SAN JOAQUIN RIVER RESTORATION PROGRAM

Seepage and Conveyance Technical Feedback Group Meeting

January 23, 2017

Patti Ransdell

INTRODUCTION

Agenda

- Introductions, Meeting Agenda
- SJRRP Updates
- Thresholds Overview
- Capillary Fringe Buffer, Almond Root Zone
- Lateral Gradient Buffers
- Historical Groundwater Method Thresholds
- Questions, Wrap-Up, Action Items

Katrina Harrison

RESTORATION PROGRAM UPDATE

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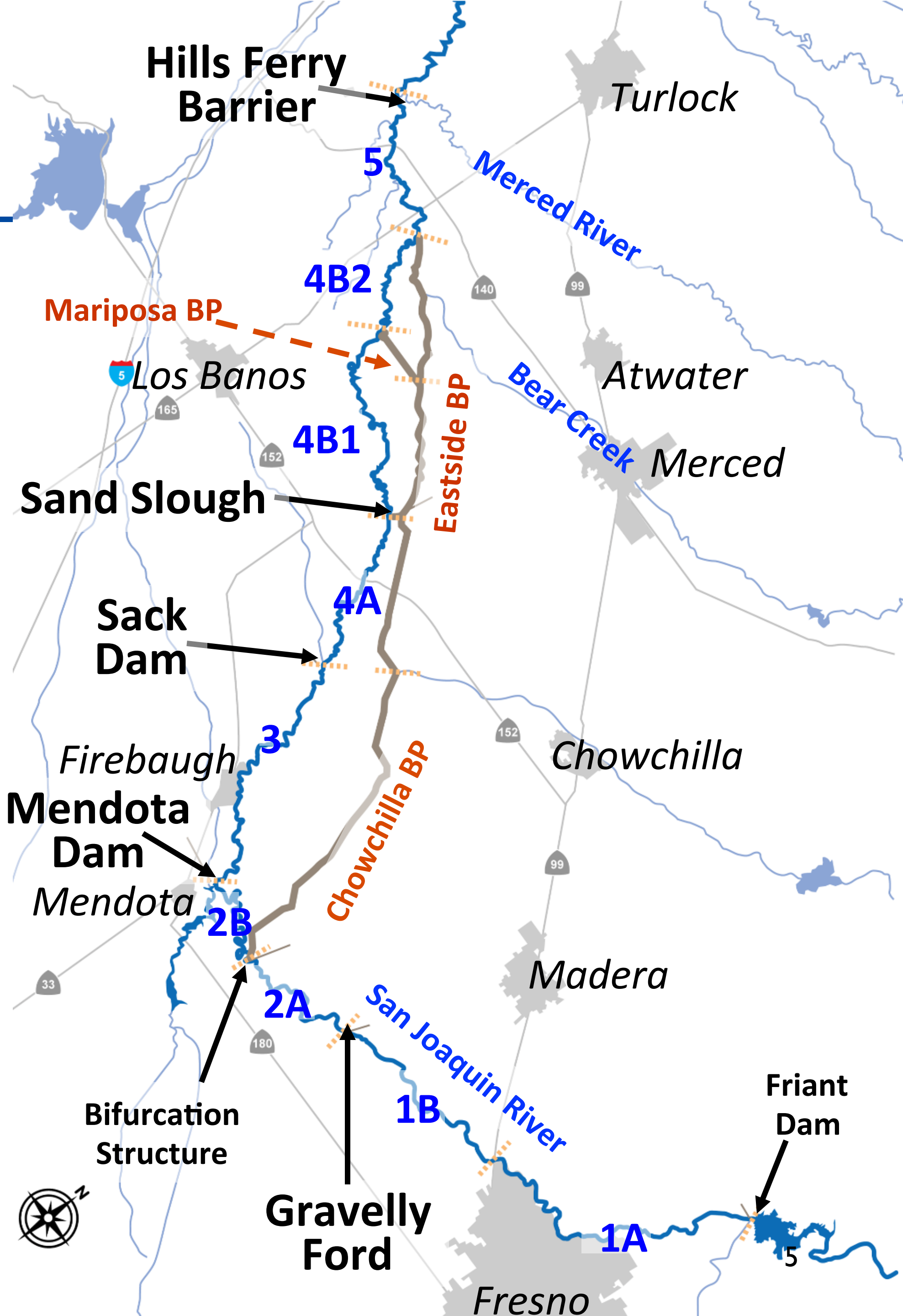
- WY 2016: Normal Dry Year Type
- Water Year 2017: Wet Year Type
  - Flood control releases
  - Longer Restoration Flows after flood releases stop



Preliminary draft – subject to change

Restoration Flows

- Flood flows released from Millerton starting January 4, 2017 – no Restoration Flows
- Restoration Flows will begin again targeting 150 cfs of flow at Sack Dam when flood flows are complete
- Restoration Administrator anticipated to request increase in flows to ~300 cfs below Sack Dam in March 2017

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Seepage Projects Update

- Reclamation completed a seepage easement on land adjacent to the Eastside Bypass on October 25, 2016
  - Anticipated to allow approximately 300 cfs below Sack Dam depending on groundwater levels
- Two additional seepage easements are in progress in Reach 4A

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Seepage Environmental Assessment

- Draft EA posted for public comment on December 22, 2016
  - Environmental compliance coverage of seepage easements
  - Environmental compliance coverage of the Seepage Management Plan changes we will discuss today
- Comments due January 30, 2017

Other Project Updates

- Record of Decision signed for the Mendota Pool Bypass and Reach 2B Project
  - Construction to start late 2017
- Construction underway
  - Hatchery Water Supply Line
  - Madera Low-Flow Valve
- Construction completed
  - Sand Removal in the Eastside Bypass

Schedule of Key Construction Actions in Framework

2015-2019	2020-2024	2025-2029	2030+
Goal: 1,300 cfs Capacity in all Reaches	**Goal: Increased Capacity**	**Goal: Phase 1 Projects Complete**	**Goal: All Remaining Projects Complete**
• Friant-Kern Capacity Restoration • Friant-Kern Canal Reverse Pumps • Madera Canal Capacity Restoration • Mendota Pool Bypass • Temporary Arroyo Canal Screen • Conservation Facility / Hatchery • Seepage Projects to 1,300 cfs	• Financial Assistance for Groundwater Banks • Reach 2B • Arroyo Canal and Sack Dam • Reach 4B Land Acquisition • Seepage Projects to 2,500 cfs • Levee Stability to 2,500 cfs	• Reach 4B • Salt and Mud Sloughs • Chowchilla Bifurcation Structure Improvements (DWR) • Gravel Pit Isolation (DWR) • Seepage Projects to 4,500 cfs • Levee Stability to 4,500 cfs	• Ongoing Operations and Maintenance

Katrina Harrison

THRESHOLDS OVERVIEW

Purpose of Today

- Receive input on proposed groundwater seepage threshold changes

- Almond Root Zone
- Capillary Fringe
- Lateral Gradient Buffers
- Historical Groundwater Method

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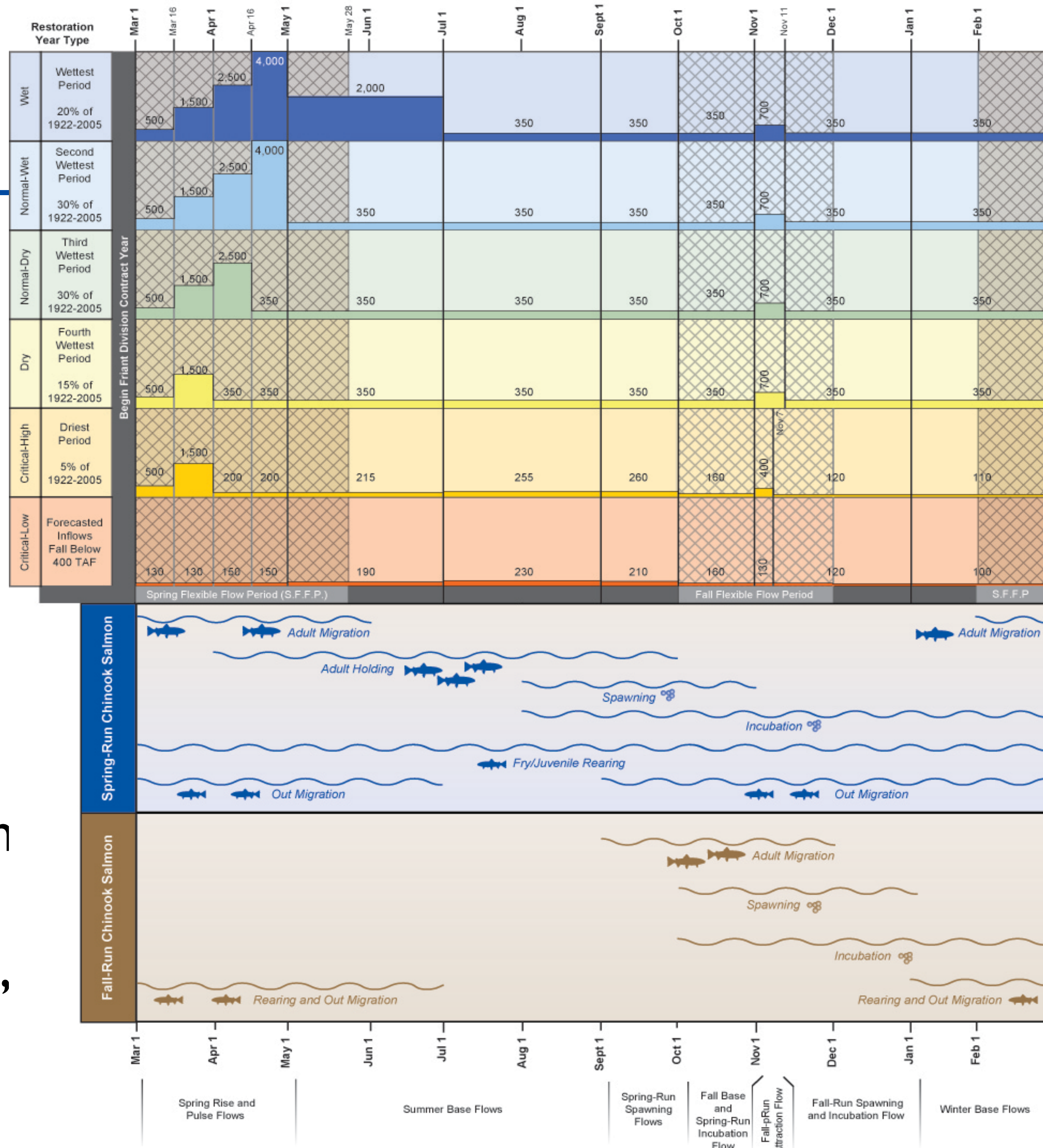
Restoration Flow Schedule

- Flexible flow periods
- Restoration Administrator
- Interim Flow monitoring program
- All flows released up to "then existing" channel capacity



Seepage Management Plan (SMP)

- "Then existing" channel capacity includes seepage
- The SMP influences flows, one of the 3 pieces of the Restoration Goal

- SMP was developed in collaboration with landowners and other members of the SCTFG
- Peer review to independently check
- Revisions to SMP in late 2012 based on peer review recommendations

Purpose and Objective

- The SMP describes
  - Monitoring and operating guidelines to reduce Restoration Flows to address adverse material impacts (per our PEIS/R)
  - Identify projects to increase flows while avoiding seepage impacts
- Meant to be dynamic and adaptive
- Objective: convey Restoration/Interim Flows while avoiding seepage impacts

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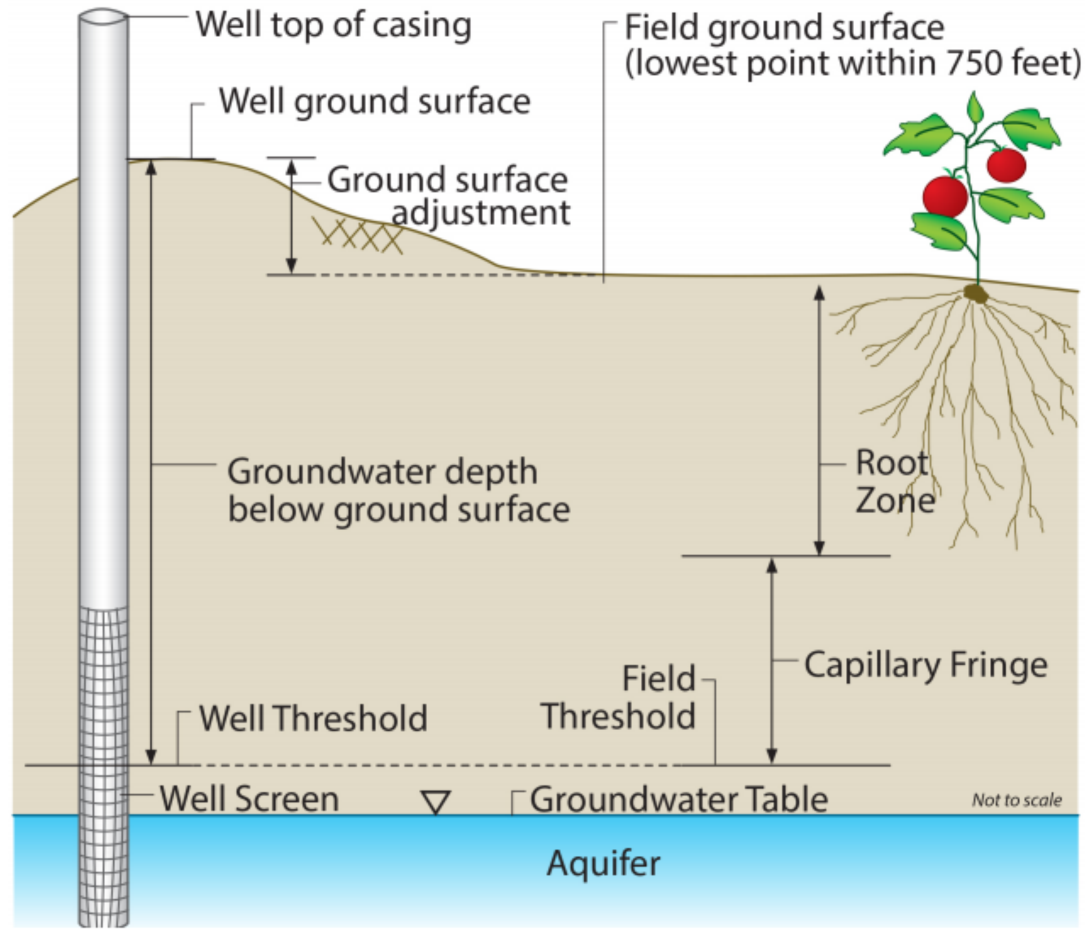
Thresholds

- Thresholds identify potential problems so that Reclamation can establish operating criteria to manage flows
- Two thresholds methods
  - Agricultural conditions
  - Historical data
- Two calculation methods
  - 1:1 stage relationship
  - Drainage direction

