Mill Creek
Flow Availability Analysis for Streamflow Enhancement Planning

December 2, 2020

Matt O'Connor, PhD, CEG
Jeremy Kobor, MS, PG

SONOMA RESOURCE CONSERVATION DISTRICT

COAST RANGE WATERSHED INSTITUTE

TROUT UNLIMITED

O E I

Agenda

- Project Goals/Approach
- Model Development & Calibration
- Existing Hydrologic Conditions
- Existing Salmonid Habitat Conditions
- Scenario Analysis
- Key Findings & Conclusions

Goals/Approach Overview

- 3-yr project funded by the Wildlife Conservation Board's Streamflow Enhancement Grant Program
- Numerical Hydrologic Model ≈ Management Tool
  - Data synthesis and comprehensive description of hydrologic conditions and processes
- Utilize hydrologic simulation model to:
  - Predict location and quantity of surface flows relative to salmonid requirements under different climate conditions
  - Evaluate cumulative effects of land and water use on stream flow
  - Prioritize reaches for restoration based on flow availability-based habitat indices
  - Predict effectiveness of strategies to maintain/enhance stream flow & evaluate climate change impacts

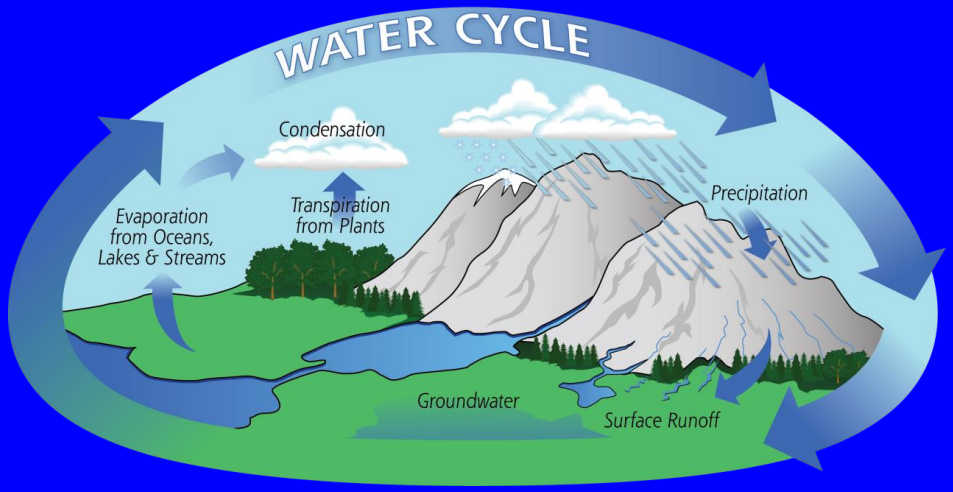
Model Overview

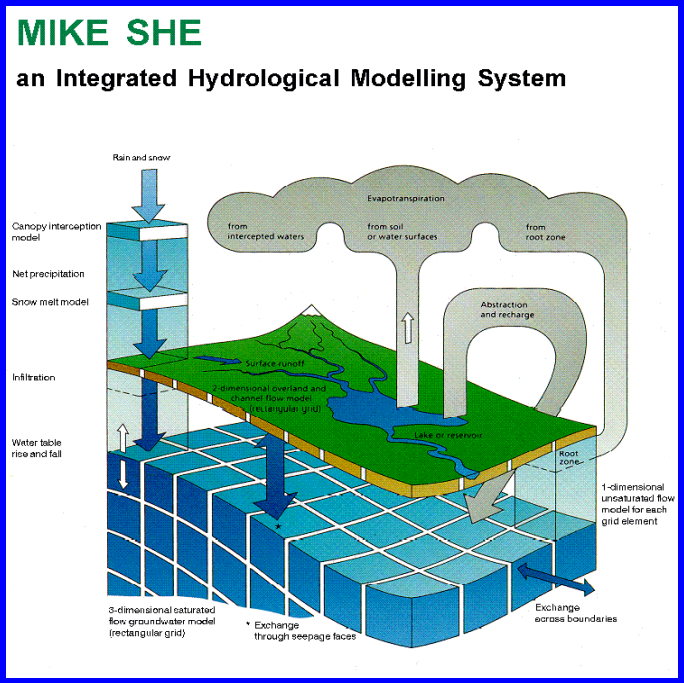
Natural Processes

Precipitation
Evapotranspiration
Runoff
Soil Moisture
Groundwater
Streams

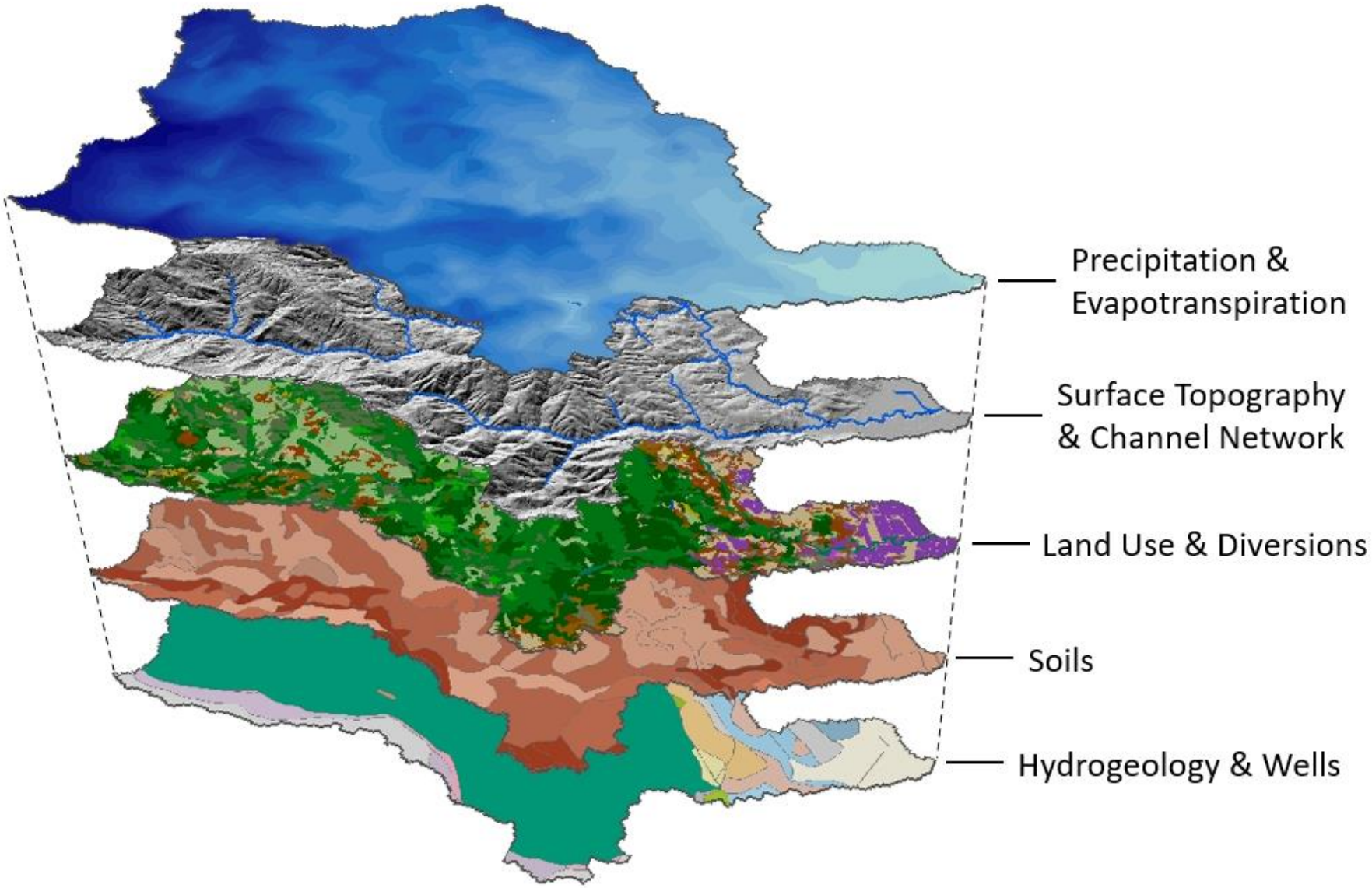
Man-made Influences

Irrigation
Wells
Ponds
Diversions

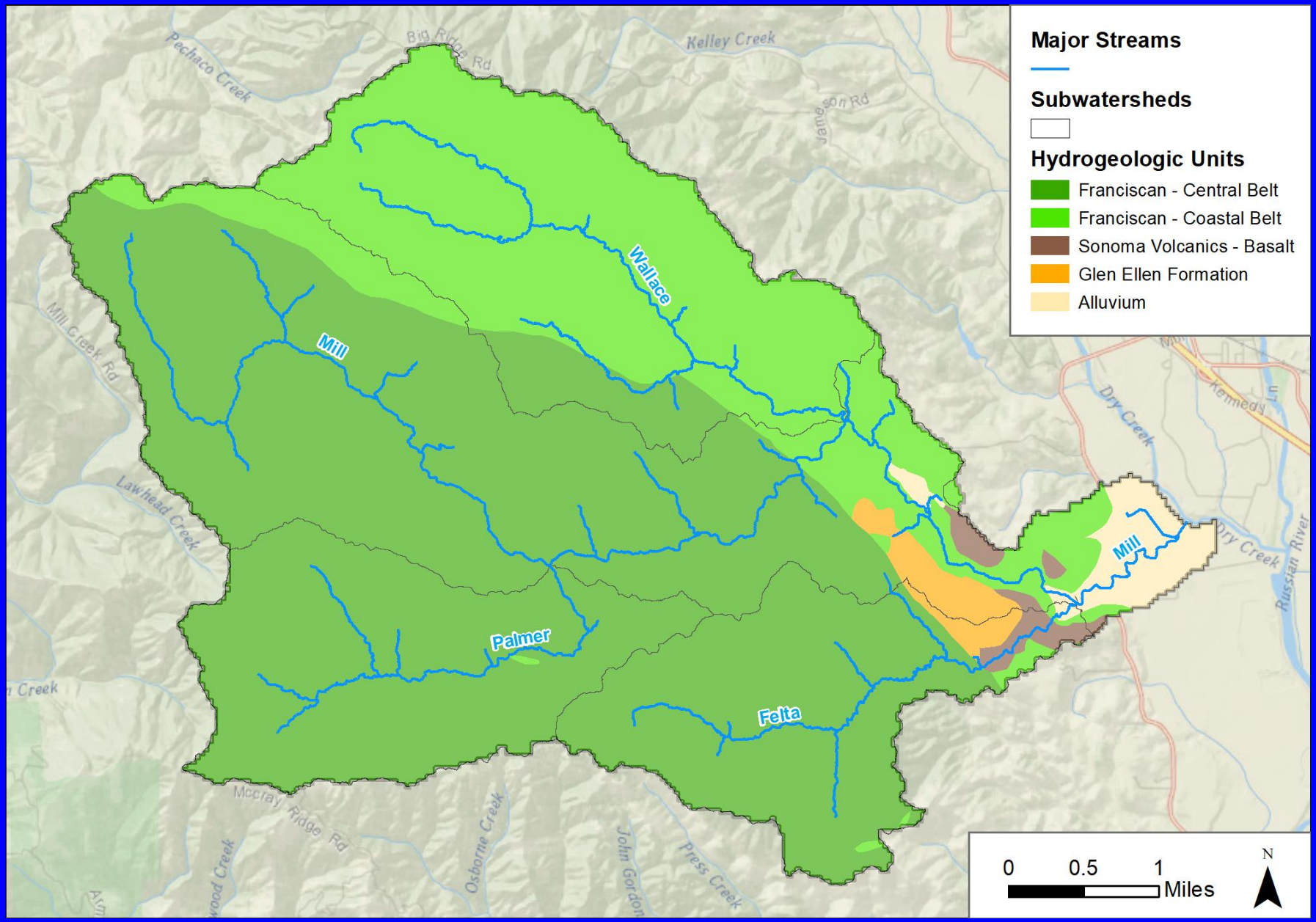




Model Development

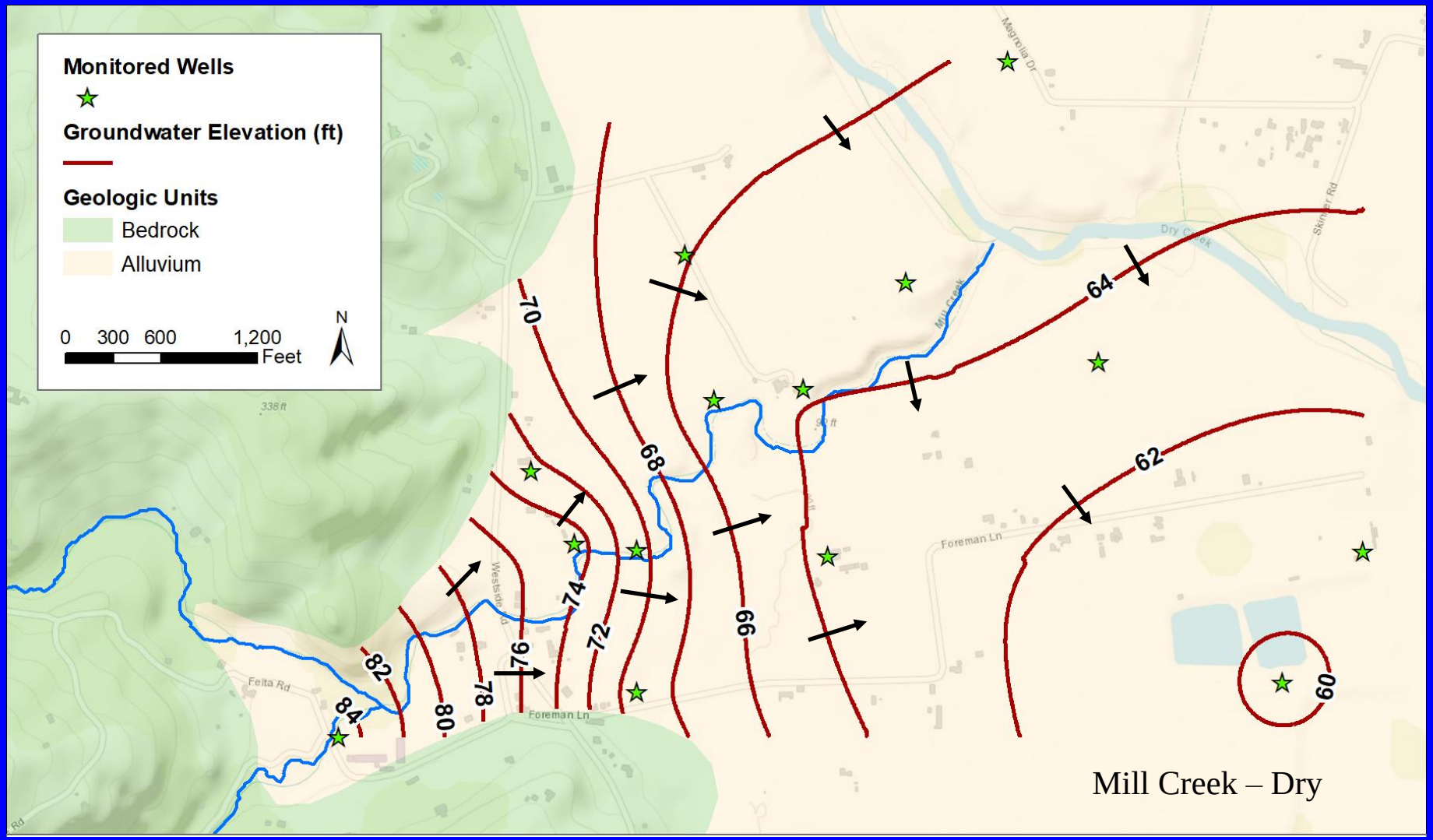


Mill Creek Watersheds & Geology

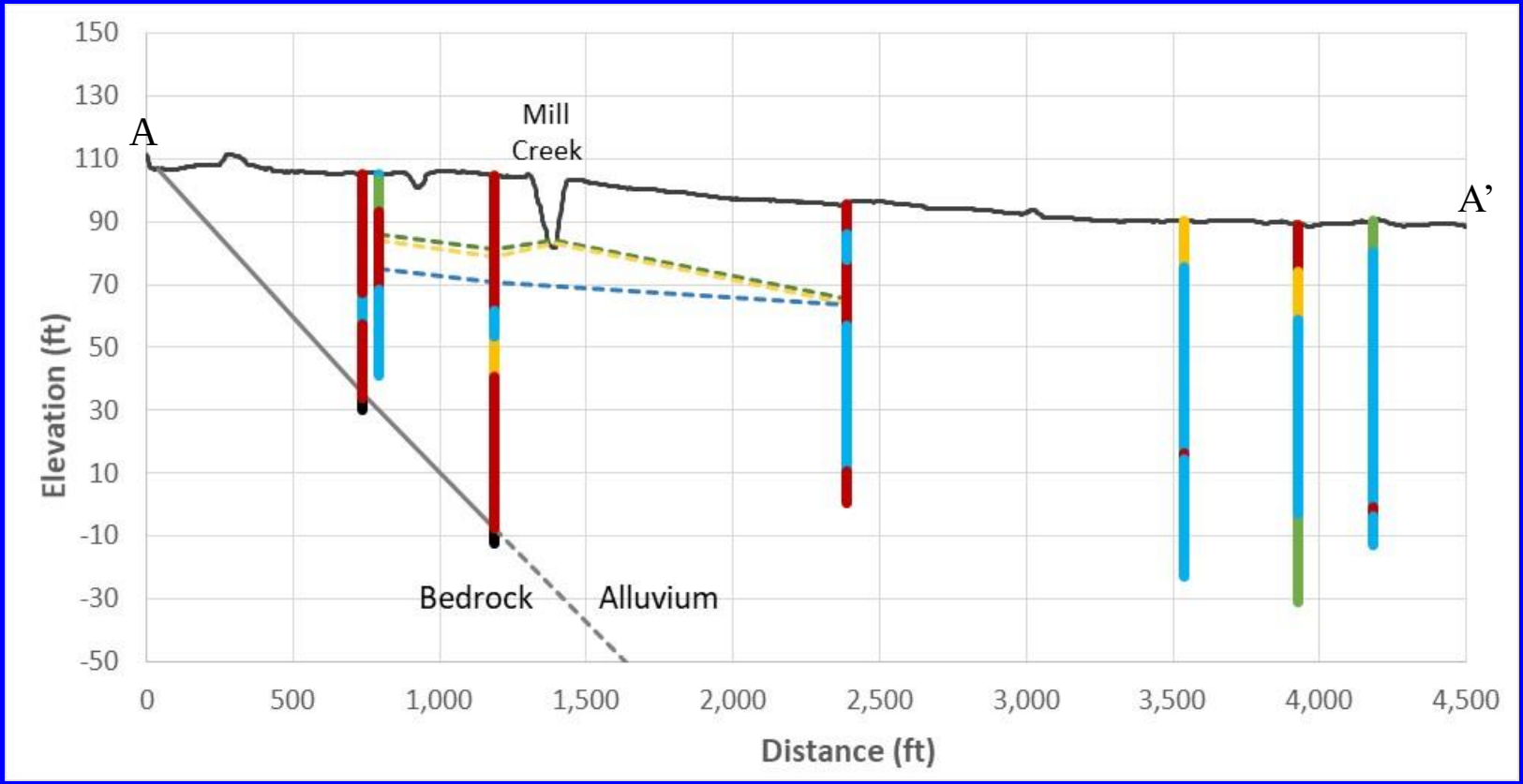


Lower Mill Groundwater Monitoring

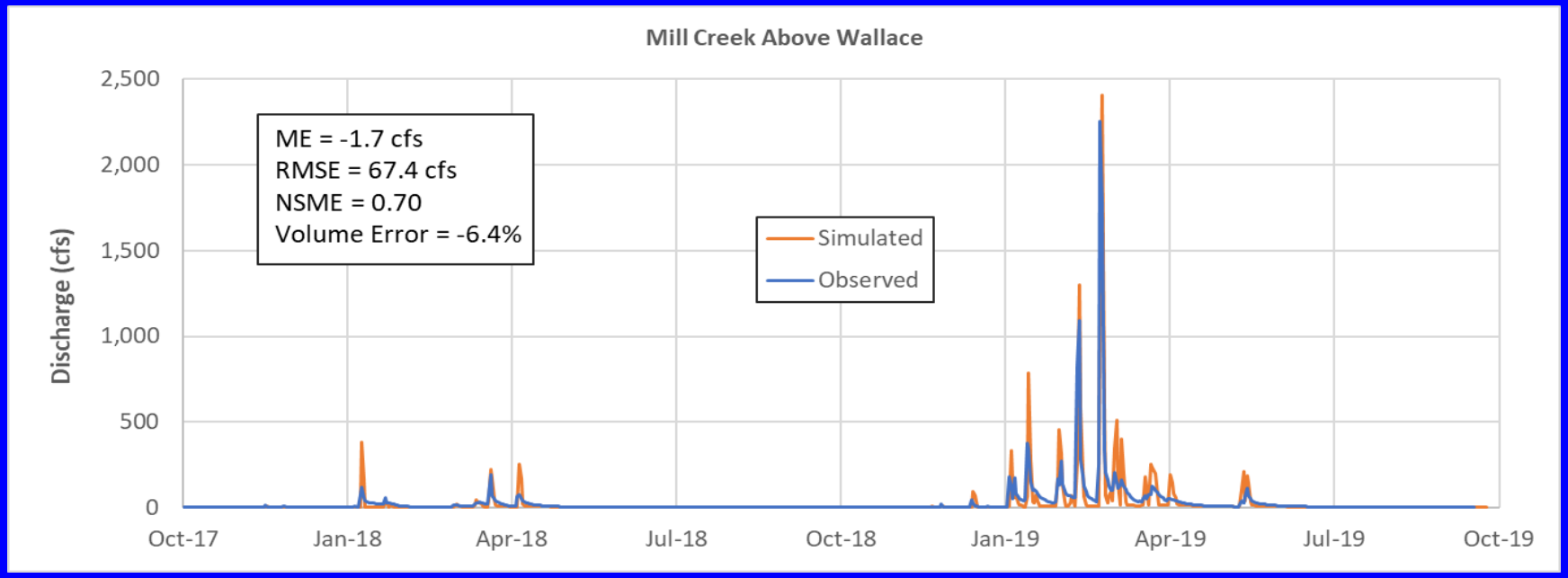
Groundwater Contours - October 24, 2018

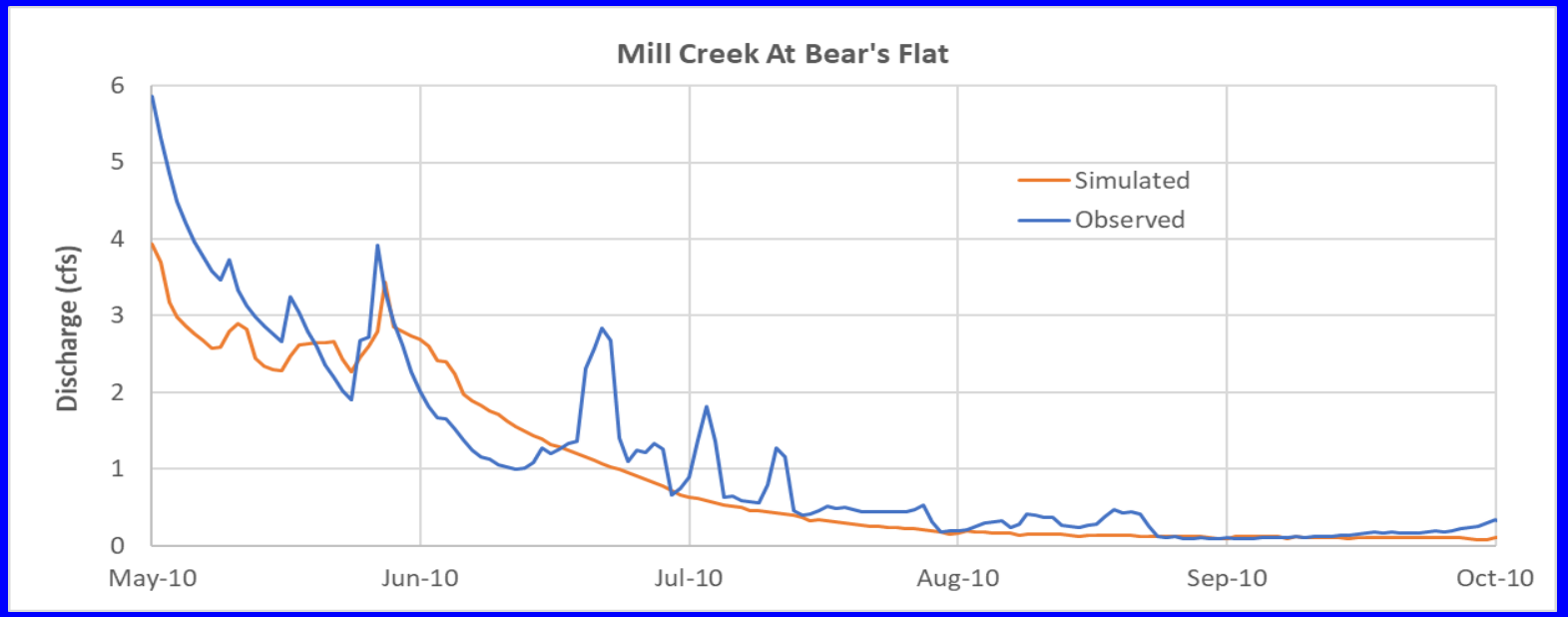


Lower Mill Hydrogeology

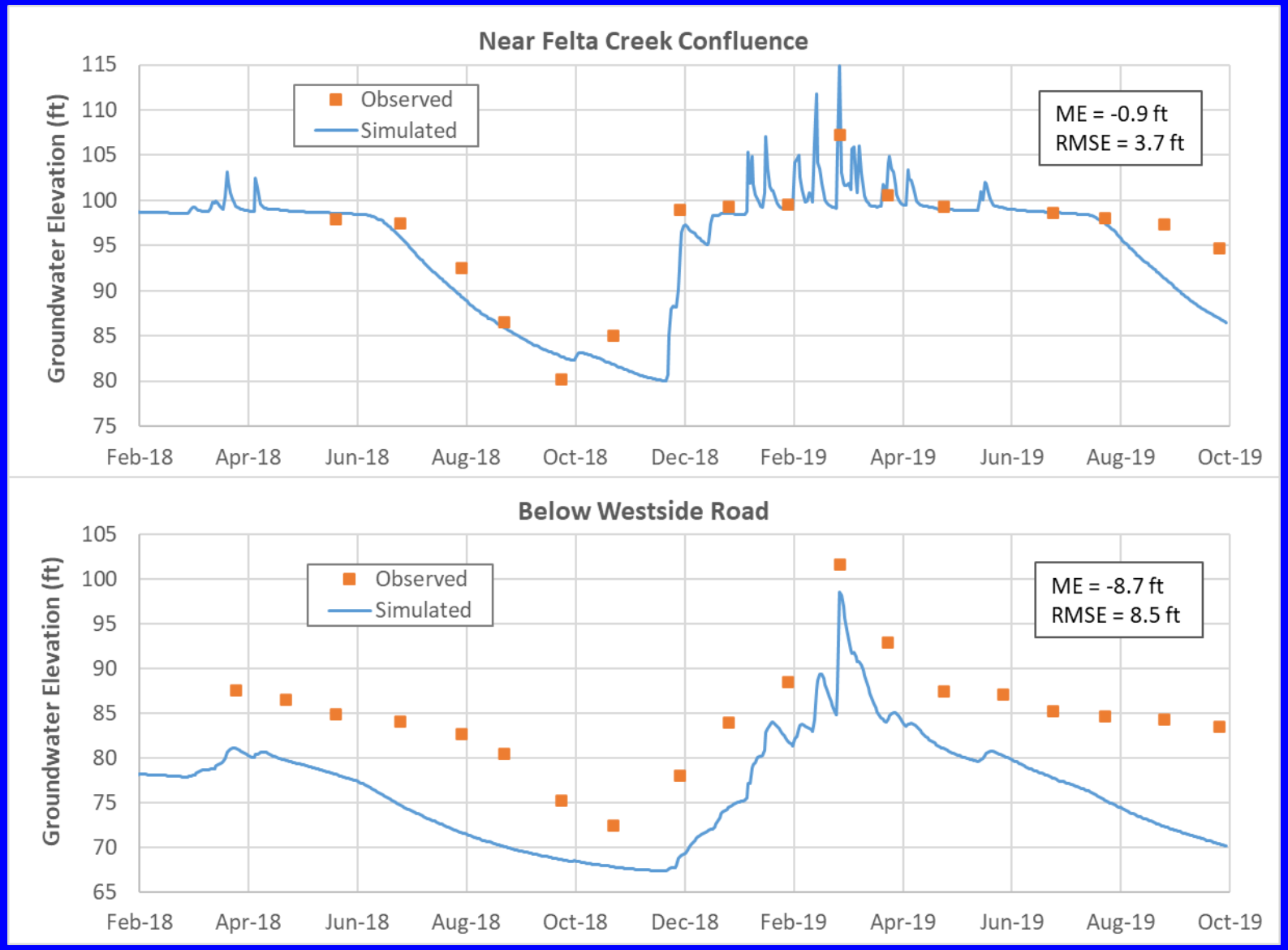


Streamflow Calibration





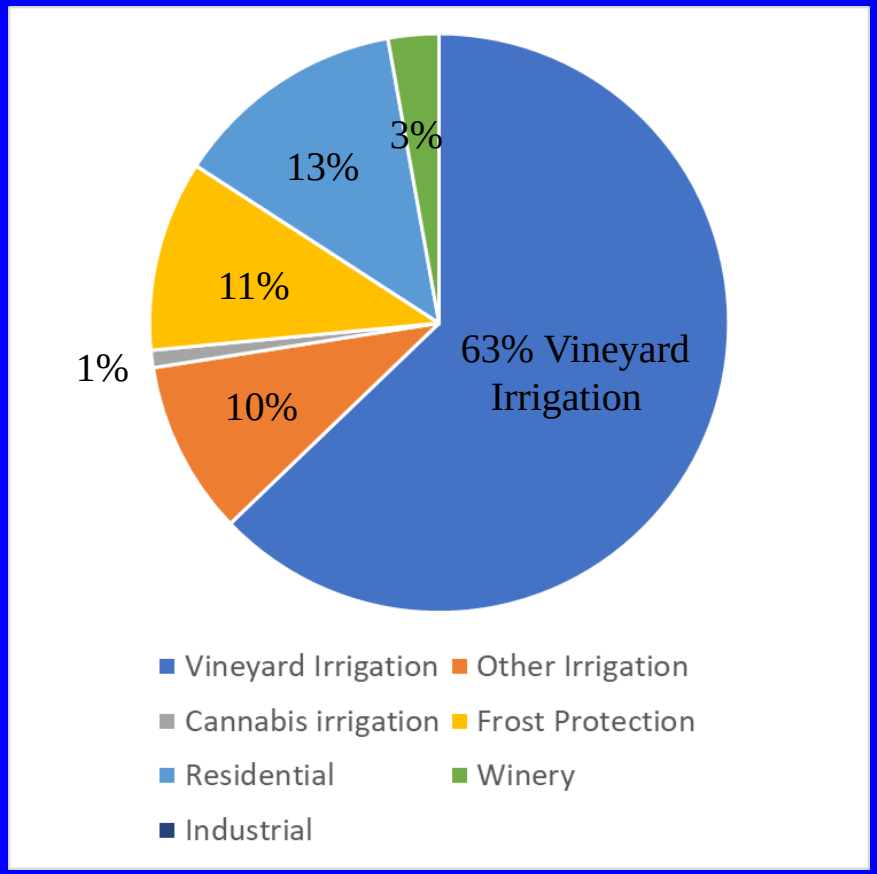
Groundwater Calibration



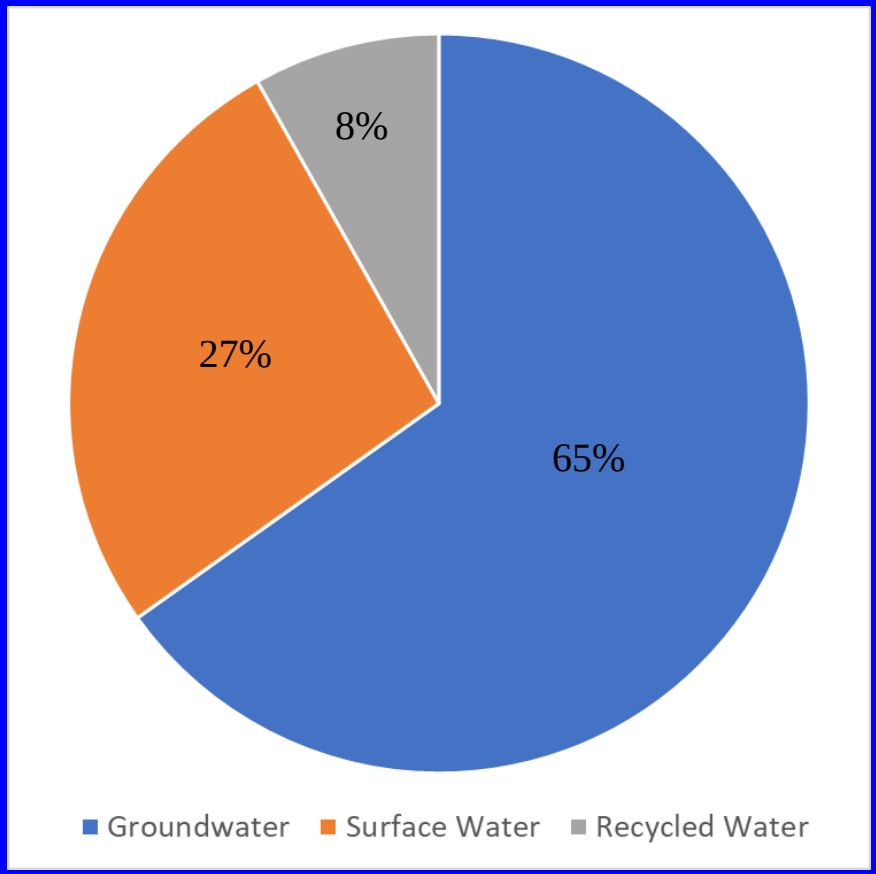
Existing Water Use

Total Annual Water Use – 257 ac-ft/yr
11.3 ac-ft/mi^2

Water Use Categories

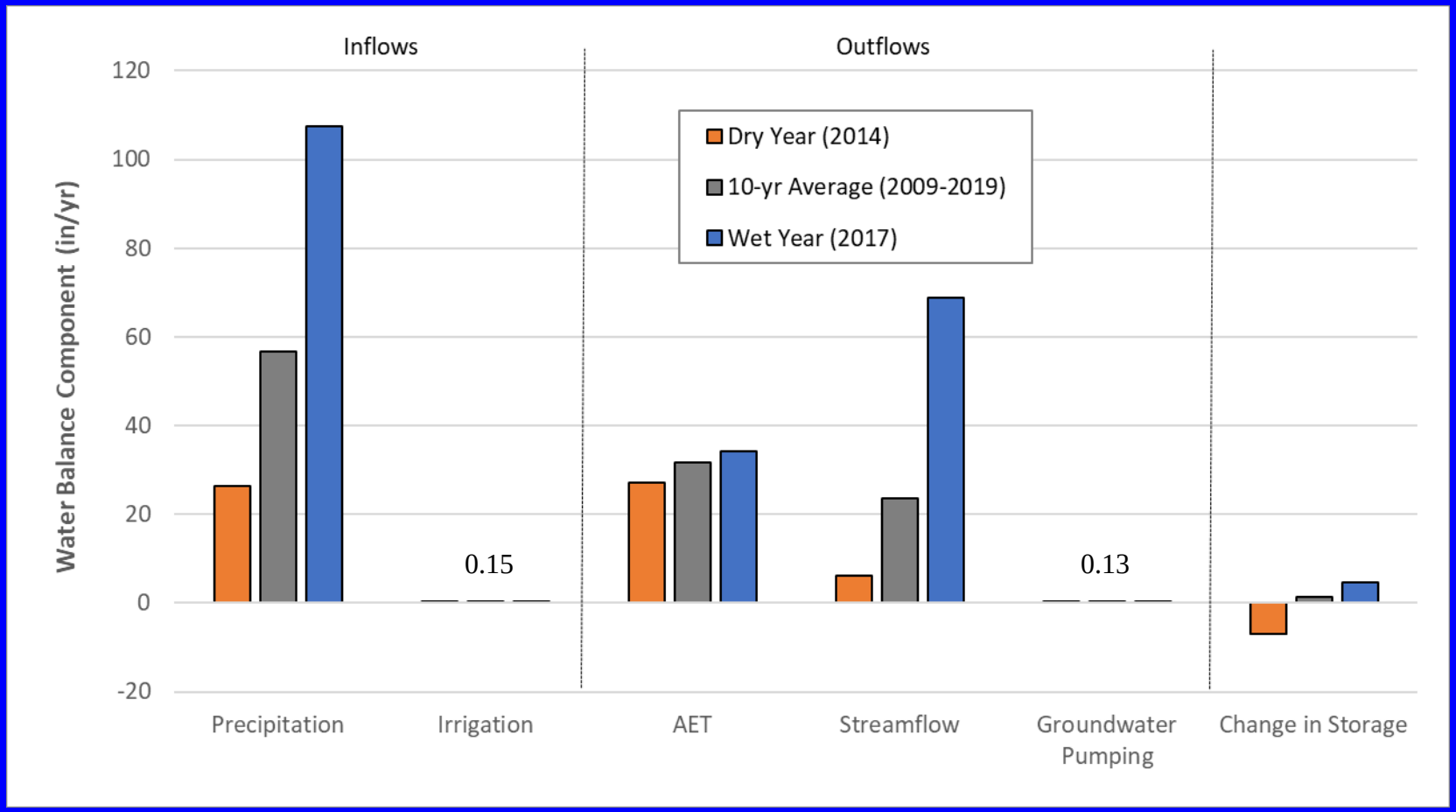


Water Use Sources



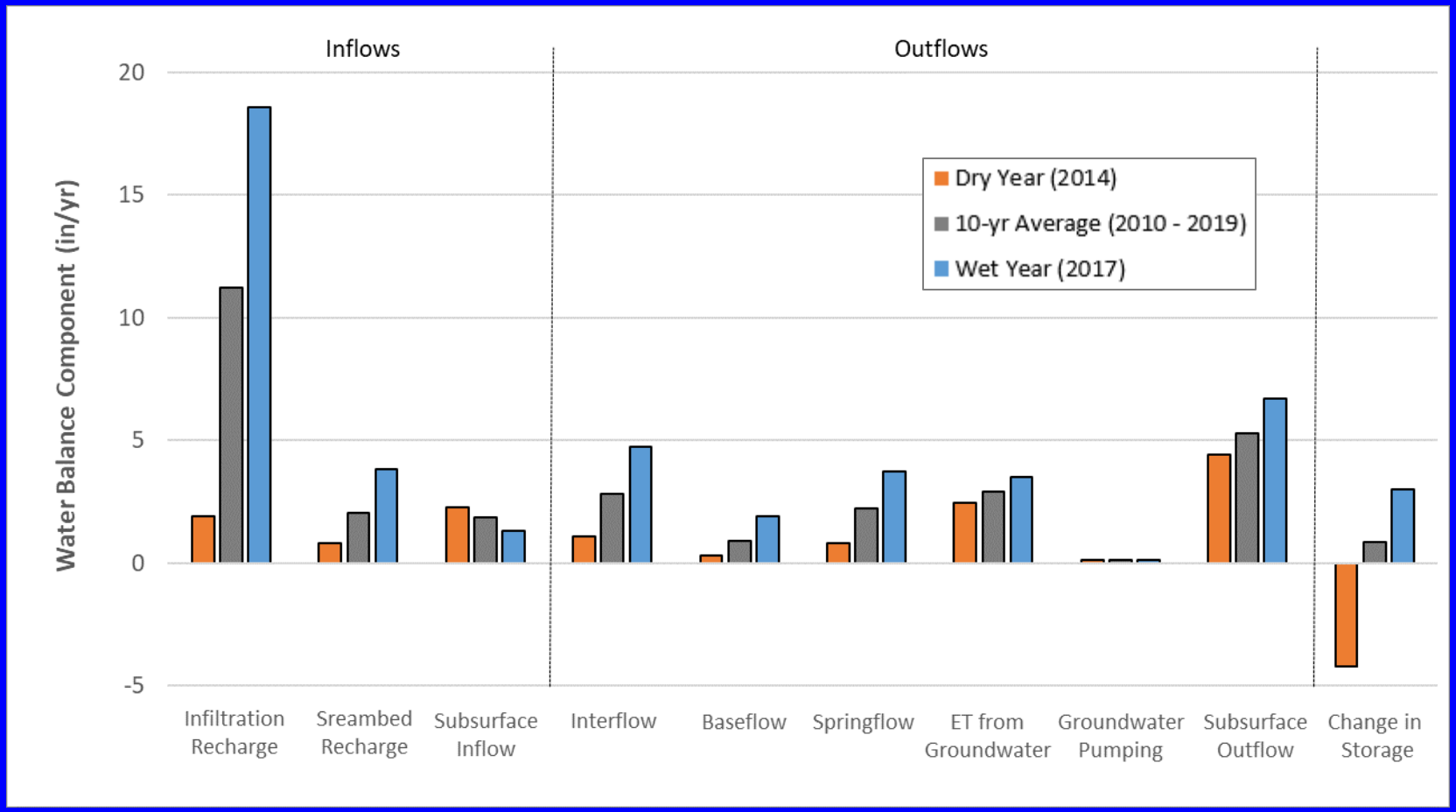
Existing Hydrology

Mean Annual Watershed Water Balance

