Groundwater-Surface Water Interaction near the Teanaway River Based on Data From Ten Monitoring Wells

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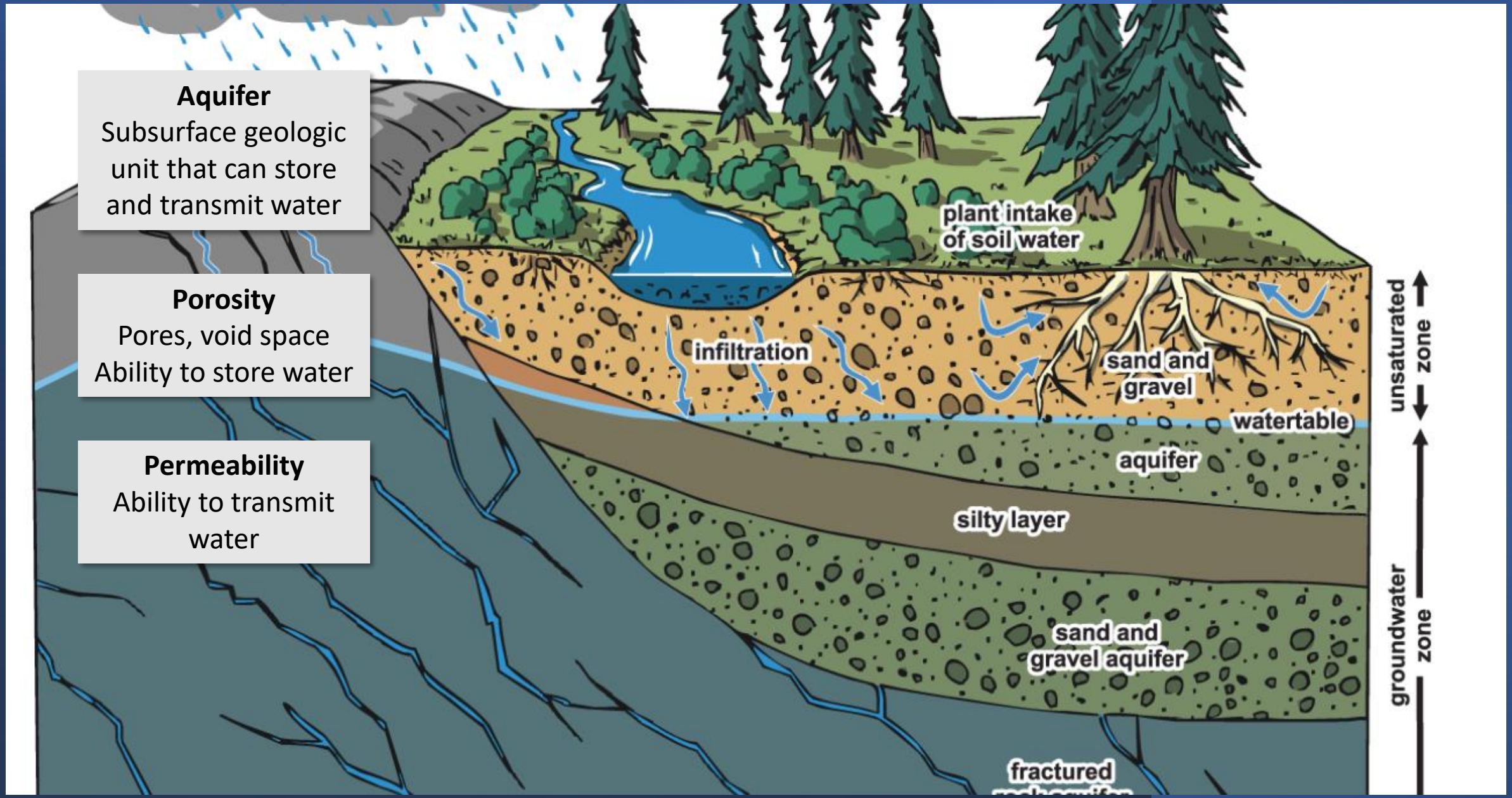
Acknowledgements: Kat Strathmann, Mid-Columbia Fisheries Enhancement Group; Lisa Ely, CWU; Yakima Basin Integrated Plan, WA Department of Ecology

Aquifer
Subsurface geologic unit that can store and transmit water

Porosity
Pores, void space
Ability to store water

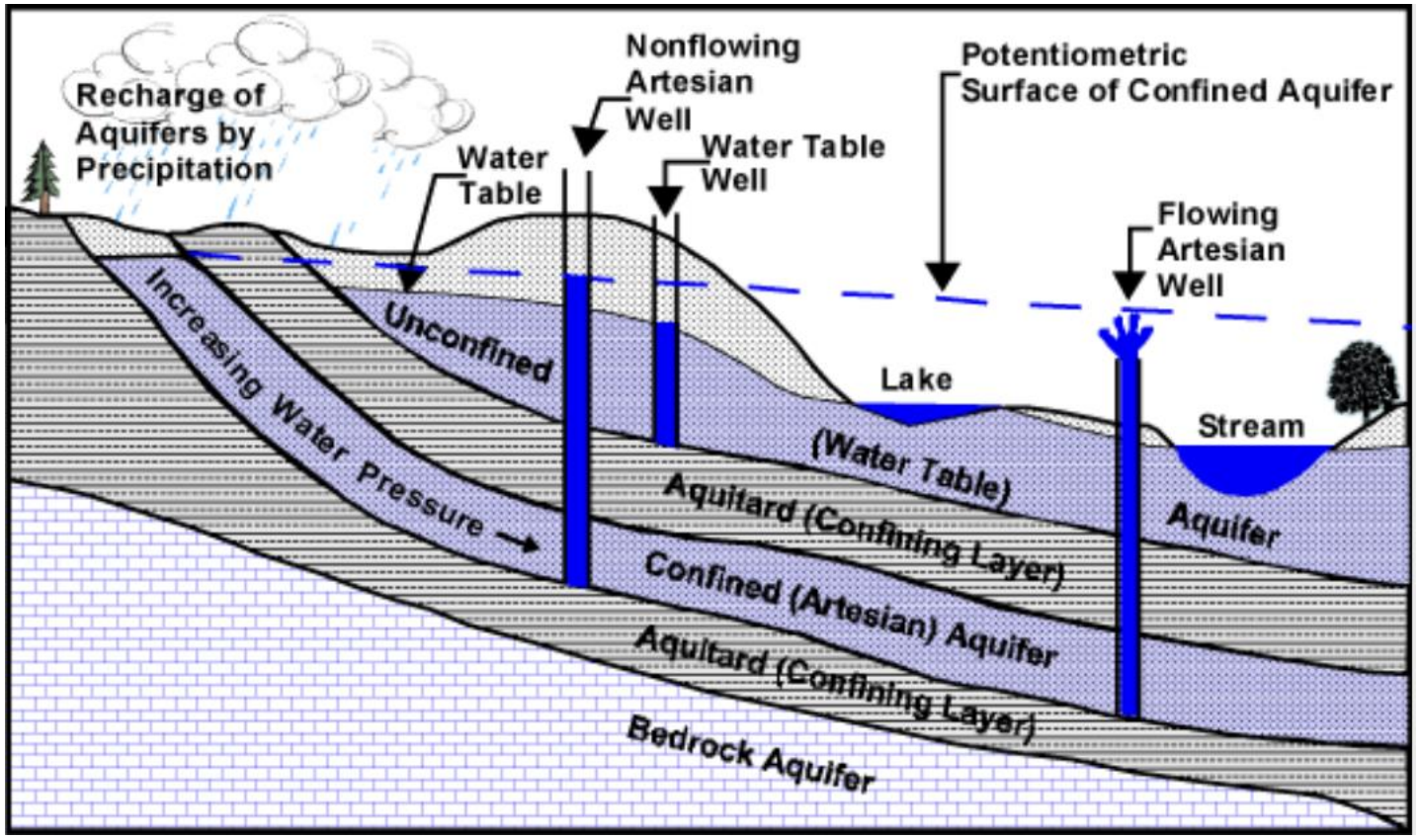
Permeability
Ability to transmit water

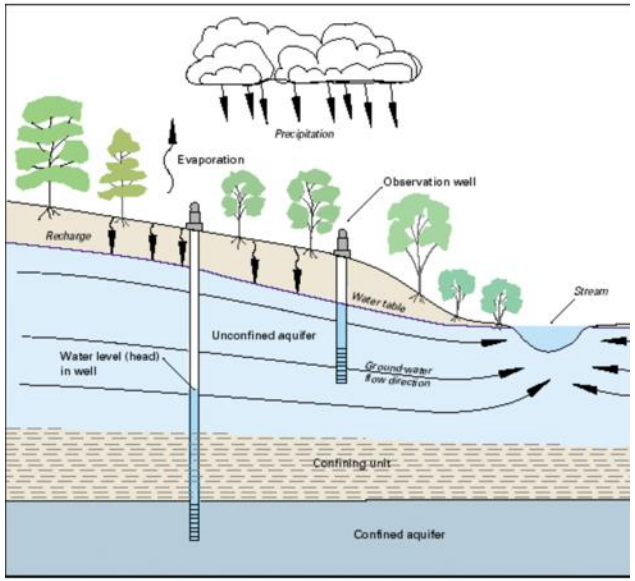


Unconfined versus Confined Aquifer

- Unconfined Aquifer:
  - higher up
  - water table marks top of groundwater
  - groundwater tends to stay within single watershed

- Confined Aquifer:
  - deeper
  - water is usually under pressure (water level in wells is above the top of the aquifer)
  - potentiometric surface
  - can be regional, crossing multiple watersheds





cross-sectional diagram showing a layered system with an upper unconfined aqu
ed aquifer. Note the water level in the two wells: In the unconfined aquifer, the wat
table. In the confined aquifer, the water level is higher than the top of the aquifer –
saturated and that the water is under pressure.

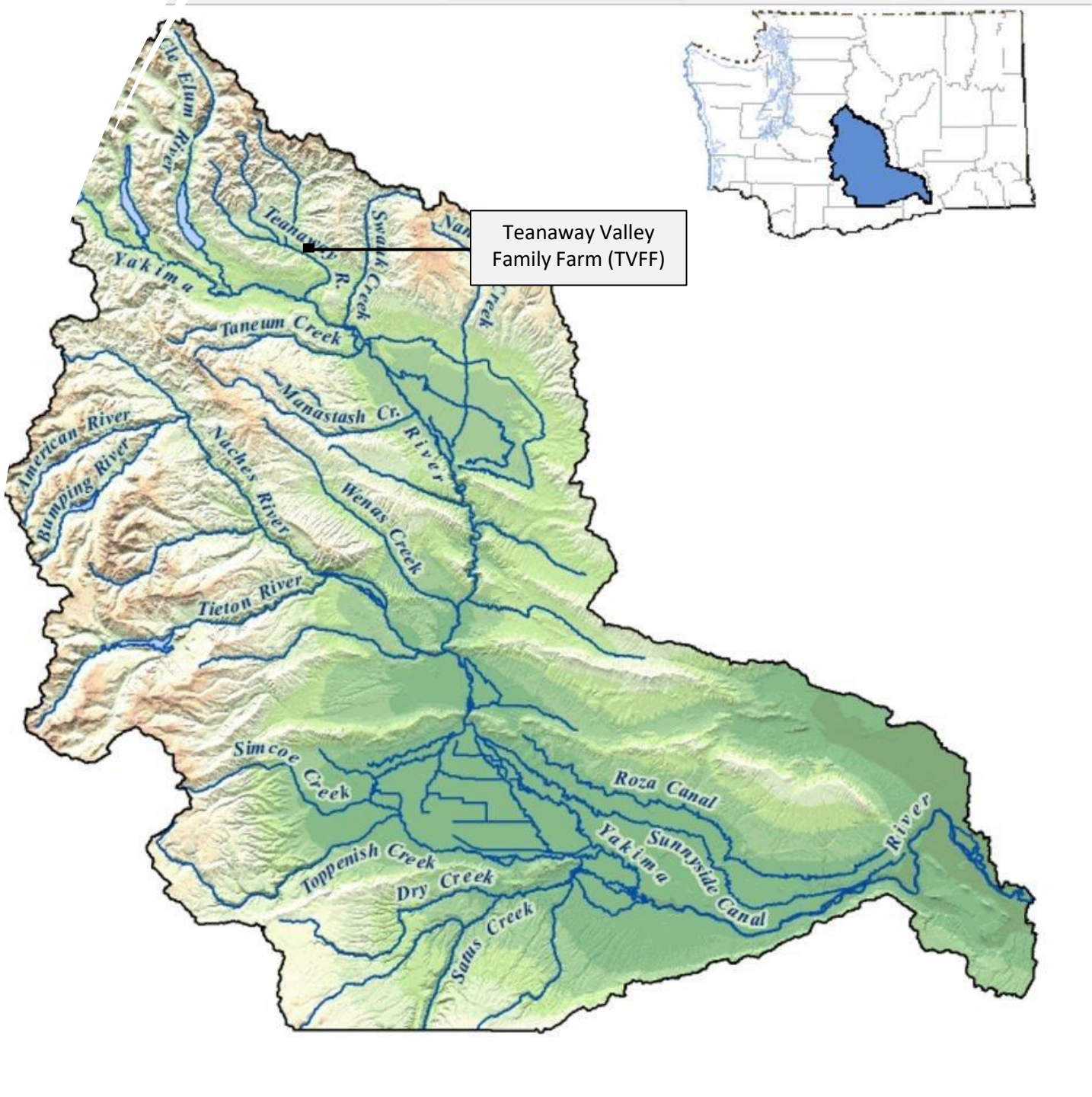
Source: USGS Water Science Photo Gallery

