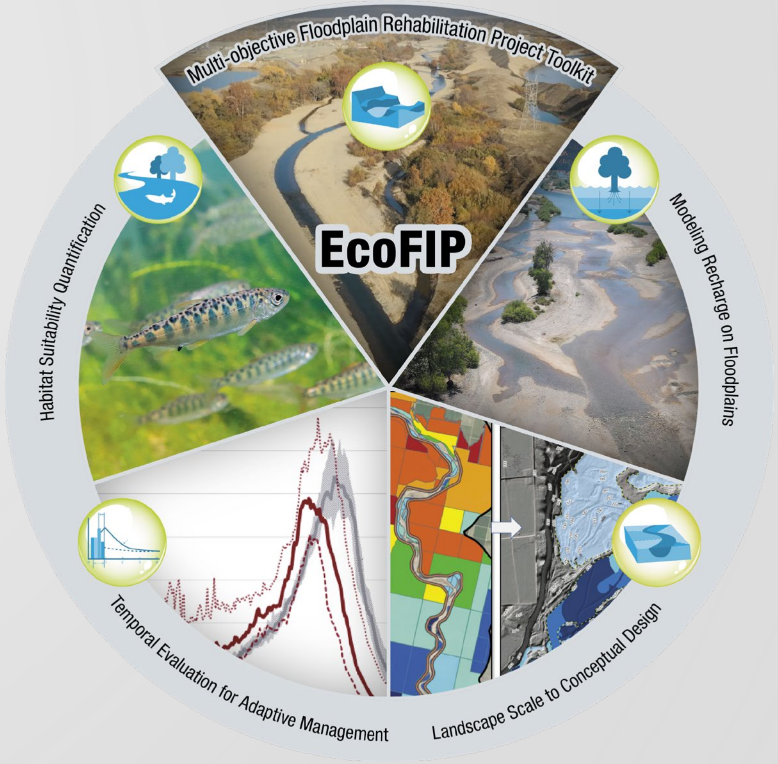
Floodplain Restoration and Recharge Pilot Studies

-Identify, Analyze, and Prioritize multi-objective opportunities for floodplain rehabilitation

-Collaboratively develop and advance floodplain rehabilitation projects



Toby Stegman, Jesse Rowles, Michael Founds, Chris Bowles
cbec eco engineering

Jeremy Thomas, Debra Bishop, CJ Porter
Jacobs

Jenny Marr, Lori Clamurro-Chew
California Department of Water Resources

October 16, 2024

Presentation Overview

- Project Overview and Engagement
- Project Sites and Concepts
- Results of Analysis & Findings
  - Surface Water Elevations
  - Floodplain Inundation/Habitat
  - Groundwater Recharge

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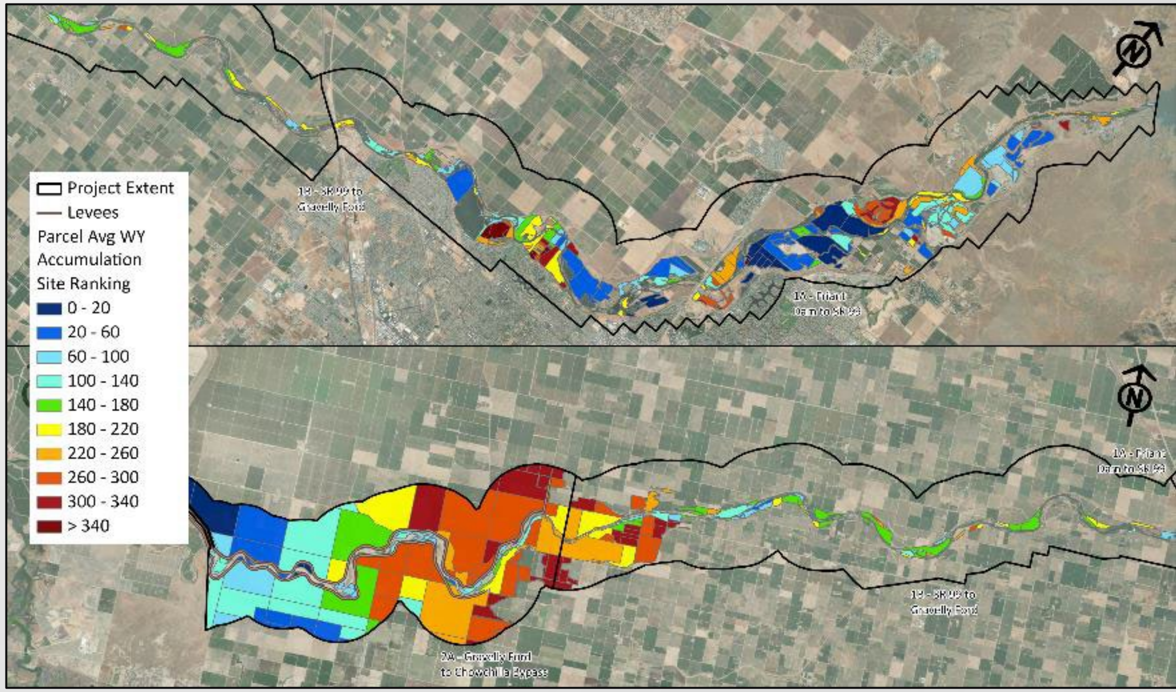
Section 1

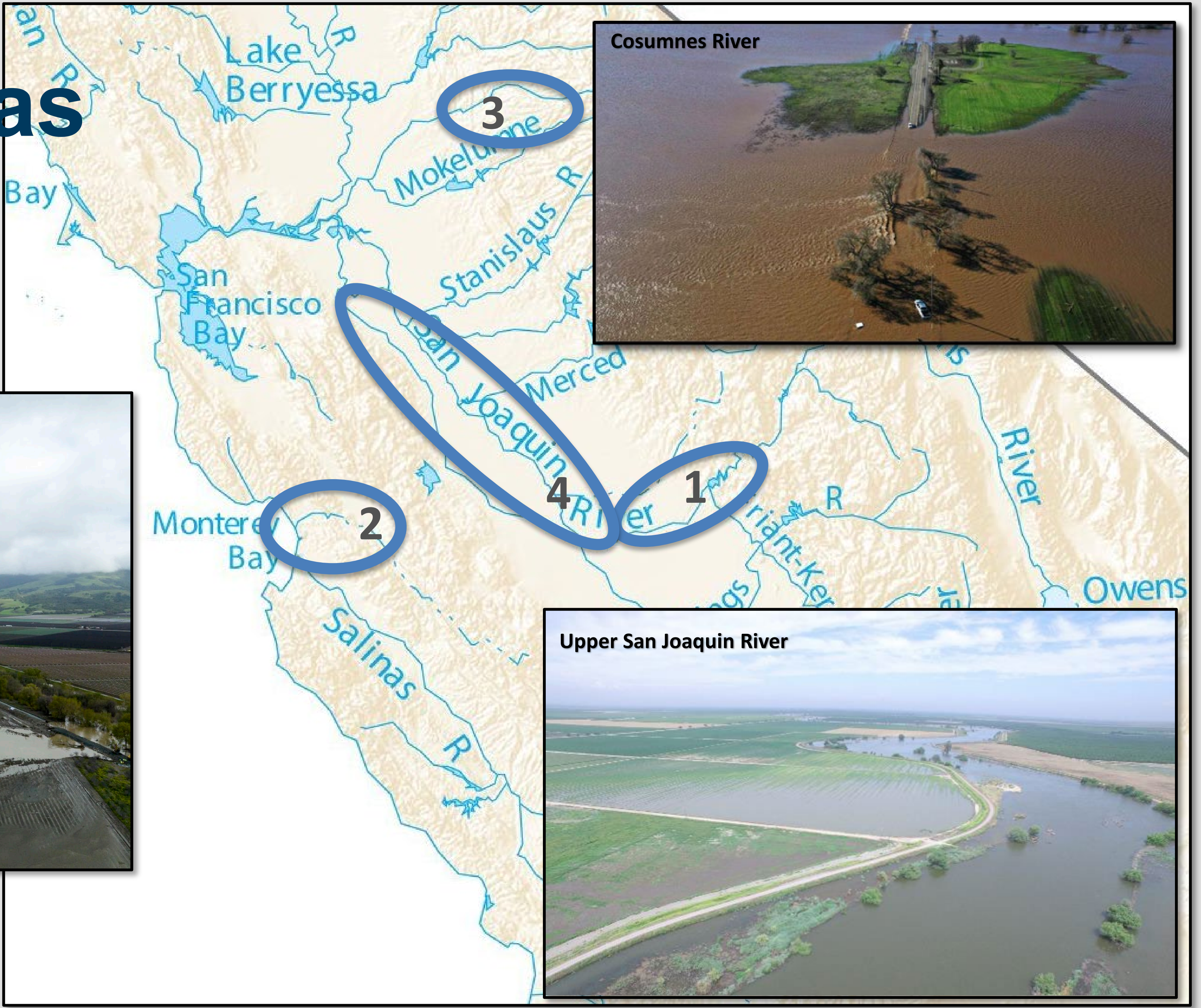
INTRODUCTION AND BACKGROUND

Multi-Benefit Floodplain Restoration Pilot Studies Objectives

- Develop systematic approach that could be applied at large scales
- Identify best opportunities for:
  - Groundwater recharge benefits (e.g., aquifer conditions, base flow, GDEs)
  - Ecosystem benefits (e.g., salmonid rearing habitat)
  - Flood-risk reduction
  - Climate change adaptation (responding to "weather whiplash")
- Identify potential areas of alignment with other local and regional efforts and willing landowners
- Lead to implementation of on-the-ground projects



Study Areas



Cosumnes River
Upper San Joaquin River


Pajaro River

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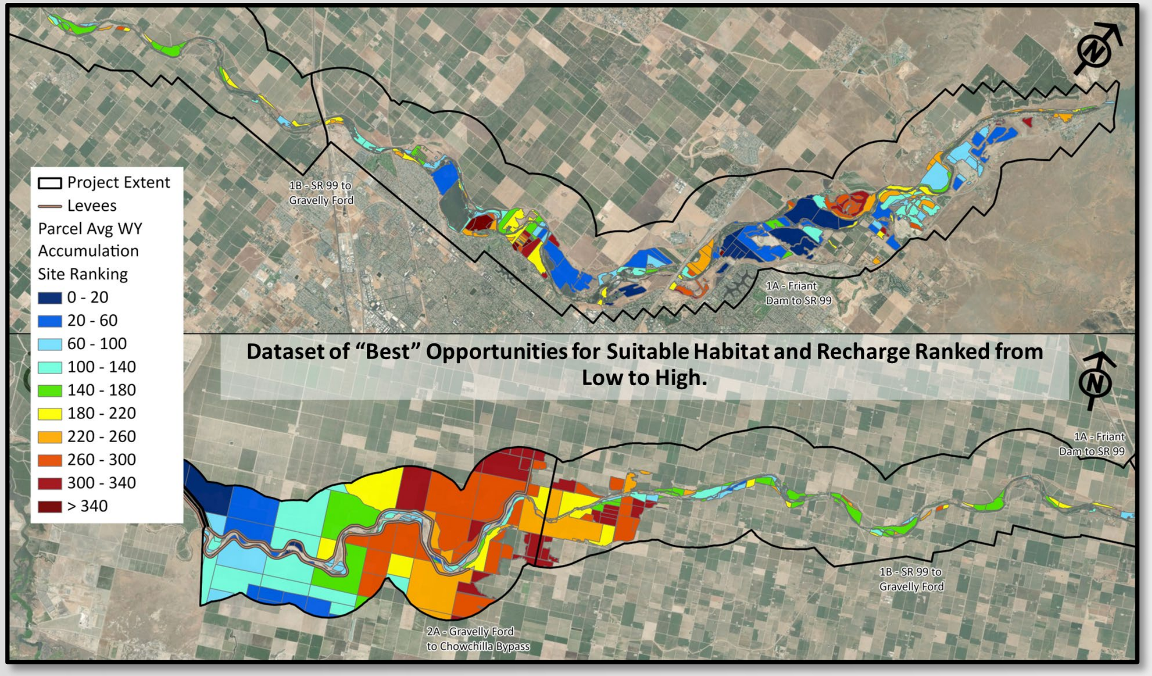
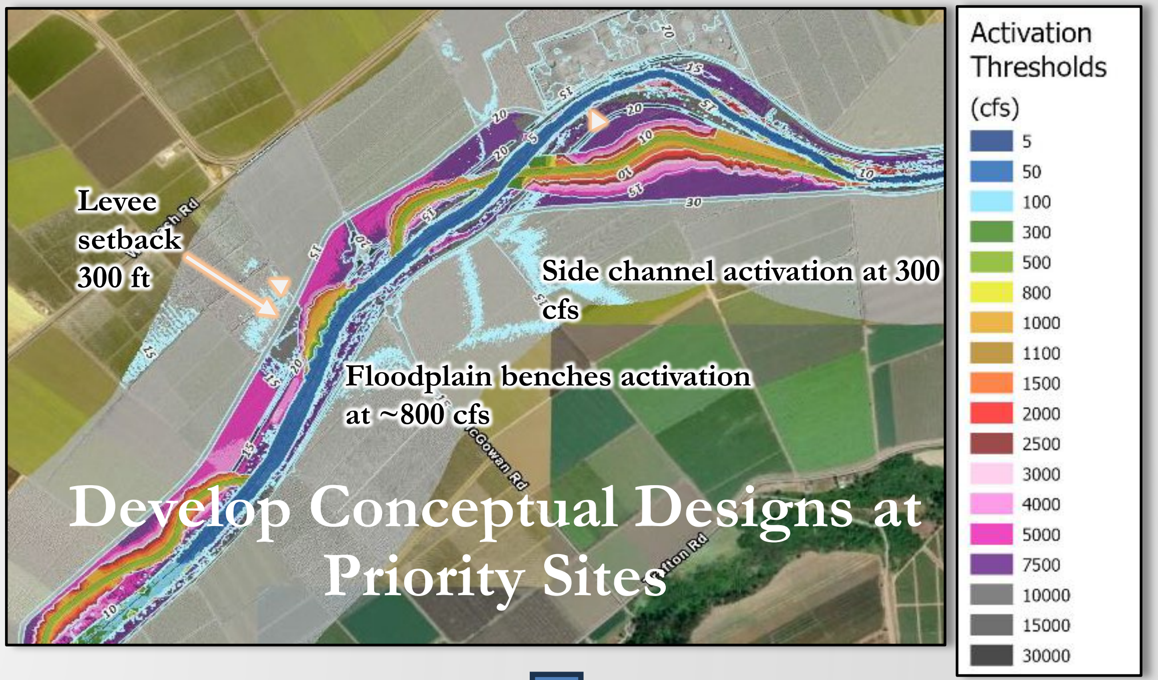
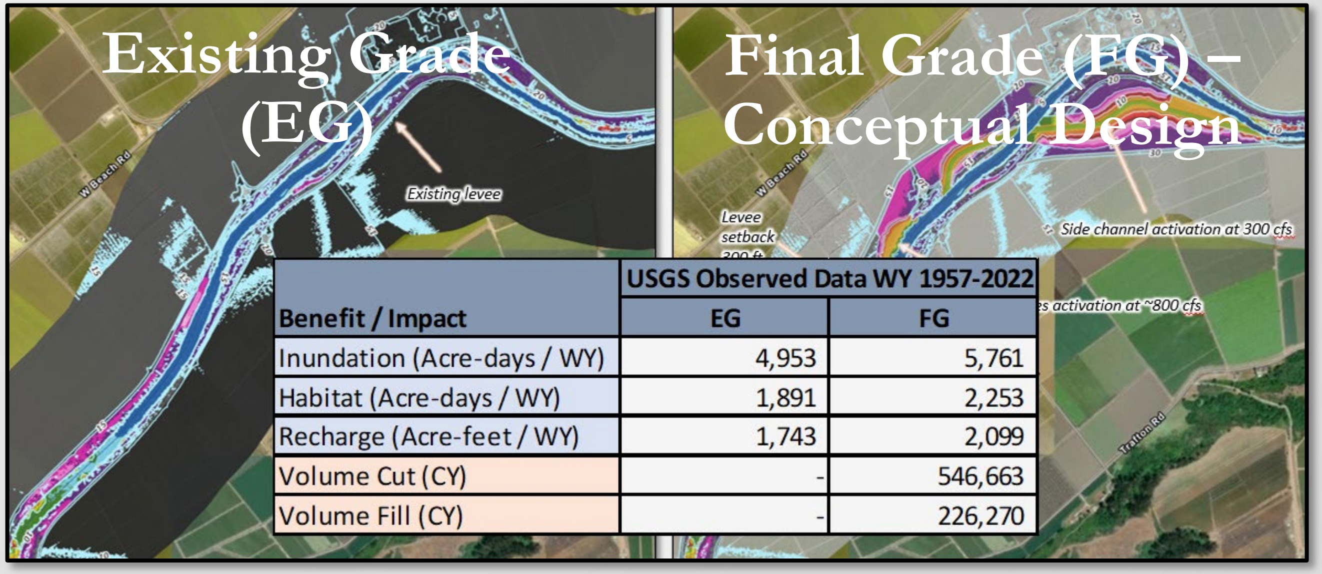
WATER RESOURCES

Study Overview



Use Study Objectives to Identify and Prioritize Potential Opportunities





Benefit / Impact	USGS Observed Data WY 1957-2022 EG	FG
Inundation (Acre-days / WY)	4,953	5,761
Habitat (Acre-days / WY)	1,891	2,253
Recharge (Acre-feet / WY)	1,743	2,099
Volume Cut (CY)	-	546,663
Volume Fill (CY)	-	226,270

Estimate Benefits and Costs of Conceptual Designs

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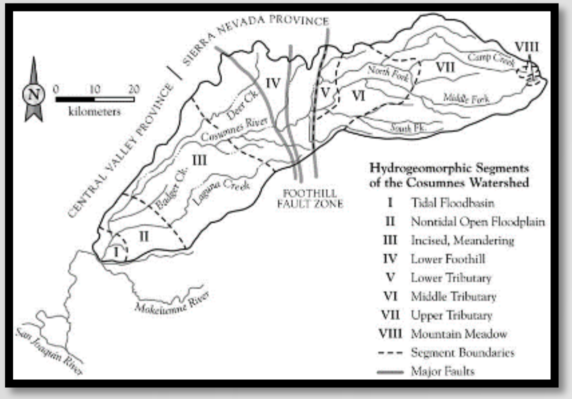
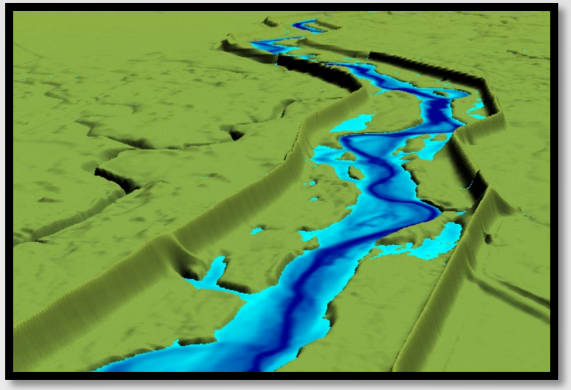
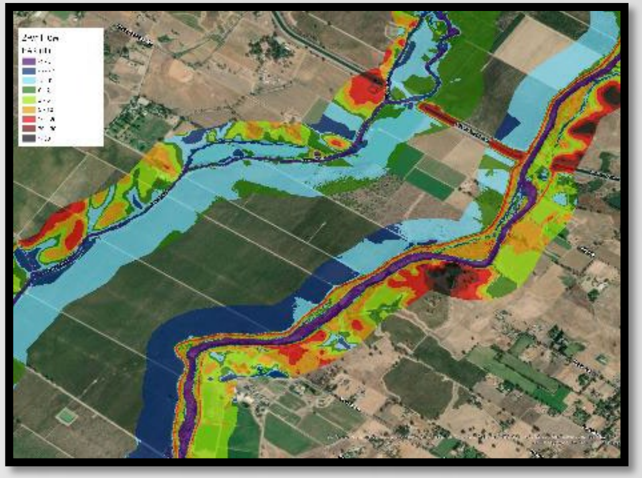
Cosumnes Study Approach

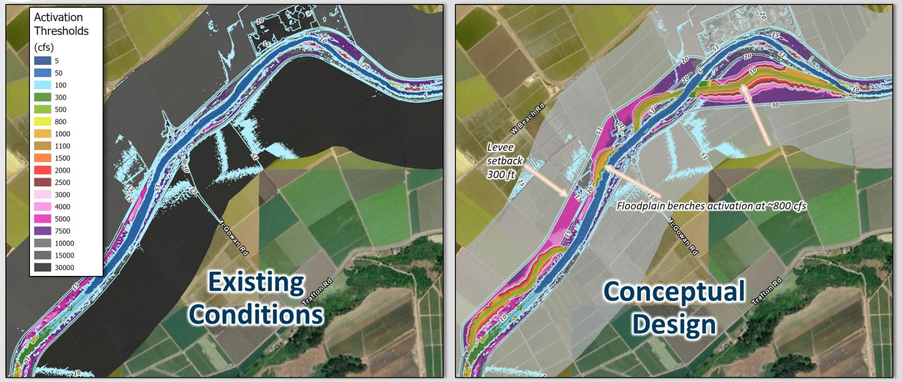


1. System Hydrology





2. Hydraulic Modeling



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Recharge (Acre-feet / WY)	1,743	2,099
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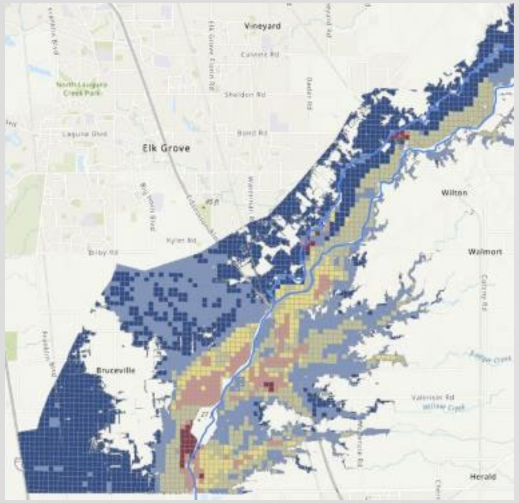
Volume Fill (CY)	-	226,270

3. EcoFIP

4. Flood Risk Reduction



5. Recharge

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EcoFIP Tiers of Analysis - Refresher

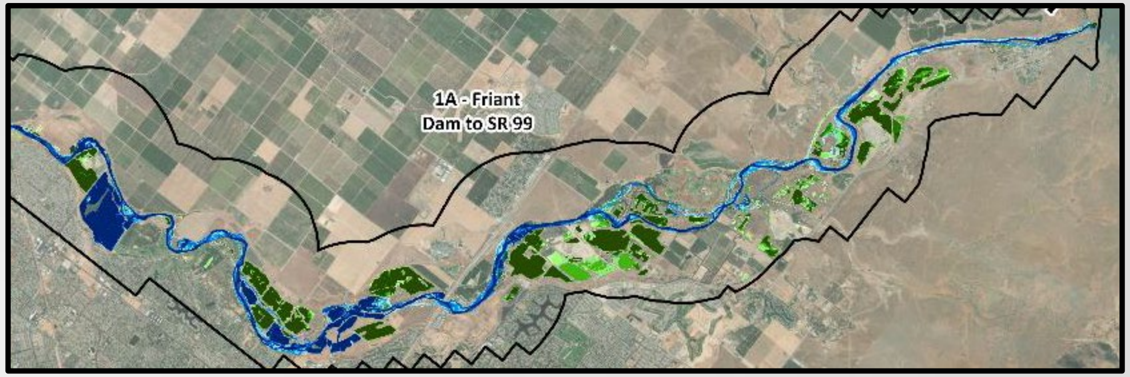
Tier 1 Large-scale Inundation Potential

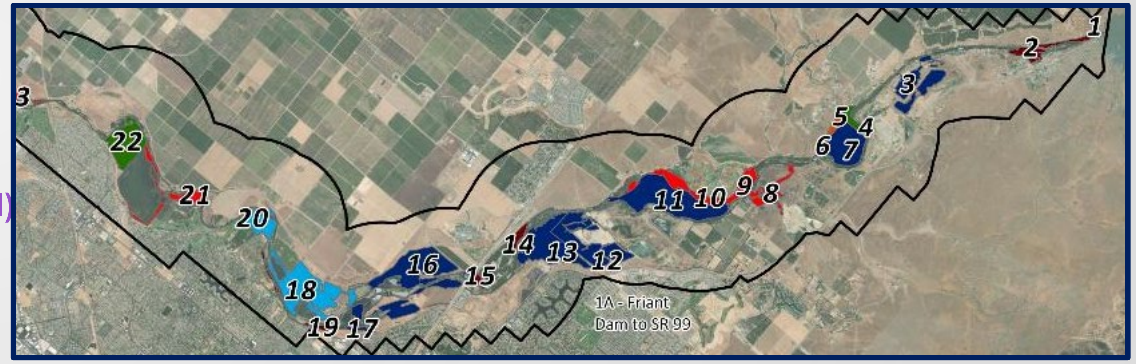
Tier 2 Multi-Objective, Site-Scale Analysis and Prioritization

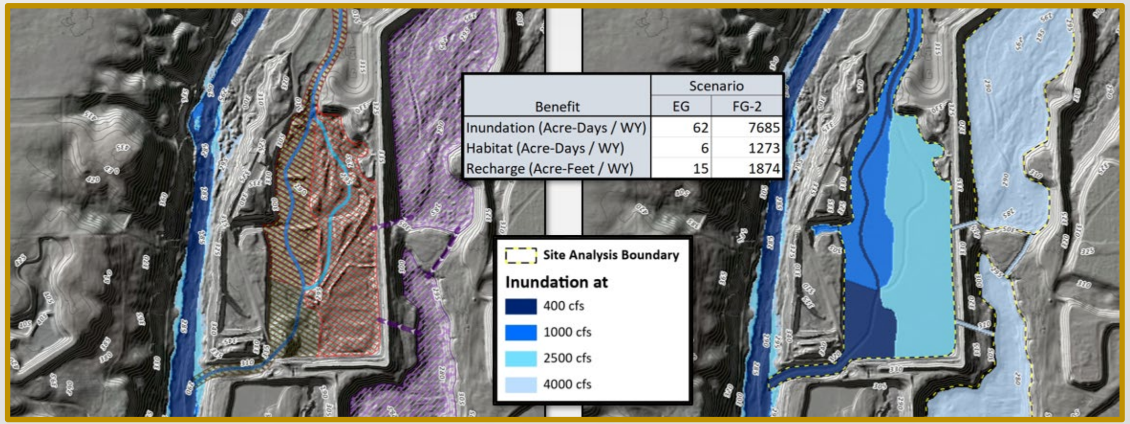
Tier 3 Site-Scale Concept Development

Analysis Dimensions

Temporal	Spatial
Individual flows	River reach
WY-based accumulated stats	Boundaries for Existing Topography (e.g., parcels, river miles, grid)
WY-based accumulated stats	Site Concept For Design Topography







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Cosumnes Outreach Overview

- Study Partners and Interested Parties
  - Sacramento County, OHWD, RD 800, Cosumnes Coalition, Wilton Rancheria, The Nature Conservancy, Sacramento Valley Conservancy, Fresh Water Trust, private landowners
- Meetings
  - Monthly coordination
  - Flood-focused objectives and opportunities
  - Eco-focused objectives and opportunities
  - Workshops and site visit

Section 2

CONCEPTS AND RESULTS

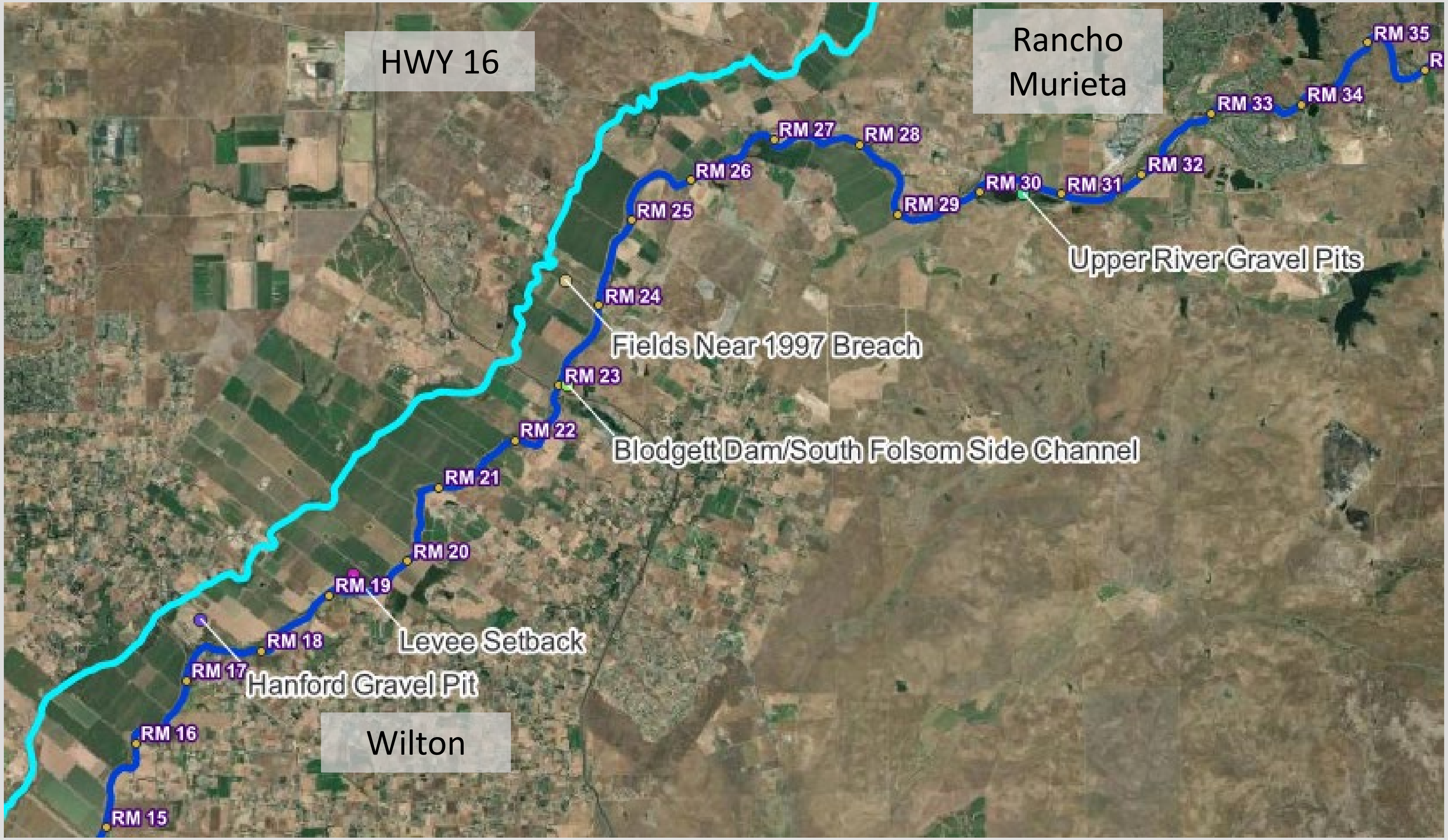
Overview

Sites (Number of Concepts):

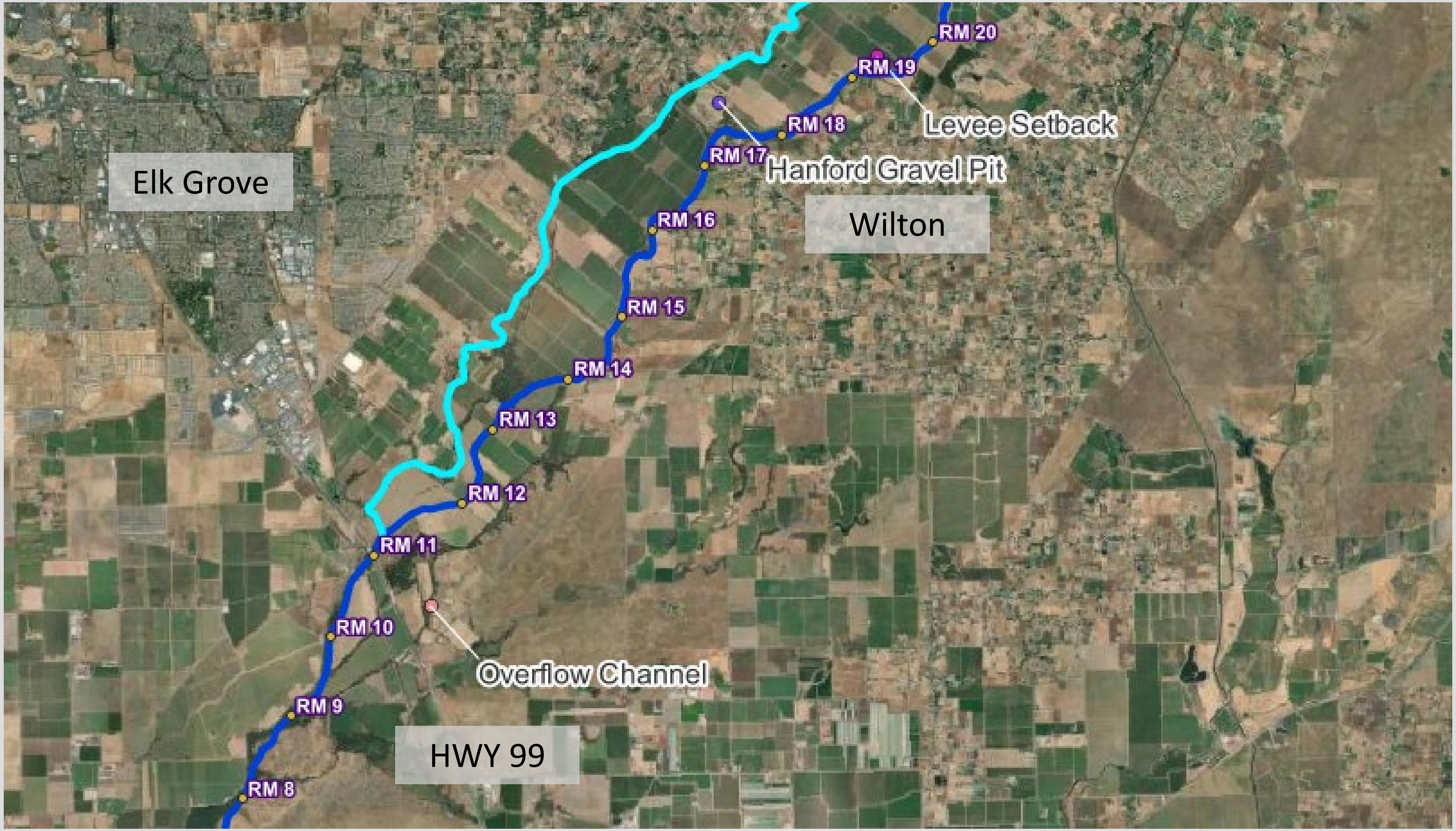
1. Upper River Gravel Pits (1)
2. Fields Near 1997 Breach (2)
3. Blodgett Dam/South Folsom Side Channel (2)
4. Levee Setback (3)
5. Hanford Gravel Pit (2)
6. Overflow Channel (1)

Recurrence Interval (yr)	Daily Flow at Michigan Bar (cfs)
1.25	2,700
2	6,000
3	10,000
5	15,000
10	20,000

Site Locations

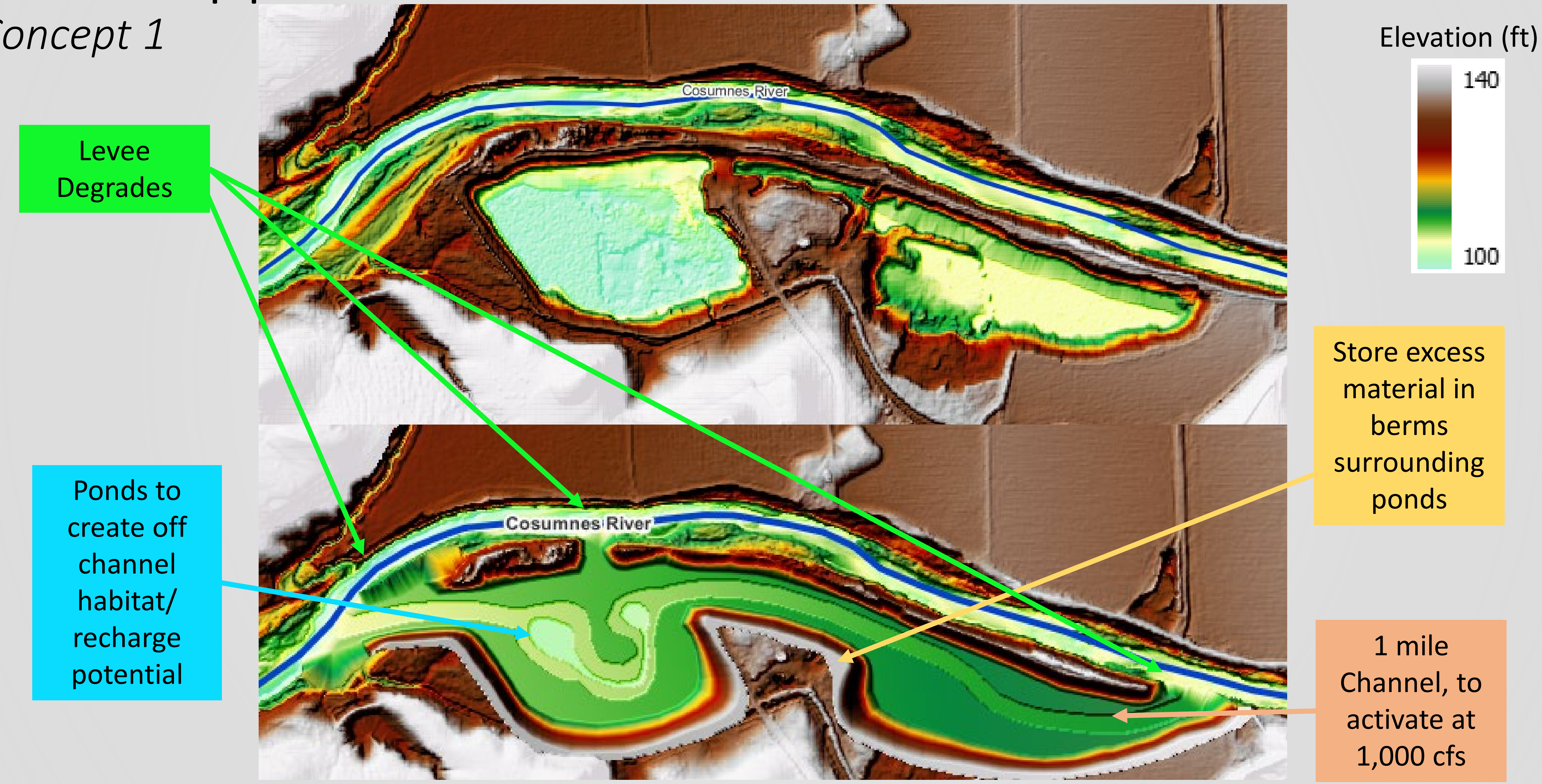


Site Locations, cont.



