed by GHD in May 2021
  – A spatial dataset of building outlines was provided by the County in March 2021 as a GIS layer
- The CADWR Land Use Geodatabase was developed by Land IQ under contract for CADWR. The application is defined by the following information:
  – Title: i15_Crop_Mapping_2018
  – Publication Date: 2021-02-08
  – Edition: 2021.02.08
  – Presentation Formats: digital map
  – FGDC Geospatial Presentation Format: vector digital data
  – Other Citation Details:

    CDWR Land Use Viewer: https://gis.water.ca.gov/app/CADWRLandUseViewer/ Statewide Crop Mapping on California Natural Resources Agency (CRNA) Open Data Portal:

https://data.cnra.ca.gov/dataset/statewide-crop-mapping. SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#waterbudget

2. Database Development

The five datasets summarized in Section 1 were used to assign land use attributes to all lands within the ERVB groundwater basin. Different land use types require different quantities of consumptive water. Additionally, variability in land use results in differences in infiltration (pervious versus impervious surfaces) and evapotranspiration. To understand the numeric implications of these differences, identifying land uses for the entire groundwater basin is necessary to determine the associated total water consumption of all land use types and complete the water budget.

2.1 Inventory of Irrigated Land Areas

The Humboldt County Resource Conservation District (HCRCD) developed an inventory of irrigated land areas in 2016 to assist the County of Humboldt (County) in the quantification of extracted groundwater within the ERVB for agricultural irrigation use. The results were published as a Technical Memorandum (Irrigation Water Use Study, dated December 8, 2016) and included as an appendix in the County's Groundwater Sustainability Plan Alternative (Humboldt County, 2016). In 2016, a total of 13,558 acres were irrigated by groundwater, primarily for pasture (including grazed pasture, hay production, and silage production).

In 2018, DWR updated their land use dataset to incorporate current data provided by HCRCD (Alternative Plan 2016) as part of DWR's basin reprioritization. In 2021, the HCRCD updated the inventory of irrigated lands by identifying and characterizing irrigated lands within the basin for 2021. Factors used to classify land as irrigated included: 1) Land being irrigated in 2021; and 2) Land with irrigation equipment infrastructure in place that would allow for irrigation. This process is similar to that used in the 2016 study with one exception. The 2016 study also considered if the land was irrigated anytime during the previous 5 years. Since 2016, the number of irrigated acres decreased by 593 acres. This includes 80 acres of land that was not irrigated in 2016, but due to recently installed new irrigation equipment, now allows for additional irrigated acres. There was no noted change in surface water use for irrigation purposes. Factors leading to the decrease in irrigated acres are related to coastal dune erosion and winter storm events causing seawater flooding of adjacent agriculture fields, chloride content in wells, and well failure. Below is an explanation of decreased irrigated acres by Assessor's Parcel Number (APN):

- APNs 100-143-002, 100-143-003, and 100-143-004: total decrease of 200 acres due to coastal dune erosion and winter storm events causing seawater flooding of agriculture fields.
- APNs 100-142-003 and 100-142-012: total decrease of 94 acres due to well capacity limitation and inability to meet irrigation pumping needs, well failure and a change in land management priorities.
- APNs 310-051-006 and 310-071-007: total decrease of 63 acres due to chloride content in groundwater well. Chloride test results indicate 320 mg/L in October 2020.
- APNs 309-161-005 and 309-161-004: total decrease of 94 acres due to land management change to dry farming. Neighboring wells showed elevated chloride concentrations of 1,600 mg/L in March 2017 and 1,500 mg/L in April 2021.
- APN 309-191-004: total decrease of 23 acres due to lack of proper winter drainage causing excessive seasonal flooding and ponding, which eliminates the need to irrigate due to retained soil moisture. Corn has been a primary crop on this parcel for the past 2 years.
- APN 308-141-020: total decrease of 119 acres due to slough levee erosion, winter storm events causing seawater flooding of agriculture fields, and salt content in groundwater well. Chloride test results indicate 260 mg/L in October 2020 and 330 mg/L in April 2021.
- APN 201-322-030: total decrease of 30 acres due to a change in land management. Area is now dry farmed.

- APN 203-181-045: total decrease of 13 acres due to change in land management. In 2016, quinoa was grown. Area is now dry farmed and grazed.
- APN 204-271-031: total decrease of 11 acres due to land management change to dry farmed and grazed.
- APNs 204-360-012, 204-360-011, 204-360-019, 204-360-010: total decrease of 26 acres due to a change in land management. Area is now dry farmed and grazed.

The 2021 updated study estimates the total area of irrigated land using groundwater, surface water, and reclaimed wastewater in the ERVB (Figure 1). Table 1 describes the amount of estimated irrigated land (acres) and sources of water used. Several pasture sites in the Ferndale, Fernbridge, Rio Dell/Metropolitan, and Scotia areas are irrigated using reclaimed wastewater from treatment plants (e.g., City of Ferndale, City of Rio Dell, Town of Scotia wastewater treatment plants) or from a milk production facility (i.e., Humboldt Creamery). Pastures where irrigation water is sourced from springs or surface water diversions are characterized as irrigated by surface water.

Groundwater is the principal irrigation water source in the basin, accounting for 12,952 of the total 13,430 acres irrigated, or 96% of the acres irrigated in 2021. Explanation of water use estimates in the basin are provided in the Agriculture Water Use Technical Memorandum 2021 and Water Budget Technical Memorandum 2021.