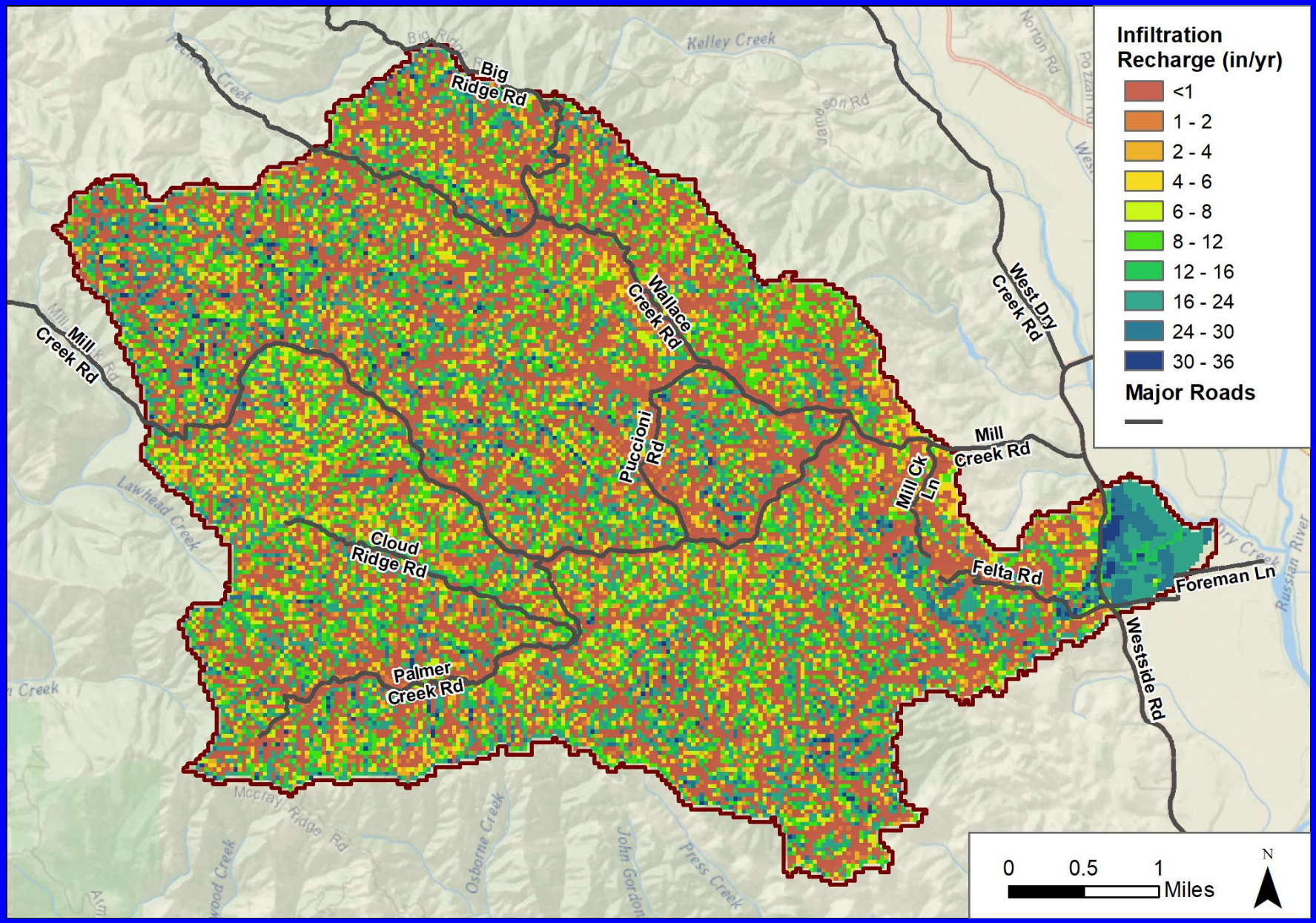


Existing Hydrology

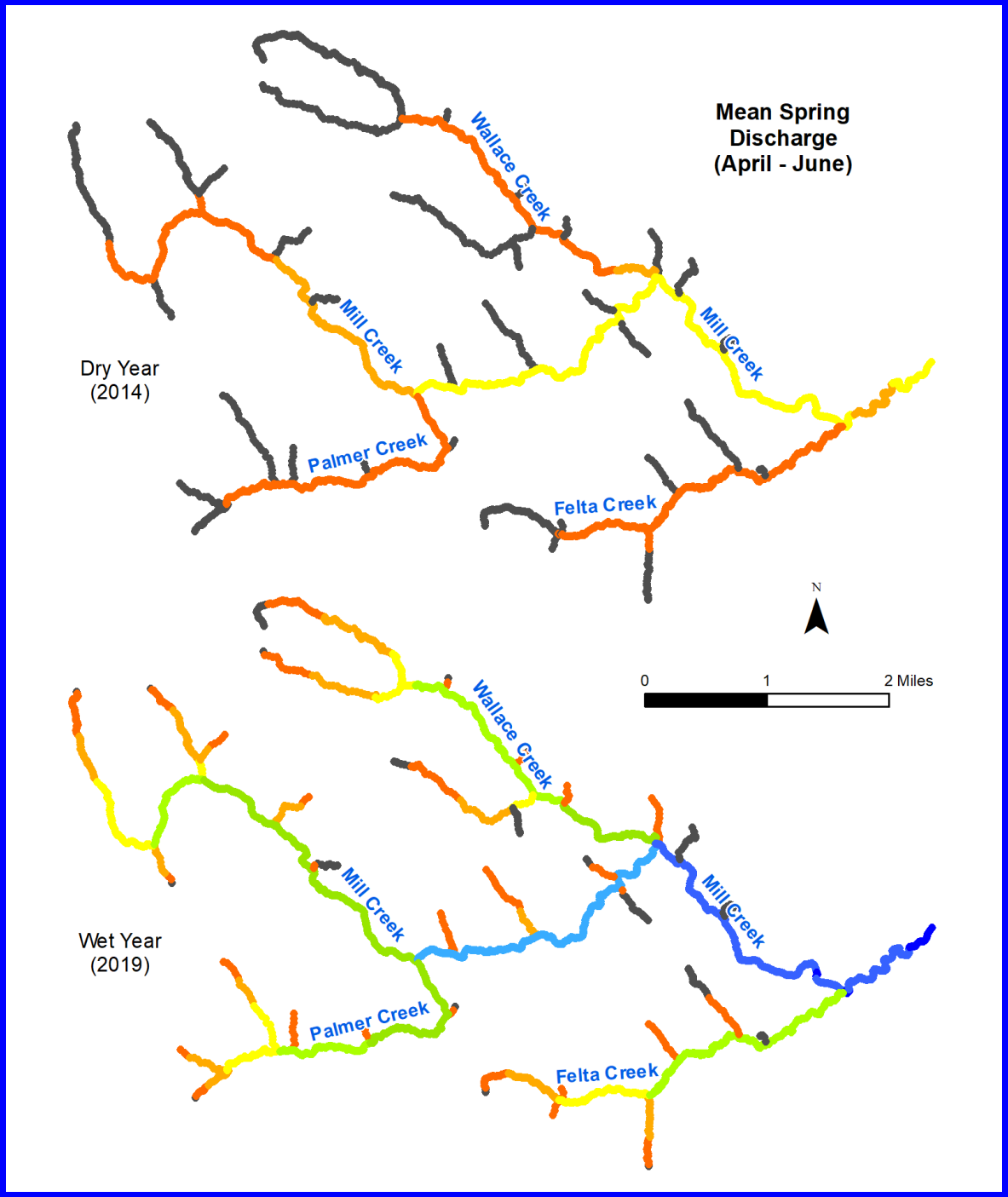
Mean Annual Groundwater Water Balance



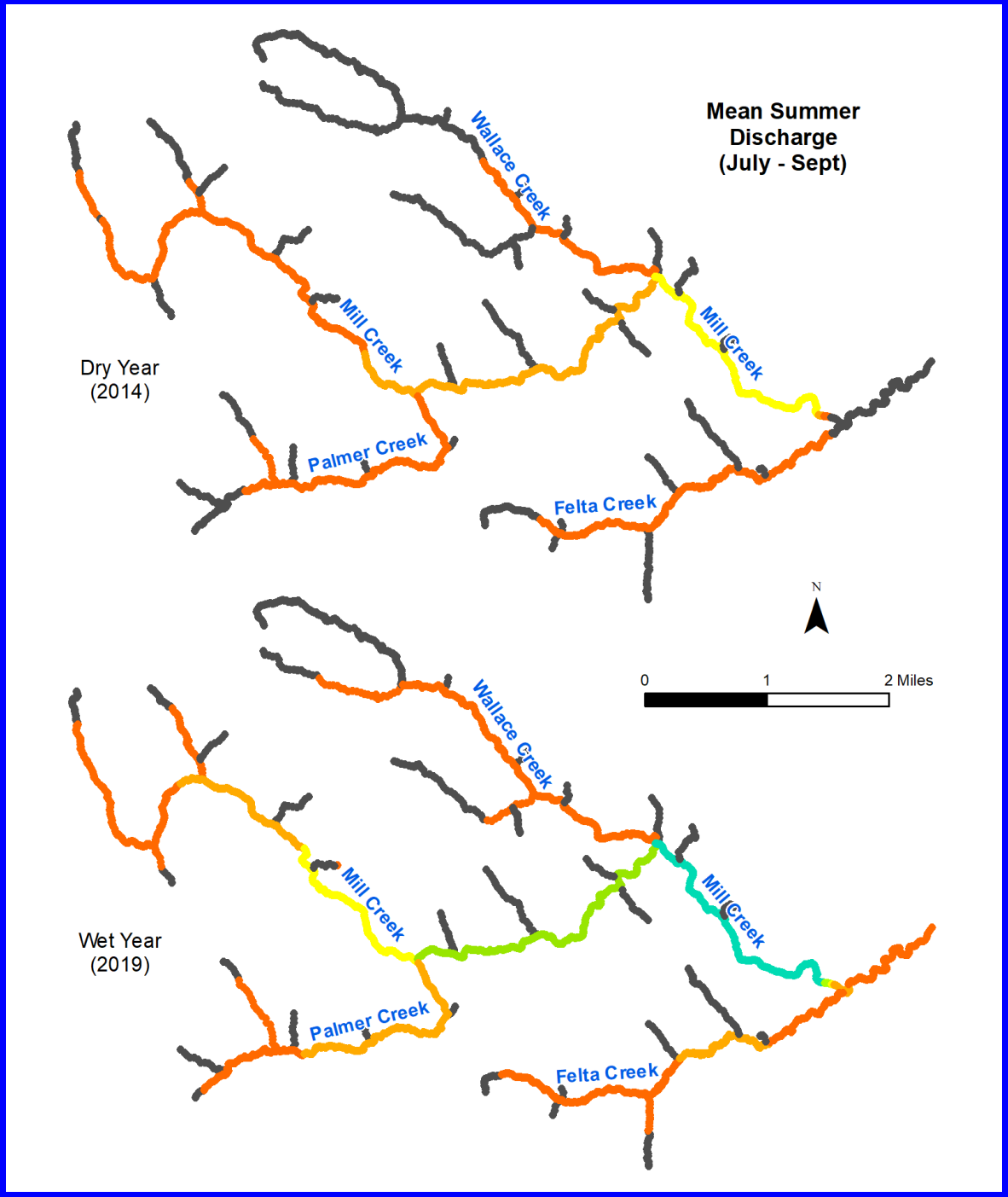
Existing Hydrology - Recharge



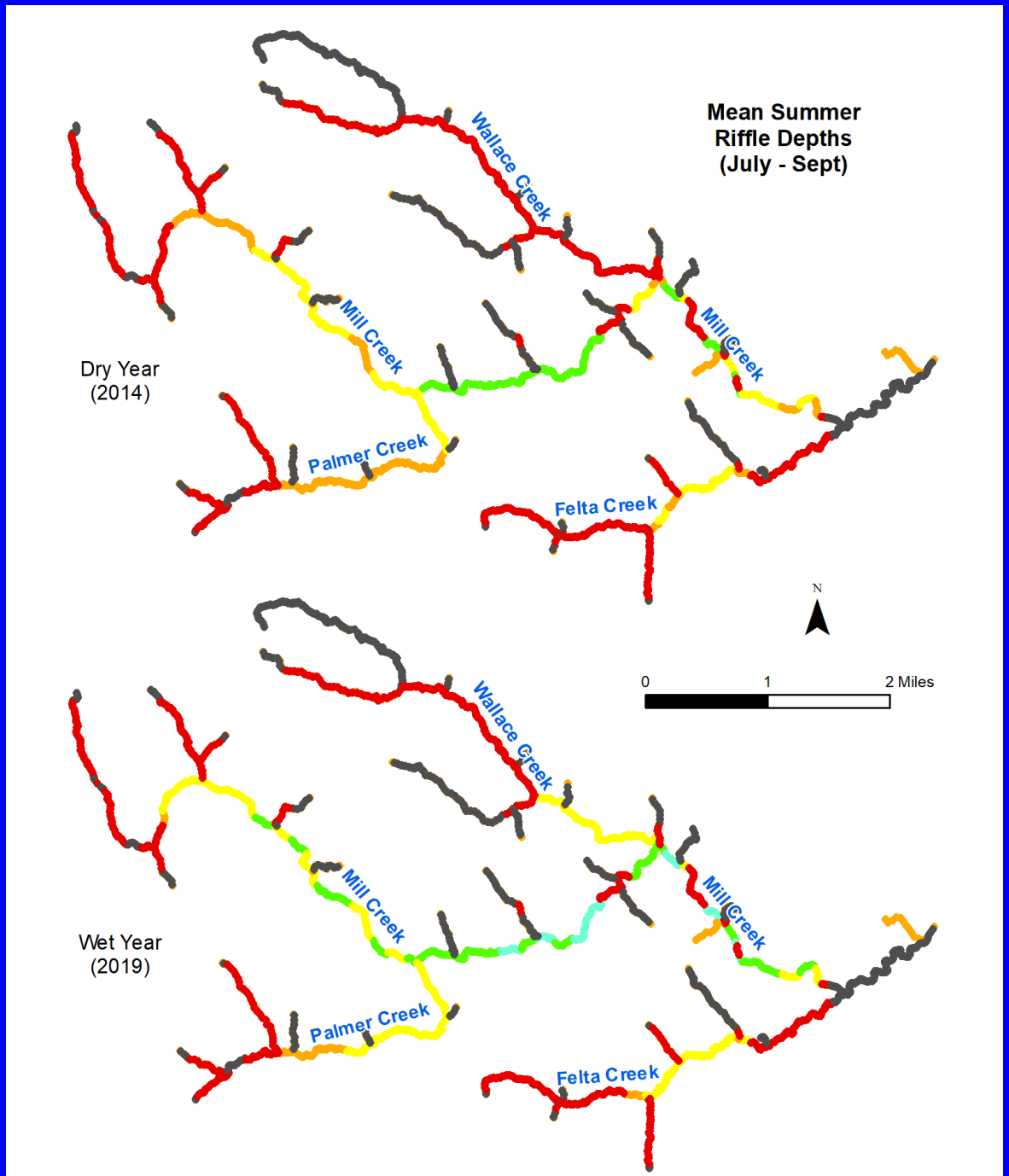
Existing Hydrology Discharges



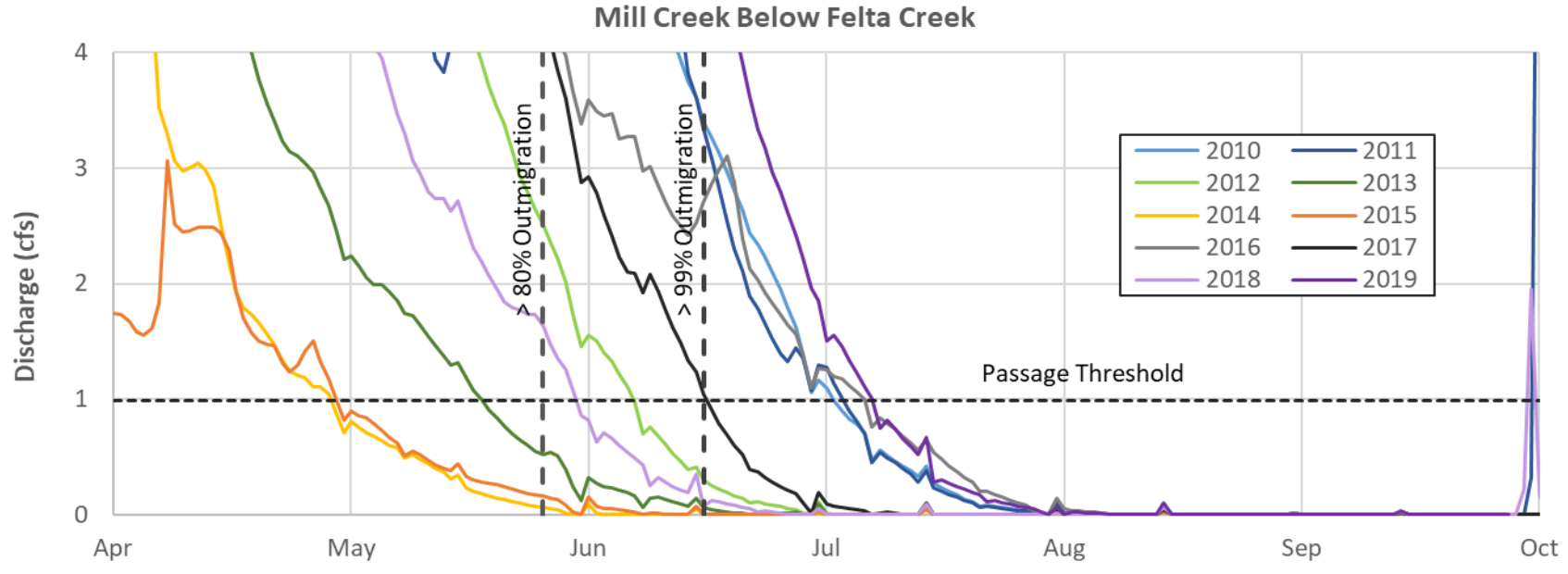
Existing Hydrology Discharges

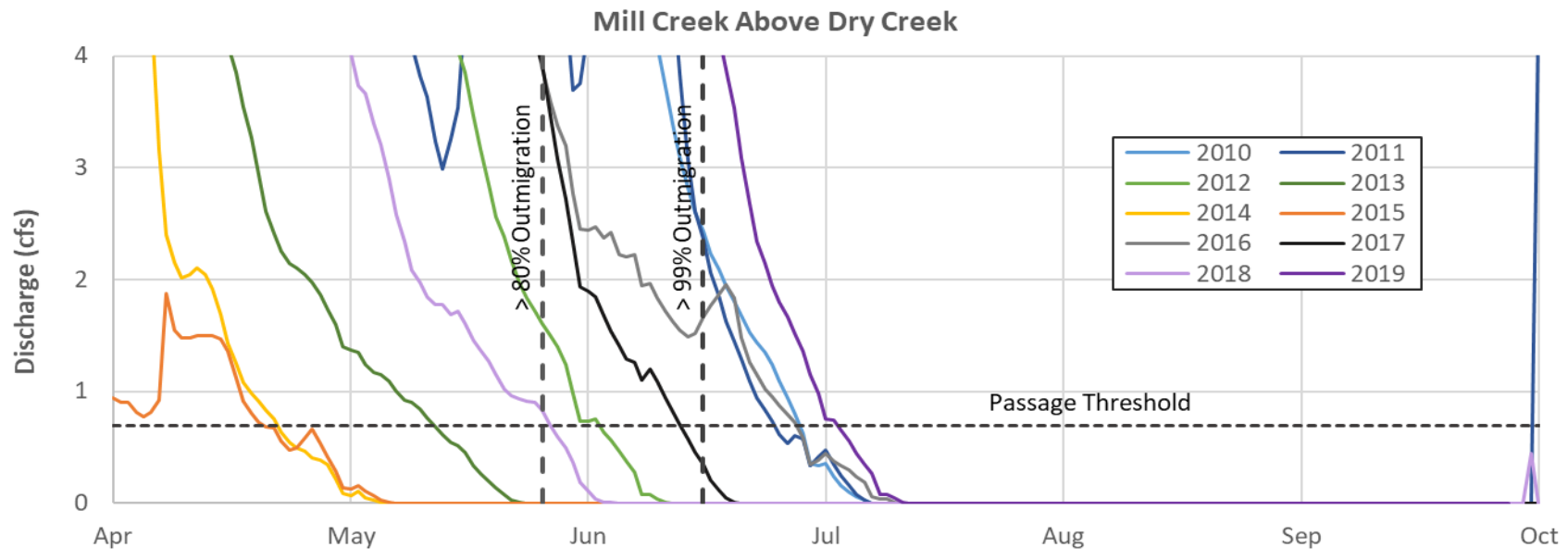


Existing Hydrology Riffle Depths



Existing Hydrology – Spring Outmigration

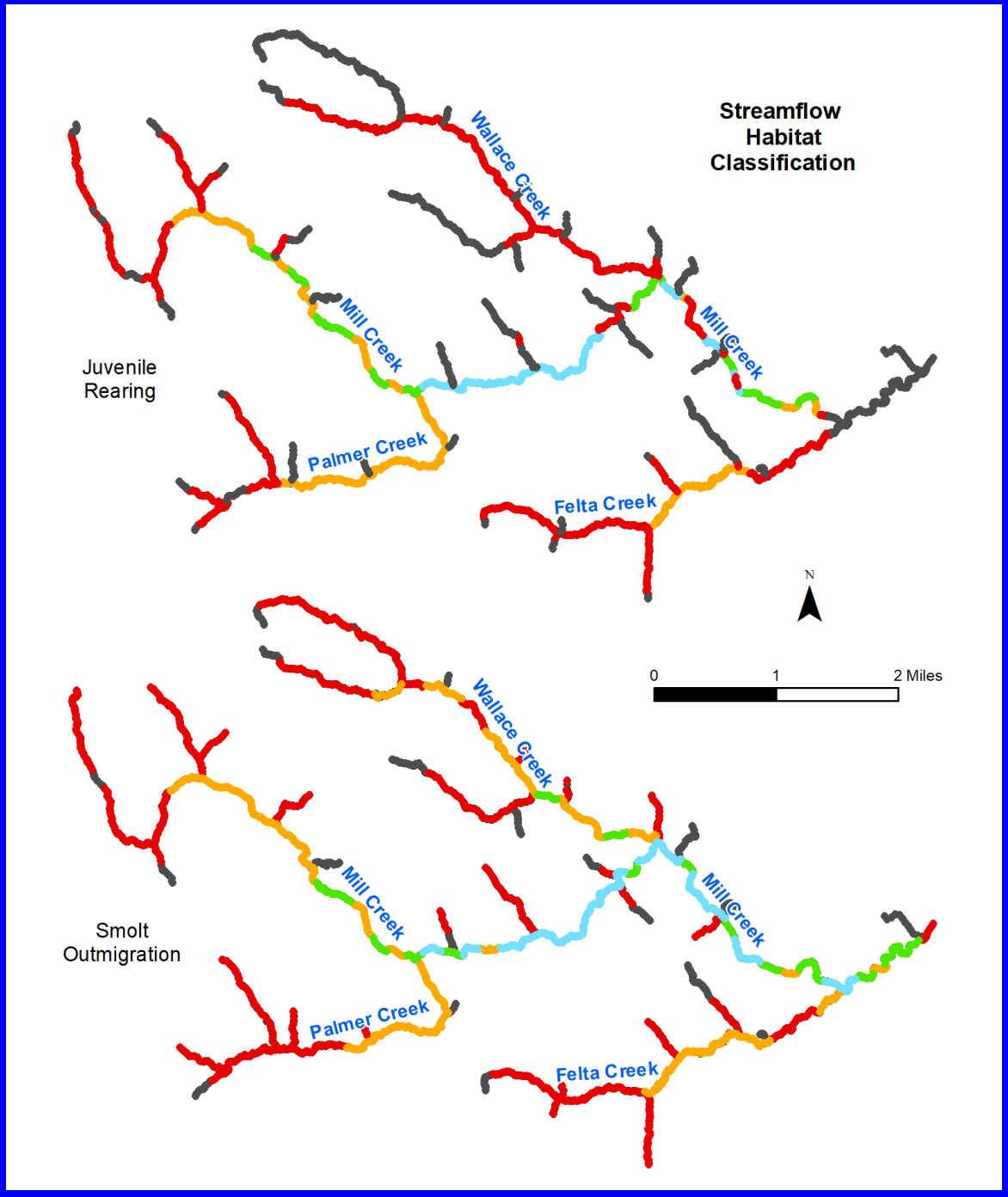




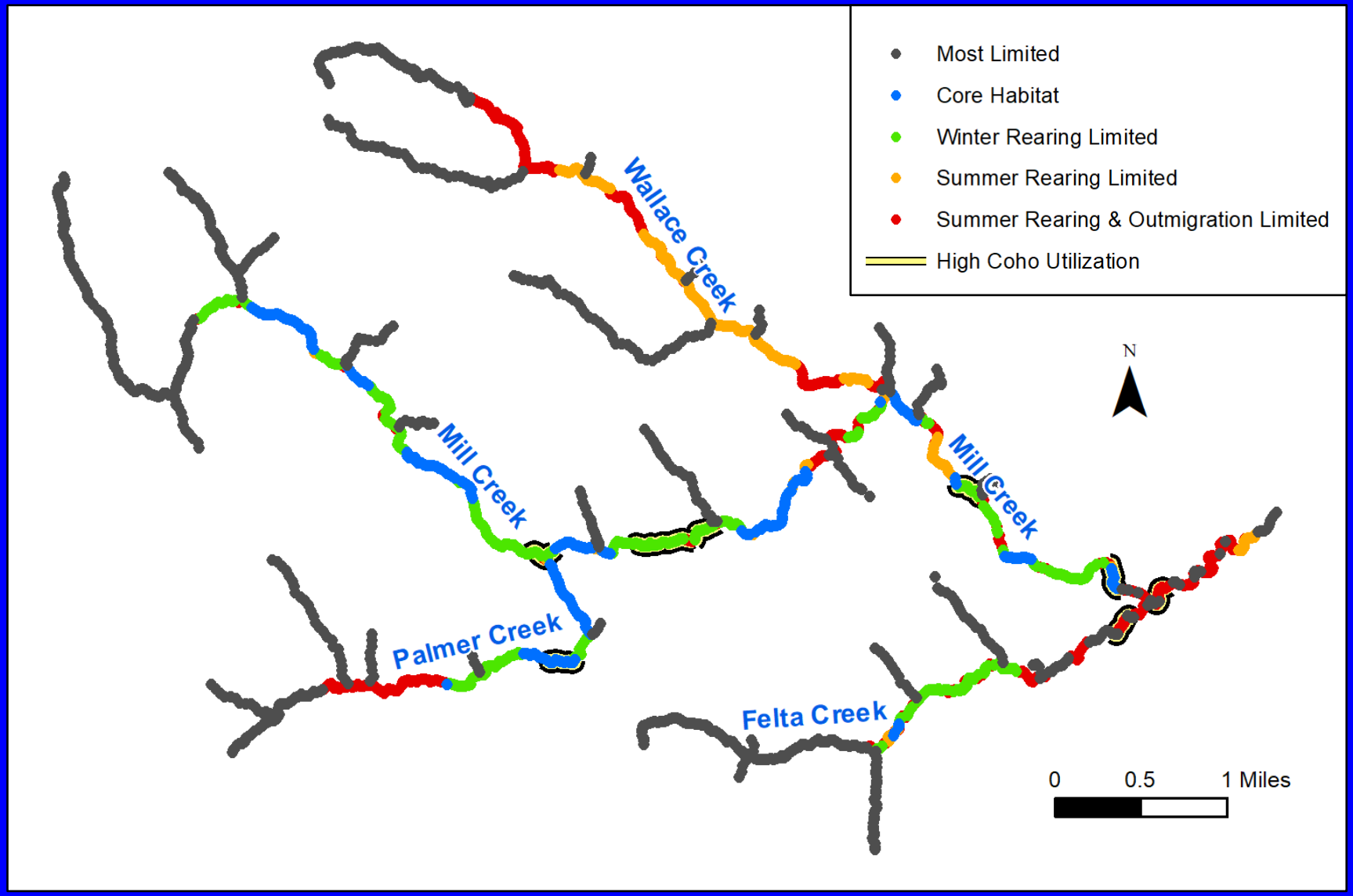
Salmonid Habitat Classification

- Juvenile Rearing
  - Maintain summer baseflows protective of water quality, supportive of BMIs, and resilient to climate change
    - Riffle Depths (>0.2-ft)
- Smolt Outmigration
  - Maintain passable flow conditions through the spring outmigration window
    - Riffle depths in relation to outmigrant timing
- Winter Rearing/Spawning
  - Not the focus of this project but considered from
    - Prior modeling work, available habitat survey & biological monitoring data