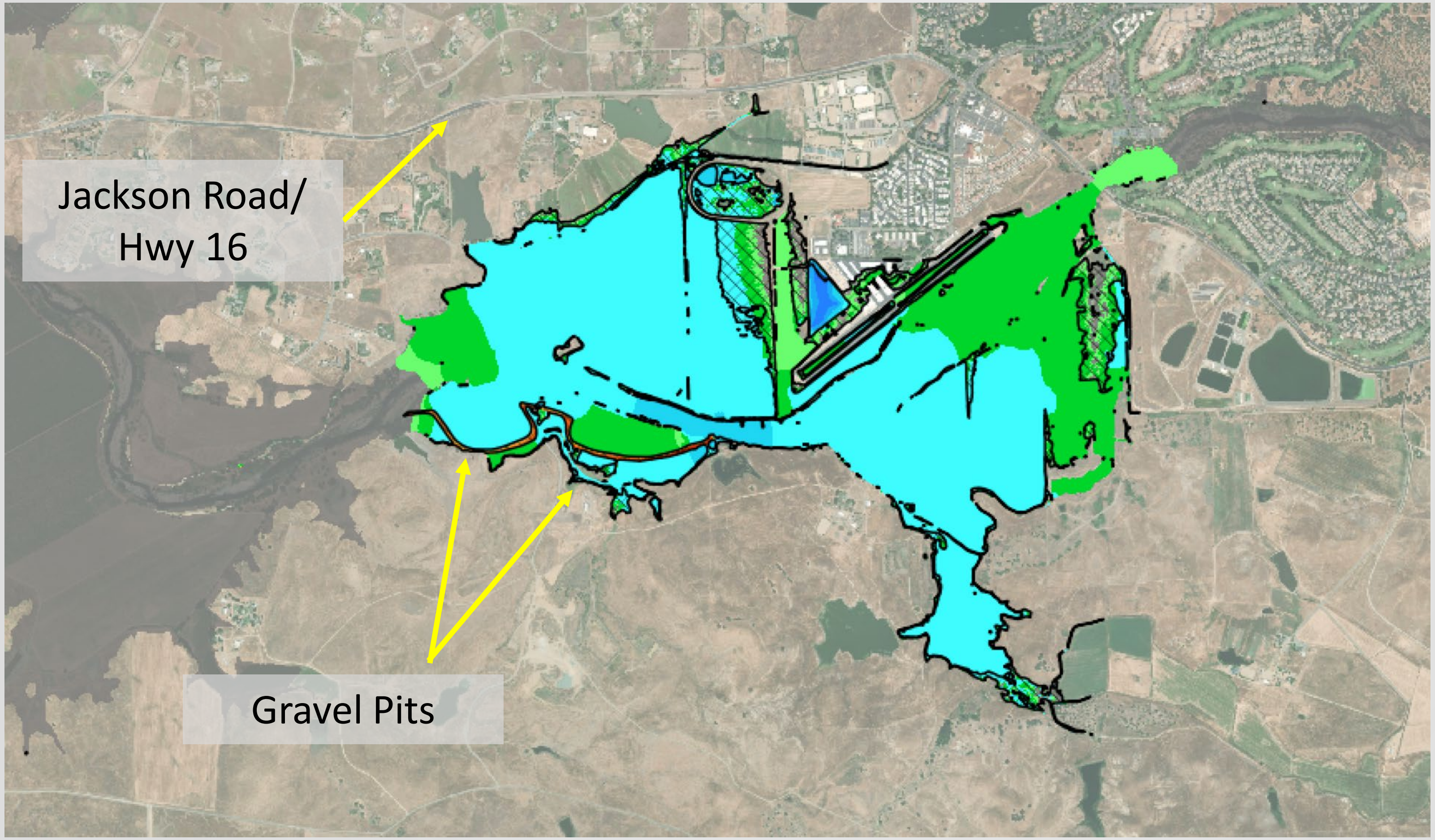
Site – Upper River Gravel Pits

Concept 1



Results

Upper River Gravel Pits Concept (Flood)



Wet → Dry or Dry → Wet Areas

Water Level Difference (ft) Mich Bar Flow = 75,000 cfs

- <= -5.00
- -5.00 - -4.00
- -4.00 - -3.00
- -3.00 - -2.00
- -2.00 - -1.00
- -1.00 - -0.50
- -0.50 - -0.25
- -0.25 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

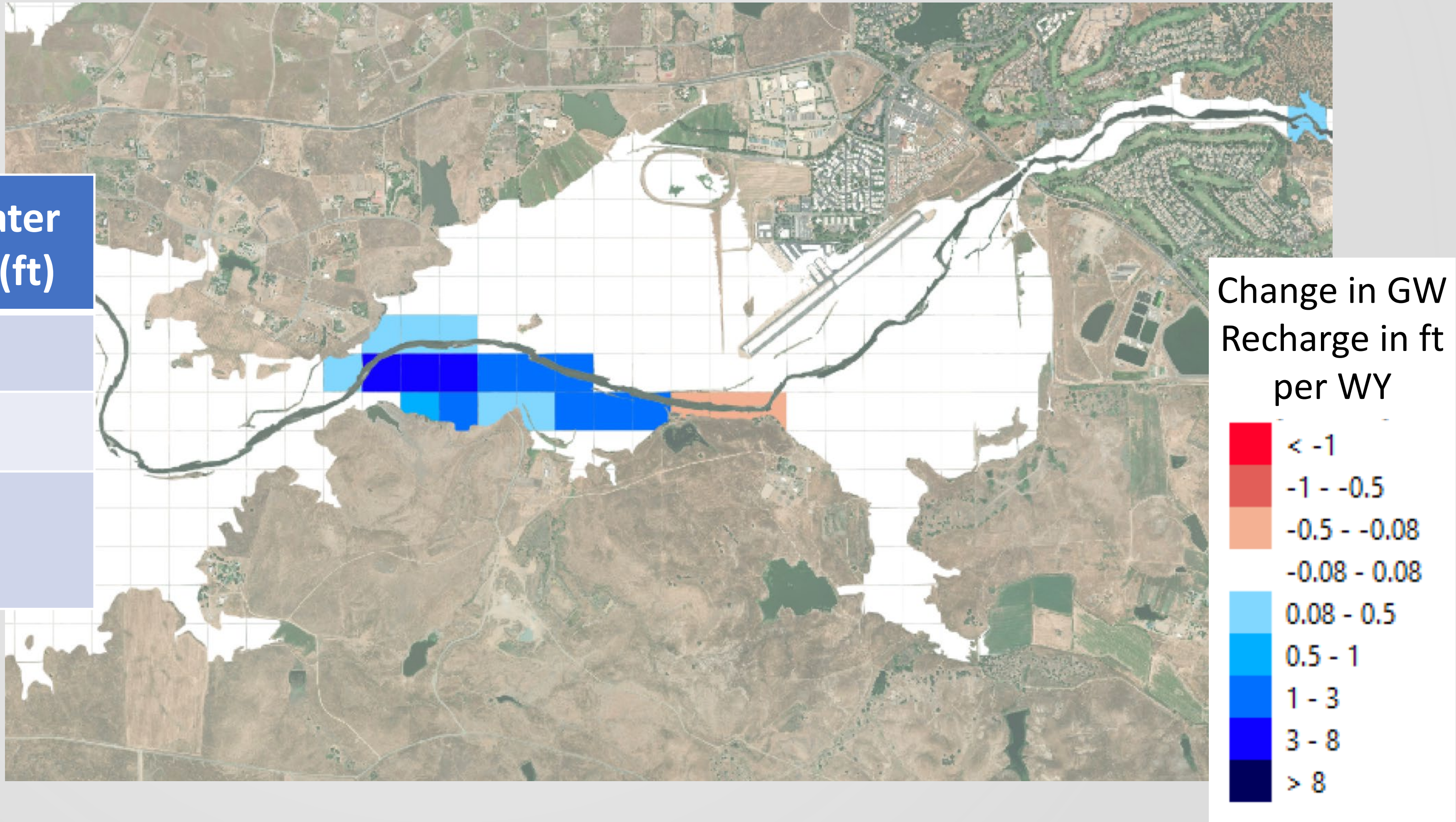
Deeper In Existing

Deeper In Project

Results

Upper River Gravel Pits Concept (Groundwater Recharge)

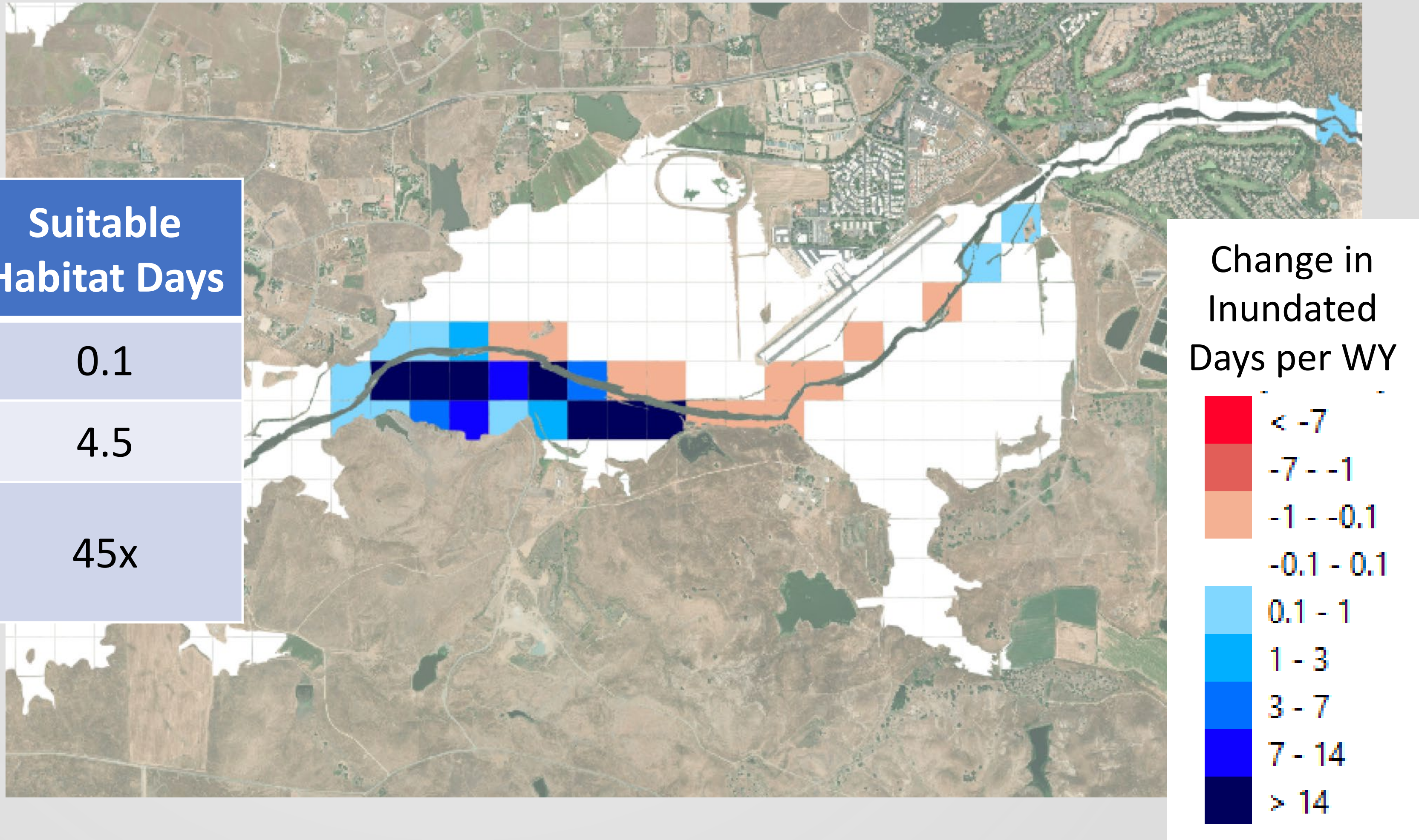
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	0.1
Project	2.1
Multiplier Difference	21x



Results

Upper River Gravel Pits Concept (Inundation/Habitat)

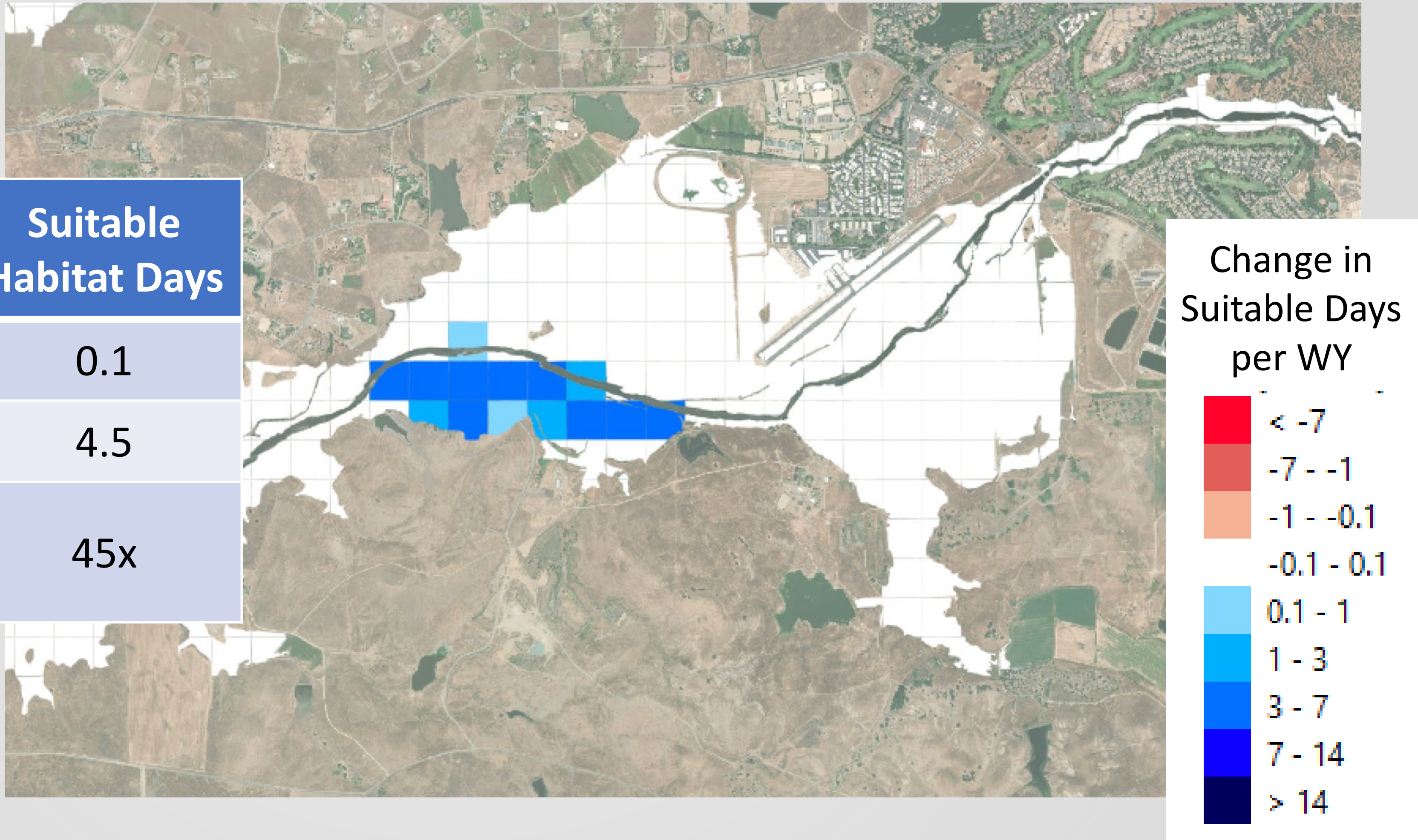
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	0.1	0.1
Project	14.5	4.5
Multiplier Difference	145x	45x



Results

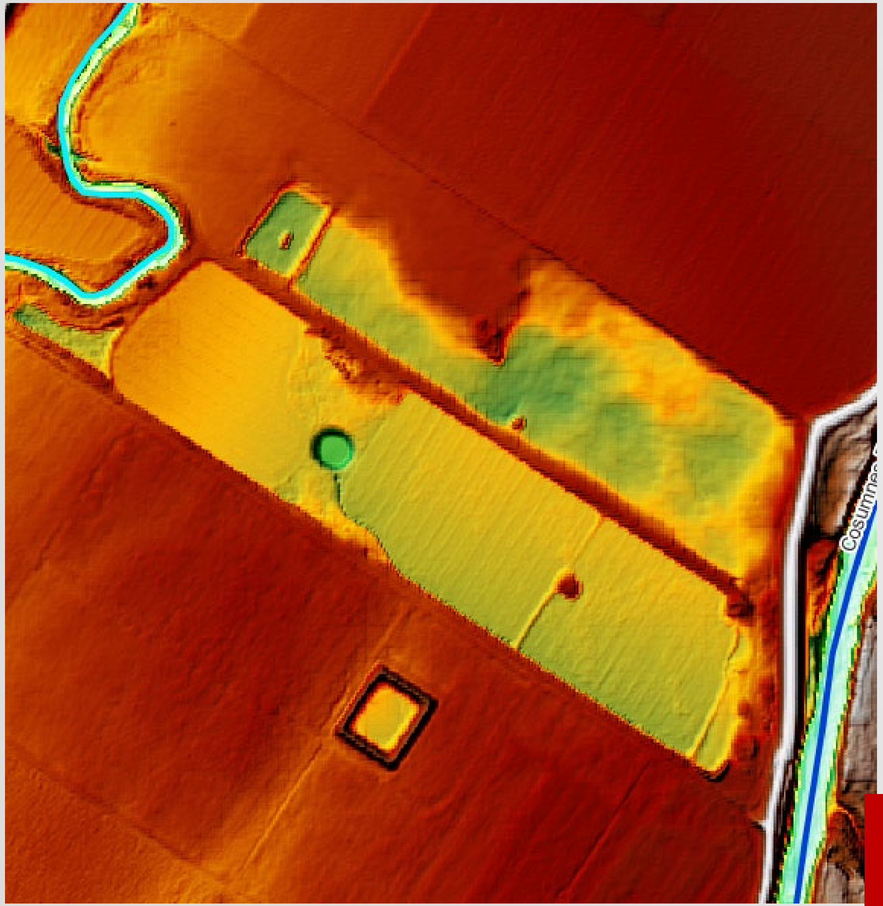
Upper River Gravel Pits Concept (Inundation/Habitat)

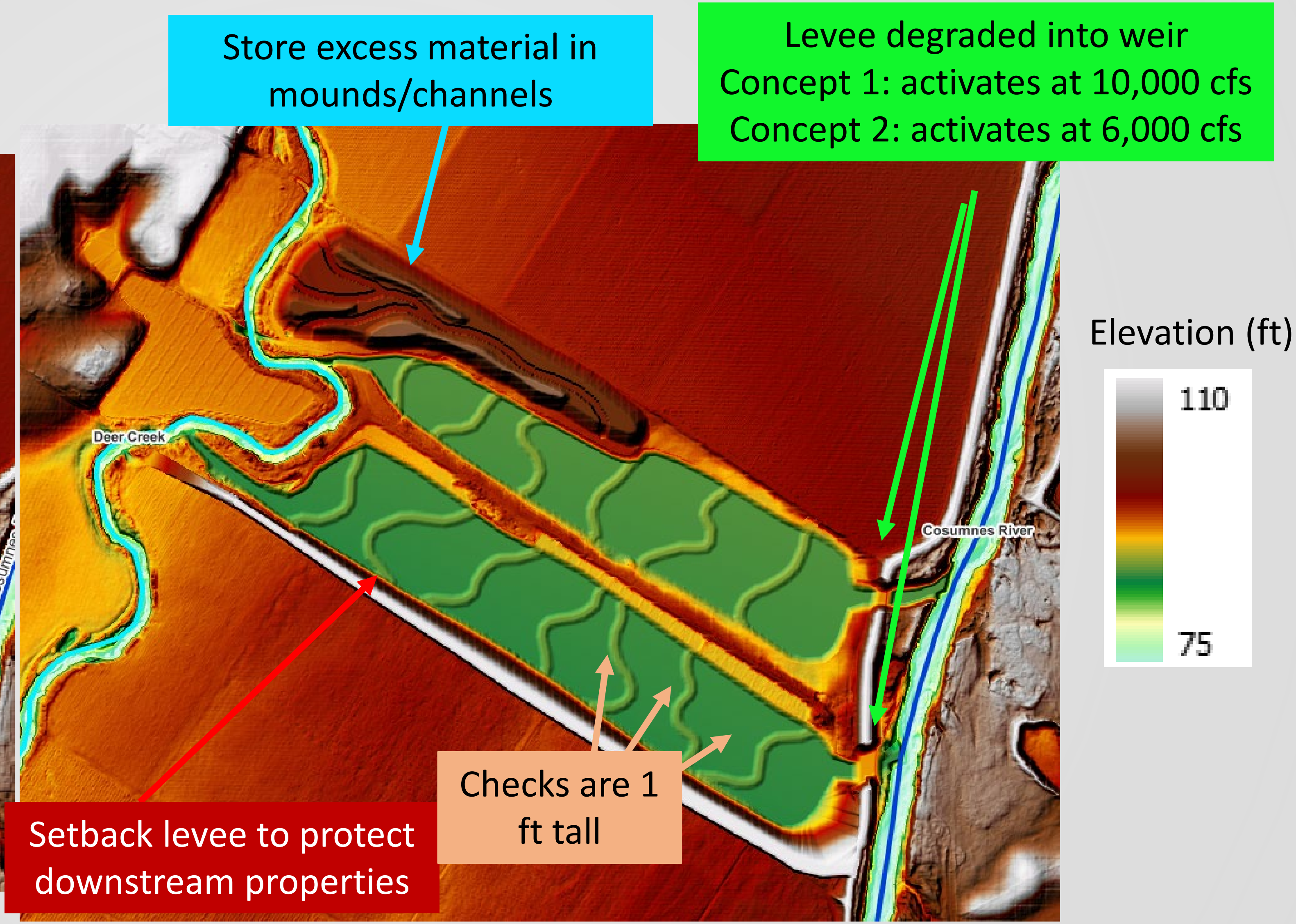
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	0.1	0.1
Project	14.5	4.5
Multiplier Difference	145x	45x



Site – Fields Near 1997 Breach

Concepts 1 & 2



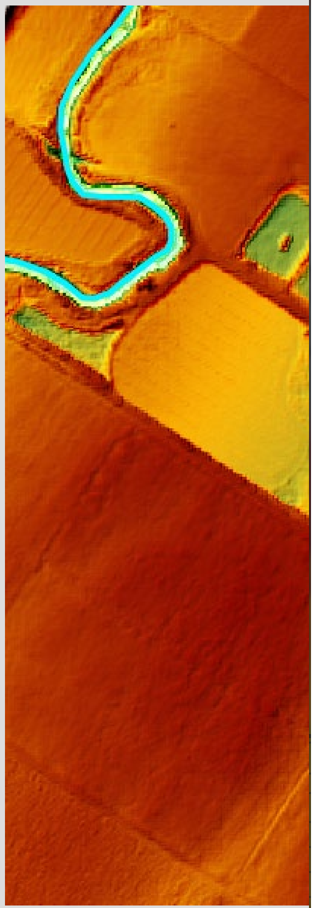


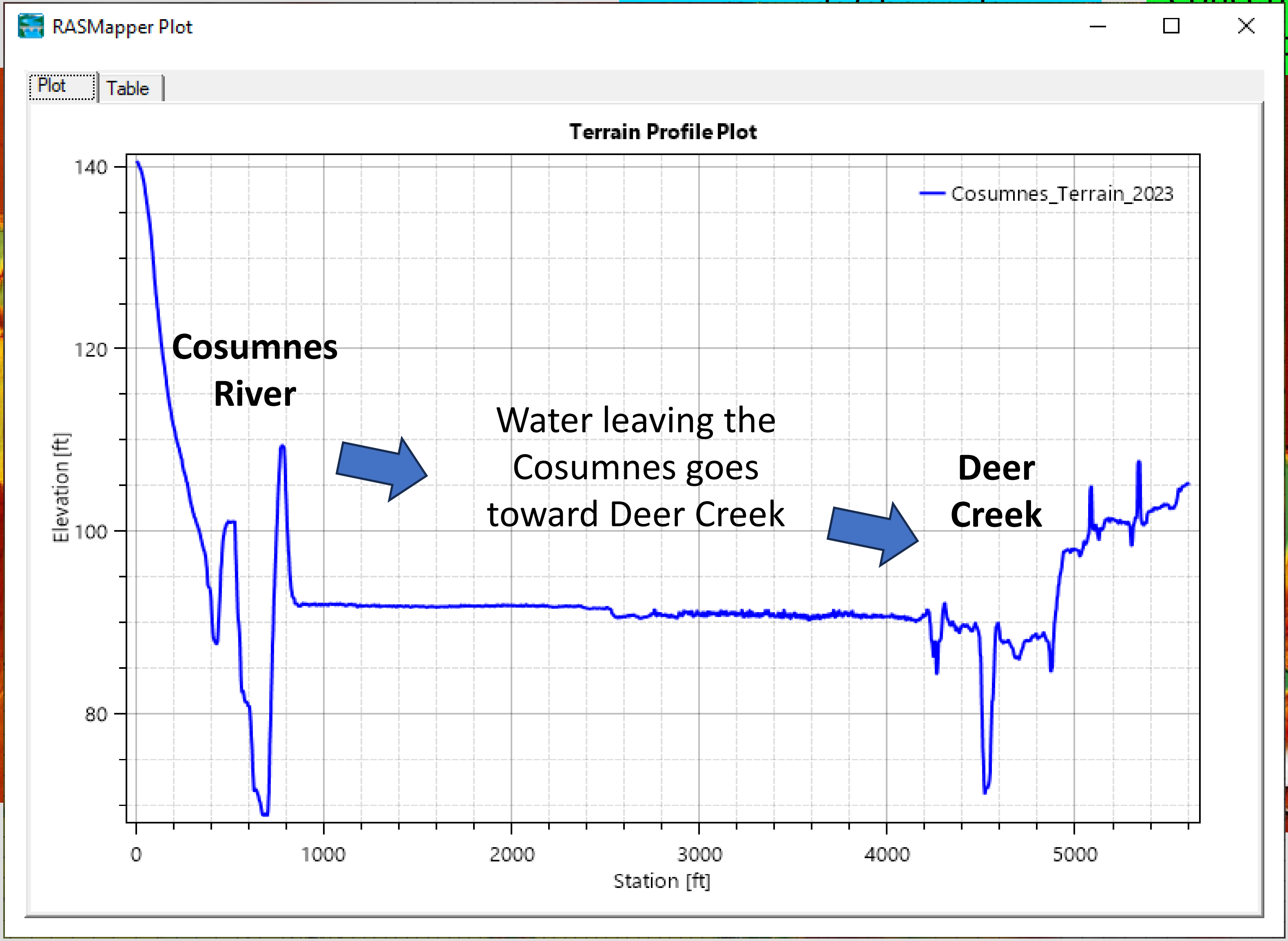
Site – Fields Near 1997 Breach

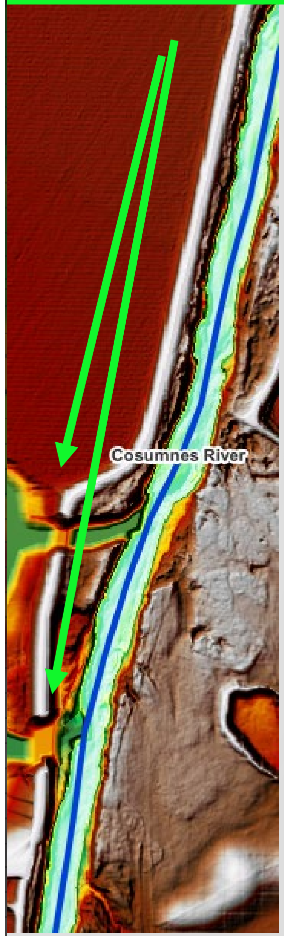
Concepts 1 & 2

Store excess material in

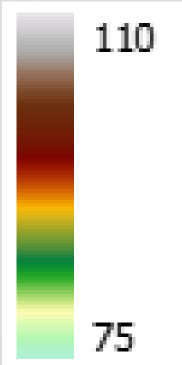
Levee degraded into weir
Concept 1: activates at 10,000 cfs
pt 2: activates at 6,000 cfs







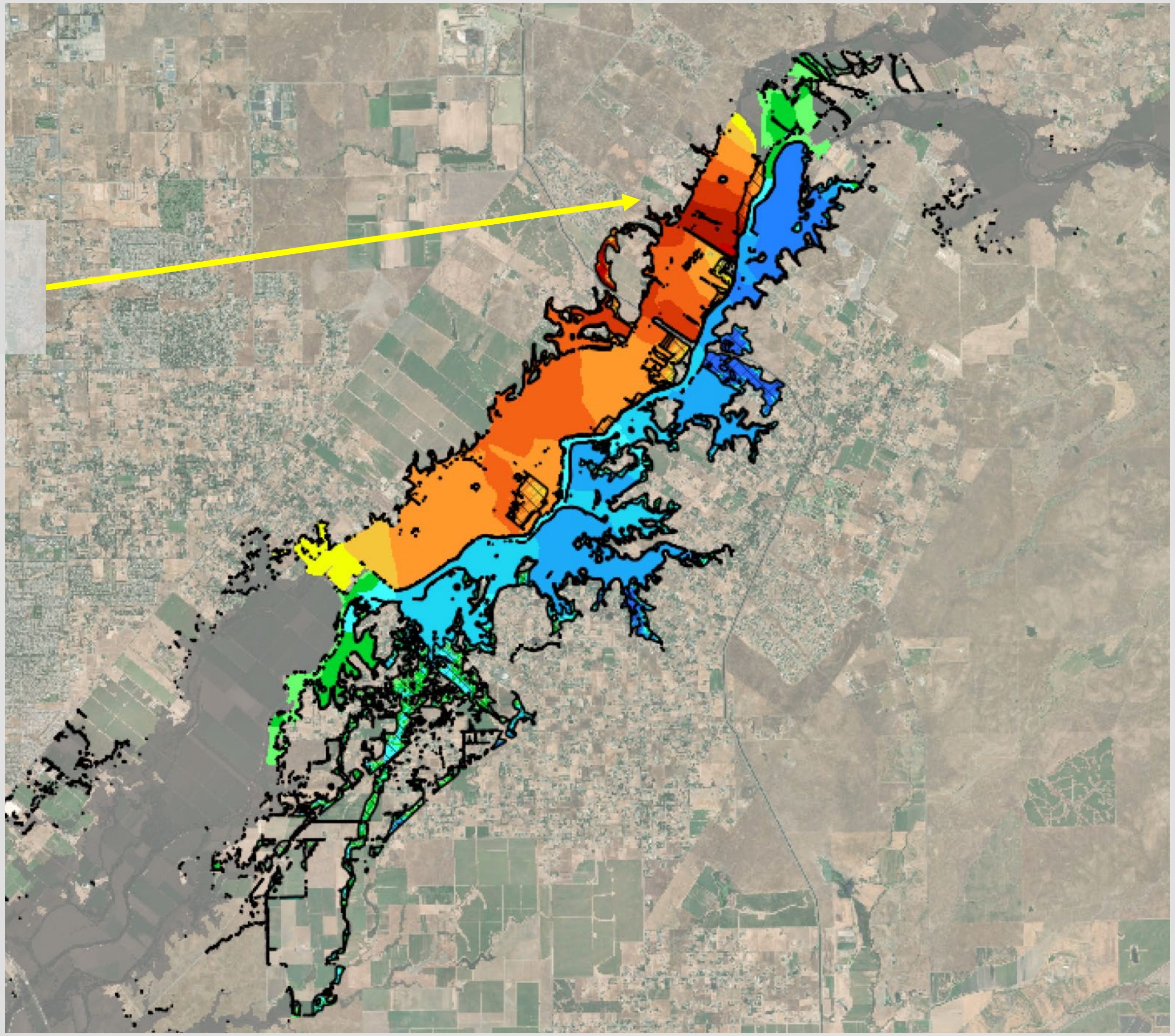
Elevation (ft)



Results

97 Breach Fields Connection Concept – 10,000 cfs Weir (Flood)

1997 Breach Fields



Wet → Dry
or
Dry → Wet
Areas

Water Level Difference (ft) Mich Bar Flow = 75,000 cfs

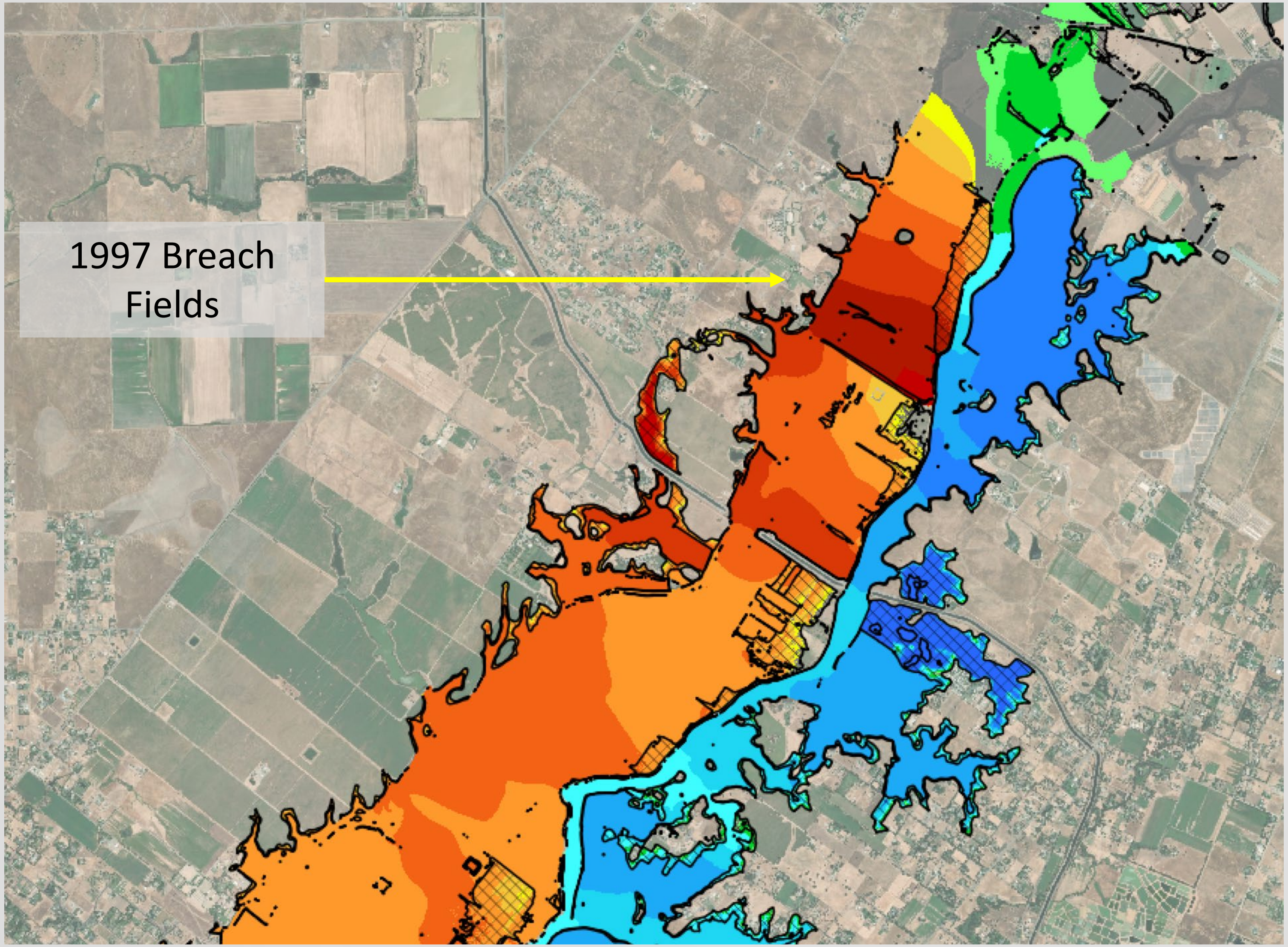
<= -5.00
-5.00 - -4.00
-4.00 - -3.00
-3.00 - -2.00
-2.00 - -1.00
-1.00 - -0.50
-0.50 - -0.25
-0.25 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 2.00
2.00 - 3.00
3.00 - 4.00
4.00 - 5.00
> 5.00

Deeper In Existing

Deeper In Project

Results

97 Breach Fields Connection Concept – 10,000 cfs Weir (Flood Upstream)



Wet → Dry
or
Dry → Wet
Areas

Water Level Difference (ft)
Mich Bar Flow = 75,000 cfs

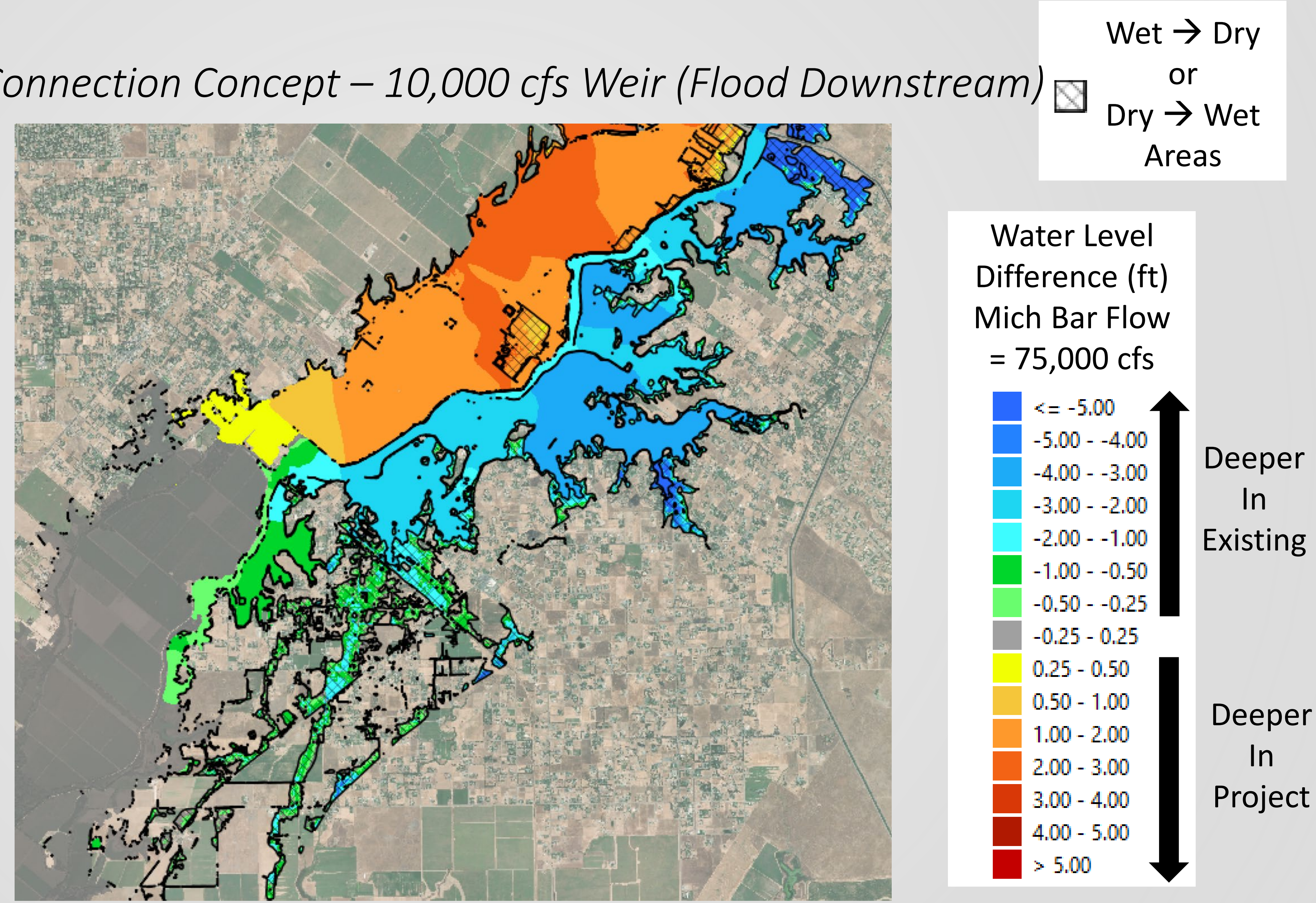
- <= -5.00
- -5.00 - -4.00
- -4.00 - -3.00
- -3.00 - -2.00
- -2.00 - -1.00
- -1.00 - -0.50
- -0.50 - -0.25
- -0.25 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

Deeper In Existing

Deeper In Project

Results

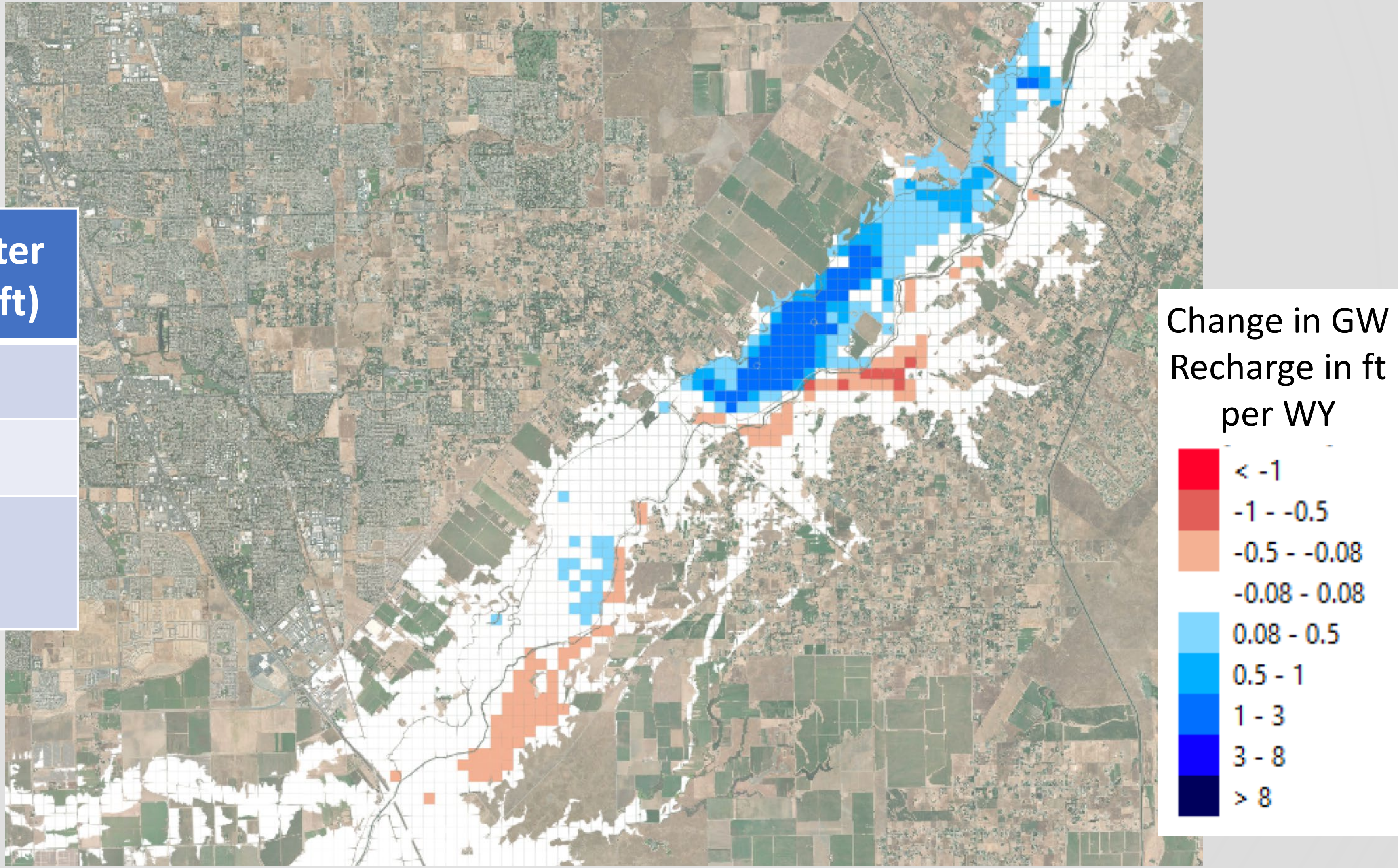
97 Breach Fields Connection Concept – 10,000 cfs Weir (Flood Downstream)



Results

97 Breach Fields Connection Concept – 10,000 cfs Weir (Groundwater Recharge)

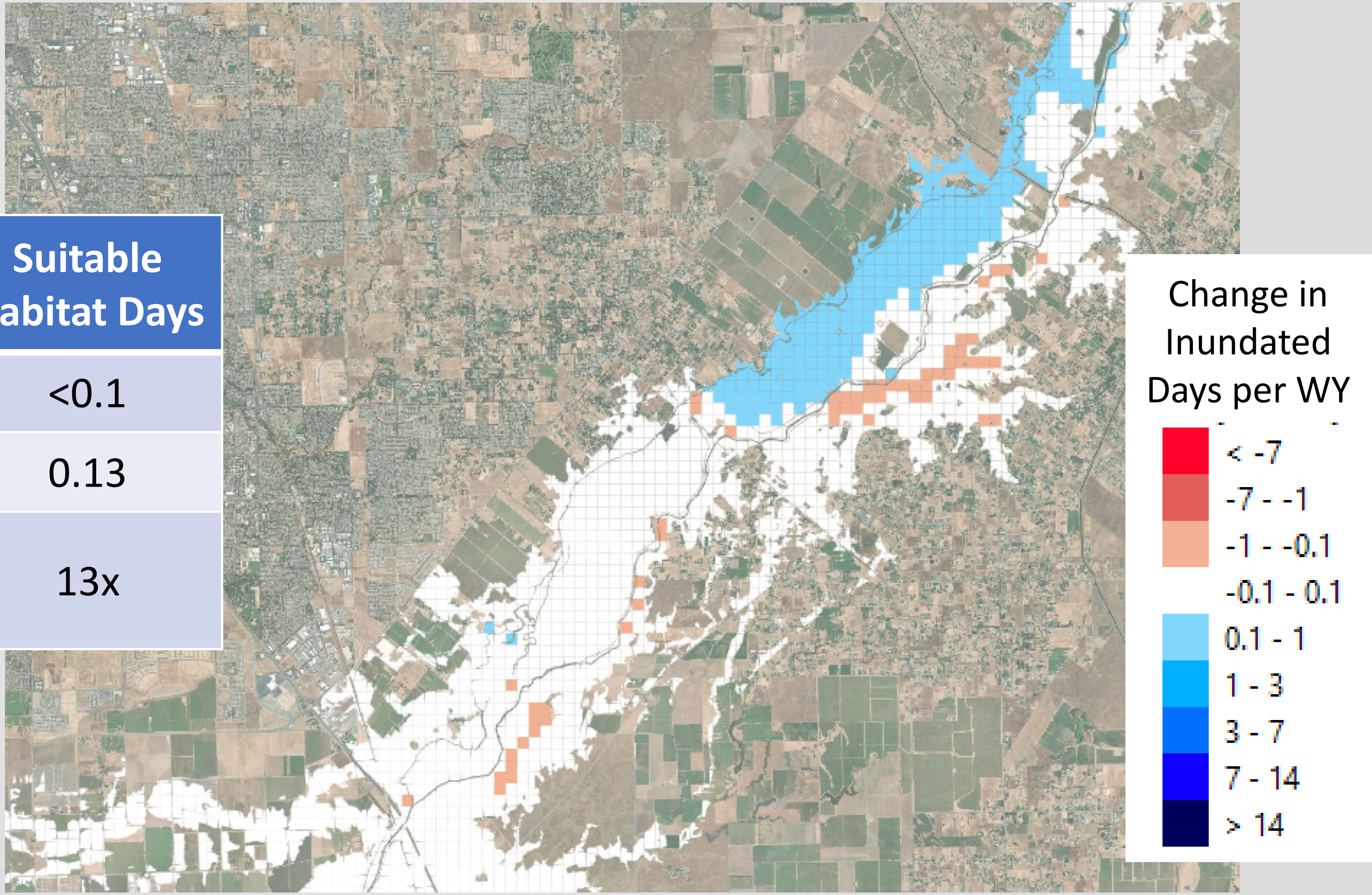
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	<0.1
Project	0.9
Multiplier Difference	87x



Results

97 Breach Fields Connection Concept – 10,000 cfs Weir (Inundation/Habitat)

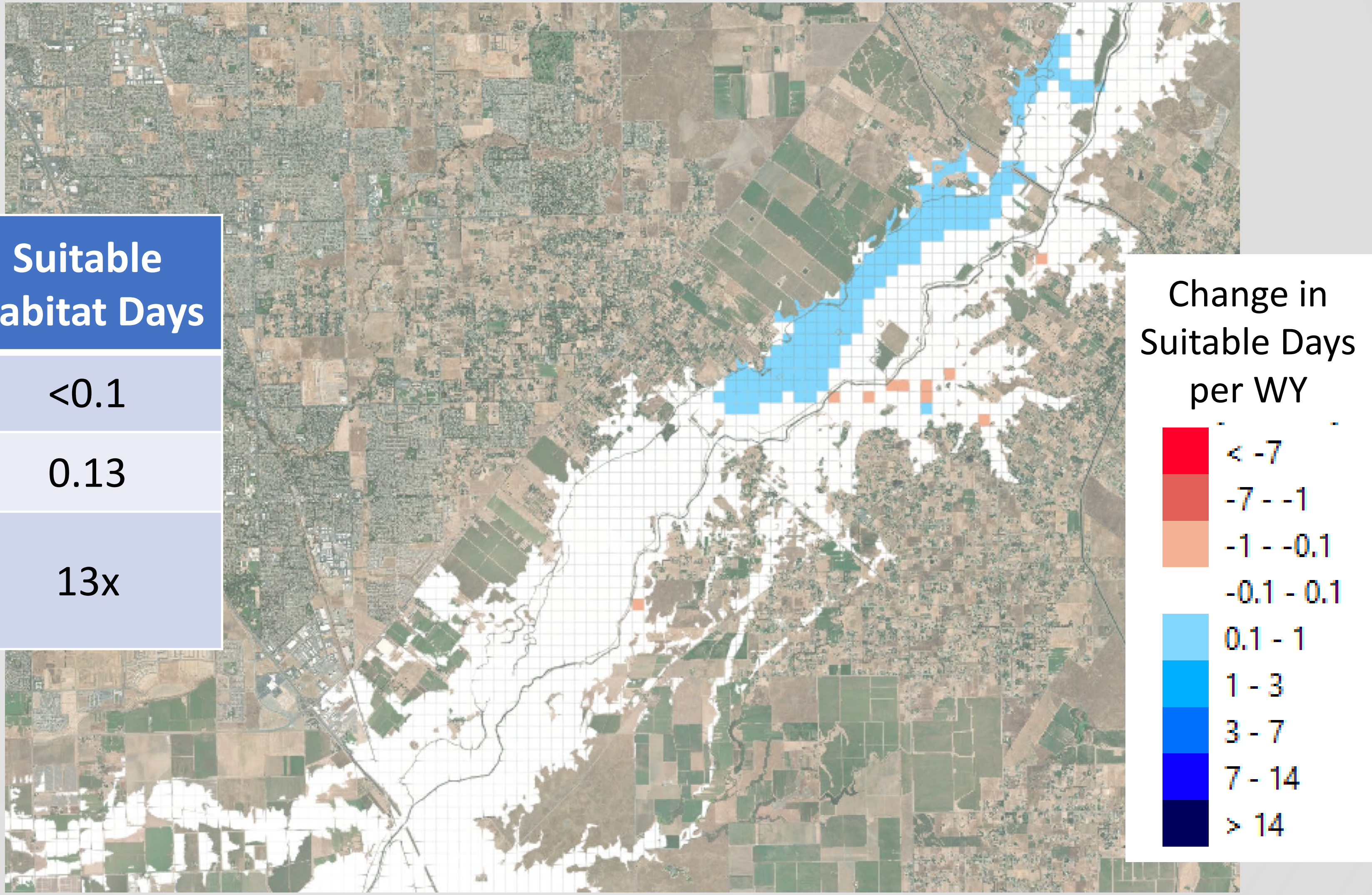
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	<0.1	<0.1
Project	0.7	0.13
Multiplier Difference	22x	13x