Thresholds - Agricultural Method

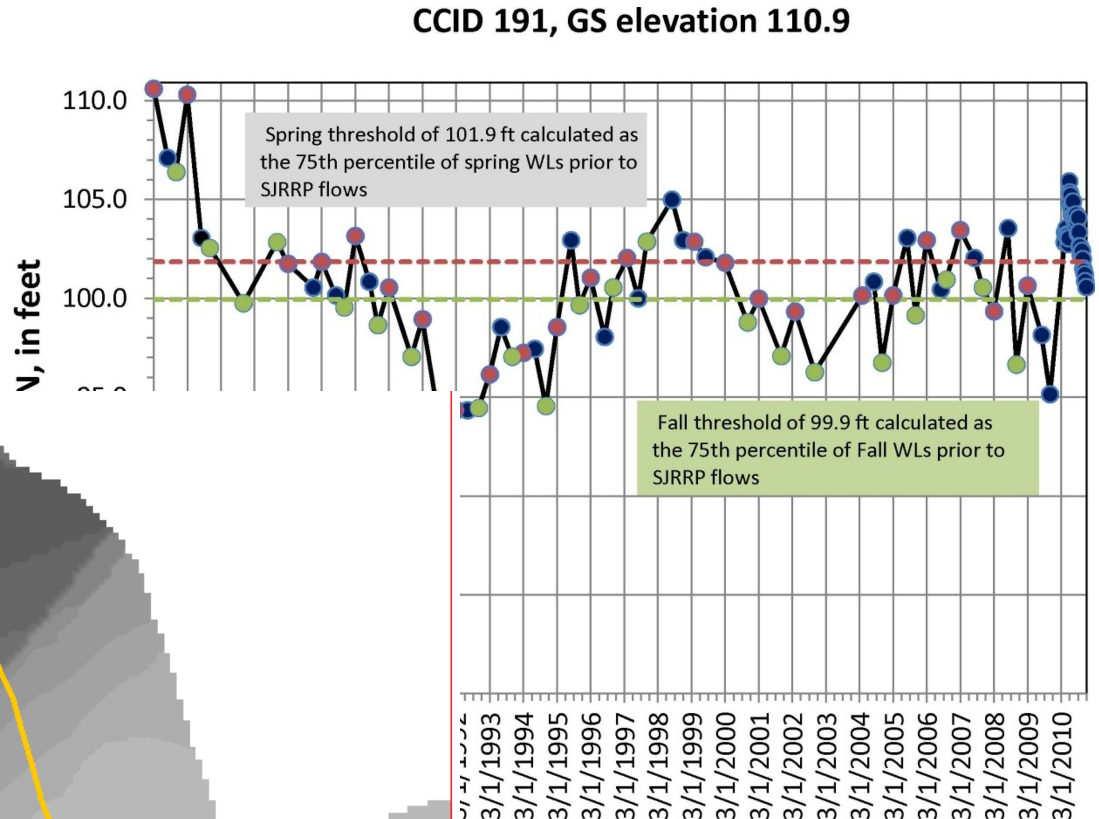
- Root Zone
- Capillary Fringe
- Ground Surface

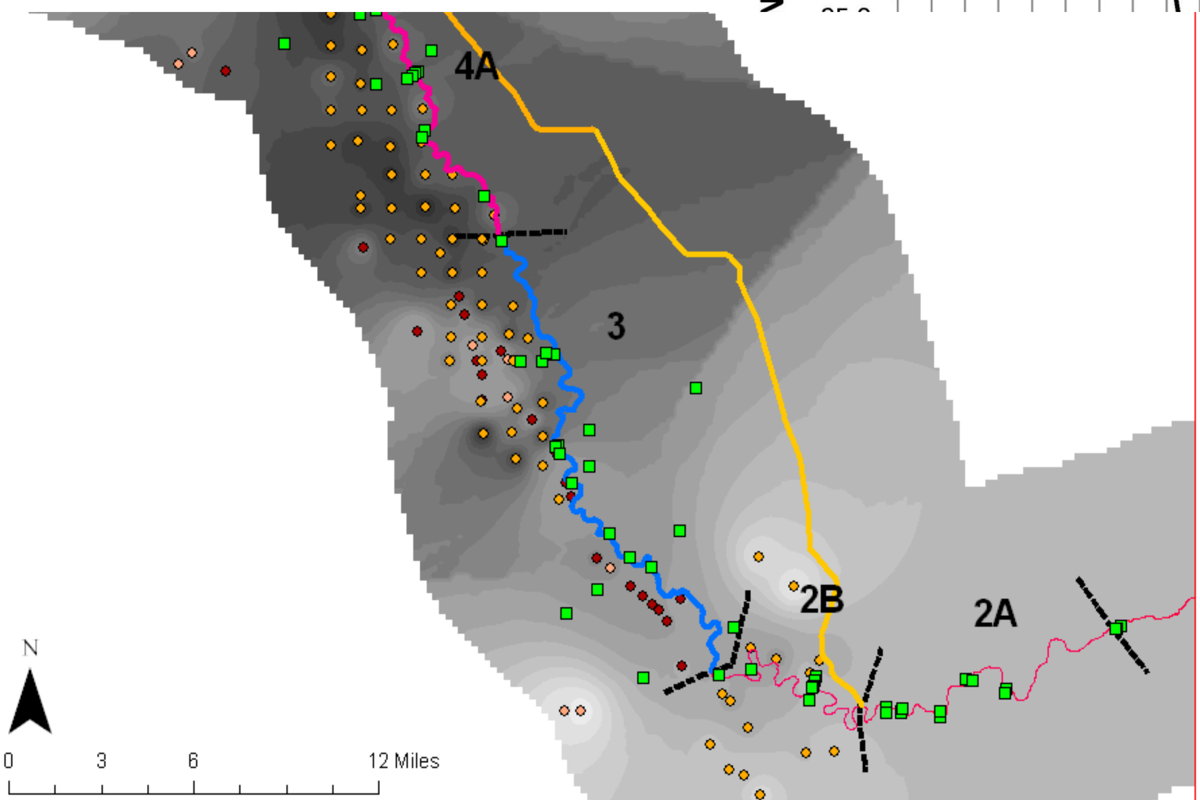
Crop Type	Root Zone (ft)
Annual Crop	4-5
Vines, etc.	6
Almond	9 (currently)



Thresholds – Historical Method

- CCID Well Database
- DWR Well Database
- 75th percentile or CCID average



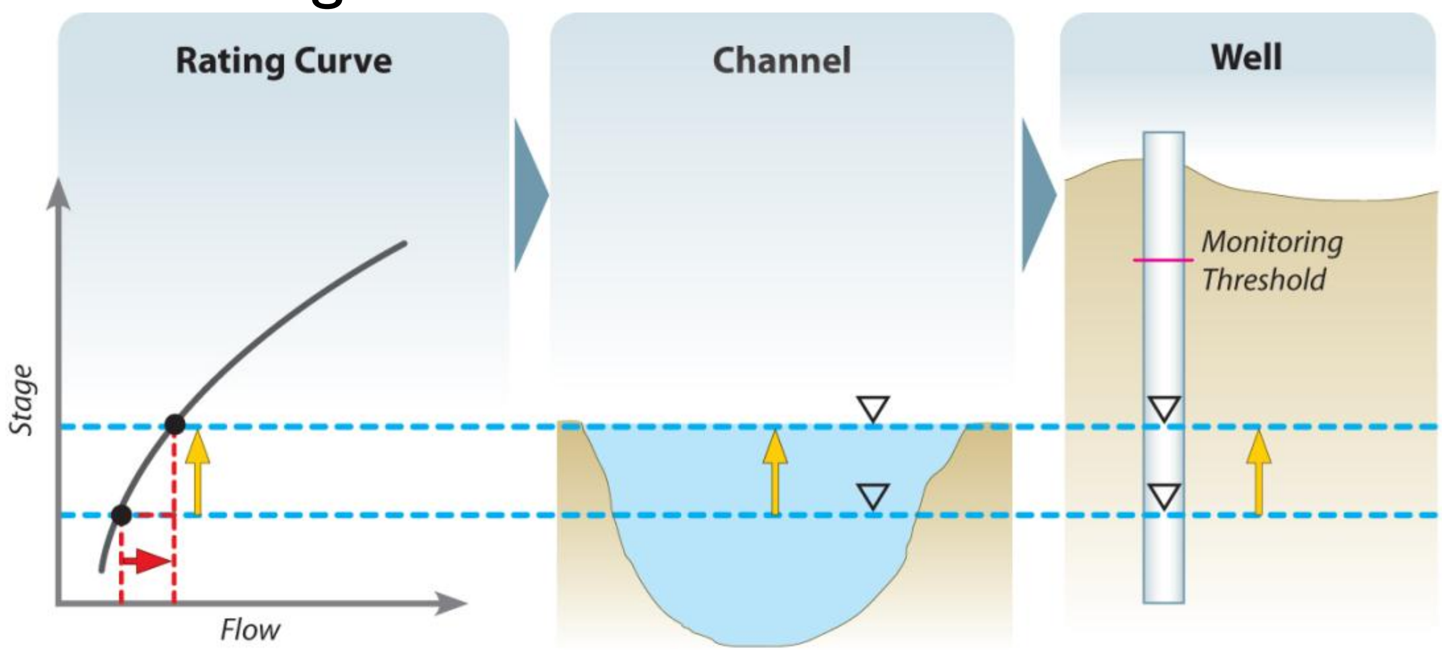


1:1 Stage Relationship

a) Determine increase in river stage from proposed flow increase

b) Assume increase in river = increase in groundwater

c) Add increase in groundwater to most recent observed groundwater level



Preliminary draft – subject to change

1:1 Stage Relationship

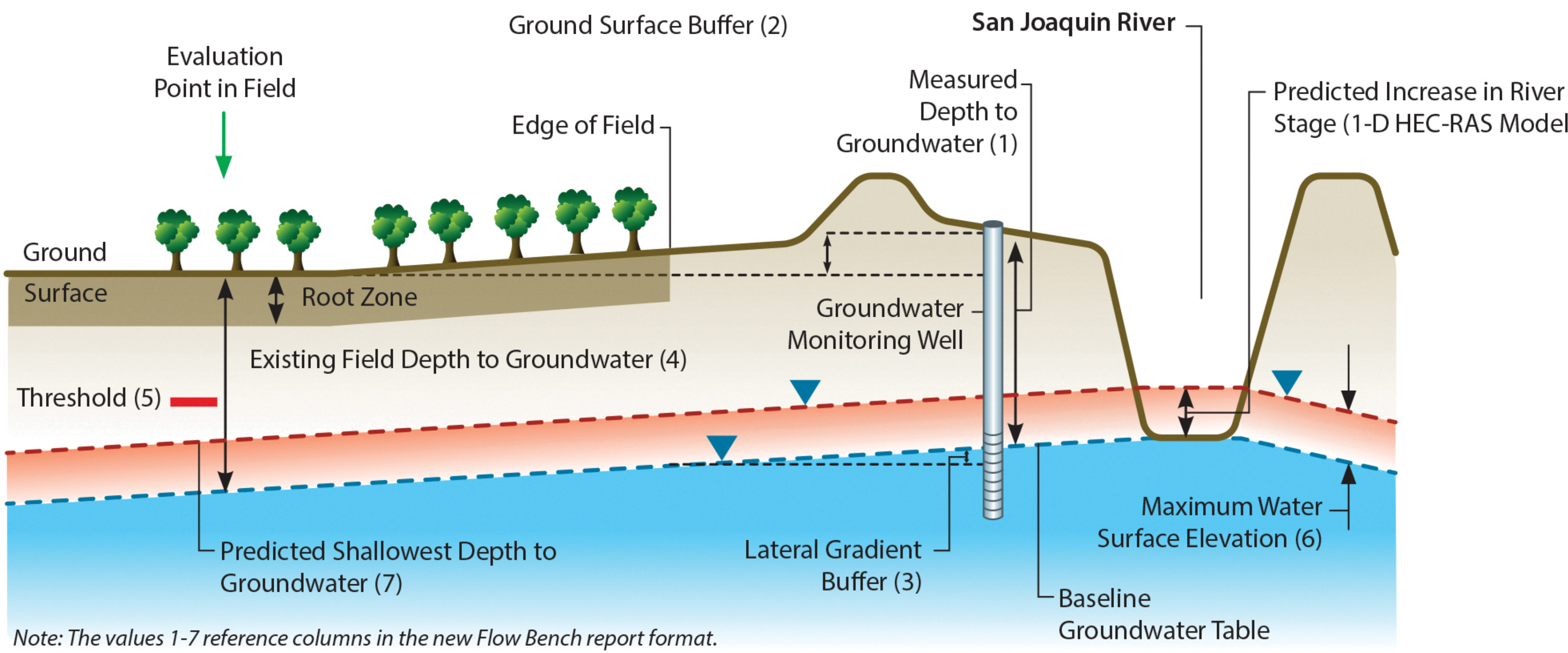
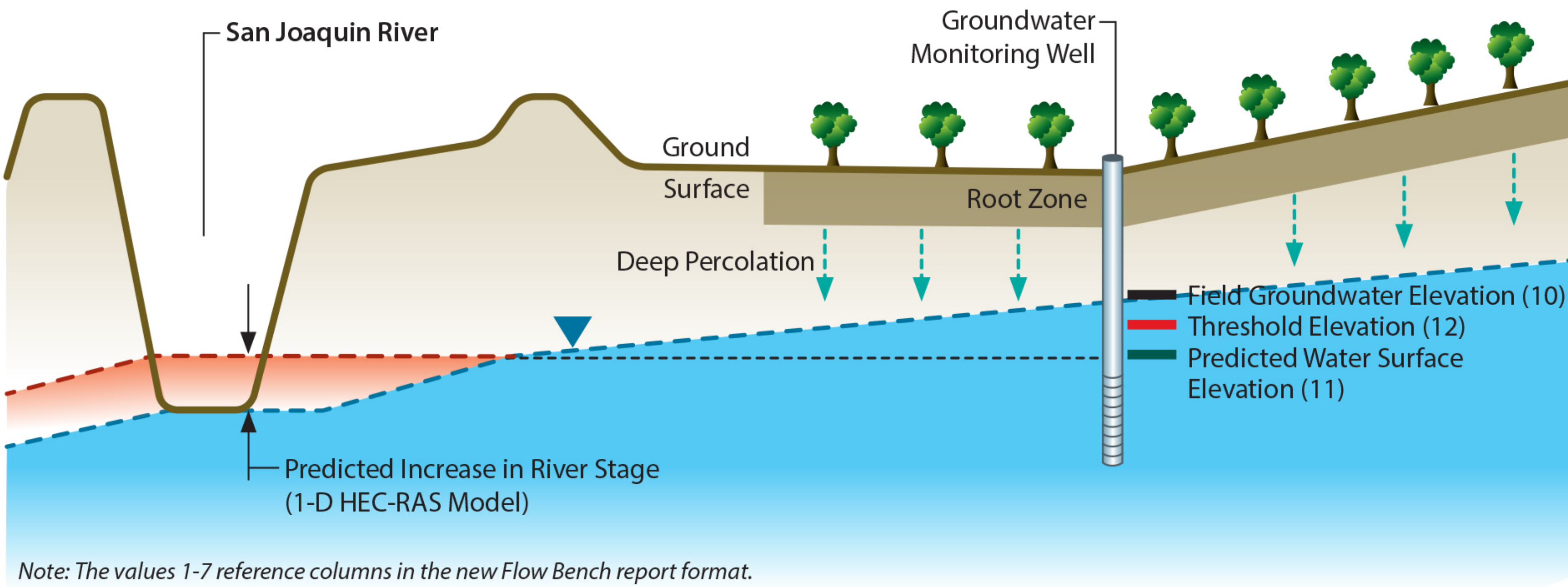


Figure J-2 from SMP Appendix J

Drainage Direction

- Gaining reaches
- Groundwater threshold elevation
- River water surface elevation