Flow-based Habitat Classification



Overall Habitat Classification



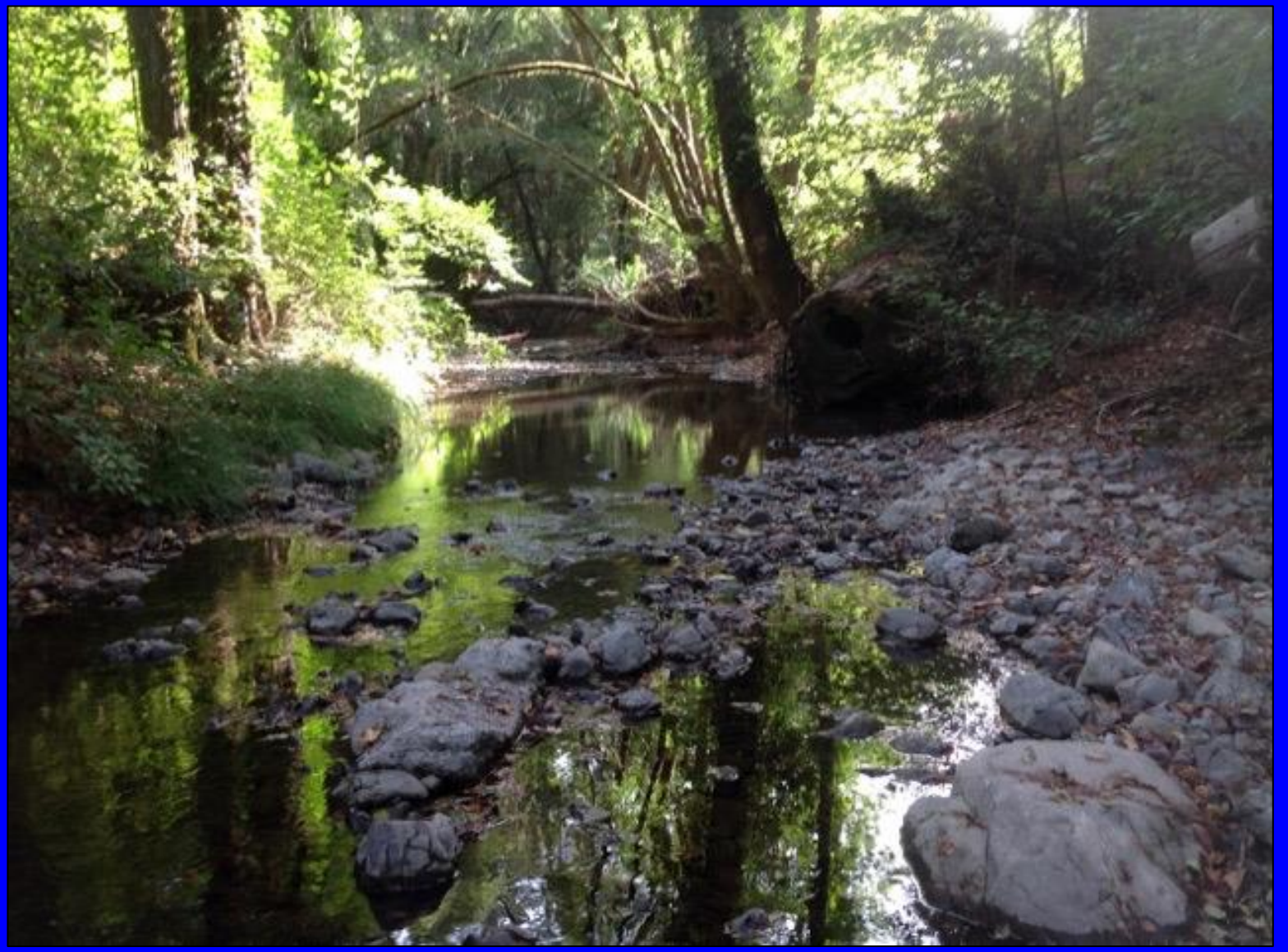
Summary of Existing Hydrology

- Streamflow
  - Highly variable springtime flows
  - Low but consistent summer baseflows in most of Mill Creek & lower Palmer Creek
  - Frequent pool disconnection in lower Mill Creek, short reaches of middle Mill Creek, Wallace Creek, & much of Felta Creek
- Water Budget
  - Relatively high recharge rates in the upper bedrock watershed (11 in/yr) with variability controlled largely by topography
  - Very high recharge in the lower alluvial watershed (24 in/yr)
- Water Use
  - Relatively high reliance on surface water resources (27%)
  - Vineyard irrigation & frost protection account for 74% of total use
  - Annual groundwater pumping is ~0.7% of mean annual recharge in the upper watershed & ~9.3% in the lower watershed

Salmonid Habitat Summary & Restoration Recommendations

- The upper and middle of reaches of Mill Creek & lower Palmer Creek have the best overall conditions
  - Large wood and off-channel habitat projects
- Lower Mill, lower Felta, and Wallace of questionable value for summer rearing - prolonged dry conditions
- Flows are problematic for spring outmigration in lower Mill with impassable conditions as early as mid-April
- Localized flow disconnection in middle Mill 'core area' also problematic

Pause for Questions



Scenario Analysis

costs
regulatory hurdles
challenges & concerns

Obstacle Focused

what actions can make a meaningful difference?

Solution Focused

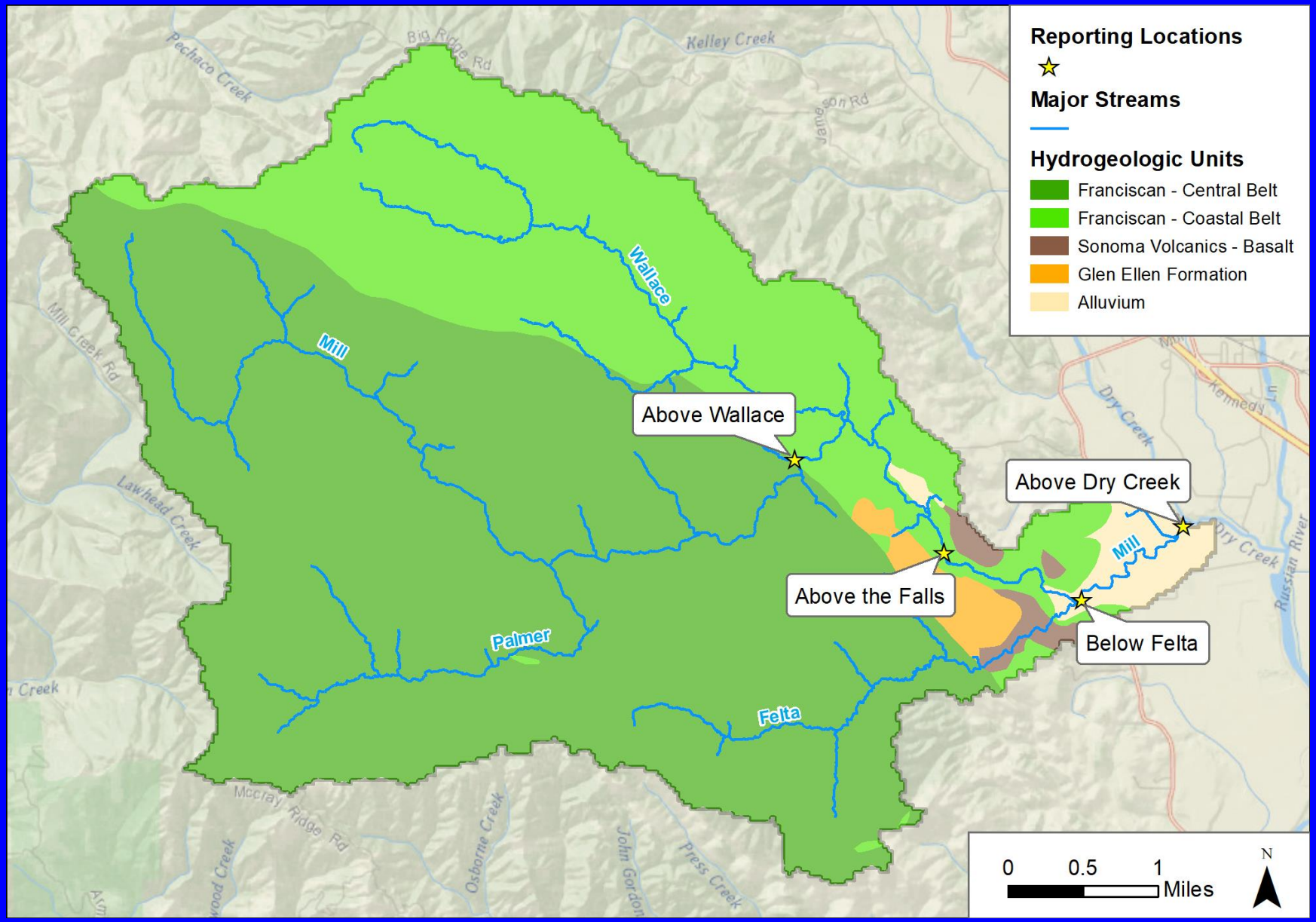
it’s simple, a pipeline from Oregon

Head in the Clouds

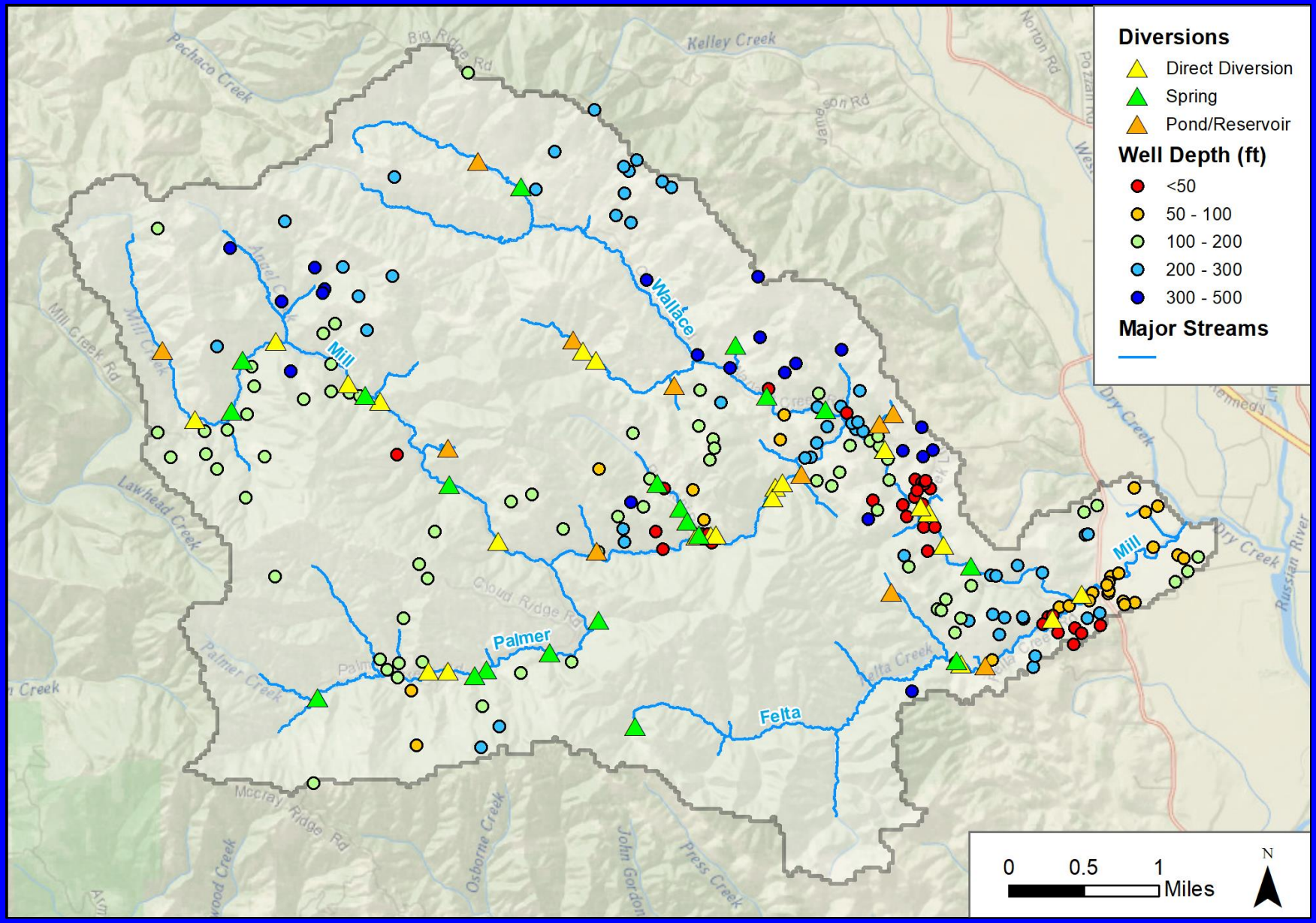
Scenario Analysis

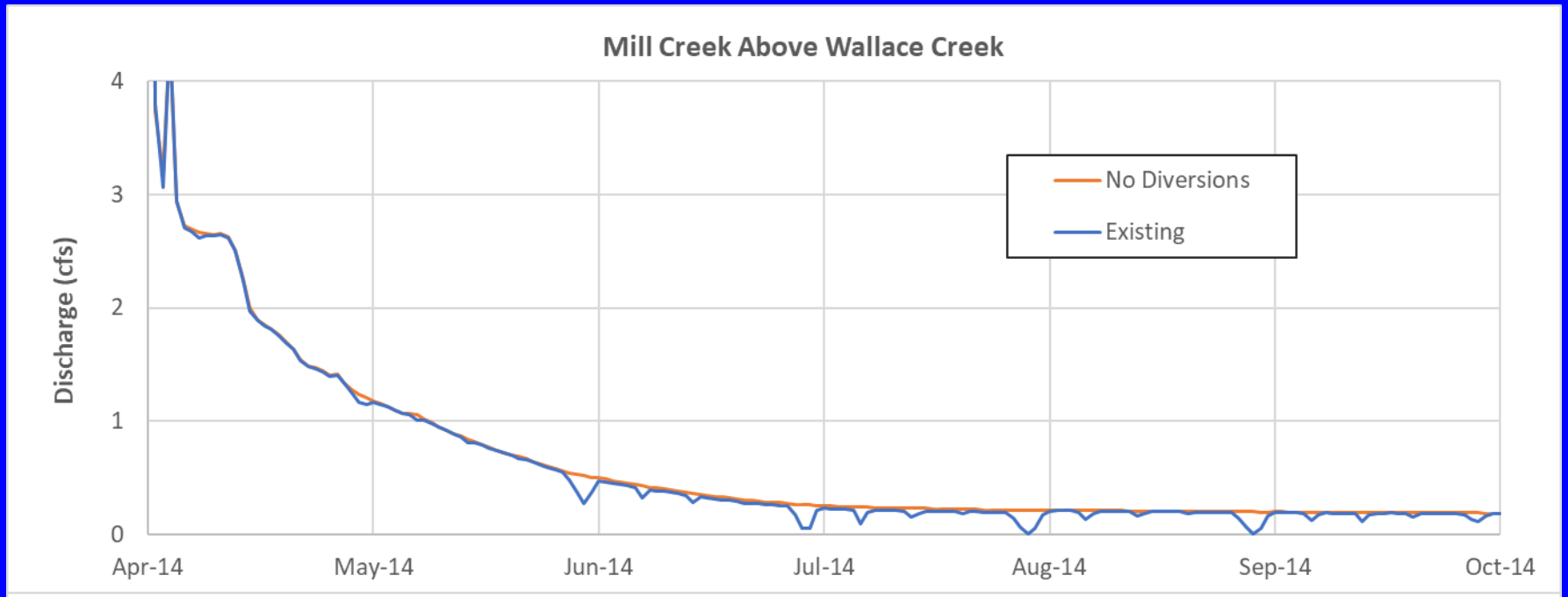
- Water Use Scenarios
  - no diversions, no groundwater pumping, no water use (unimpaired)
- Flow Releases
  - spring outmigration releases, summer baseflow releases
- Recycled Water
  - Re-use of treated wastewater for irrigation & recharge/streamflow enhancement
- Combined
  - Summer flow enhancement & spring flow enhancement
- Climate Change
  - Coming soon