Results

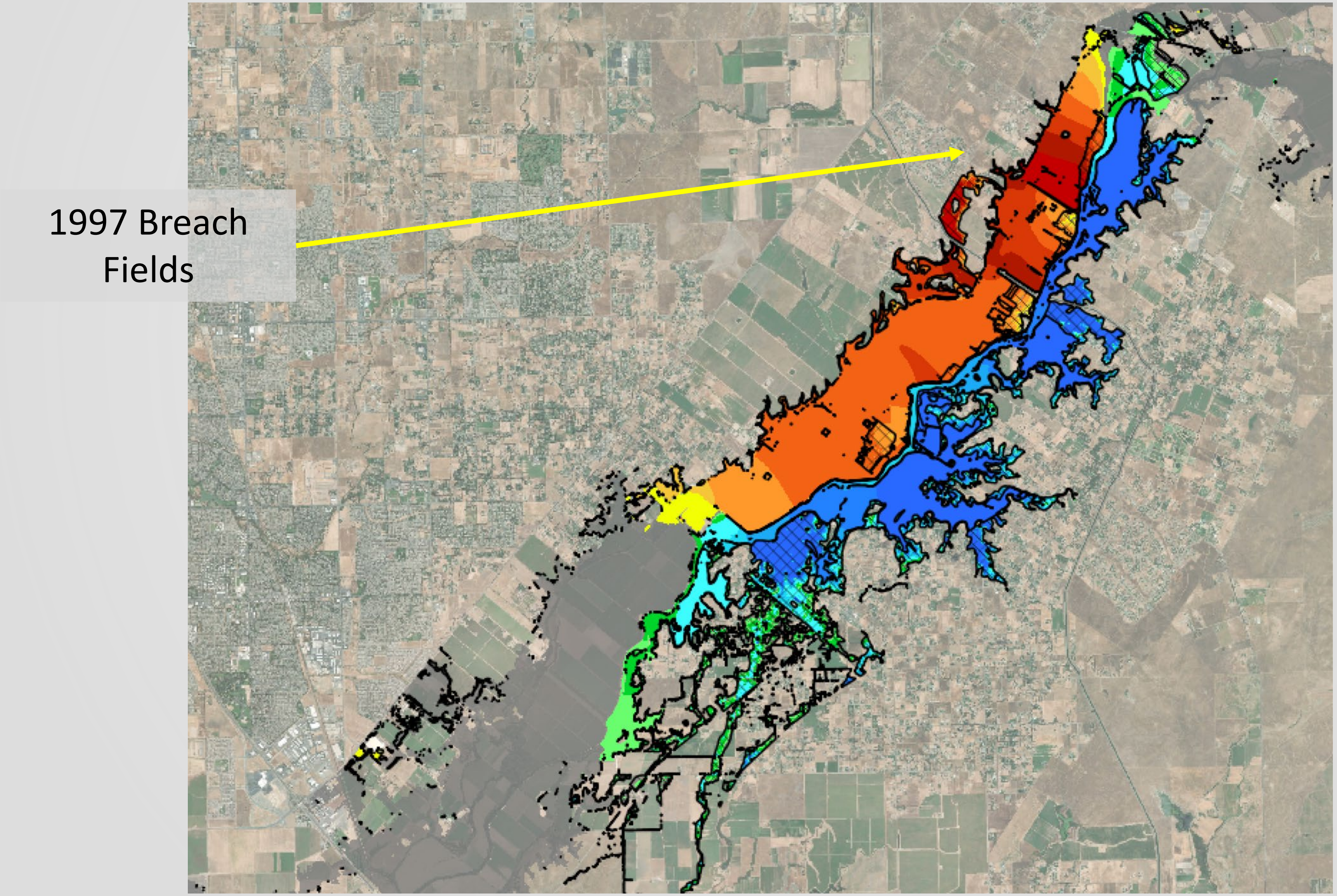
97 Breach Fields Connection Concept – 10,000 cfs Weir (Inundation/Habitat)

Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	<0.1	<0.1
Project	0.7	0.13
Multiplier Difference	22x	13x



Results

97 Breach Fields Connection Concept – 6,000 cfs Weir (Flood)



Wet → Dry
or
Dry → Wet
Areas

Water Level Difference (ft) Mich Bar Flow = 75,000 cfs

<= -5.00
-5.00 - -4.00
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-3.00 - -2.00
-2.00 - -1.00
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-0.50 - -0.25
-0.25 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 2.00
2.00 - 3.00
3.00 - 4.00
4.00 - 5.00
> 5.00

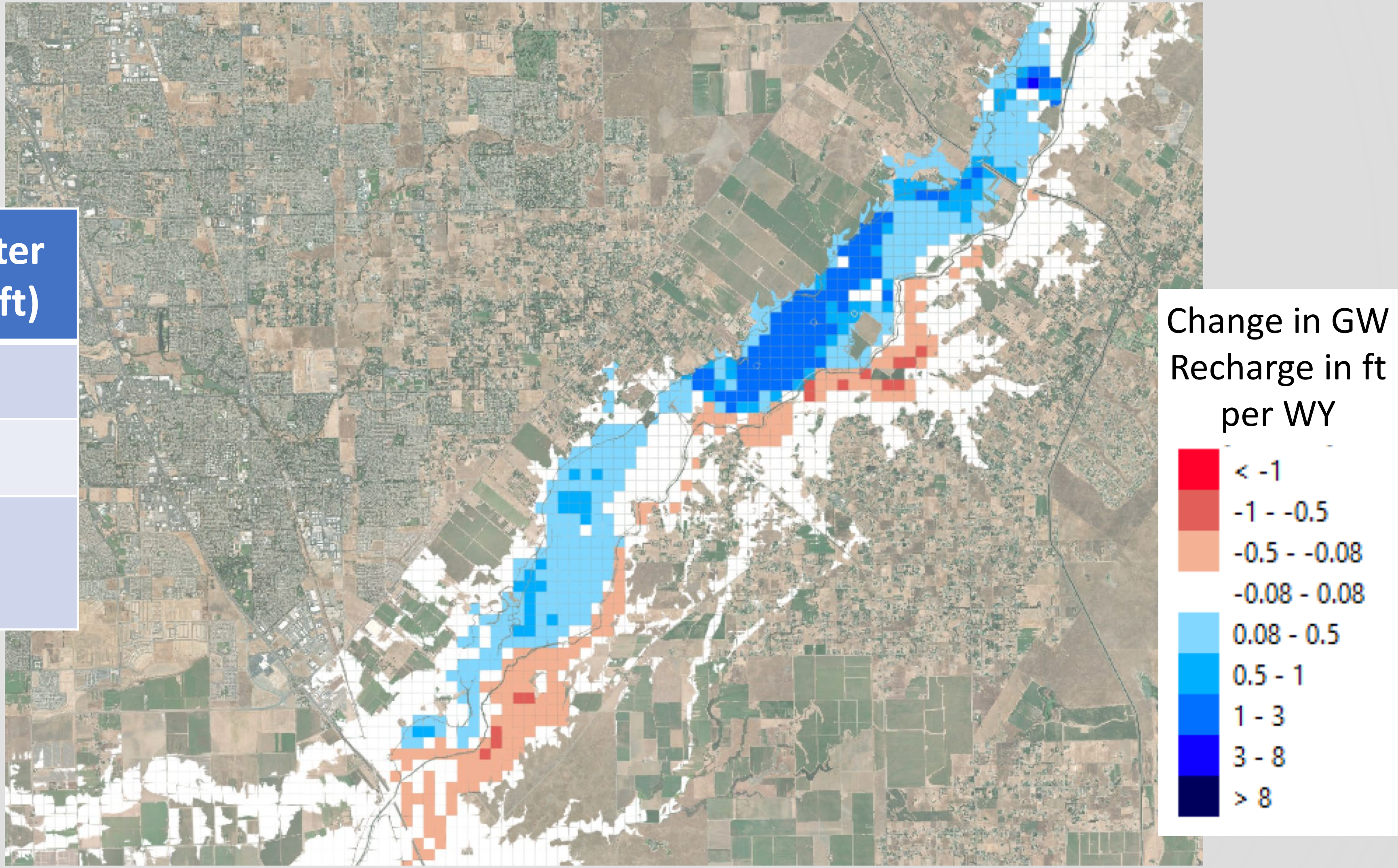
Deeper In Existing

Deeper In Project

Results

97 Breach Fields Connection Concept – 6,000 cfs Weir (Groundwater Recharge)

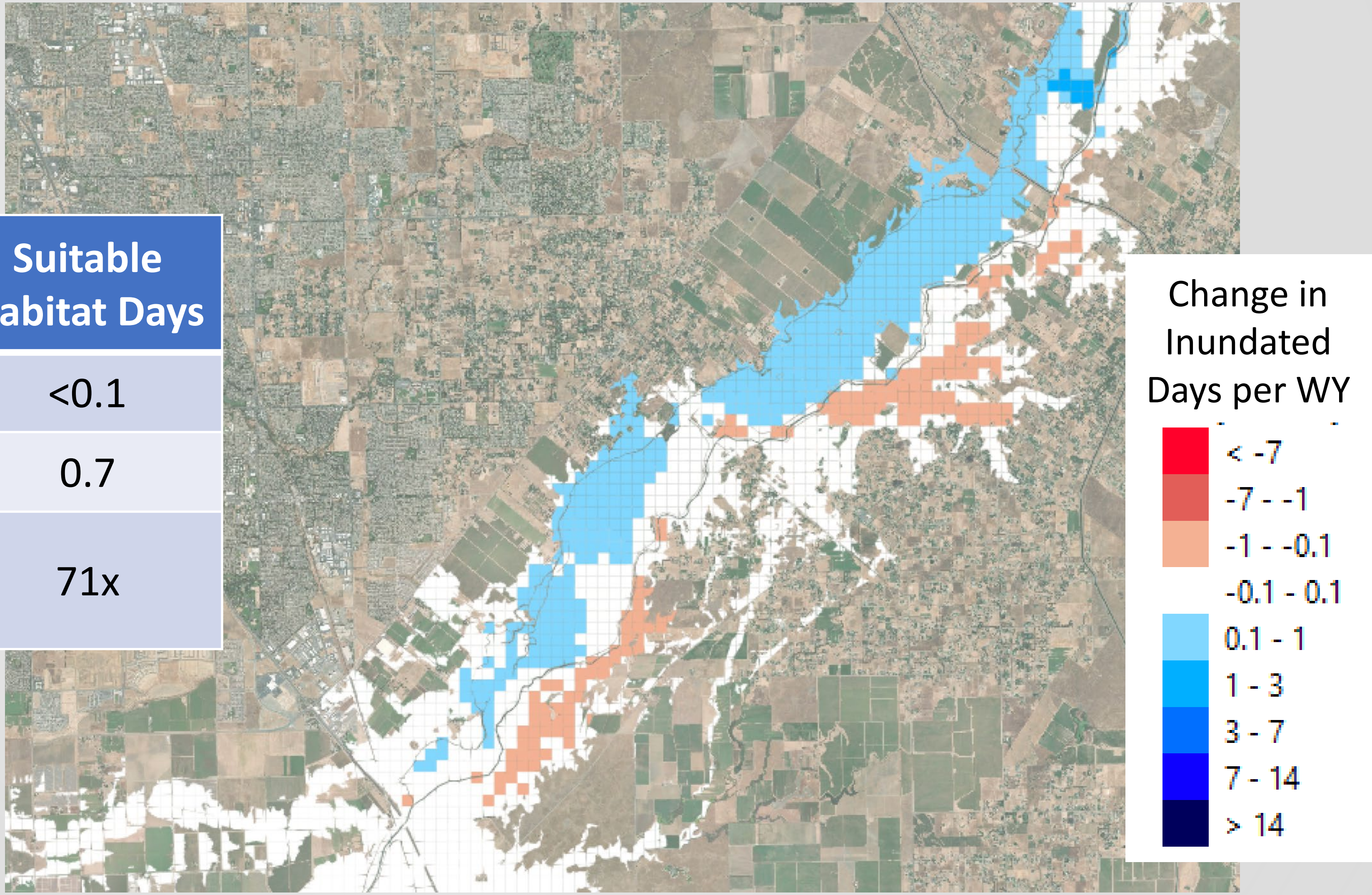
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	<0.1
Project	2.1
Multiplier Difference	42x



Results

97 Breach Fields Connection Concept – 10,000 cfs Weir (Inundation/Habitat)

Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	<0.1	<0.1
Project	1.6	0.7
Multiplier Difference	54x	71x



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97 Breach Fields Connection Concept – 10,000 cfs Weir (Inundation/Habitat)

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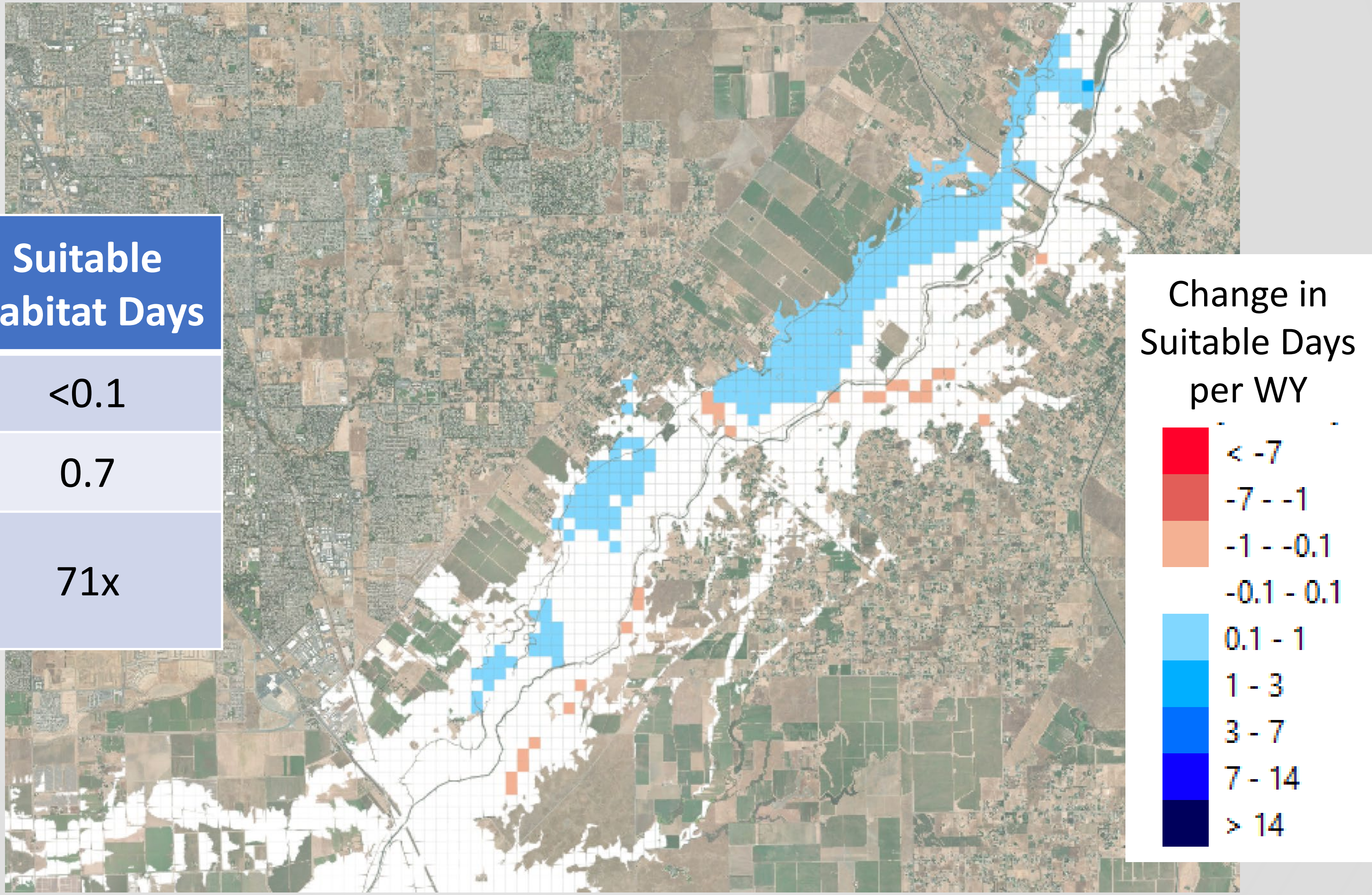
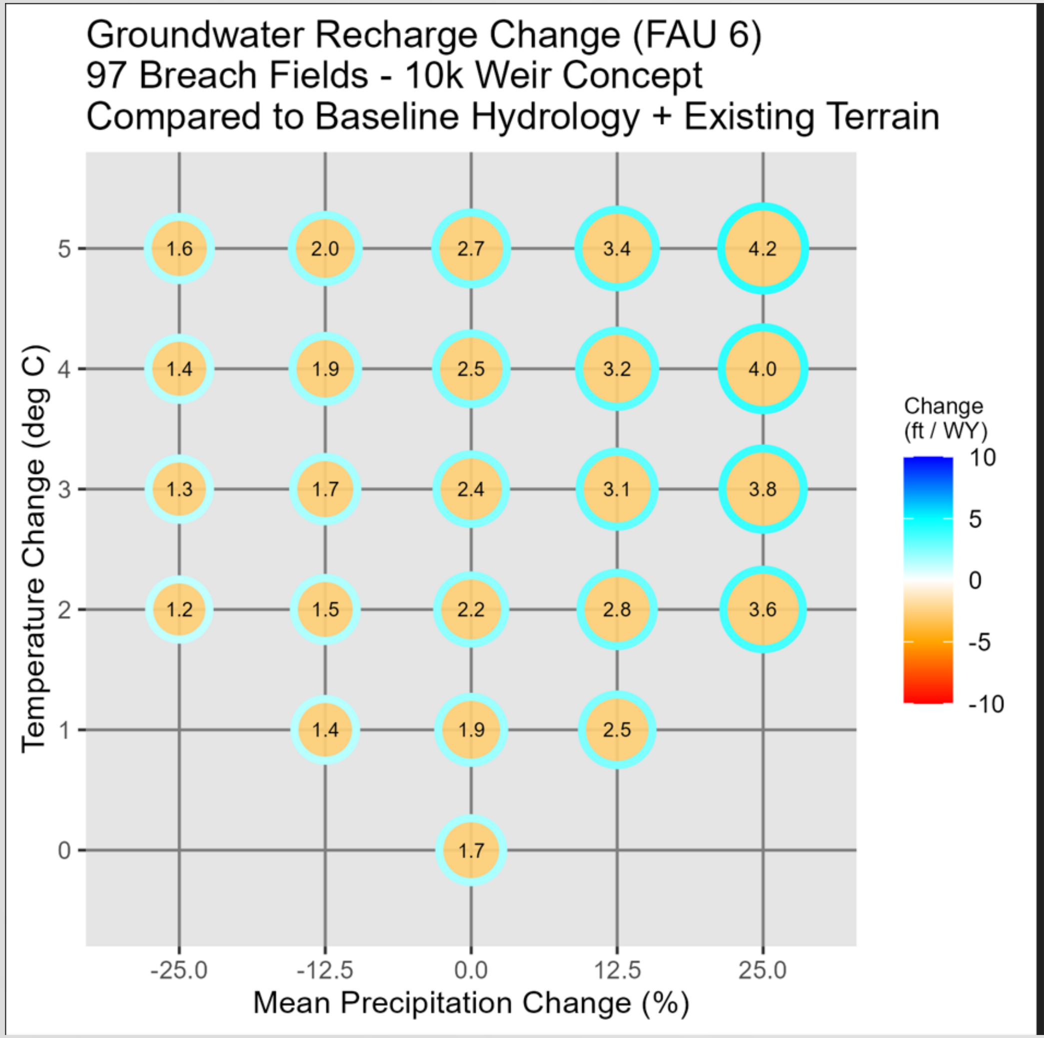
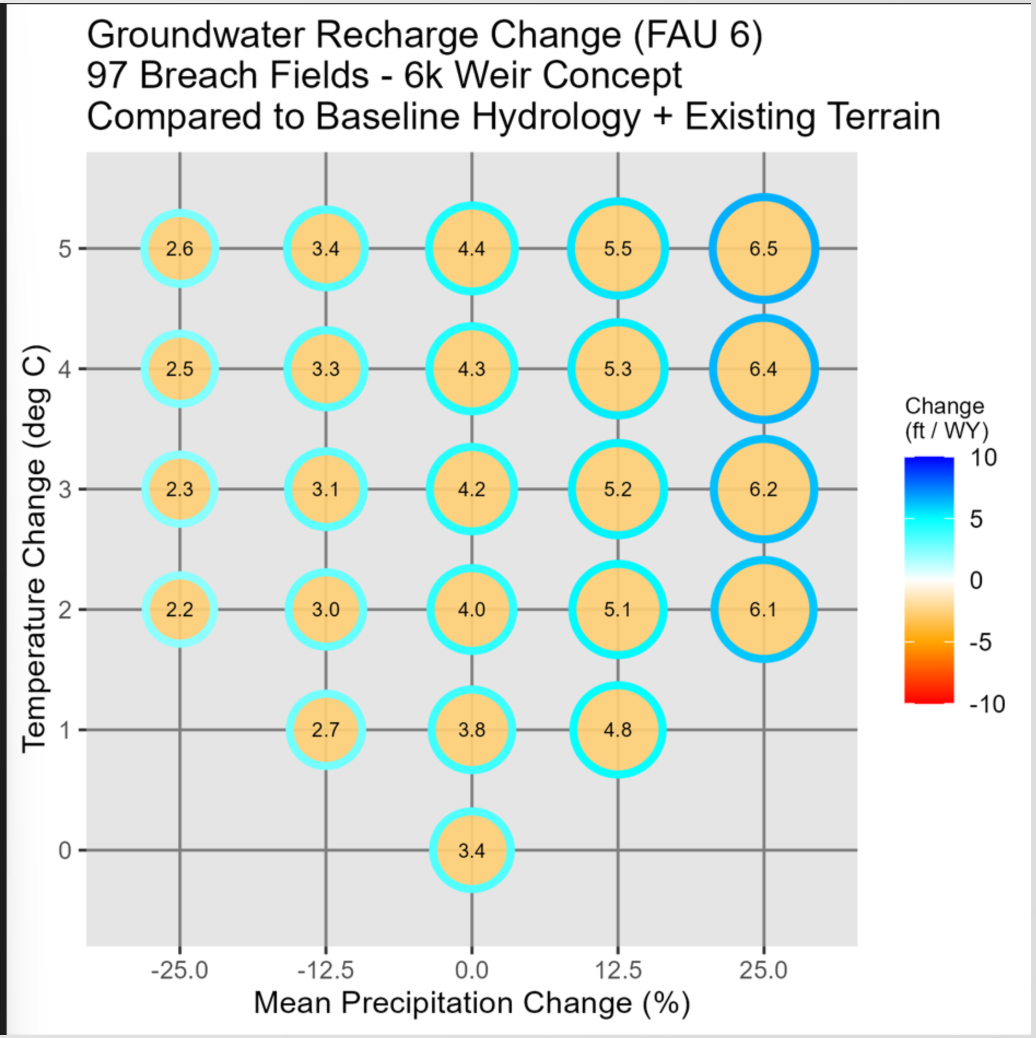


Climate Resiliency of 97 Field Concepts

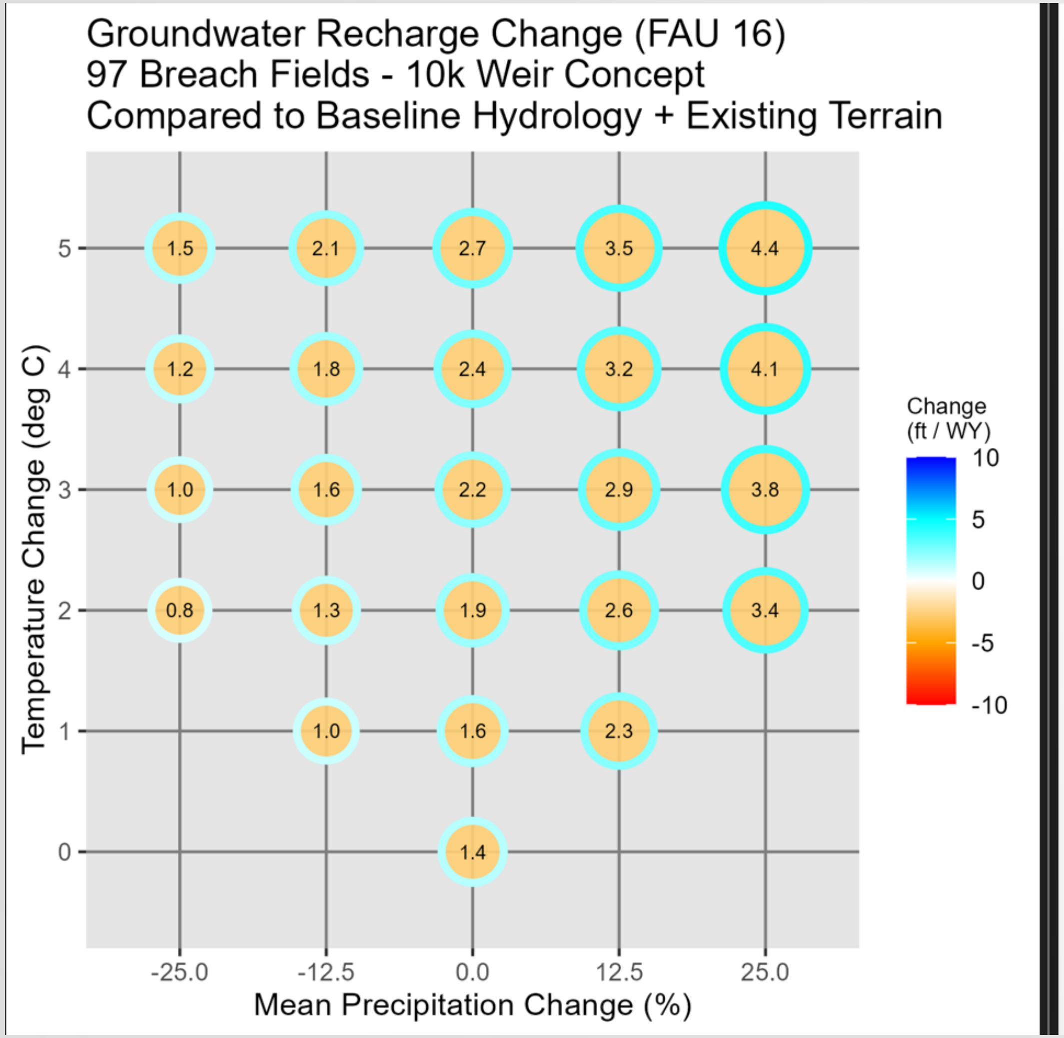
Groundwater Recharge Within Concept Footprint

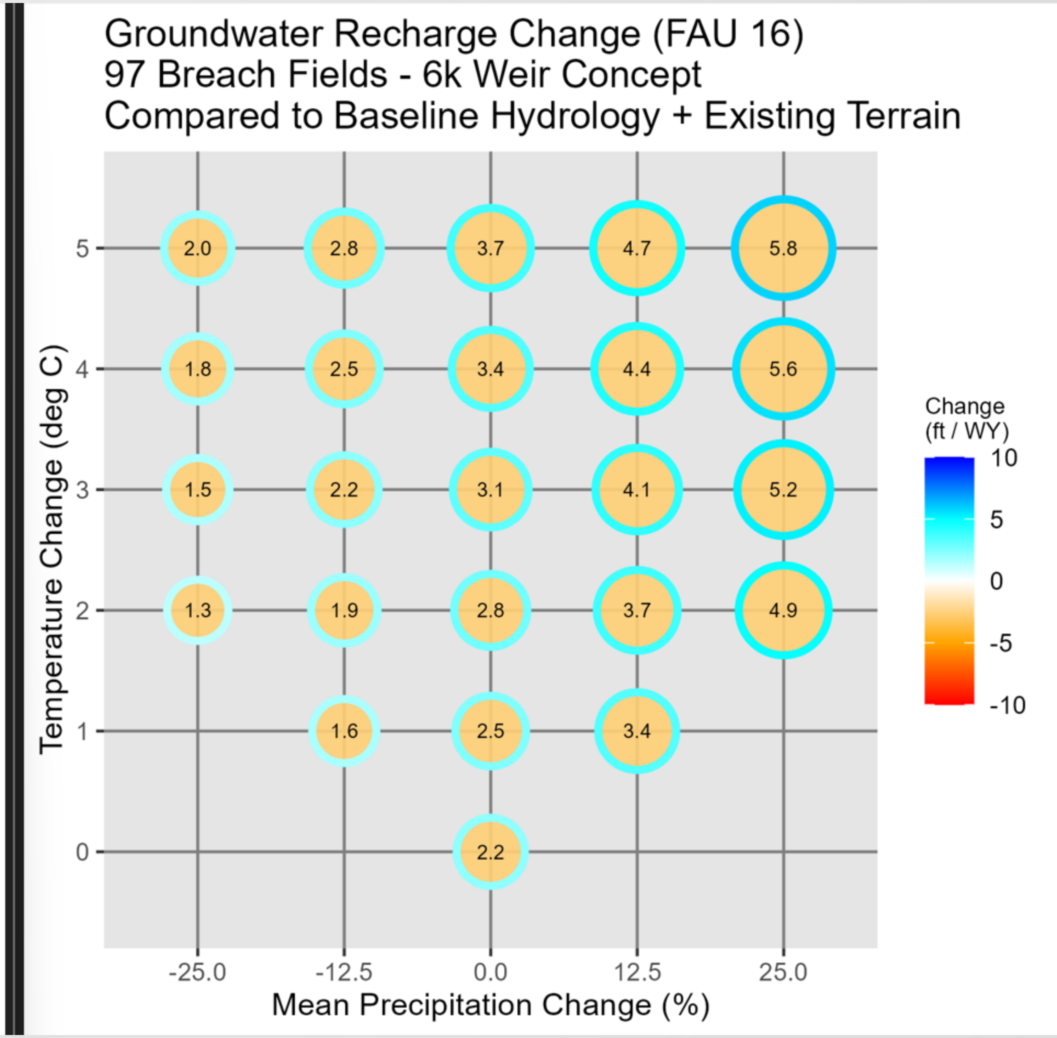




Climate Resiliency of 97 Field Concepts

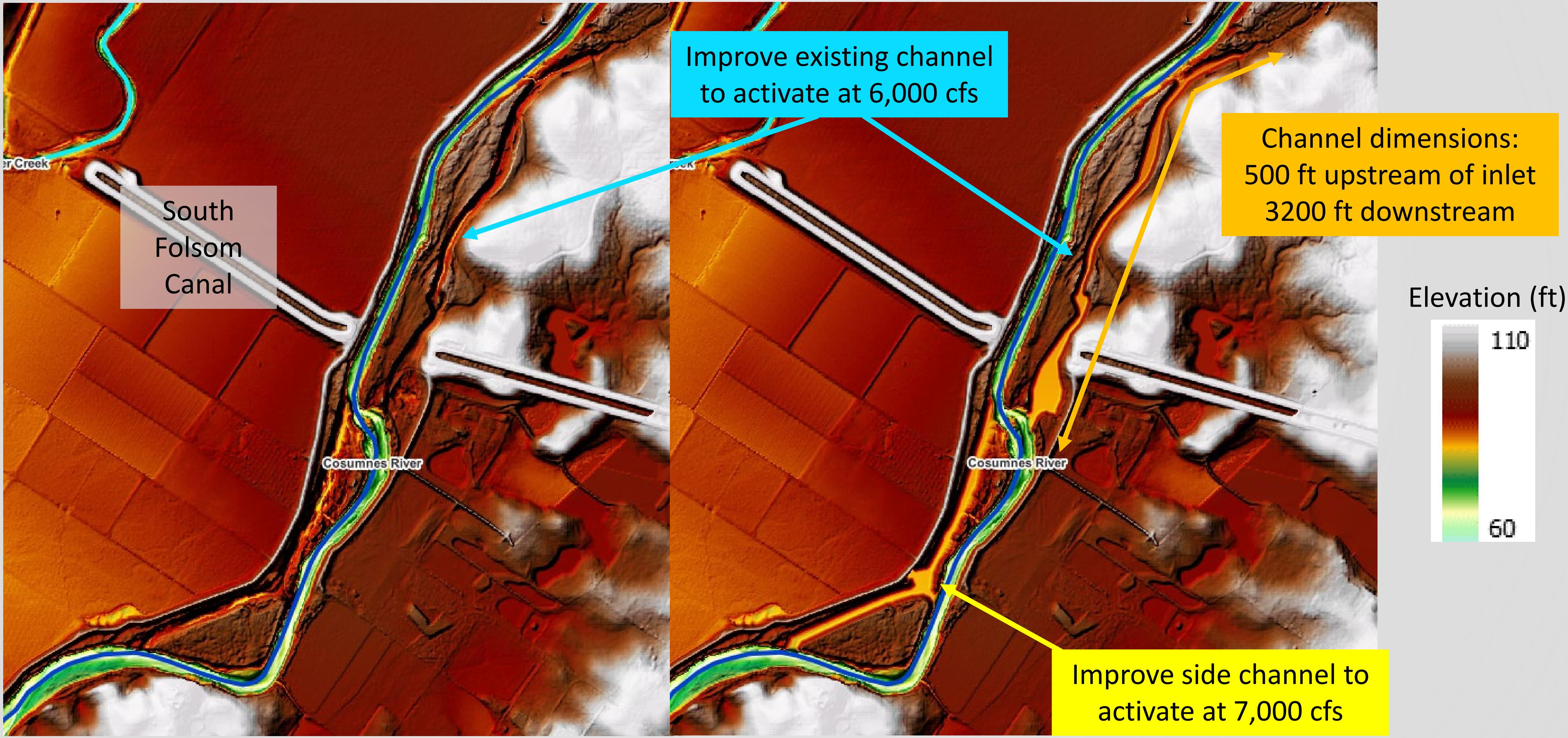
Groundwater Recharge in Floodplain Downstream Concept





Site – Blodgett Dam/South Folsom Side Channel

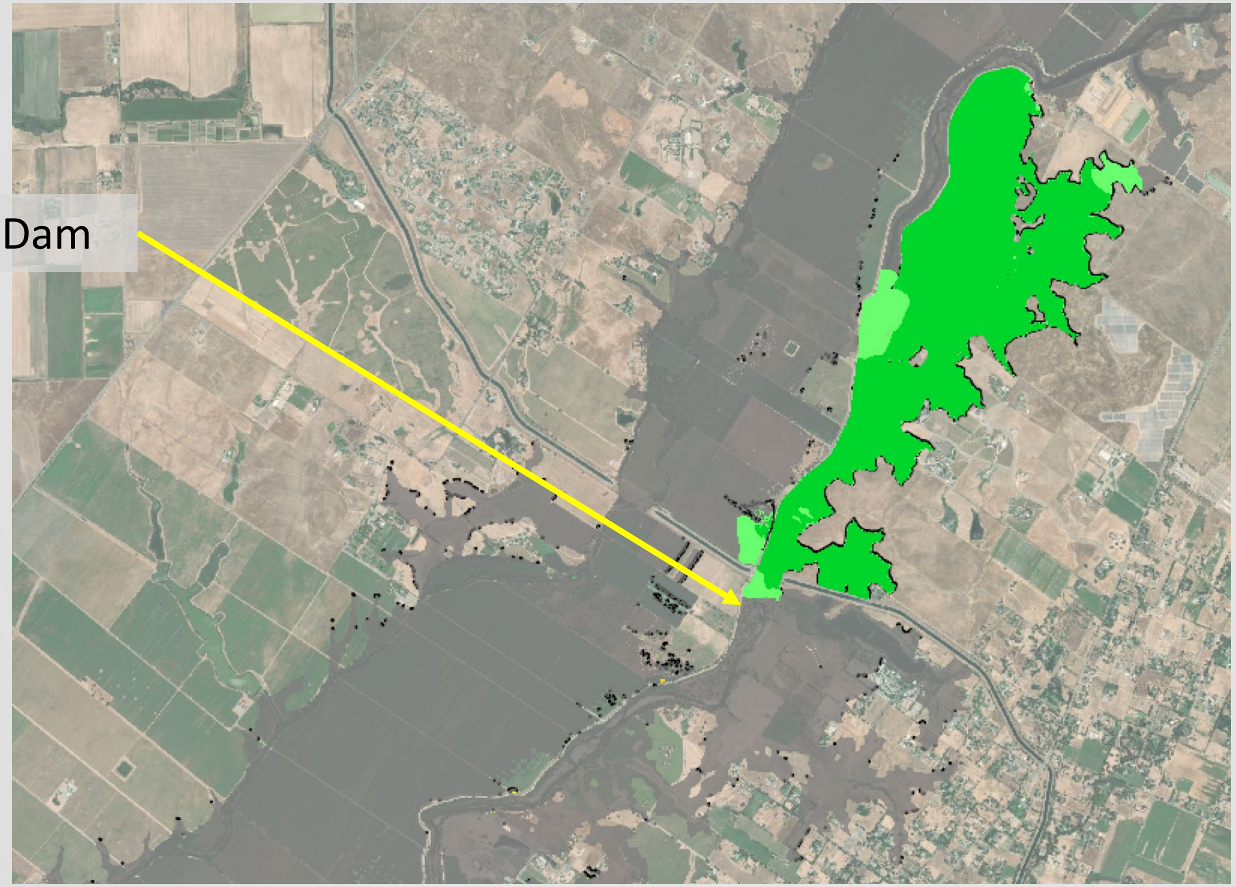
Concept 1



Results

Blodgett Dam + Folsom South Canal Improvements (Flood)

Blodgett Dam



Wet → Dry
or
Dry → Wet
Areas

Water Level Difference (ft)
Mich Bar Flow = 75,000 cfs

<= -5.00
-5.00 - -4.00
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-3.00 - -2.00
-2.00 - -1.00
-1.00 - -0.50
-0.50 - -0.25
-0.25 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 2.00
2.00 - 3.00
3.00 - 4.00
4.00 - 5.00
> 5.00

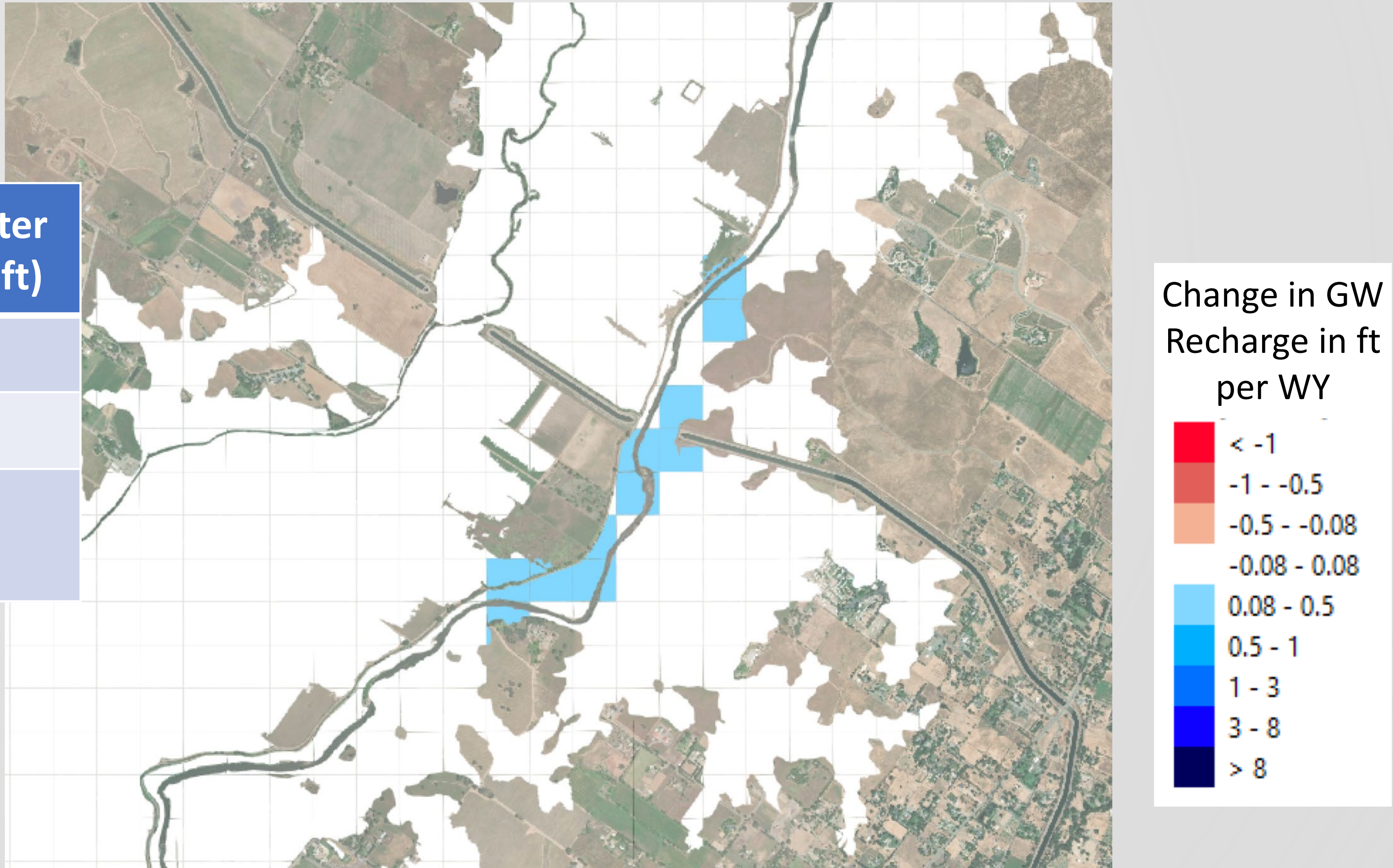
Deeper In Existing

Deeper In Project

Results

Blodgett Dam + Folsom South Canal Improvements (Groundwater Recharge)

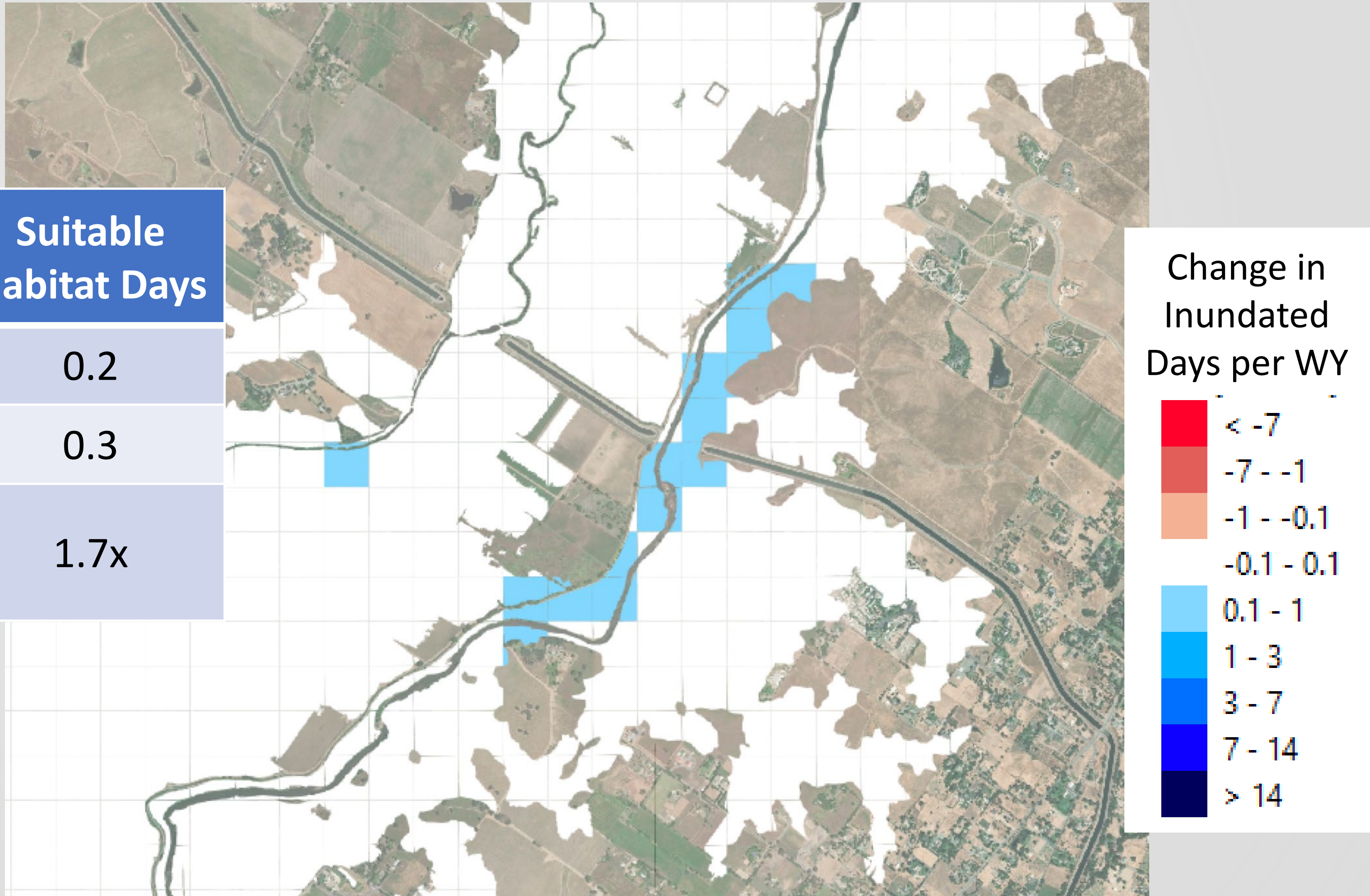
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	0.2
Project	0.4
Multiplier Difference	2x



