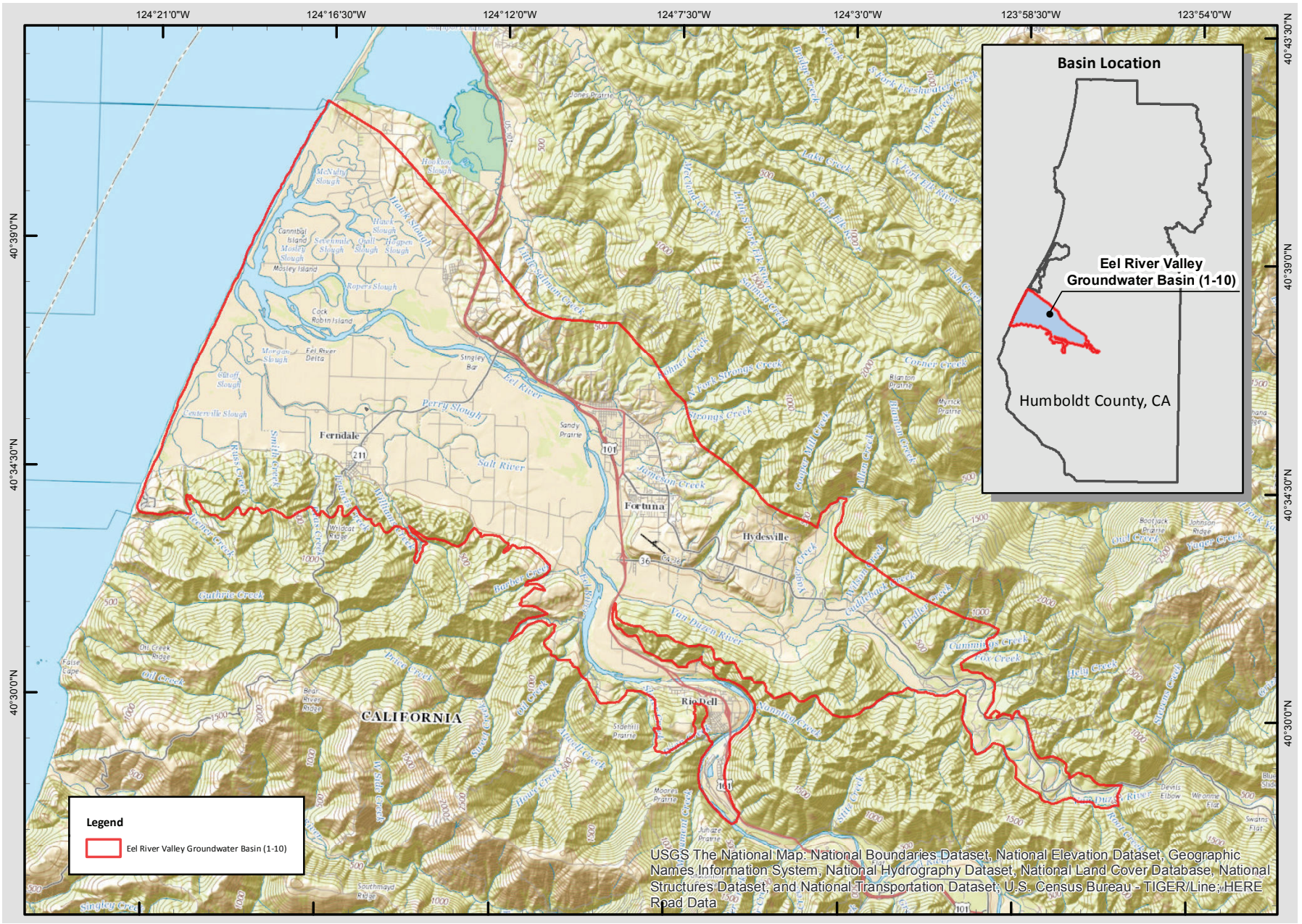
Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\FIGURES\Report_Figures\1-1_SiteLocationMap.pdf



BASEMAP FROM HUMBOLDT COUNTY PUBLIC WORKS (DECEMBER, 2016)

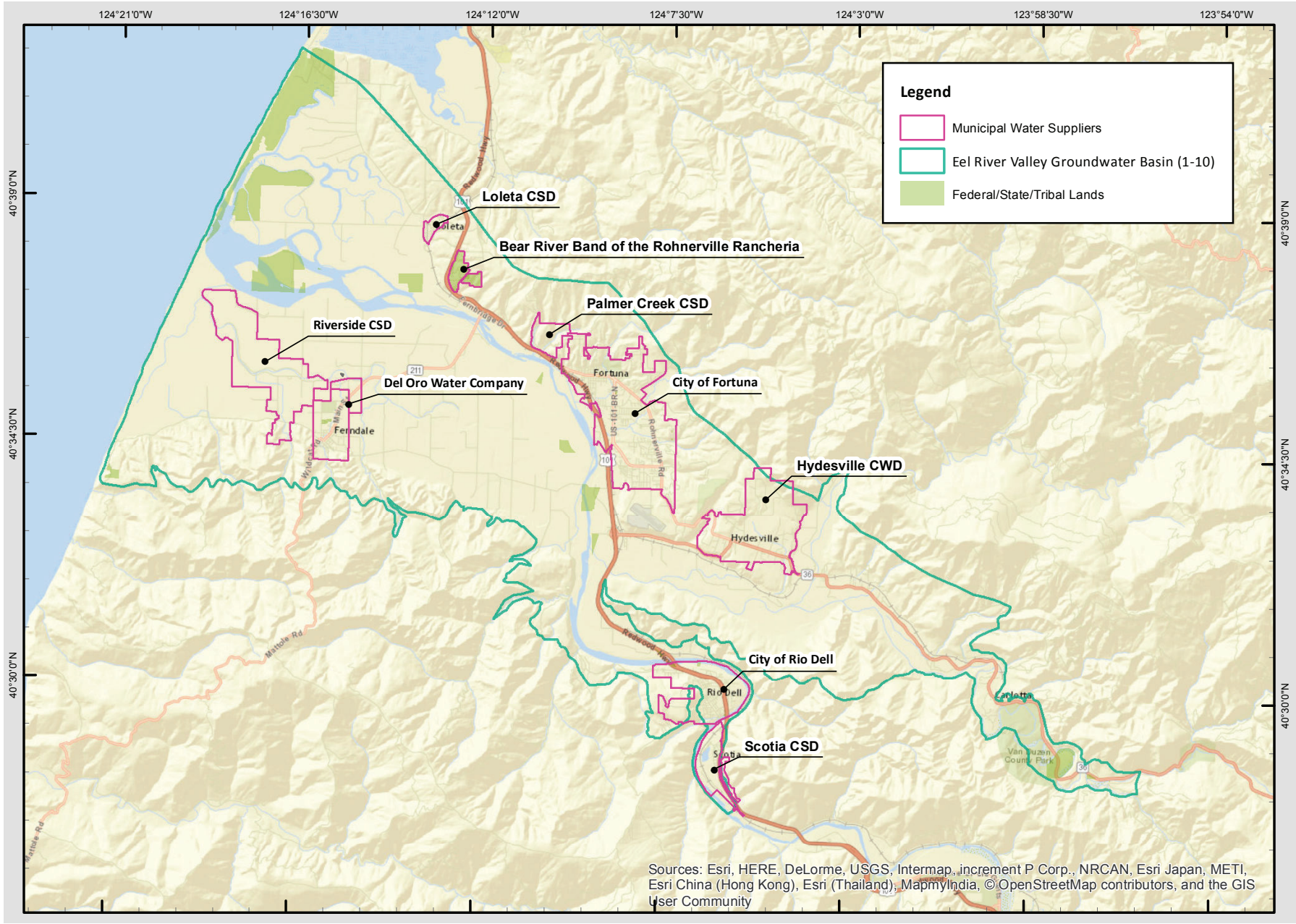
SHN Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Site Location Map
SHN 016219

December 2016 | 1-1_SiteLocationMap.ai | Figure 1-1

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\FIGURES\Report_Figures\2-1_MunicipalWaterSuppliers.pdf



BASEMAP FROM HUMBOLDT COUNTY PUBLIC WORKS (DECEMBER, 2016)

SHN Consulting Engineers & Geologists, Inc.