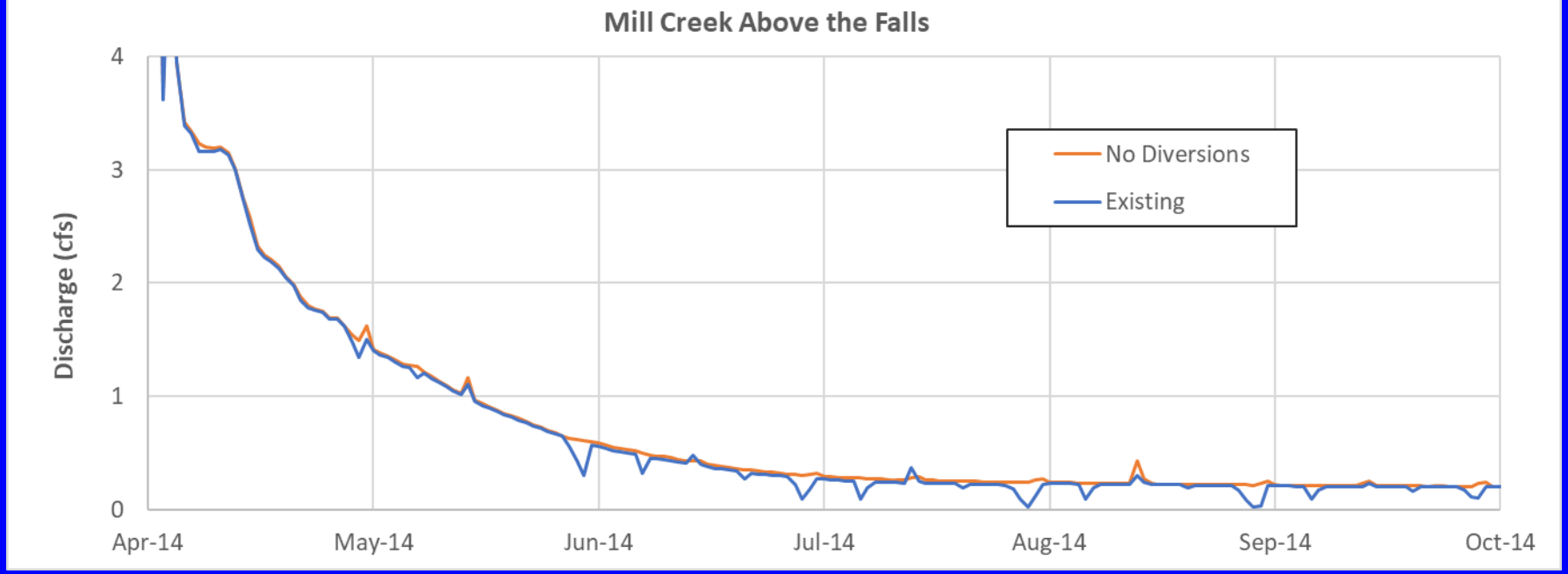
Scenario Analysis

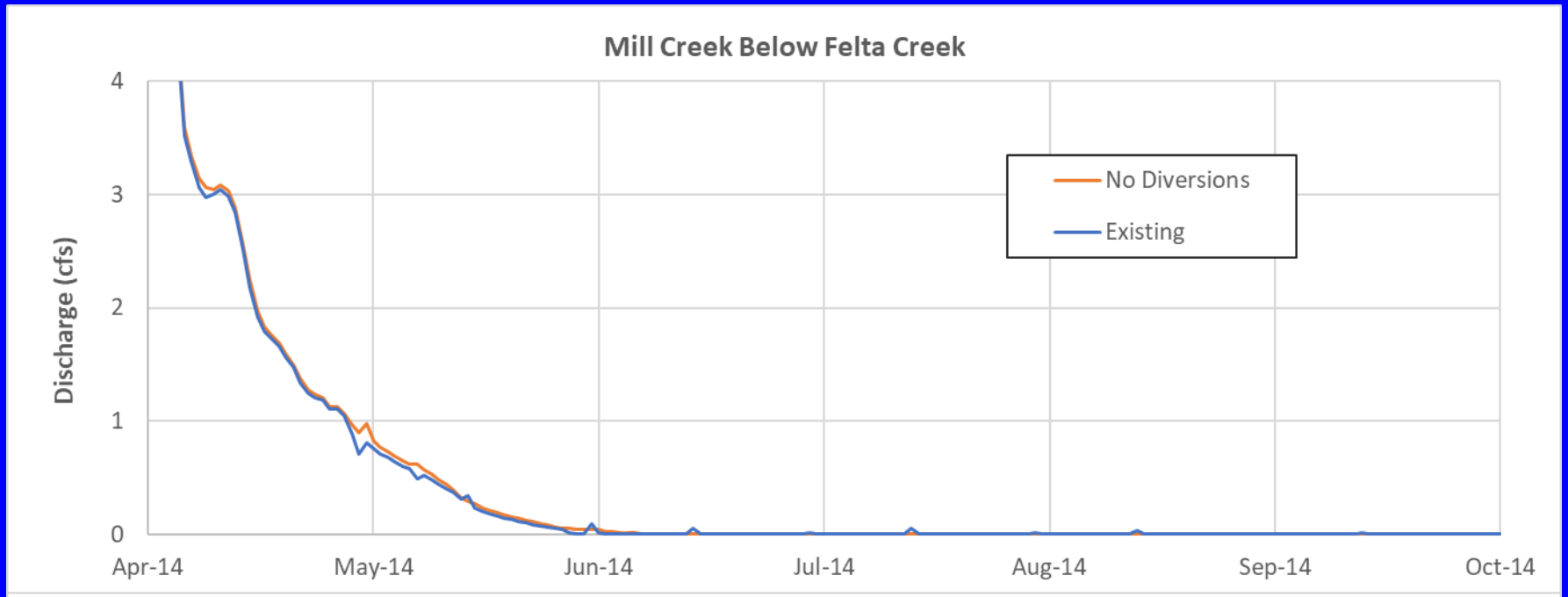


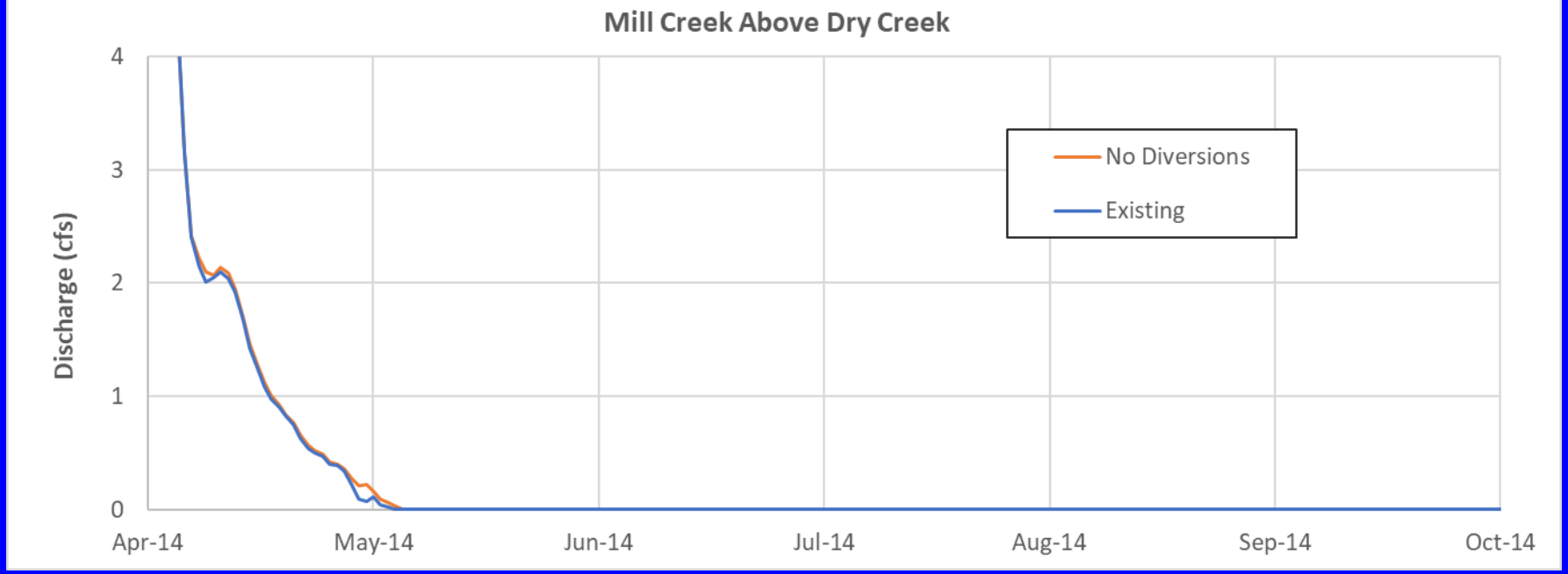
Scenario Analysis – Water Use



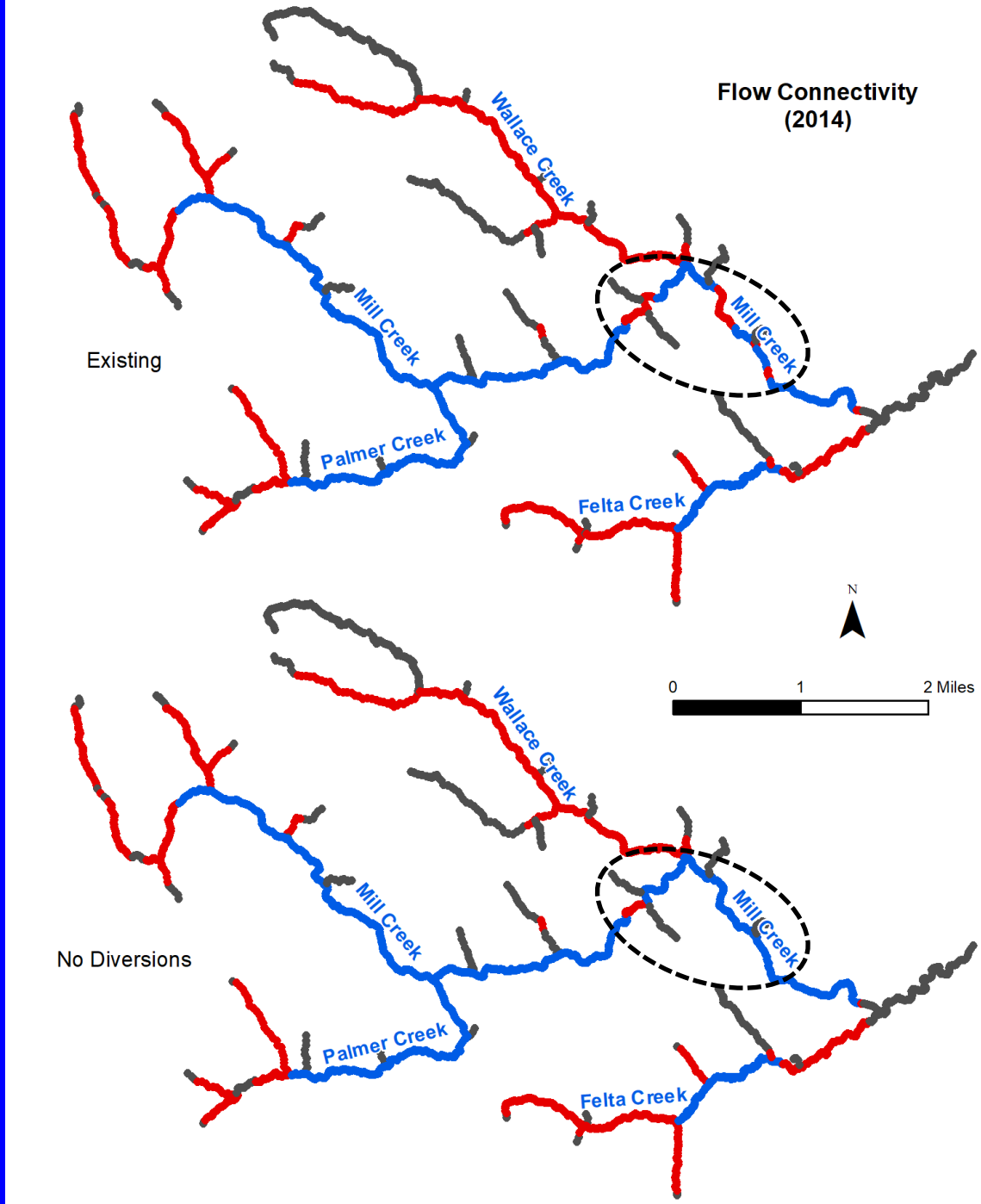

Mill Creek Above Wallace Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
No Diversions
Existing


Mill Creek Above the Falls
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
No Diversions
Existing


Mill Creek Below Felta Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
No Diversions
Existing

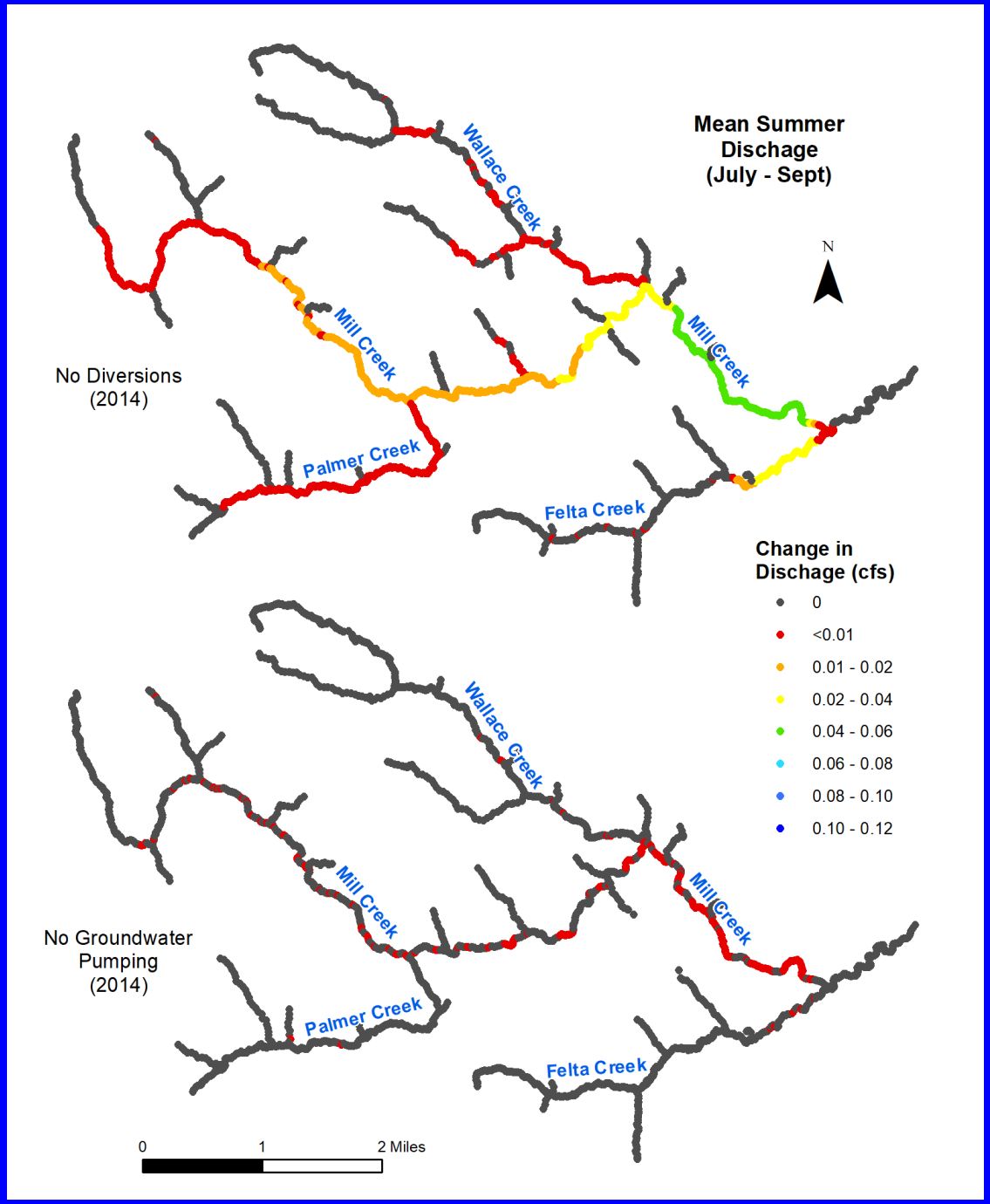

Mill Creek Above Dry Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
No Diversions
Existing

Surface Diversions Flow Connectivity

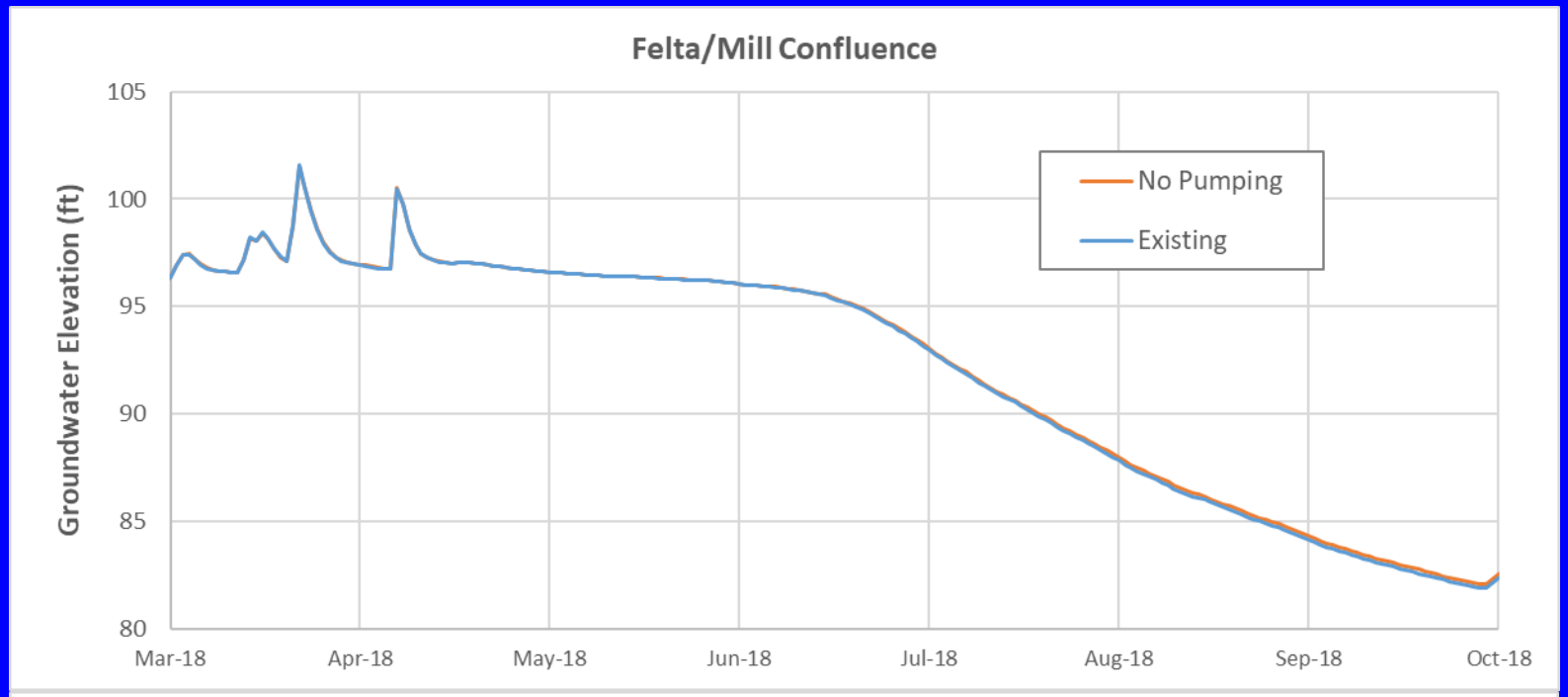


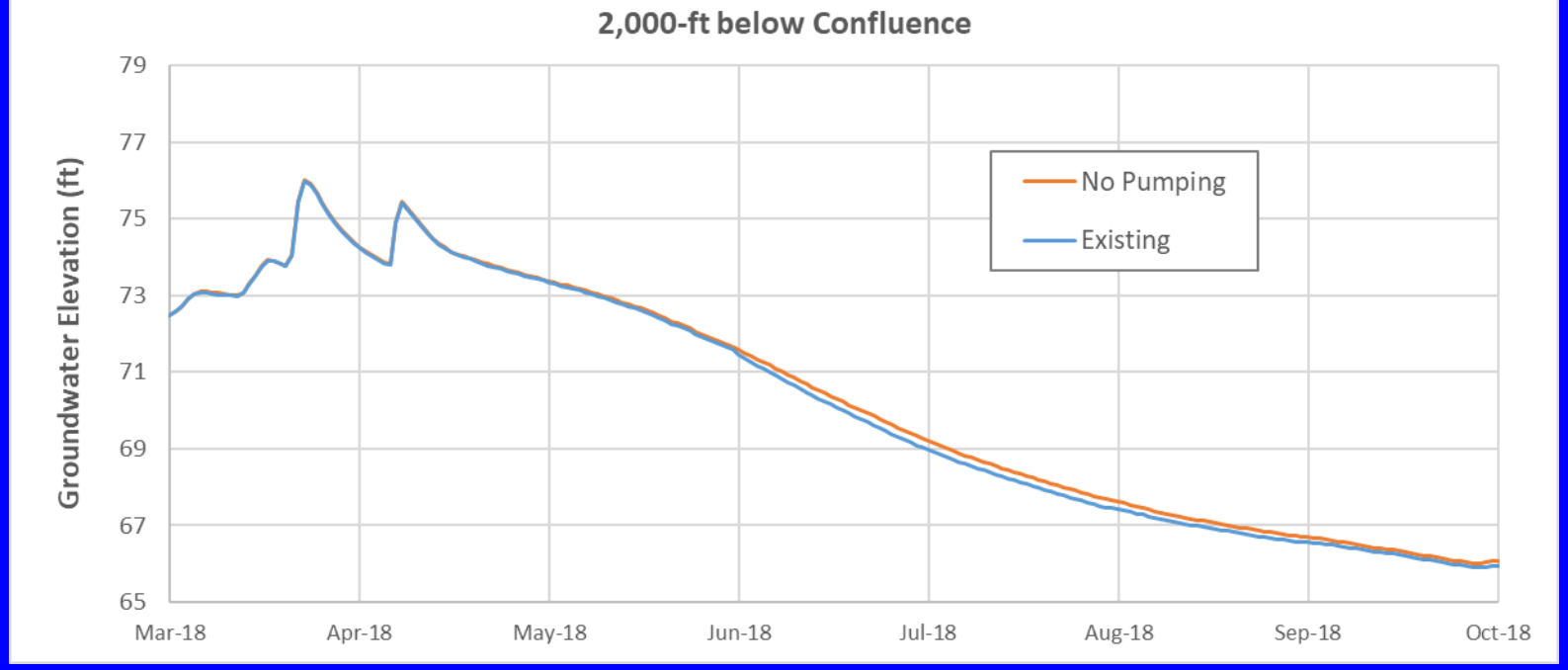
Flow Condition

- Connected
- Disconnected >14 days
- Disconnected <14 days



Water Use Scenarios Summer Discharge Change

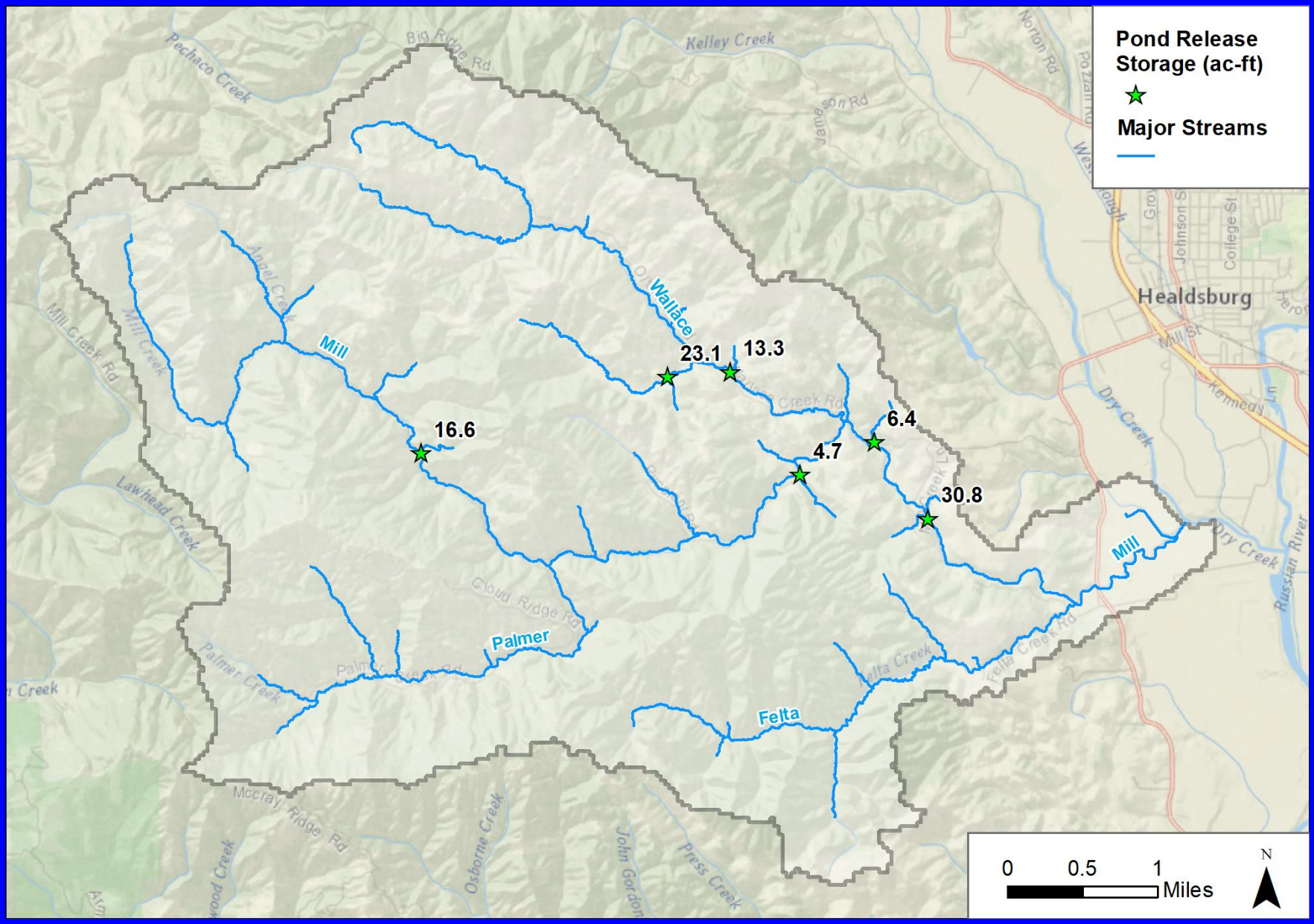

Felta/Mill Confluence
Groundwater Elevation (ft)
105
100
95
90
85
80
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
No Pumping
Existing