Results

Blodgett Dam + Folsom South Canal Improvements (Inundation/Habitat)

Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	0.5	0.2
Project	1.1	0.3
Multiplier Difference	2.1x	1.7x



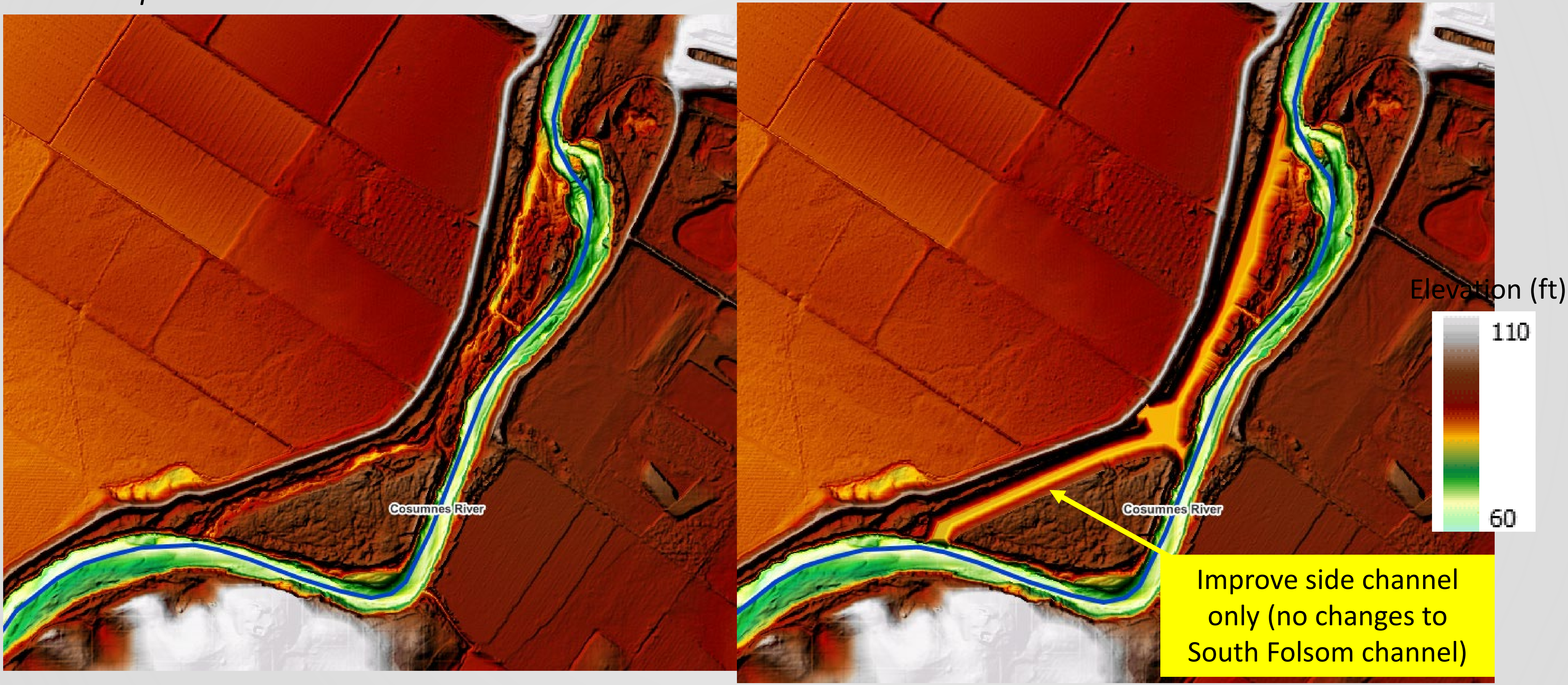
Results

Blodgett Dam + Folsom South Canal Improvements (Inundation/Habitat)

Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	0.5	0.2
Project	1.1	0.3
Multiplier Difference	2.1x	1.7x

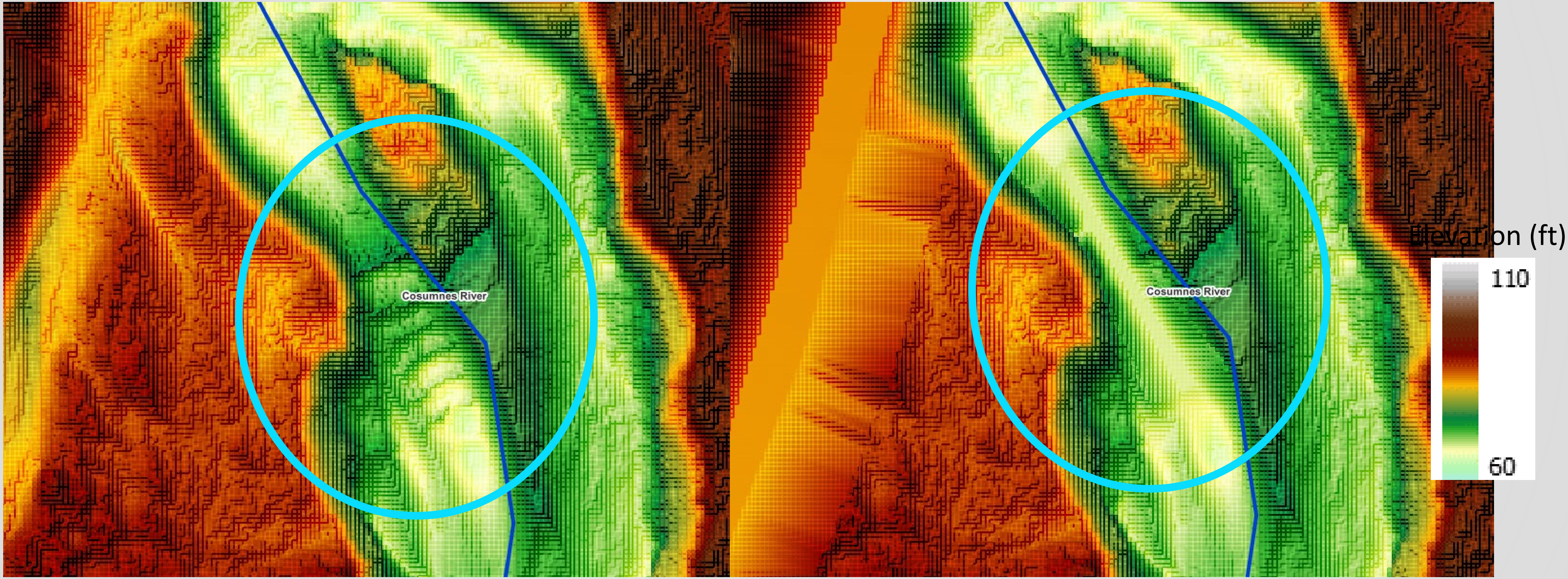
Site – Blodgett Dam/South Folsom Side Channel

Concept 2



Site – Blodgett Dam/South Folsom Side Channel

Concept 1 & 2



Both concepts remove in-channel Blodgett Dam

Results

Blodgett Dam Improvements Only (Flood)

Wet → Dry
or
Dry → Wet
Areas

Water Level Difference (ft)
Mich Bar Flow = 75,000 cfs

<= -5.00	Deeper In Existing
-5.00 - -4.00	
-4.00 - -3.00	
-3.00 - -2.00	
-2.00 - -1.00	
-1.00 - -0.50	
-0.50 - -0.25	
-0.25 - 0.25	
0.25 - 0.50	Deeper In Project
0.50 - 1.00	
1.00 - 2.00	
2.00 - 3.00	
3.00 - 4.00	
4.00 - 5.00	
> 5.00	

Results

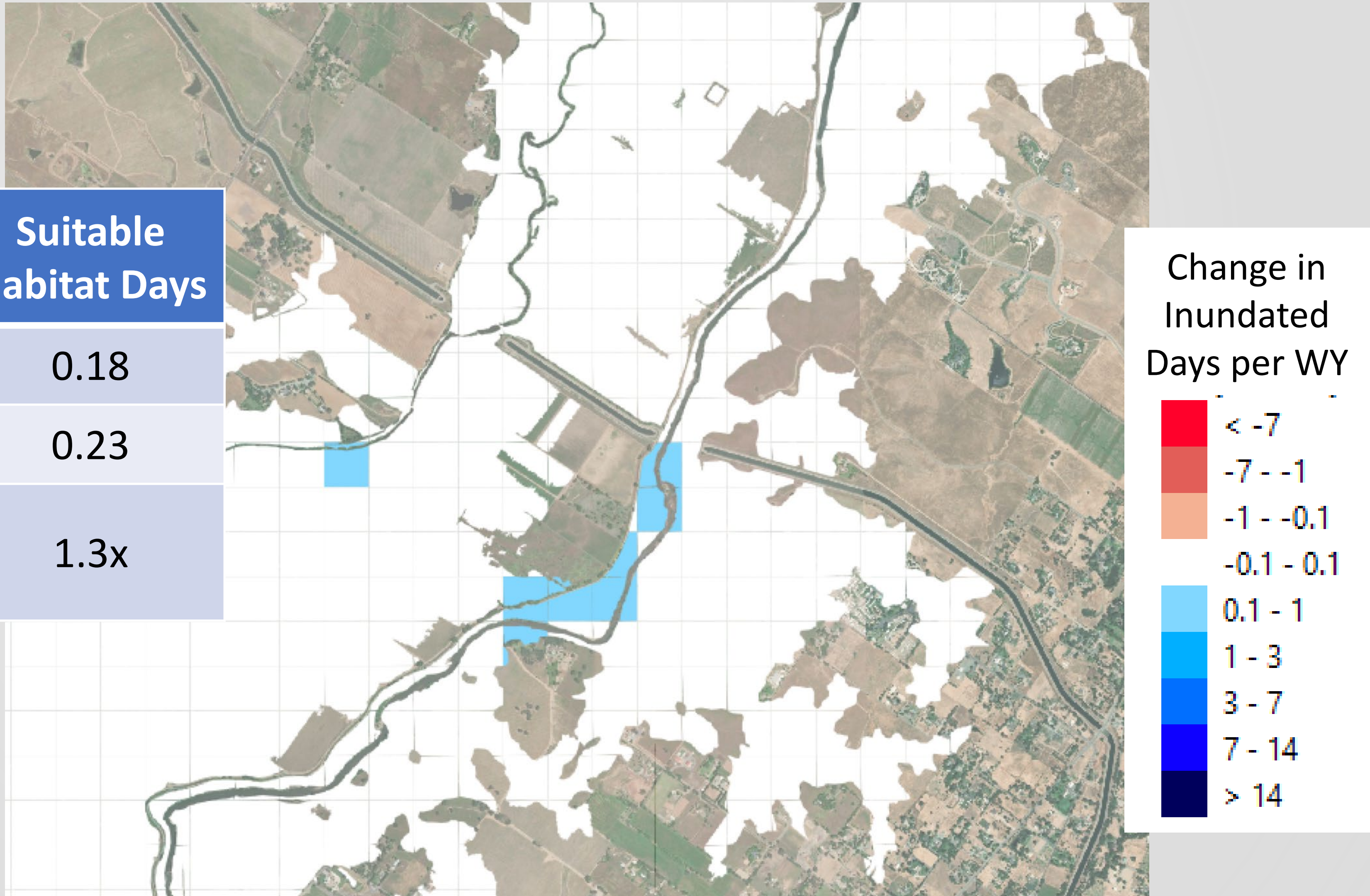
Blodgett Dam Improvements Only (Groundwater Recharge)

Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	0.2
Project	0.3
Multiplier Difference	1.7x

Results

Blodgett Dam Improvements Only (Inundation/Habitat)

Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	0.6	0.18
Project	1.1	0.23
Multiplier Difference	1.9x	1.3x



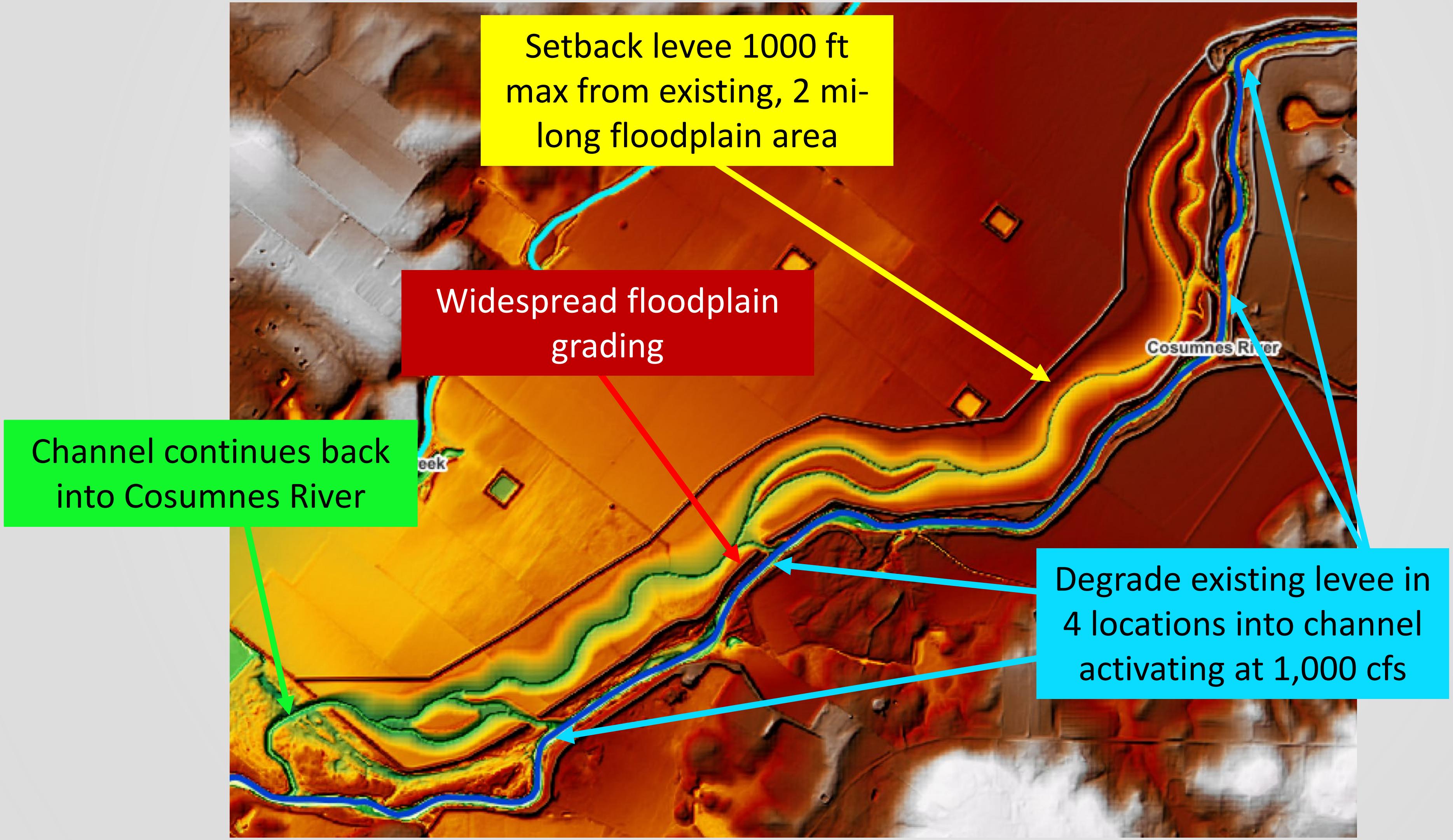
Results

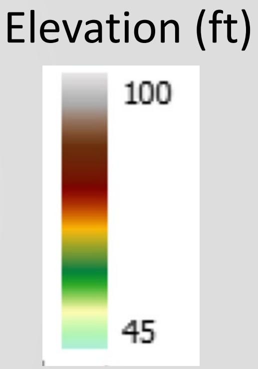
Blodgett Dam Improvements Only (Inundation/Habitat)

Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	0.6	0.18
Project	1.1	0.23
Multiplier Difference	1.9x	1.3x

Site – Levee Setback

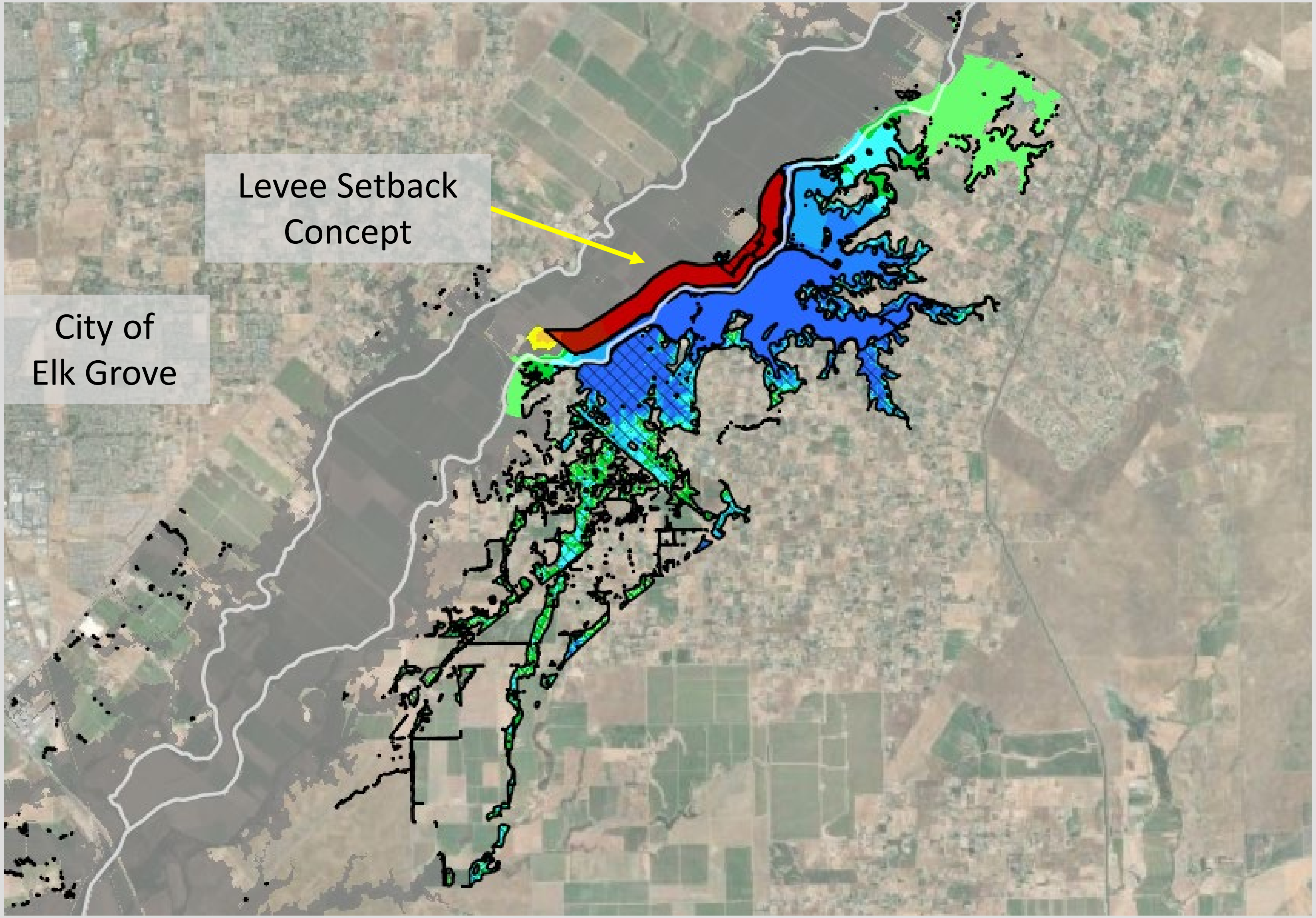
Concept 1

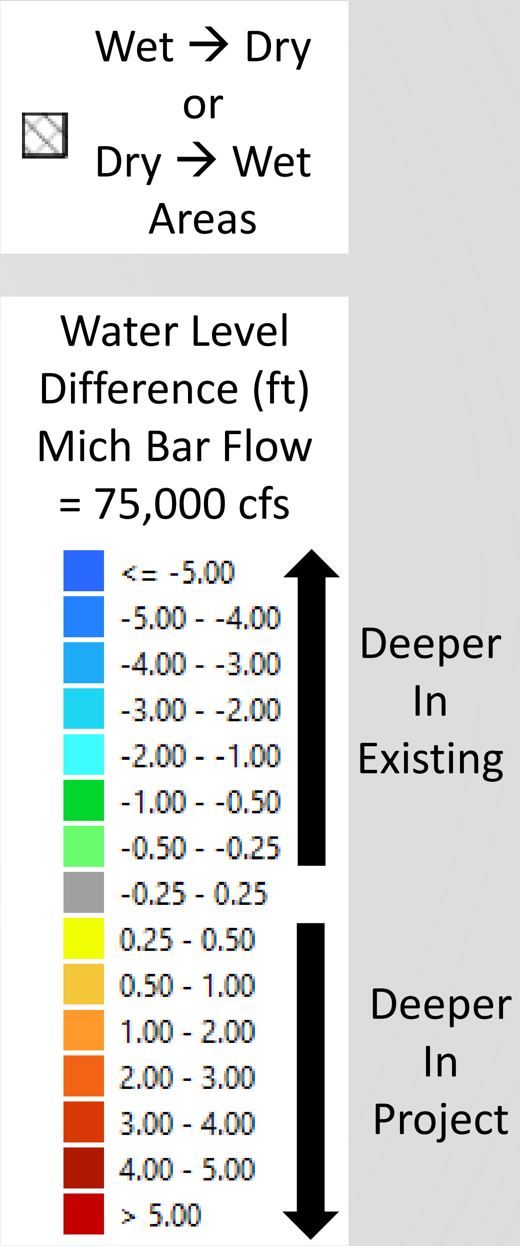




Results

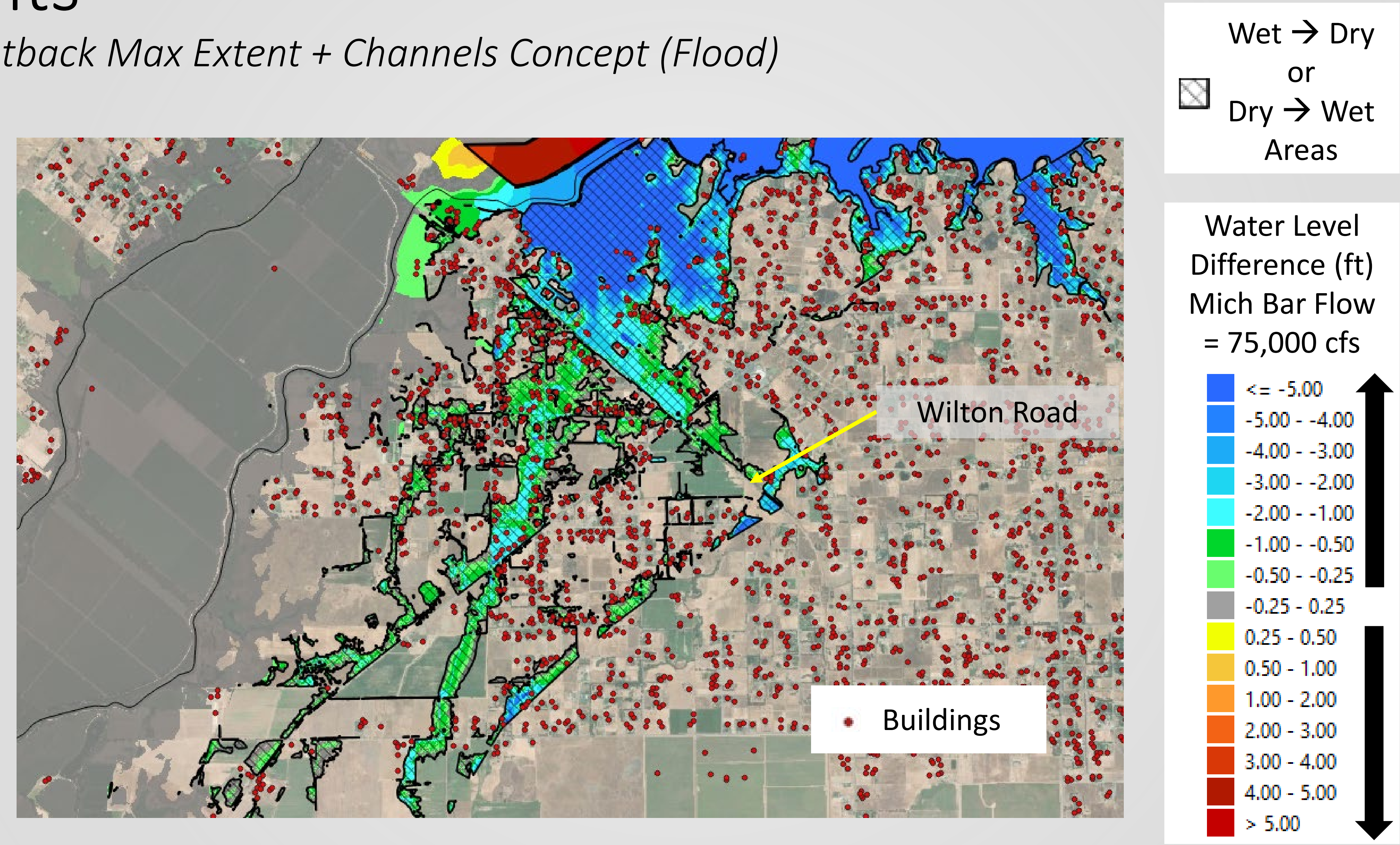
Levee Setback Max Extent + Channels Concept (Flood)





Results

Levee Setback Max Extent + Channels Concept (Flood)



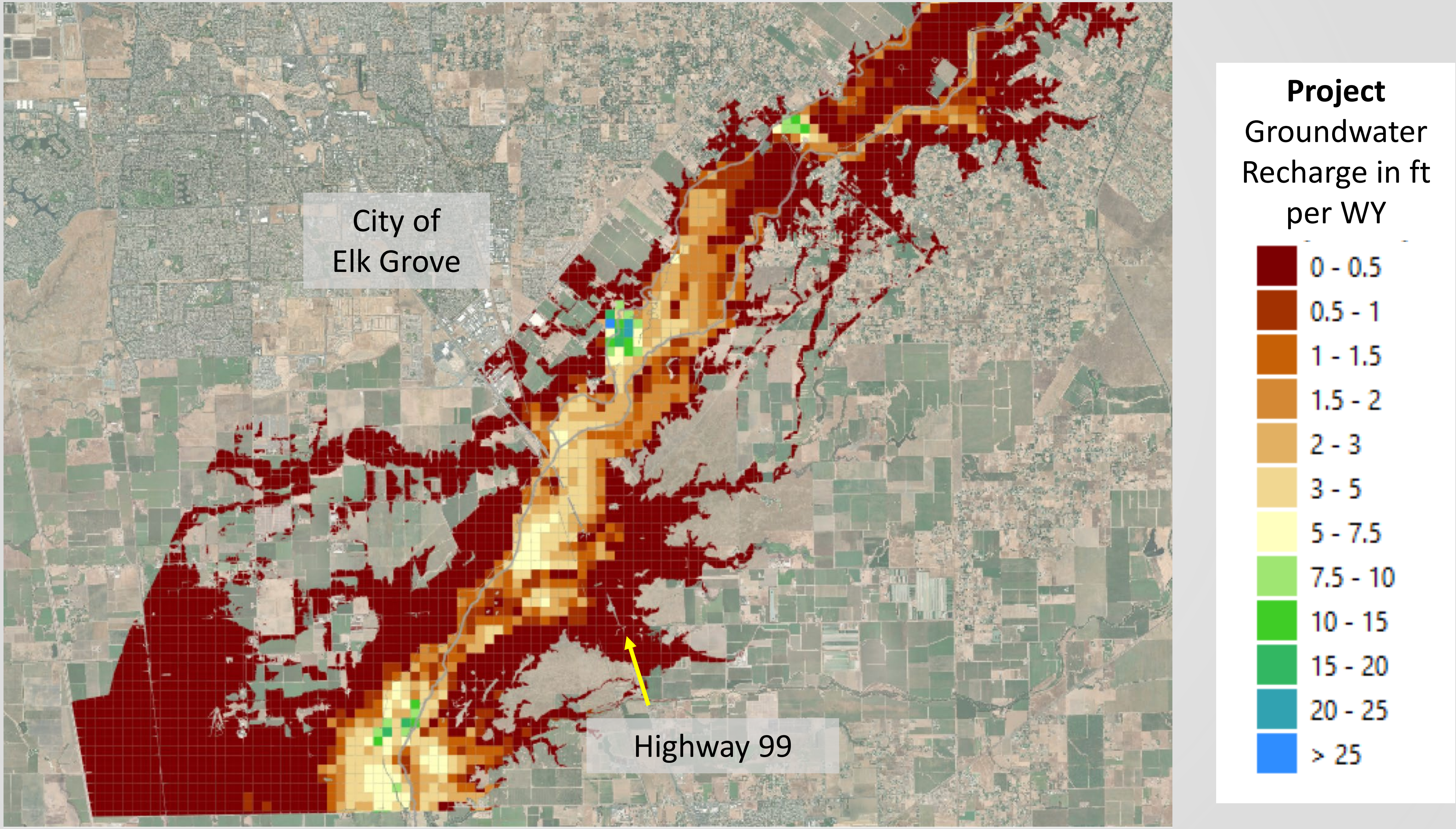
Results

Levee Setback Max Extent + Channels Concept

Existing Conditions **Project**

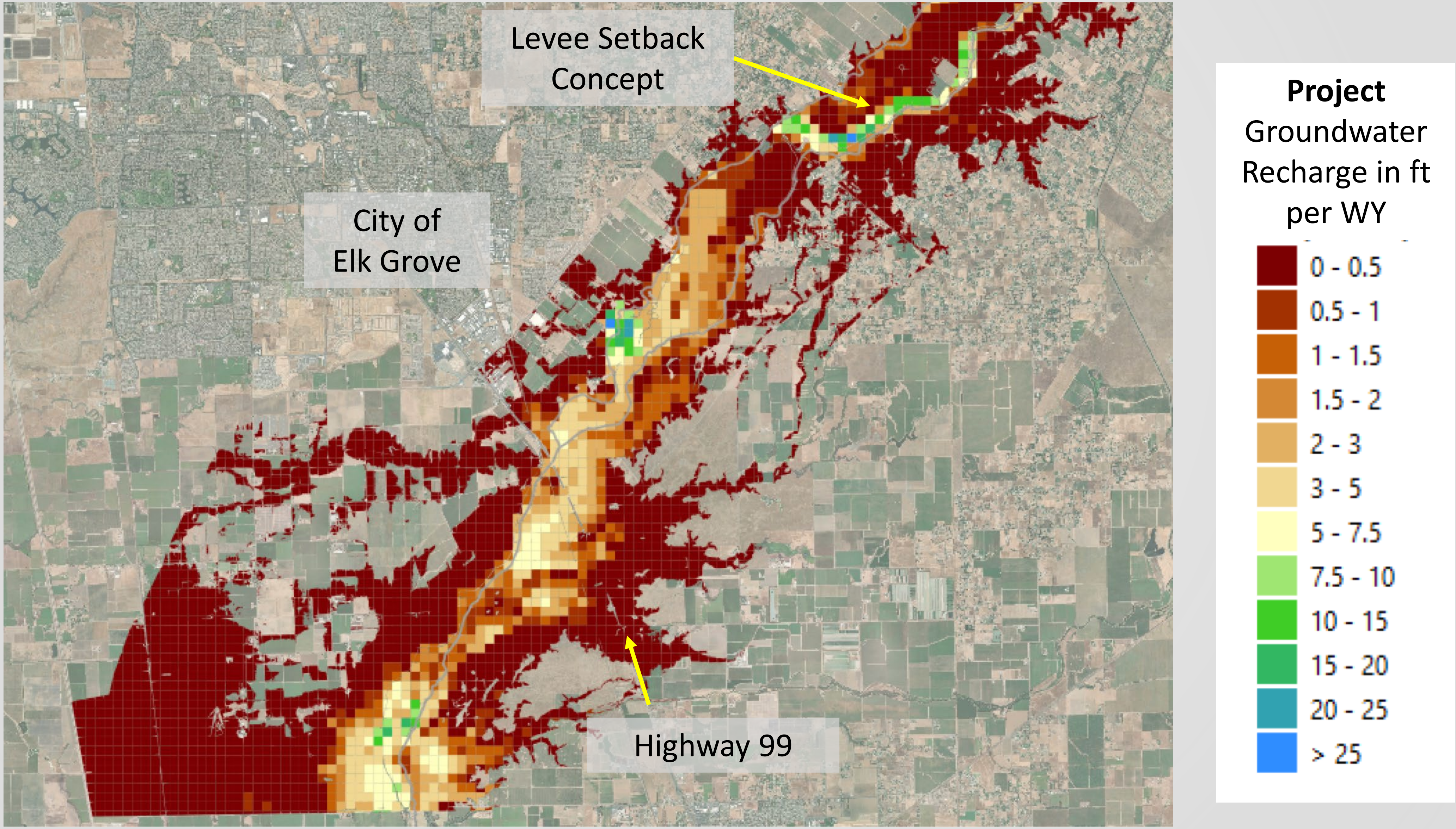
Results

Levee Setback Max Extent + Channels Concept (Groundwater Recharge)



Results

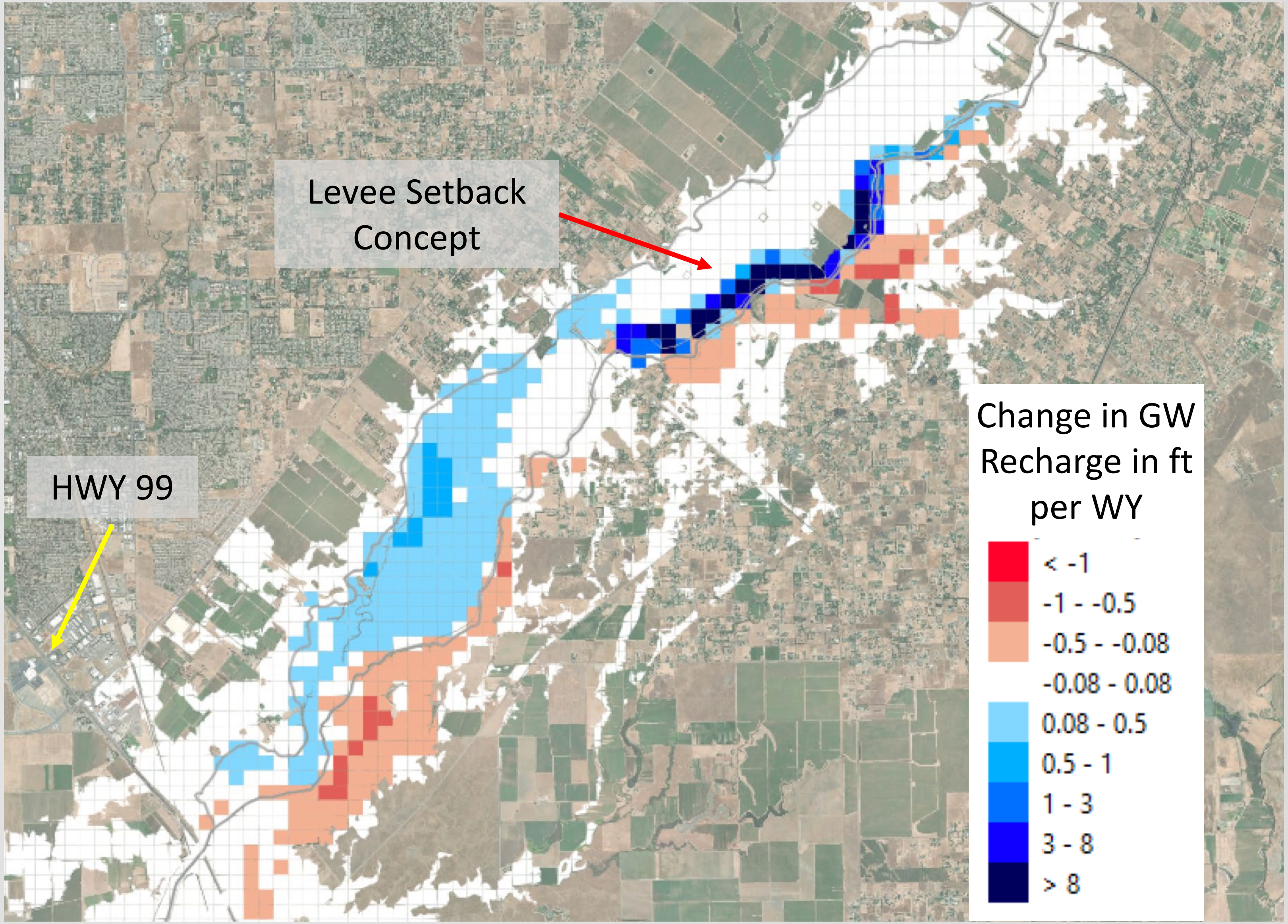
Levee Setback Max Extent + Channels Concept (Groundwater Recharge)



Results

Levee Setback Max Extent + Channels Concept (Groundwater Recharge)

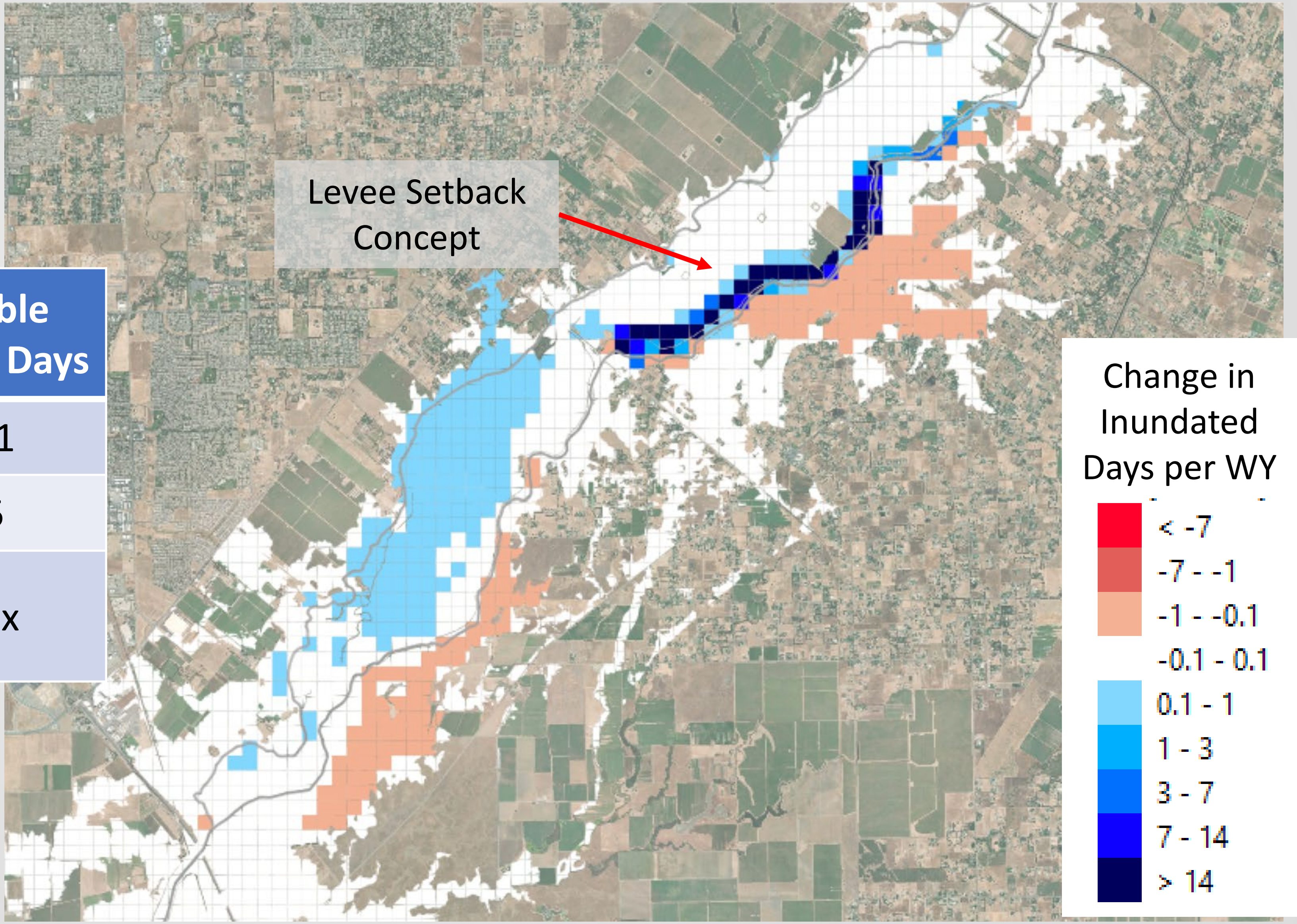
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	0.1
Project	11.0
Multiplier Difference	110x



Results

Levee Setback Max Extent + Channels Concept (Inundation/Habitat)

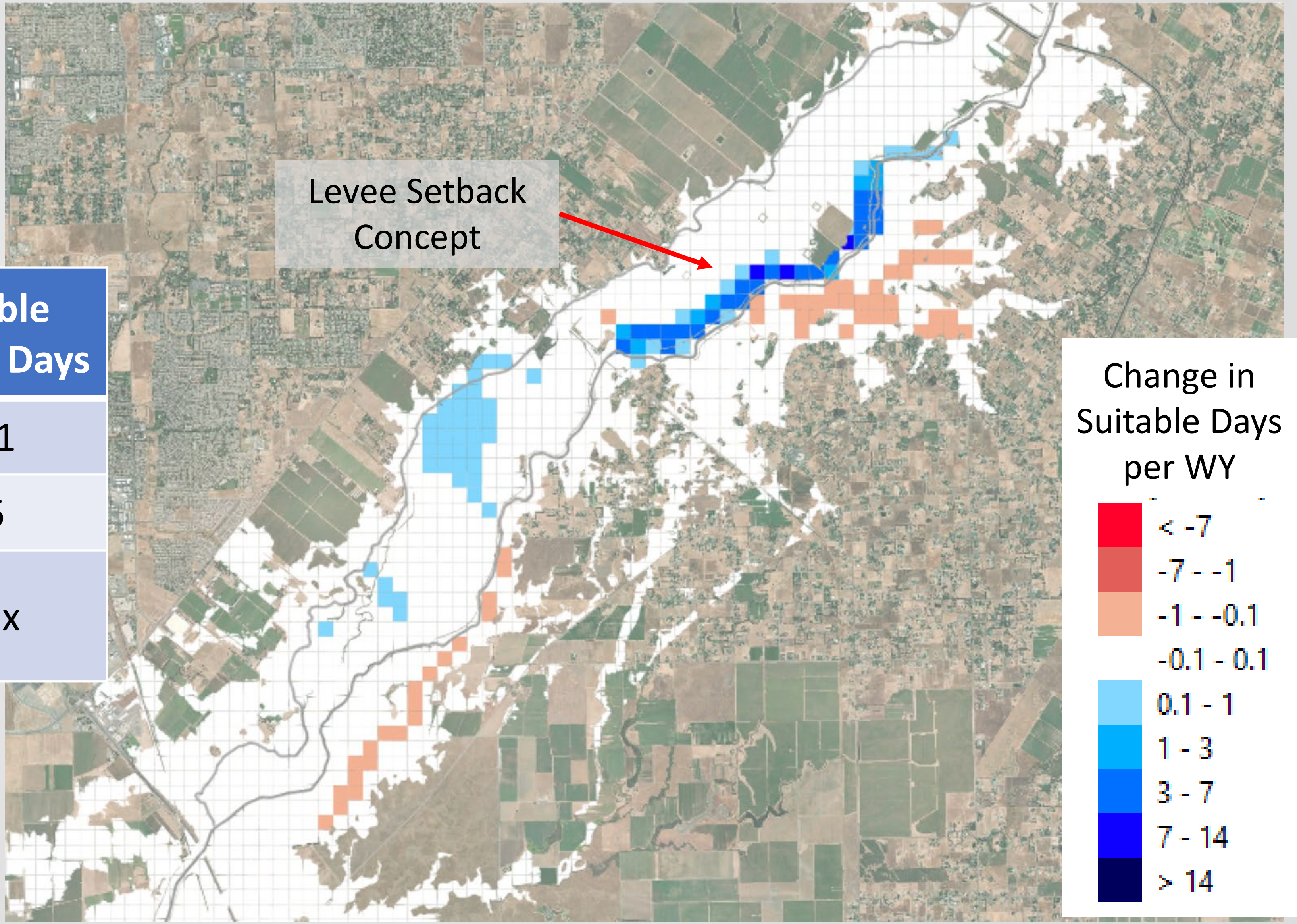
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	<0.1	<0.1
Project	17.1	4.5
Multiplier Difference	855x	445x