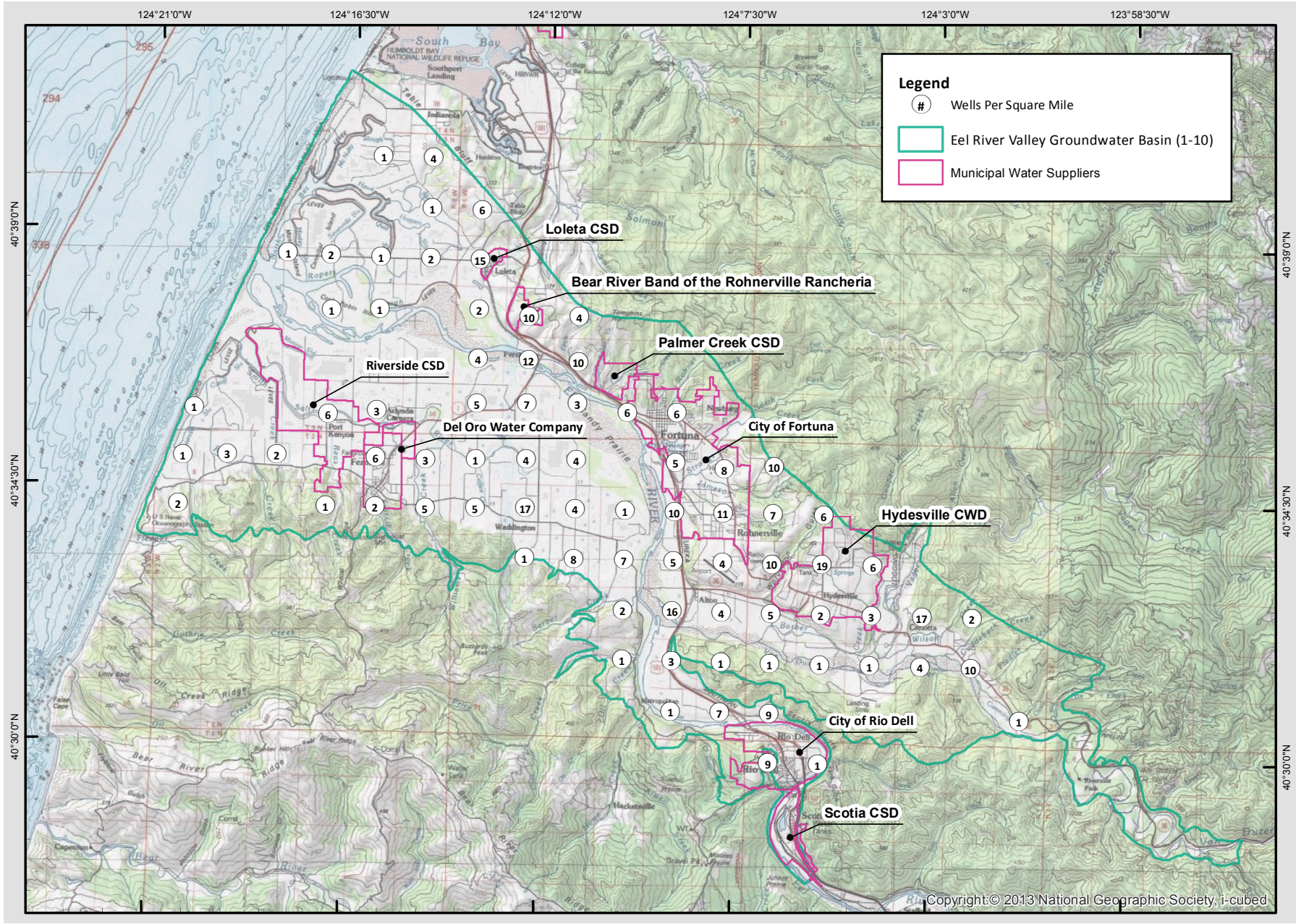
Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Municipal Water Suppliers

SHN 016219

December 2016 | 2-1_MunicipalWaterSuppliers.ai | Figure 2-1

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\FIGURES\Report_Figures\2-2_WellDdensities.pdf



BASEMAP FROM HUMBOLDT COUNTY PUBLIC WORKS (DECEMBER, 2016)

Consulting Engineers & Geologists, Inc.

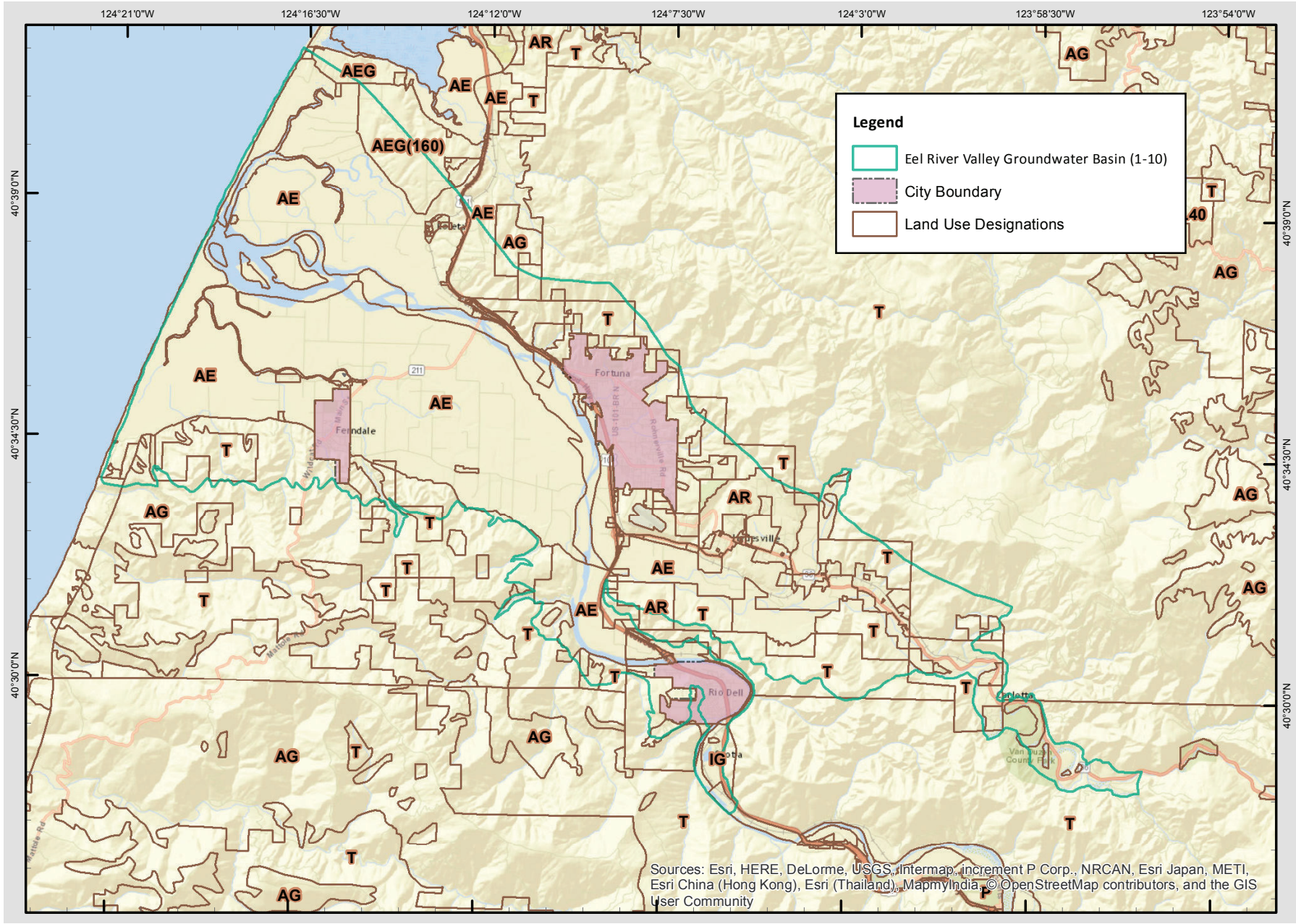
Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Well Densities

SHN 016219

December 2016 | 2-2_WellDensities.ai | Figure 2-2

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\FIGURES\Report_Figures\2-3_ExistingLandUseDesignations.pdf



BASEMAP FROM HUMBOLDT COUNTY PUBLIC WORKS (DECEMBER, 2016)

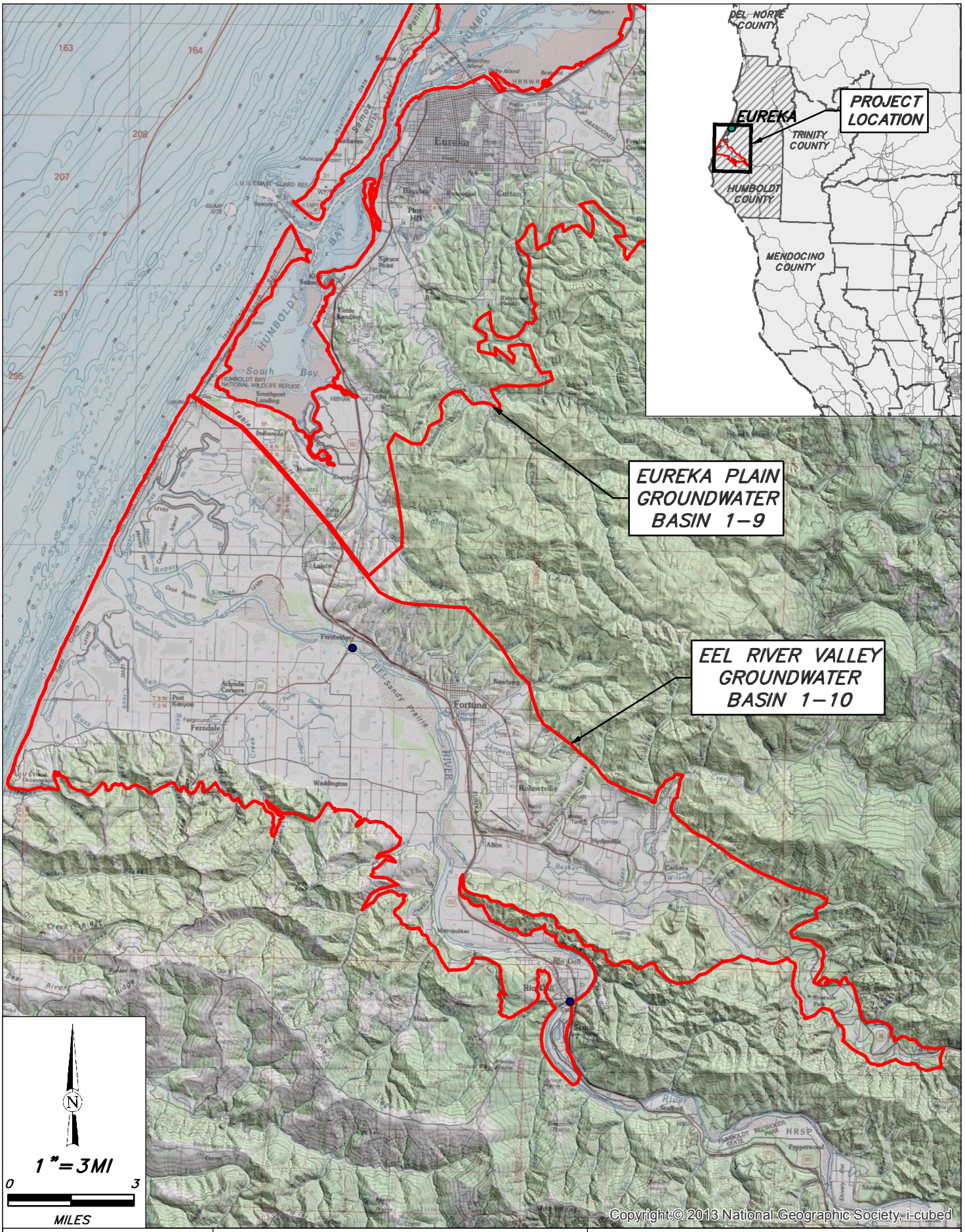
SHN Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Existing Land Use Designations