WELLS

- Window into the subsurface
- Water levels – information on water table, potentiometric surface, groundwater flow direction
- Aquifer tests – used to determine aquifer properties (permeability)
- Water chemistry – information about interaction between different waters, rocks, and soils

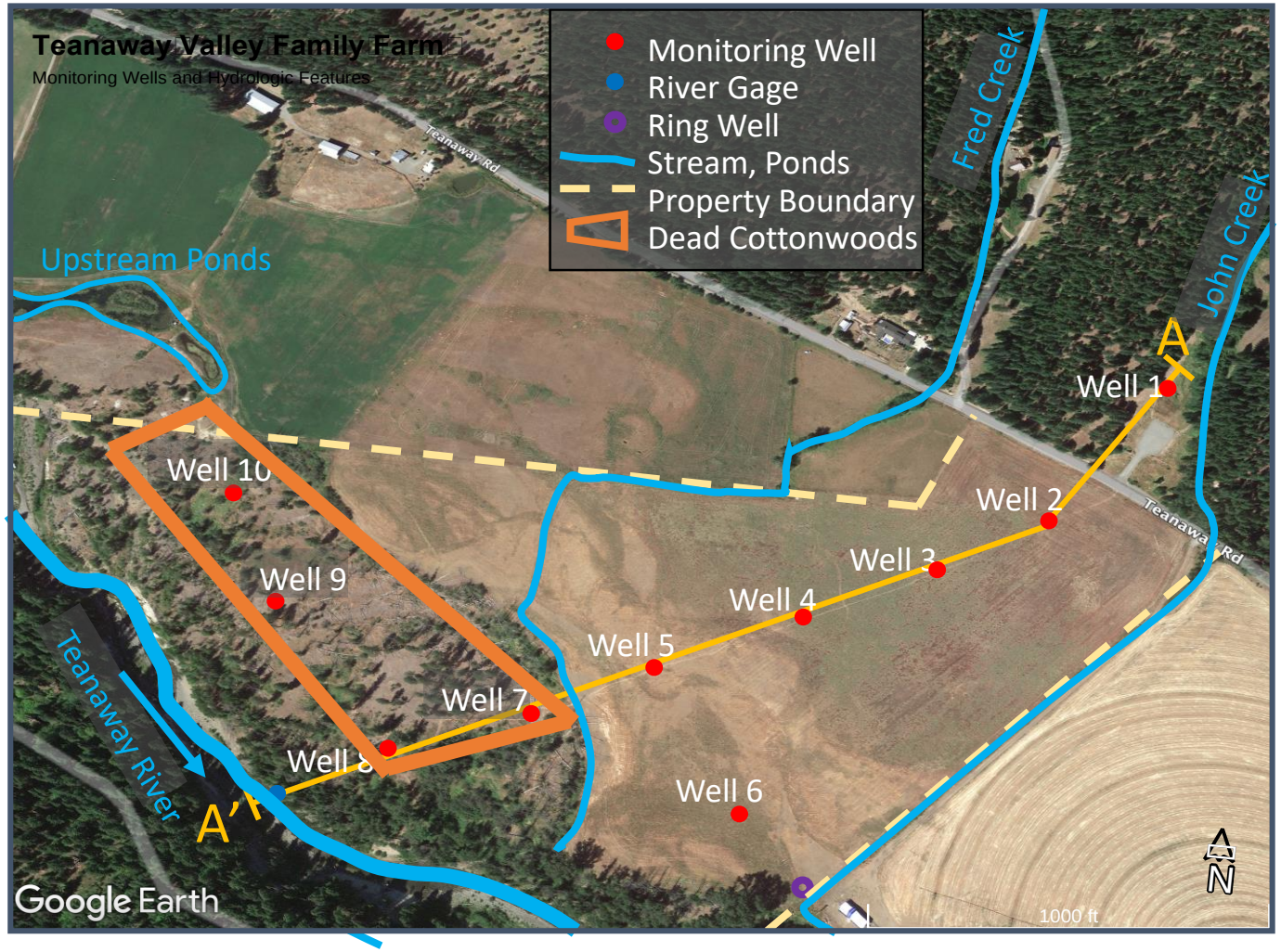
TEANAWAY RIVER

TEANAWAY VALLEY FAMILY FARM



Teanaway Valley Family Farm

- 87 hectare (215 acres)
- Previously farmed for timothy hay
- Irrigation shift around year 2000
- Purchased by WA Department of Fish and Wildlife in 2017
- Grove of dead cottonwoods
- Installed 10 monitoring wells in 2018
- Finished in sandstone bedrock (except well 2)
- Depths 3.1 to 7.0 m (10-23 ft)



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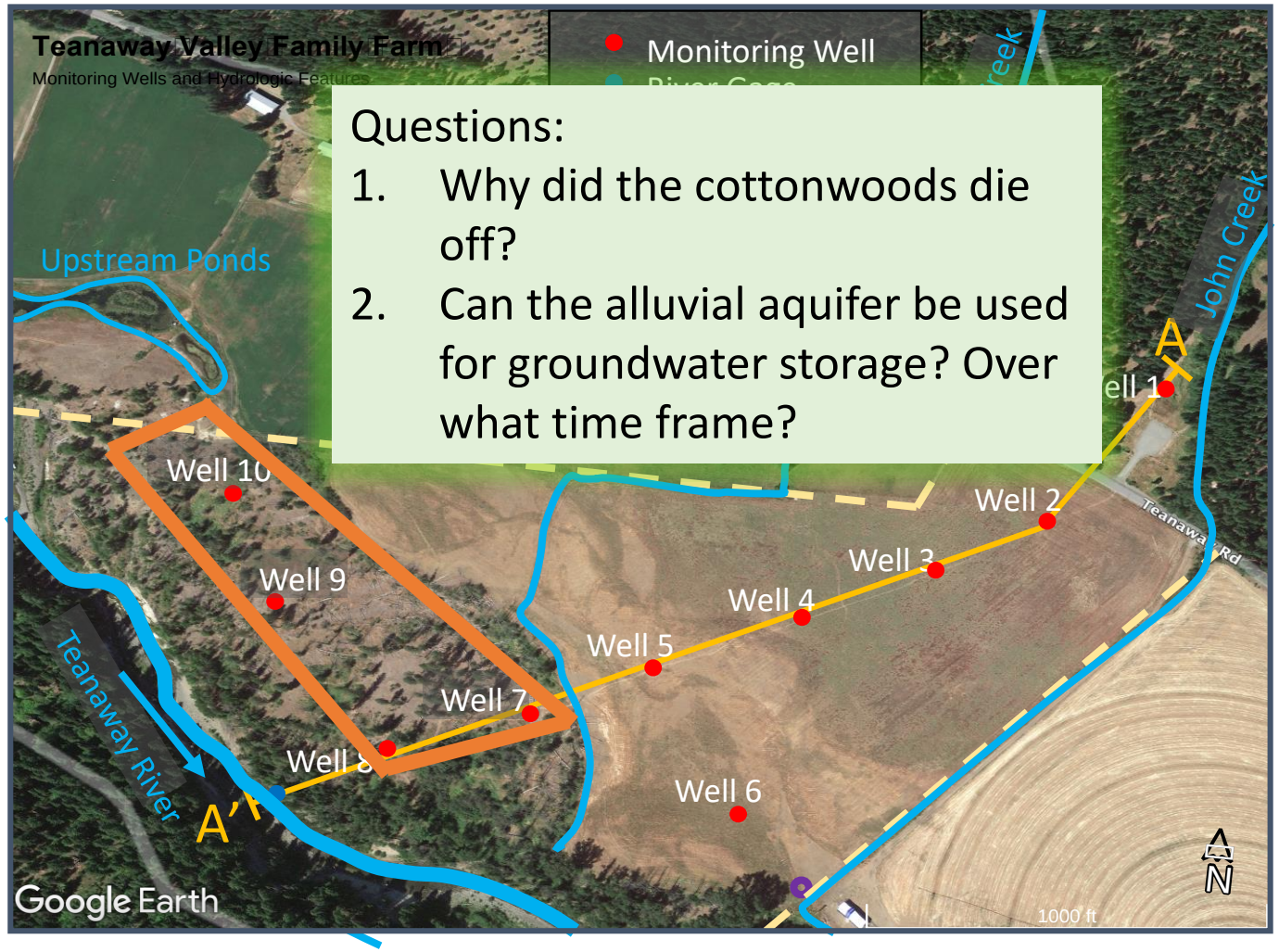
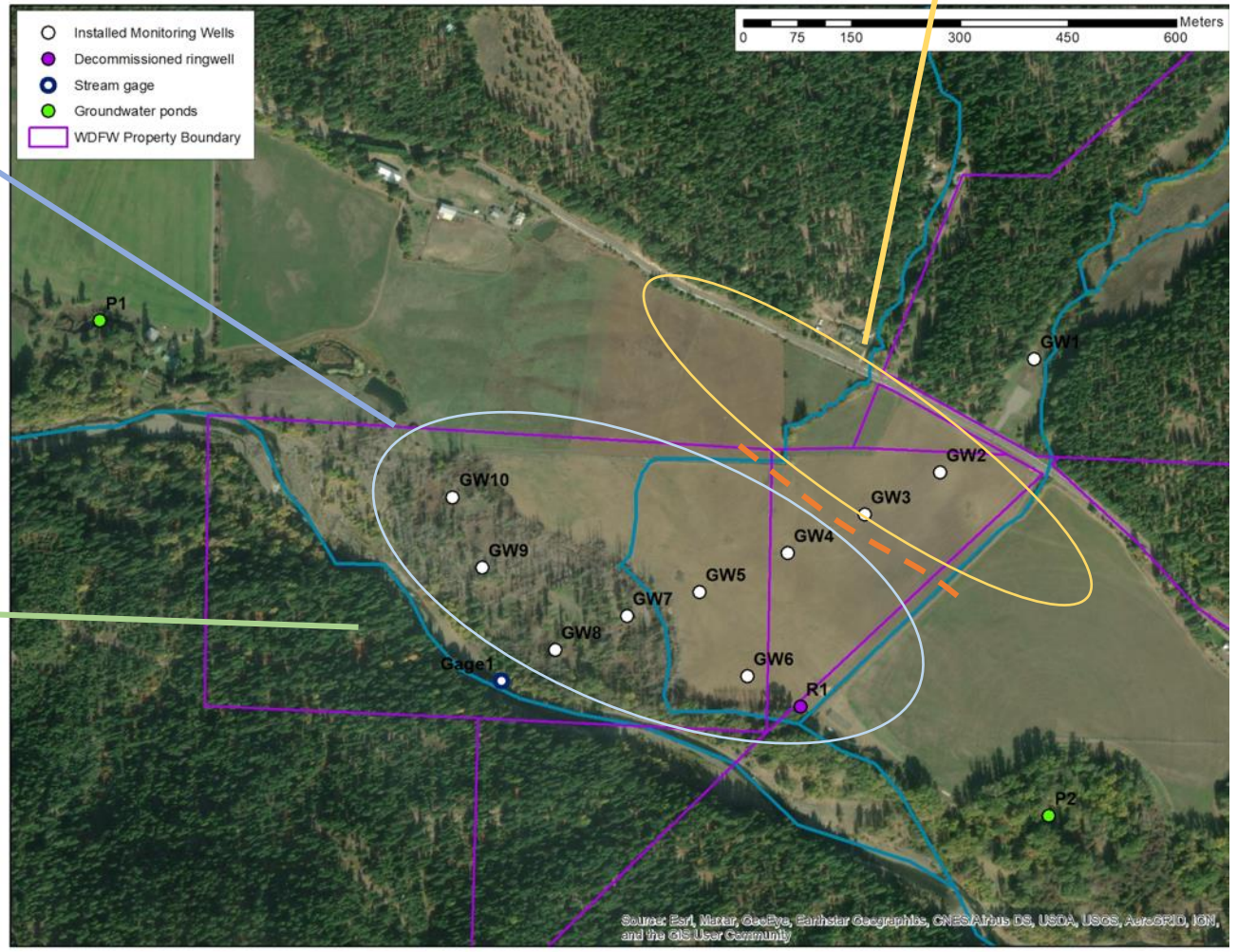