Results

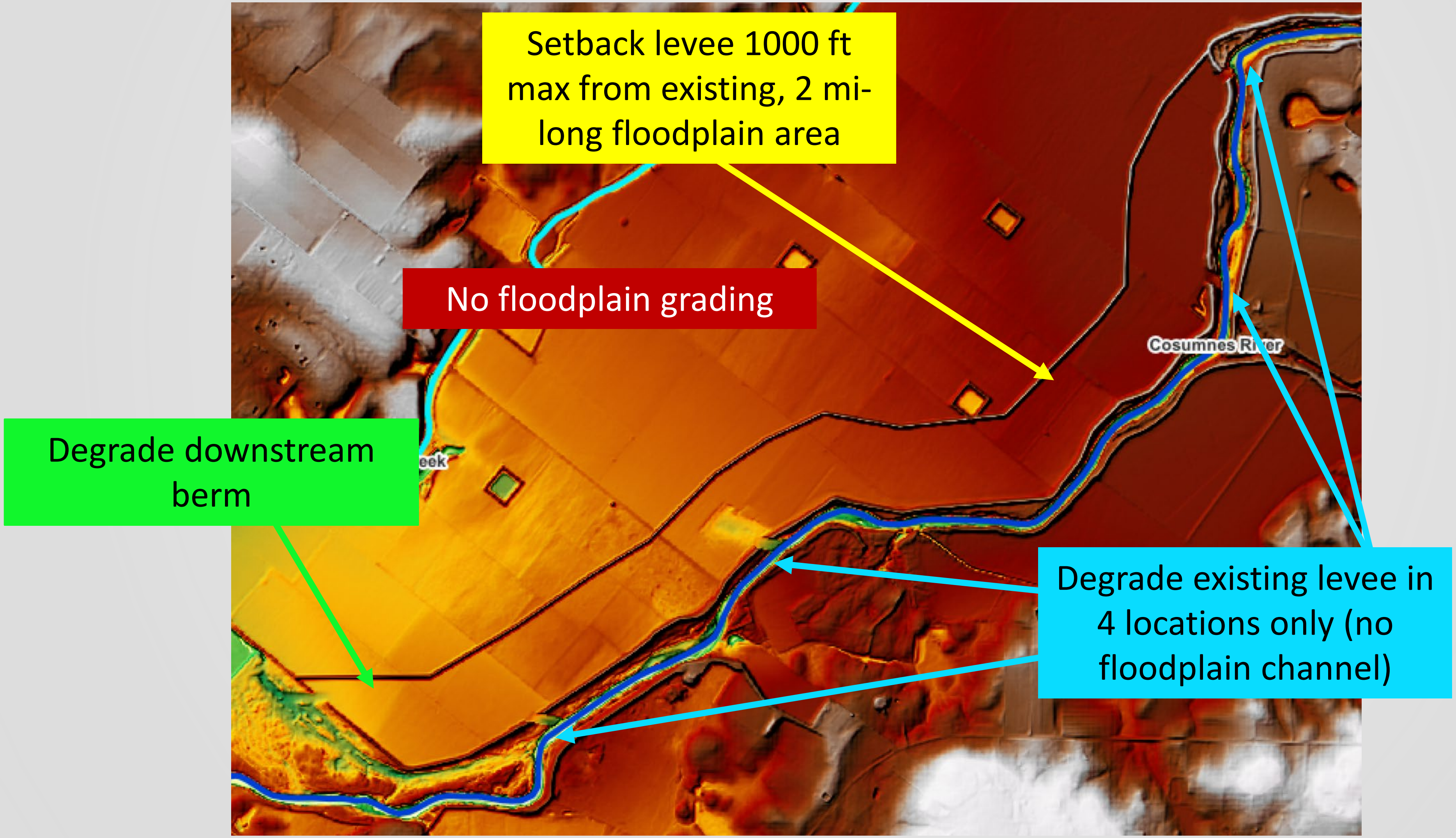
Levee Setback Max Extent + Channels Concept (Inundation/Habitat)

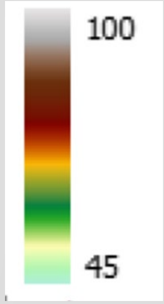
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	<0.1	<0.1
Project	17.1	4.5
Multiplier Difference	855x	445x



Site – Levee Setback

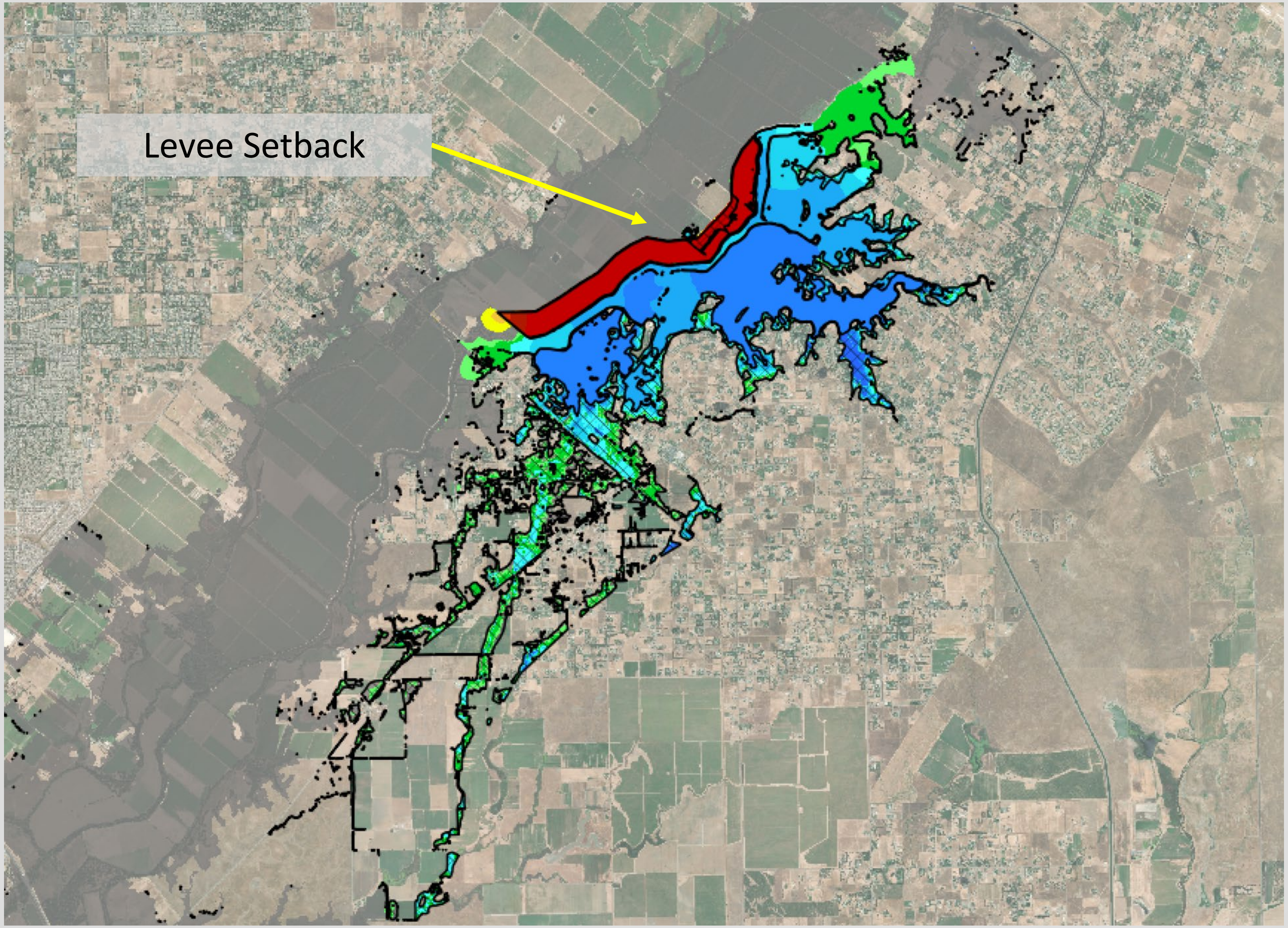
Concept 2

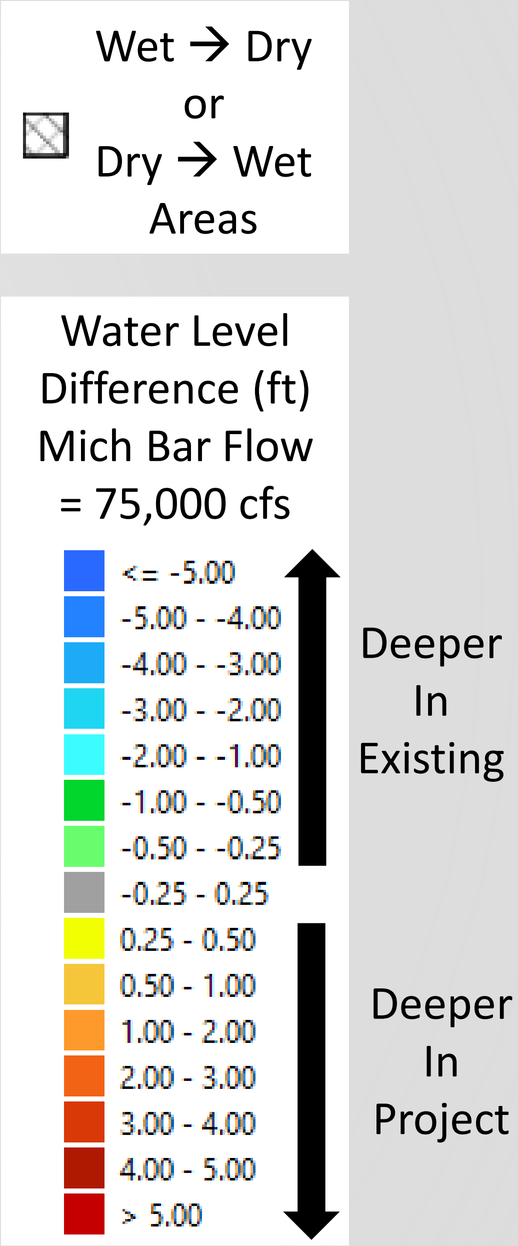




Results

Levee Setback Max Extent Floodplain Only (Flood)

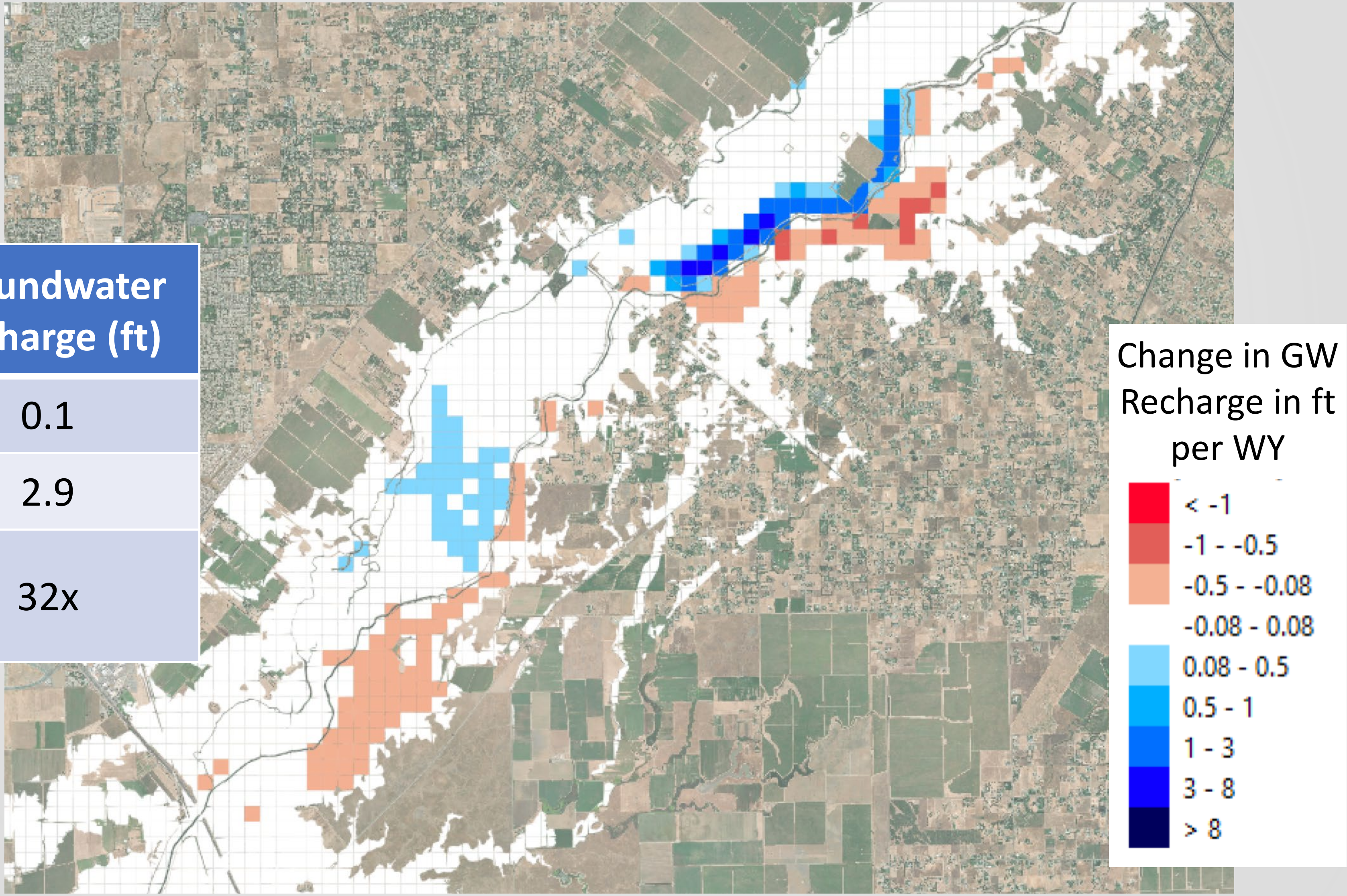




Results

Levee Setback Max Extent Floodplain Only (Groundwater Recharge)

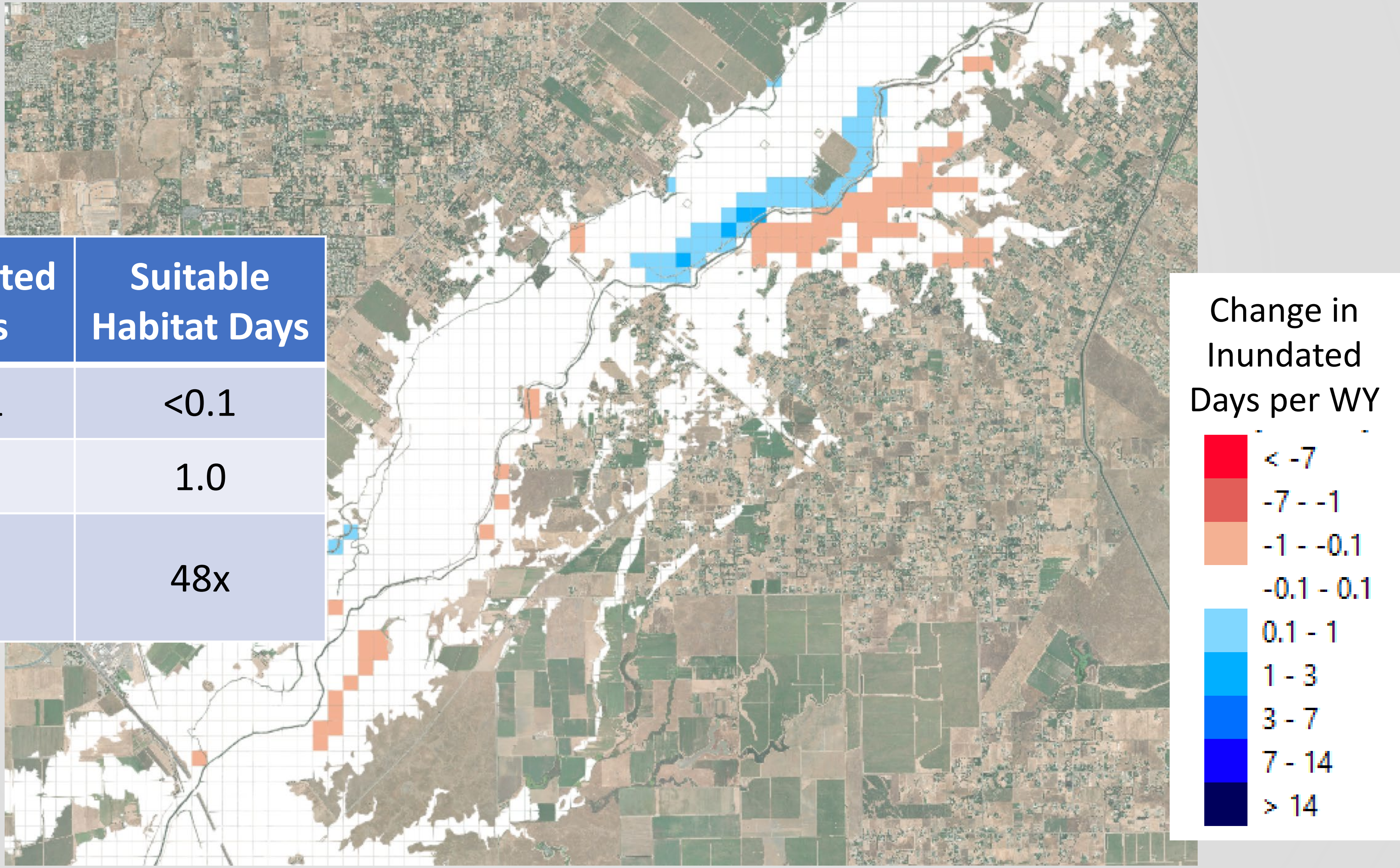
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	0.1
Project	2.9
Multiplier Difference	32x



Results

Levee Setback Max Extent Floodplain Only (Inundation/Habitat)

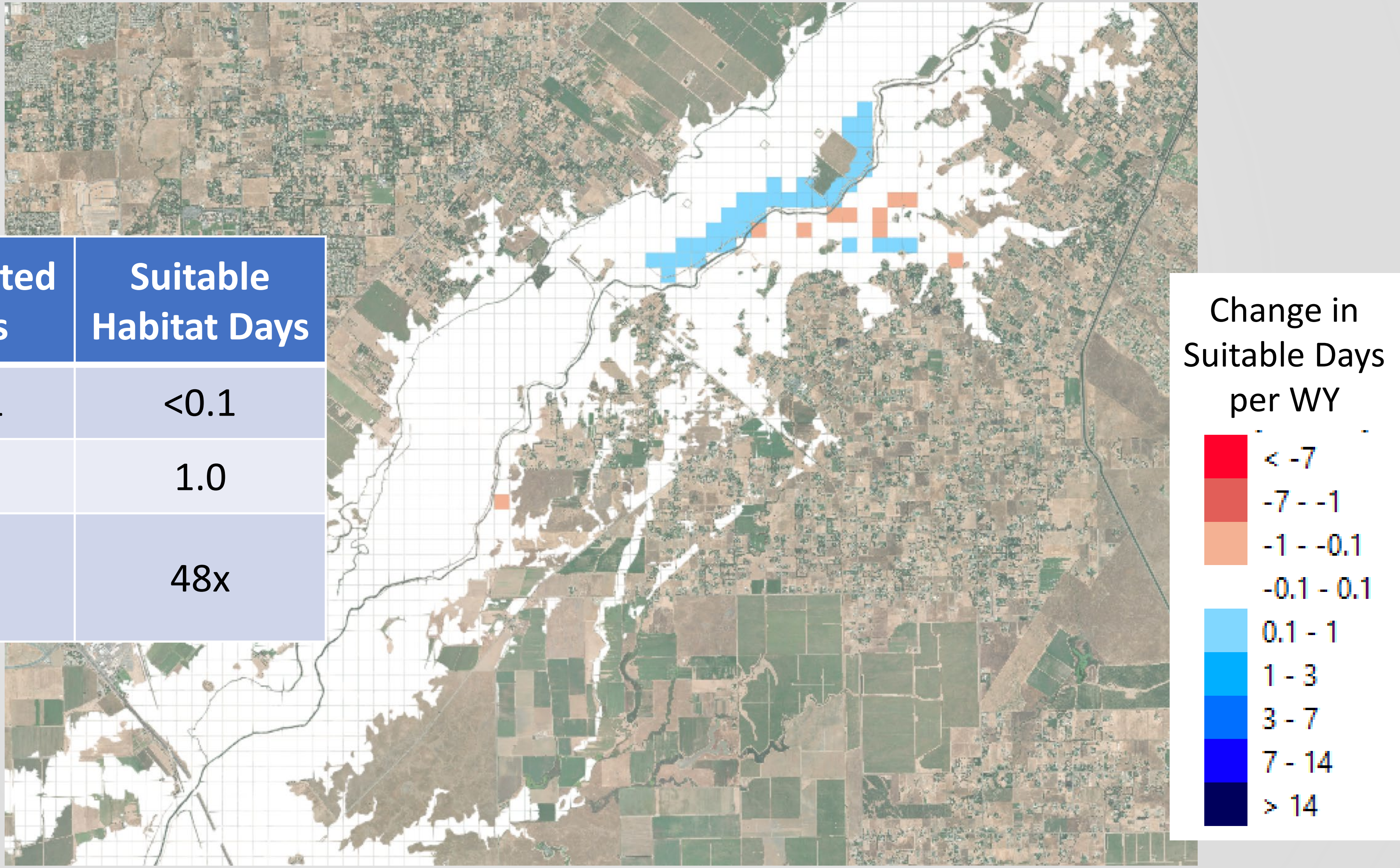
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	<0.1	<0.1
Project	0.4	1.0
Multiplier Difference	39x	48x



Results

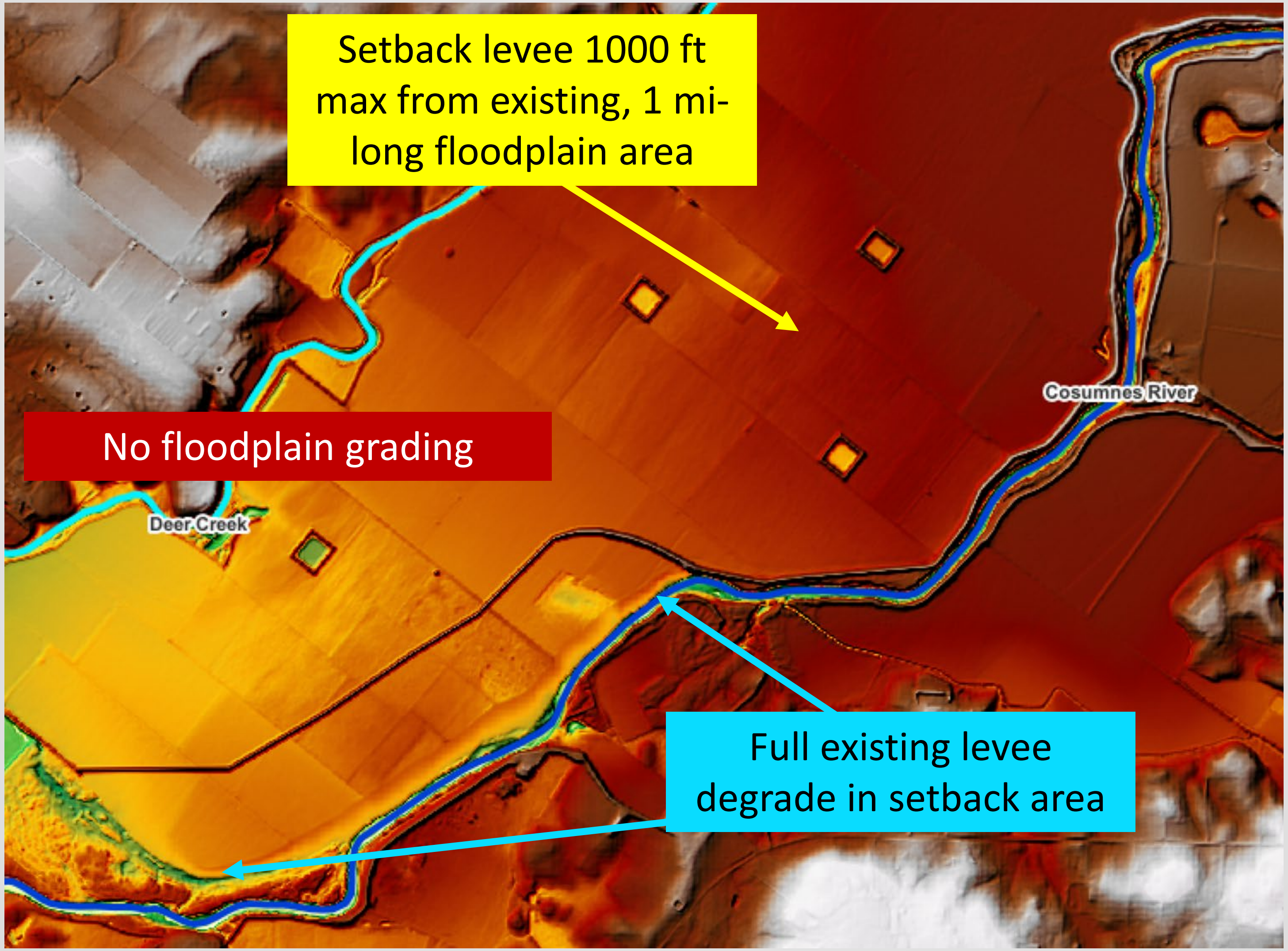
Levee Setback Max Extent Floodplain Only (Inundation/Habitat)

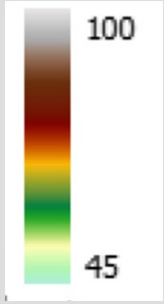
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	<0.1	<0.1
Project	0.4	1.0
Multiplier Difference	39x	48x



Site – Levee Setback

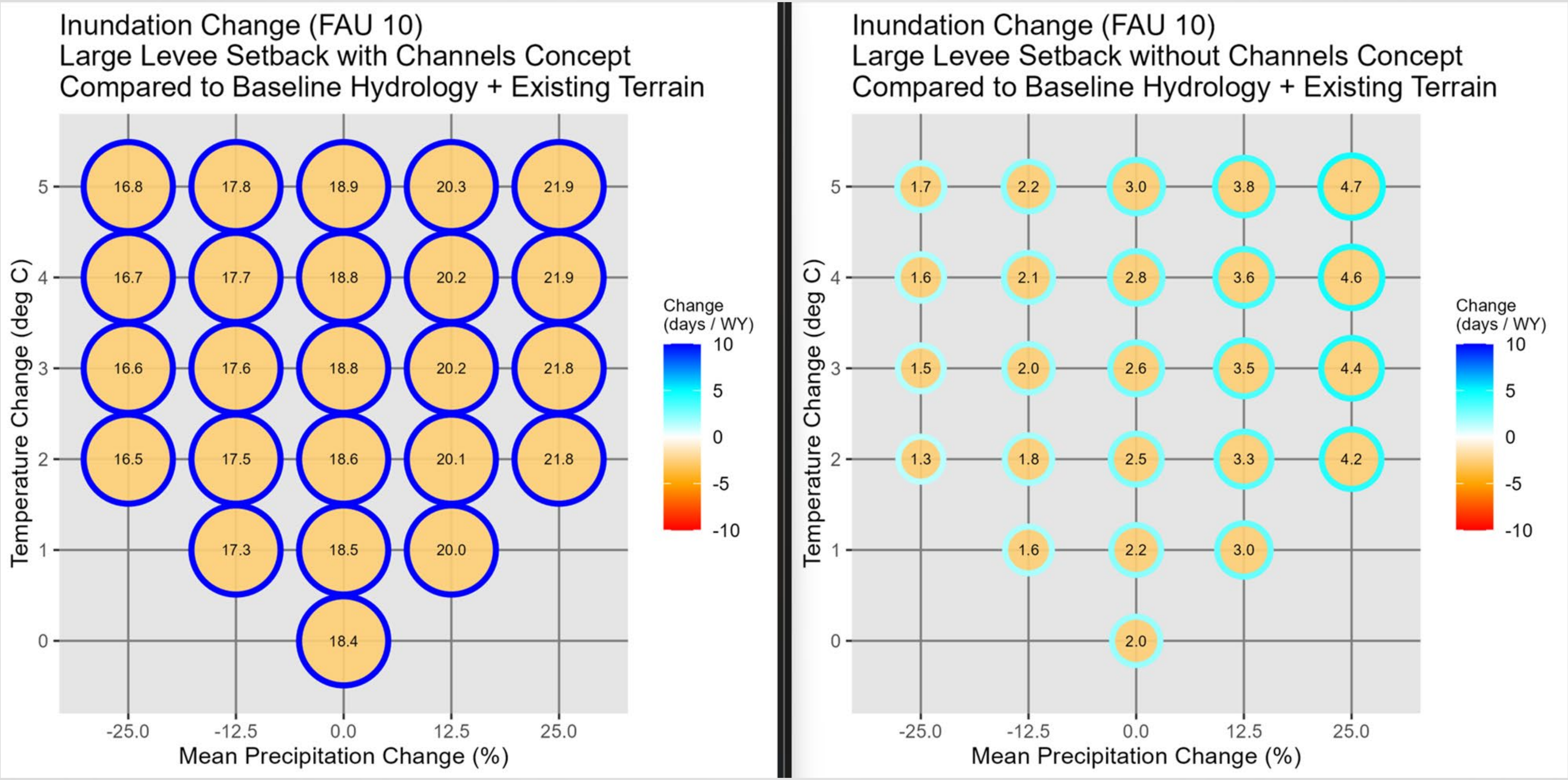
Concept 3





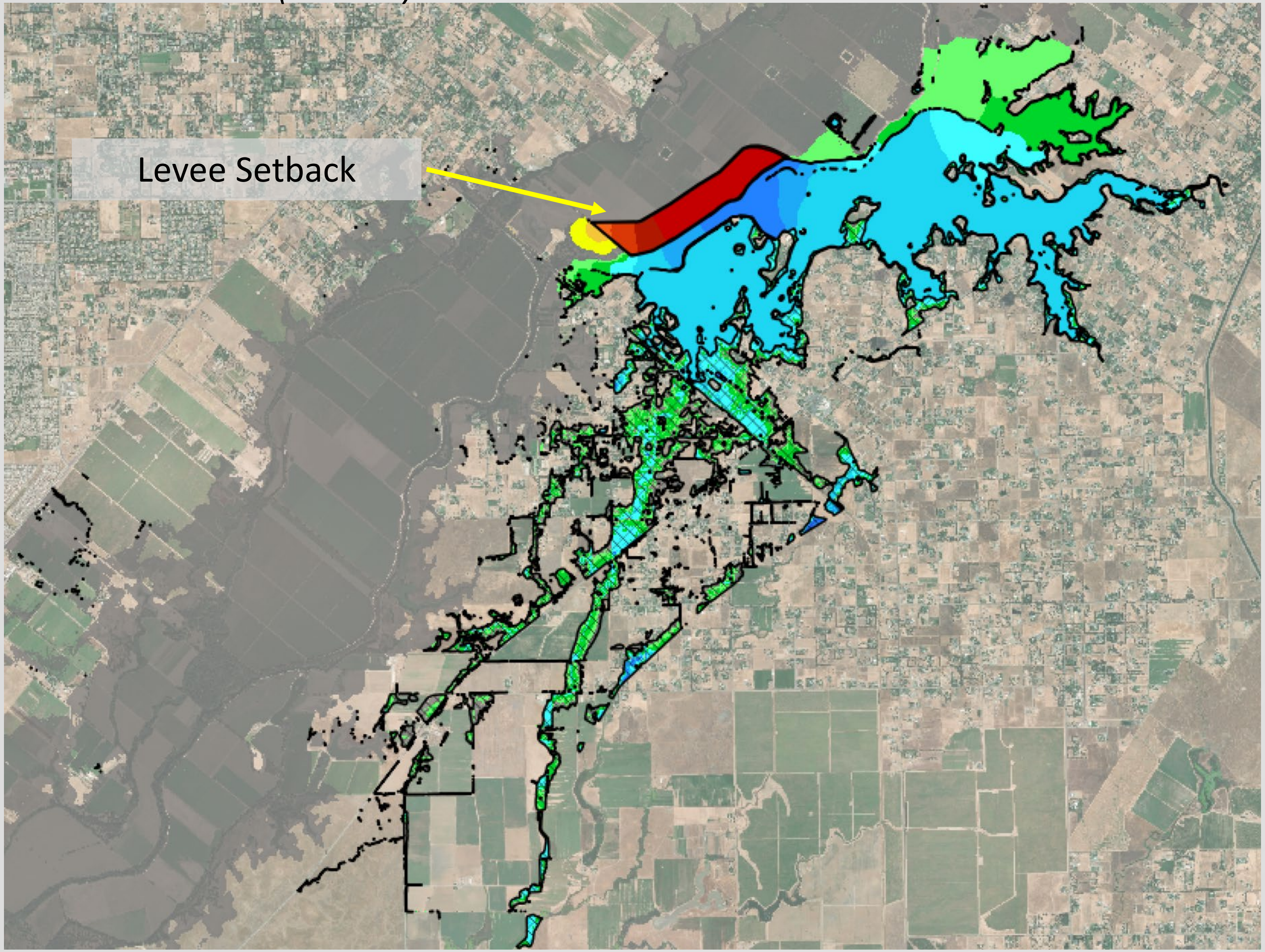
Climate Resiliency of Large Levee Setback Concepts

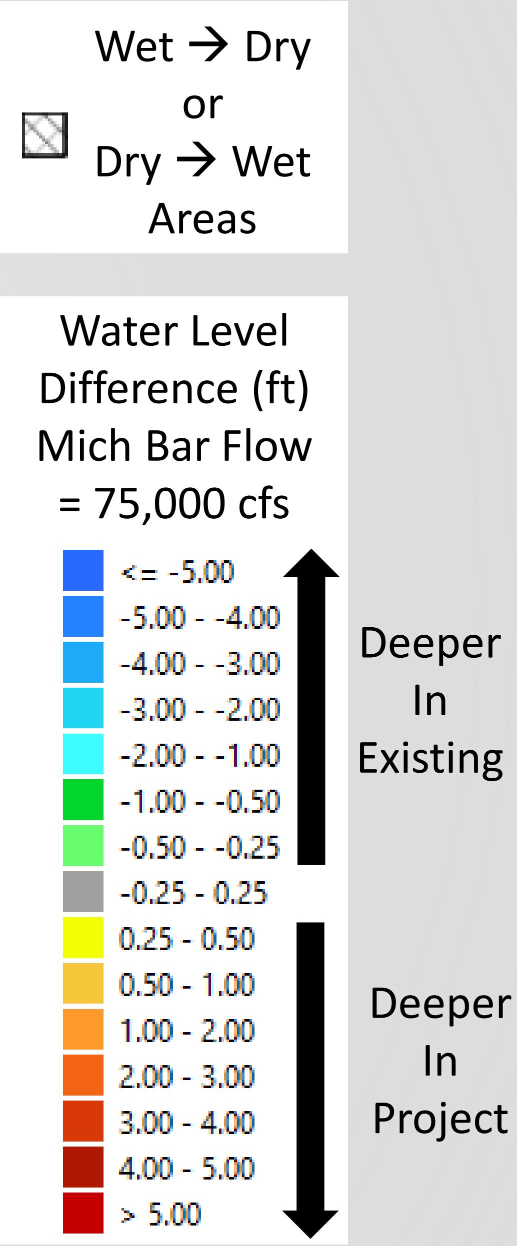
Inundated Days Within Concept Footprint



Results

Levee Setback Min Extent (Flood)

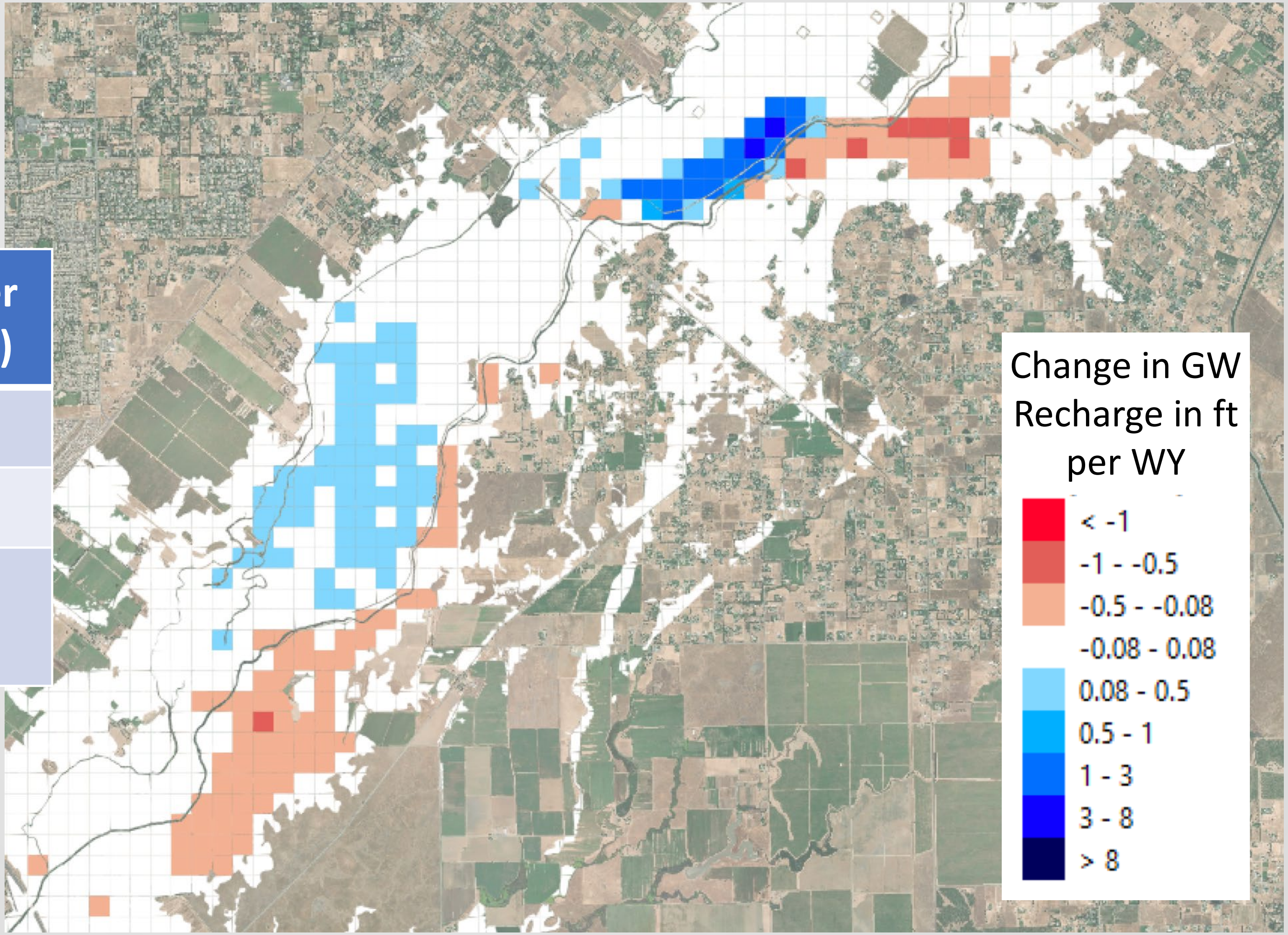




Results

Levee Setback Max Extent Floodplain Only (Groundwater Recharge)

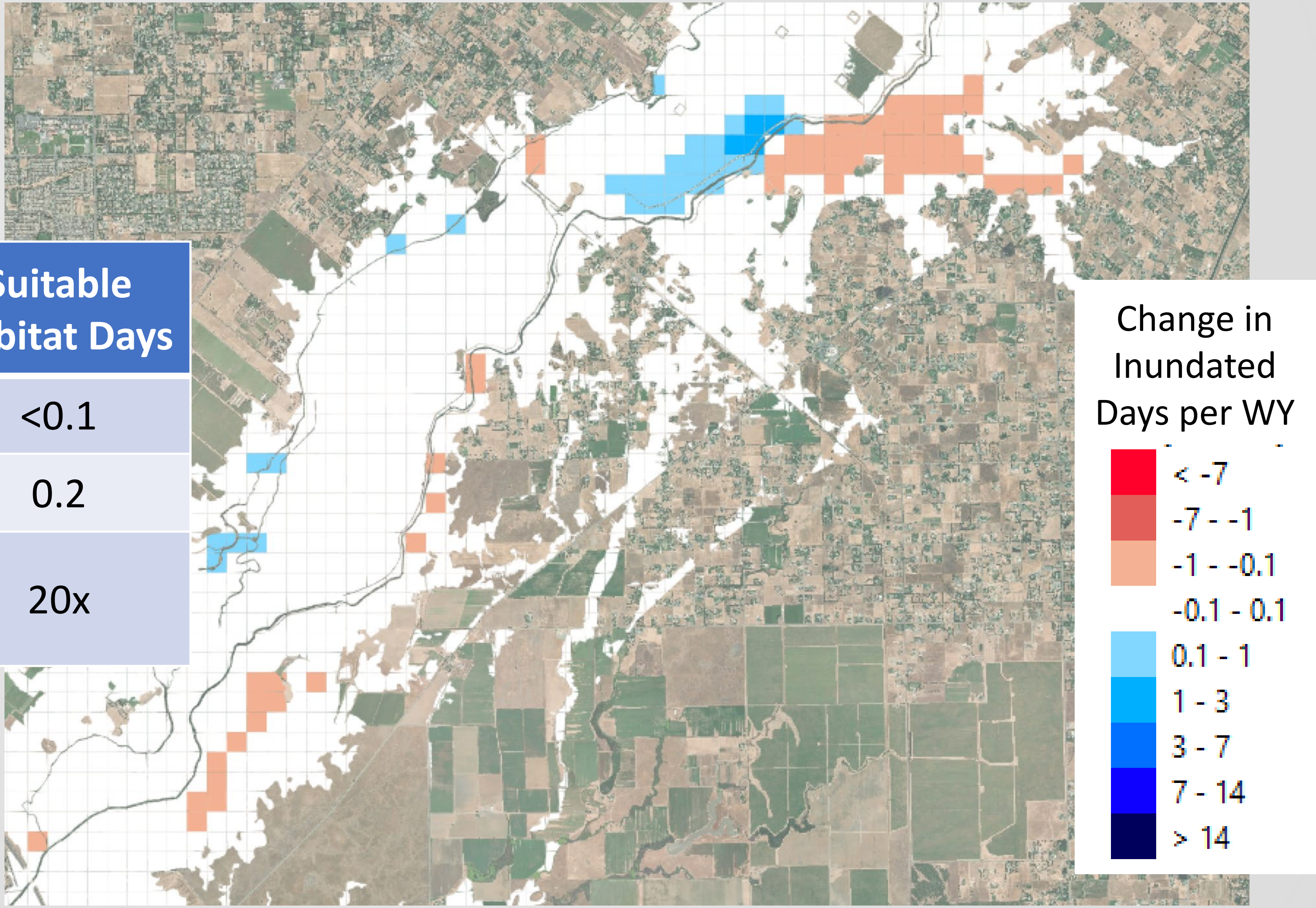
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	0.1
Project	1.4
Multiplier Difference	16x



Results

Levee Setback Max Extent Floodplain Only (Inundation/Habitat)