Table 1 Irrigated Land Use by water source in the Eel River Valley Groundwater Basin (2021).

Irrigation Water Source	**Acres**
Groundwater	12,952
Surface Water	126
Reclaimed Wastewater	352
Total	13,430

A geographical area was designated based on the proximity of an area to the nearest city or town. These designations include: Alton, Carlotta, Fernbridge, Ferndale, Fortuna, Hydesville, Loleta, Metropolitan, Rohnerville, Rio Dell, and Scotia (Table 2).

Table 2 ***Irrigated lands by geographic area***

Irrigated Lands by Geographical Area	**Acres**
ALTON	870
CARLOTA	436
FERNBRIDGE	160
FERNDALE	10,020
FORTUNA	13
HYDESVILLE	85
LOLETA	1,164
METROPOLITAN	566
SCOTIA	116
ROHNERVILLE	0
Total	13,430

There are five types of irrigation equipment systems commonly used throughout the basin: handline; traveling gun; center pivot; K-line; and wheel-line. The use of other irrigation equipment, such as hoses, drip irrigation, and flood

irrigation, was infrequent and uncommon and therefore classified as other (Table 3). A description of each equipment system is included in the Agriculture Water Use Technical Memorandum 2021. The City of Fortuna and Rio Dell flood irrigate crop lands to dispose of reclaimed wastewater. Within the area where groundwater is the principal irrigation water source, handlines and traveling guns are the primary irrigation equipment types used.

Table 3 ***Equipment type used for irrigation in Eel River Valley Groundwater Basin***

Equipment Type (Includes acres where groundwater, reclaimed wastewater and surface water is applied)	**Acres**	**Percent of total acres irrigated with equipment type**
Handline	6,856	51%
Traveling Gun	4,271	32%
Wheel Line	1,147	9%
K-Line	713	5%
Center Pivot	272	2%
Other	171	1%
Total	13,430	100%

There are five main crop types grown throughout the basin, which include: corn; alfalfa; grazed pasture; hay or silage; quinoa; and row crops. However, quinoa is a dry farm crop (Table 4). Grazed pasture accounts for approximately 90% of the irrigated crop type in the basin.

Table 4 ***Crop types grown in 2021***

DWR Crop Type Classification Grown in 2021	**Acres**
Field Crop (Corn)	917
Grain/Hay-Pasture (Grazed pasture/Hay or Silage Crop)	12,037
Grain/Hay (Alfalfa/clover)	27
Grain/Hay (Quinoa)	327
Truck Crop (Row)	122
Total	13,430

This estimate of land use was developed as an update to a previous inventory of land use in the basin (HCRCD, 2016) and is based on using the best available science and information to accurately capture on-the-ground conditions and reflects local data and professionals' knowledge of the basin. The accuracy of inventory of irrigated lands is considered high. The County is currently working with DWR Northern Region office to provide a land use update to DWR's land use dataset.

2.2 Water Year Classification

Water year classification was completed using a 30-year period of record as summarized in the *Agriculture Water Use Technical Memorandum for the Eel River Valley Groundwater Basin* (County et al. 2021). The results from applying this methodology to the Ferndale rainfall data for the 30-year period from 1992 through 2021 are summarized on Table 5 and depicted in Image 1.

Table 5 Water year types with annual precipitation, index values and ranking (1992-2021).

Water Year	Annual Precipitation (inches)	Water Year Index	Index Rank (30 = highest #, 1 =lowest #)	Water Year Type
2017	67.2	61.9	30	Wet
1998	66.2	61.8	29	Wet
1999	53.3	57.2	28	Wet
2003	61.6	55.3	27	Wet
2006	58.0	54.5	26	Wet
1995	56.4	49.2	25	Wet
1997	51.5	49.0	24	Wet
2004	43.1	48.6	23	Wet
2011	47.8	47.8	22	Wet
2000	45.1	47.6	21	Above Normal
1996	43.3	47.2	20	Above Normal
2016	49.6	46.0	19	Above Normal
2005	46.1	45.2	18	Above Normal
2018	34.8	44.5	17	Above Normal
2007	38.0	44.0	16	Above Normal
2019	47.9	43.9	15	Below Normal
2010	47.9	42.7	14	Below Normal
2012	39.7	42.1	13	Below Normal
1993	45.1	38.6	12	Below Normal
2013	36.2	37.3	11	Below Normal
2002	40.7	36.9	10	Below Normal
2020	31.7	36.5	9	Dry
1994	32.4	36.2	8	Dry
2008	33.7	35.0	7	Dry
2001	28.0	33.1	6	Dry
2015	37.5	32.2	5	Dry
2009	30.5	31.5	4	Critical
2021	30.3	30.7	3	Critical
2014	19.9	24.8	2	Critical
1992	23.3	23.7	1	Critical