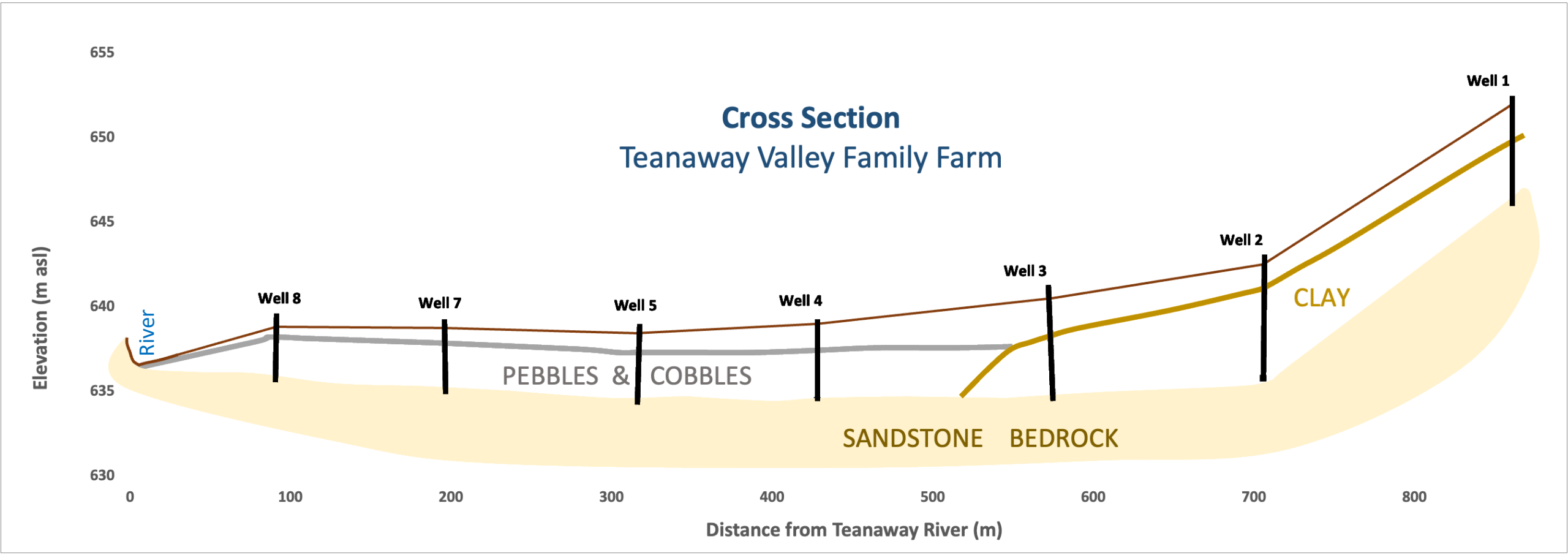
Substrate Stratigraphy

Cobble-rich alluvial sediment
Wells 4-10

Sandstone bedrock cut
by river

Thick clay
deposit
Wells 1-3




Cross Section
Teanaway Valley Family Farm
Elevation (m asl)
655
650
645
640
635
630
0
100
200
300
400
500
600
700
800
Distance from Teanaway River (m)
River
Well 8
Well 7
Well 5
Well 4
Well 3
Well 2
Well 1
PEBBLES & COBBLES
CLAY
SANDSTONE BEDROCK