SHN 016219

December 2016 | 2-3_ExistingLandUseDesignations.ai | Figure 2-3



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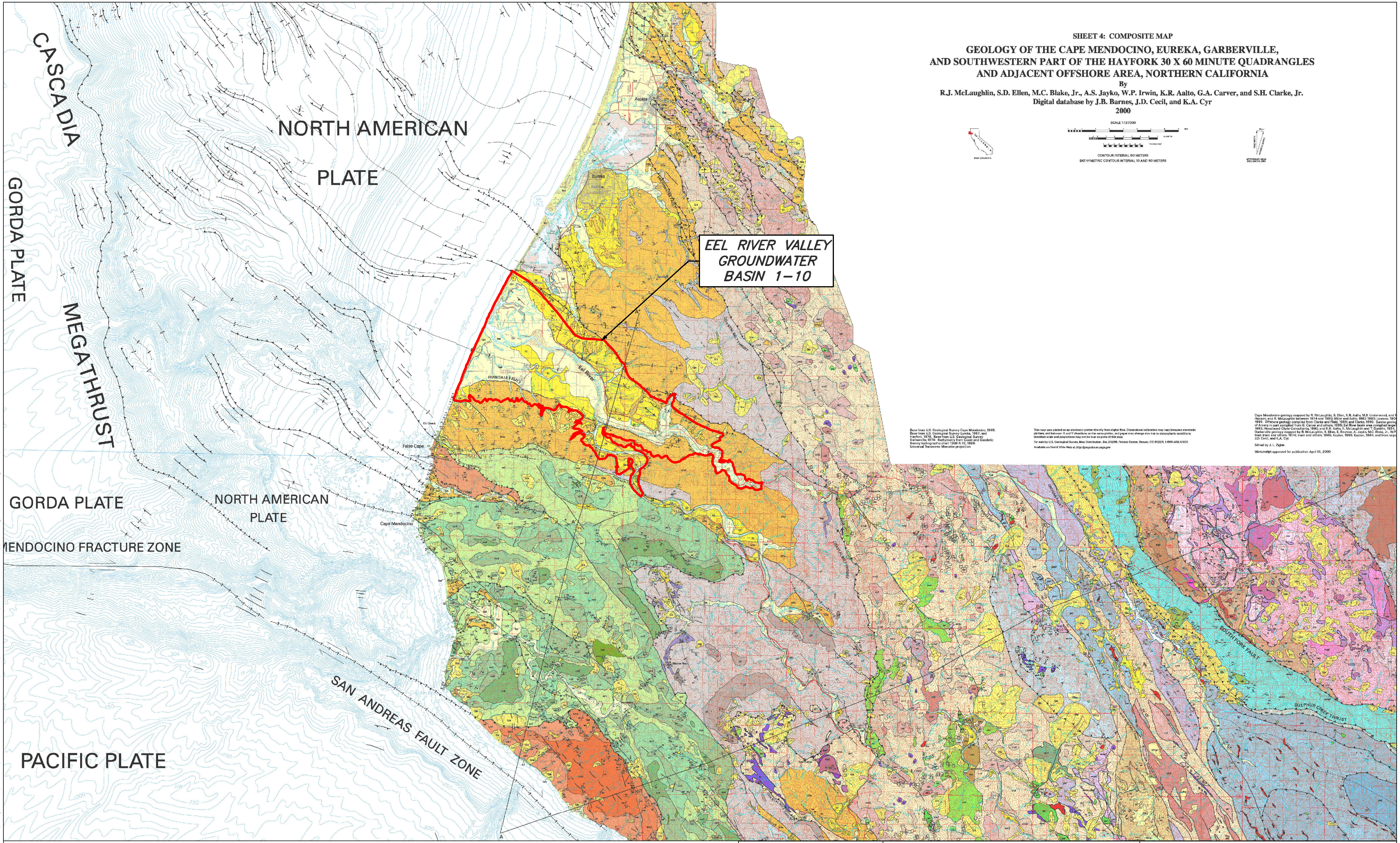
Consulting Engineers & Geologists, Inc.	Humboldt County Public Works Eel River Valley Groundwater Assessment Humboldt County, California	Project Location SHN 016219
	December 2016 | 3_1_ProjectLocationMap	Figure 3-1



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SHN Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Geologic Map
(McLaughlin, 2002)
SHN 016219

December 2016 | McLaughlin_GeologicMap | Figure 3-2

NOTE: CROSS-SECTION LINES EXTEND OFF IMAGE TO THE NORTH

TABLE BLUFF ANTICLINE

EEL RIVER SYNCLINE

LITTLE SALMON FAULT

FORTUNA

FERNDALE

GOOSE LAKE FAULT

YAGER FAULT

VAN DUZEN RIVER

RIO DELL

SCOTIA

CROSS-SECTION 1 (THIS STUDY)
B-B' (OGLE)

CROSS-SECTION 2 (THIS STUDY)
C-C' (OGLE)

D-D' (OGLE)

CROSS-SECTION 3 (THIS STUDY)
E-E' (OGLE)
OGLE, 1953
DIBBLEE, 2008

F-F' (OGLE)

EXPLANATION

LOCATION OF CROSS-SECTION LINE

OGLE, 1953–SEE FIGURE 3-4

THIS STUDY–SEE FIGURES 3-5, 3-6 & 3-7

QUATERNARY

Recent

- Landslides
- Alluvium (recent gravel, sand, and mud)
- Old Alluvium (old alluvial deposits)
- Young stream terrace deposits (stream and stage shown by t_1-t_2-t_3)
- Undifferentiated terrace deposits (elevated terraces)

Upper Pleistocene

- Rohnerville formation (gravel, sand, and clay)
- Hookton formation (gravel, sand, and clay)

UNCONFORMITY

TERTIARY

Lower Pleistocene

- Carlotta formation (conglomerate, sandstone, and claystone)

Upper Pliocene

- Scotia Bluffs sandstone (massive sandstone with mudstone members)
- Rio Dell formation (mudstone, siltstone, and thin sandstone) (members mapped in Ferndale Quad.)
- Wildcat group, undifferentiated (Eastern Fortuna Quad.) (mudstone and sandstone)

Lower Pliocene

- Eel River formation (mudstone and glauconitic sandstone)

Miocene

- Pullen formation (mudstone, partly diatomaceous, with local basal sandstone member)

UNCONFORMITY

JURASSIC

Lower Cretaceous? to Upper Jurassic

- Yager formation (biotitic graywacke, shale, and conglomerate)

Upper Jurassic

- Franciscan formation (graywacke, shale, chert, basalt, and glaucophane schist)
- False Cape shear zone rocks (mostly sheared Franciscan, with some younger rocks included)

1 "=2 MILES
0 2
MILES

SYMBOLS

Contacts
- Known position
- Approximate position
- Terraces and alluvium

Faults
- Known position
- Approximate position
- Concealed extension

- 50 Strike and dip
- 30 Strike and dip, overturned
- Axis of anticline
- Axis of syncline

Wells (numbers indicate wells listed in report)
- Abandoned oil well
- Abandoned oil well with oil shows
- Gas well
- Gas well, abandoned
- Water well