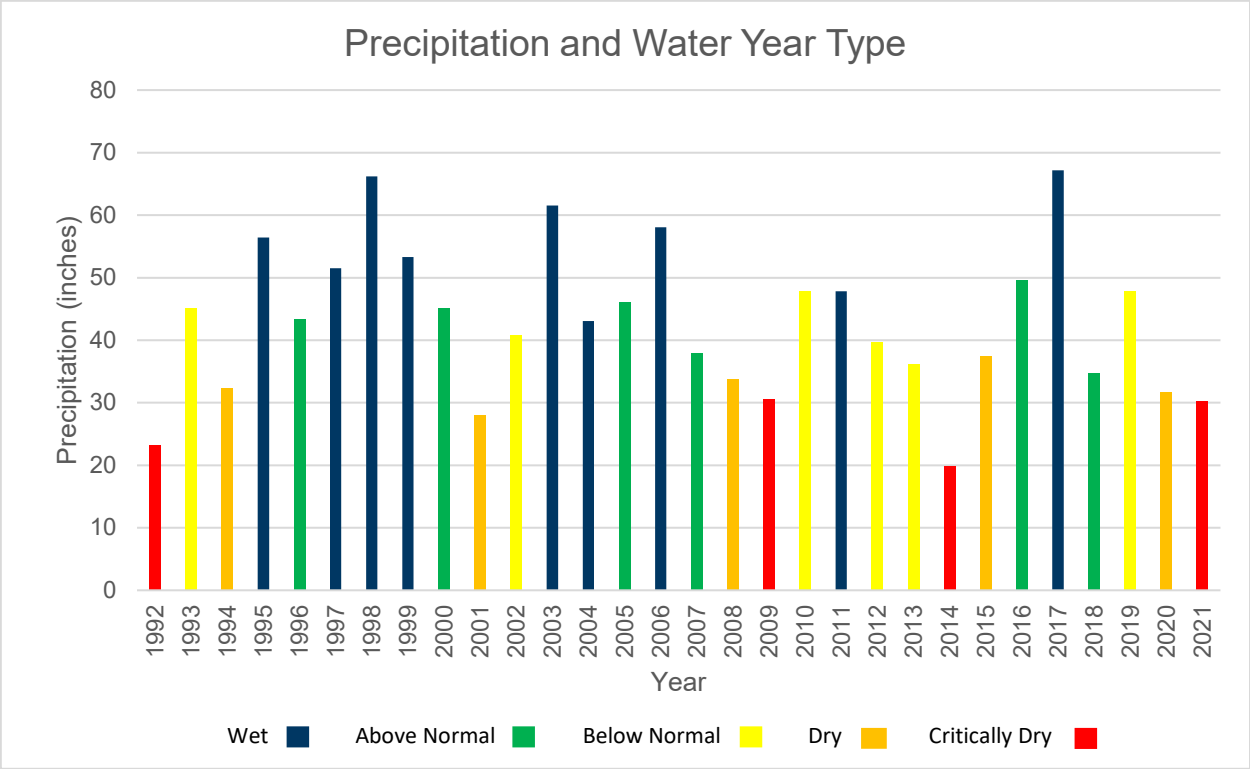

Image 1. Water year types (1992-2021), based on rainfall data collected in Ferndale

2.3 County and Municipal Parcel Geodatabase

Six GIS datasets were used to develop the County and municipal parcel geodatabase, as listed above in Section 1.1. The geodatabase was used to determine which agricultural parcels in the Irrigated Acreage Database draw water from municipal systems. The geodatabase was also used to distinguish between irrigated urban and un-irrigated wild open spaces. These distinctions were used for the irrigated acreage inventory, as well as for determining the source of groundwater pumping for use in the water budget.

City, Community Service District, and tribal boundaries were spatially joined to the County assessor parcel data based on the center point of each assessor parcel boundary. For example, if the center point of a parcel fell within a city boundary, even though the entire boundary was not contained in the city boundary, then the parcel was considered within the city. In places where a CSD and city boundary overlapped, both entities were listed. This produced a GIS layer of parcels that noted which local agency may be providing water or wastewater services.

The total square footage of buildings within each parcel was calculated by dissolving the GIS building outlines layer provided by the County by the assessor parcel number (APN) and then joined to the parcel layer by APN. This gave a general sense of building sizes within each parcel. It should be noted that the buildings layer provided by the County was generated by AI software and may not include some buildings that do exist and may also include buildings that no longer exist. Once all the layers were joined, the data was exported from GIS to excel to support additional analysis regarding water demand.

2.4 Groundwater Dependent Ecosystems Geodatabase

Groundwater Dependent Ecosystems (GDE) are ecosystems which are dependent on groundwater for survival. Potential GDE units in the ERVB were identified using the DWR indicators of groundwater-dependent ecosystems (iGDE) database, which includes vegetation and wetland natural communities, is published online, and is referred to as the Natural Communities Commonly Associated with Groundwater dataset (DWR 2020). These data were reviewed

and augmented with additional vegetation mapping datasets to produce a map of final GDE Units; additional information on vegetation community composition, aerial imagery, depth to groundwater, species distributions, salinity tolerance, and rooting depths was also reviewed to support this determination.

The GDE Geodatabase was created by Stillwater Sciences, and provides an inventory of GDE's within the ERVB. Stillwater Sciences used the iGDE database (Klausmeyer et al. 2018) to generate a preliminary map to serve as a guide for initial identification of potential GDEs in the ERVB. Before further analysis, The GDE Geodatabase was subdivided into two categories; Vegetation Communities and Special-status Species, to provide a more detailed method of conducting inventory of the ecosystems within the basin.