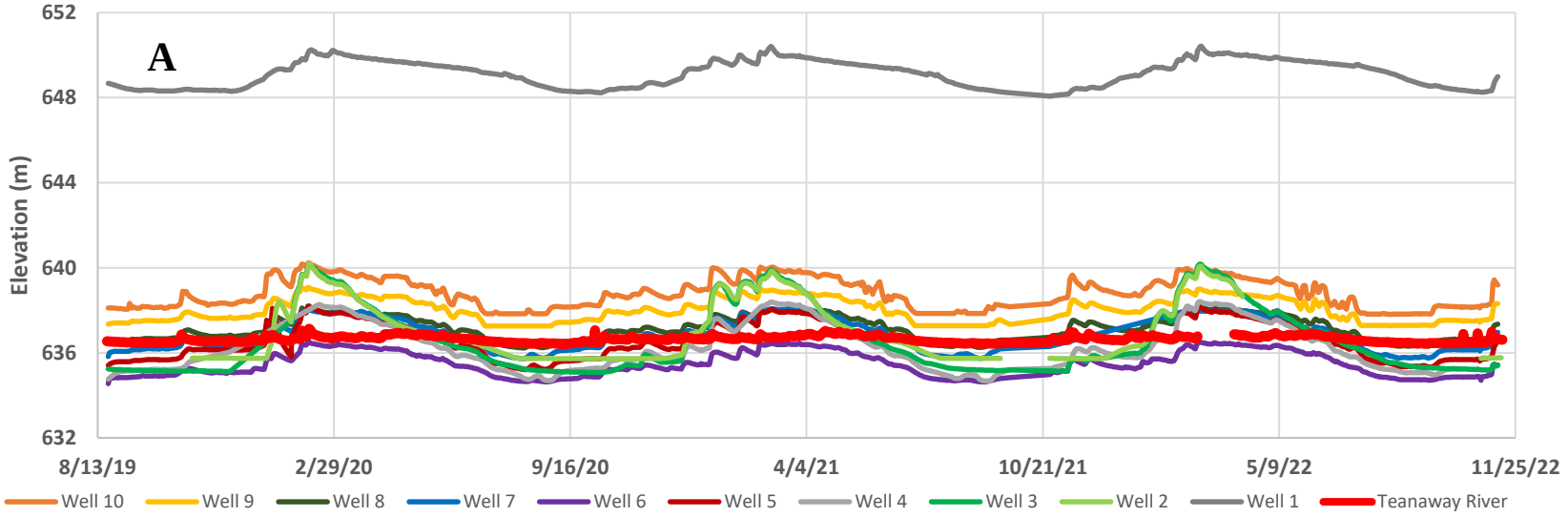
Groundwater Levels

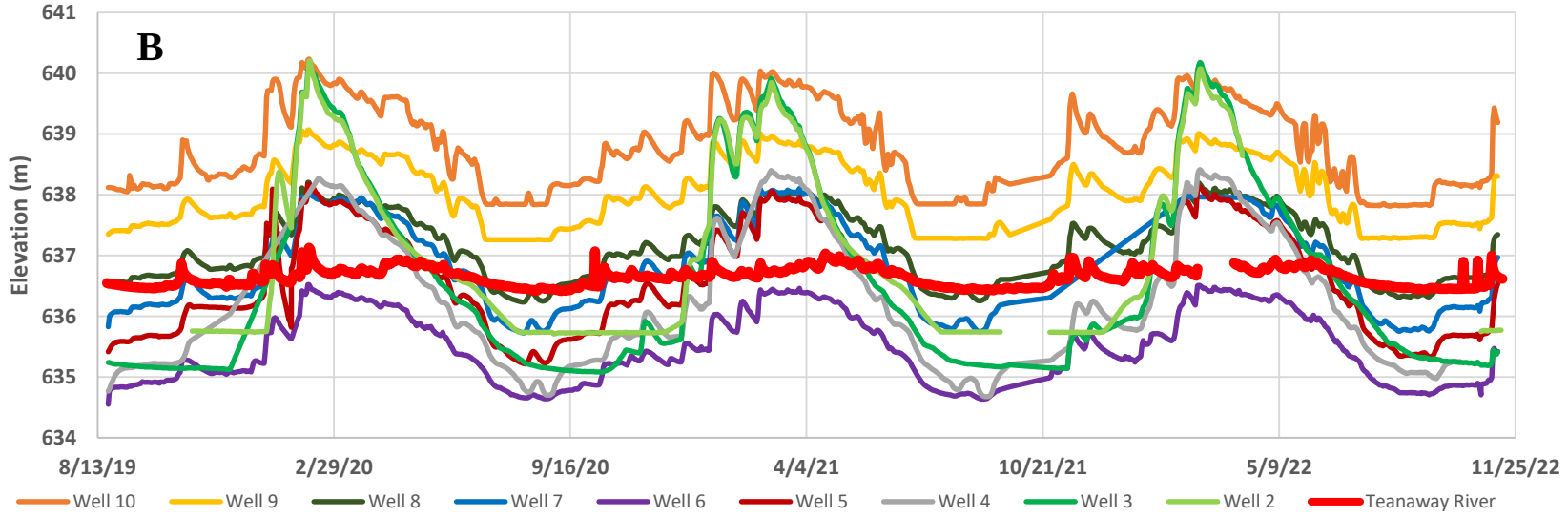
Transducer Measurements

Well 1 – confined aquifer above floodplain

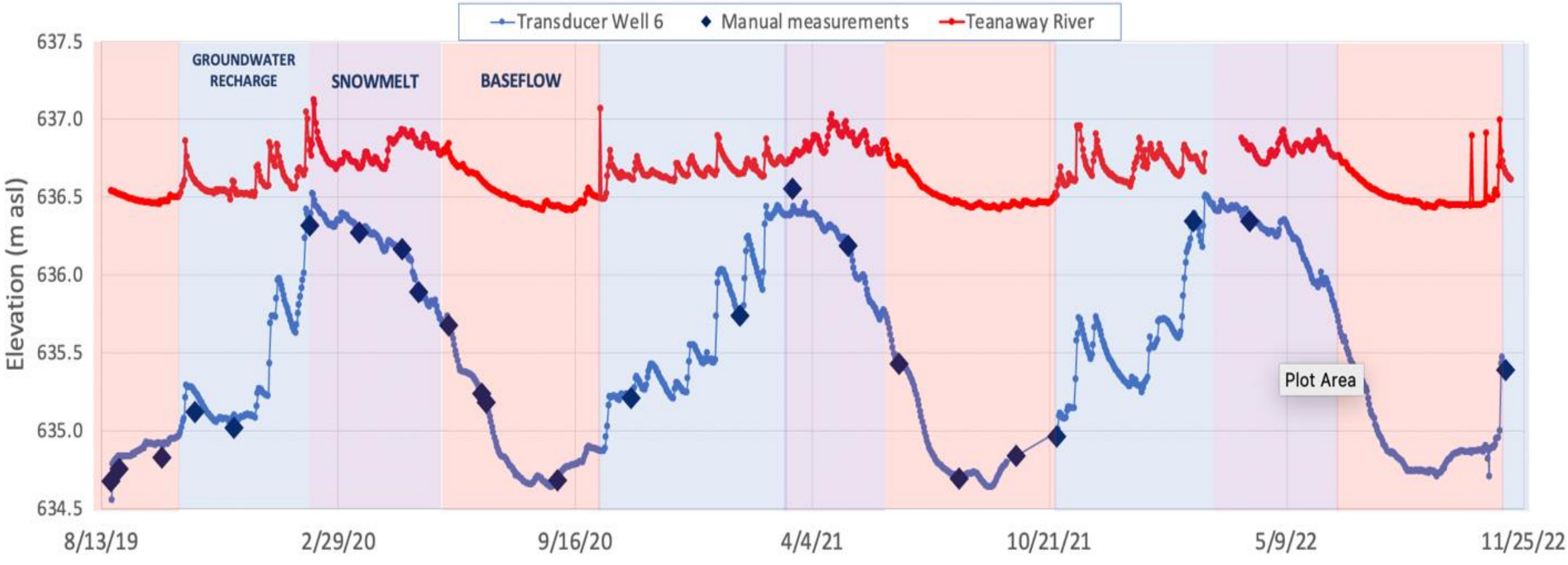
Well 2 and 3 – confined aquifer on floodplain, beneath clay

Well 4-10 – alluvial floodplain aquifer, unconfined, groundwater levels define water table





Seasonal Variation – Cobble-Rich Alluvium Aquifer versus Teanaway River



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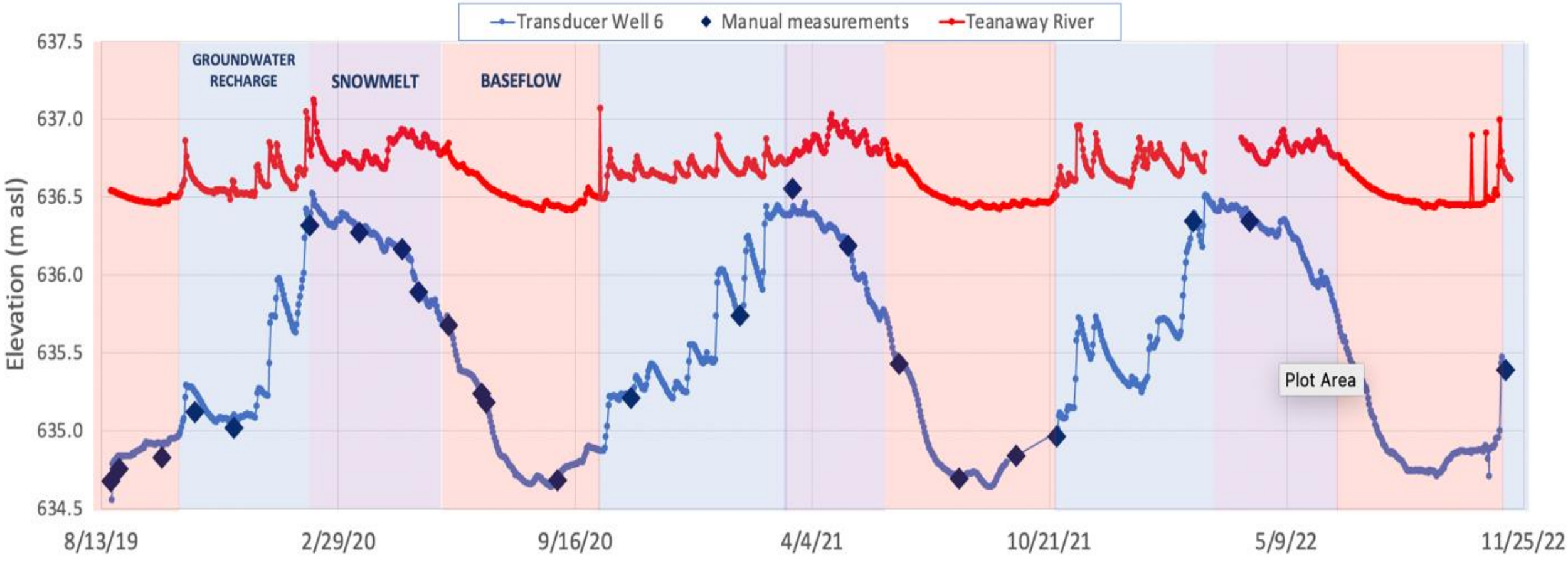

- Groundwater Recharge – Fall rain and early Winter thaws or rain on snow

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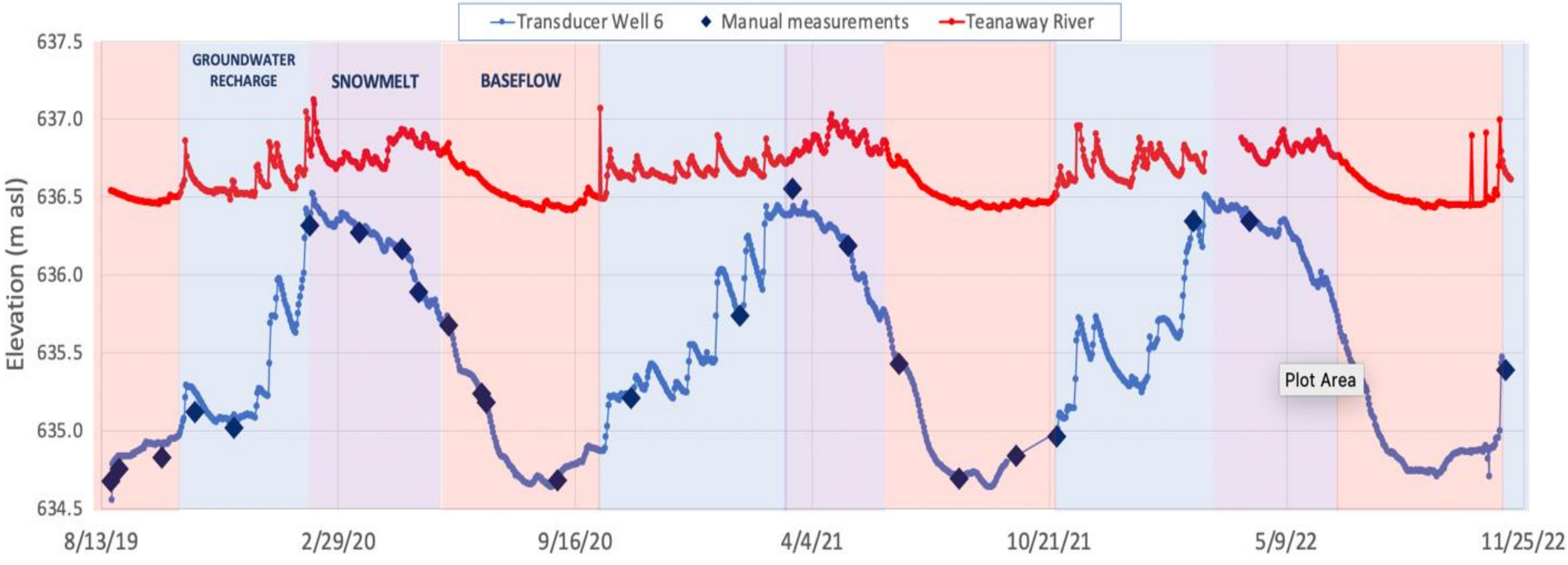