- Oil seep
- Gas seep

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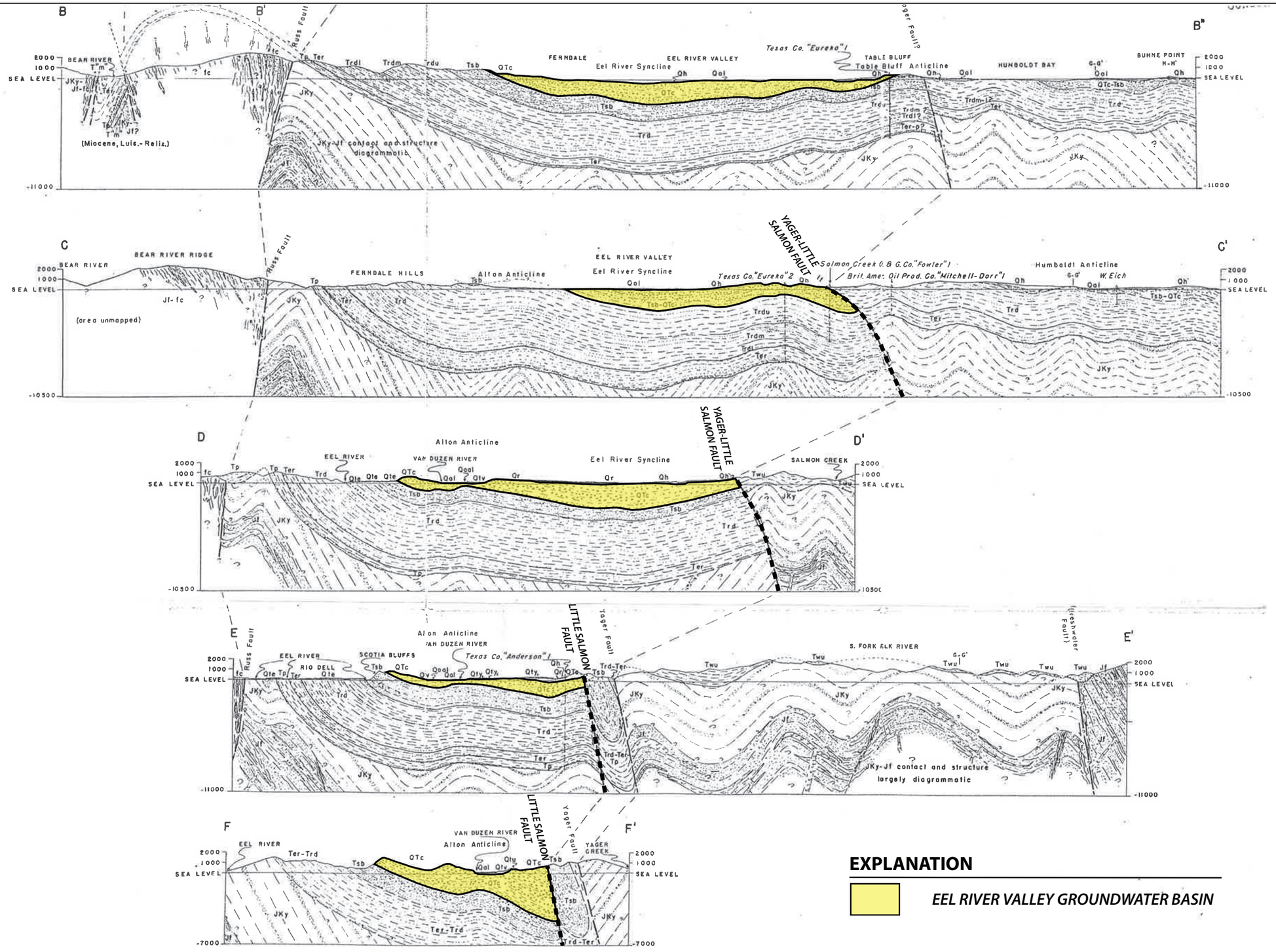
Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Geologic Map
(Ogle, 1953; Dibblee, 2008)
SHN 001283

December 2016 | GeologicMap_OgleDibblee | Figure 3-3

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\PROJ_MXDs\Report_MXDs\GeologicMap_OgleDibblee.mxd



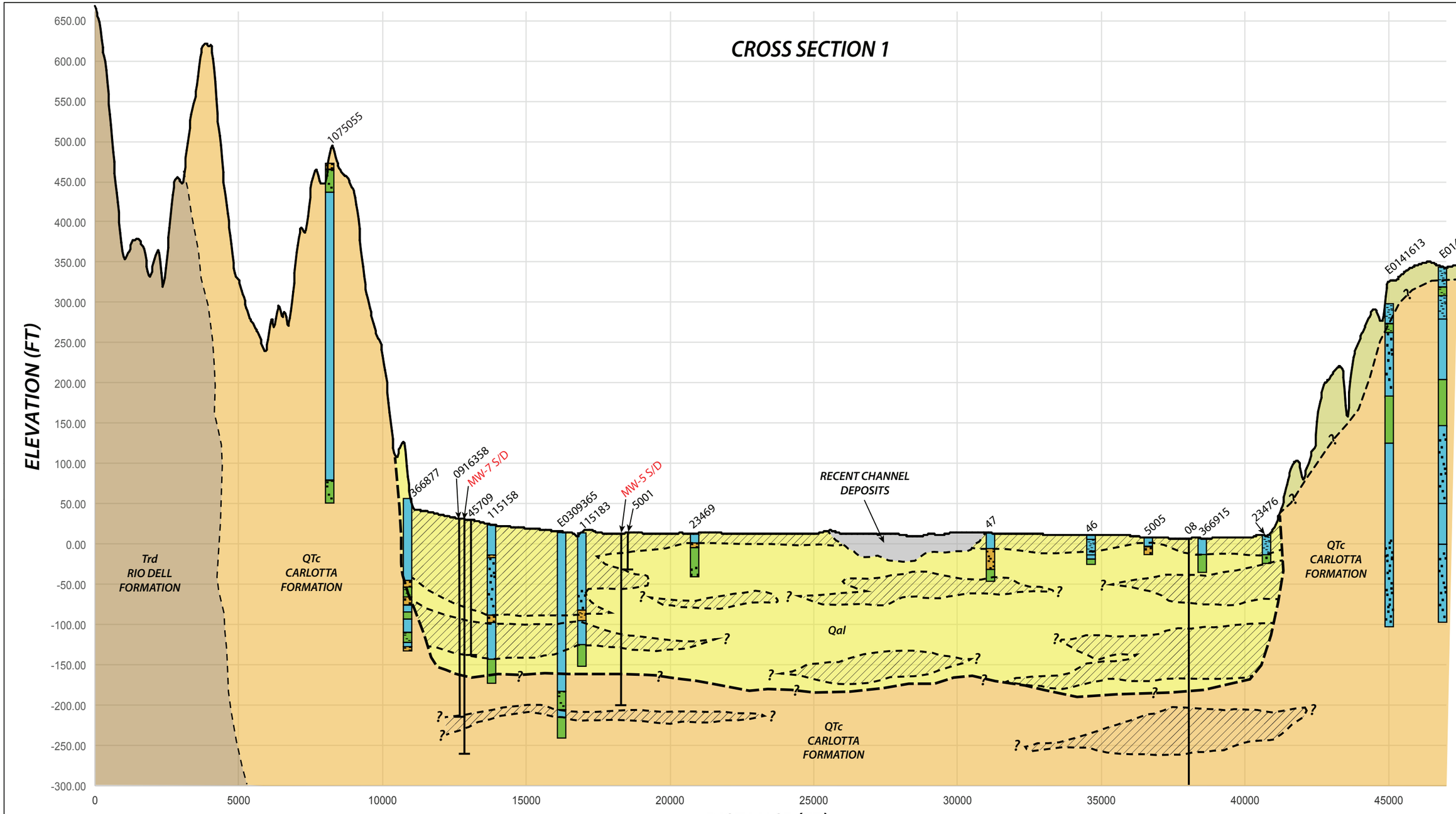
EXPLANATION

EEL RIVER VALLEY GROUNDWATER BASIN

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\FIGURES\Presentation_Figures\3-4_OgleCrossSections.pdf

Consulting Engineers & Geologists, Inc.	Humboldt County Public Works Eel River Groundwater Assessment Humboldt County, California	Geologic Cross-Sections (Ogle, 1953) SHN 016219
	December 2016 | OgleCrossSections.ai	Figure 3-4

CROSS SECTION 1



EXPLANATION

- QUATERNARY ALLUVIUM (Qal)
- CARLOTTA FORMATION (QTc)
- RIO DELL FORMATION (Trd)
- FINE-GRAINED ALLUVIUM
- SILT/CLAY
- SAND
- GRAVEL
- 23469 DWR WELL LOG #
- MW-7 COUNTY WELL #

SCHEMATIC SECTION SHOWS SHALLOW STRATIGRAPHY ALONG CROSS-SECTION LINE B-B' AS SHOWN ON FIGURE 3-3.

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Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Geologic Cross-Section 1
(This Study)
SHN 016219

December 2016 | CrossSection1.ai | Figure 3-5

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\FIGURES\Presentation_Figures\3-5_CrossSection1.pdf

CROSS SECTION 2

EEL RIVER VALLEY GROUNDWATER BASIN

ELEVATION (FT)

DISTANCE (FT)

Ter
EEL RIVER
FORMATION

Trd
RIO DELL
FORMATION

Qal

QTc
CARLOTTA
FORMATION

Qh
HOOKTON
FORMATION

RECENT CHANNEL
DEPOSITS

LITTLE
SALMON
FAULT

Twu
WILDCAT
GROUP

13810
951197
E0081512
22871
951170
13592
23455
E0211621
29895
0962984
E0243714
76846
E0116244

EXPLANATION

- QUATERNARY ALLUVIUM (Qal)
- HOOKTON FORMATION (Qh)
- CARLOTTA FORMATION (QTc)
- RIO DELL FORMATION (Qrd)
- WILDCAT GROUP (Twu)
- EEL RIVER FORMATION (Ter)
- FINE-GRAINED ALLUVIUM
- SILT/CLAY
- SAND
- GRAVEL
- BEDROCK
- 23469 DWR WELL LOG #

SCHEMATIC SECTION SHOWS SHALLOW STRATIGRAPHY ALONG CROSS-SECTION LINE C-C' AS SHOWN ON FIGURE 3-3.