2.4.1 Vegetation Communities Database

For more precise identification of potential Vegetation Communities GDEs, a refined vegetation map was developed by adjusting Classification and Assessment with Landsat of Visible Ecology Groupings (CalVeg) to better match current imagery (USDA 2020). The refined vegetation map incorporates the following datasets:

- Classification and Assessment with Landsat of Visible Ecological Groupings (CalVeg) – United States Department of Agriculture - Forest Service (USDA 2014). North Coast region: Imagery date: 2000-2007; Minimum mapping unit (MMU): 2.5-acre.
- National Agriculture Imagery Program (NAIP) – United States Department of Agriculture (USDA 2020). Humboldt County: Imagery date: 2020; Resolution: 1 meter.

In addition, other available vegetation assessments (H.T. Harvey & Associates 2015, Golec and Miller 2017) were reviewed to further refine vegetation boundaries. The geomorphic description classification from the USDA-NRCS Soil Survey Geographic Database (SSURGO) was subsequently incorporated to assess the landscape position and likelihood of groundwater dependence for select vegetation types.

2.4.2 Special-status Species Database

Special-status species and sensitive natural communities that are potentially associated with GDEs in the Lower Eel Valley Groundwater Basin were identified as part of the ecological inventory. For the purposes of this document, special-status species are defined as those:

- Listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA);
- Designated by California Department of Fish and Wildlife (CDFW) as a Species of Special Concern;
- Designated by CDFW as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515);
- Designated by Bureau of Land Management (BLM) as a sensitive species;
- Designated as endangered or rare under the California Native Plant Protection Act (CNPPA); and/or
- Taxa that meet the criteria for listing as described in Section 15380 of the CEQA Guidelines, including species listed on CDFW's Special Vascular Plants, Bryophytes, and Lichens List (CDFW 2021) or plants with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4

Sensitive natural communities are defined as those natural community types (i.e., legacy natural communities in CDFW's California Natural Diversity Database [CNDDB], vegetation alliances and/or associations) with a state ranking of S1 (critically imperiled), S2 (imperiled), S3 (vulnerable), or an unranked association that is considered sensitive on CDFW's California Sensitive Natural Communities List (CDFW 2020) or in the California Natural Diversity Database (CDFW 2021b).

The following spatial database were queried to assess potential GDEs and included a 1-mile buffer surrounding the potential site:

- California Natural Diversity Database (CNDDB) (CDFW 2020);

- eBird (2021);
- The Nature Conservancy freshwater species lists generated from the California Freshwater Species Database (CAFSD) (TNC 2021);
- National Marine Fisheries Service California Species List tools (NMFS 2021); and
- Consortium of California Herbaria (CCH) (queried from CCH1 Berkeley Mapper and CalFlora 2021)

2.5 Evapotranspiration (ET) Land Use Geodatabase

The Evapotranspiration (ET) Land Use Geodatabase was created by GHD for use in the DWR Cal-SIMETAW evapotranspiration model. The purpose of this analysis was to develop a general approach to quantifying land use types for use in an evapotranspiration analysis for the basin.

More information on the Cal-SIMETAW model can be found in the Water Use Technical Memorandum 2021. The ET Land Use Geodatabase was developed in ArcGIS as a land use layer that covered the entire ERVB extent. Please see Section 1.1 for a list of the data sources utilized in the ET Land Use Geodatabase. The goal for the database was to produce a seamless shapefile of land use polygons within the Eel River groundwater basin and identify total acres of each land use type within each parcel boundary. Land use was broken into six categories with significant differences in evapotranspiration:

1. Irrigation
2. Impervious
3. Open Water
4. Riparian
5. Natural vegetation
6. Urban Landscape

To fit mixed land use polygons (polygons that included more than one of the six land uses) into one of the six land use categories, a prioritized rule matrix was applied using the following criteria:

- Anything falling within the “Irrigated areas” data were considered irrigated regardless of whether any other dataset overlapped.
- Excluding areas already covered by the previous step, all building outline polygons were considered impervious.
- Excluding areas already covered by the previous steps, any GDE polygon with a cover type attribute that included the following values: Intermittent lake or pond, Ocean, Perennial lake or pond, Reservoir, River/stream/canal, was considered open water.
- Excluding areas already covered by the previous steps, any GDE polygon with a non-open water cover type attribute was considered riparian. Excluding areas already covered by the previous steps, any Parcel with a center point within a City/Community Service District/tribal boundary was considered urban landscape.

Once the above steps were completed, any remaining unclassified areas were passed through an image classification exercise to assign an appropriate land use type. The steps for completing and image classification exercise include:

Step 1: The image classification system used was performed on 4-band multispectral imagery provided by the 2020 USDA NAIP. Imagery tiles were downloaded from the U.S. Geologic Service Geospatial Data server. Approximately 325 individual imagery tiles were downloaded for the Eel River Valley Groundwater Basin, as defined by the CA Bulletin 118 Groundwater Basins shapefile for the ERVB. The individual tiles were combined to create a single multiband orthomosaic of the entire extent of the ERVB. The areas to be classified within the boundary were defined by the GHD shapefile that defines the area for classification (AreaforImageClassification_20210429.shp shapefile). This shapefile was created by excluding Urban and City boundaries, as well as omitting most buildings and roads within the ERVB.