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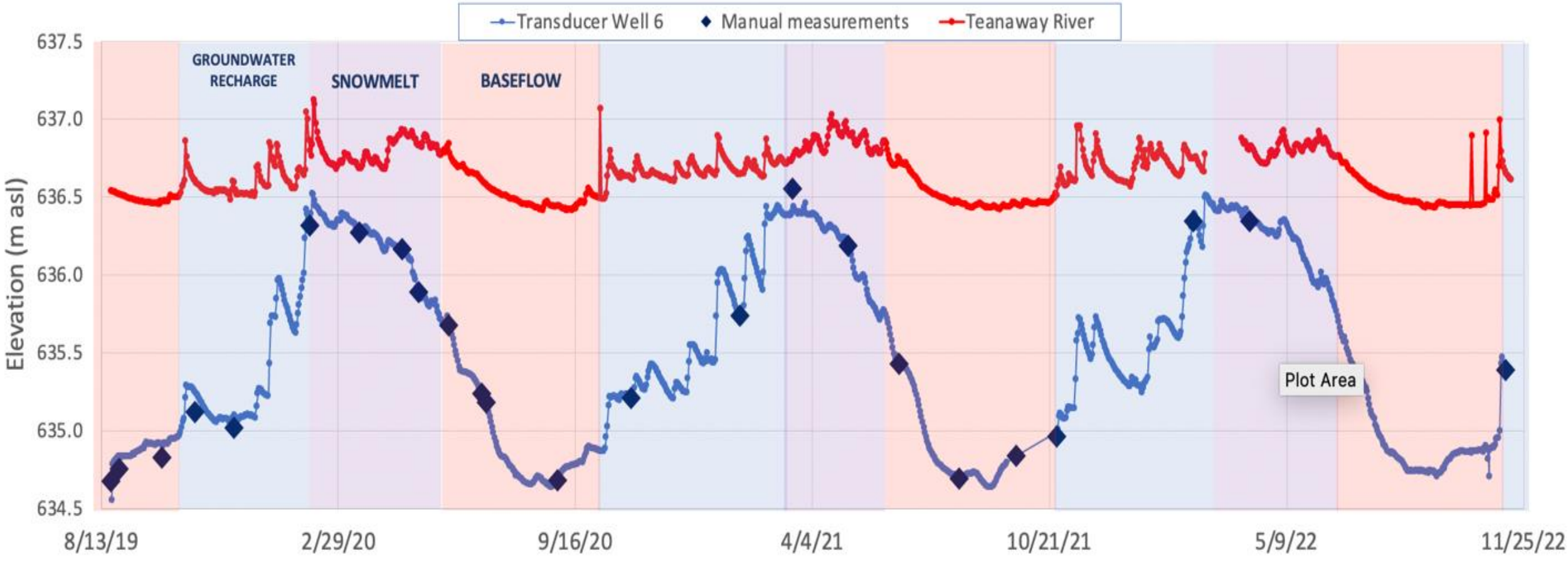
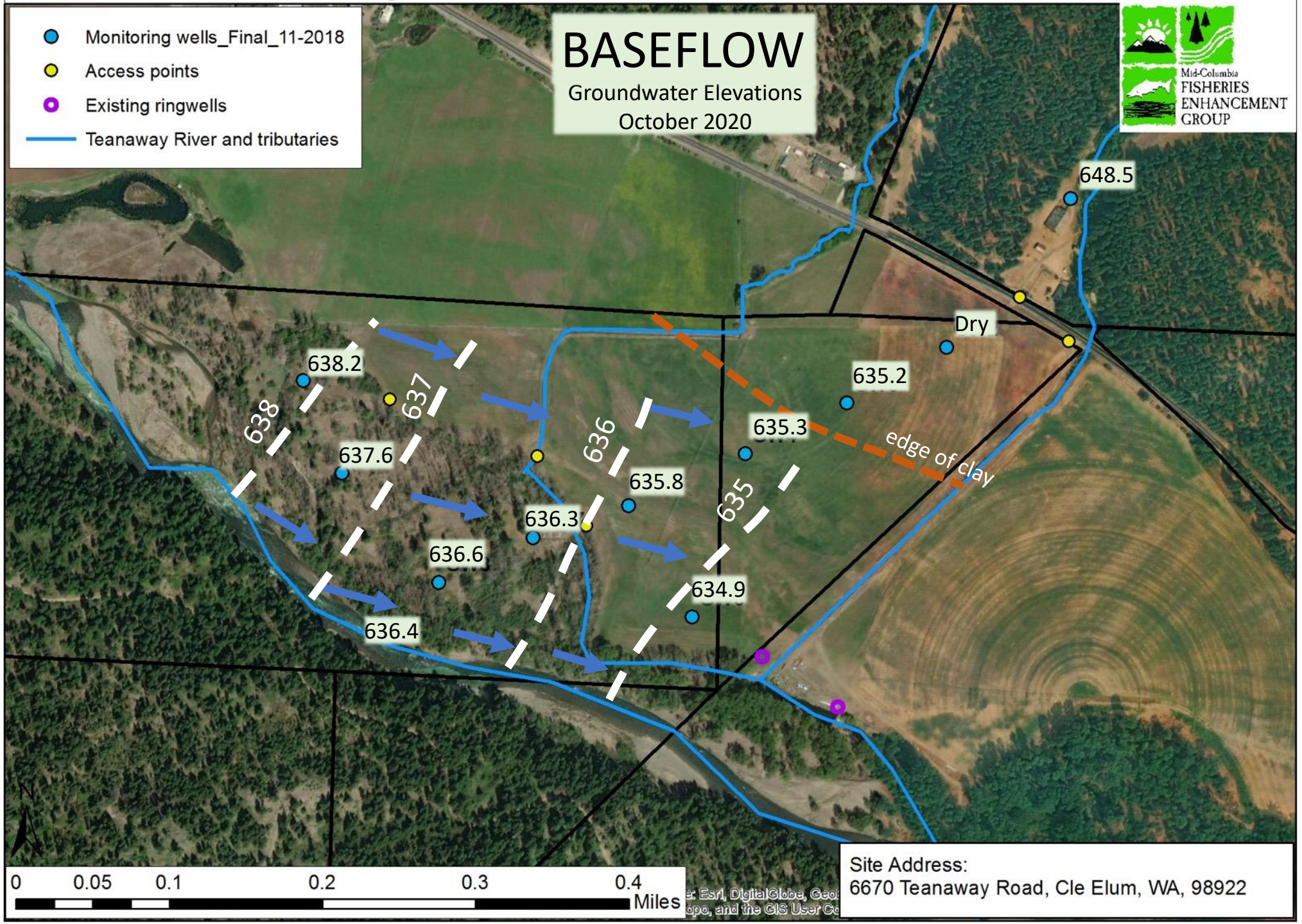
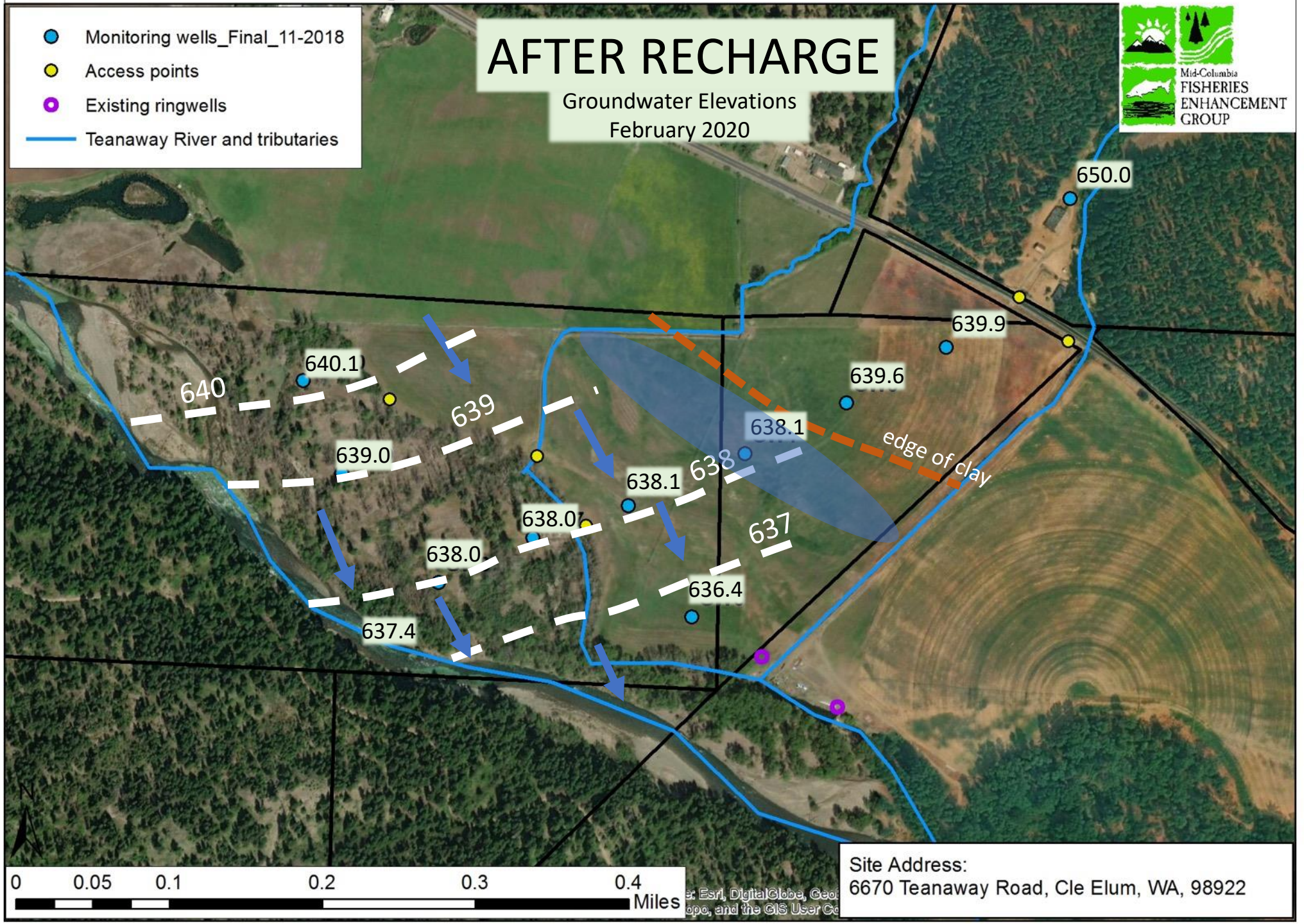


- Groundwater Recharge – Fall rain and early Winter thaws or rain on snow
- Snowmelt – Late Winter and Spring, sustains high river flow
- Baseflow – Summer and early Fall, little precipitation, groundwater is main input to river


Monitoring wells_Final_11-2018
Access points
Existing ringwells
Teanaway River and tributaries
BASEFLOW
Groundwater Elevations
October 2020
Mid-Columbia
FISHERIES
ENHANCEMENT
GROUP
648.5
Dry
638.2
637
638
635.2
635.3
edge of clay
637.6
636
635.8
635
636.3
636.6
634.9
636.4
N
0
0.05
0.1
0.2
0.3
0.4
Miles
Site Address:
6670 Teanaway Road, Cle Elum, WA, 98922


Monitoring wells_Final_11-2018
Access points
Existing ringwells
Teanaway River and tributaries
AFTER RECHARGE
Groundwater Elevations
February 2020
Mid-Columbia
FISHERIES
ENHANCEMENT
GROUP
650.0
639.9
639.6
638.1
640.1
639.0
638.1
638.0
638.0
636.4
637.4
640
639
638
637
edge of clay
0
0.05
0.1
0.2
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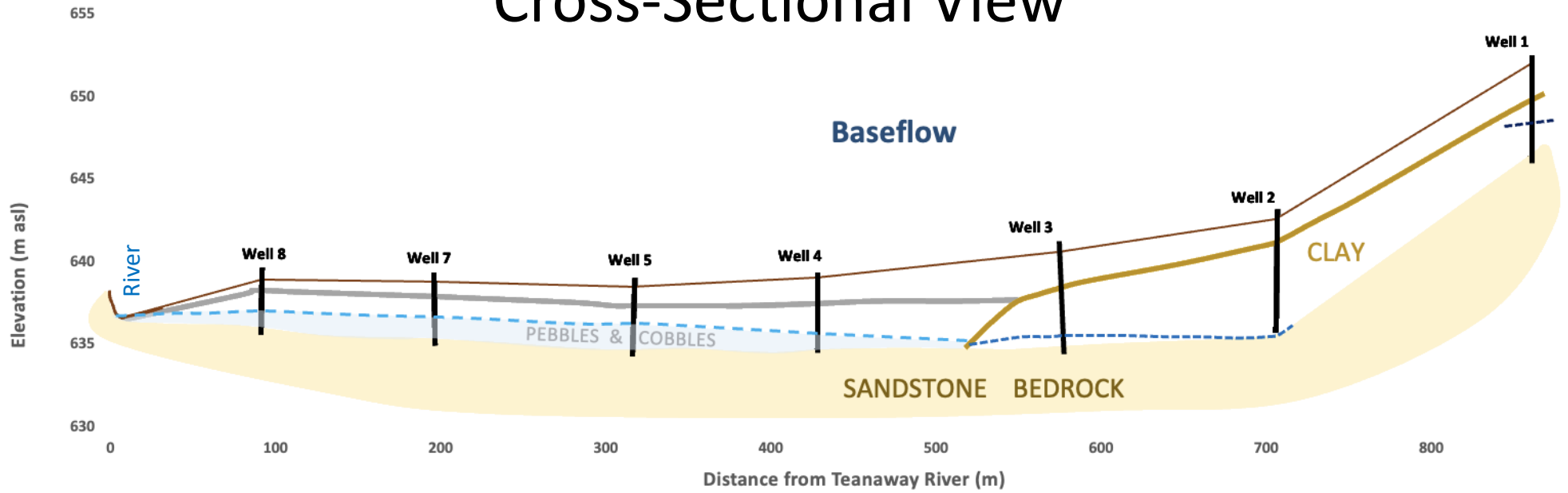
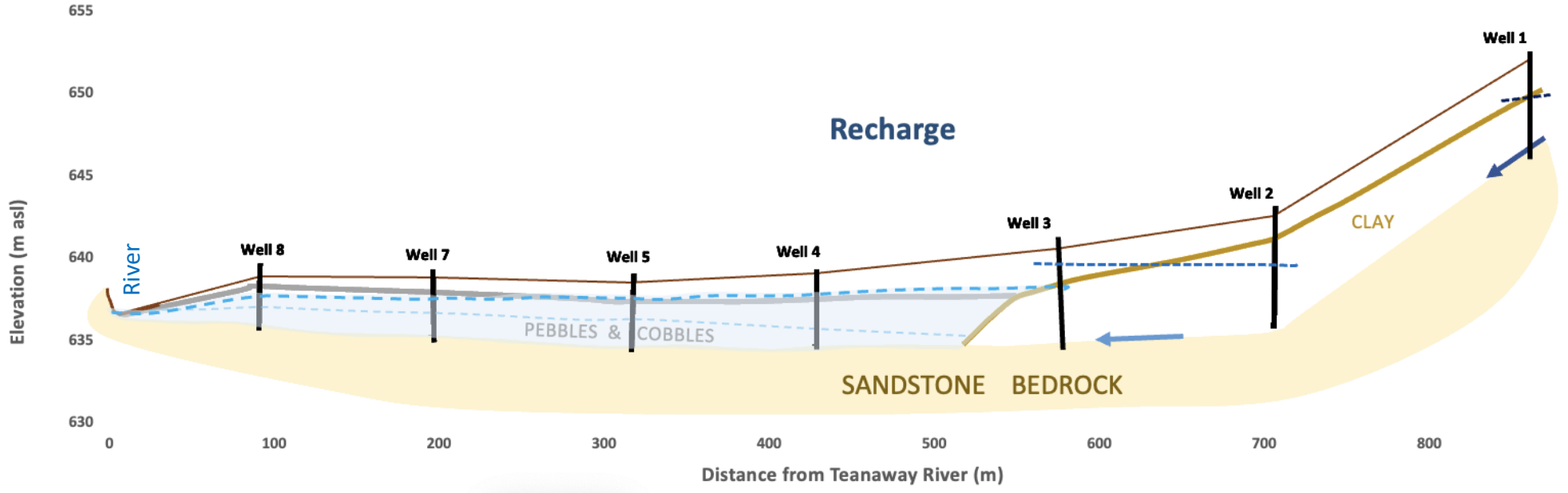
Cross-Sectional View