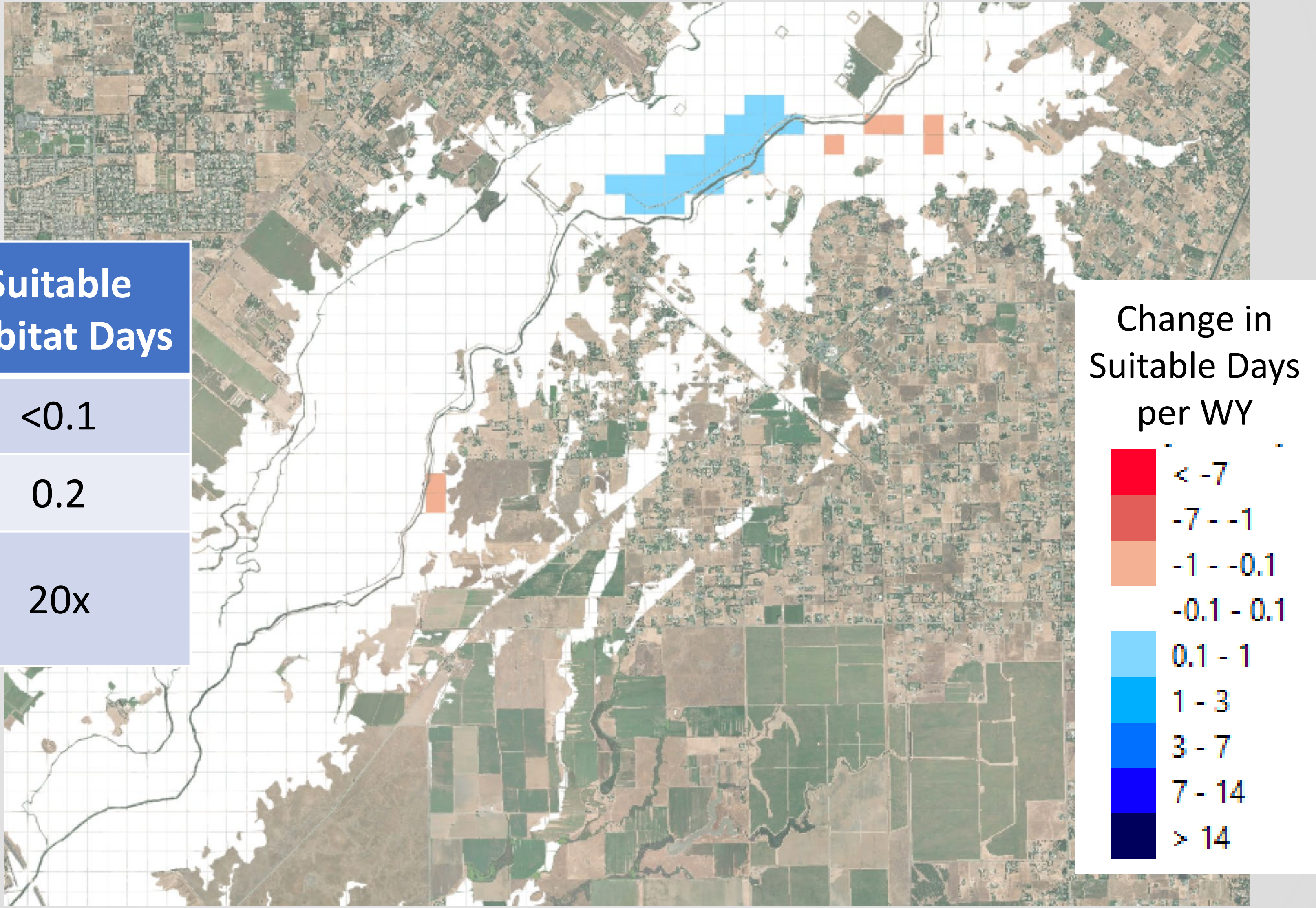
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	<0.1	<0.1
Project	0.5	0.2
Multiplier Difference	24x	20x



Results

Levee Setback Max Extent Floodplain Only (Inundation/Habitat)

Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	<0.1	<0.1
Project	0.5	0.2
Multiplier Difference	24x	20x

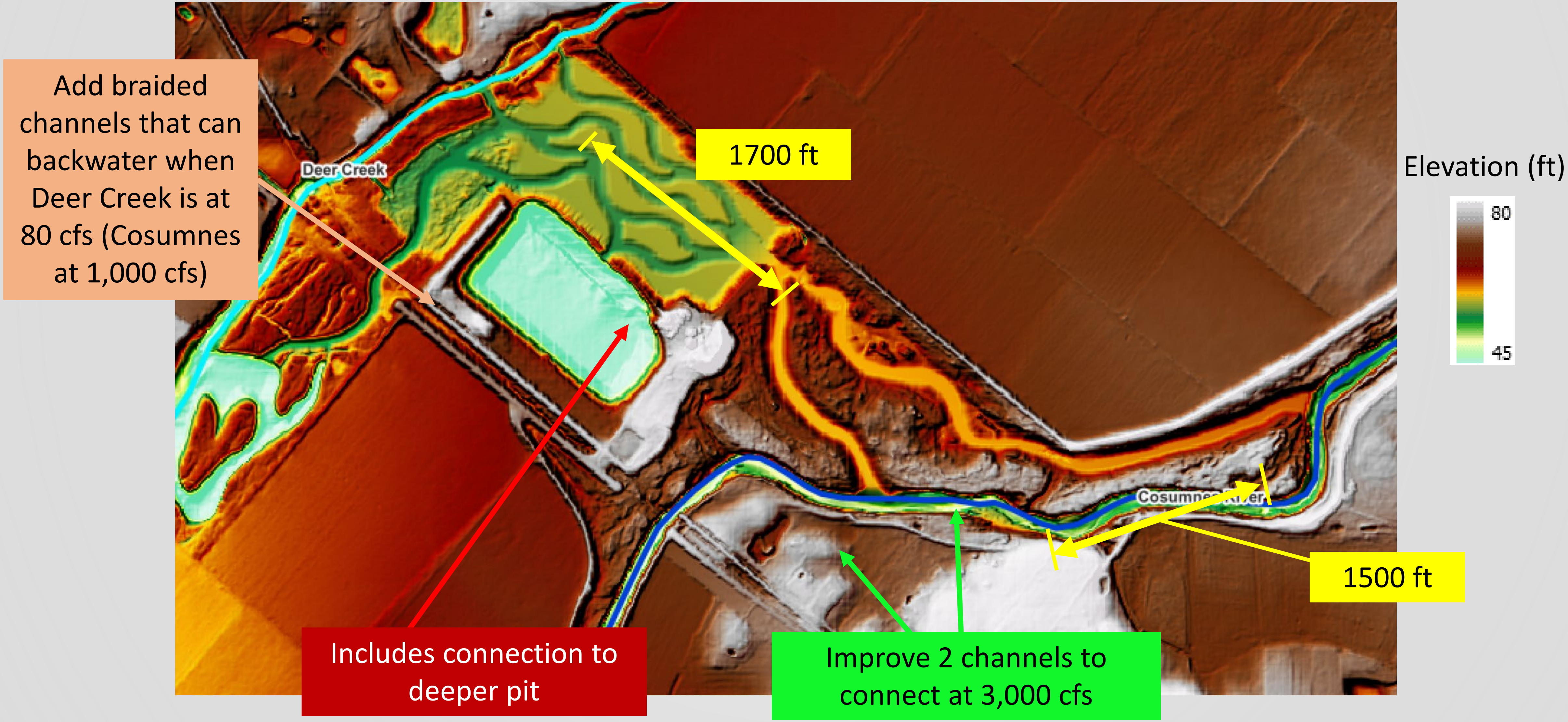


Site – Hanford Gravel Pit

1937 Imagery

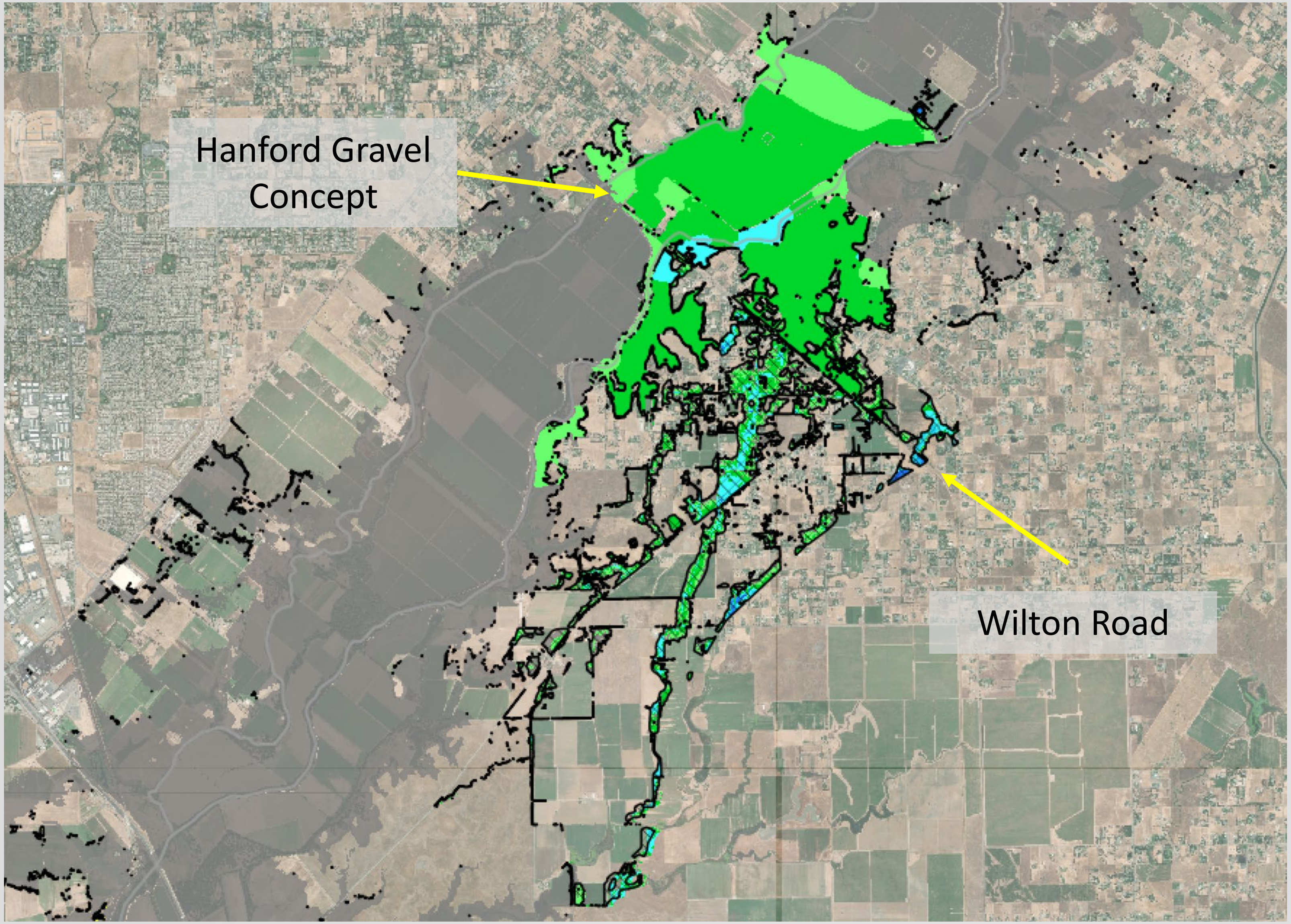
Site – Hanford Gravel Pit

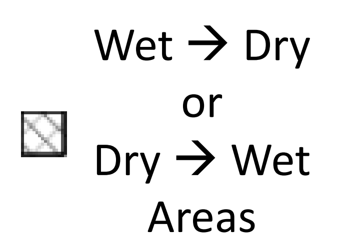
Concept 1 (Max Grading)

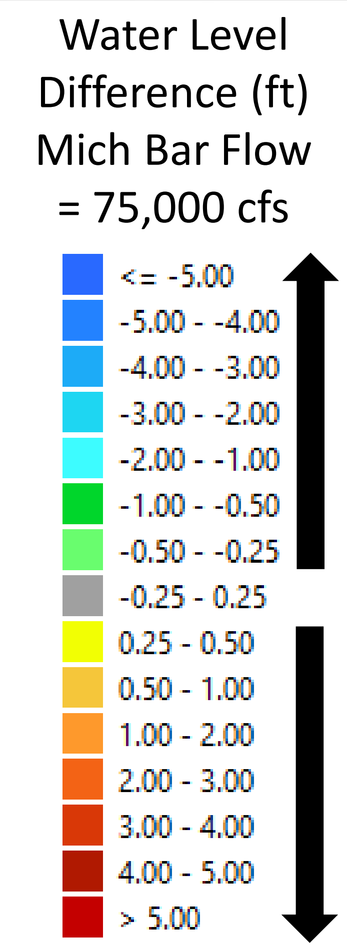


Results

Hanford Gravel Max Grading Concept (Flood)

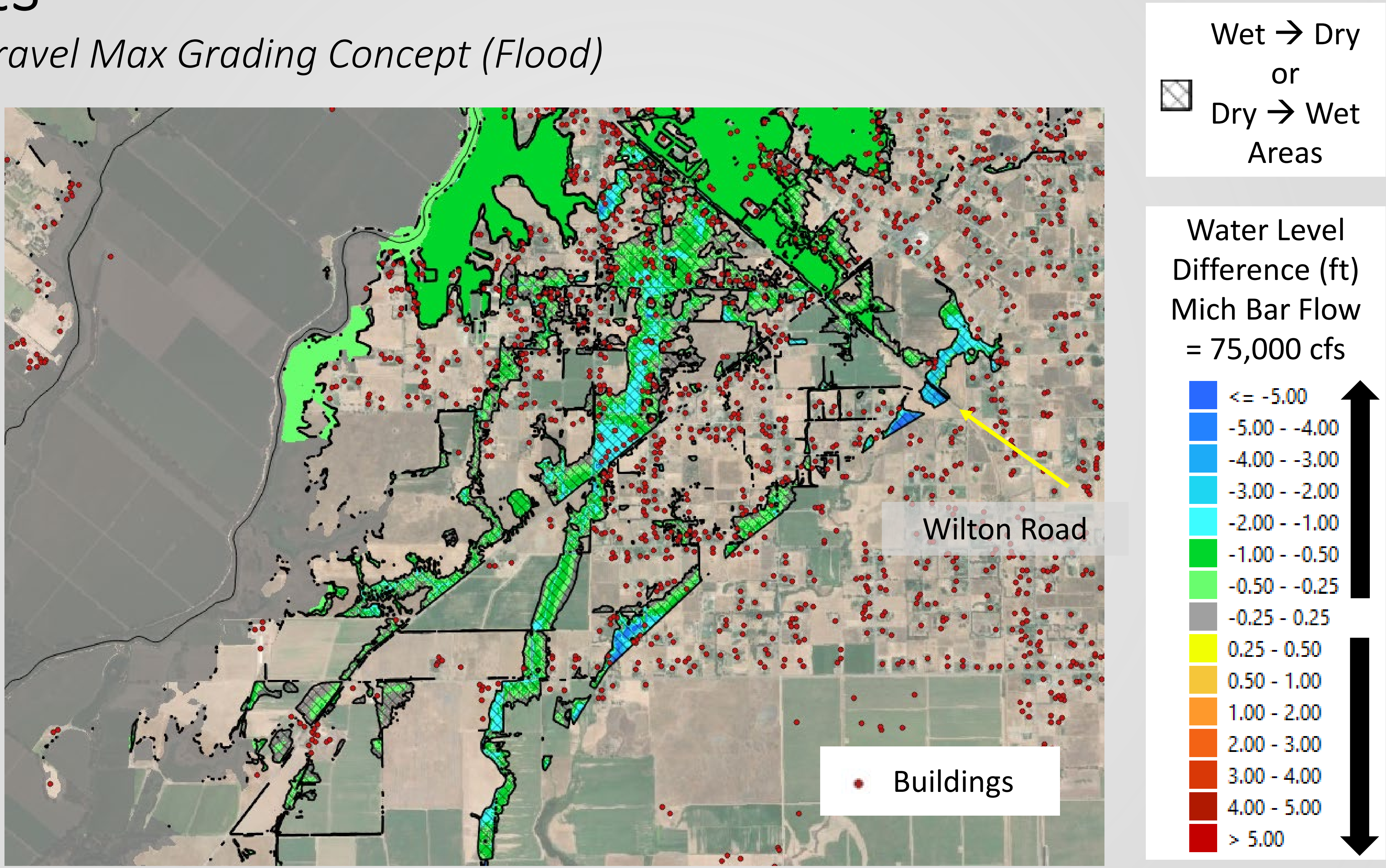






Results

Hanford Gravel Max Grading Concept (Flood)



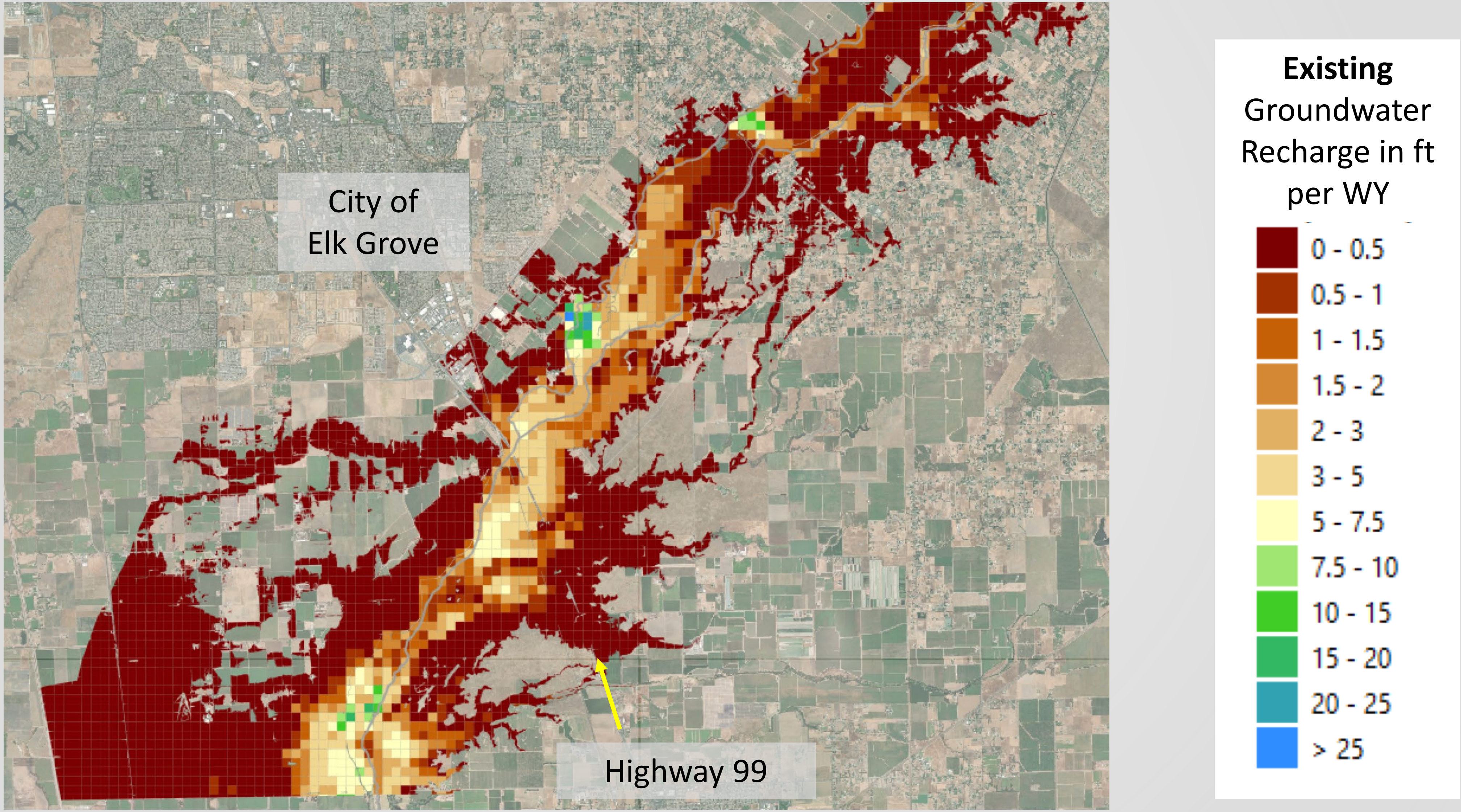
Results

Hanford Gravel Max Extent

Existing Conditions **Project**

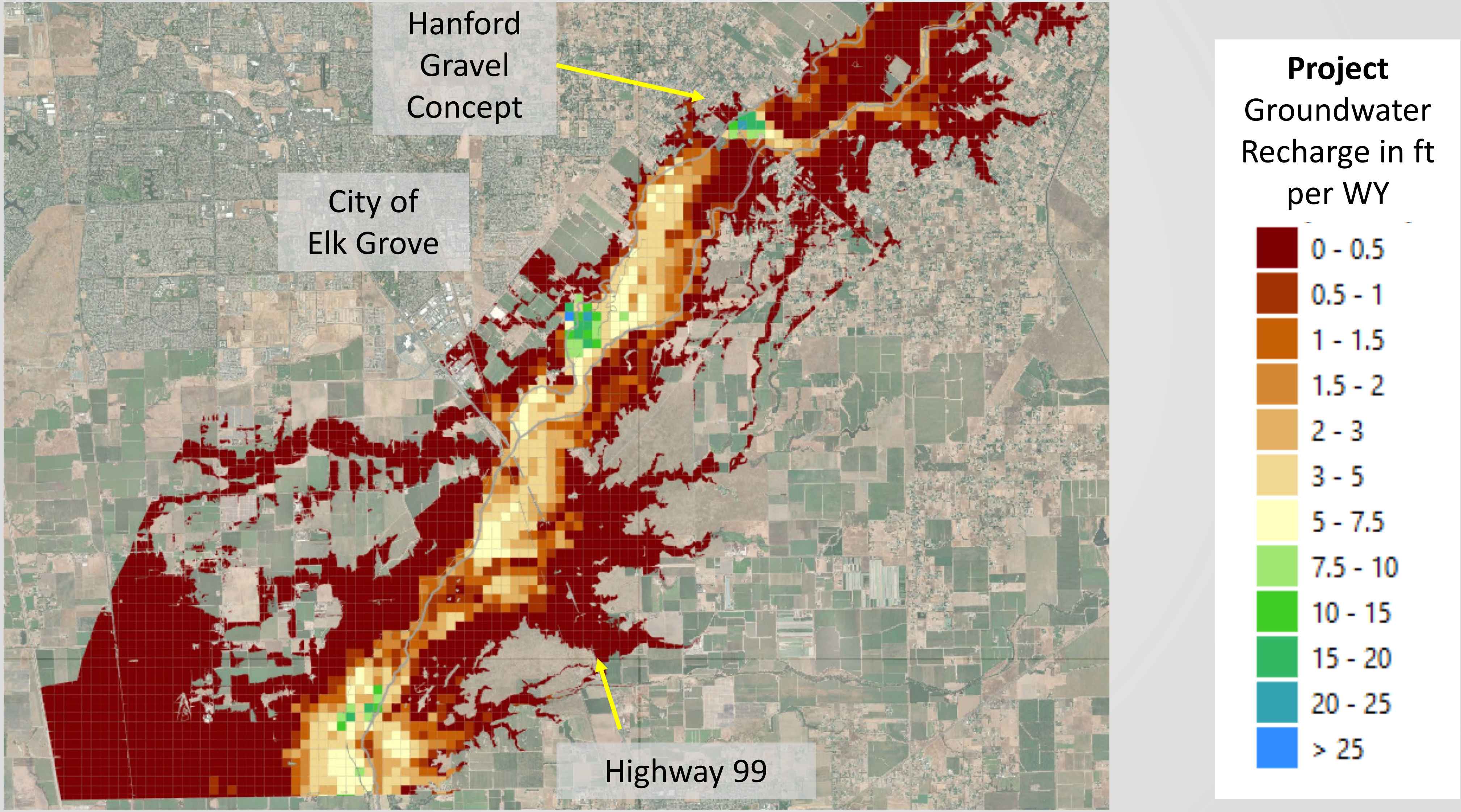
Results

Hanford Gravel Max Grading Concept (Groundwater Recharge)



Results

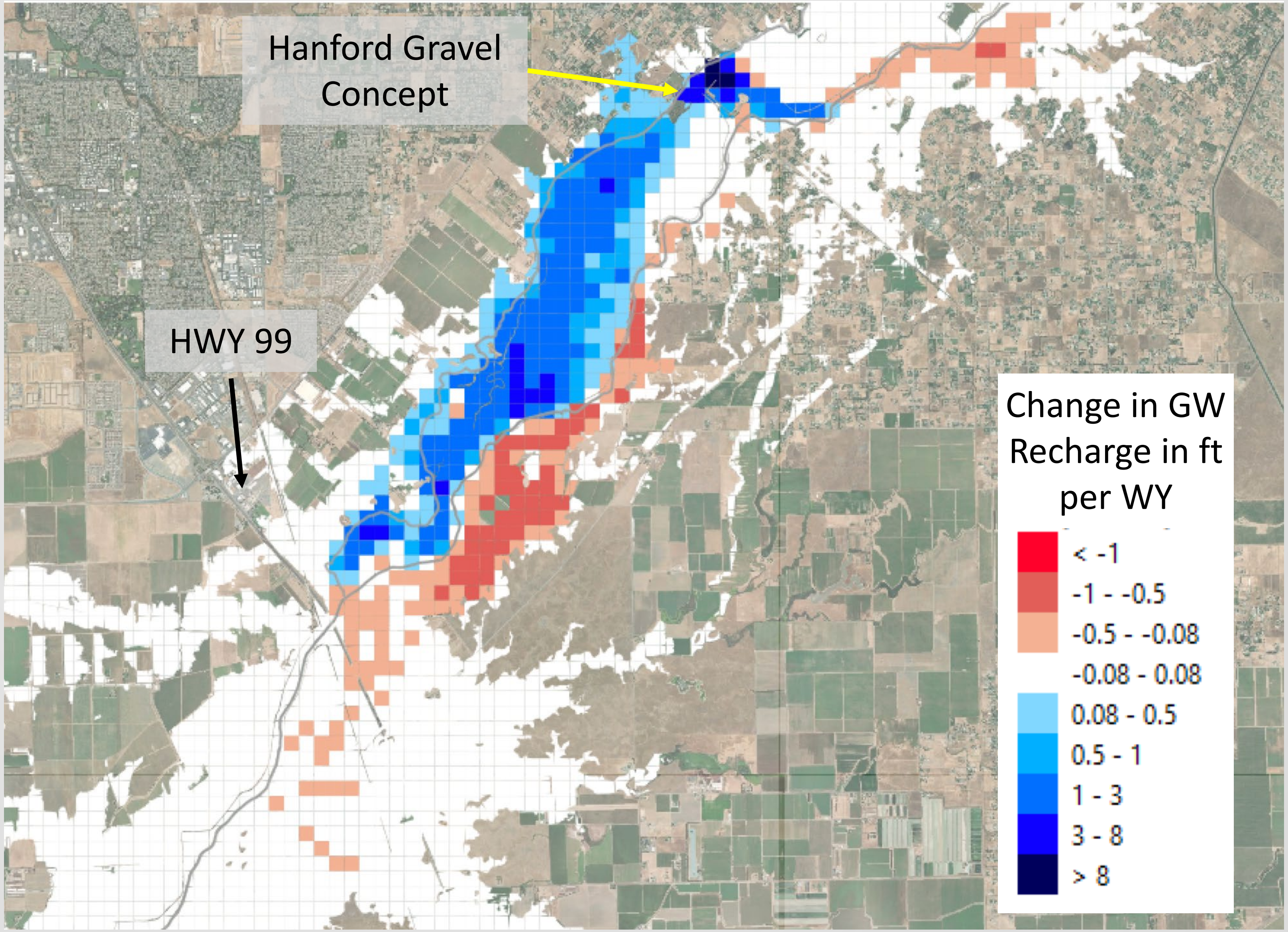
Hanford Gravel Max Grading Concept (Groundwater Recharge)



Results

Hanford Gravel Max Grading Concept (Groundwater Recharge)

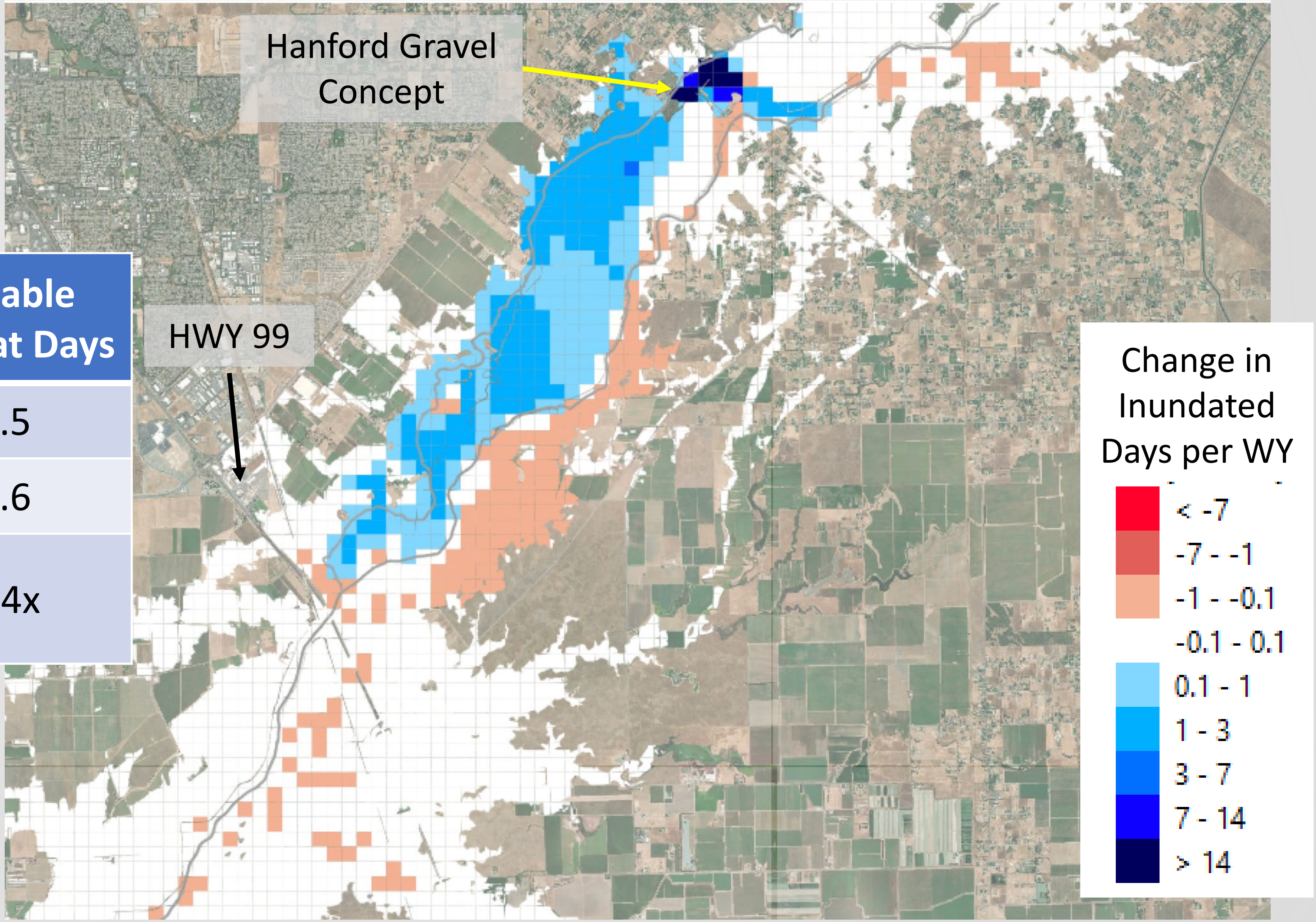
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	4.9
Project	10.1
Multiplier Difference	2x



Results

Hanford Gravel Max Grading Concept (Inundation/Habitat)

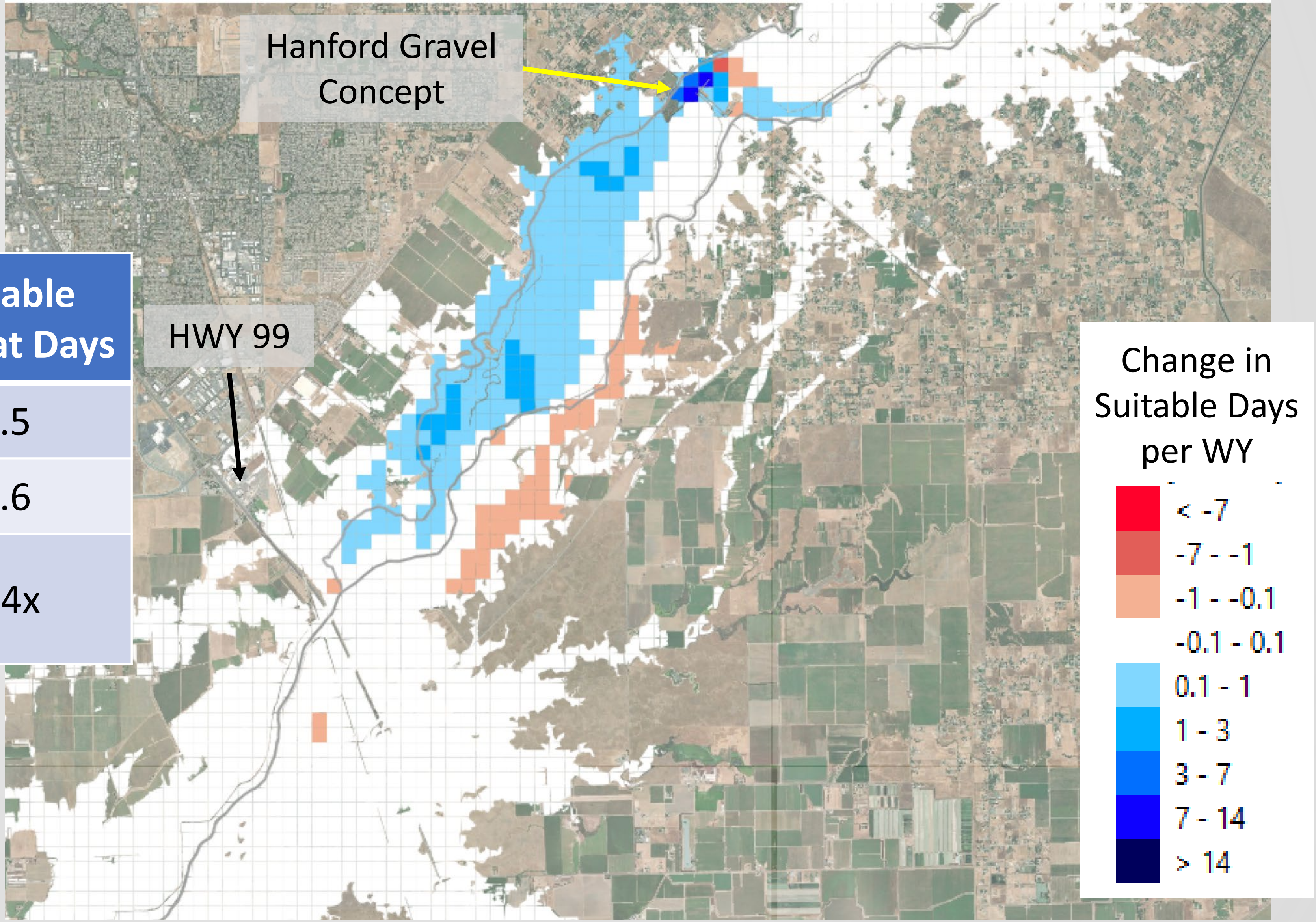
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	5.3	1.5
Project	20.3	3.6
Multiplier Difference	3.8x	2.4x



Results

Hanford Gravel Max Grading Concept (Inundation/Habitat)

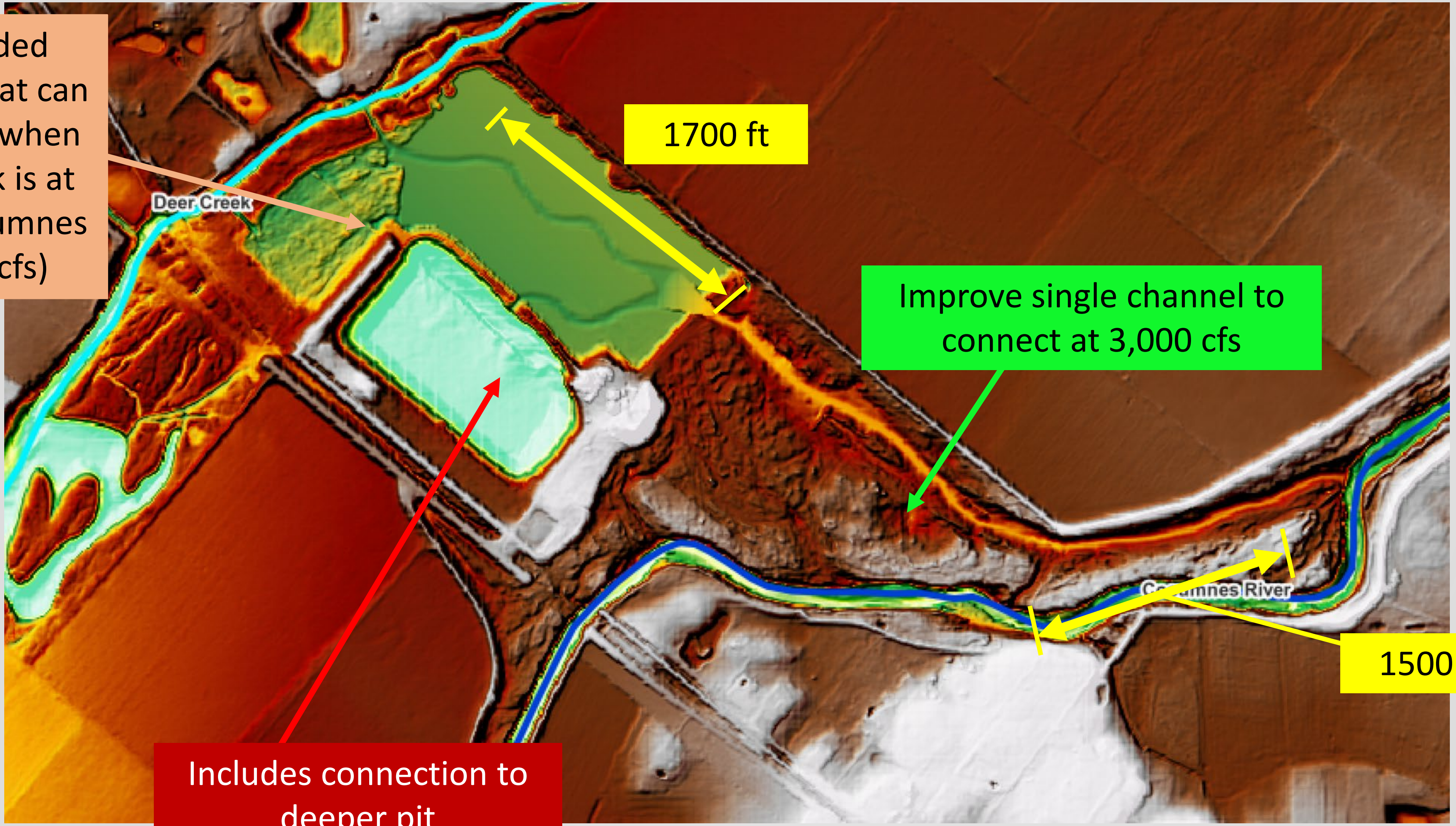
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	5.3	1.5
Project	20.3	3.6
Multiplier Difference	3.8x	2.4x



Site – Hanford Gravel Pit

Concept 2 (Min Grading)

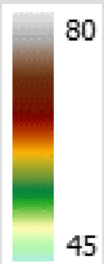
Add braided channels that can backwater when Deer Creek is at 80 cfs (Cosumnes at 1,000 cfs)



Improve single channel to connect at 3,000 cfs

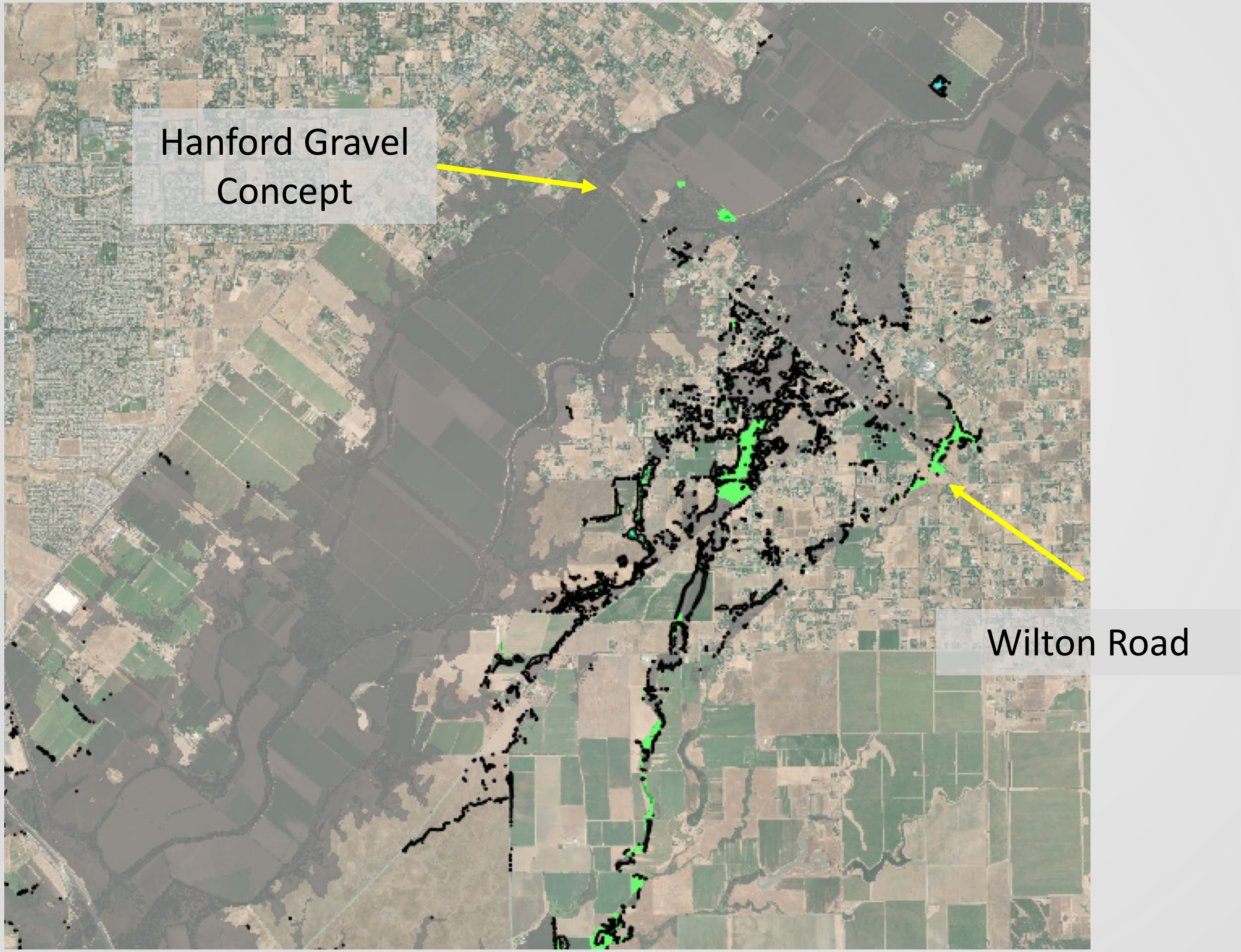
Includes connection to deeper pit

Elevation (ft)



Results

Hanford Gravel Min Grading Concept (Flood)



Wet → Dry
or
Dry → Wet
Areas

Water Level Difference (ft)
Mich Bar Flow = 75,000 cfs

<= -5.00
-5.00 - -4.00
-4.00 - -3.00
-3.00 - -2.00
-2.00 - -1.00
-1.00 - -0.50
-0.50 - -0.25
-0.25 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 2.00
2.00 - 3.00
3.00 - 4.00
4.00 - 5.00
> 5.00

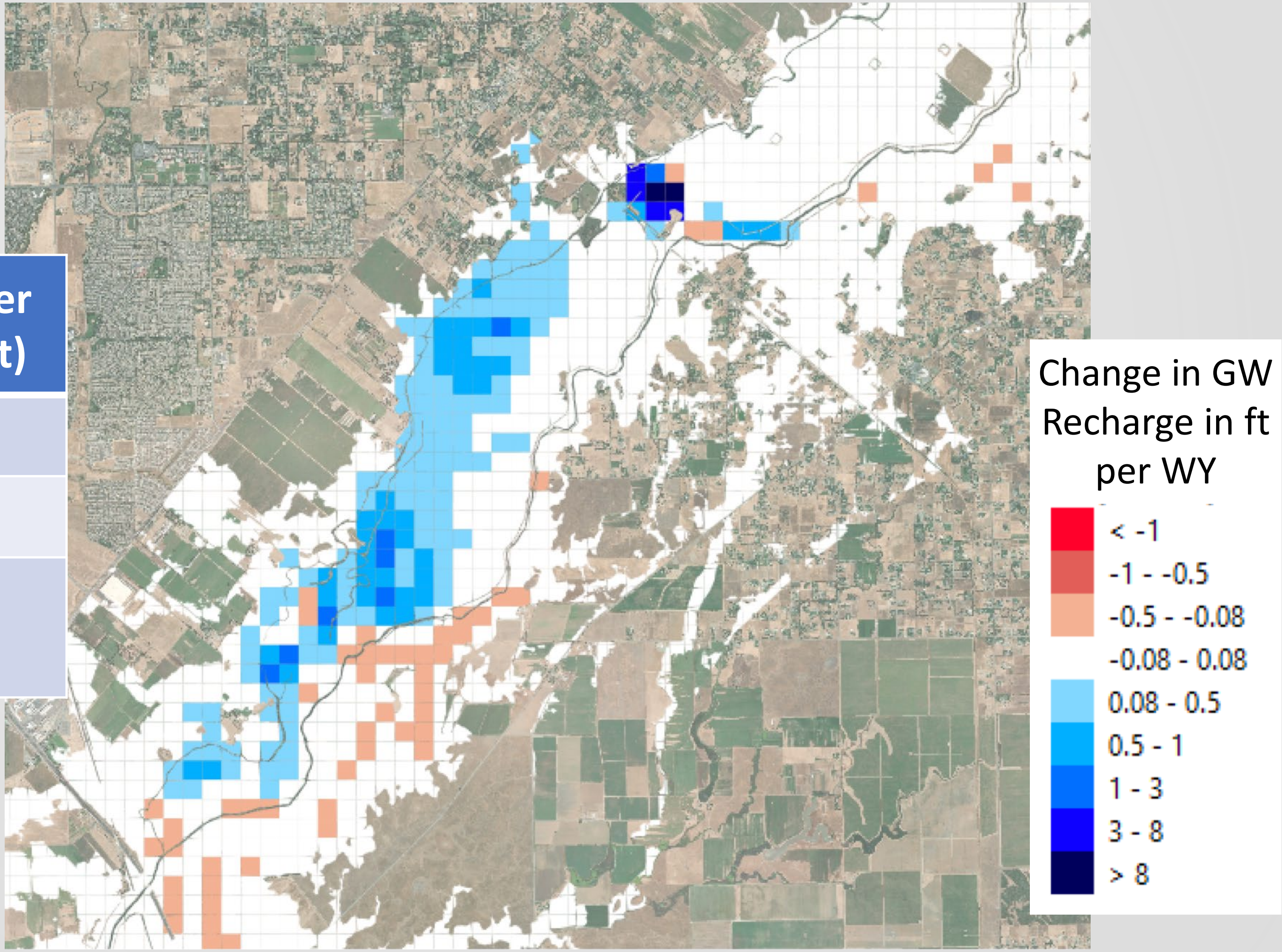
Deeper In Existing

Deeper In Project

Results

Hanford Gravel Min Grading Concept (Groundwater Recharge)