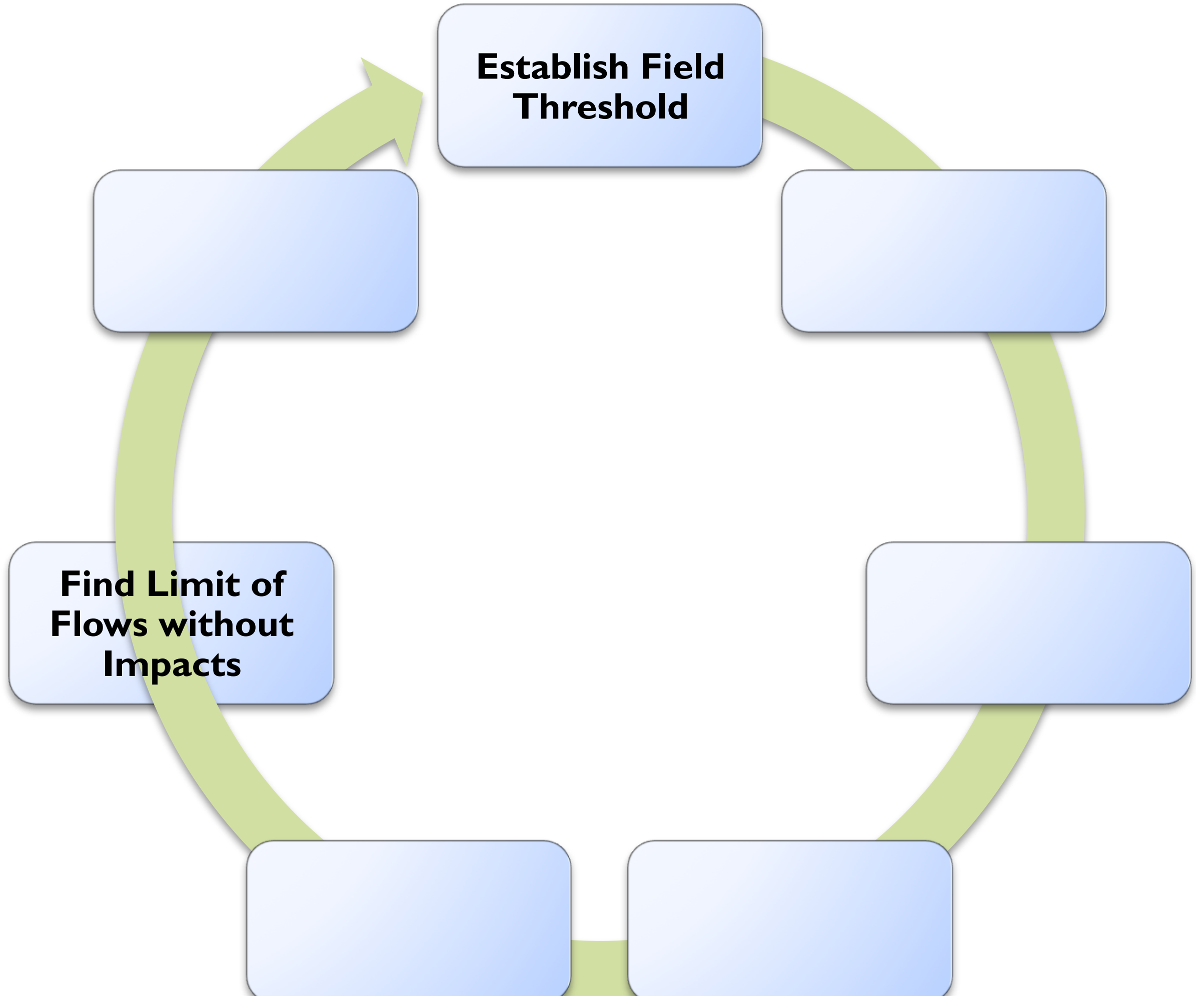
Triggers, Site Visit, and Response

- Monitoring Data
- Triggers
  - Flow Bench Evaluations
  - Hotline Intake
- Site Visit
- Response

Seepage Hotline
916-978-4398

Iterative Approach to Increase Flows while Avoiding Impacts

- Flow Bench Evaluation
- Seepage Hotline



Proposed Changes

- Almond Root Zone
- Capillary Fringe
- Lateral Gradient Buffers
- Historical Groundwater Method

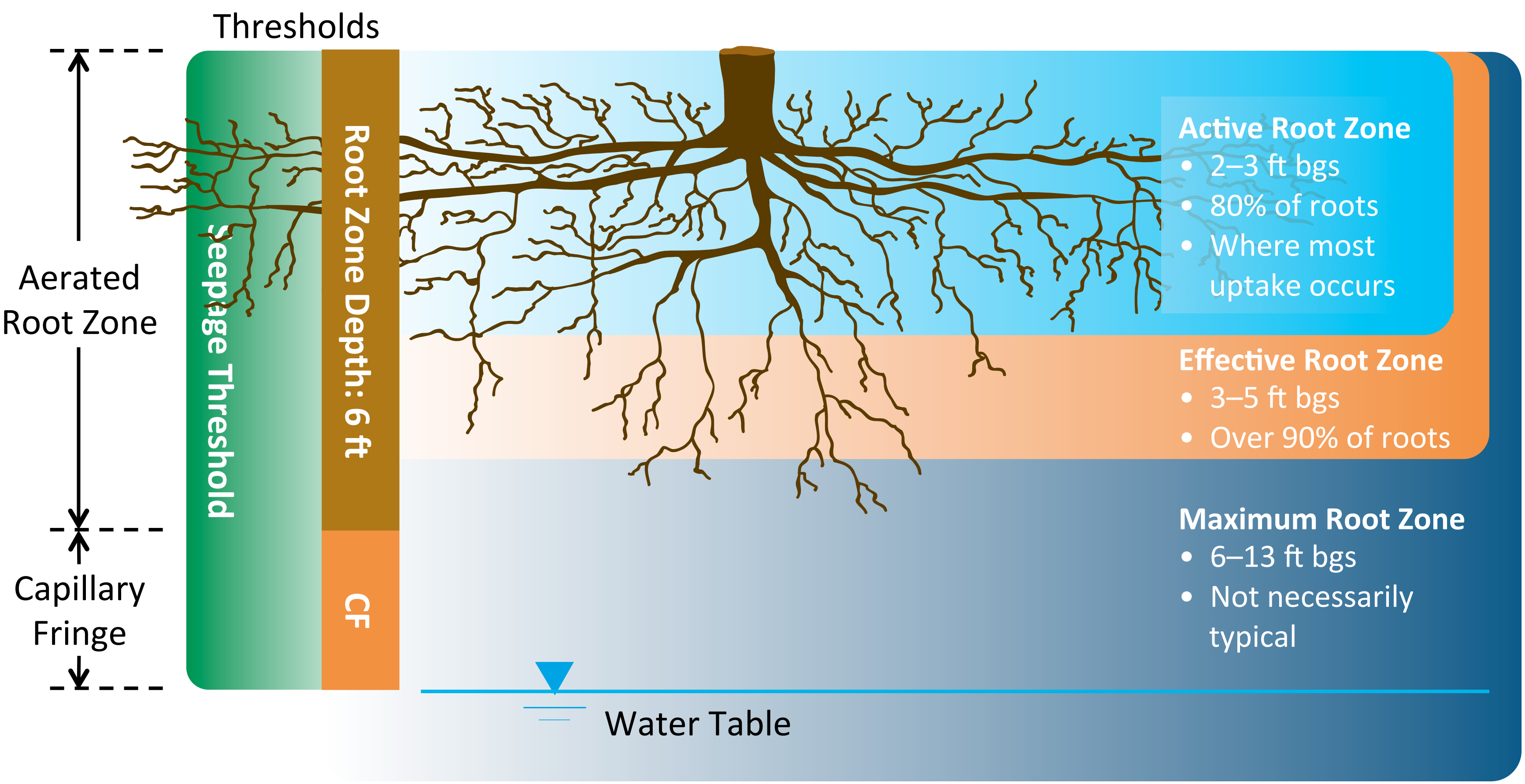
Stephanie Tillman, Mica Heilmann

ALMOND ROOT ZONE AND CAPILLARY FRINGE STUDY

Outline

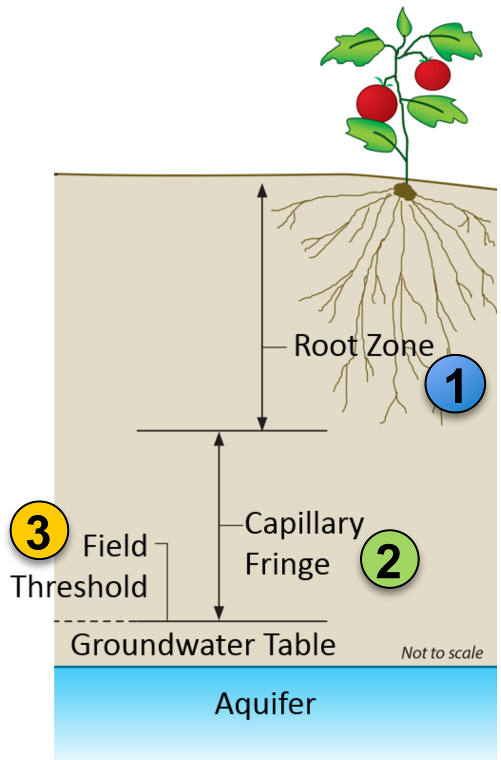
- Phase 1 - Root zone study conclusions
- Phase 2 - Capillary fringe study
  – Literature review
  – Expert input
  – Data review
  – Outcomes and recommendations

Root Zone Threshold Terms



Preliminary draft – subject to change

Threshold Calculation: Agricultural Practices Method



Root Zone Depth (1) + (2) = (3)

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March 2016 SCTFG – Conclusions

- Discussed 6-foot root zone for almonds
- Should be combined with appropriate capillary fringe depending on site-specific factors
- Capillary Fringe
  - Current SMP: capillary fringe is 6 inches or 1 foot
  - Need: Further refine the understanding of site specific capillary fringe

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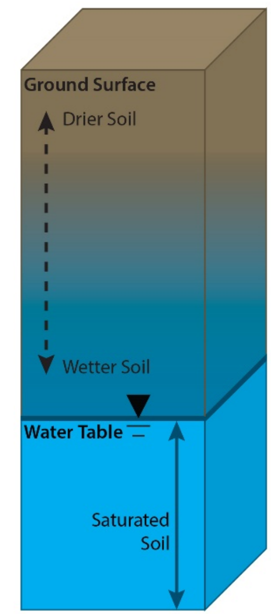
March 2016 SCTFG – Path Forward

- Capillary fringe arose out of Phase 1 efforts as an important topic
- Objectives:
  - Evaluate existing data and literature and identify data gaps that need to be addressed.
  - Develop specific guidelines for the range of capillary fringe in various soils and site conditions, to be used in conjunction with root depth estimates to protect almond roots from seepage in the project area.



Preliminary draft – subject to change

Phase 2 Capillary Fringe Study

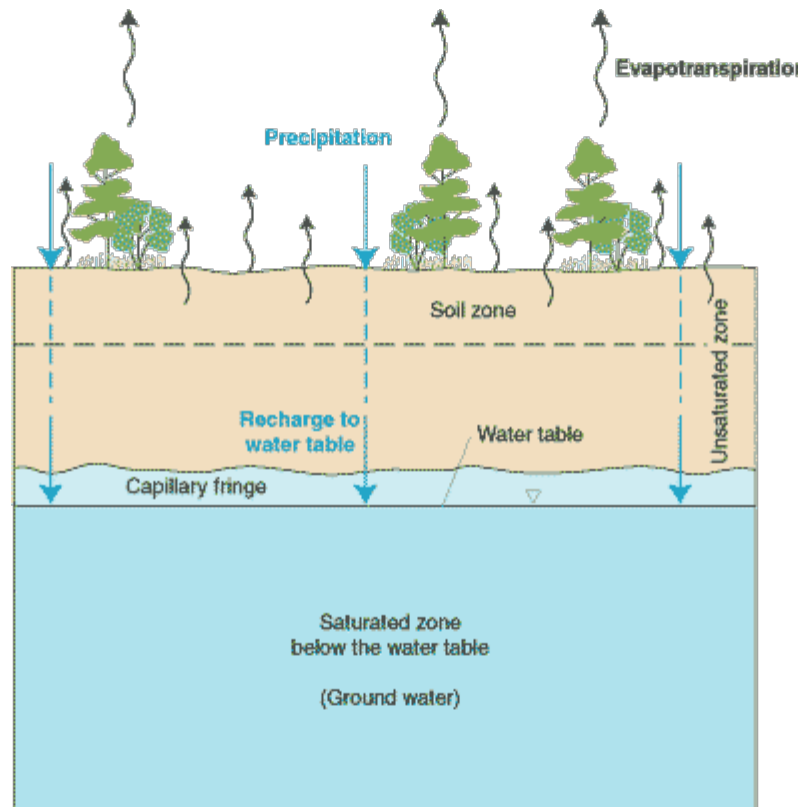
- Evaluate capillary fringe information
  - Literature
  - Regional expert input
  - Site specific data review
- Engage subcommittee to review information
- Propose refined capillary fringe values

Literature Review – Purpose

- Define capillary rise and capillary fringe
- Summarize findings
  - Characteristics of capillary fringe
  - Influences on capillary fringe
  - Typical heights of capillary fringe in fine soil types
  - Spatial and temporal variability of capillary fringe
  - Methods used to measure capillary fringe in the field
- Determine applicability of existing data to interpretations in current literature
- Recommend potential approaches to refine SMP capillary fringe values

Literature Review – Key Findings

- In general, capillary rise is defined as the movement of pore water against the flow of gravity
- Depends on
  - Soil type
  - Soil moisture depletion
  - Depth to the water table
  - Recharge



Literature Review – Key Findings

The definition of capillary fringe has differed among experts. Definitions for this study:

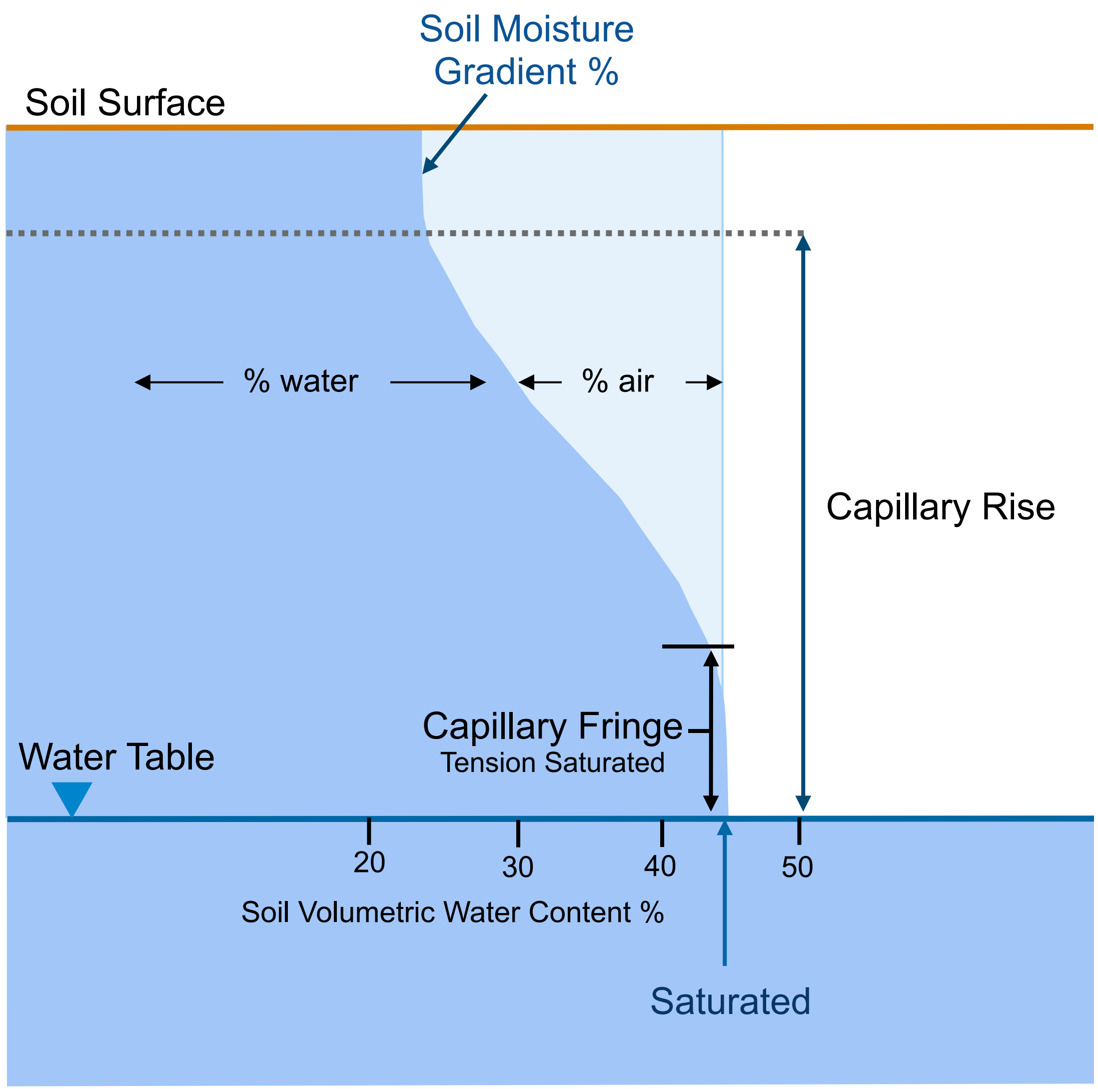
Capillary Rise

- The full range of capillary moisture above the water table
- A large portion of the capillary rise contains air and is not detrimental to root growth