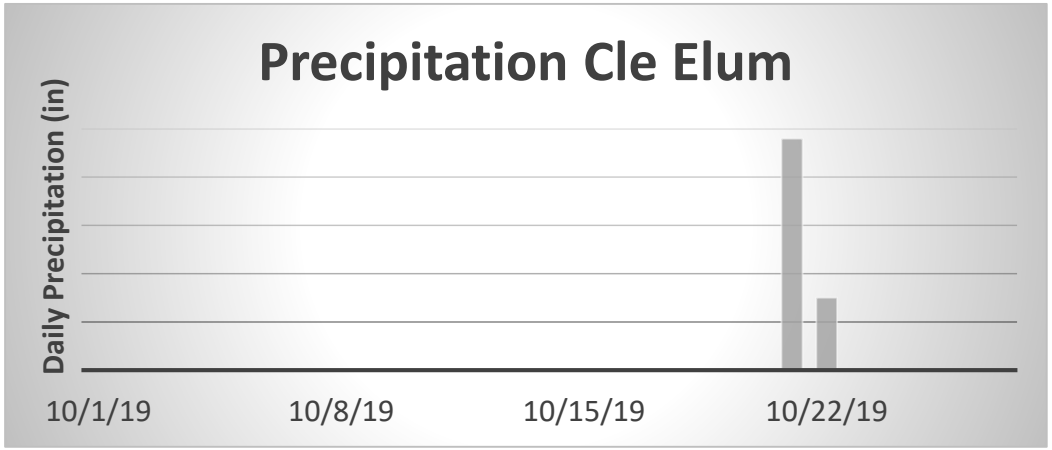


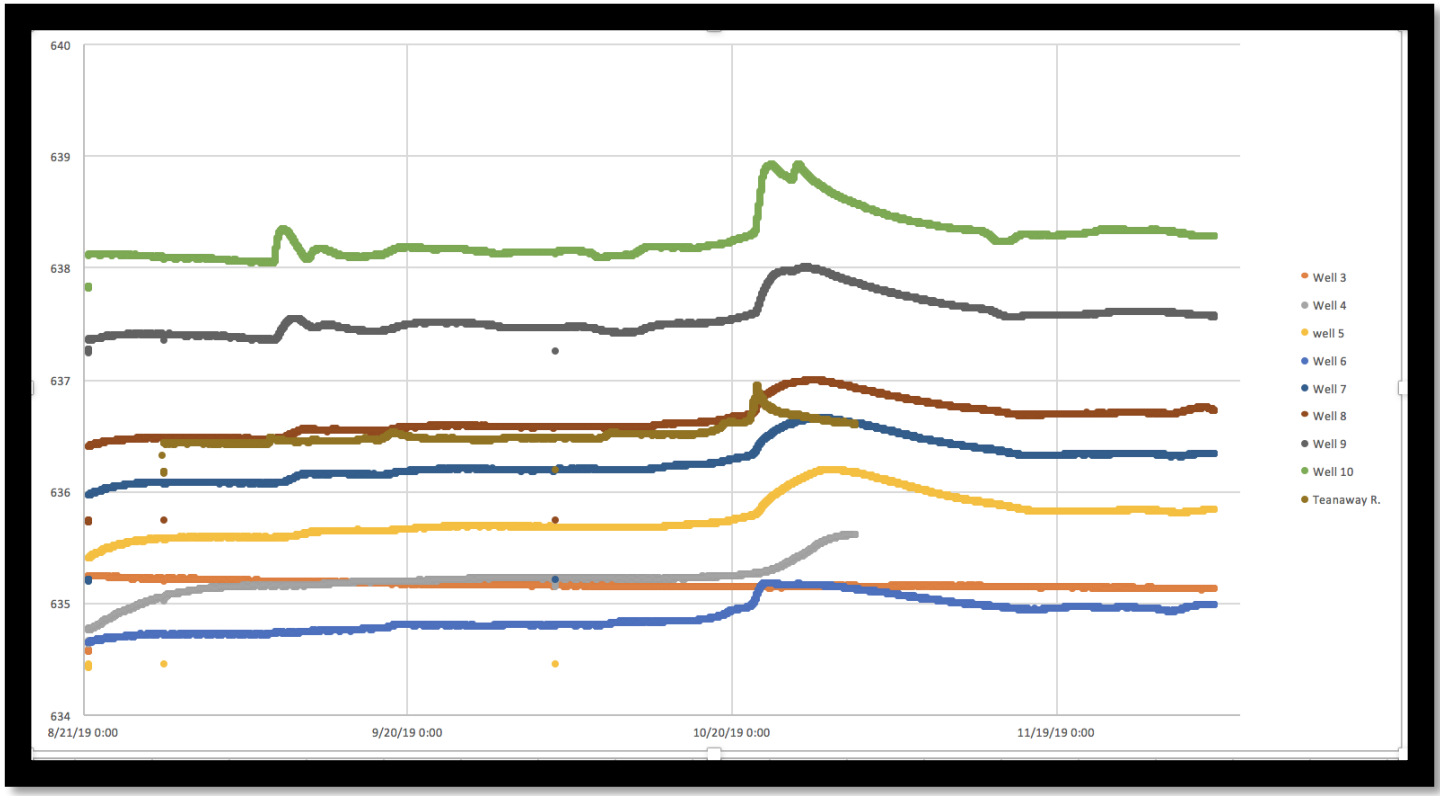


Why did the cottonwoods die off?