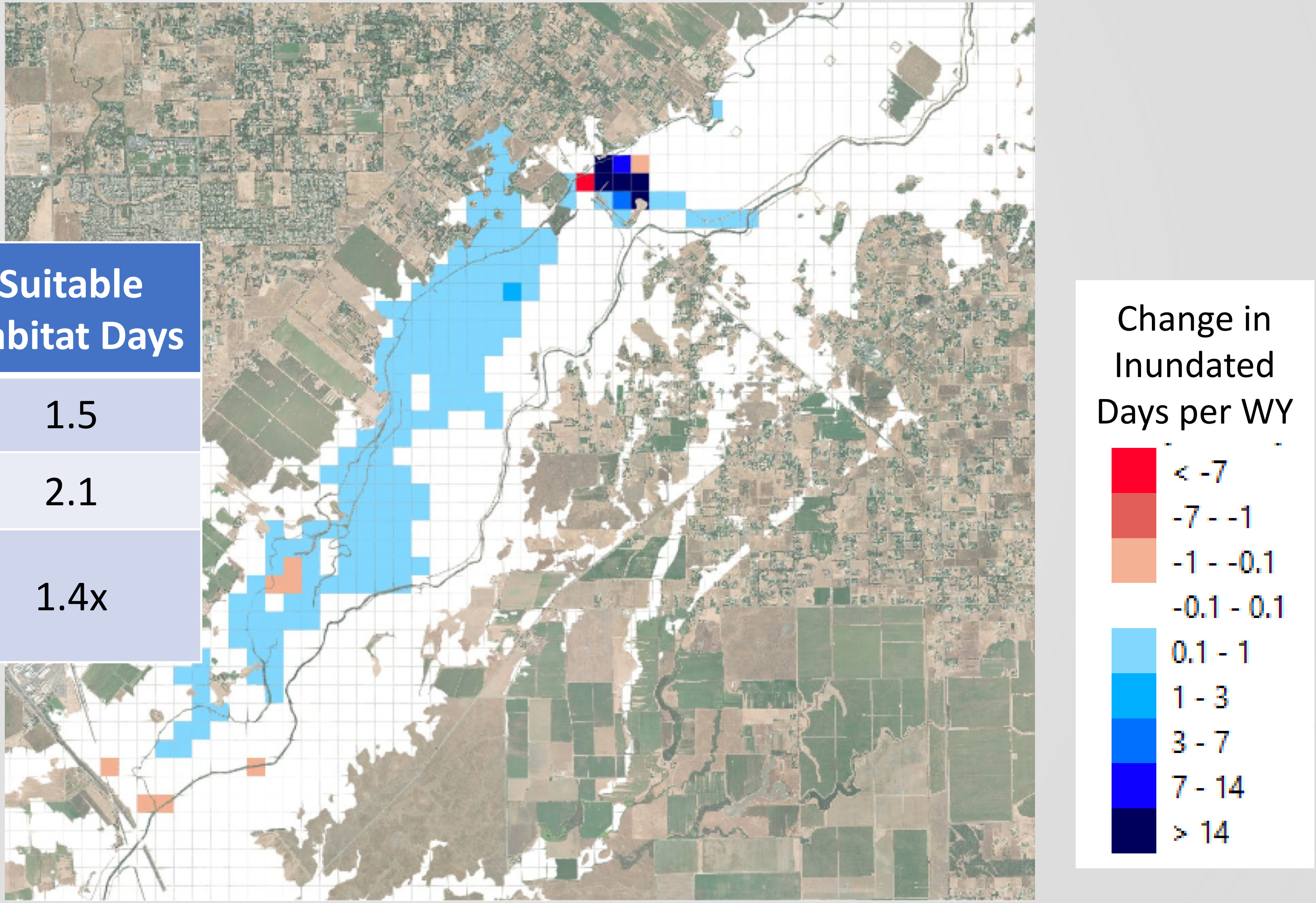
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	4.9
Project	8.6
Multiplier Difference	1.8x



Results

Hanford Gravel Min Grading Concept (Inundation/Habitat)

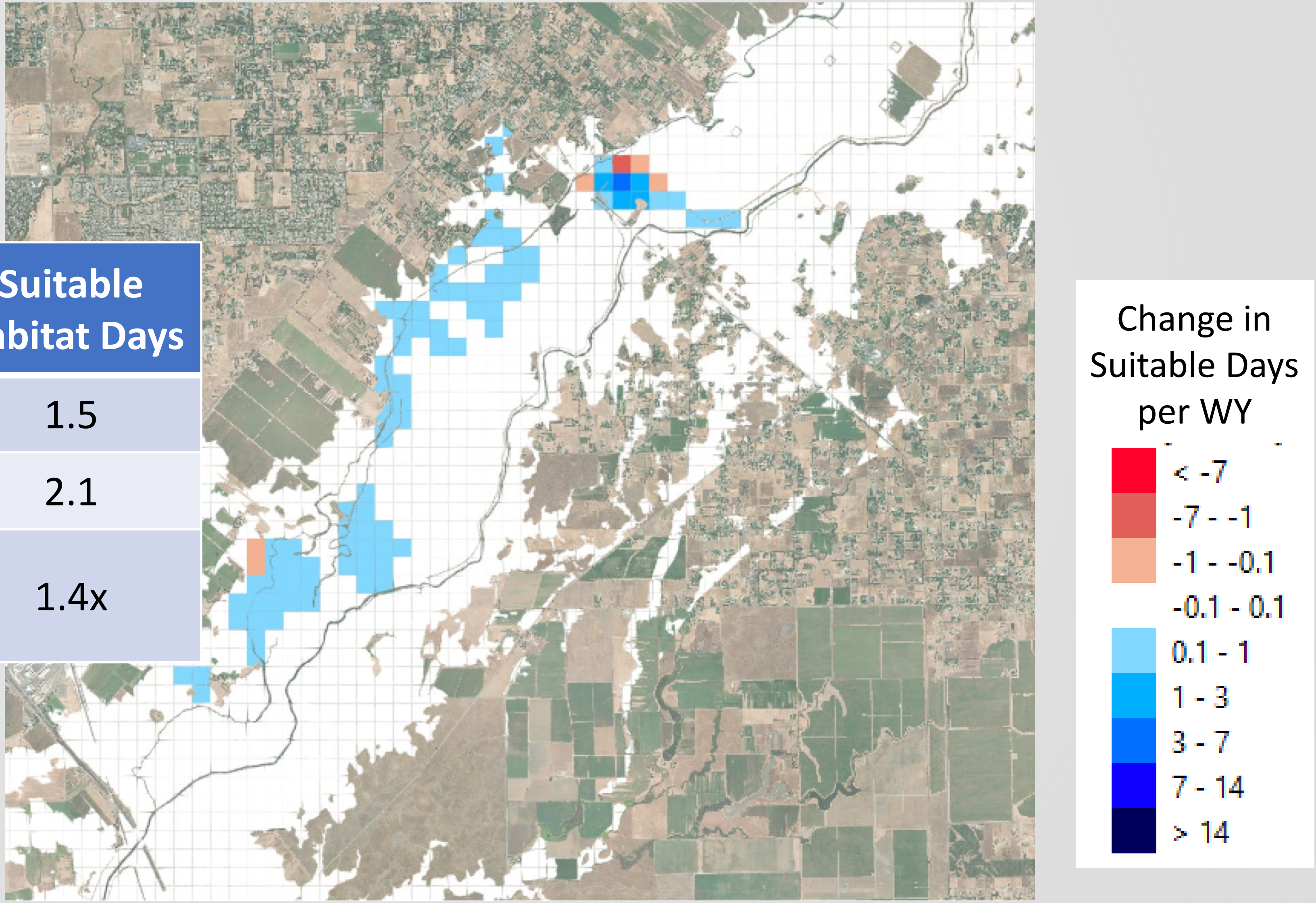
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	5.3	1.5
Project	15.9	2.1
Multiplier Difference	3.0x	1.4x



Results

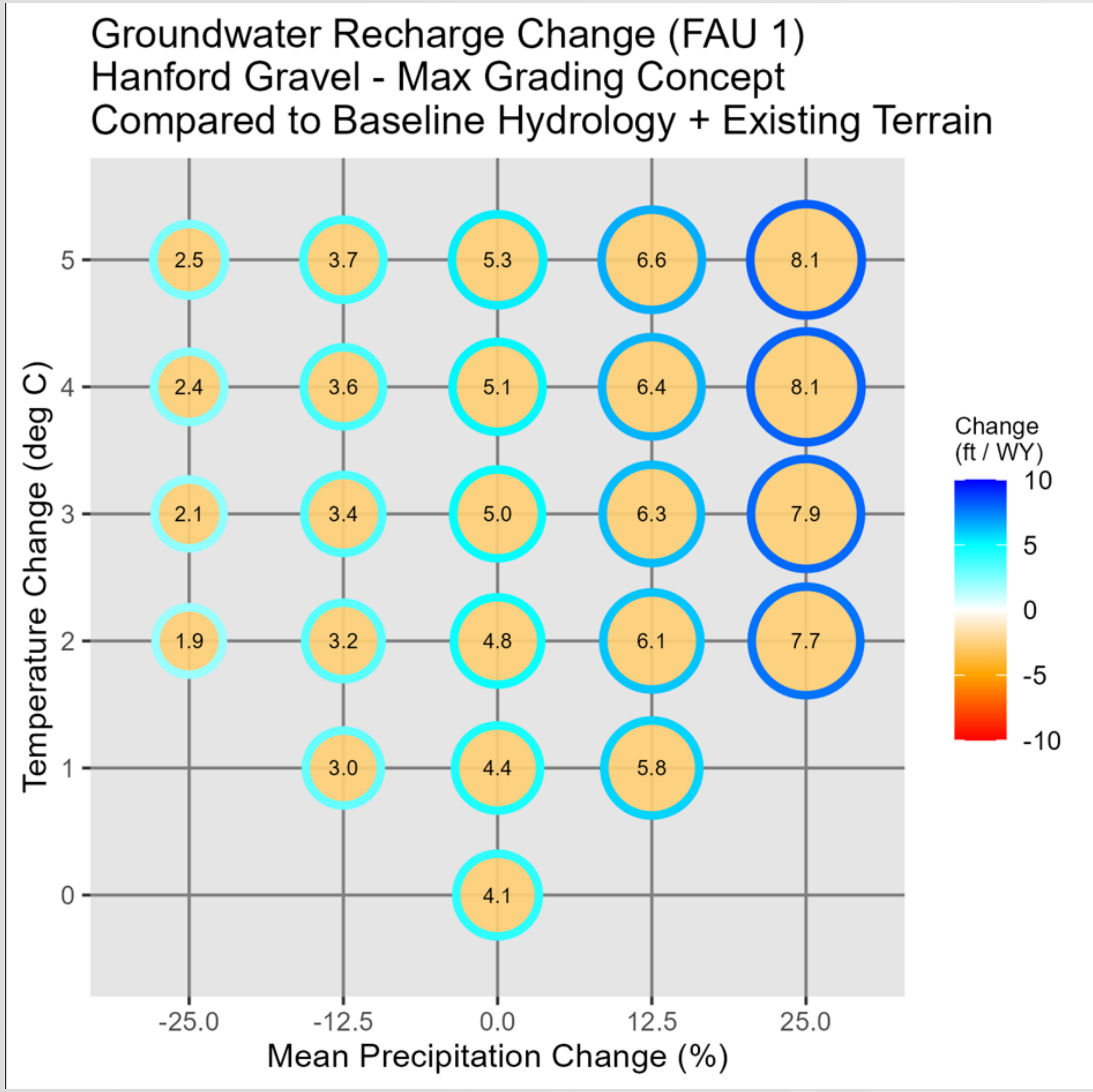
Hanford Gravel Min Grading Concept (Inundation/Habitat)

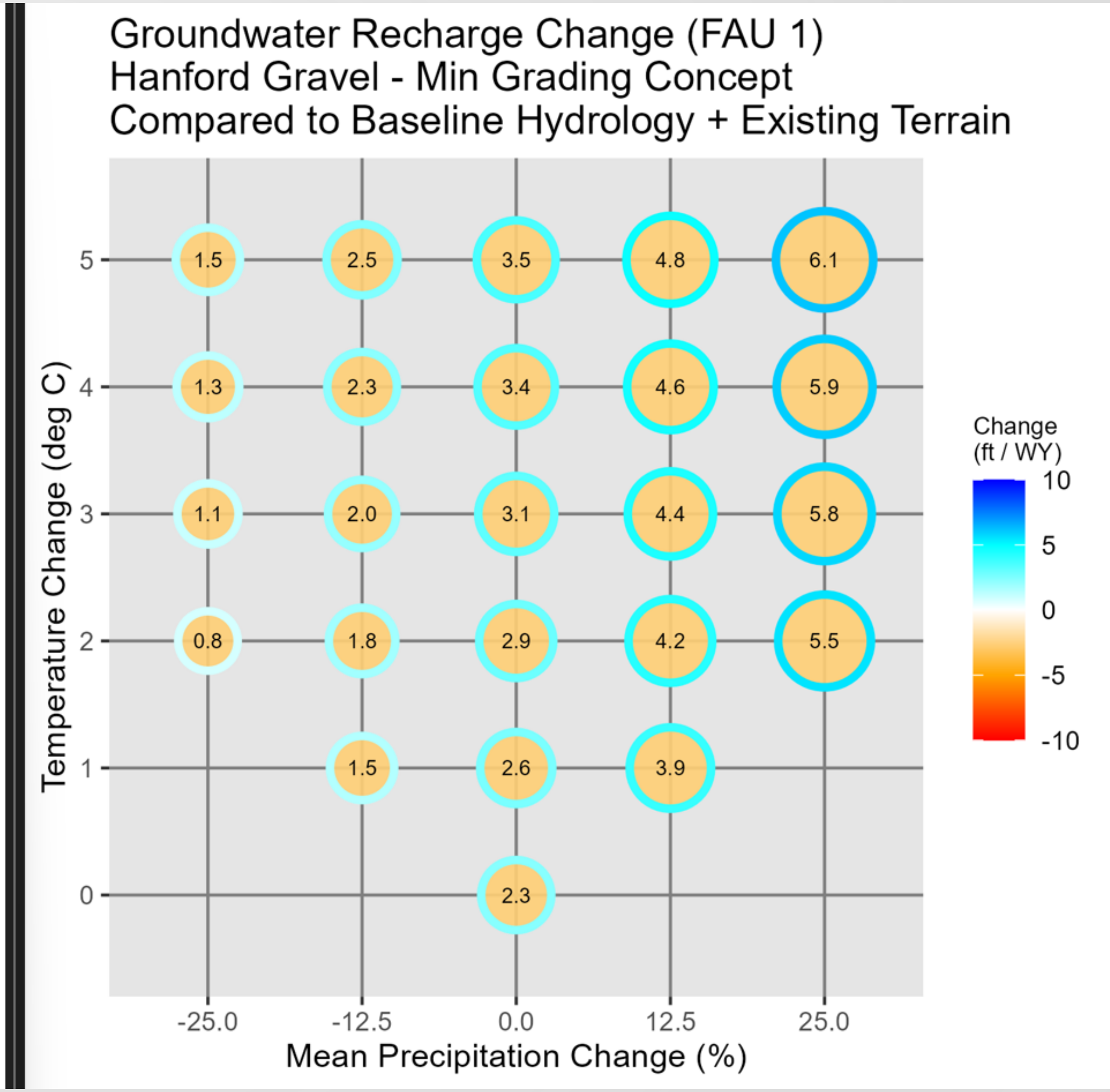
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	5.3	1.5
Project	15.9	2.1
Multiplier Difference	3.0x	1.4x



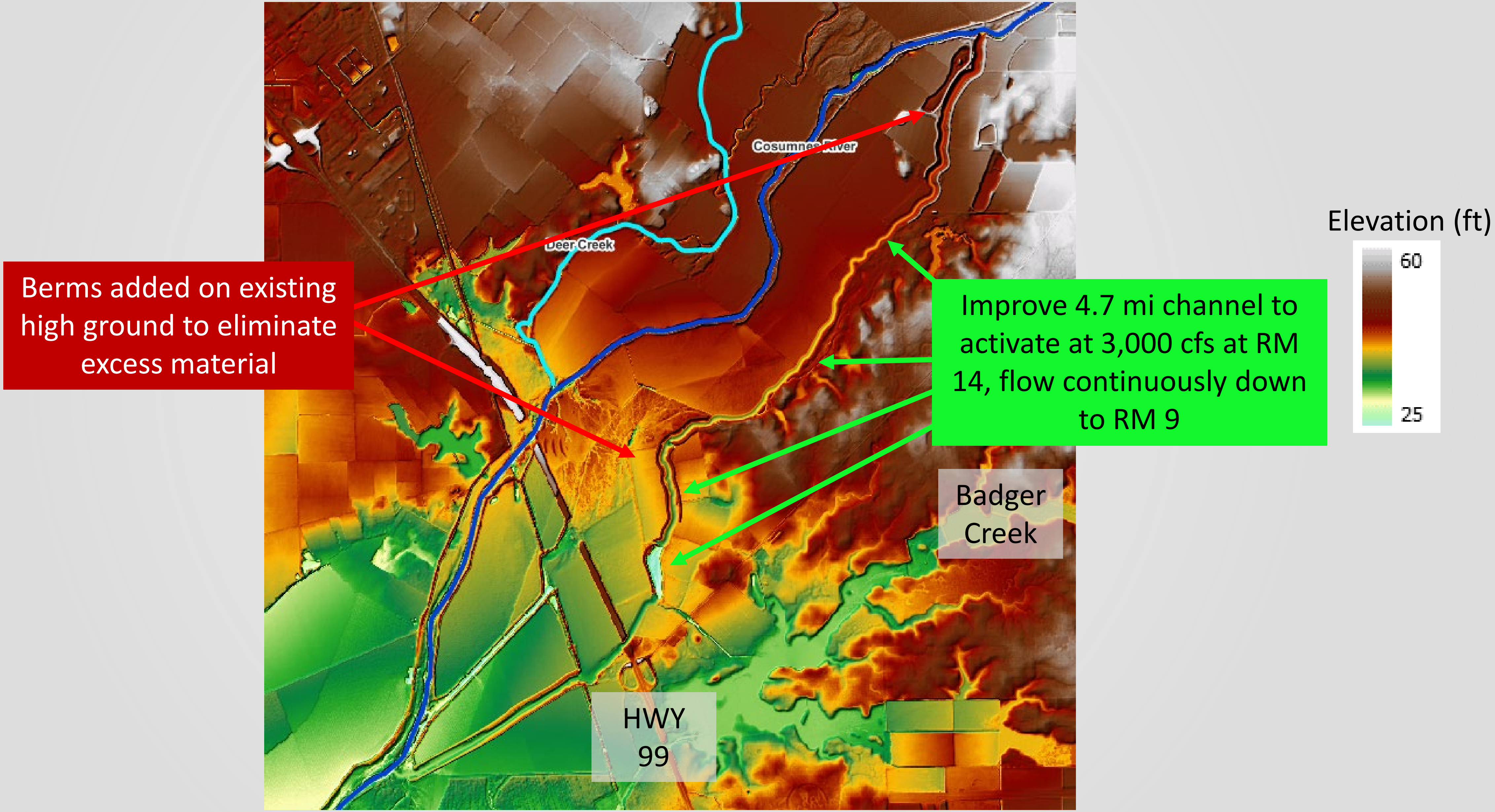
Climate Resiliency of Hanford Gravel Concepts

Groundwater Recharge Within Concept Footprint



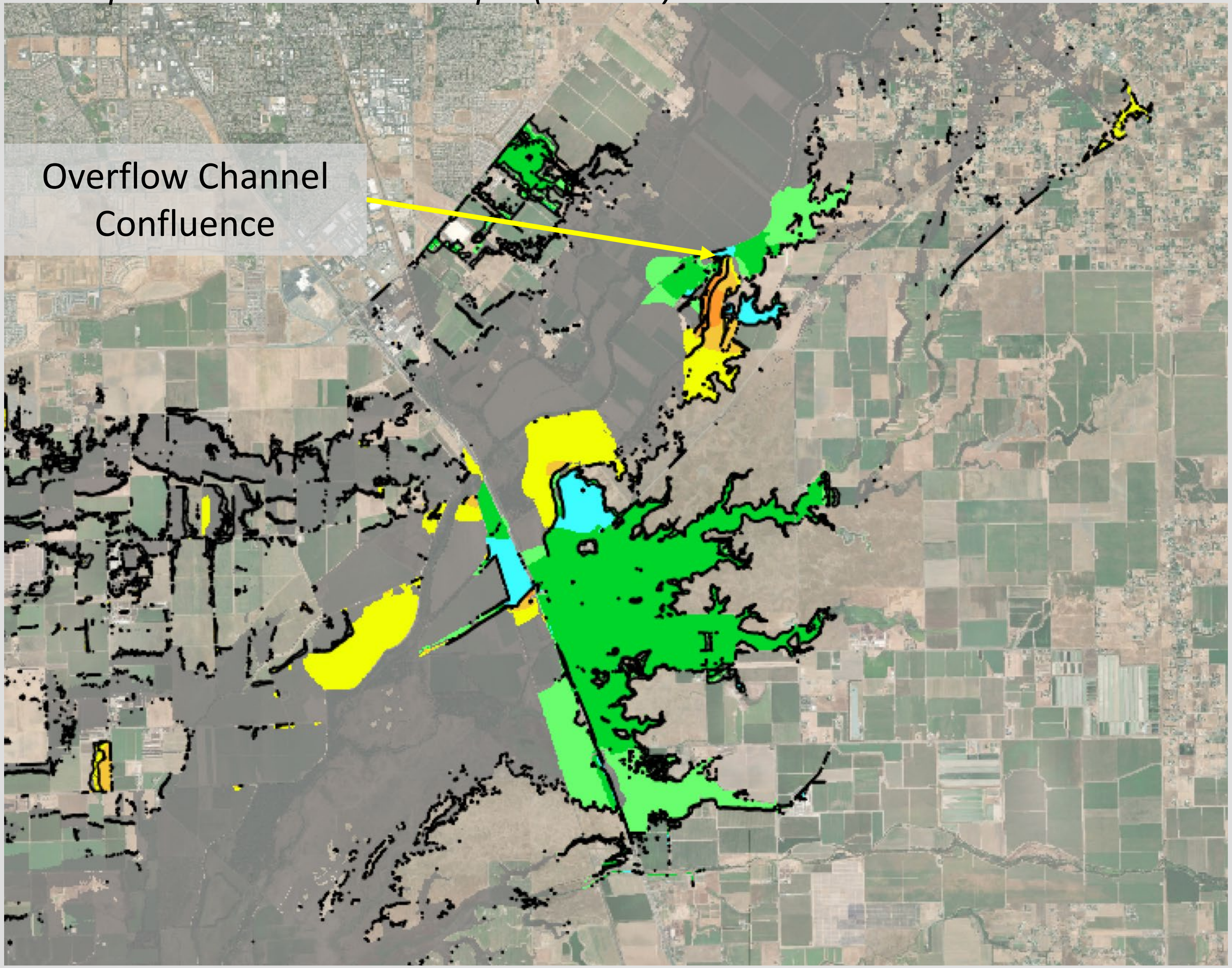


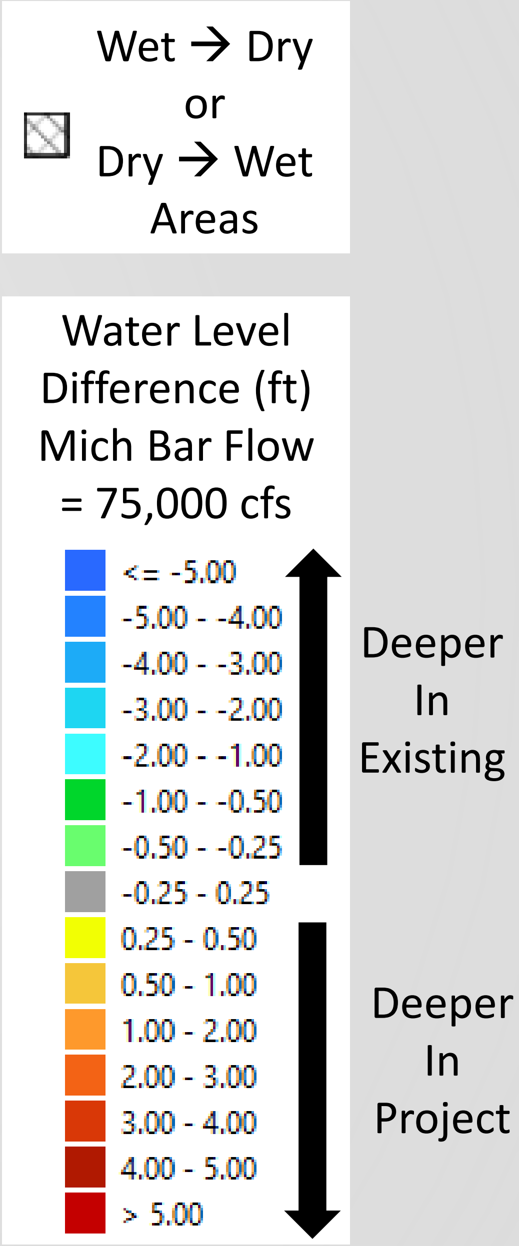
Site – Overflow Channel



Results

Overflow Channel Improvement Concept (Flood)

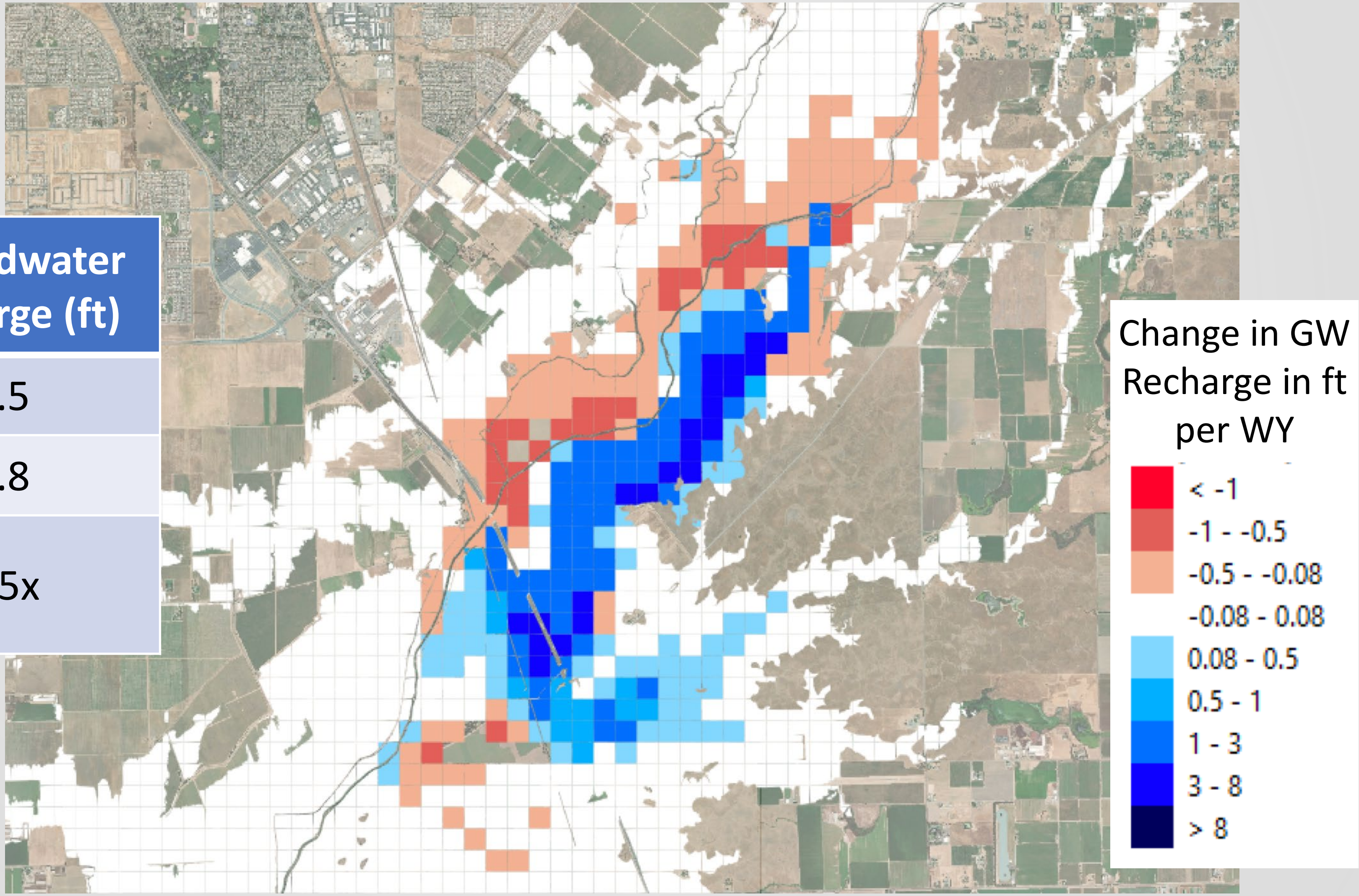




Results

Overflow Channel Improvement Concept (Groundwater Recharge)

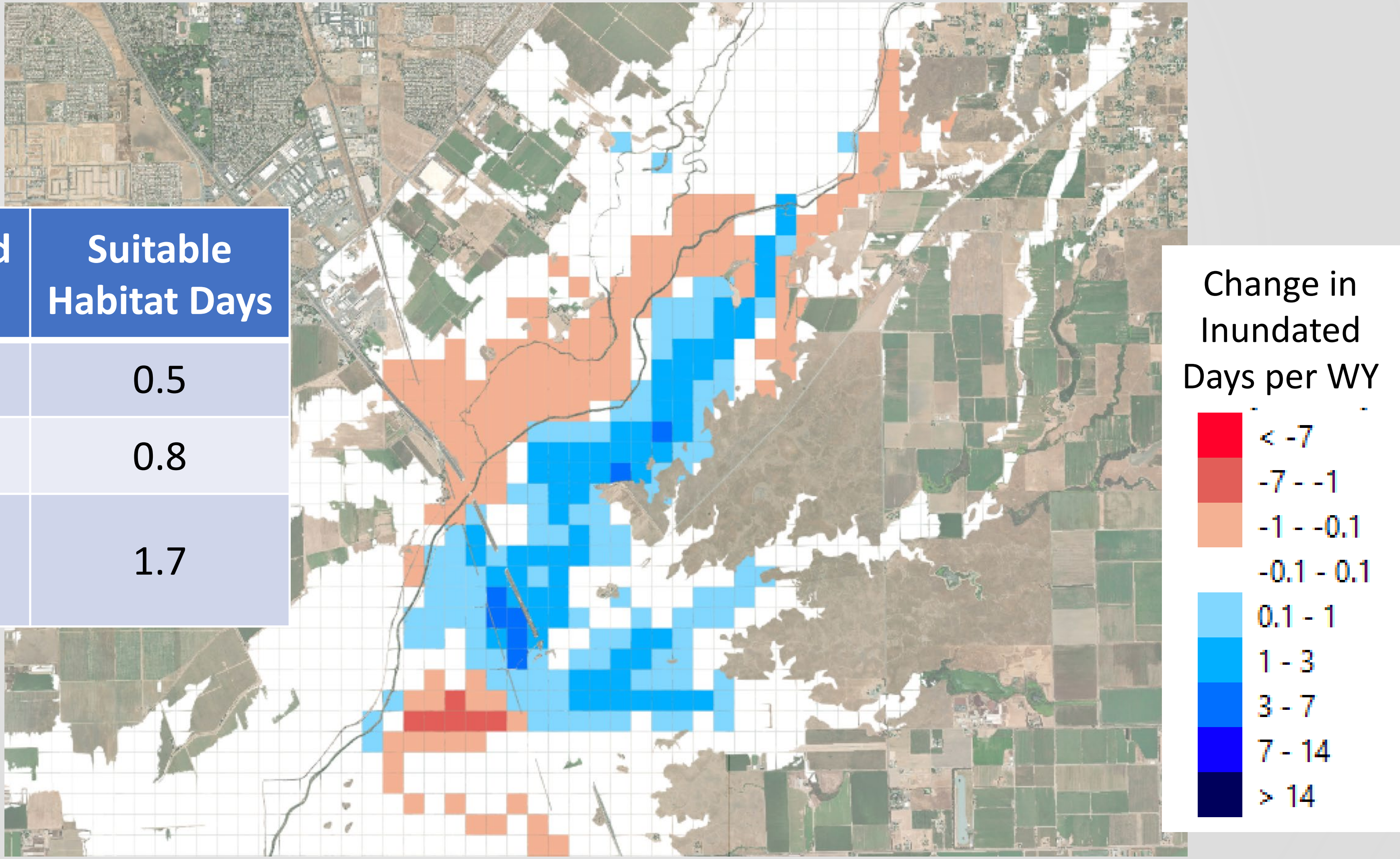
Metrics within Project Footprint	Groundwater Recharge (ft)
Existing	2.5
Project	3.8
Multiplier Difference	1.5x



Results

Overflow Channel Improvement Concept (Inundation/Habitat)

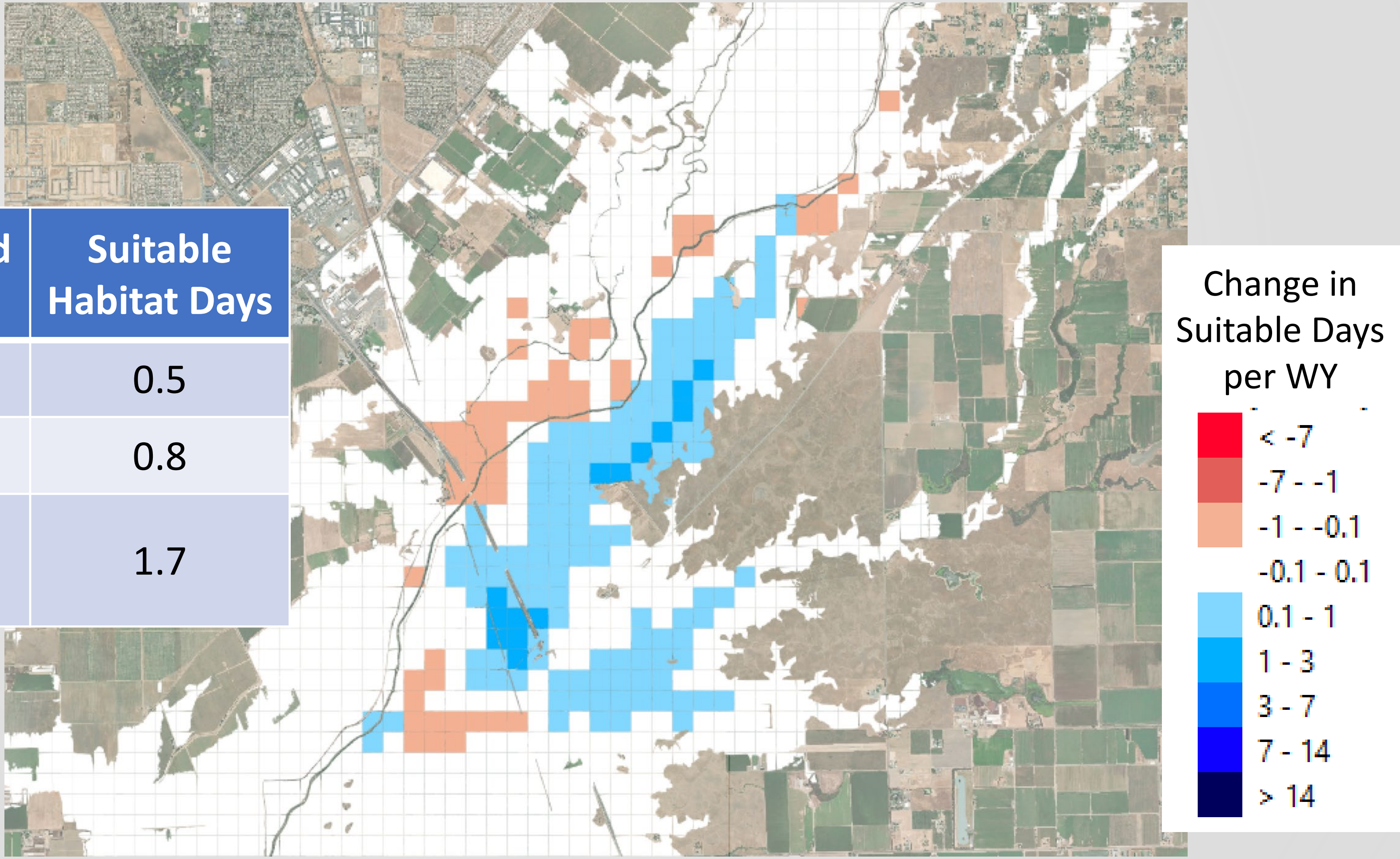
Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	1.2	0.5
Project	2.0	0.8
Multiplier Difference	1.5x	1.7



Results

Overflow Channel Improvement Concept (Inundation/Habitat)

Metrics within Project Footprint	Inundated Days	Suitable Habitat Days
Existing	1.2	0.5
Project	2.0	0.8
Multiplier Difference	1.5x	1.7



Section 3

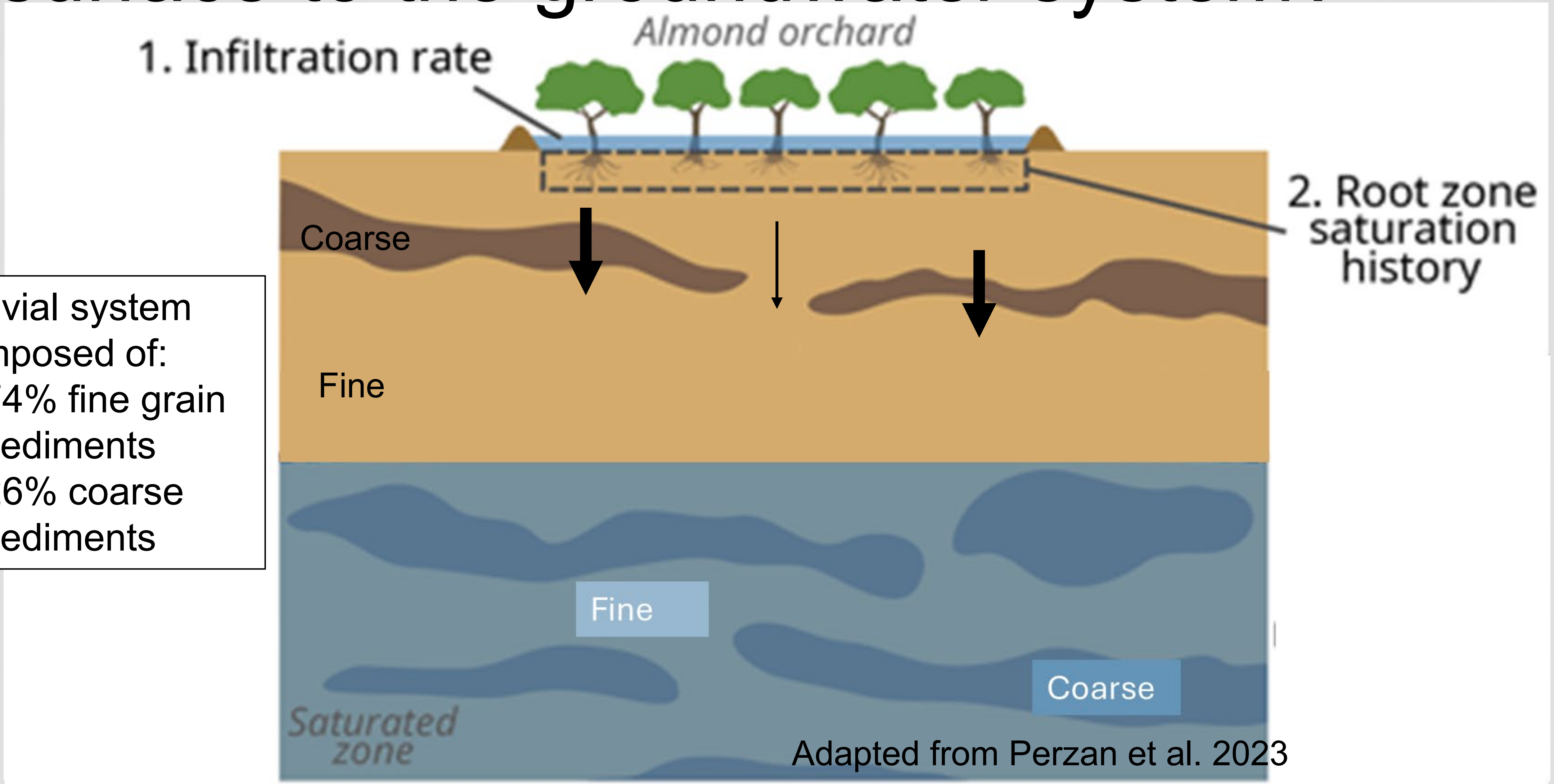
RESULTS

The EcoFIP Process

Cosumnes River corridor floodplain recharge conceptualization and MODFLOW model

RECHARGE AND GROUNDWATER MODEL BACKGROUND

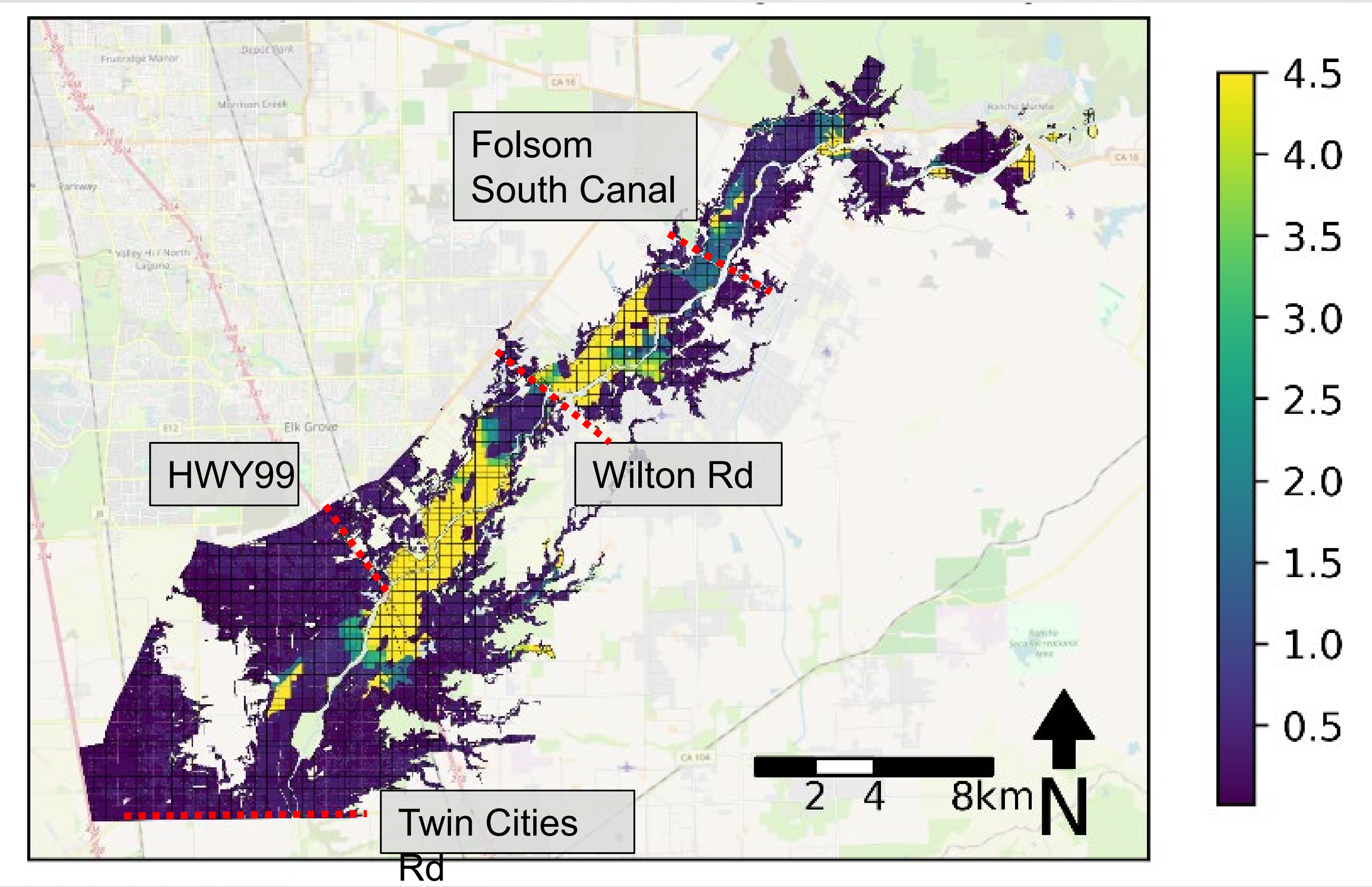
How does recharge move from the surface to the groundwater system?



