Tools for analyzing groundwater – surface water interaction in the BWRGWMA

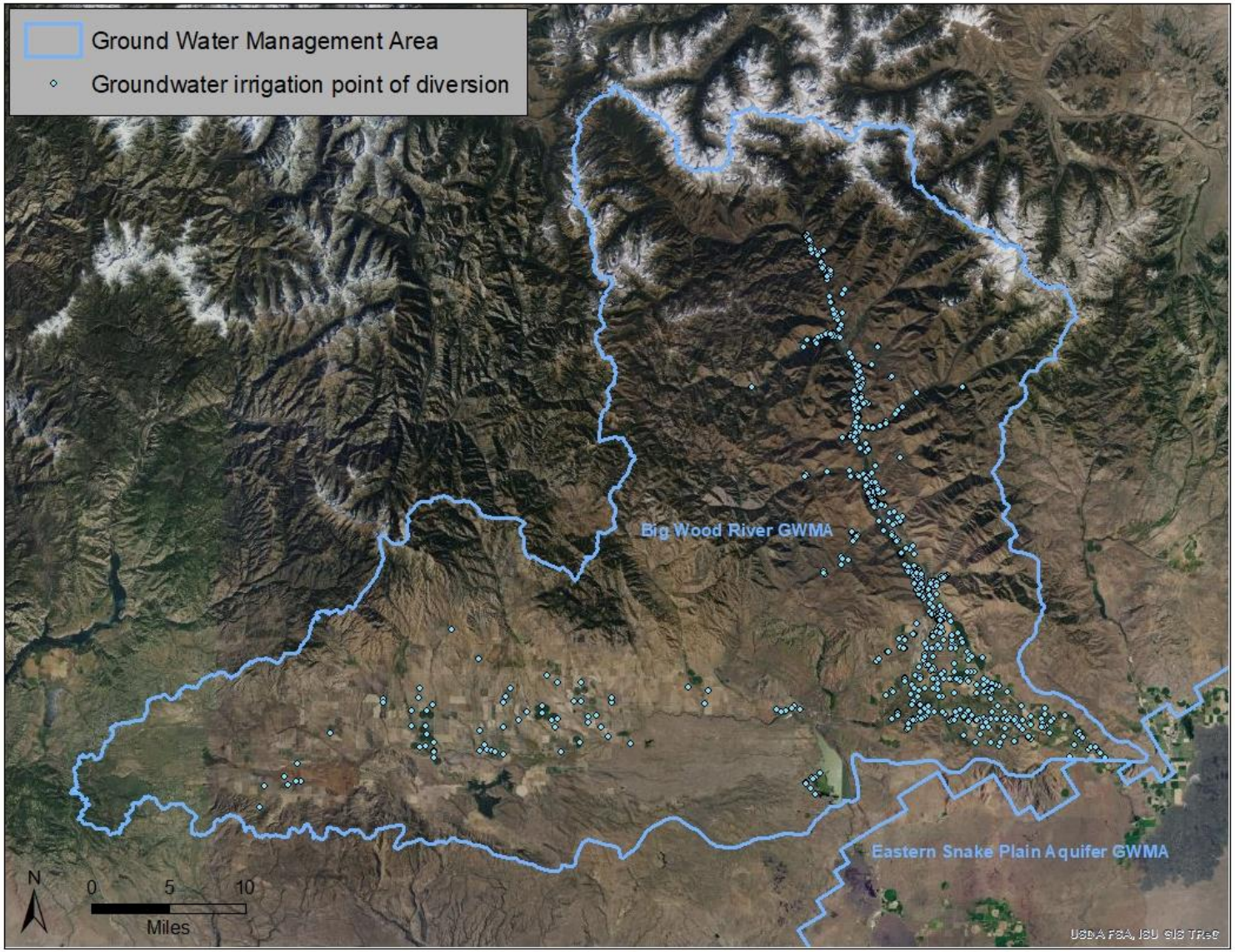
Presented to the BWRGWMA Advisory Committee

December 16, 2020

Presentation outline

- Aquifer systems in BWRGWMA
- Conceptual models
- Quantifying consumptive use of groundwater
- Evaluating impacts of consumptive use of groundwater
- Other analyses of groundwater-surface water interaction