October Precipitation Event

Transport of water pulse through subsurface

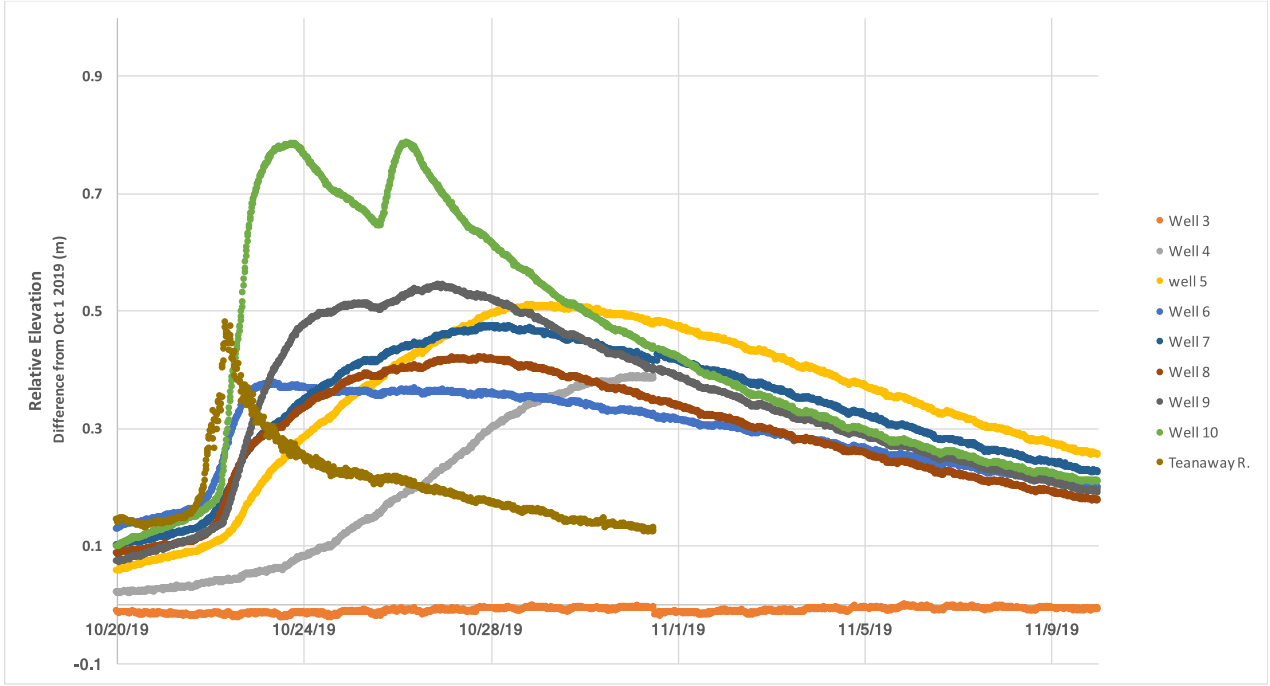


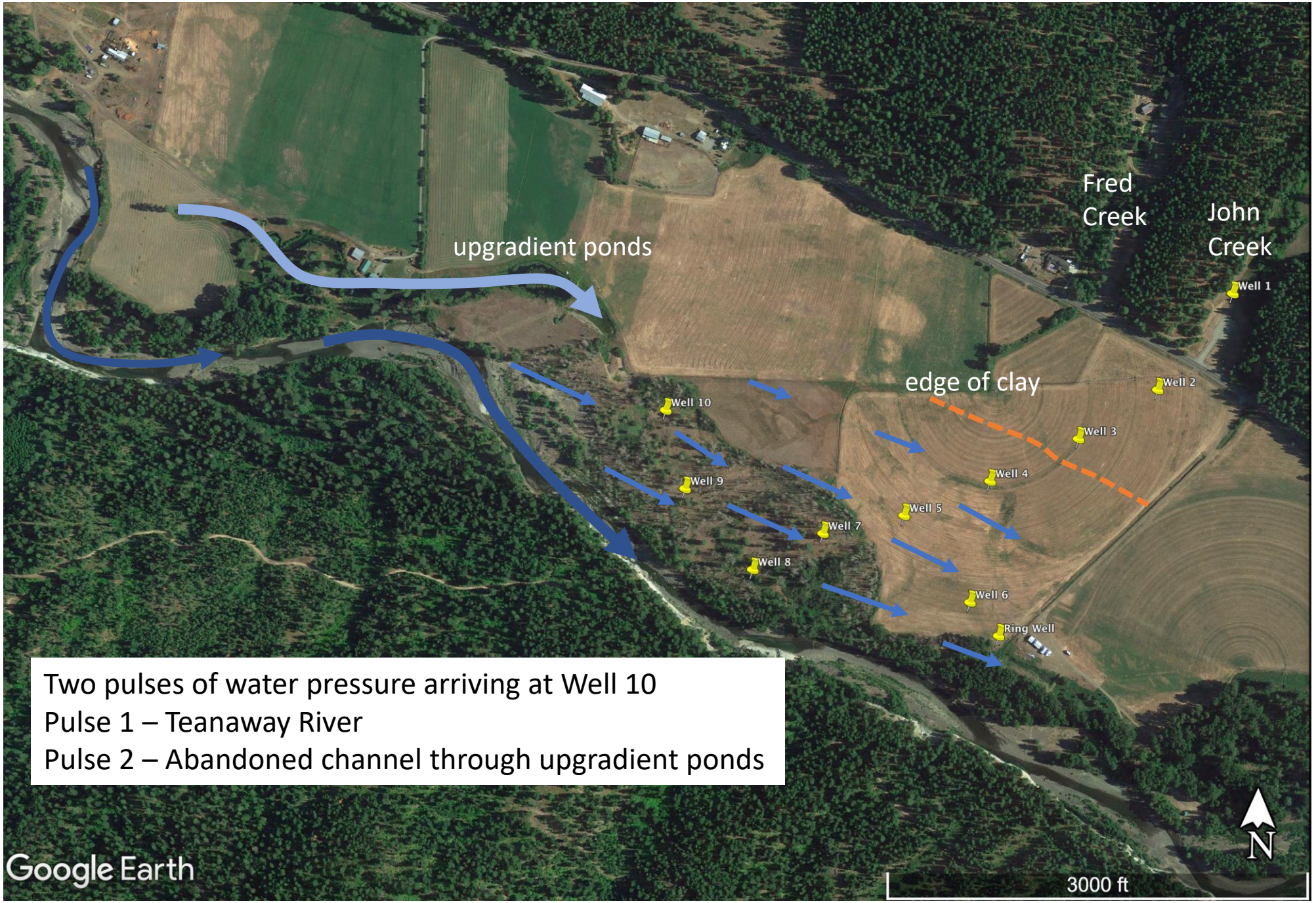


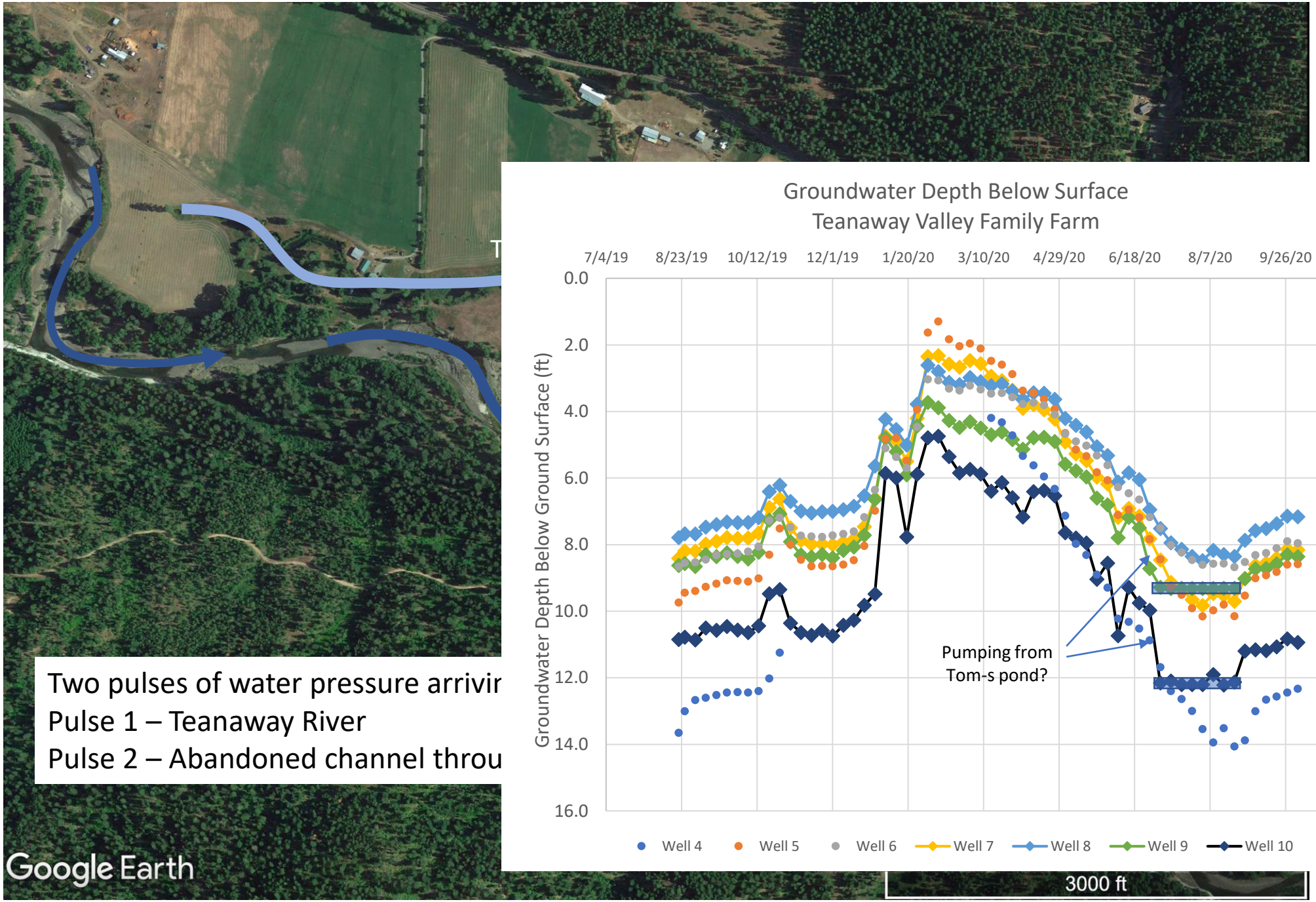
Why did the cottonwoods die off?

October Precipitation Event

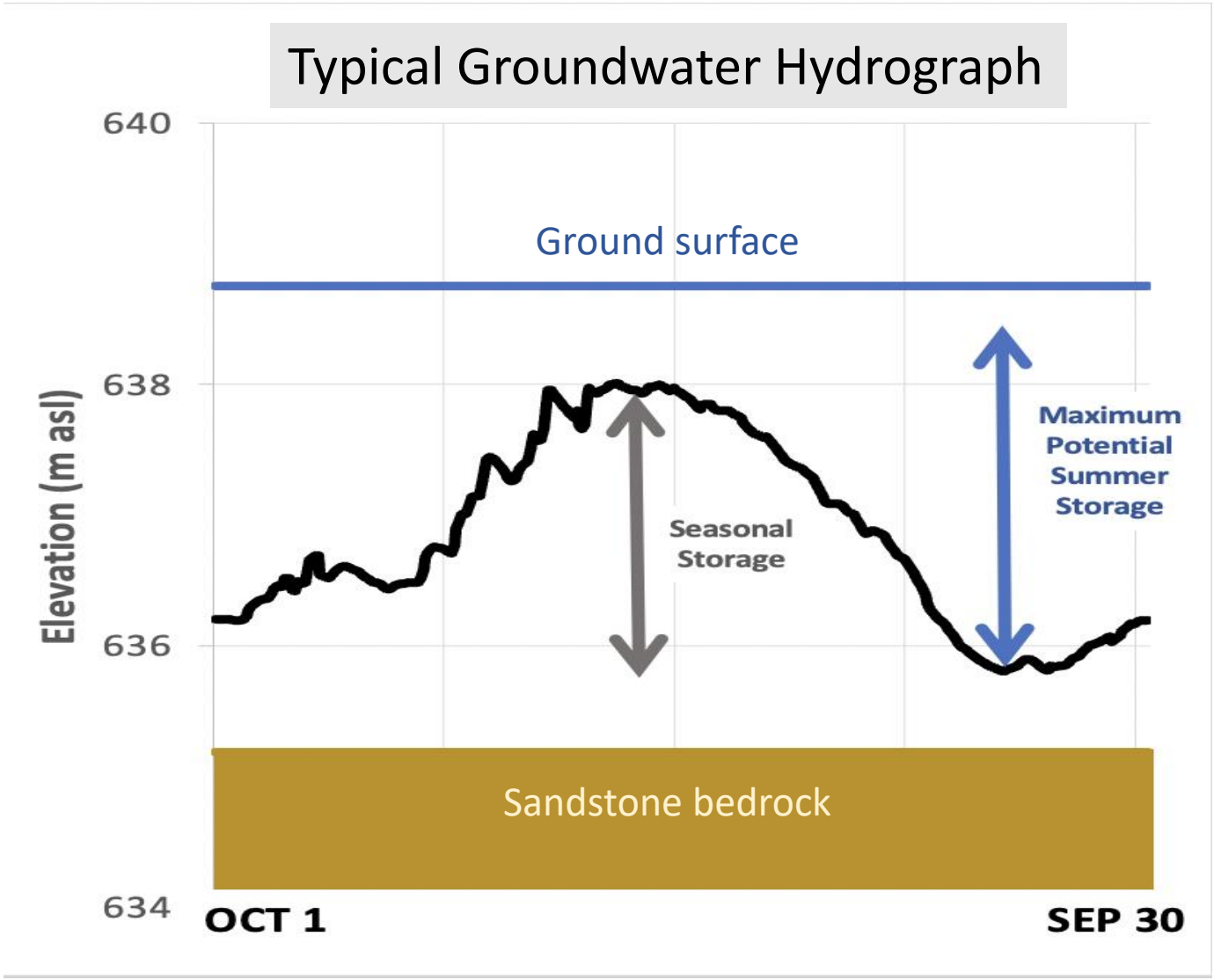
- Hydraulic pressure moves through wells (6, 10, 9, 8, etc.)
- ≈2 weeks to reach Well 4
- Double pulse in Wells 10, 9, 8?
- No river signal in Well 3



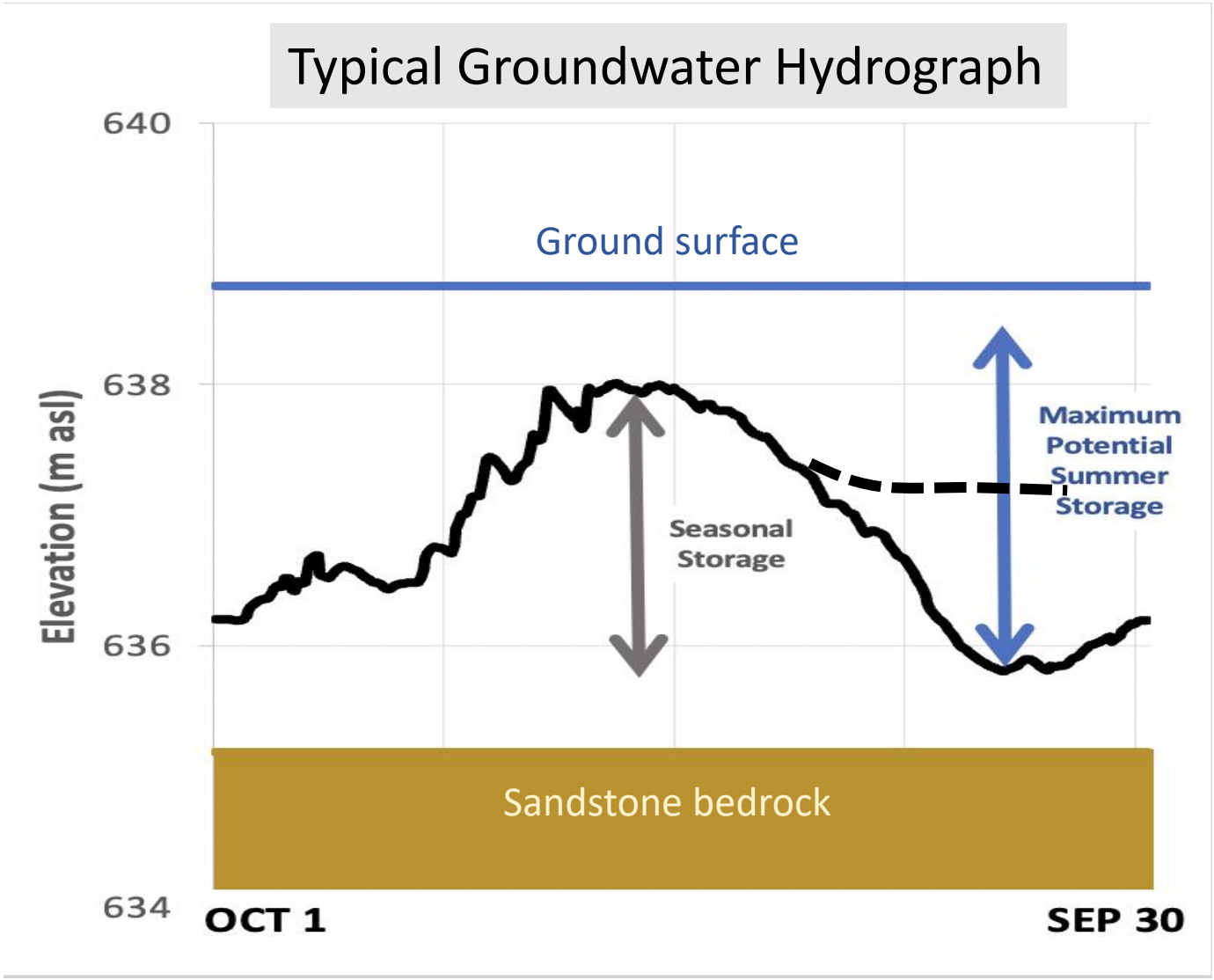

upgradient ponds
Fred Creek
John Creek
edge of clay
Well 1
Well 2
Well 3
Well 4
Well 5
Well 6
Well 7
Well 8
Well 9
Well 10
Ring Well
Two pulses of water pressure arriving at Well 10
Pulse 1 – Teanaway River
Pulse 2 – Abandoned channel through upgradient ponds
Google Earth
N
3000 ft