Step 2: The single multiband orthomosaic (NAIP20_4B_Pro_SPC.tif) was clipped with areas defined for image classification (AreaforImageClassification_20210429). This resulted in a single multiband orthomosaic containing only the areas selected for image classification.

Step 3: Spectral differences were observed in the individual tiles used to create the single orthomosaic, and therefore it was necessary to segment the project area into five different regions. Each region was determined by combining areas of similar land cover and area with similar spectral detail. The regions include:

Step 4: A false color composite image was created for each region to use for Image Classification by changing the band number assignment in the Symbology settings in ArcGIS Pro Version 2.7.2. The band number was changed as follows:

– Red was updated to Band_4
– Green was updated to Band_3
– Blue was updated to Band_2

Step 5:

A Supervised, object-based Image Classification was performed in ArcGIS Pro Version 2.7.2 using the Classification Wizard. A custom classification schema was developed for the classification. The following classes were used as the basis of the classification schema:

– Impervious
  - Asphalt
  - Buildings
– Pervious
  - Deciduous
  - Evergreen
  - Wetlands
  - Bush –Vegetation
  - River Bar
  - Bare Ground
  - Pasture
  - Turf
  - Beach Sand
  - Water

Step 6:

The following settings were determined to be the most appropriate for the dataset by evaluating the different spectral and spatial segmentation of the multiband raster:

– Spectral Detail: 15
– Spatial Detail: 14
– Minimum Segment Size in Pixels: 10

The segmentation settings were used to create a segmented image for each unique area. Training samples were created using the training sample manager in ArcGIS Pro Version 2.7.2 by using the segment picker tool and by drawing polygons in unique areas within the multiband mosaic with many samples for each class in the classification schema.

Step 7:

The training samples were used to train the classifier. Results were evaluated, training samples adjusted and the classifier ran various times. Any incorrectly classified areas were re-classified using the reclassify tools inside the Image Classification Wizard. Once classified, the resulting classes were merged into two main classes:

1. Pervious
2. Impervious

Areas of vegetation that were within urban boundaries were classified as “Urban Vegetation.” Areas of vegetation outside urban vegetation were classified as “Natural Vegetation.” Areas of non-irrigated agricultural land were classified as “Natural Vegetation.”

Additionally, the image classification exercise output seven categories of land type: Asphalt, beachsand, pervious, riverbar, water, and wetlands. All “asphalt” areas were assigned a land use of “impervious,” all “water” and “wetlands” were assigned a land use category of “open water,” and all “pervious”, “beachsand” and “riverbar” areas were assigned a land use of “natural vegetation.”

At this point, all areas within the ERVB were assigned a land use category. To ensure the acreage values were accurate, the sum of the parcel boundary areas was compared to the total area of the ERVB. The parcel dataset included some areas with gaps between parcels, such as around roads, highways, the ocean, or rivers. Pseudo-parcels for the gaps were created and each parcel was assigned a unique identification so that the acreage could be calculated for these gaps. The pseudo-parcels were then rejoined to the original dataset, providing the land use acreage totals for each parcel.

The ET Land Use Geodatabase assumes some amount of error such as not all areas mapped reflect what is on the ground due to the nature of aerial imagery and remote sensing.

2.6 Evapotranspiration (ET) Land Use Geodatabase Summary

Resulting land use types are summarized by area in Table 6 and Figure 3. Natural vegetation was the largest land use within the Basin, followed by urban, irrigated, and riparian areas.

Table 6 ERVB GSP acreages

ERVB GSP Category	New Category	Acres
Impervious	Urban	1,916
Irrigated	Irrigated	13,430
Natural Vegetation	Natural Vegetation	29,722
Open Waters	Open Waters	3,824
Riparian	Riparian	11,529
Urban Landscape	Urban	12,072
Total		**72,492**

3. Comparison of DWR Land Use with ERVB Irrigated Acres

The California Department of Water Resources developed a statewide mapping system for classifying land use for developing Groundwater Sustainability Plans (GSPs) (DWR 2014). This mapping was used in developing the estimates of irrigation water use. The land use classification system is periodically updated as new or more current data is available. DWR incorporates land use datasets provided by local agencies. The local datasets were reviewed by DWR subject matter experts for accuracy and if the datasets were determined to be better, local data for the basin was then utilized instead of the statewide dataset.

The basin prioritization conducted in 2015 used the CASGEM 2014 Basin Prioritization Land Use mapping data to determine the estimated irrigated acres and water use. This system was developed by Land IQ. The system used remote sensing and multiple data sets to identify irrigated parcels and was used to create an Irrigated Acreage Database. The data sets include current and historical land use, land use forecasting and trend analysis, landscape evapotranspiration data, permanent crop age, irrigation method on a field-by-field basis, root zone depth on a field-by-field basis, and groundwater recharge suitability.

The HCRCD used the original LandIQ database to develop 2016 Irrigated Acreage Database and updated irrigated acreage database for all irrigated parcels within the basin. The update incorporated actual irrigated crop areas from field survey and local input. This work was done as part of the Irrigation Water Use Study published in the County's Groundwater Sustainability Plan Alternative in 2016. The updated Irrigated Acreage Database was reviewed and accepted by DWR and used to perform the basin re-prioritization in 2018.

During the development of the Eel River Valley Basin GSP, the 2016 Irrigated Acreage Database was updated in 2021 and used in the water use estimates for the GSP.