Capillary Fringe

- The tension saturated, anoxic portion of the capillary rise
- Used in the SMP to determine seepage thresholds

Capillary Fringe



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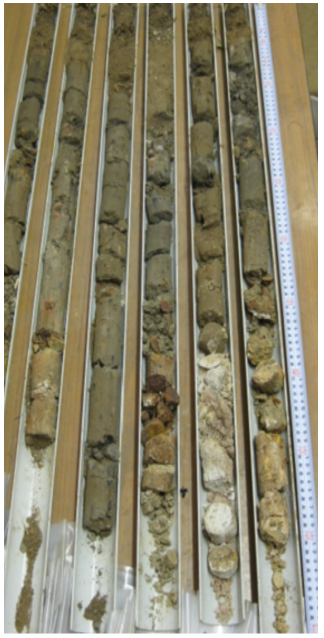
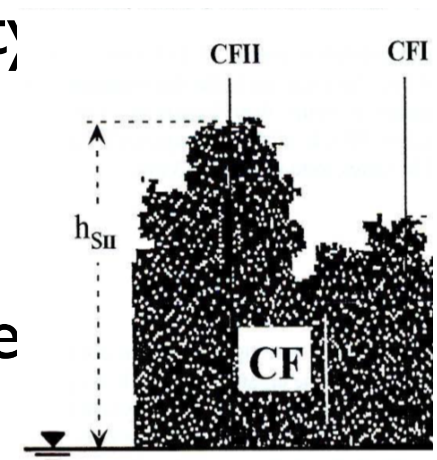
Literature Review – Key Findings

- The tension saturated capillary fringe is “compact,” meaning that soil moisture decreases abruptly above its upper limit
- Literature values for coarse soils generally agreed with the SMP, but literature values for fine soils are generally higher than in the SMP
- Modeled or laboratory capillary fringe in fine soils can reach multiple yards, however, field values for similar soils are typically lower
- Data for field studies are less prevalent because they are difficult to obtain



Literature Review – Key Findings

- Capillary fringe varies temporally and spatially (within a few feet)
- Can be measured in the field using portable soil moisture instruments in situ or on extracted cores, however
  - Methods performance varies by soil ty
  - Field study results can be variable
  - Experts indicate field measurement may only nominally improve literature capillary fringe estimates



Expert Consultation – Purpose

- Provide regional perspective
- Provide hands-on knowledge
- Comment on literature review findings
- Contribute to subject knowledge based on local and/or regional experience

Expert Consultation – Experts

- Dr. Jan Hopmans
  - Associate Dean International Programs Office Soil Physicist Professor of Vadose Zone Hydrology, UC Davis
- Dr. Robert Hutmacher
  - UCCE Specialist and Center Director West Side Research and Extension Center.
- Dr. Charles Burt
  - Retired Professor, Bioresource and Agricultural Engineering, Cal Poly San Luis Obispo; Chairman of Irrigation Training and Research Center
- Dr. Mark Grismer
  - Professor of Hydrology and Biological and Agricultural Engineering, UC Davis
- Dr. James Ayars
  - Agricultural Engineer, USDA ARS Parlier

Expert Consultation – Protocol

1. Phone conversation
2. Notes were sent to expert for review
3. Experts responded with any clarifications

Documentation of discussions with experts in October 2016 Phase 2 report on website

Expert Input – Recommendations

- The problem of determining capillary fringe is difficult
  - There is no simple solution
- There is no published literature on the exact level of oxygen that almond roots require
  - In this situation, the tension saturated zone (capillary fringe) is the only practical measurement that affects roots.
  - This can be observed in the field or in the lab

Expert Input – Recommendations

- Capillary fringe measurements will always be approximations because of variability
  - Difficult to find specific thresholds to apply generally because of site-specific conditions

Expert Input – Recommendations

- Published values of capillary rise
  - In various soil types are applicable to the SMP purpose
  - Are a good starting point
  - Should definitely be used to inform field investigations
  - Are likely accurate for coarse soils
  - May not be as accurate for fine soils
  - Are a good approximation and field investigation data may only improve these estimates incrementally

Data Review

- USBR data from well borings and soil logs
- Phea please fill this in just to demonstrate that we did data review and it informed our adaptation of the cap fringe values table

2009 to 2015					
Category	Number of Observations	Average Thickness (Inches)	95% Confidence Range (Inches)	Anoxic Zone Thickness (Inches)	Anoxic Zone Adjustment (Inches)
Sands, loamy sands	39	8.6	7.2 - 10.0	4.3	6
All other soils	160	17.0	15.5 - 18.5	8.5	12

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Capillary Fringe – Published Values

- Most widely cited values in Handbook of Soil Science (Sumner 1999)
  - Values derived from the work of Rawls and Brakensiek (1982, 1992)
  - Represent 1,320 soils in 32 states
  - Consulted 400 soil scientists
  - Various types of data
- Categorized into 11 texture-types from sand to clay
- Simplified/adapted for SMP

Proposed CF Values

- Values adapted from Handbook of Soil Science (Sumner 1999)
- Soil physical characteristics of fine and very fine sands result in greater CF
- Texture classes with very similar CF were grouped

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Proposed CF Values

- Estimates focus on the tension saturated capillary fringe
- When an actively growing crop is present and is consuming water from the upper portion of the capillary fringe, the thickness of the capillary fringe would likely be less than tabular values

Current vs. Proposed SMP

- Currently, SMP provides two Capillary Fringe (CF) values
  - Coarse soils (0.5 ft)
  - Finer soils (1.0 ft)
- Capillary fringe information indicates more soil textural categories and CF depths are appropriate

Capillary Fringe – Proposed Values

Soil Texture	Capillary Fringe (inches)	Capillary Fringe (feet)
Sand	6	0.5
Loamy sand; very fine sand; fine sand	8	0.7
Sandy loam; loamy very fine sand; loamy fine sand	12	1.0
Very fine or fine sandy loam; silt loam; loam	20	1.7
Sandy clay loam; clay loam	24	2.0
Silty clay loam	28	2.3
Sandy clay; silty clay	32	2.7
Clay	36	3.0

Values adapted from Handbook of Soil Science. Ed. Sumner. 2000. CRC Press LLC, Boca Raton, FL. Data source: from Rawls et al. (1982) and Brakensiek and Rawls (1992).

2017 SMP Revisions – Ag. Thresholds

- Capillary fringe assignment:
  1. Identify USCS soil classifications from well logs at deep and shallow crop root zones
  2. Convert USCS to USDA soil textures
     - Using logs and soil gradation curves
  3. Assign capillary fringe value from proposed table of capillary fringe by soil texture

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2017 SMP Revisions – Ag. Thresholds

GEOLOGIC LOG OF DRILL HOLE NO. MW-10-98

SHEET 1 OF 2

FEATURE: Groundwater Monitoring
LOCATION: Reach 4B1, River Bank Left, RM 167
BEGUN: 3/31/10 FINISHED: 3/31/10
WATER LEVEL DEPTH AND ELEVATION: NA
DATE WATER LEVEL WAS MEASURED: NA

PROJECT: San Joaquin River Restoration Program
COORDINATES: N 2,293,516.2 E 6,091,162.9 (NAGD83)
TOTAL DEPTH: 31.2 ft.

STATE: California
GROUND SURFACE ELEVATION: 102.2 ft. (NAVD88)
T.O.C ELEVATION: 105.1 ft. (NAVD88)
HOLE LOGGED BY: J. Vauk
REVIEWED BY: A. Warren

DEPTH	% CORE RECOVERY	% SILT	% CLAY	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT %	LABORATORY CLASSIFICATION / ELEVATION	VISUAL CLASSIFICATION / ELEVATION	GEOLOGIC UNIT SYMBOL
	57										s(CL) 98.8	Fill
											CL 98.0	
5	100	39.9	12.4	52.3	47.7	0.0	NP	NP	21.5	s(ML) 95.7	s(ML) 95.6	
											CL 94.8	
10	100	40.9	18.0	58.9	41.1	0.0	NP	NP	25.8	s(ML) 89.2	s(CL/ML) 89.0	Qal

NOTES

ALL MEASUREMENTS ARE IN FEET FROM THE GROUND SURFACE.

PURPOSE OF HOLE:
To recover core, collect data to determine geologic and hydrologic site conditions, and install a groundwater monitoring well.

LOCATION:
Reach 4B1, RM 167, river left, about 160 feet south from the center of the SJR, about 1 mile west of the intersection of Indian Road and the SJR.

DRILLED BY:
PN-Regional Drill Crew
Jerry Hansen, Driller
Cody Kelly, Helper
Ken Kreitz, Helper

DRILL RIG:
Central Mining Equipment 75 drill rig (CME-75)

DRILLING & SAMPLING METHODS:
Drill hole MW-10-98 was advanced using hollow stem flight augers with a continuous dry core sampling system (FADC) from the ground surface to a total depth of 31.2 feet. FADC uses 7-5/8-inch O.D., 4-1/4-inch I.D. hollow stem augers, with a 5-foot-long, 3-inch I.D. split sample barrel.

Interval Method
0.0 to 31.2 ft. - FADC

DRILLING CONDITIONS AND DRILLER'S COMMENTS:
0.0 to 8.7 ft. smooth drilling, very soft
8.7 to 31.2 ft. soft, wet to very wet

CAVING CONDITIONS:
None

DRILL FLUID, RETURN AND

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 3.4 feet
FILL (Fill)

0.0 to 3.4 ft.: SANDY LEAN CLAY, s(CL): About 60% fine sand; about 40% fines with medium plasticity, toughness and dry strength, slow dilatancy; maximum size: fine sand; dry, medium brown, no reaction to HCl; soft consistency; organics; fill embankment material.

3.4 to 31.2 feet
QUATERNARY ALLUVIUM (Qal)

3.4 to 4.2 ft.: LEAN CLAY, CL: About 90% fines with medium to high plasticity, medium toughness and dry strength, no dilatancy; about 10% fine sand; maximum size: fine sand; moist, dark brown, no reaction to HCl; soft consistency.

4.2 to 6.6 ft.: SANDY SILT, s(ML): About 65% non-plastic fines with rapid dilatancy; about 35% fine sand; maximum size: fine sand; moist, light brown, no reaction to HCl; soft consistency.

Laboratory Data Interval
4.3 to 6.5 ft.

6.6 to 7.4 ft.: LEAN CLAY, CL: About 90% fines with medium plasticity, toughness and dry strength, no dilatancy; about 10% fine sand; maximum size: fine sand; moist, dark brown, no reaction to HCl; firm consistency.

7.4 to 13.2 ft.: SANDY SILTY CLAY, s(CL/ML): About 60% fines with medium plasticity, low toughness, medium dry strength, rapid dilatancy; about 40% fine sand; maximum size: fine sand; moist, brown, no reaction to HCl; soft consistency.

Laboratory Data Interval
8.0 to 13.0 ft.

13.2 to 18.7 ft.: SITLY SAND, SM: About 70% fine to medium sand; about 30% non-plastic fines with rapid dilatancy; maximum size: medium sand; wet, greenish brown, no reaction to HCl; soft consistency; black organic material encountered at bottom

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2017 SMP Revisions – Ag. Thresholds

GRADATION OF SAND SIZES

DRY MASS OF SPECIMEN	86.2 g	FACTOR = % TOTAL PASSING NO. 4 / DRY MASS OF SPECIMEN = 100.0 / 86.2 =	1.1601
DISH NO.	65	DRY MASS OF SPECIMEN (SIEVED)	39.6
SIEVING TIME	15 Min.	DATE	5/6/2010

SIEVE NO.	MASS RETAINED (g)	MASS PASSING (g)	FACTOR X MASS PASSING % OF TOTAL PASSING	% OF TOTAL	PARTICLE D.
8	0.0	86.2		100.0	2.36 mm
16	0.1	86.1		99.9	1.18 mm
30	0.1	86.1		99.9	600 µm
50	0.3	85.9		99.7	300 µm
100	11.1	75.1		87.1	150 µm
200	35.4	50.8		58.9	75 µm
PAN	39.6				
TOTAL	86.2				

REMARKS

GRAVEL %	0.0	LL =	na
SAND %	41.1	PL =	na
FINES %	58.9	PI =	na

Classification of Fines: ML

MOISTURE % 25.8

TESTED AND COMPUTED BY	DATE	CHECKED BY	DATE
Van Deusen	5/6/2010	Albert	05/06/10

HYDROMETER ANALYSIS

HYDROMETER NO.	1350	DISPERSING AGENT	SODIUM HEXAMETAPHOSPHATE
STARTING TIME	9:33	DATE	5/5/10
AMOUNT	125 mL		

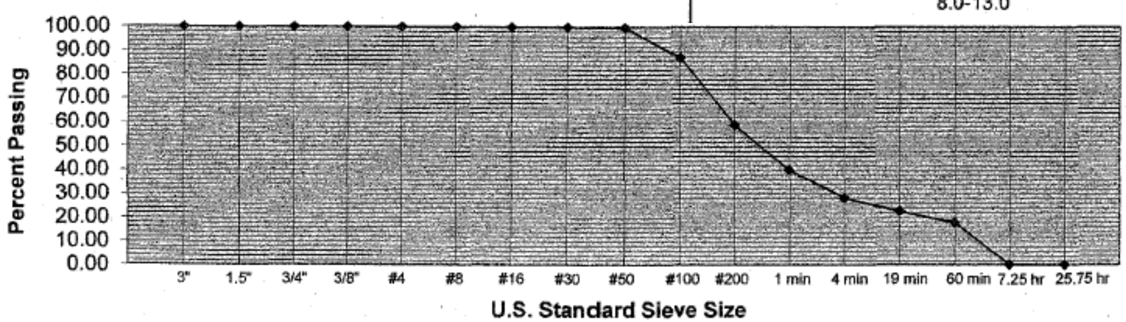
TIME	TEMP °C	HYD READ	HYD CORR	CORR READ	FACTOR X CORRECT READ % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
1 min	20.5	40.0	5.5	34.5		40.0	37µm
4 min	20.5	30.0	5.5	24.5		28.4	19 µm
19 min	20.5	25.0	5.5	19.5		22.6	9 µm
60 min	20.5	21.0	5.5	15.5		18.0	5 µm
7h 15 min							2 µm
25 h 45 min							1 µm