Two pulses of water pressure arrivir
Pulse 1 – Teanaway River
Pulse 2 – Abandoned channel throu
Groundwater Depth Below Surface
Teanaway Valley Family Farm
7/4/19
8/23/19
10/12/19
12/1/19
1/20/20
3/10/20
4/29/20
6/18/20
8/7/20
9/26/20
11/15/20
Groundwater Depth Below Ground Surface (ft)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
Pumping from
Tom-s pond?
Well 4
Well 5
Well 6
Well 7
Well 8
Well 9
Well 10
Google Earth
3000 ft

Can the alluvial aquifer be used for groundwater storage?

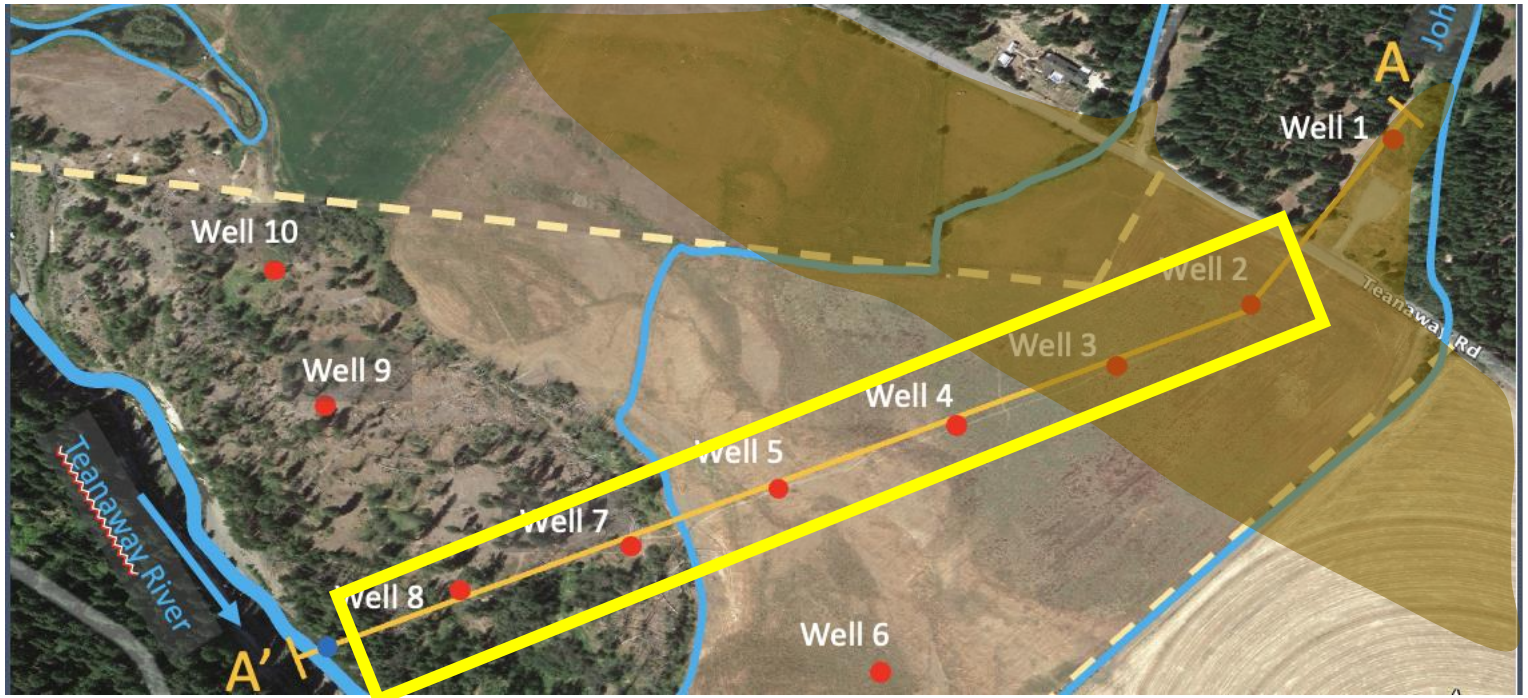


Can the alluvial aquifer be used for groundwater storage?



$$t = \frac{n * \sum(r_i * d_i)}{\sum d_i}$$

t = uniform thickness
n = effective porosity
r_i = additional elevation in well i
d_i = distance between well I and well I +1

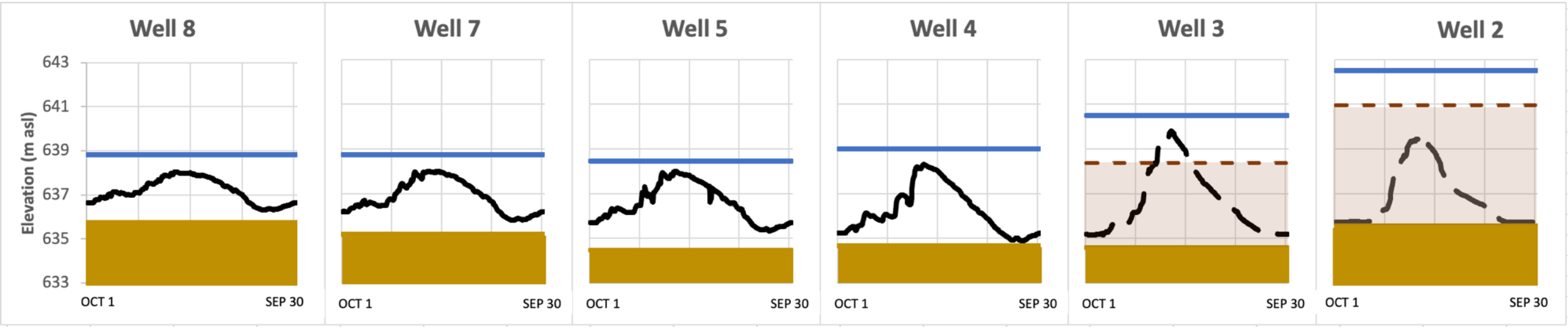


Potential additional summer storage

t = 0.76 m

Equivalent to 2.5 acre-ft per acre

50 acres of floodplain = 125 acre-ft

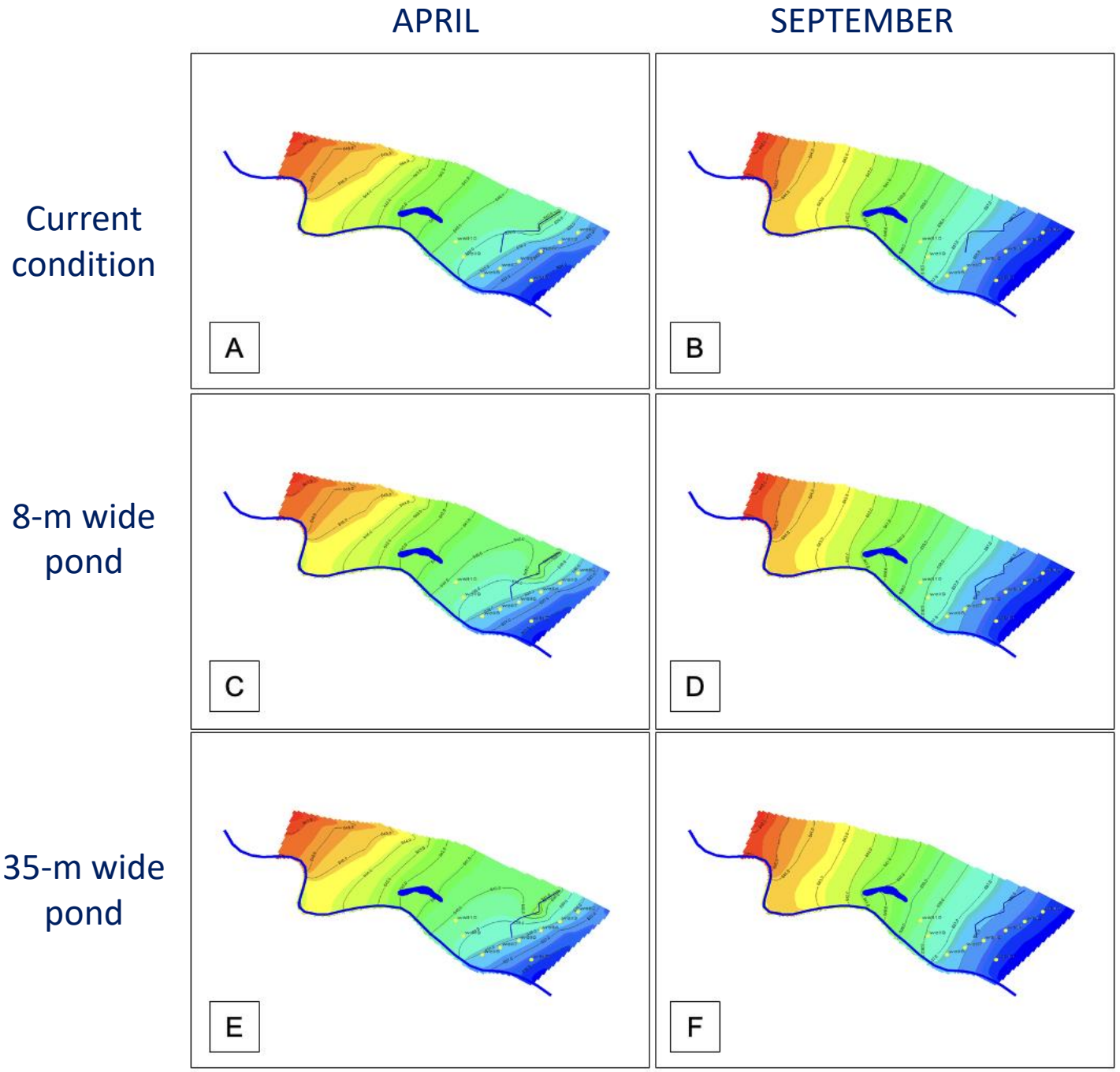


Over what time frame?

Modelling Results

(Lindsay Henning thesis)

- Added pond on upgradient side of field
- Different widths 8m, 35 m
- In all cases, groundwater level returns to baseline by September



Conclusions/Implications

- Clay dominates northern side of valley, restricts groundwater flow and available storage
- Recharge from hillslopes, seasonal variation in flow
- Rapid loss of groundwater storage during baseflow, role of incised river
- Cobble-rich alluvium rapidly transmits water
- Depth to groundwater is much greater than needed to sustain cottonwoods during drought stress
- Shift in irrigation likely contributed to cottonwood die-off
  - Shorter irrigation season
  - Drawing from pond immediately upgradient of some of the riparian zone


Questions?