Table 7 Irrigated Land use acreage comparison

Land Use	DWR 2014 (LandIQ) Acres	ERVB 2016 Acres	ERVB 2021 Acres
Irrigated Acreage	23,287	13,558	13,430

As shown on Table 7, DWR 2014 Irrigated Acres database has mapped far more irrigated areas than the ERVB GSP. Figure 2 compares the irrigated parcels identified in the DWR 2014 Irrigated Acres and the 2021 ERVB GSP Irrigated Acres database. Parcels that were identified in the DWR 2014 Irrigated Acres that are not identified the 2021 ERVB GSP Irrigated Acres database are shown in red, parcels that are in both databases are shown in tan, and parcels that are only in the 2021 ERVB GSP Irrigated Acres database are shown in green.

The primary reason DWR's 2014 inventory significantly over-estimated irrigated acreage is that their methods did not ground-truth actual land management practices and assumed that all agricultural land was irrigated. Another factor for the difference in the assigned irrigated acreage has to do with the amount of area of an individual parcel that is actually irrigated. The DWR 2014 database assigned the entire parcel area as irrigated area. The 2021 ERVB GSP database assigned the actual irrigated area for fields on individual parcels. The HCRCD updated the database based upon field visits, producer input and local input.

DWR land use categories were different than the land use categories used by the ERVB GSP. DWR included more detailed breakdown of crop types and less information on other land use types. The land use types were consolidated into similar categories.

The DWR Land Use database did not include data that covered the entire extent of the groundwater basin area and left out a significant portion of the basin that had to be considered “no data.” Because of this, and because the 2018 DWR data did not include any mapped areas of Riparian, Natural Vegetation, or Open Waters, these values were estimated using aerial imagery and remote sensing. The estimation of the areas associated with these categories is used in evaluating the water demands due to evapotranspiration.

The DWR Land Use also included one category of “Urban” and did not break down into either “Impervious” or “Urban Landscape;” as the ERVB GSP does. Assuming the DWR’s Urban category includes both Impervious and Urban Landscape, then by combining the ERVB GSP’s Impervious and Urban Landscape impervious areas of DWR’s Urban category were reclassified as impervious.

Additionally, the ERVB GSP mapped all paved and gravel roads, and paved parking areas as impervious. Within city boundaries, lands that were not attributed as riparian, agricultural, or open water were also mapped as urban lands. Table 8 and Figure 3 present the breakdown of ERVB GSP land use acres.

Table 8 ERVB GSP land use acreages

Cal-SIMETAW / DWR Crop Type	**ERVB GSP Category**	**GSP Acres**
Corn	Corn	942
Pasture	Grazed pasture/Hay or Silage Crop	12,015
Safflower	Quinoa	327
Truck Crops	Row Crops	7
Alfalfa	Alfalfa/Clover	27
Native Vegetation	Tree/Row	116
Total Irrigated Land		**13,430**
Riparian	Riparian	11,529
Native Vegetation	Natural Vegetation (non-tree farm)	29,722
Open Waters	Open Waters	3,824
Urban Landscape	Urban Landscape	12,072
Non-Irrigated Vegetated/Open Water Area		**57,146**
Impervious	Impervious	1,916
Total Basin		**72,492**

4. Electronic Deliverable Summary

The following electronic deliverables are attached as digital databases:

- Irrigated Acreage 2021 Geodatabase
- County and Municipal Parcels Geodatabase
- Groundwater Dependent Ecosystems Geodatabase
- ET Land Use Geodatabase
- CADWR Land Use Geodatabase metadata