REMARKS: Sandy silt s(ML)

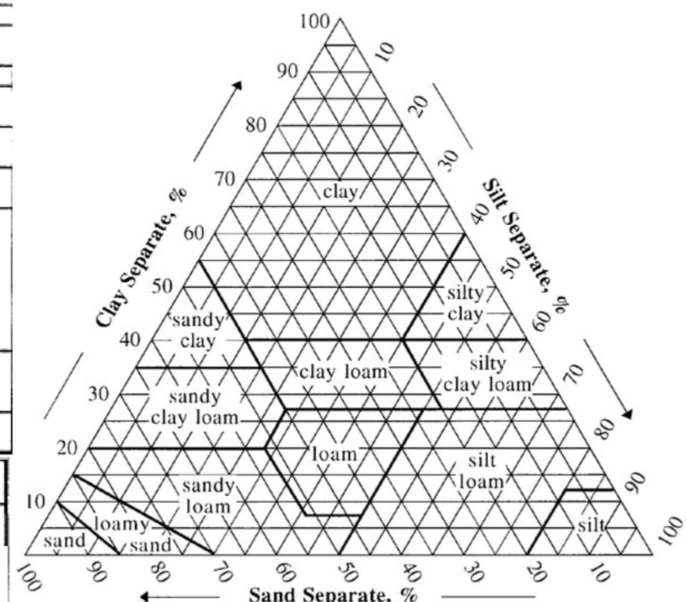
TESTED AND COMPUTED BY	DATE	CHECKED BY	DATE
Albert	5/5/10	Van Deusen	05/05/10

Gradation Test

FEATURE	San Joaquin River Restoration
DEPTH	8.0-13.0



USDA Soil Textures



2017 SMP Revisions – Ag. Thresholds

- In most wells, the capillary fringe value is the same for both crop root zone categories. If different, use the largest value.
- Example: MW-10-98

Depth Interval (ft)	USCS texture	USDA texture	Capillary Fringe (ft)
6.6 – 7.4	Lean clay, CL	Clay loam	2.0
7.4 – 13.2	Sandy silty clay, s(CL/ML)	Loam	1.7

  – Capillary fringe assignment: 2.0 ft

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2017 SMP Revisions

	Current 2016 Restoration Flows		**Proposed** 2017+ Restoration Flows
Almond Root Zone	9 ft	→	6 ft
Capillary Fringe	0.5 or 1 ft	→	0.5 to 3.0 ft (soil dependent)
Net Almond Agricultural Threshold Change	9 to 10 ft	→	6 to 9 ft
Net Row Crop Agricultural Threshold Change	4 to 6 ft	→	4 to 8 ft

Comments?

- We would like to hear your thoughts on these changes

- We have incorporated input from the subcommittee

Regina Story

LATERAL GRADIENT BUFFERS

Purpose

- Account for slope of groundwater table away from the river

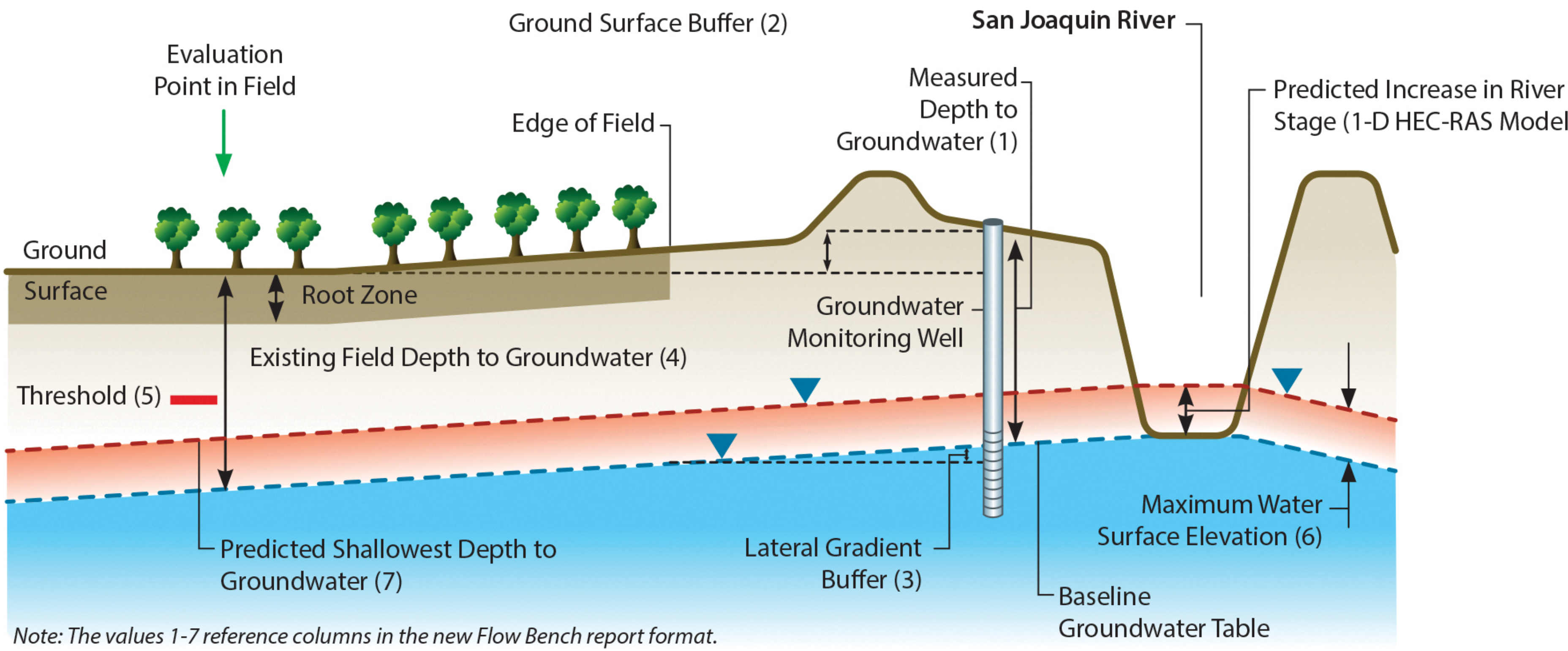
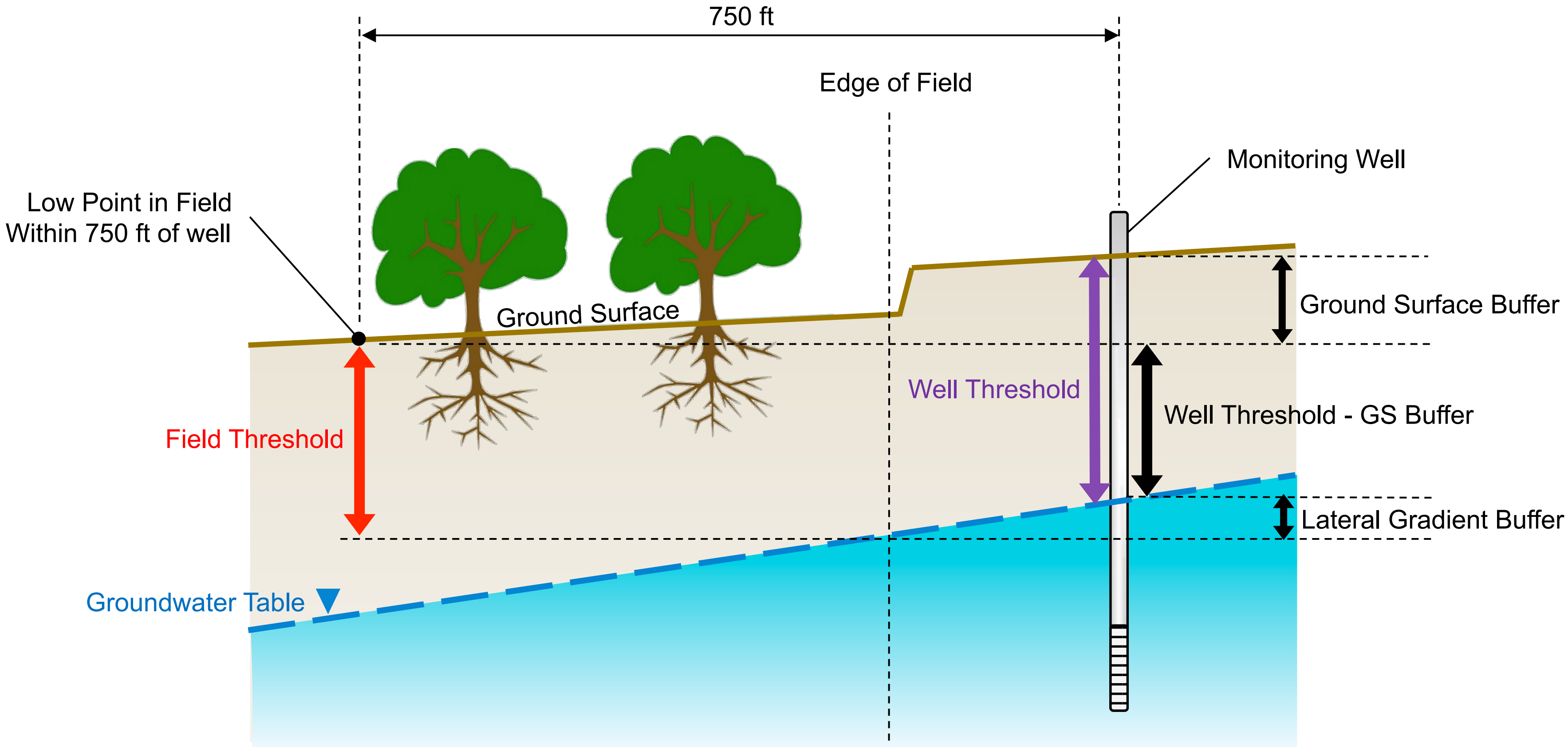
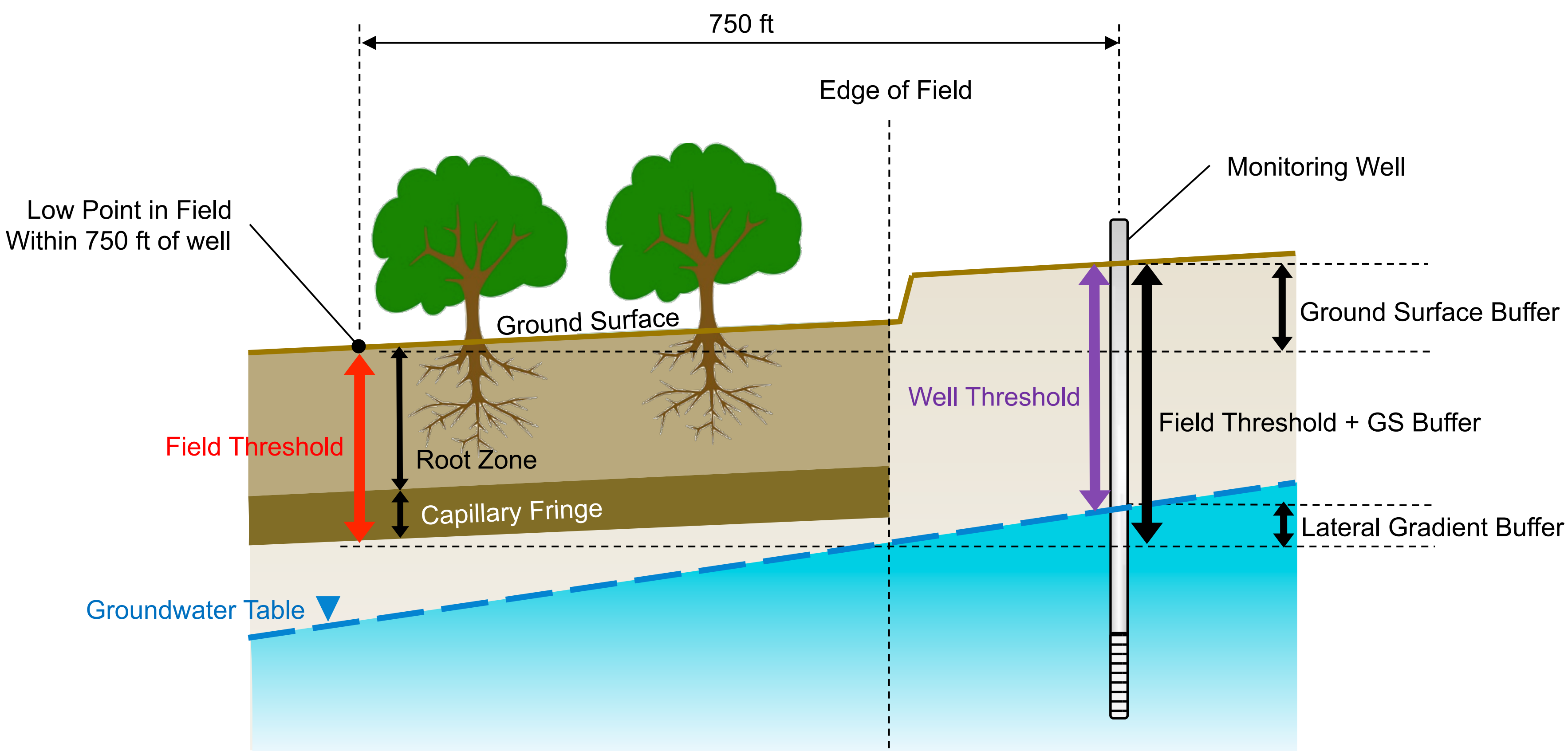


Figure J-2 from SMP Appendix J

Threshold – Historical Method



Threshold – Agricultural Method



SAN JOAQUIN RIVER RESTORATION PROGRAM

Lateral Gradient Calculation

1. Identified well transects
2. Calculated the river water surface elevation
3. Calculated groundwater table elevation
4. Calculated slope of the groundwater table from the edge of the river to the well
5. Assumed the same slope from well to field
6. Multiplied slope by distance from well to field