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Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Geologic Cross-Section 2
(This Study)
SHN 016219

December 2016 | CrossSection2.ai | Figure 3-6

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\FIGURES\Presentation_Figures\3-6_CrossSection2.pdf

CROSS SECTION 3

Elevation (ft)

1000 950 900 850 800 750 700 650 600 550 500 450 400 350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300

0 5000 10000 15000 20000 25000 30000 35000 40000

DISTANCE (FT)

EEL RIVER VALLEY GROUNDWATER BASIN

EEL RIVER VALLEY GROUNDWATER BASIN

EEL RIVER

Tp PULLEN FORMATION

Ter EEL RIVER FORMATION

RIO DELL

746502

76767

22021

563642

703276

798211

Qal

Tsb SCOTIA BLUFFS

VAN DUZEN RIVER

3 50

E0187421

TERRACE DEPOSITS

113222

E066491

E0120654

E0190435

Twu WILDCAT GROUP

LITTLE SALMON FAULT

JKy YAGER FORMATION

Trd RIO DELL FORMATION

QTc CARLOTTA FORMATION

Jf FRANCISCAN FORMATION

EXPLANATION

- QUATERNARY ALLUVIUM (Qal)
- CARLOTTA FORMATION (QTc)
- SCOTIA BLUFFS (Tsb)
- RIO DELL FORMATION (Trd)
- EEL RIVER FORMATION (Ter)
- PULLEN FORMATION (Tp)
- YAGER FORMATION (JKy)
- FRANCISCAN FORMATION (Jf)
- FINE-GRAINED ALLUVIUM
- SILT/CLAY
- SAND
- GRAVEL
- BEDROCK
- 23469 DWR WELL LOG #

SCHEMATIC SECTION SHOWS SHALLOW STRATIGRAPHY ALONG CROSS-SECTION LINE E-E' AS SHOWN ON FIGURE 3-3.

Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Geologic Cross-Section 3
(This Study)
SHN 016219

December 2016 | CrossSection3.ai | Figure 3-7

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\FIGURES\Presentation_Figures\3-7_CrossSection3.pdf

TABLE BLUFF ANTICLINE

INFILTRATION OF PRECIPITATION AND SURFACE FLOWS FROM UPLAND RECHARGES ALLUVIAL AQUIFER

RECHARGES ALLUVIAL AQUIFER

LITTLE SALMON FAULT

OGLE, 1953
DIBBLEE, 2008

YAGER FAULT

UPLAND EXPOSURES OF CARLOTTA RECHARGE THE UNDERLYING CARLOTTA

SURFACE FLOW RECHARGES CARLOTTA

UPLAND EXPOSURES OF CARLOTTA RECHARGE THE UNDERLYING CARLOTTA

EXPLANATION

- EEL RIVER GROUNDWATER BASIN
- ALLUVIAL AQUIFER RECHARGE AREA
- EEL RIVER RECHARGE AREA
- VAN DUZEN RECHARGE AREA
- UPLAND CARLOTTA RECHARGE AREAS

N

1 " = 2 MILES

0 2

MILES

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\Report_MXDs\Important_Recharge_Areas.mxd

Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Important Recharge Areas
SHN 001283

December 2016 | Important_Recharge_Areas | Figure 3-8

USGS FERNBRIDGE
STATION–11479560
(GAUGE ONLY)

EEL RIVER
ESTUARY

SALT RIVER

YAGER CREEK

EEL RIVER

VAN DUZEN
RIVER

USGS SCOTIA
STATION–11477000

USGS BRIDGEVILLE
STATION–11478500

EXPLANATION

USGS STREAM GAUGE STATION

EEL RIVER GROUNDWATER BASIN

0 2
MILES

1 "=2 MILES

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\Report_MXDs\SurfaceWatersMap.mxd

Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Surface Waters Map

SHN 016219

December 2016 | SurfaceWatersMap | Figure 3-9

Surface Flow Discharge Measurements

Measurement Location	Measured Discharge (cfs)		
	8/16/2016	8/23-24/2016	10/4/2016
Eel River			
Scotia (**SC**)		55.96	65.8
USGS Scotia Station	79.5	61	55
Eel River 1 (**E1**)		63.03	
Eel River 2 (**E2**)		53.03	60.92
Eel River 3 (**E3**)	75.81	57.19	71.21
Eel River 4 (**E4**)	74.16	50.65	63.55
Fernbridge (**FB**)*	81.36	61.31	
Van Duzen River			
USGS Bridgeville Station	6.9	5.7	6.5
Van Duzen Gauge (**VDG**)		4.89	
Lower Van Duzen 3 (**VD3**)		6.84	
Lower Van Duzen 2 (**VD2**)		6.25	6.9
Lower Van Duzen 1 (**VD1**)	1.43	0.60	
Yager Creek			
Yager 1 (**Y1**)**		3.02	4.31
Yager 2 (**Y2**)		0.59	

* Location is within the intertidal reach of the Eel River and may have a portion of the flow volume attributable to bank discharge.

** Meaurements at this location provided by Humboldt Redwood Company

INTERTIDAL REACH OF THE EEL RIVER

FB 61.31

E4 50.65

E3 57.19

E2 53.03

VD1 0.60

VD2 6.25

VD3 6.84

E1 63.03

SC 55.96

MEASUREMENTS AT "Y1" PROVIDED BY HUMBOLDT REDWOOD COMPANY

Y1 3.02

SEEPAGE THROUGH COBBLE BAR

Y2 0.59

VAN DUZEN RIVER FLOWING SUBSURFACE AT CONFLUENCE WITH EEL RIVER

USGS SCOTIA STATION–11477000 61

USGS BRIDGEVILLE STATION–11478500 5.7

VDG 4.89

EXPLANATION

- SURFACE FLOW MEASUREMENT LOCATIONS (E1)

SURFACE FLOW REACHES (FROM 8/23–24/16)

- FLOW INCREASE (GAINING STEAM)
- FLOW REDUCTION (LOOSING STEAM)
- AREAS OF ACCUMULATED ALLUVIAL MATERIAL, SOME OF WHICH IS ASSOCIATED WITH THE 1964 FLOOD
- 63.03 MEASURED DISCHARGE DURING 8/23–24/16

0 7,000 FEET

1"=7,000'±

FLOW STUDY PERFORMED BY THOMAS GAST & ASSOCIATES ENVIRONMENTAL CONSULTANTS

SHN Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

2016 Surface Flow Discharge Measurements Locations and Results
SHN 016219

December 2016 | SurfaceFlowMap | Figure 3-10

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\Report_MXDs\SurfaceFlowMap.mxd

RIVER AND WELL LOCATIONS BEING MONITORED CONTINUOUSLY THROUGH THE 2017 WATER YEAR

R-1
MW-1 (S/D)
MW-5 (S/D)
MW-7 (S/D)
MW-8
R-2
MW-2 (S/D)
R-3
MW-3 (S/D)
20
22
C-23
MW-9 (S/D)
R-4
MW-10
MW-11

EXPLANATION

- SURFACE WATER TRANSDUCERS
- PRIVATE WELLS WITH TRANSDUCERS

COUNTY MONITORING WELLS 2016

- WITH TRANSDUCER
- WITHOUT TRANSDUCER
- EEL RIVER GROUNDWATER BASIN

0 6,000
FEET

1 "= 6,000 '

N

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Groundwater and Surface Water Monitoring Locations
SHN 016219

December 2016 | GWSW_Monitoring_Locations | Figure 3-11

SPRING 2016 GROUNDWATER CONTOUR MAP

10

10

20

20

30

40

50

60

60

60

80

100

EXPLANATION

EEL RIVER GOUNDWATER BASIN

WELLS

CASGEM WELLS

PRIVATE WELLS

N

1 "= 7,000 '±

0 7,000

FEET

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

CASGEM WELLS MEASURED BY DWR ON 3/29/2016;
PRIVATE WELLS MEASURED BY DON AND CHERYL LAFFRANCHI ON 3/1/2016

SHN Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River GW Assessment
Humboldt County, California

Groundwater Elevation
Map - Spring 2016
SHN 016219

December 2016 | GW_Elevations_Spring2016 | Figure 3-12

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\Report_MXDs\GW_Elevations_Spring2016.mxd

FALL 2016 GROUNDWATER CONTOUR MAP

EXPLANATION

EEL RIVER GOUNDWATER BASIN

WELLS

- CASGEM WELLS
- HUMBOLDT CREAMERY WELLS
- MUNICIPAL WELLS
- PRIVATE WELL
- COUNTY MONITORING WELLS

1"= 7,000'±

0 7,000

FEET

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

SEE APPENDIX F FOR DETAILS ON SAMPLING DATES

Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River GW Assessment
Humboldt County, California

Groundwater Elevation Map - Fall 2016
SHN 016219

December 2016 | GW_Elevations_Fall2016 | Figure 3-13

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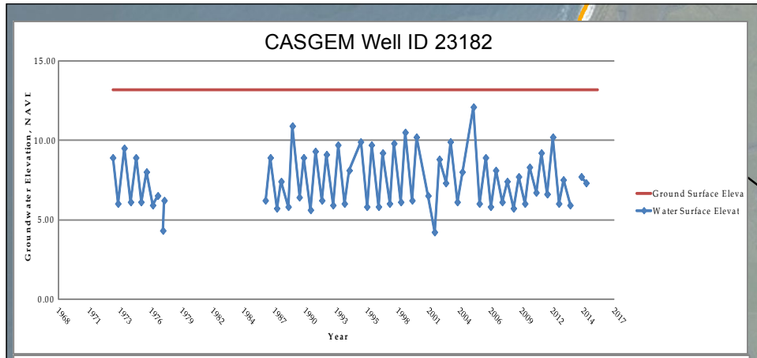