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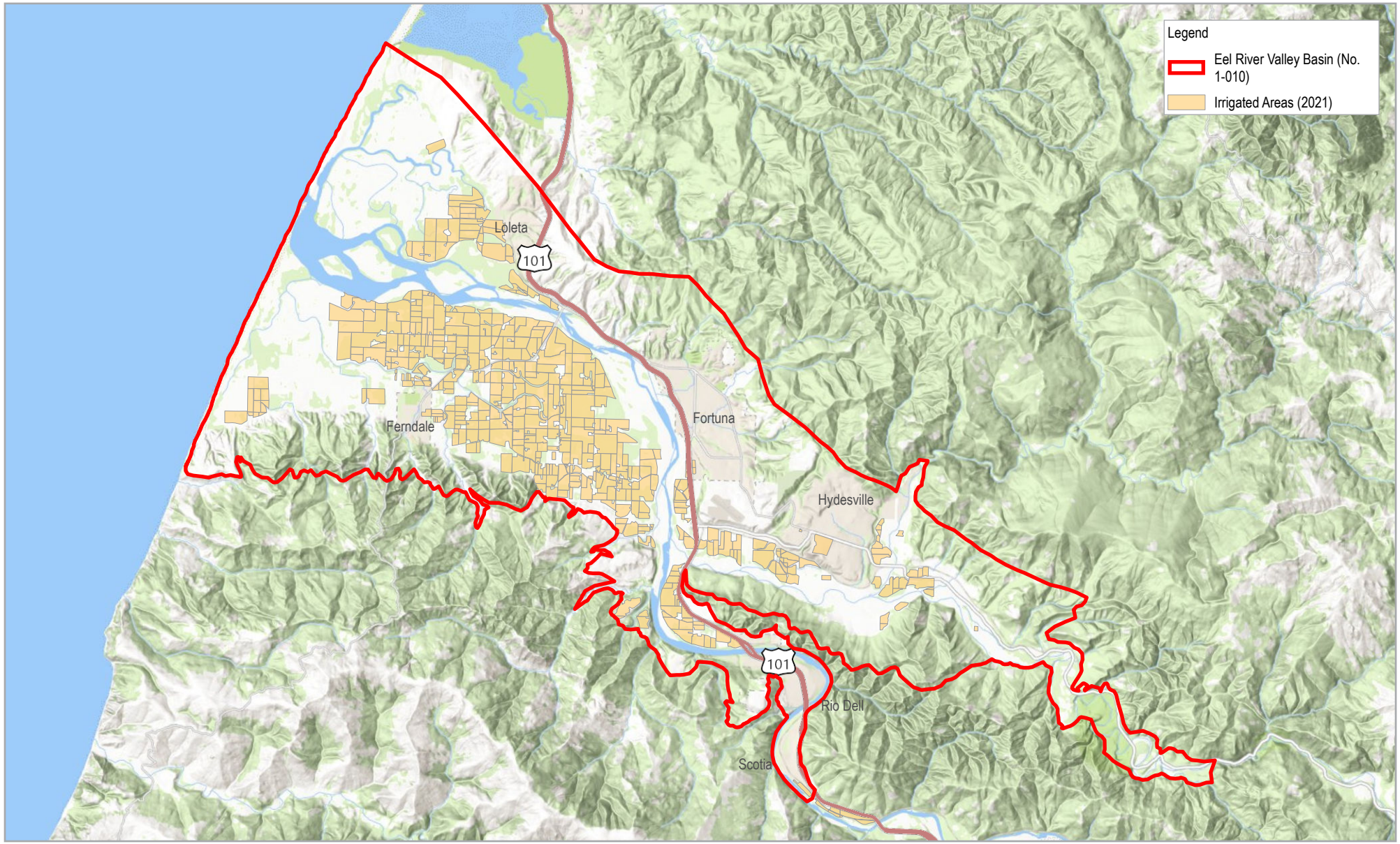
Attachments

Attachment 1

Figures



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Humboldt County Department of Public Works
Eel River Valley Groundwater Sustainability Plan

Project No. **11217388**
Revision No. **-**
Date **November 2021**

Irrigated Areas

FIGURE 1

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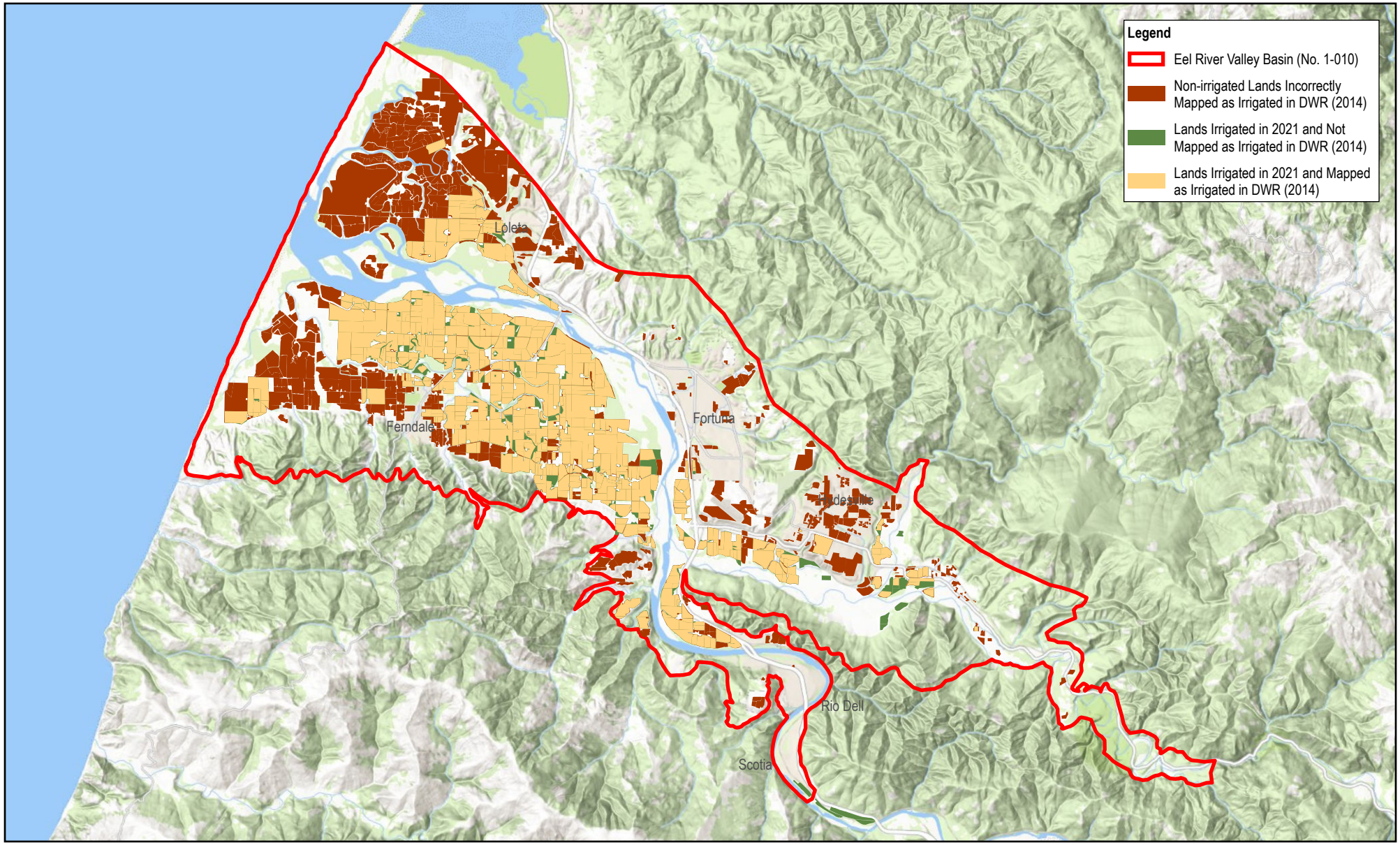