Selecting wells

1. Identifying well transects
   – For key groundwater wells evaluated in flow bench evaluations

Preliminary draft – subject to change

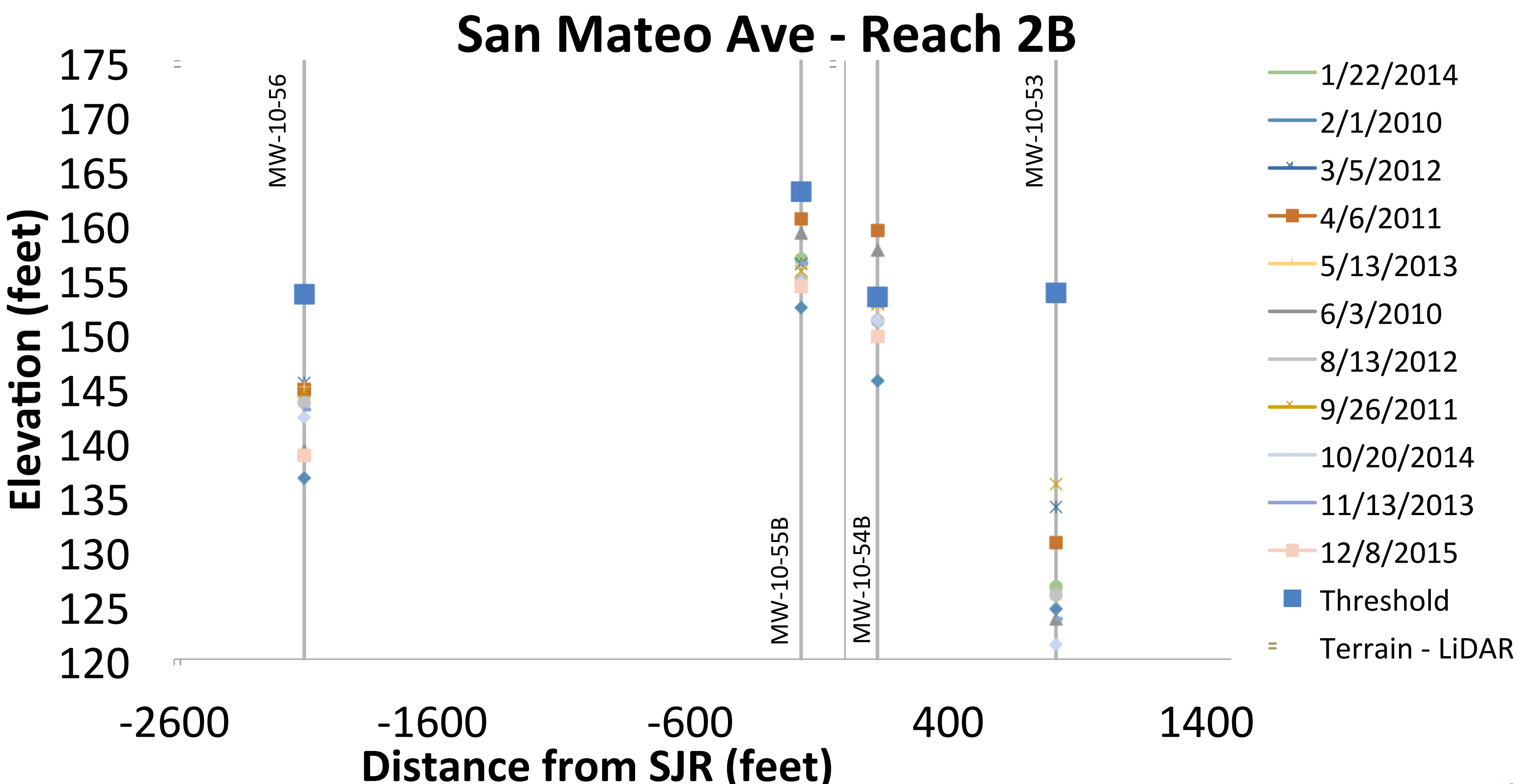
SAN JOAQUIN RIVER RESTORATION PROGRAM

Calculating elevations

2. Calculated the river water surface elevation
   - Staff gage data
3. Calculated groundwater table elevation
   - Groundwater monitoring data

Calculating groundwater table slope

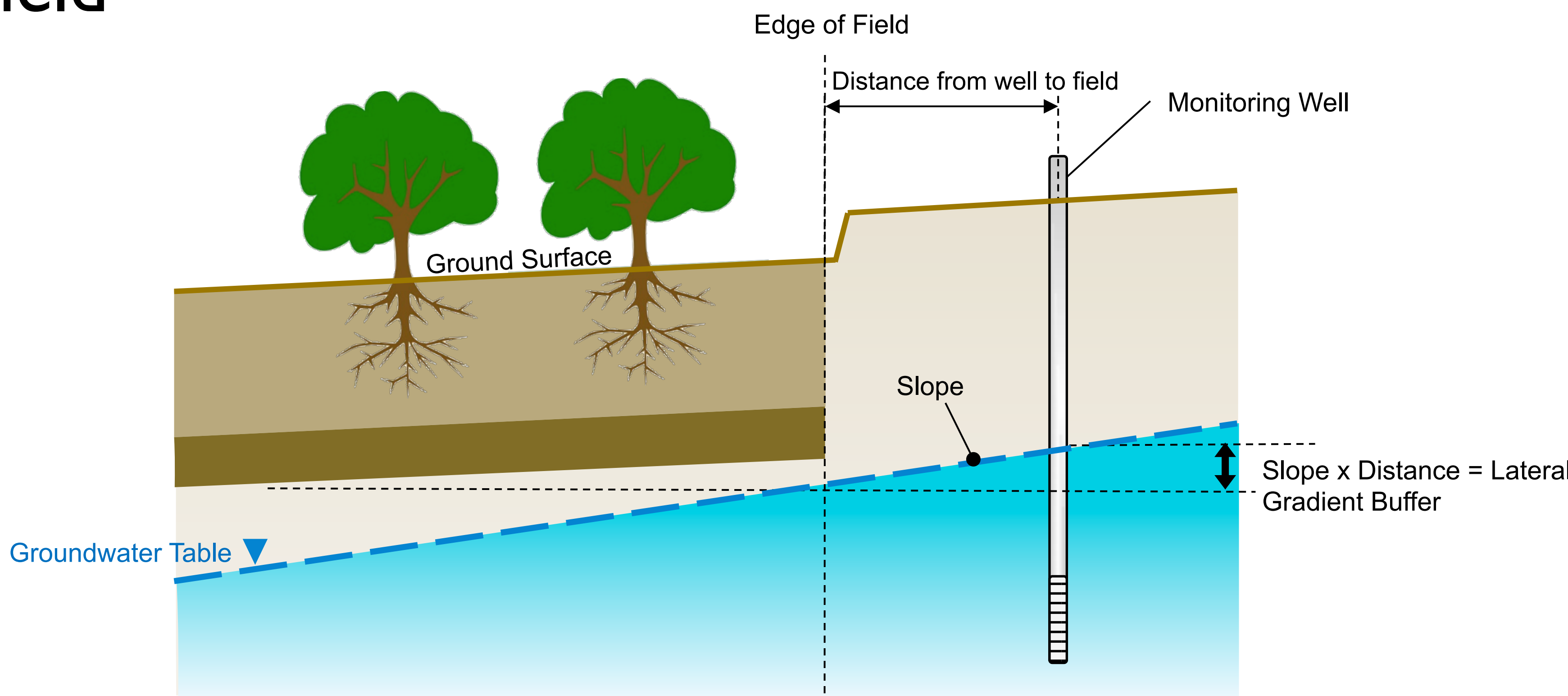
4. Calculated slope of the groundwater table from the edge of the river to the well



Preliminary draft – subject to change

Calculating drop to field

5. Assumed the same slope from well to field
6. Multiplied slope by distance from well to field



Preliminary draft – subject to change

SAN JOAQUIN RIVER RESTORATION PROGRAM

Lateral Gradient Values

Table H-1. Difference Between Well and Field Groundwater Elevations[1]

Well	Reach	Bank	Minimum Difference (feet)	Maximum Difference (feet)	Average Difference (feet)	Lateral Gradient Buffer (feet)
FA-9	2A	Left	-2.1	4.5	-1.1	0.0
MA-4	2A	Right	-1.2	7.1	1.6	0.0
MW-09-47	2A	Right	-15.0	18.3	-7.7	0.0
MW-09-49B	2A	Left	-7.3	-0.1	-1.7	0.0
MW-09-54B	2B	Right	0.0	0.0	0.0	0.0
MW-09-55B	2B	Left	6.5	9.6	7.2	6.5
MW-09-87B	4A	Left	0.0	0.0	0.0	0.0
MW-10-75	3	Left	0.0	0.0	0.0	0.0
MW-10-89	4A	Right	0.0	0.0	0.0	0.0
MW-10-92	4A	Left	0.0	0.0	0.0	0.0
MW-10-94	4B1	Right	0.0	0.0	0.0	0.0
MW-11-130	4A	Left	0.0	0.0	0.0	0.0
MW-11-142	4B1	Right	0.0	0.0	0.0	0.0
MW-12-191	3	Right	-0.5	0.6	0.0	0.0
MW-14-208	4A	Right	0.0	0.0	0.0	0.0
PZ-09-R3-5	3	Right	0.0	0.0	0.0	0.0
PZ-09-R3-7	3	Right	0.0	0.0	0.0	0.0

Notes:
[1] Difference is calculated as the slope of (1) the river stage adjacent to the monitoring well to the groundwater level in the well (if there is flow in the river) or (2) the assumed water table under the river and the groundwater level in the well (no flow in the river), times the distance between the monitoring well and the adjacent field.

Table H-1

If negative, zero

Threshold Calculation

- Relates the threshold in the well to the threshold in the field.

$$Threshold_{field} = Threshold_{well} - GS_{Buffer} + LG_{Buffer}$$

$$Threshold_{well} = Threshold_{field} + GS_{Buffer} - LG_{Buffer}$$

- GS_{Buffer}: Difference in elevation between well and field
  - Positive when the well is above the field elevation
- LG_{Buffer}: *Accounts for GW table slope*
  - Positive when the section of the river is a losing reach (groundwater table slopes away from the river)

Comments?

- MW-09-55B is the only well with a proposed lateral gradient buffer
- Lateral gradients were previously in the SMP in Appendix J, now updated with more recent data and in Appendix H

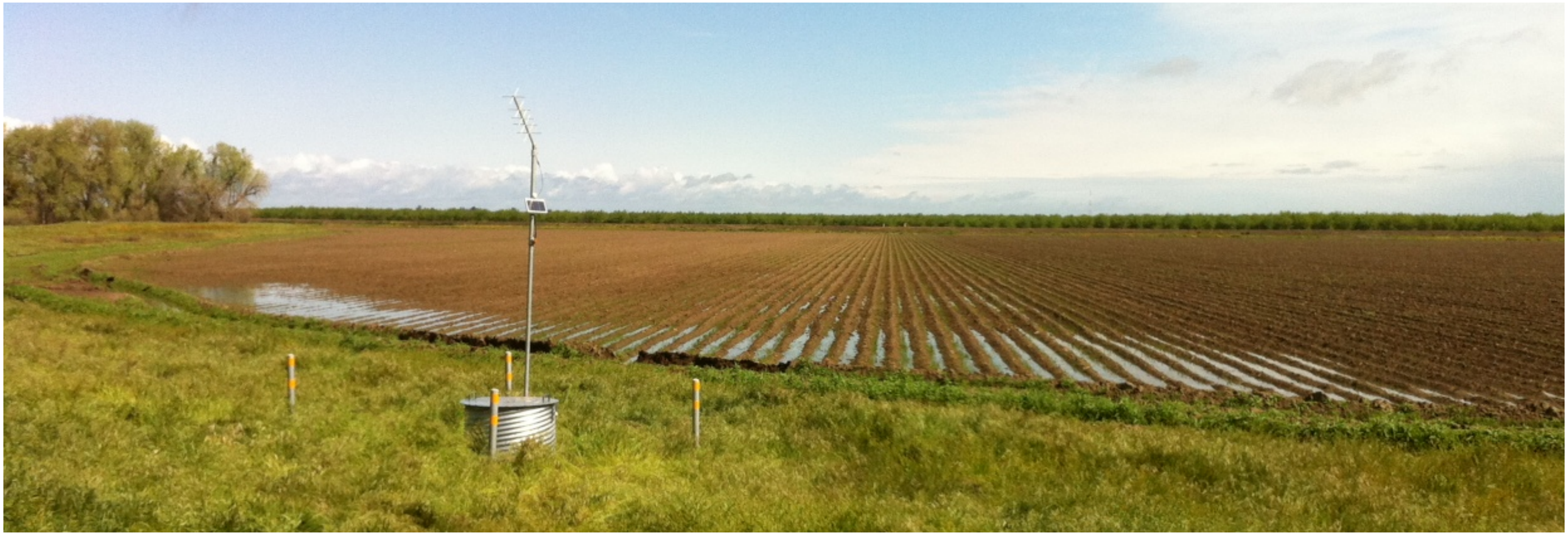
- We would like to hear your thoughts on these changes
- Are there better ways to present this concept?

Katrina Harrison

HISTORICAL GROUNDWATER METHOD

Purpose

- Account for pre-existing shallow groundwater conditions adjacent to some parts of the river



SAN JOAQUIN RIVER
RESTORATION PROGRAM

Explanation

- Restoration Program is not responsible for improving groundwater conditions that existed prior to the SJRRP
- Periods without Restoration or flood flow provide a reasonable estimate of historical conditions where pre-SJRRP data is unavailable
- Utilize best available information and update as we get more data
  - Include 4 years of data with no Restoration or flood flow in the San Joaquin River

SAN JOAQUIN RIVER RESTORATION PROGRAM

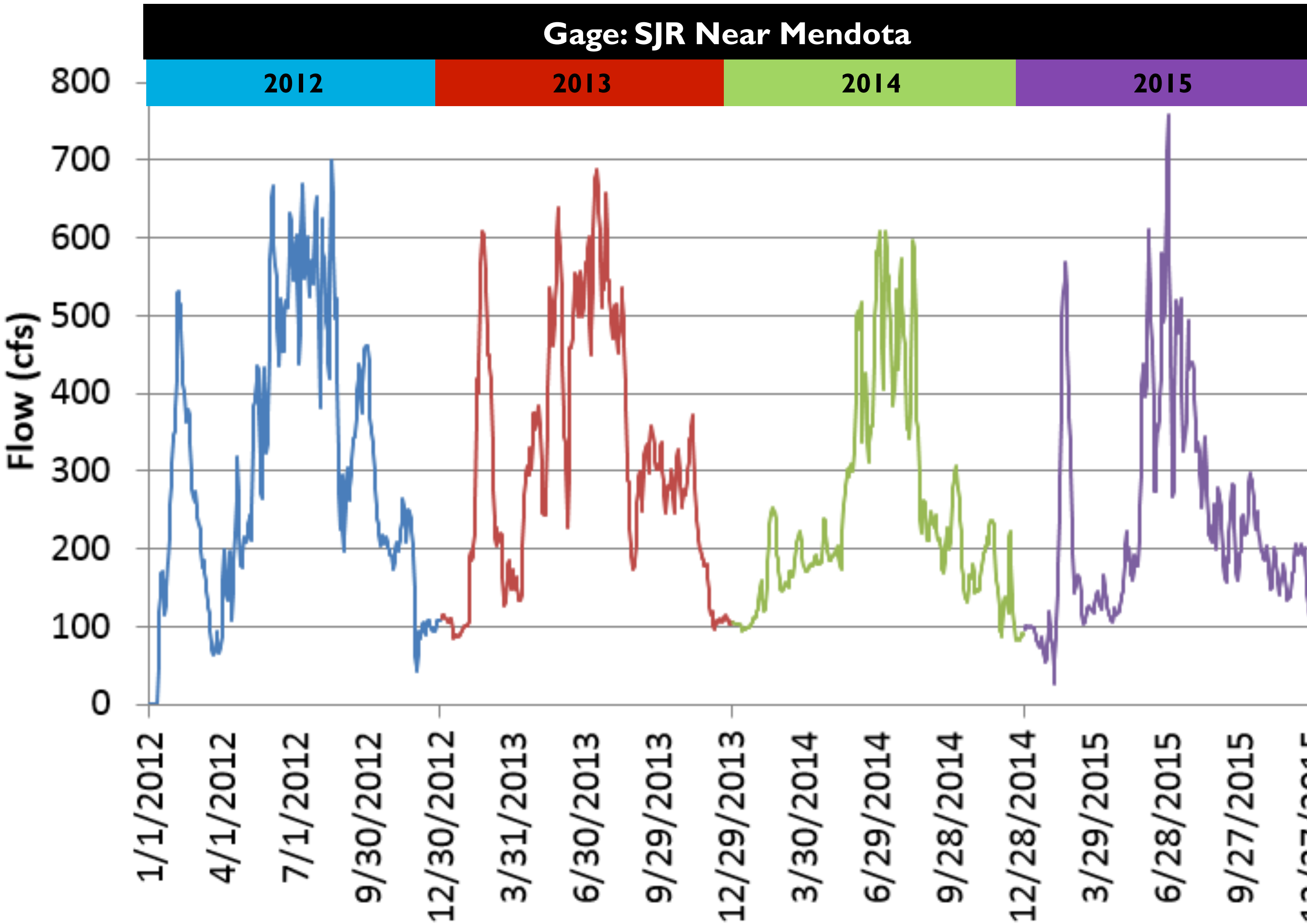
Historical Groundwater Method

- 4 methods:
  1) Long-term record
     - No change proposed
  2) Nearby long-term record
     - No change proposed
  3) Depth to water interpolations
     - No change proposed
  4) January / February 2012
     - Proposed change: December 2011 – January 2016
     - For wells in Reach 3 and downstream