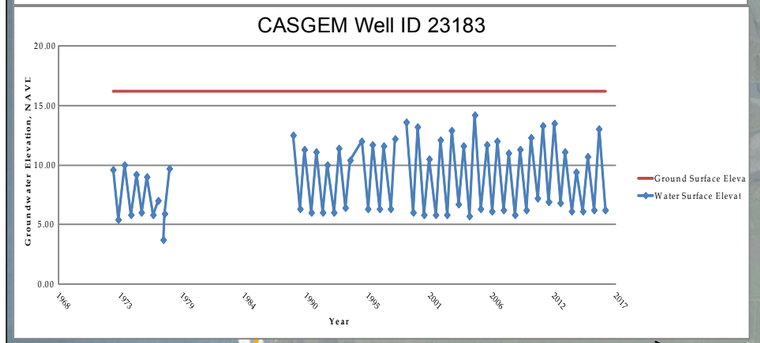

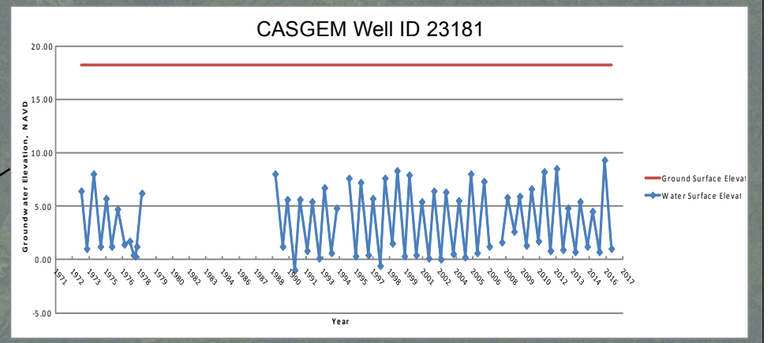

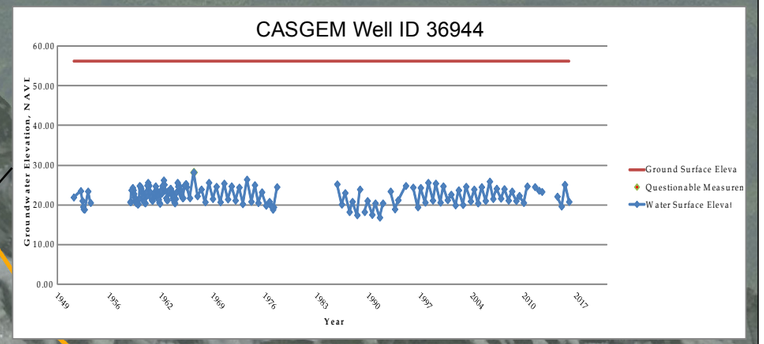

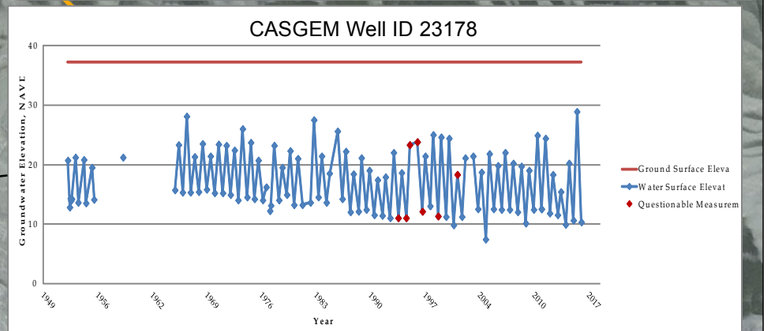

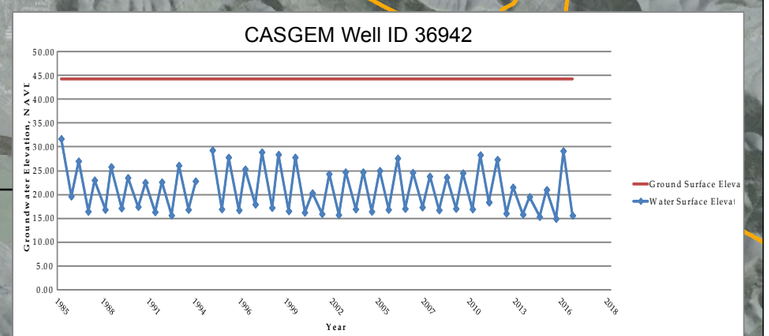

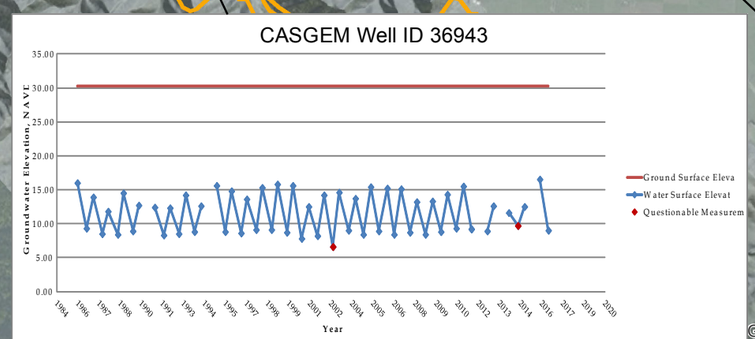

NO RECORDS BEYOND 1999

23180

23182

23181

23183

36944

36943

23178

36942

ONLY HAD RECORD FROM 1986 TO 1994

23179

EXPLANATION

CASGEM WELLS

EEL RIVER GROUNDWATER BASIN

0 1

MILES

1 " = 1 MILES

N

GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Path: \\eureka\projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\Report_MXDs\CASGEMWell_Locations.mxd

Consulting Engineers & Geologists, Inc.

Humboldt County Public Works Eel River GW Assessment Humboldt County, California	CASGEM Well Locations and Hydrographs SHN 016219	
December 2016	CASGEMWell_Locations	Figure 3-14

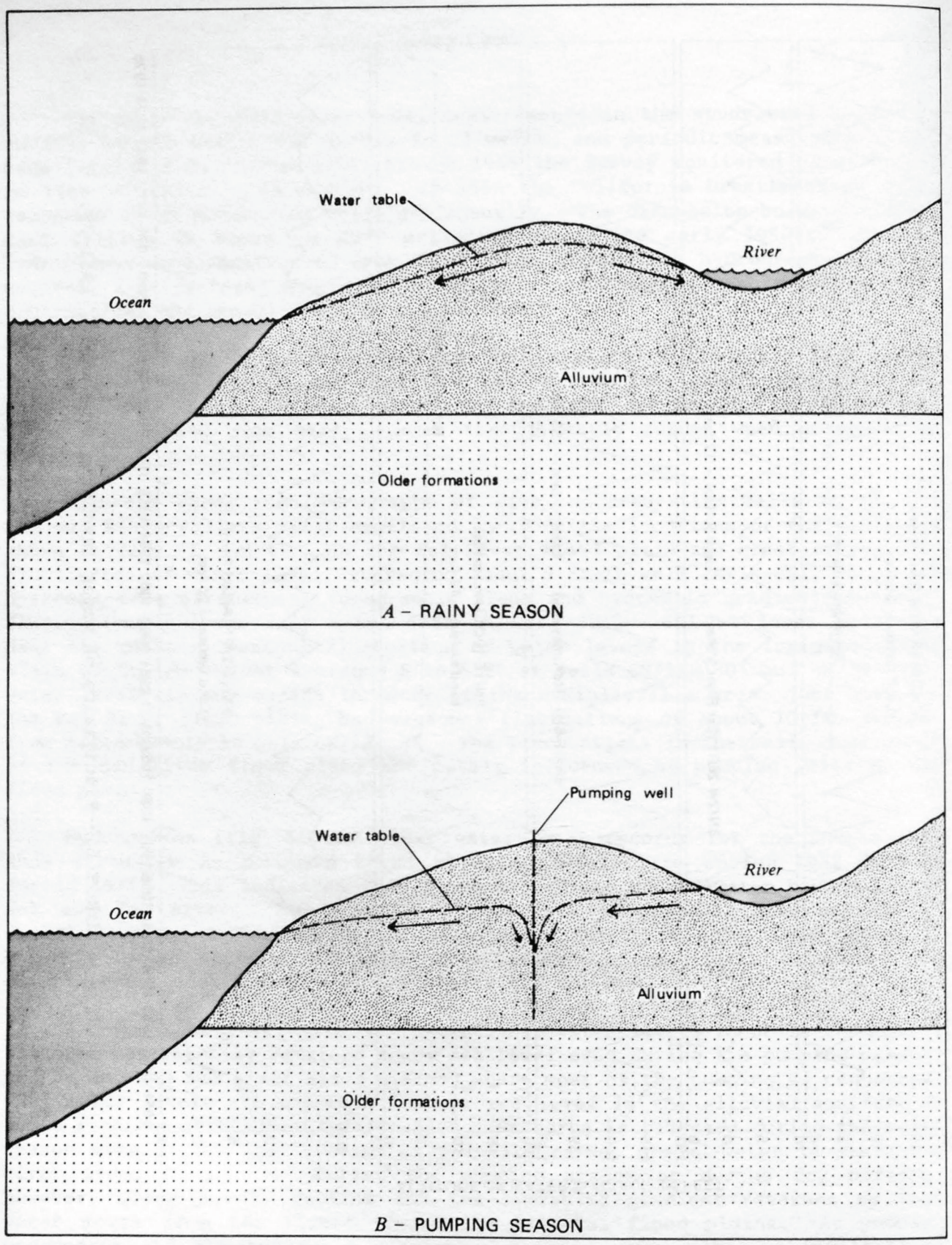

FIGURE 6.--Relation of water table to river and direction of ground-water flow during the rainy season and pumping season.