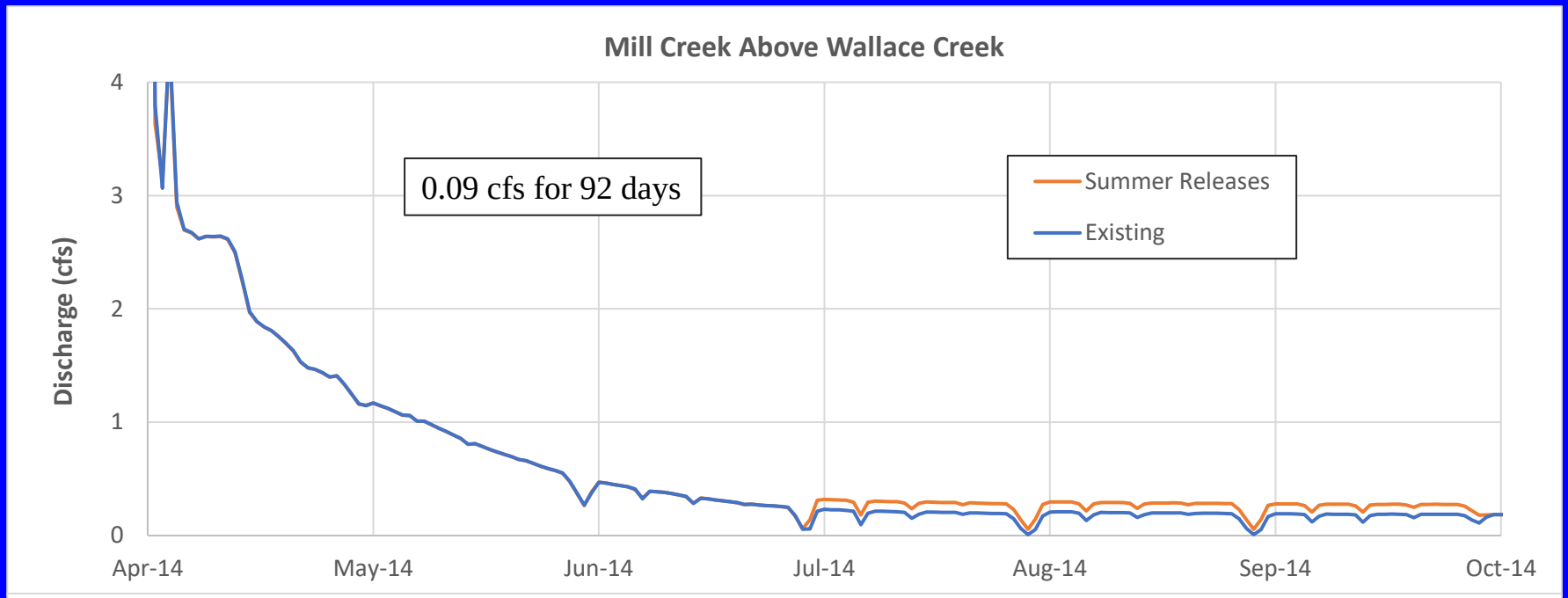

2,000-ft below Confluence
Groundwater Elevation (ft)
79
77
75
73
71
69
67
65
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
No Pumping
Existing

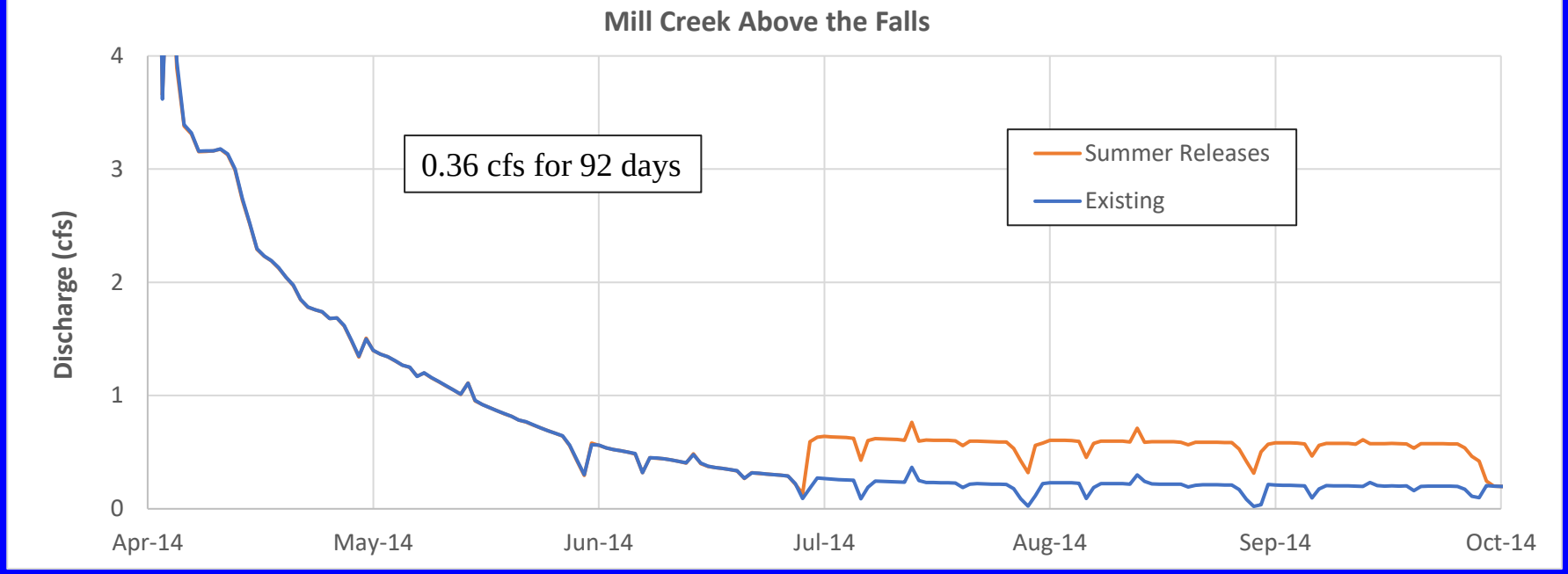
Scenario Analysis – Pond Releases

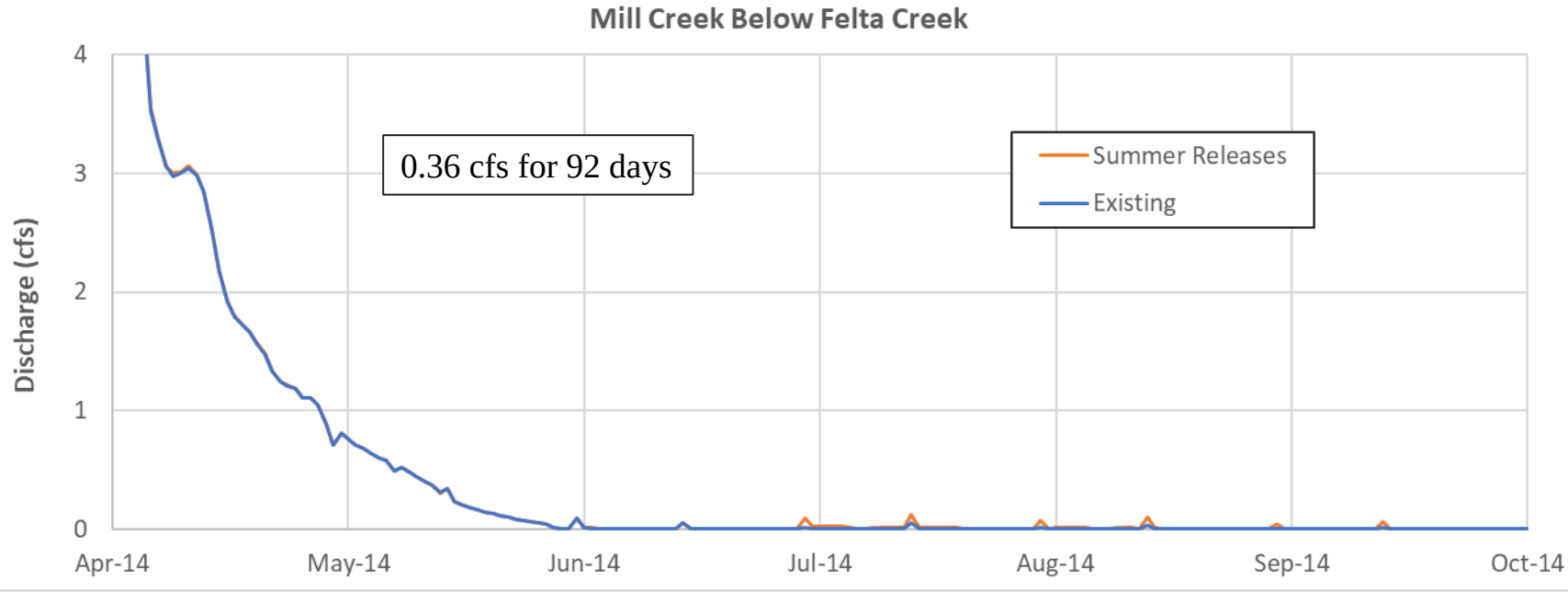
- Controlled releases from 6 ponds
- Total release volume: 95 ac-ft/yr
- Release timing
  - Summer release: July1st - Sept 30th (0.36 cfs)
  - Spring release: May 7th - May 27th (1.6 cfs)
  - Optimized spring release: April 20th - May 28th (0 to 1.8 cfs)
- Assumes 50% of pond storage must be retained for fire suppression/recreation

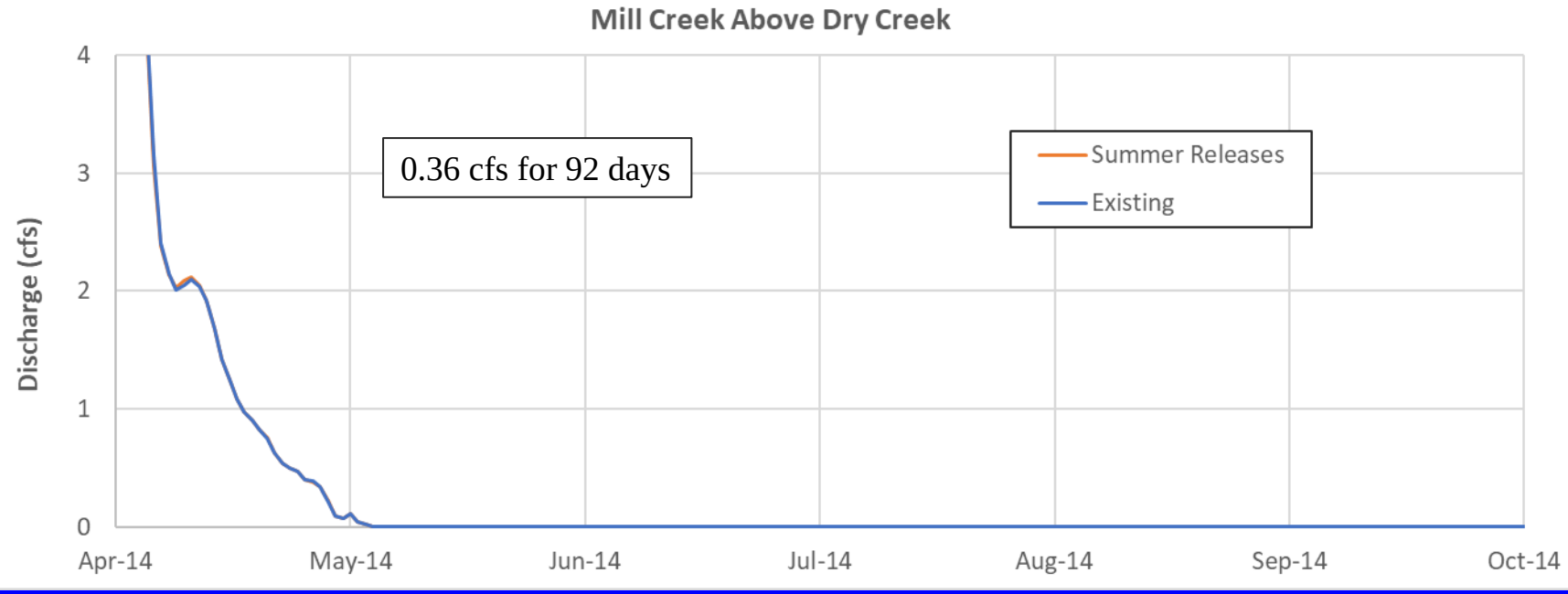
Scenario Analysis – Pond Releases

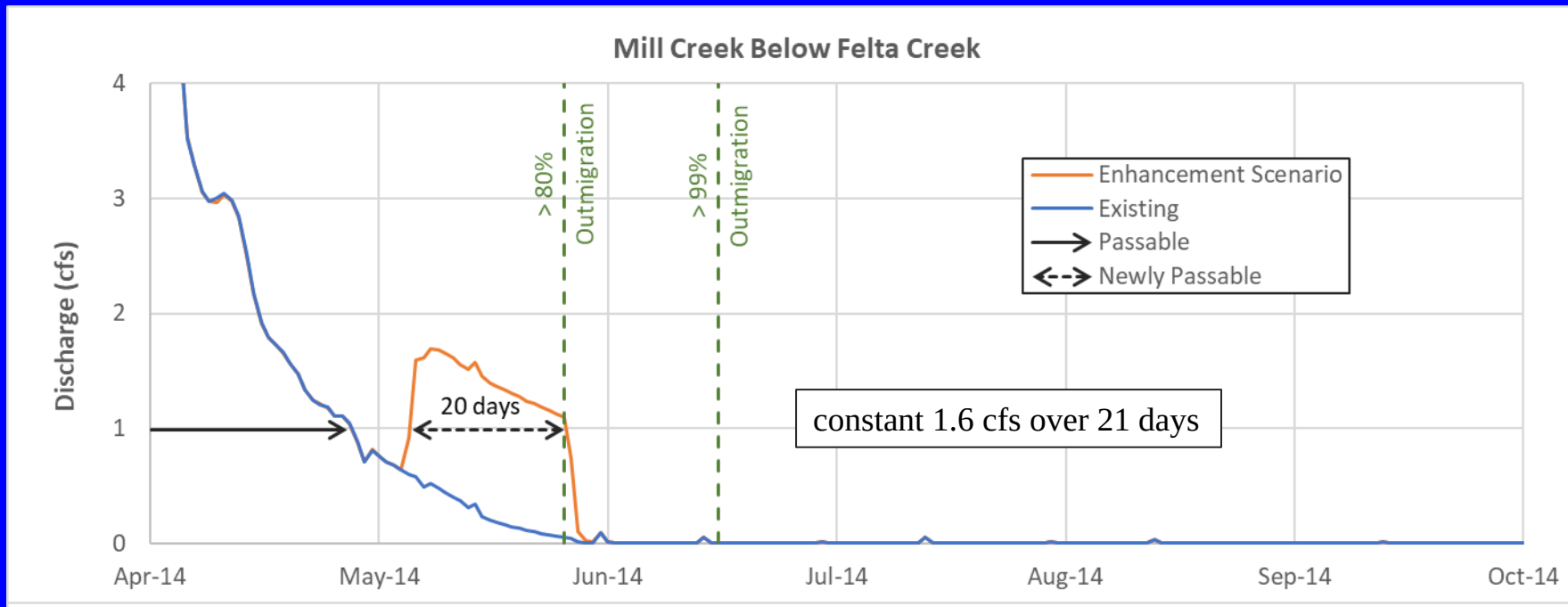


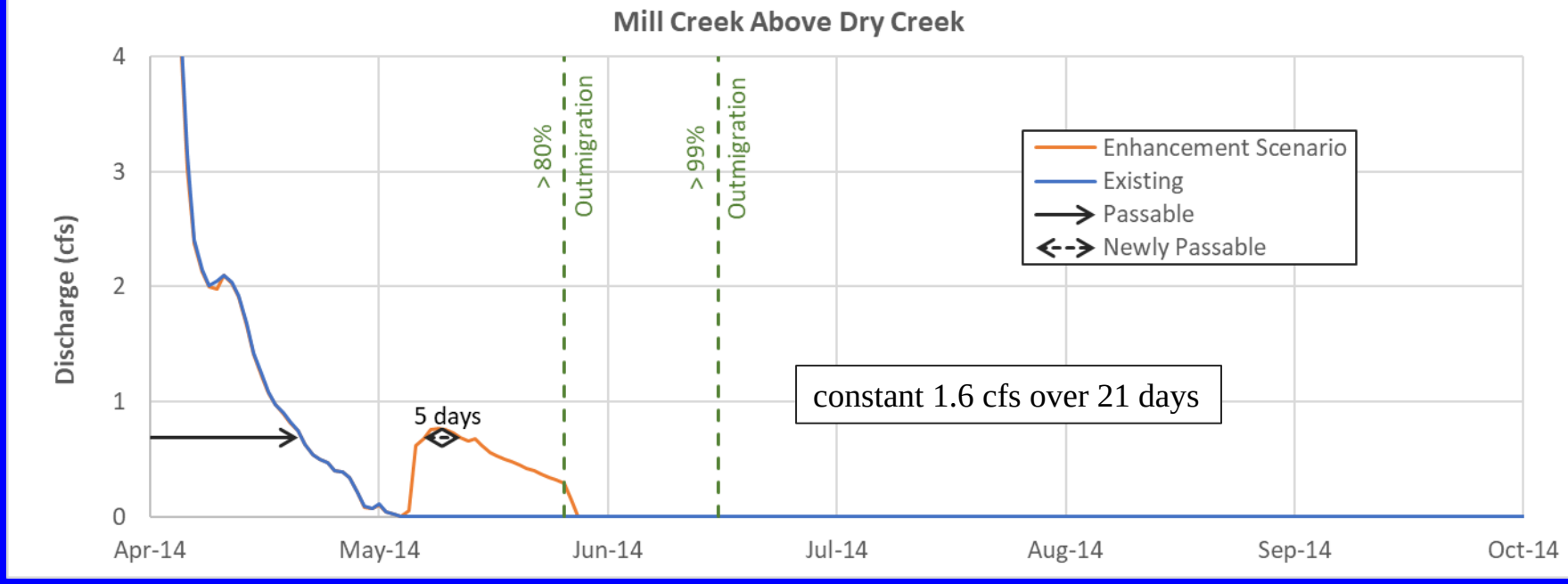

Mill Creek Above Wallace Creek
Discharge (cfs)
4
3
2
1
0
0.09 cfs for 92 days
Summer Releases
Existing
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14

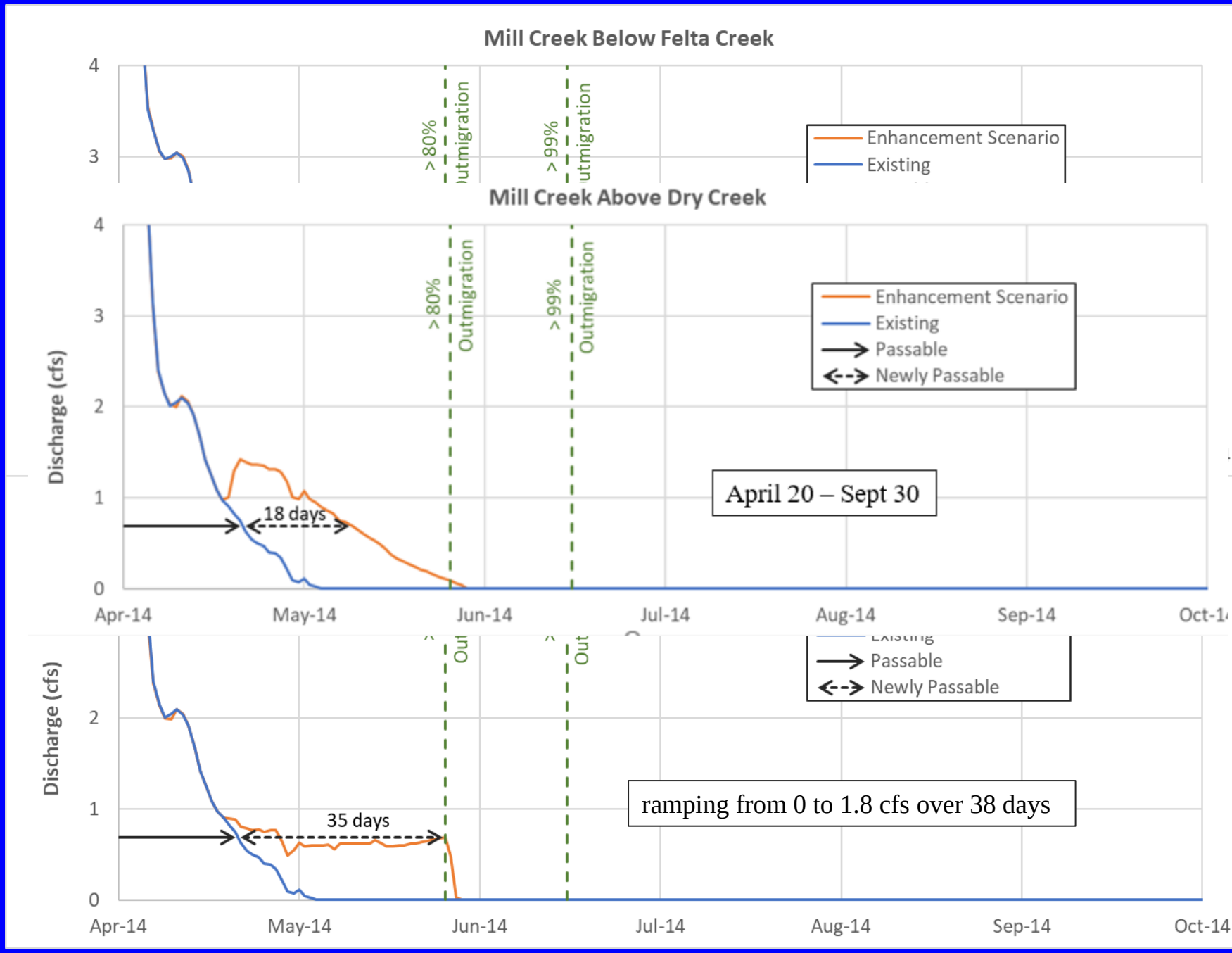

Mill Creek Above the Falls
Discharge (cfs)
4
3
2
1
0
0.36 cfs for 92 days
Summer Releases
Existing
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14


Mill Creek Below Felta Creek
Discharge (cfs)
4
3
2
1
0
0.36 cfs for 92 days
Summer Releases
Existing
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14


Mill Creek Above Dry Creek
Discharge (cfs)
4
3
2
1
0
0.36 cfs for 92 days
Summer Releases
Existing
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14


Mill Creek Below Felta Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
> 80% Outmigration
> 99% Outmigration
20 days
constant 1.6 cfs over 21 days
Enhancement Scenario
Existing
Passable
Newly Passable


Mill Creek Above Dry Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
> 80% Outmigration
> 99% Outmigration
5 days
constant 1.6 cfs over 21 days
Enhancement Scenario
Existing
Passable
Newly Passable


Mill Creek Below Felta Creek
4
3
> 80% Outmigration
> 99% Outmigration
Enhancement Scenario
Existing
Mill Creek Above Dry Creek
Discharge (cfs)
4
3
2
1
0
> 80% Outmigration
> 99% Outmigration
Enhancement Scenario
Existing
Passable
Newly Passable
18 days
April 20 – Sept 30
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
Discharge (cfs)
2
1
0
Passable
Newly Passable
35 days
ramping from 0 to 1.8 cfs over 38 days
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14