4- year period

- Flood flows damage crops, and while part of the pre-SJRRP hydrology, are not what controls farming
  – No floods from December 2011 – January 2016
- San Luis Canal Company deliveries are included
  – Part of historical condition
- During drought – low groundwater levels
  – Low groundwater levels = deeper thresholds, more protective of crops

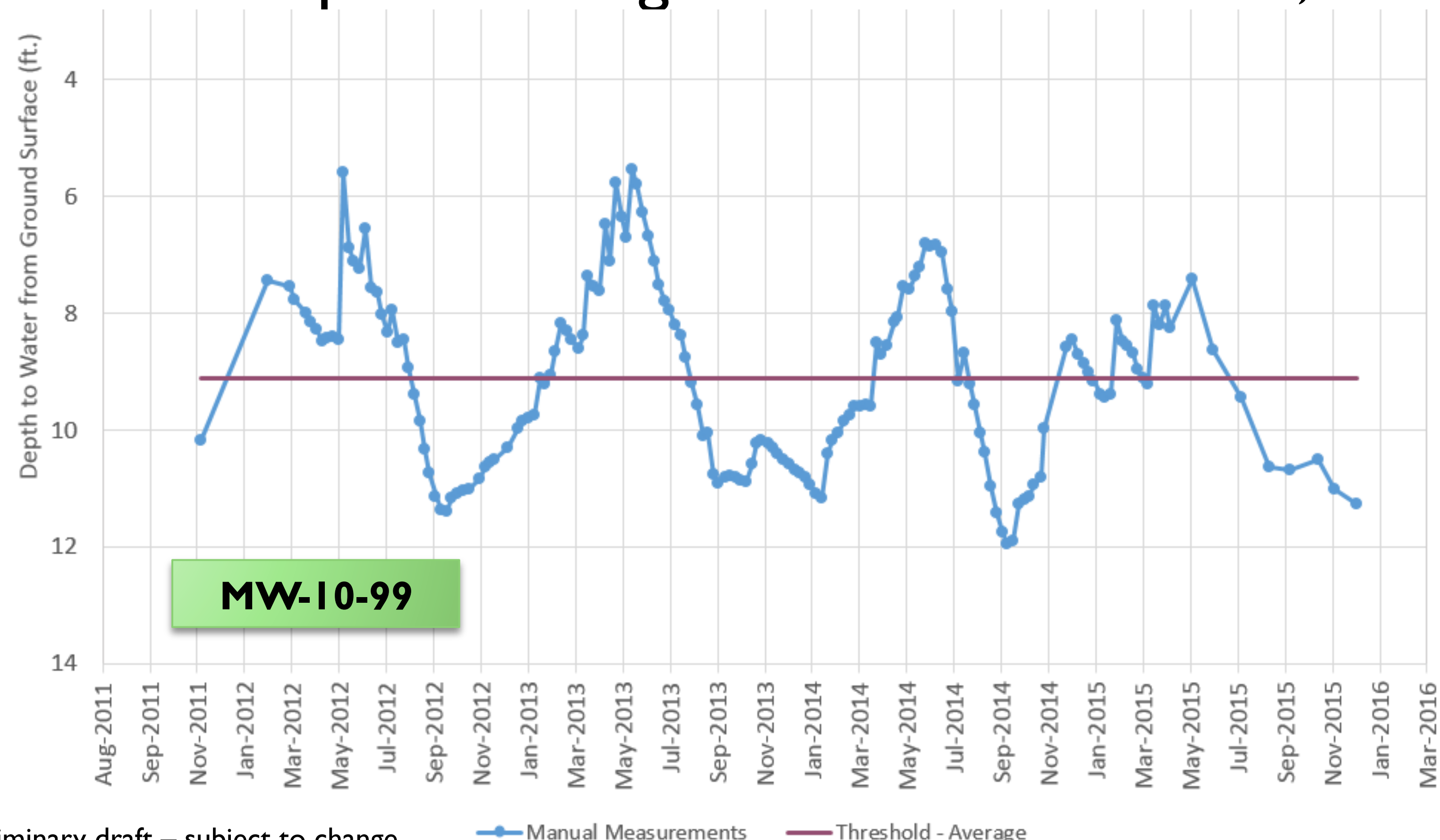
No Restoration Flows or Flood Flows



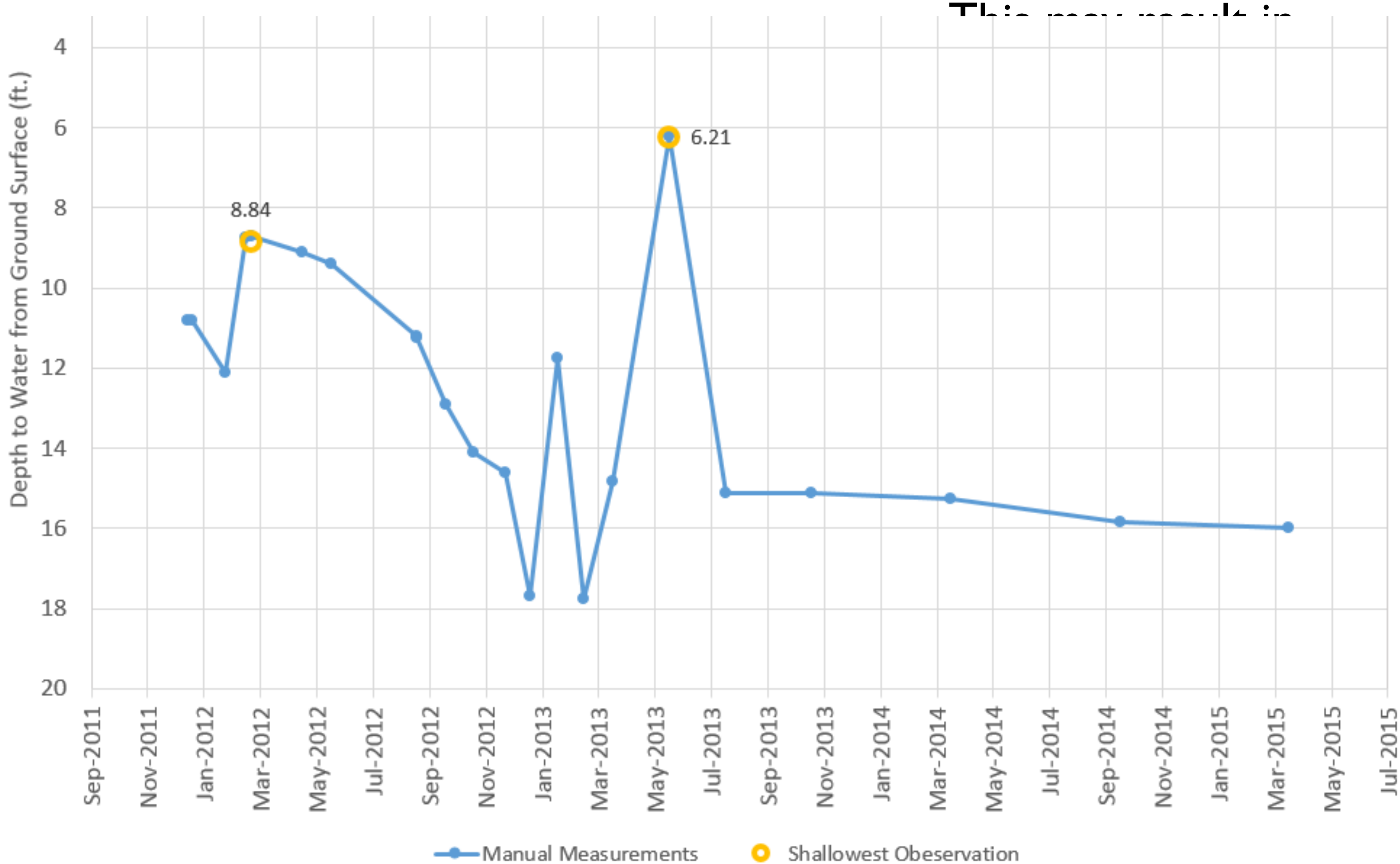
Preliminary draft – subject to change

Average Groundwater Level?

- This results in the SJRRP keeping groundwater levels lower than without the SJRRP
- This improves the groundwater condition, not the



Shallowest groundwater level?