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Humboldt County Department of Public Works
Eel River Valley Groundwater Sustainability Plan

Comparison of Land Use Designations between DWR (2014) and Humboldt County (2021)

Project No. **11217388**
Revision No. **-**
Date **Jan 2022**

FIGURE 2

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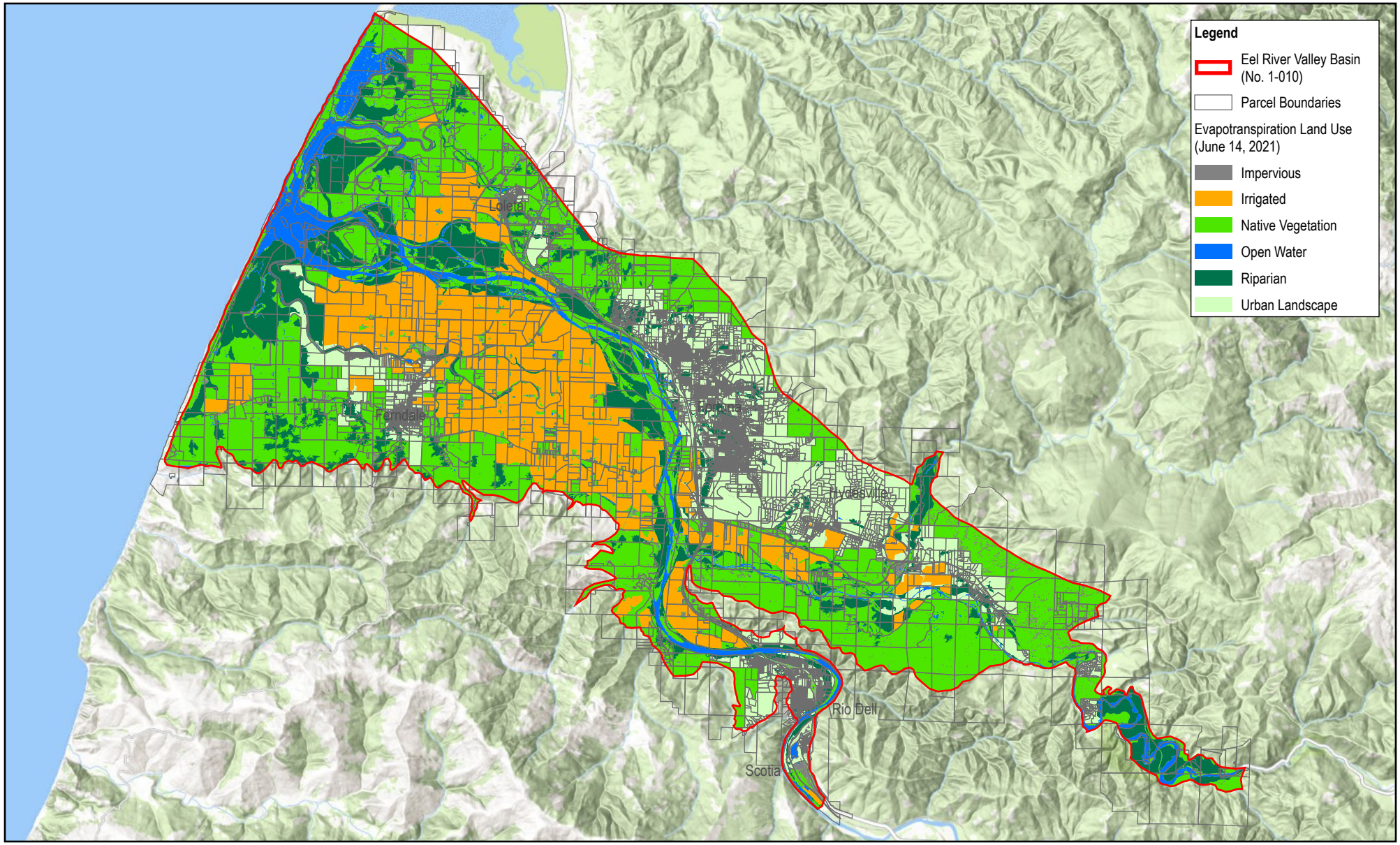

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Humboldt County Department of Public Works
Eel River Valley Groundwater Sustainability Plan

Project No. **11217388**
Revision No. **-**
Date **Jan 2022**

Land Use Classification

FIGURE 3

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