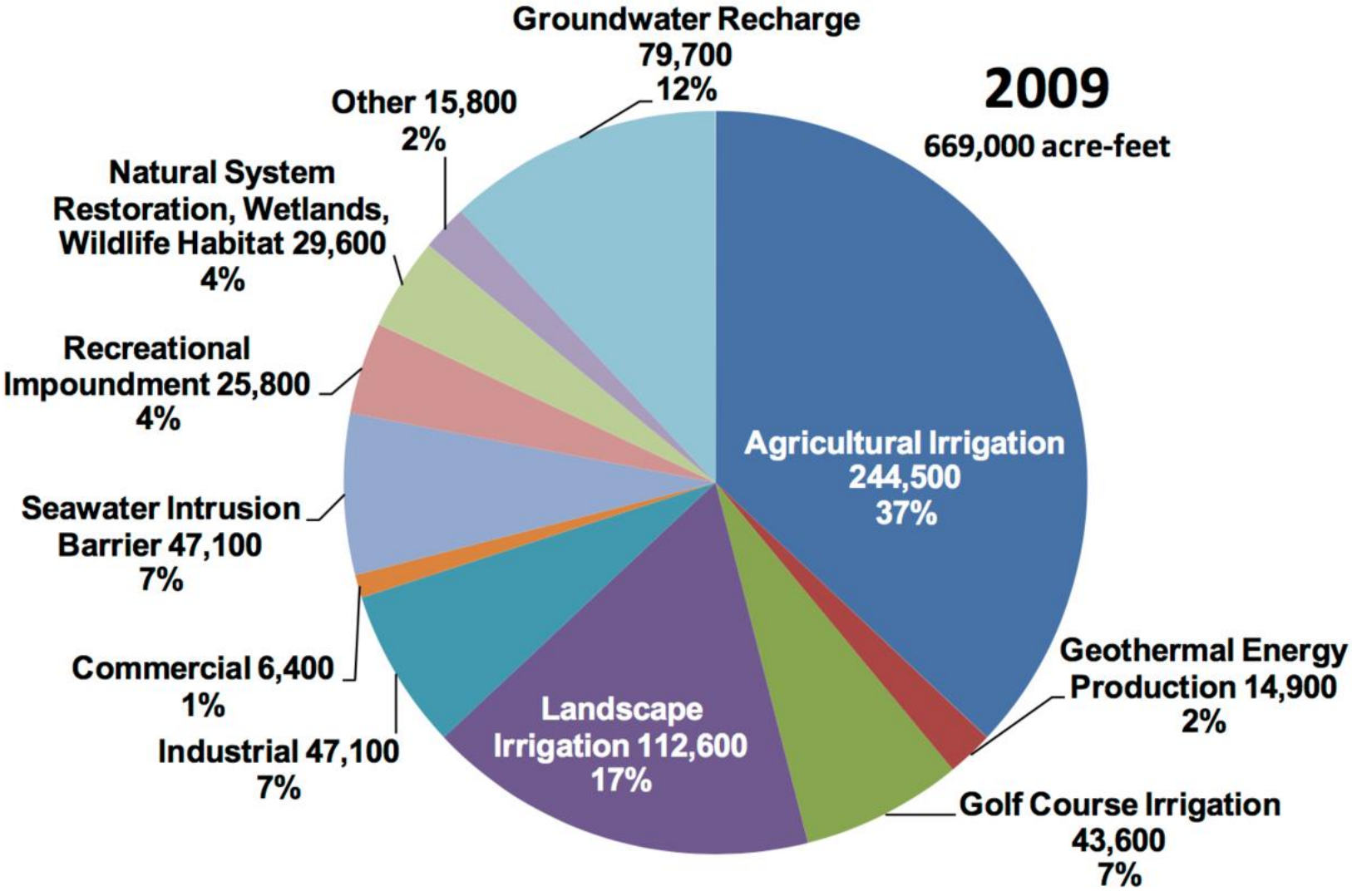
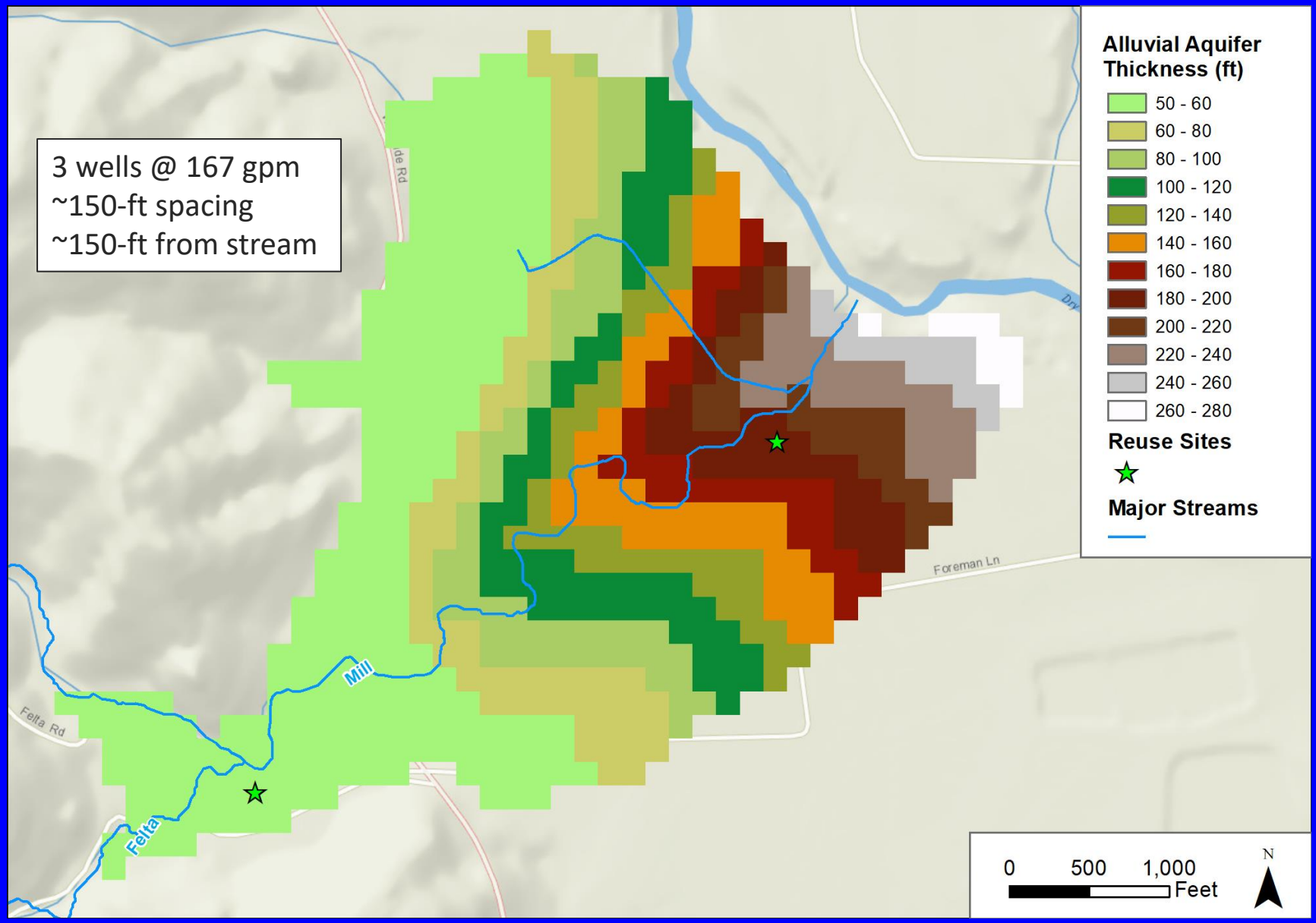


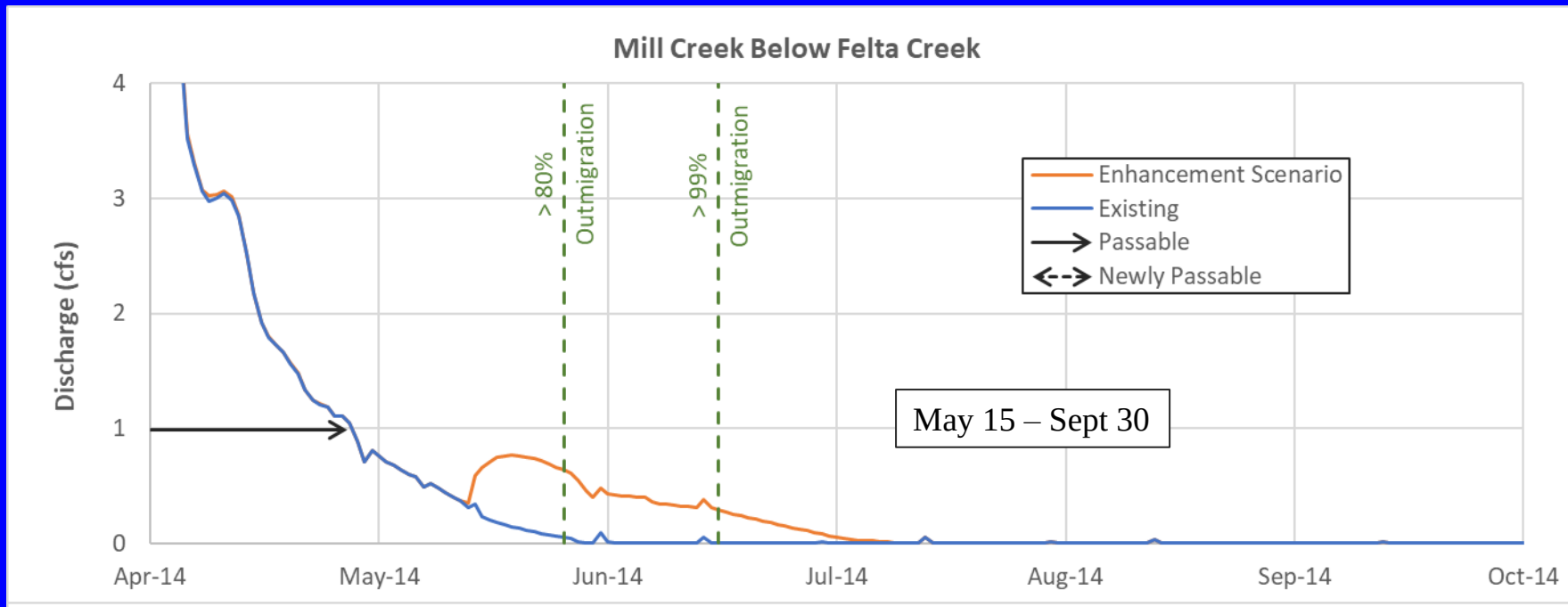
Figure 5-37
Uses of recycled water in Calif. (SWRCB 2011)

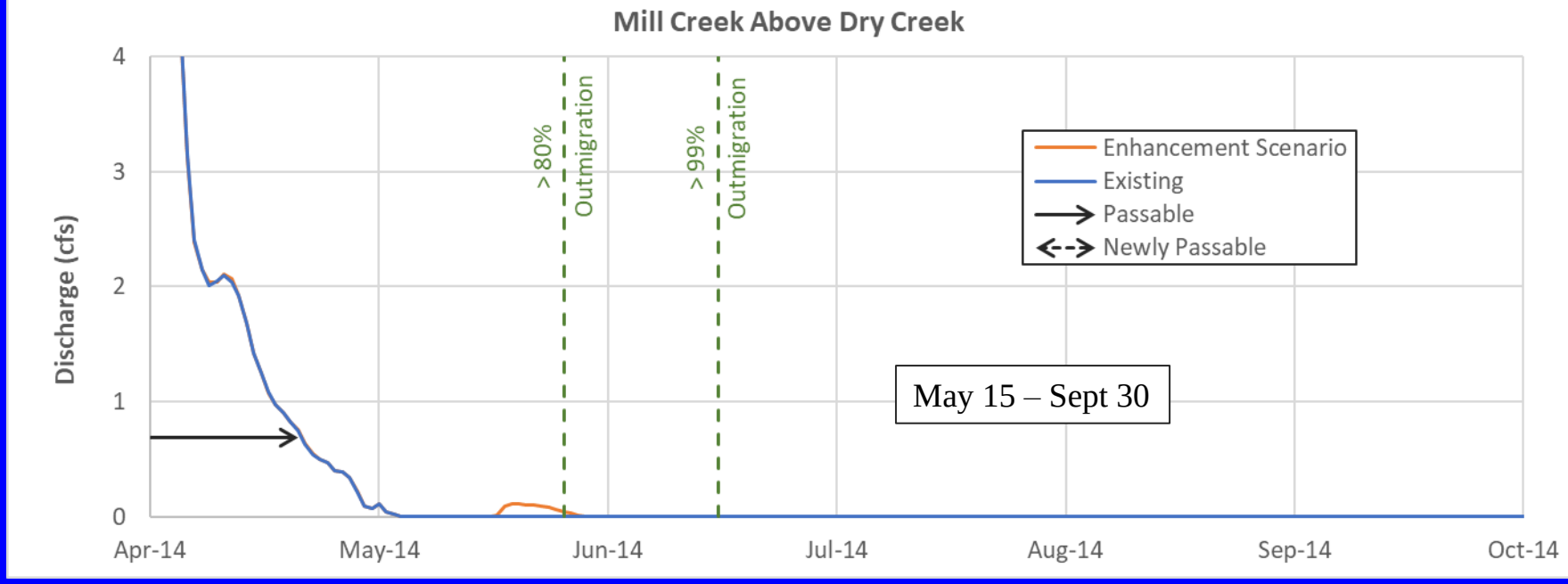
Scenario Analysis – Recycled Water

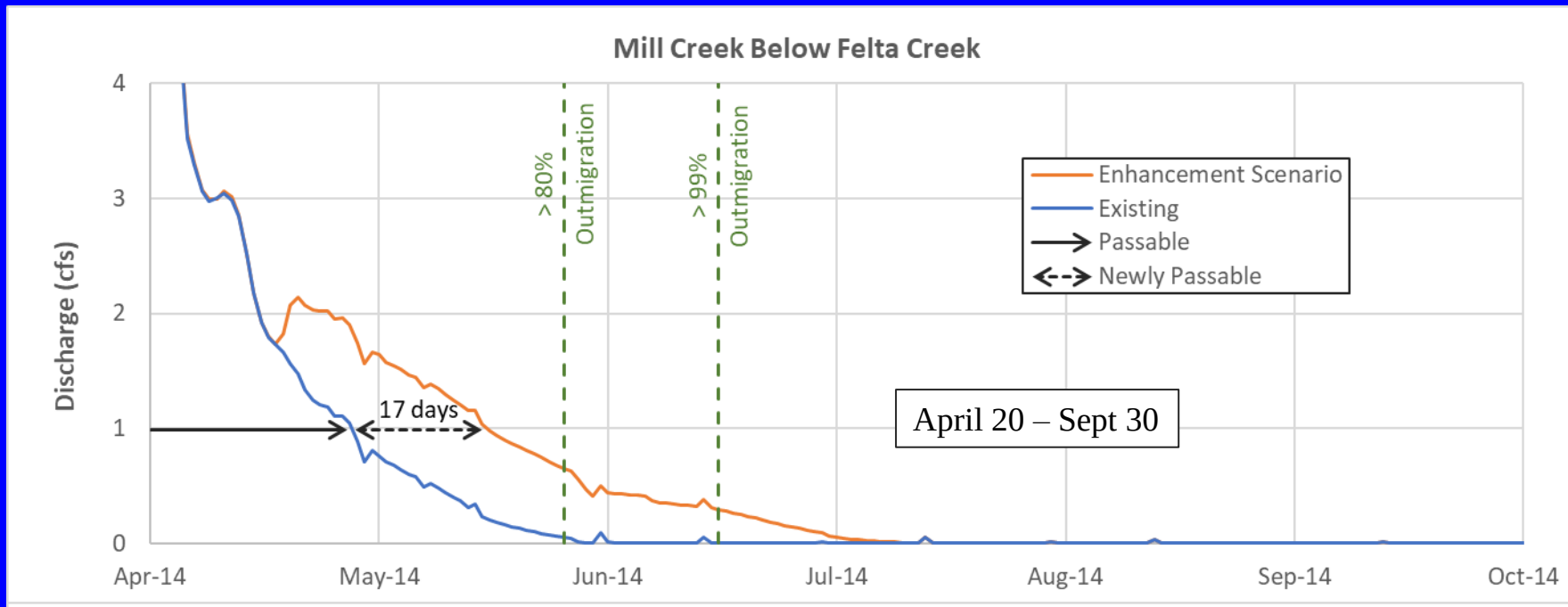
- Healdsburg Treatment Plant
  - 430 ac-ft/yr available May 15 – Sept 30
  - 123 ac-ft/yr already allocated (21 ac-ft/yr in lower Mill)
  - Existing pipeline down Foreman Lane
- Irrigation
  - Irrigation of 196 acers of vineyard and 4 acres of pasture
  - 85 ac-ft/yr groundwater pumping offset
- Recharge/streamflow Enhancement
  - Injection wells
  - Infiltration basins (coming soon)
  - 500 gpm (1.1 cfs) available

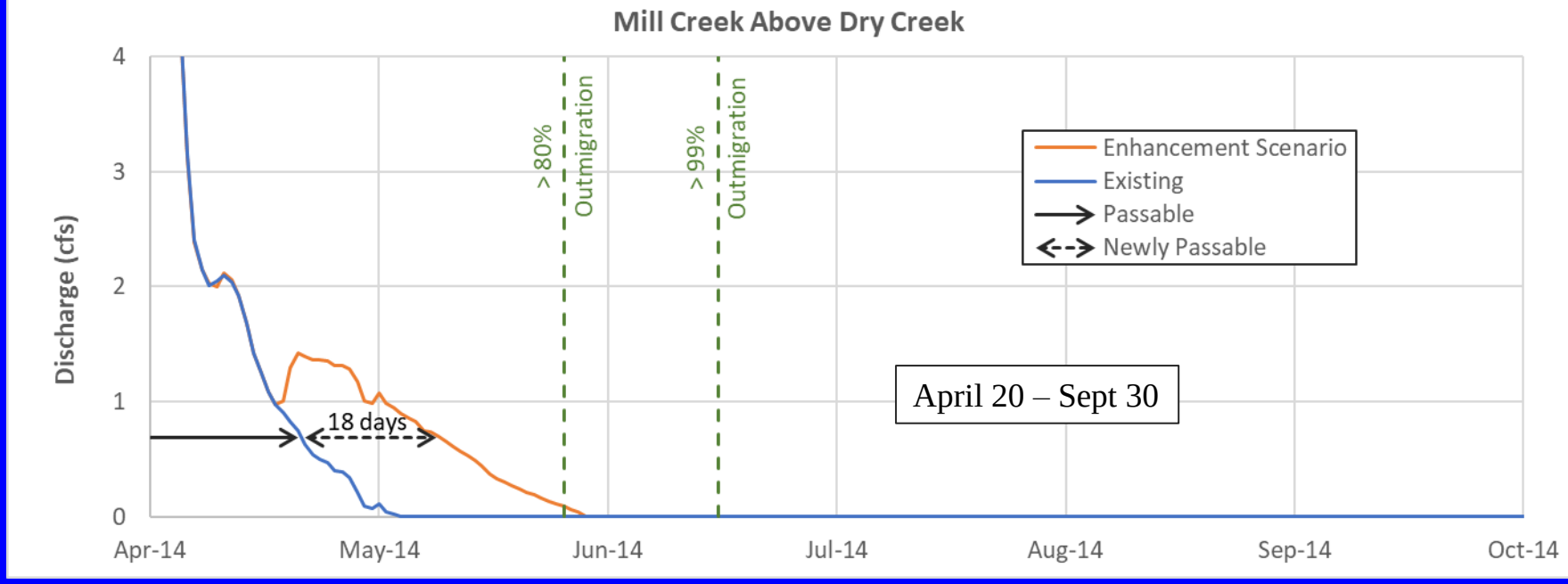
Scenario Analysis – Recycled Water

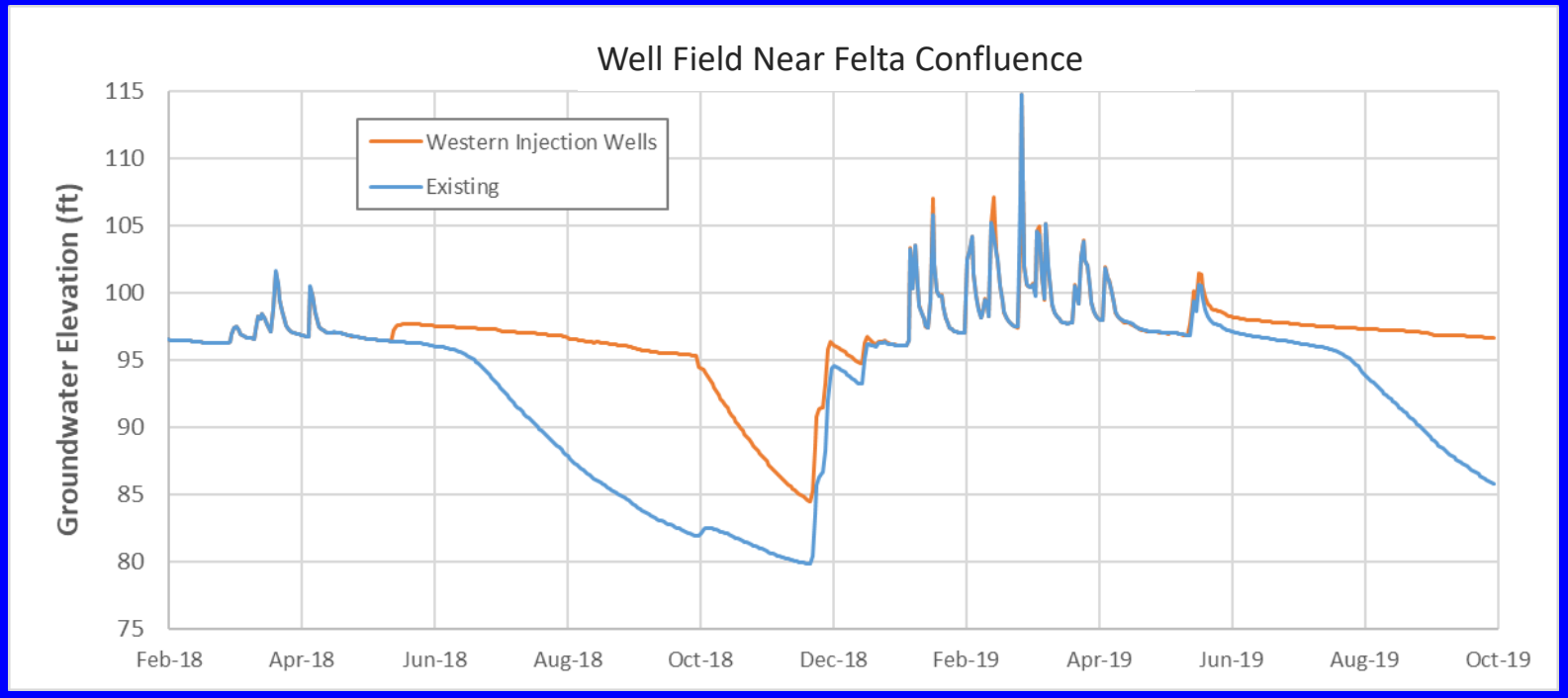


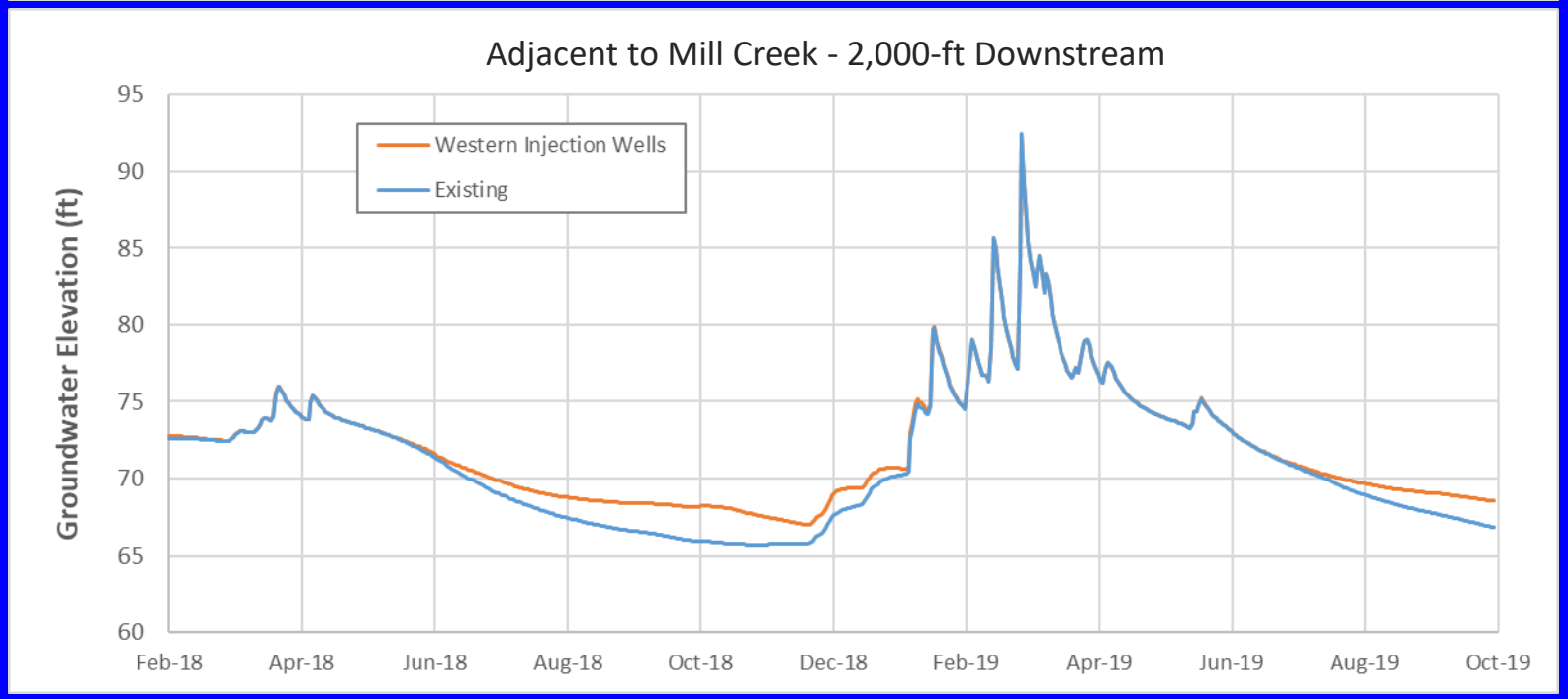

Mill Creek Below Felta Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
> 80% Outmigration
> 99% Outmigration
Enhancement Scenario
Existing
Passable
Newly Passable
May 15 – Sept 30