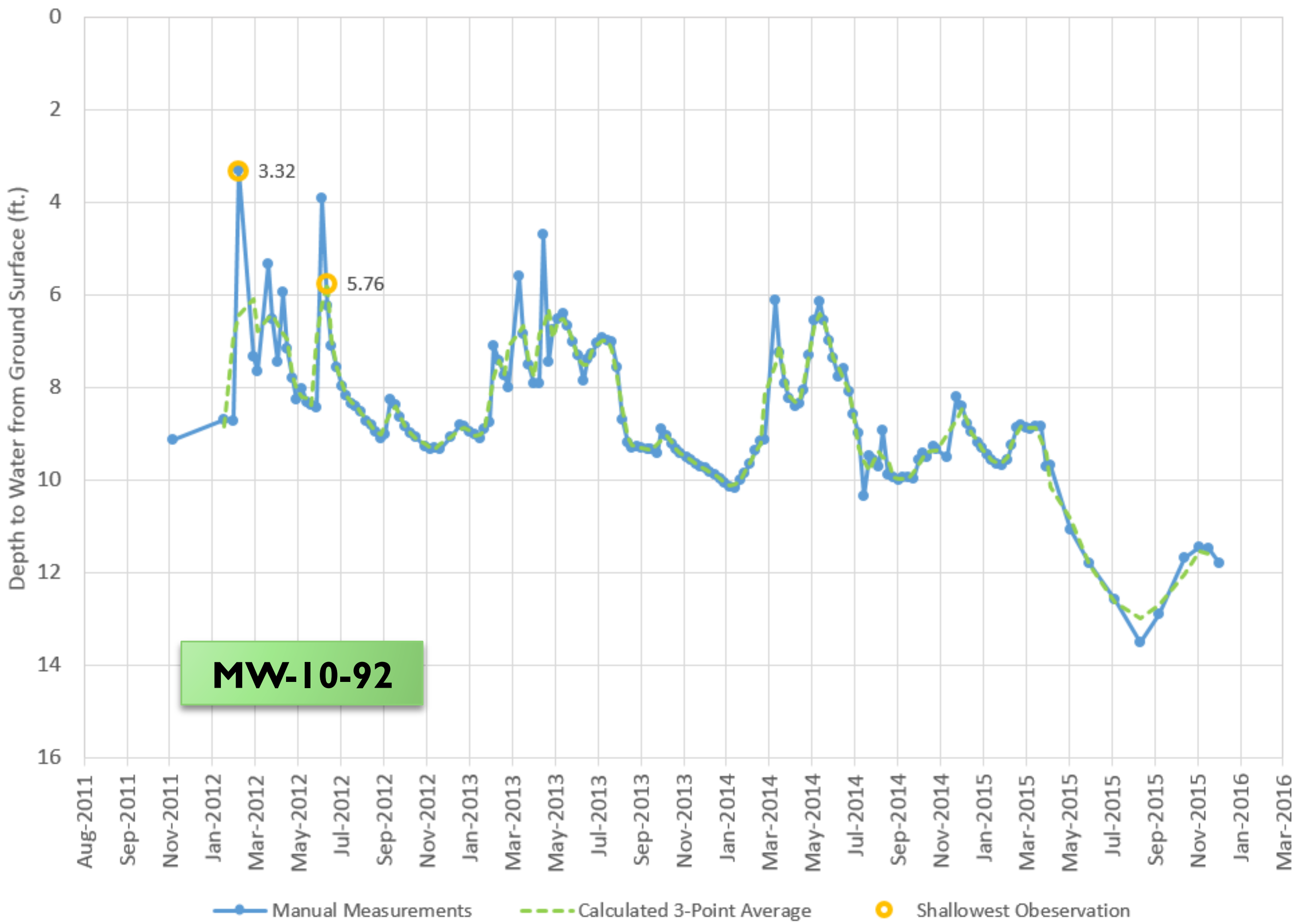


Preliminary draft – subject to change

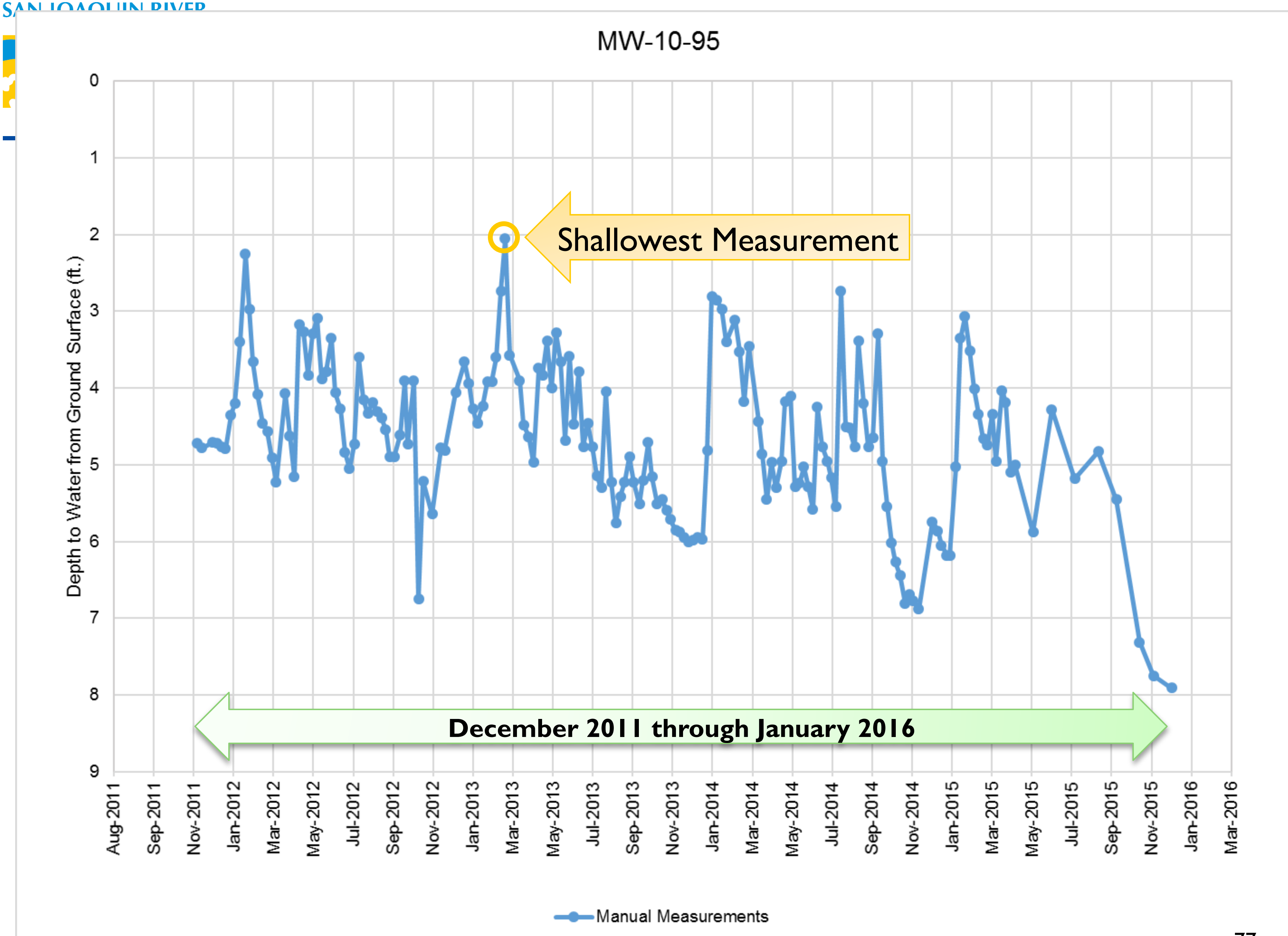
Shallowest of 3-point moving average

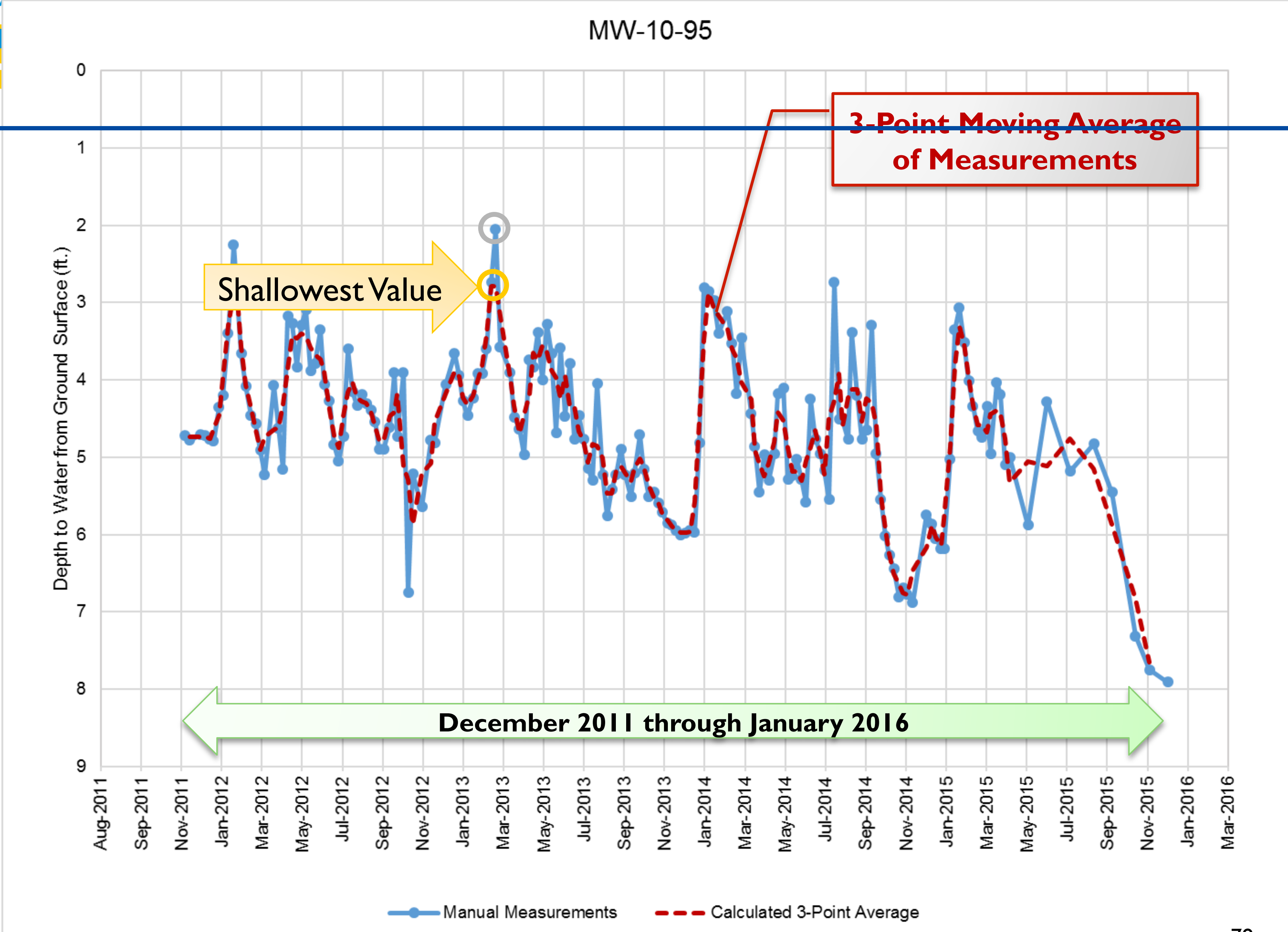
– Avoids potential outlier issue

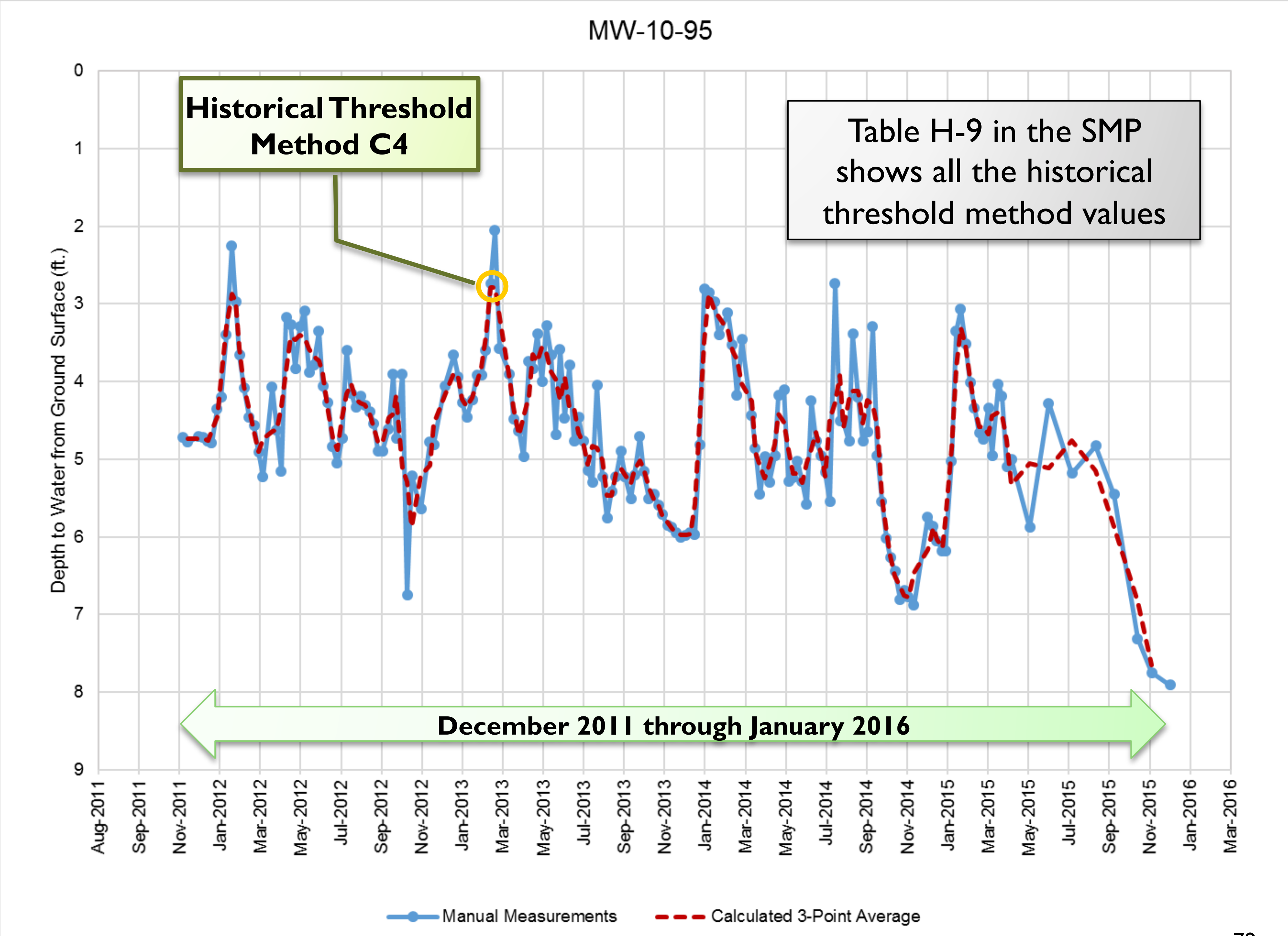
shallowest



Preliminary draft – subject to change


MW-10-95
Depth to Water from Ground Surface (ft.)
0
1
2
3
4
5
6
7
8
9
Aug-2011
Sep-2011
Nov-2011
Jan-2012
Mar-2012
May-2012
Jul-2012
Sep-2012
Nov-2012
Jan-2013
Mar-2013
May-2013
Jul-2013
Sep-2013
Nov-2013
Jan-2014
Mar-2014
May-2014
Jul-2014
Sep-2014
Nov-2014
Jan-2015
Mar-2015
May-2015
Jul-2015
Sep-2015
Nov-2015
Jan-2016
Mar-2016
Shallowest Measurement
December 2011 through January 2016
Manual Measurements


MW-10-95
Depth to Water from Ground Surface (ft.)
0
1
2
3
4
5
6
7
8
9
3-Point Moving Average of Measurements
Shallowest Value
December 2011 through January 2016
Aug-2011
Sep-2011
Nov-2011
Jan-2012
Mar-2012
May-2012
Jul-2012
Sep-2012
Nov-2012
Jan-2013
Mar-2013
May-2013
Jul-2013
Sep-2013
Nov-2013
Jan-2014
Mar-2014
May-2014
Jul-2014
Sep-2014
Nov-2014
Jan-2015
Mar-2015
May-2015
Jul-2015
Sep-2015
Nov-2015
Jan-2016
Mar-2016
Manual Measurements
Calculated 3-Point Average



Preliminary draft – subject to change

SAN JOAQUIN RIVER RESTORATION PROGRAM

Number of Wells Affected

- Most thresholds calculated based on agricultural practices (root zone + capillary fringe)
- Second most thresholds calculated by this method

Table H-12. Count of Thresholds Calculated via Each Method	
Threshold Method	**Number of Wells**
Agricultural Practices	137
Historical Groundwater Method A	2
Historical Groundwater Method B	0
Historical Groundwater Method C	109
Method C1, CCID Well	8
Method C2, 1999	1
Method C3, 2009	5
Method C4 (Dec/2011 – Jan/2016)	95

Comments?

- We would like to hear your thoughts on this method
- Are there factors we did not take into consideration?
- Is there other information we should consider?

Katrina Harrison

SUMMARY OF CHANGES

SAN JOAQUIN RIVER RESTORATION PROGRAM

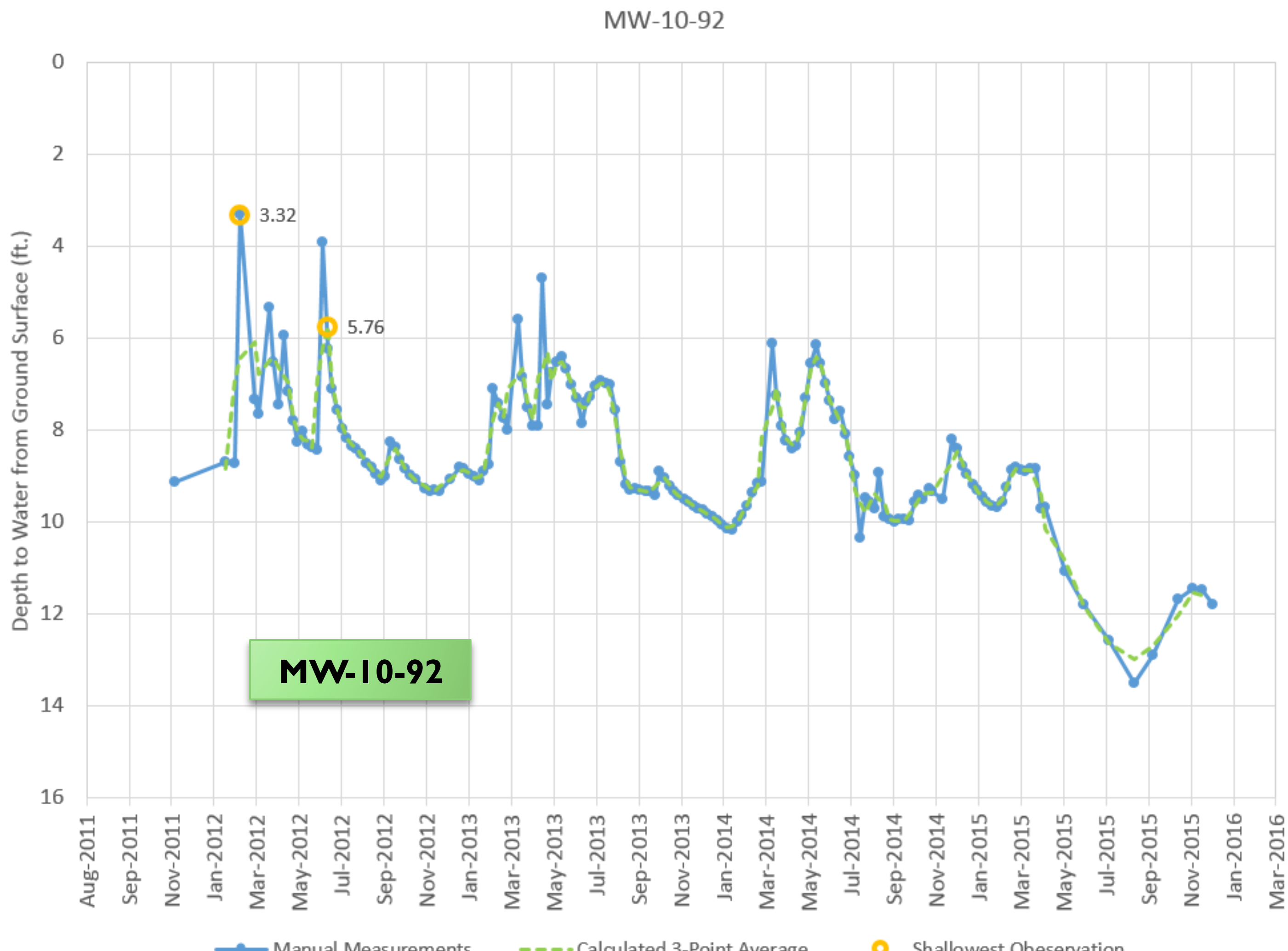
Agricultural Threshold Changes

	Current 2016 Restoration Flows		**Proposed** 2017+ Restoration Flows
Almond Root Zone	9 ft	→	6 ft
Capillary Fringe	0.5 or 1 ft	→	0.5 to 3.0 ft (soil dependent)
Net Almond Agricultural Threshold Change	9 to 10 ft	→	6 to 9 ft
Net Row Crop Agricultural Threshold Change	4 to 6 ft	→	4 to 8 ft

Preliminary draft – subject to change

Historical Groundwater Threshold Changes

– Shallowest of 3-point moving average



Comments?

- We would like to hear your thoughts on the changes
- Are there factors we did not take into consideration?
- Is there other information we should consider?

Patti Ransdell

WRAP-UP, ACTION ITEMS

Contact

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  - 916-978-4398
  - RestorationFlows@restoresjr.net