Consulting Engineers & Geologists, Inc.	Humboldt County Public Works Eel River Groundwater Assessment Humboldt County, California	Schematic Illustration Showing Relationship Between Eel River and Ocean (USGS, 1975) SHN 016219
December 2016	Schematic_EelRiver_Ocean.ai	Figure 3-15

Parameters Used in Analysis of Storage Changes

CASGEM Well ID#	Area of Associated Polygon (acres)	Estimated Specific Yield
23182	4346	15%
23181	2673	20%
23183	7331	10%
36942	5724	22%

CASGEM WELL 23182

CASGEM WELL 23181

CASGEM WELL 23183

CASGEM WELL 36942

EXPLANATION

- CASGEM WELLS
- CHANGE IN STORAGE CALCULATION AREAS
- EEL RIVER GROUNDWATER BASIN

0 6,000 FEET

1 "= 6,000 '

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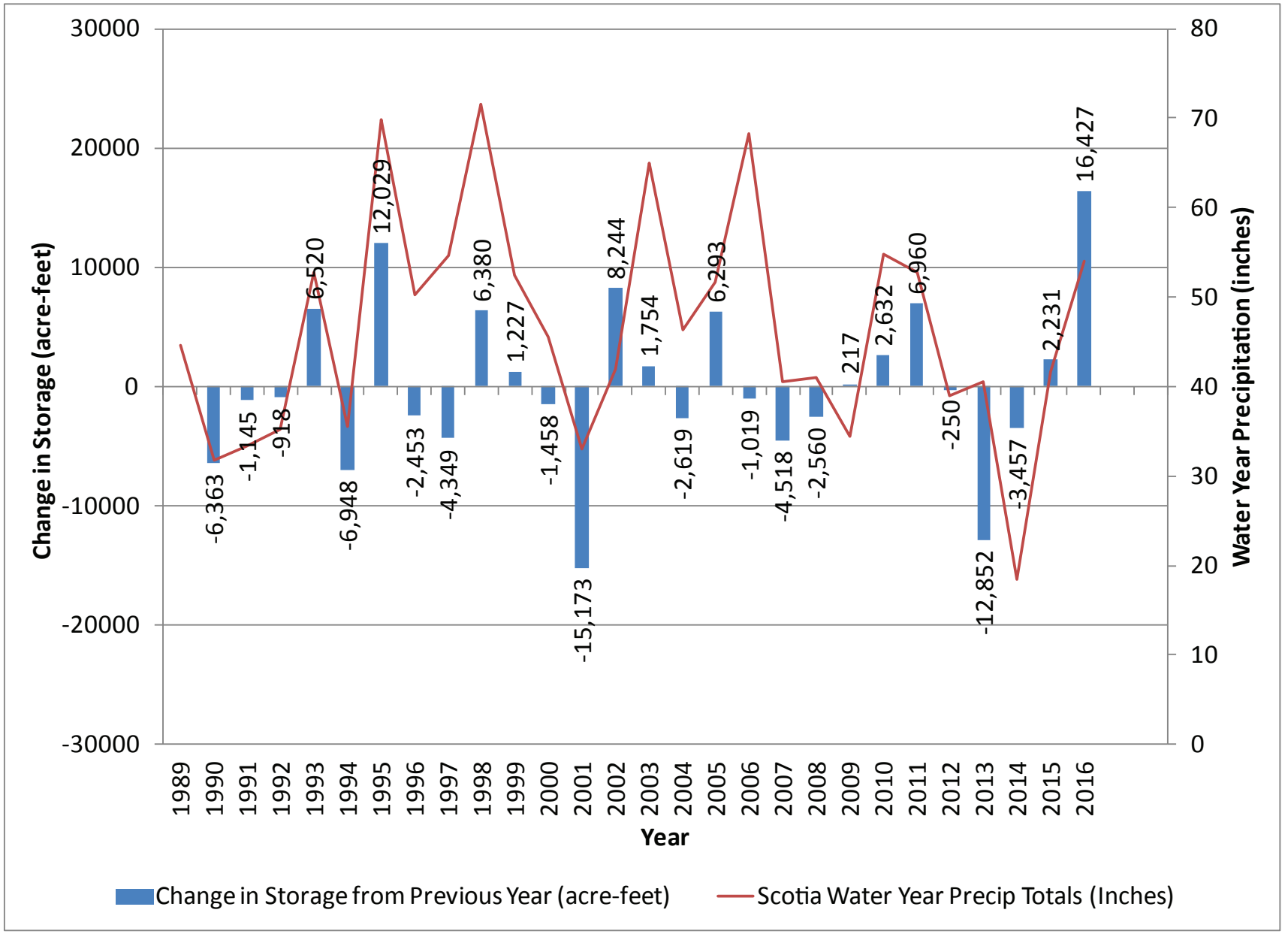
CASGEM Wells and Associated Areas Used in Change in Storage Analysis
SHN 016219

December 2016 | Change_in_Storage_Analysis | Figure 3-16



NOTE: CHANGES IN GROUNDWATER STORAGE WERE CALCULATED USING THE LONG-TERM BI-ANNUAL WATER LEVELS RECORDED BY DWR IN REPRESENTATIVE WELLS (SEE FIGURE 3-16).

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Changes in Groundwater Storage in the Lower Eel River Valley
SHN 016219

December 2016 | StorageWY.ai | Figure 3-17

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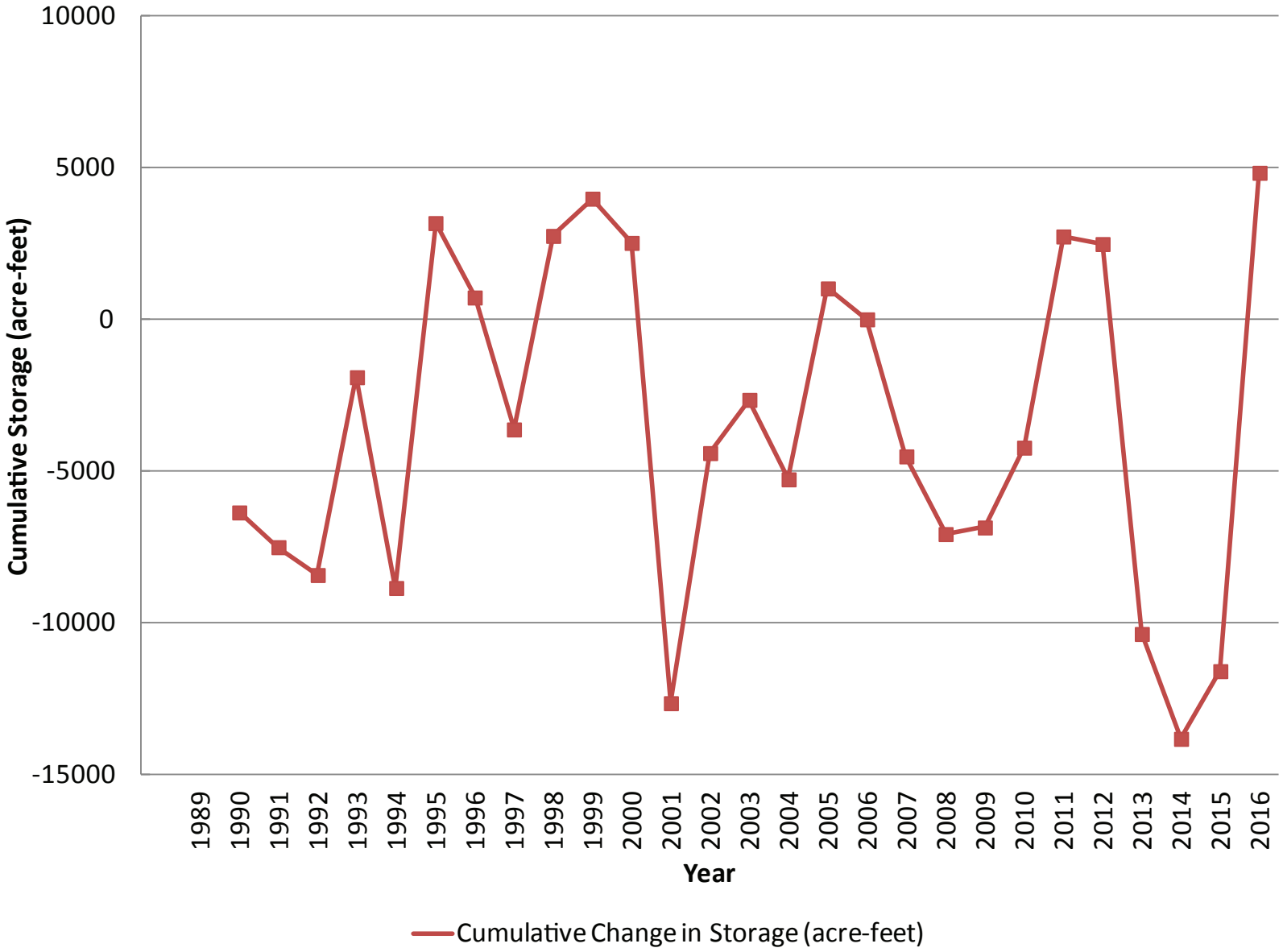
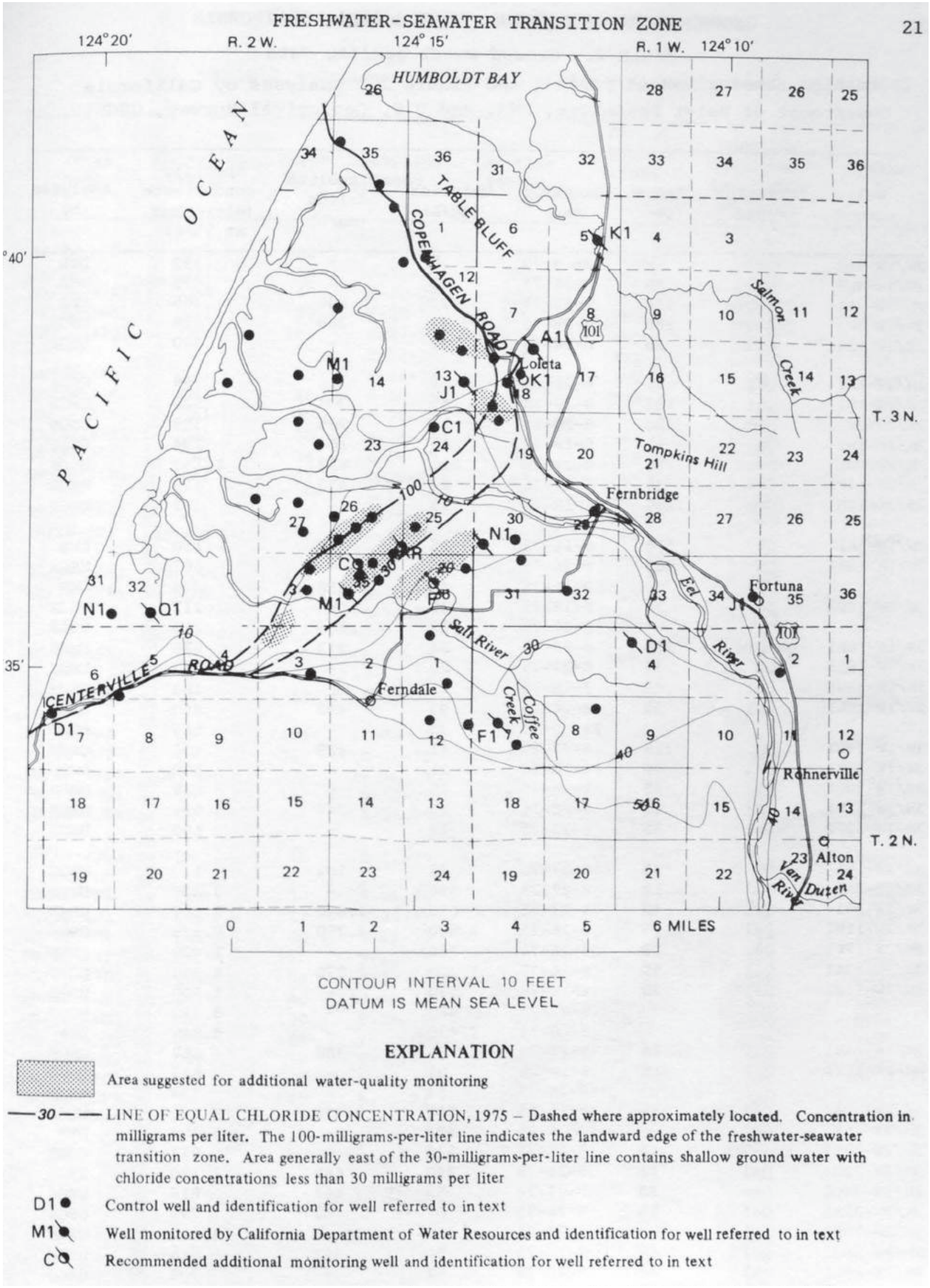