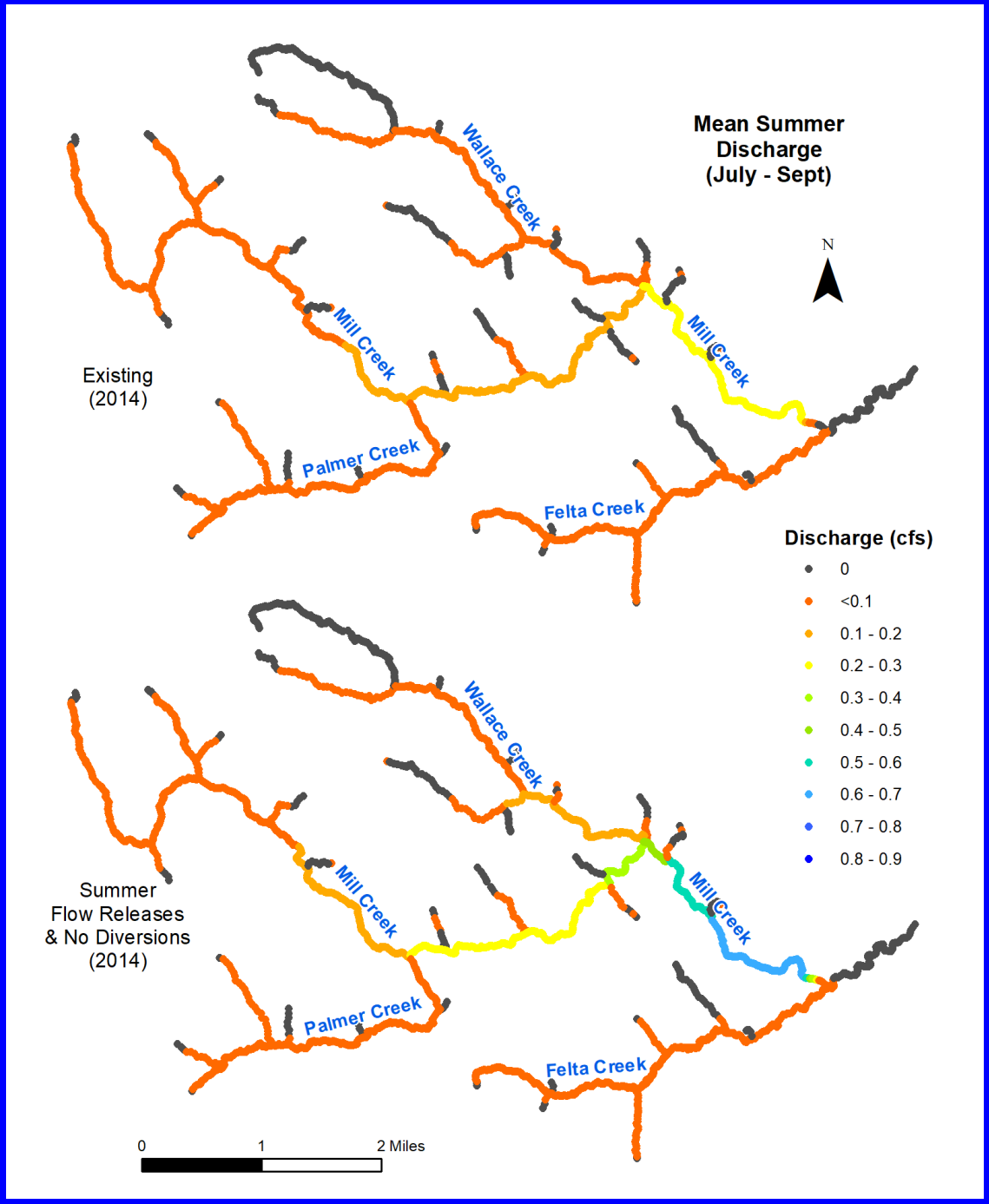

Mill Creek Above Dry Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
> 80% Outmigration
> 99% Outmigration
Enhancement Scenario
Existing
Passable
Newly Passable
May 15 – Sept 30


Mill Creek Below Felta Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
> 80% Outmigration
> 99% Outmigration
Enhancement Scenario
Existing
Passable
Newly Passable
17 days
April 20 – Sept 30

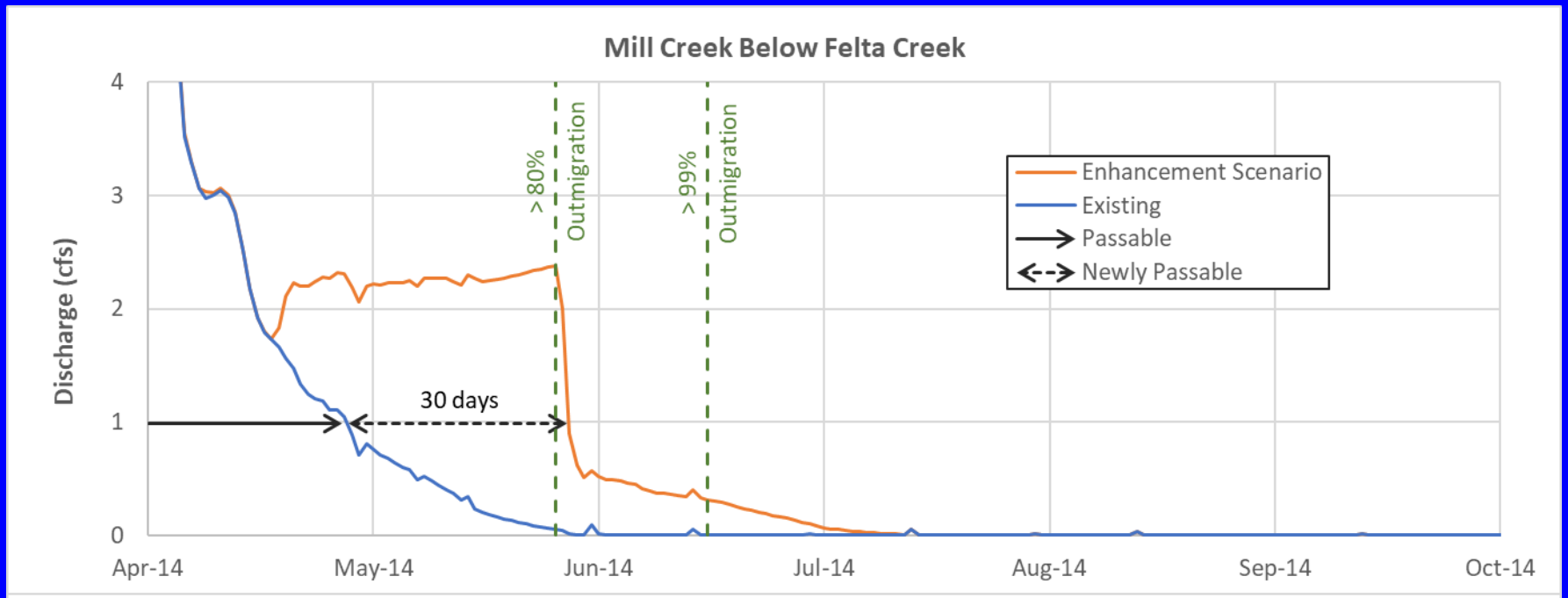

Mill Creek Above Dry Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
> 80% Outmigration
> 99% Outmigration
Enhancement Scenario
Existing
Passable
Newly Passable
18 days
April 20 – Sept 30

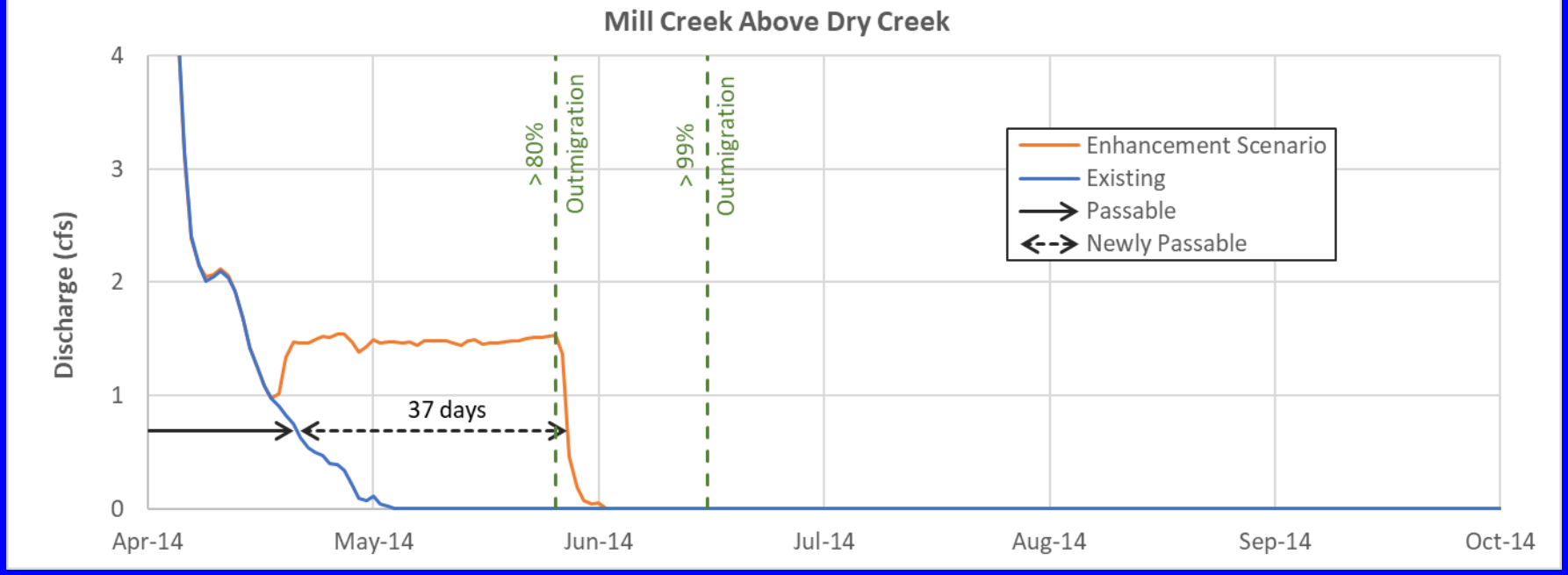

Well Field Near Felta Confluence
Western Injection Wells
Existing
Groundwater Elevation (ft)
115
110
105
100
95
90
85
80
75
Feb-18
Apr-18
Jun-18
Aug-18
Oct-18
Dec-18
Feb-19
Apr-19
Jun-19
Aug-19
Oct-19


Adjacent to Mill Creek - 2,000-ft Downstream
Western Injection Wells
Existing
Groundwater Elevation (ft)
95
90
85
80
75
70
65
60
Feb-18
Apr-18
Jun-18
Aug-18
Oct-18
Dec-18
Feb-19
Apr-19
Jun-19
Aug-19
Oct-19



Scenario Analysis – No Diversions & Summer Flow Releases


Mill Creek Below Felta Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
> 80% Outmigration
> 99% Outmigration
30 days
Enhancement Scenario
Existing
Passable
Newly Passable


Mill Creek Above Dry Creek
Discharge (cfs)
4
3
2
1
0
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
> 80% Outmigration
> 99% Outmigration
37 days
Enhancement Scenario
Existing
Passable
Newly Passable

Other Enhancement Strategies

- Forest management for reduced fire risk and lower transpiration demands – Walbridge Fire
- Grassland compost application for carbon sequestration and recharge enhancement
- Runoff management for recharge enhancement

Scenario Analysis – Climate Change

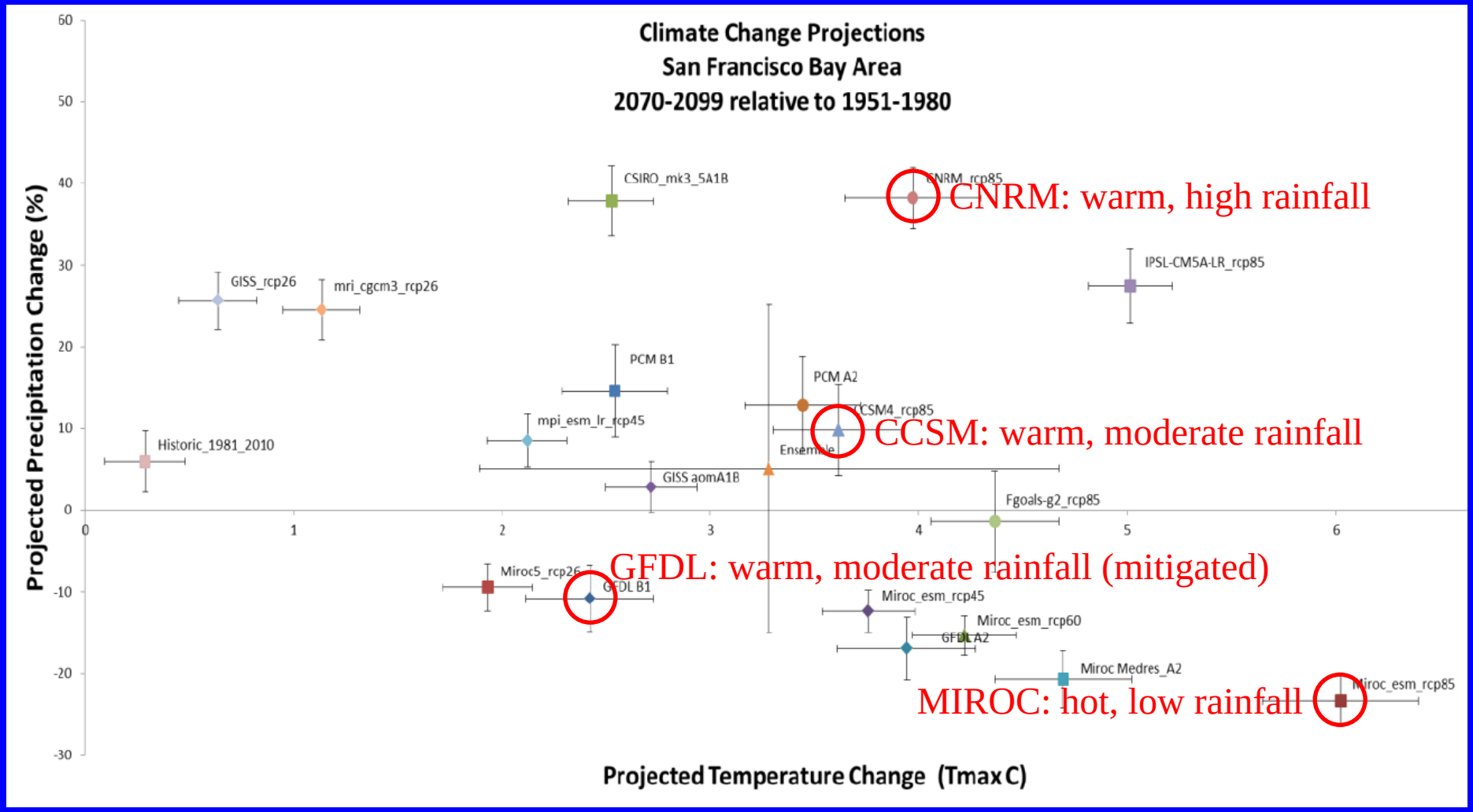
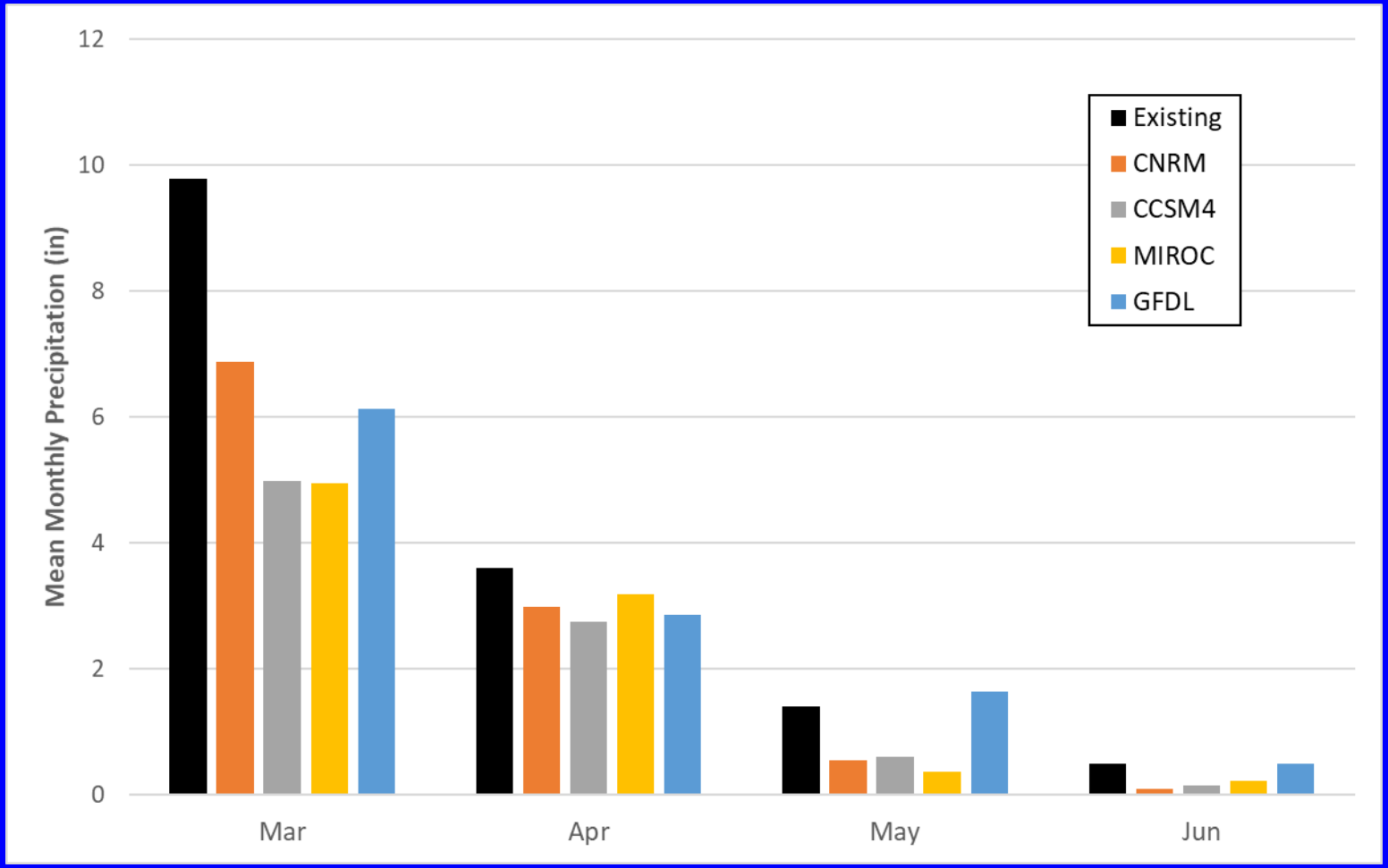


figure and selection of futures based on NCRP, Pepperwood, USGS

Scenario Analysis – Climate Change

- Increased rainfall seasonality = reduced springtime flows



Scenario Summary

- Surface water diversions may be resulting in short-term flow disconnection in portions of middle Mill Creek – not in lower Mill
- Groundwater pumping impacts on streamflow are minimal
- Summer pond releases can significantly enhance summer streamflow (but not in lower Mill)
- Spring pond release can significantly improve outmigration conditions in lower Mill
  - Major benefits to adaptive management/optimized releases
- Reuse of recycled water with injection wells can significantly improve outmigration in lower Mill if located in the upper alluvial reach and started early

Overall Recommendations

- Implement LWD and off-channel enhancement projects in the identified core areas of Mill and lower Palmer creeks
- Pond release projects are the 'low hanging fruit' – ability to adaptively respond to climate change
  - Hurdles: landowner willingness, temperature control, water rights, invasive species
- Replace direct diversions where possible
- Recycled water recharge/flow enhancement feasibility study
- Post-fire streamflow monitoring & adaptive management
- Additional post-fire & forest management hydrologic analysis

Final Questions/Discussion