Alluvial system composed of:
- 74% fine grain sediments
- 26% coarse sediments

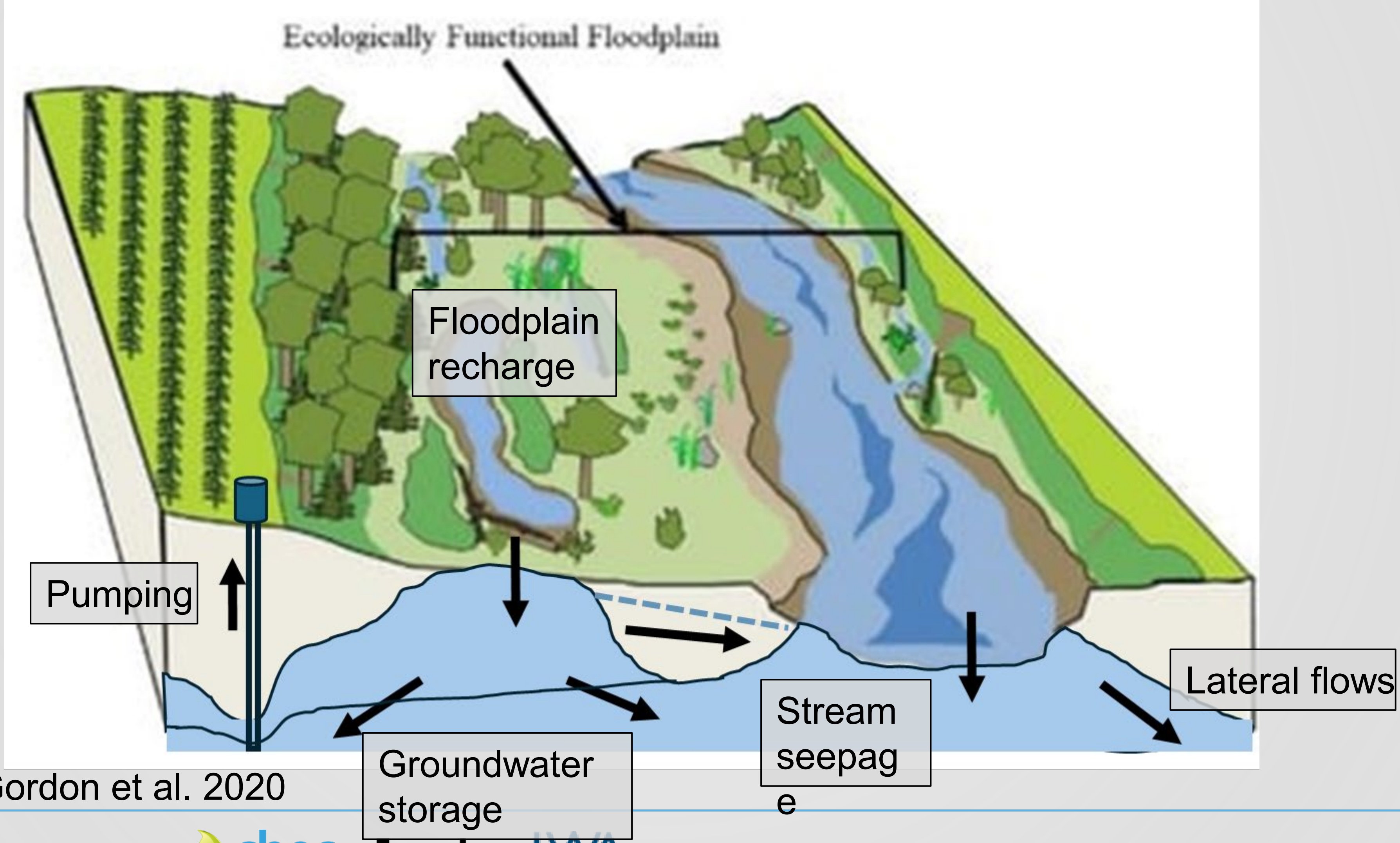
Adapted from Perzan et al. 2023

The minimum of soil and AEM conductivity gives the limiting recharge rate



Vertical conductivity (ft/day)

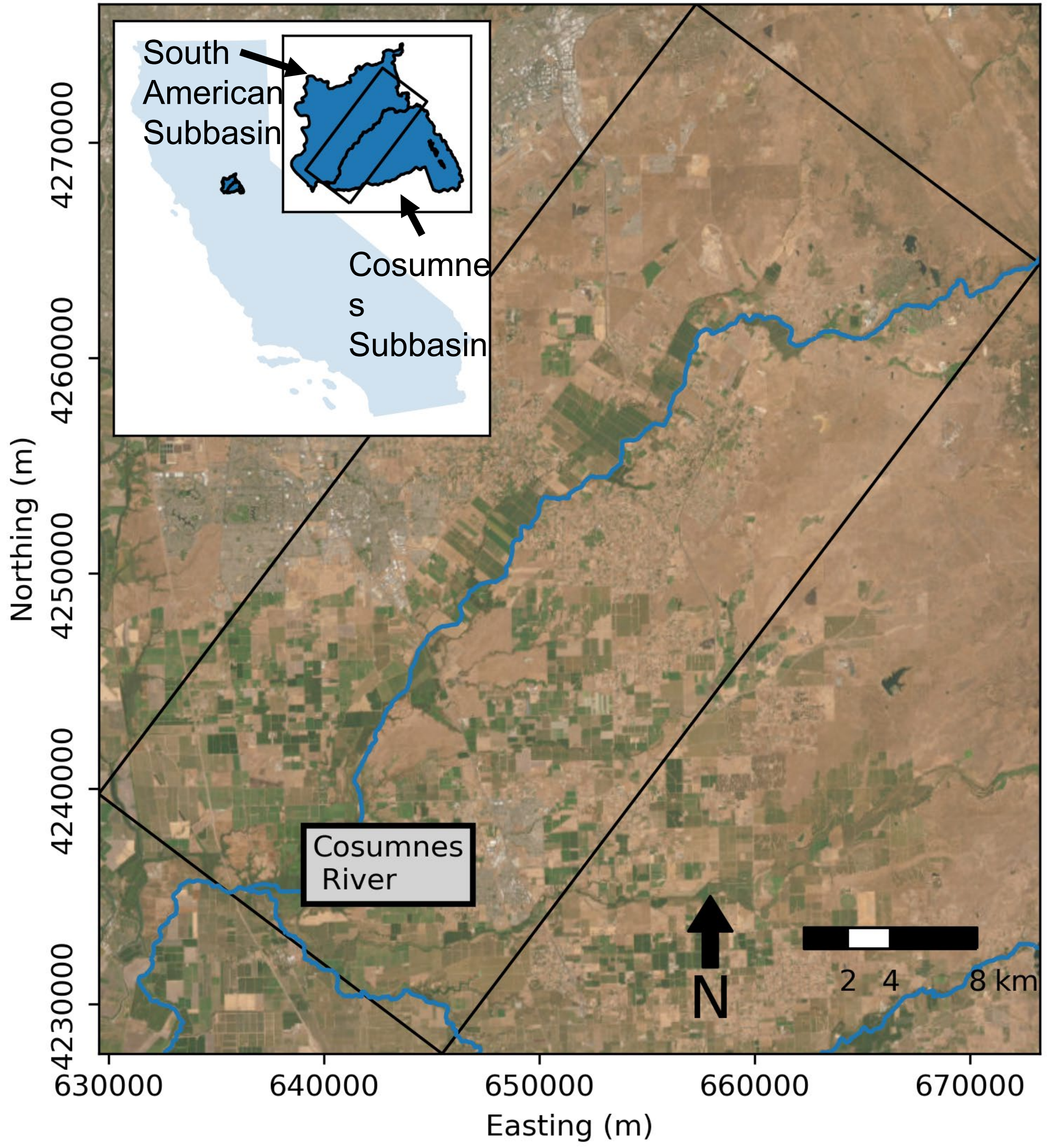
A groundwater model helps identify the impact of floodplain recharge on the system



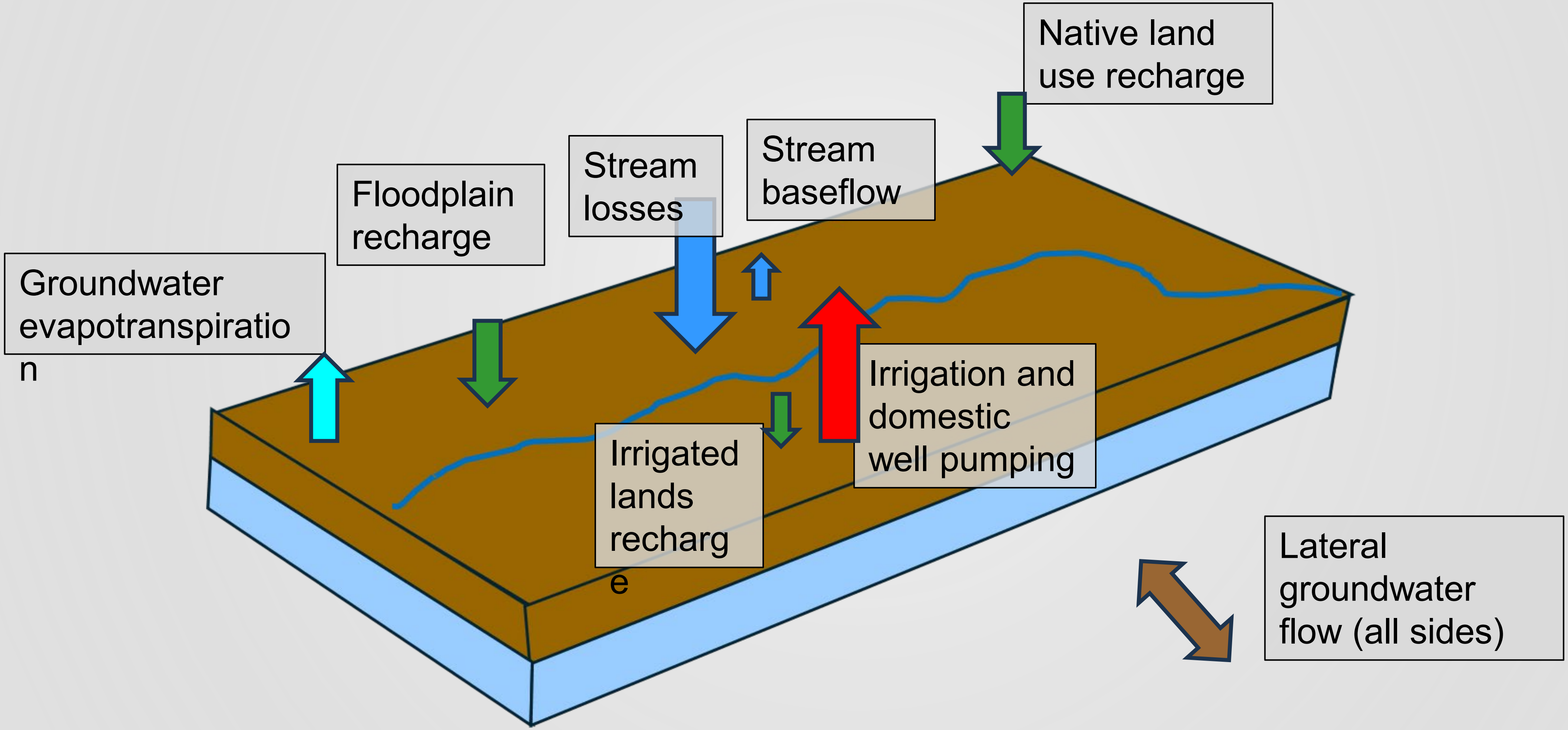
Adapted from Gordon et al. 2020

Groundwater Model Domain

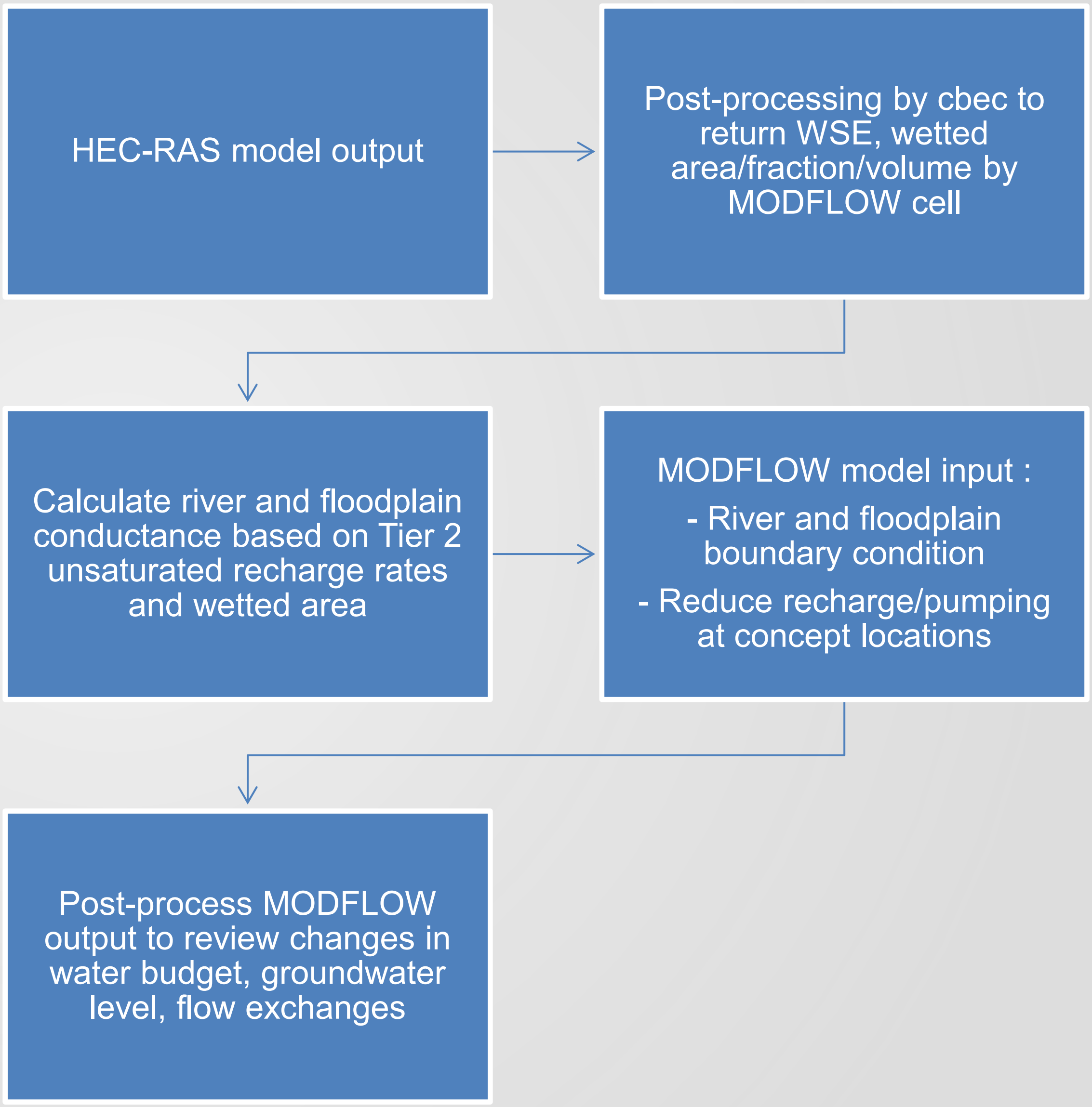
- Centered on the lower Cosumnes River
- Heterogeneous alluvial aquifer to represent variability in stream seepage across space
- Daily time steps to capture stream-aquifer exchange with simulation periods of 6-20 year for long-term effects

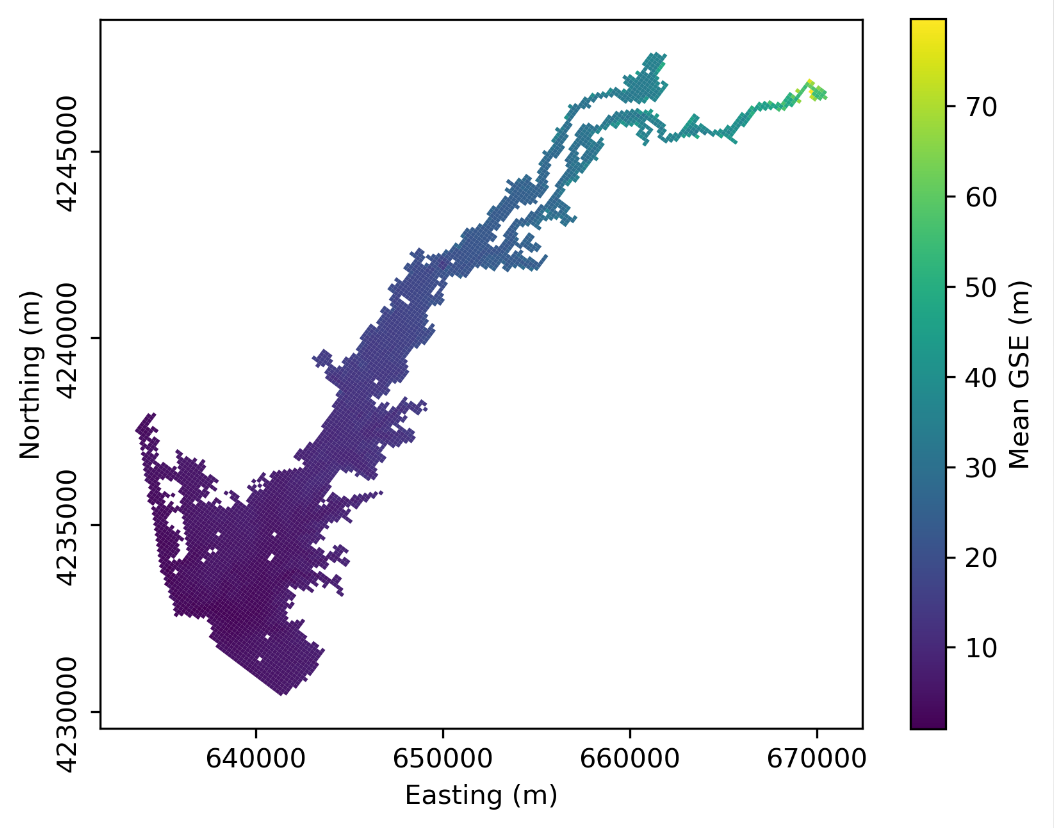


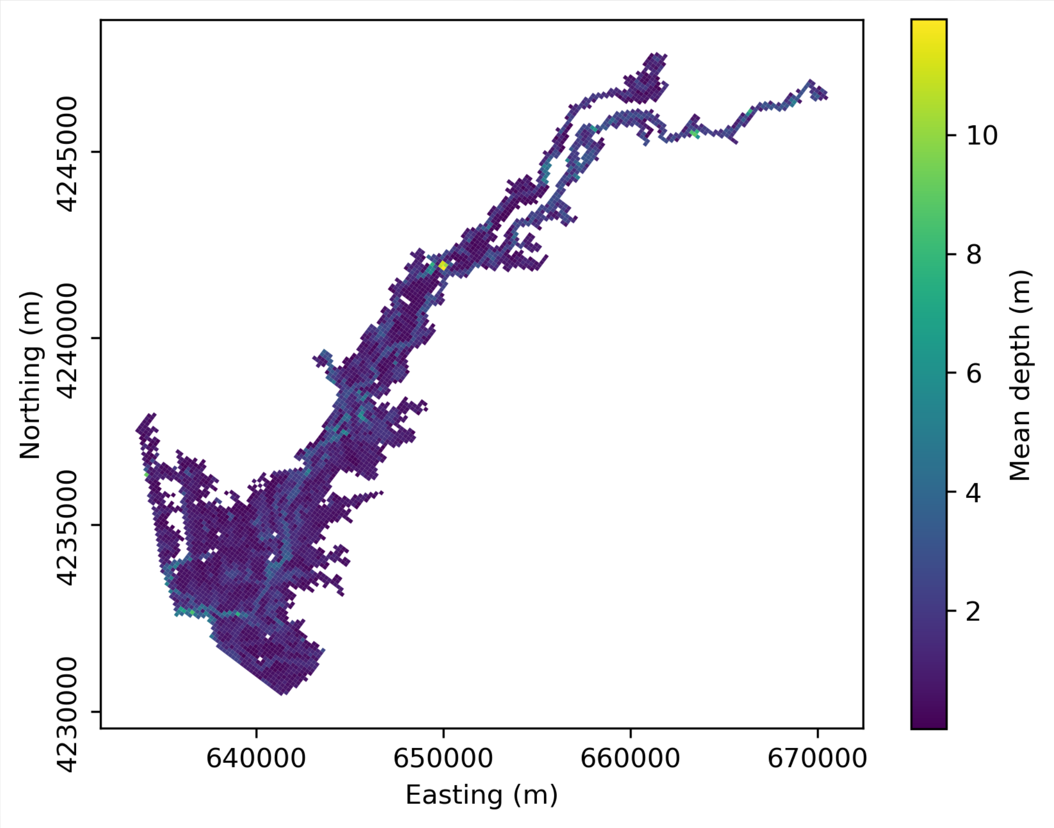
Groundwater Model Boundary Conditions



HEC-RAS to MODFLOW integration

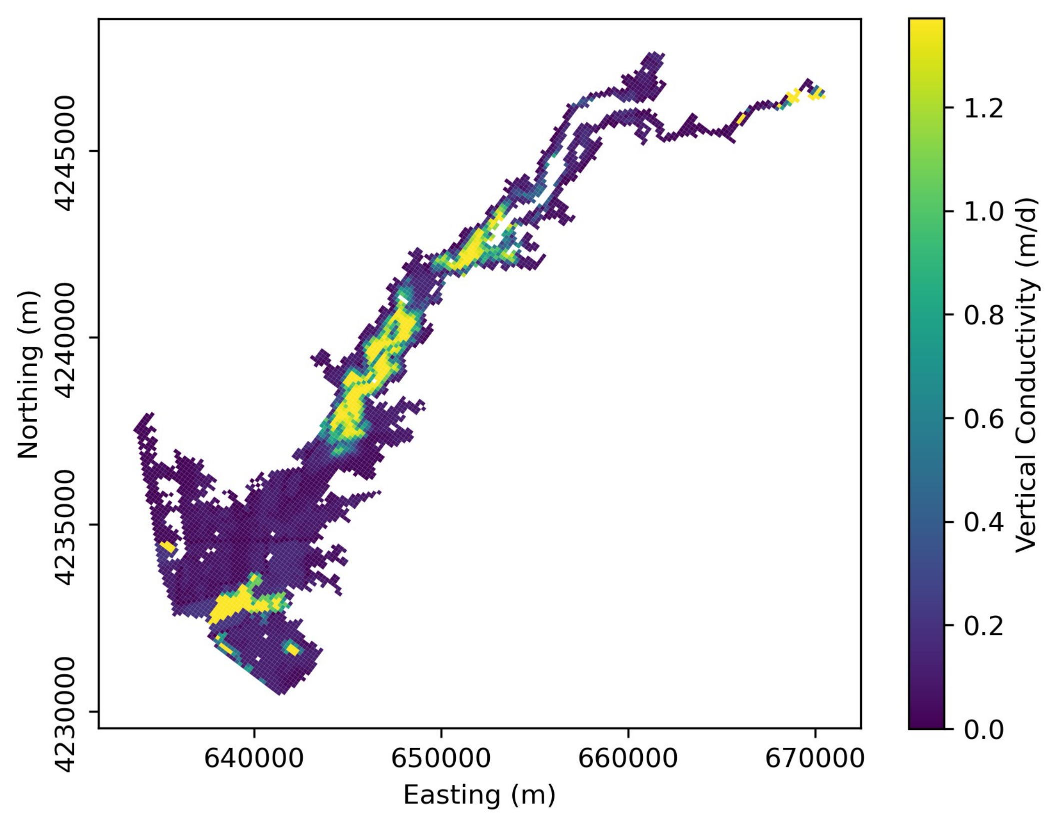


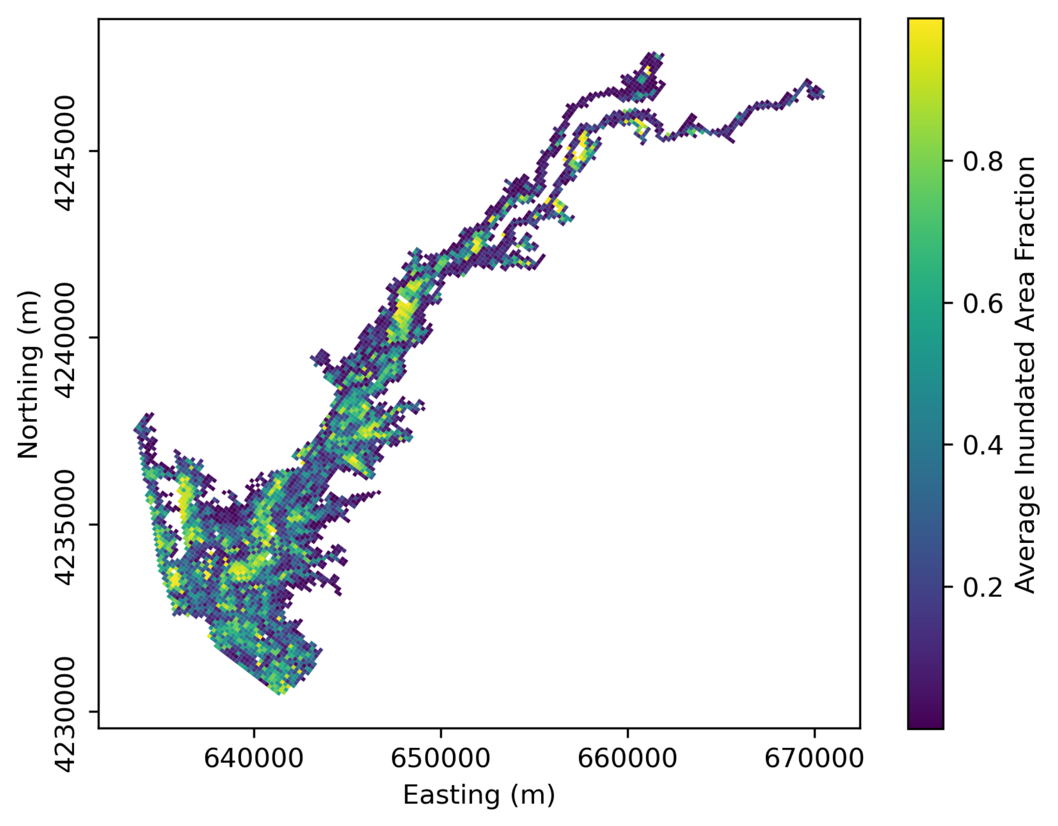




Elevation statistics from fine resolution DEM inform the floodplain and river bottom elevations

Water surface elevation from HEC-RAS informs stream stage that controls hydraulic gradient





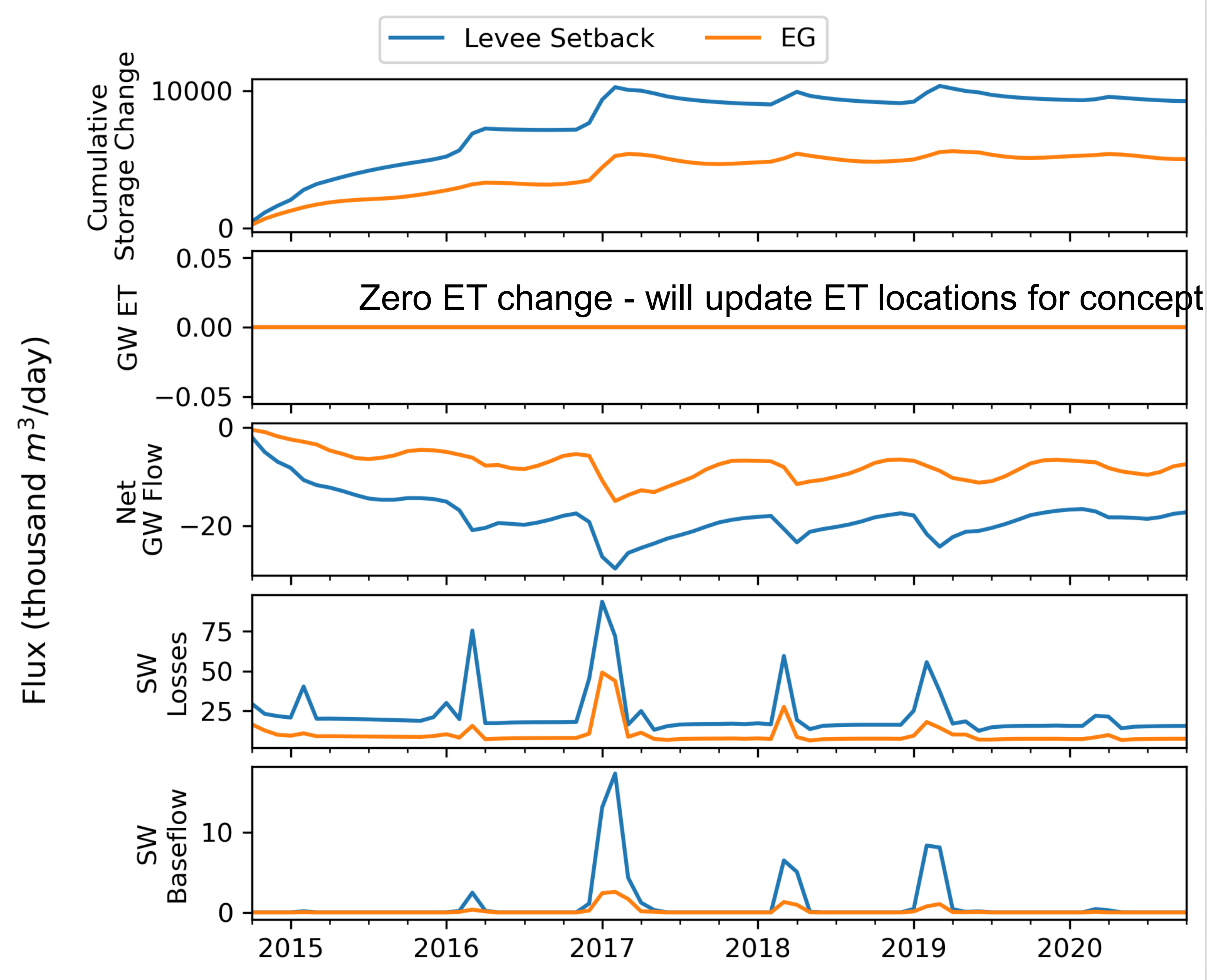
Vertical conductivity informed by Tier 2 unsaturated recharge rates

Wetted area from HEC-RAS is multiplied by vertical conductivity to calculate the conductance

Comparison of Existing Grade (EG) and Levee Setback to determine the impact of changing inundation depth and spatial extent

PRELIMINARY GROUNDWATER MODEL CONCEPT RESULTS

Locally we see increased floodplain + stream recharge increases groundwater storage and baseflow



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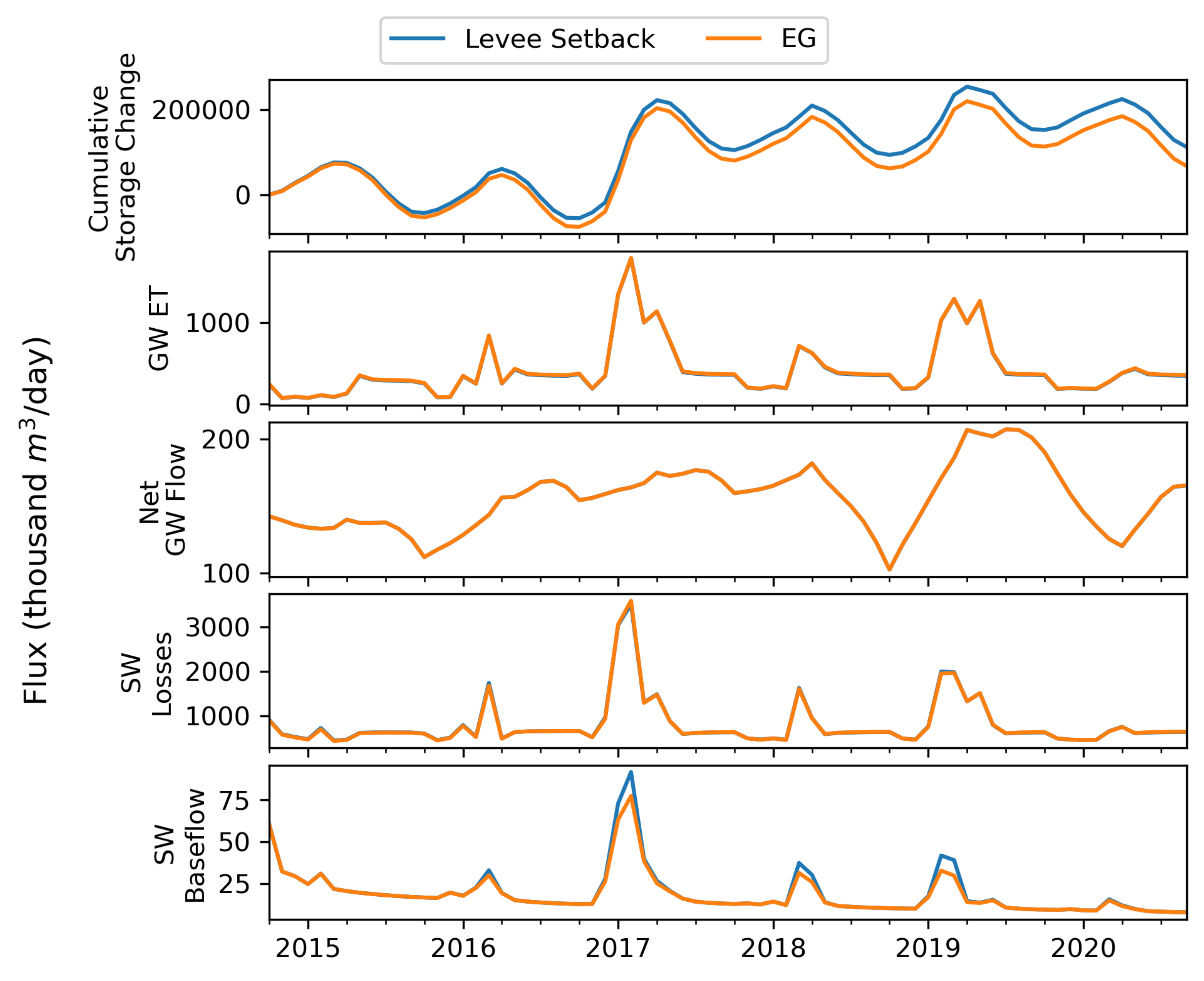
The impacts are dampened on a domain scale but there are still increases in groundwater storage and baseflow



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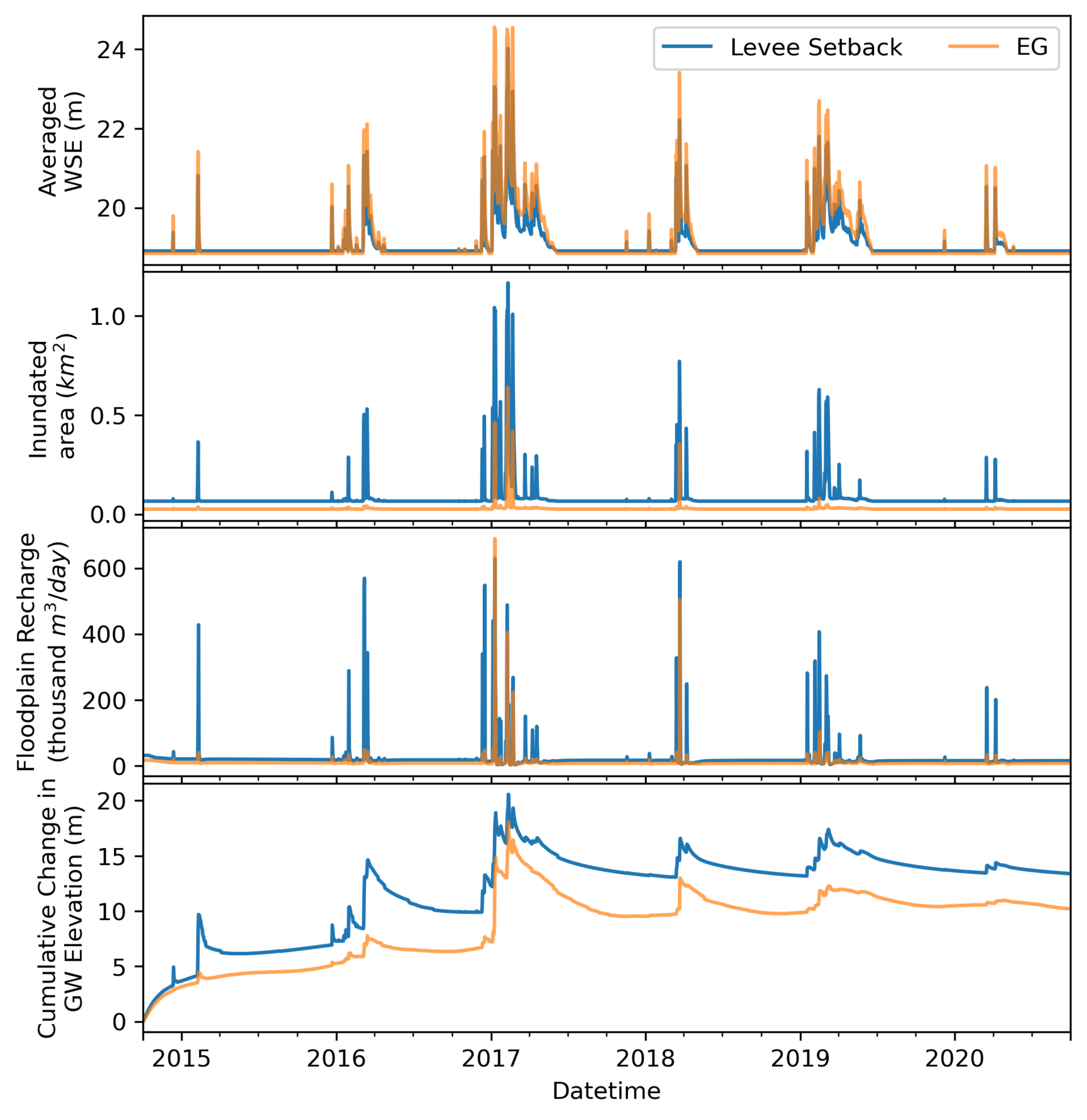
Concept area increases in inundated area, with reduced WSE, increase floodplain recharge leading to elevated groundwater levels



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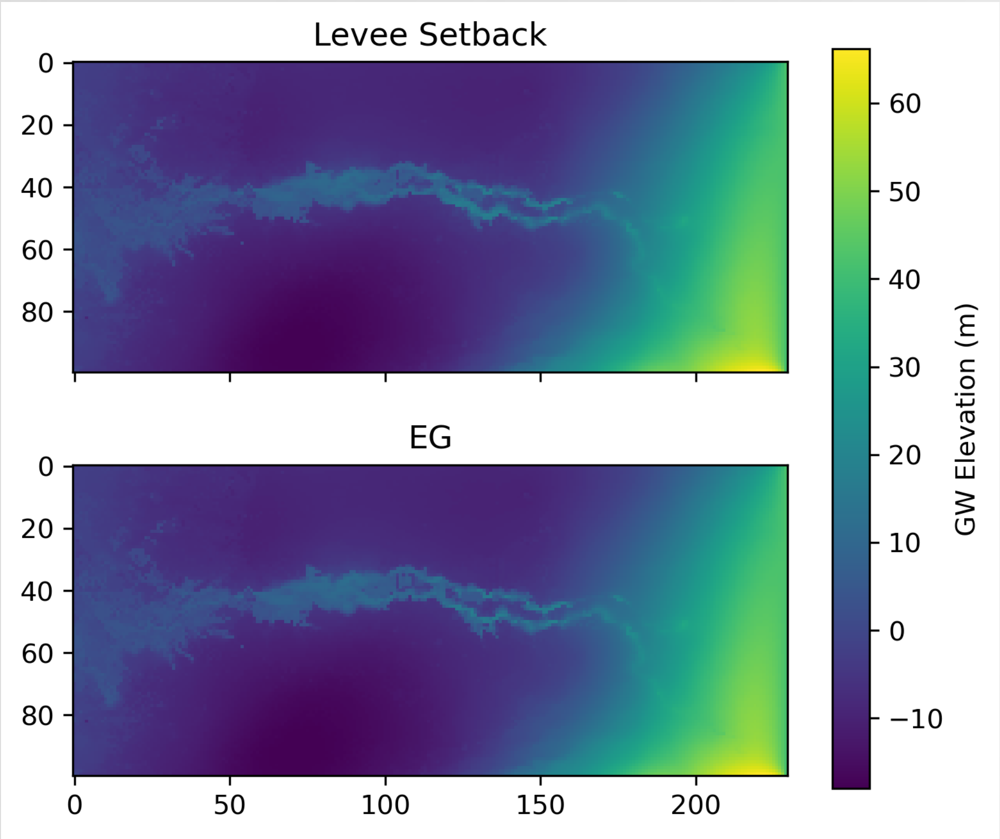
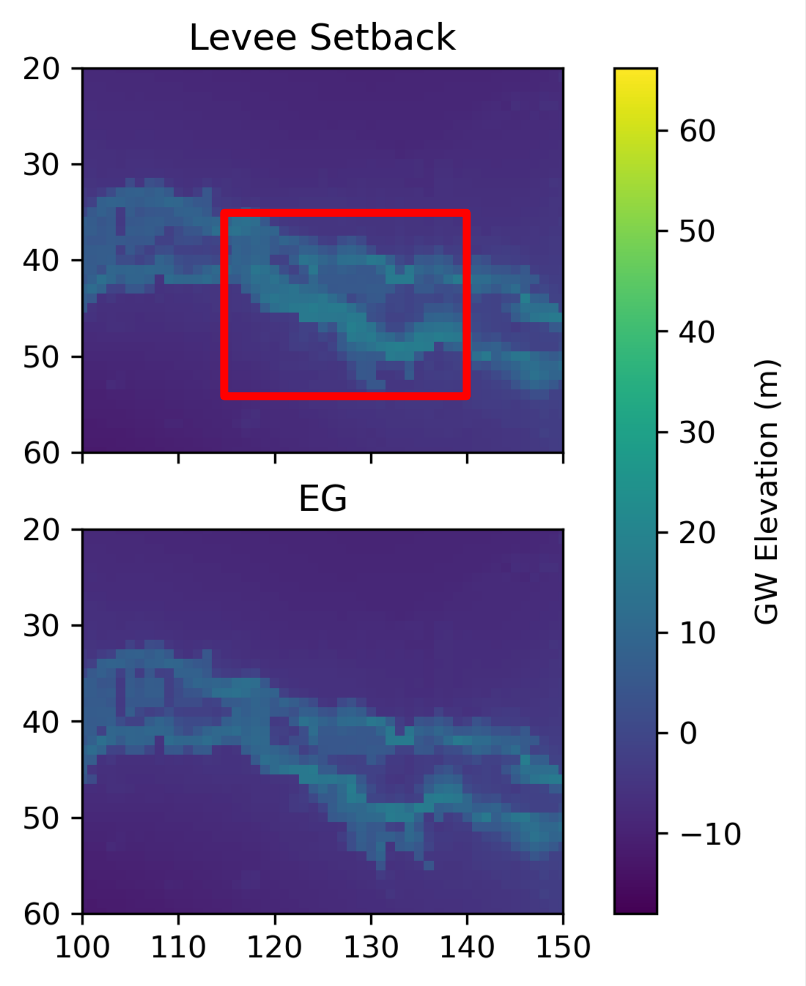
System wide groundwater elevation patterns remain constant with site specific increases





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Groundwater Model Integration Next Steps

- Revise MODFLOW ET input to cover concept areas to represent potential restoration
- Apply modeling framework to additional concepts for groundwater recharge
- Run 20-year simulations to evaluate long-term impacts

Section 4

NEXT STEPS

Next Steps and Potential Areas of Interest and Alignment

- Development of Cosumnes Study StoryMap
- Study findings are as follows:
  - Sacramento County and OHWD both using DWR study to leverage federal funding
  - Sacramento County working on watershed plan, with focus on flood risk reduction
  - OHWD continuing and expanding GW recharge efforts, and developing concepts for Blodgett Dam area
  - Wilton Rancheria exploring multi-benefit projects at Hanford Gravel site
  - Regional Water Authority recipient of DWR Watershed Resilience Program grant
  - Study team noted lack of gage information on Deer Creek as study gap

    OHWD, Sloughhouse RCD, and TNC identified several new stream gage needs on Deer and Laguna creeks and Cosumnes River through DWR's Stream Gage Improvement Program