	Consulting Engineers & Geologists, Inc.	Humboldt County Public Works Eel River Groundwater Assessment Humboldt County, California	Cumulative Changes in Storage in the Lower Eel River Valley SHN 016219
		December 2016 | CumulativeStorage.pdf	Figure 3-18



NOTE: FROM USGS, 1975

Consulting Engineers & Geologists, Inc.	Humboldt County Public Works Eel River Groundwater Assessment Humboldt County, California	Freshwater/Seawater Transition Zone In Alluvial Aquifer, Eel River Valley-1975 SHN 016219
December 2016	SaltwaterFreshwater_Interface_1975.pdf	Figure 3-19

EXPLANATION

100 MG/L LINE OF EQUAL CHLORIDE CONCENTRATION (JOHNSON, 1975)

CERTAIN

APPROXIMATE

2016 CHLORIDE DATA VALUES (MG/L)

INDICATES WELL DEPTH >100 FEET

23/20 INDICATES SHALLOW/DEEP CONCENTRATIONS

N

1"=3,000'±

0 3,000

FEET

1975 CHLORIDE CONCENTRATION 100 MG/L

1500 320 22 680 250 180 33 38 28 25 23/20 63 32 67 41 62 89 2600 130 36/170 39 49 87 47 49

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

NOTE: SEE APPENDIX F FOR DETAILS ON SAMPLING DATES

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2016 Chloride Concentrations Map
SHN 016219

December 2016 | Chloride_Concentrations | Figure 3-20

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EXPLANATION

- ESTUARINE AND MARINE DEEPWATER
- ESTUARINE AND MARINE WETLAND
- FRESHWATER EMERGENT WETLAND
- FRESHWATER FORESTED/SHRUB WETLAND
- FRESHWATER POND
- LAKE
- OTHER
- RIVERINE

0 7,000
FEET

1"=7,000'±

N

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

NOTE: NATIONAL WETLANDS INVENTORY FROM U.S. FISH AND WILDLIFE SERVICE–ACCESSED 2016

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Humboldt County, California

National Wetlands Inventory
SHN 016219

December 2016 | NWI | Figure 3-21

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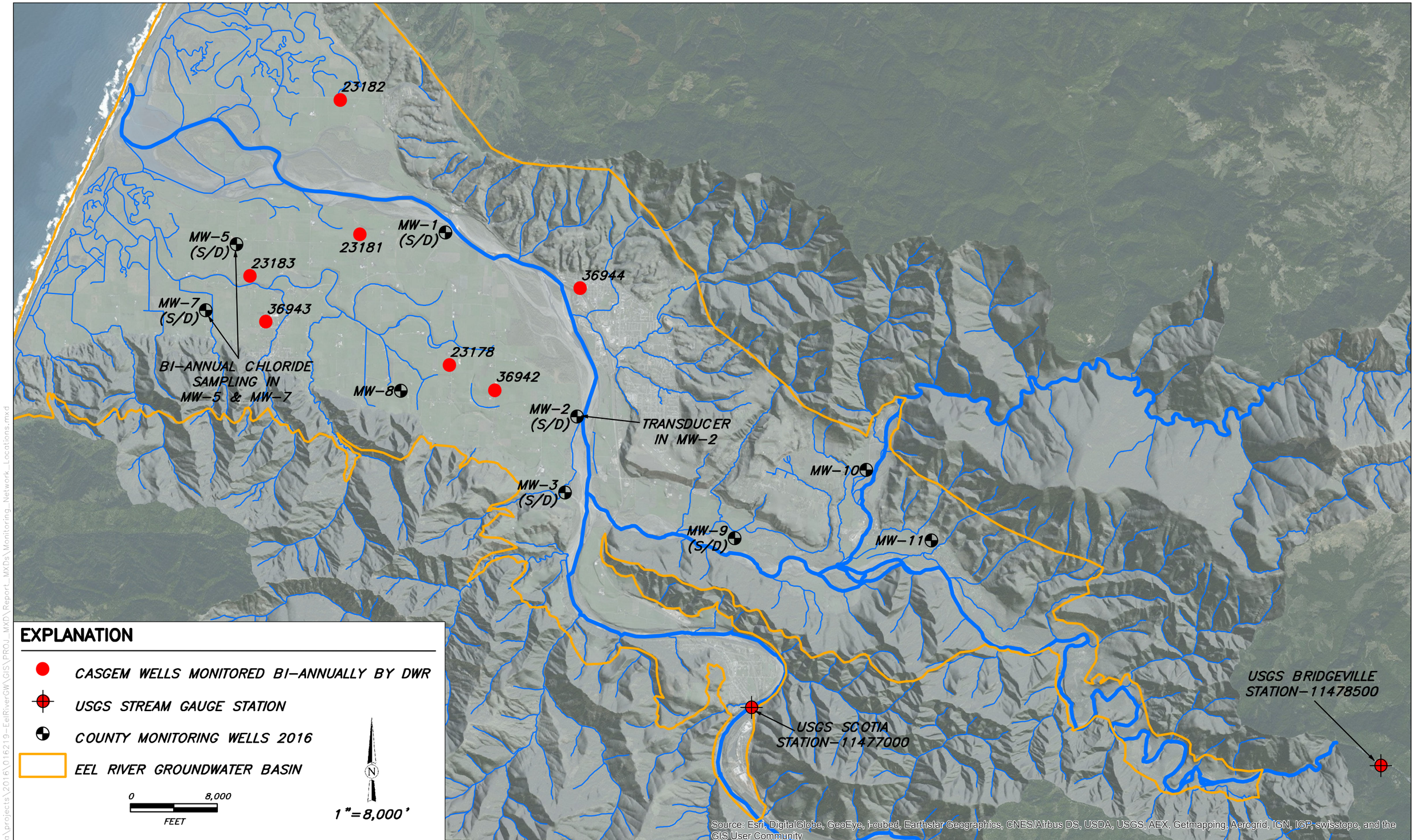

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Humboldt County, California

Monitoring Network Locations
SHN 016219

December 2016 | Monitoring_Network_Locations | Figure 4-1

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