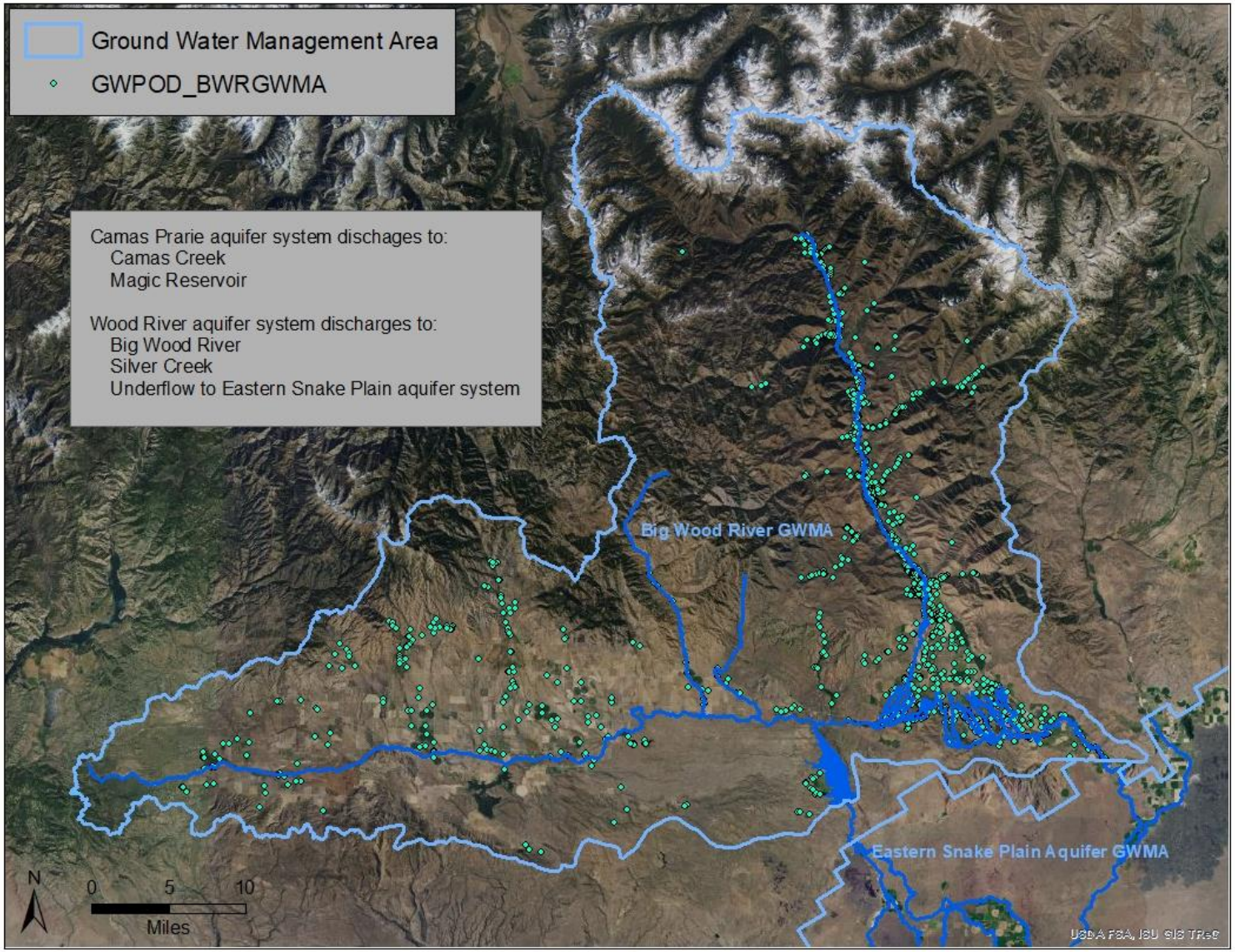
Big Wood River GWMA



From 1991 order establishing BWRGWMA

- *"The surface and ground waters of the Big Wood River drainage are interconnected. Diversion of ground water from wells can deplete the surface water flow in streams and rivers. New ground water uses can also deplete available supplies for other users and affect basin underflow which presently accumulates in the Magic Reservoir."*
- *"Injury could occur to prior surface and ground water rights including the storage right in Magic Reservoir if the flows of streams, rivers and ground water underflow in the Big Wood River Basin are intercepted by junior priority ground water diversions."*

Aquifer systems in the BWRGWMA



From 1991 order establishing BWRGWMA

Big Wood River, Silver Creek, Camas Creek

Underflow from Camas Prairie to Magic Reservoir

- "The surface and ground waters of the Big Wo drainage are interconnected. Diversion of ground water from wells can ***deplete the surface water flow in streams and rivers***. New ground water uses can also deplete available supplies for other users and affect ***basin underflow which presently accumulates in the Magic Reservoir***."
- "***Injury could occur*** to prior surface and ground water rights including the storage right in Magic Reservoir if the flows of streams, rivers and ground water underflow in the Big Wood River Basin are intercepted by junior priority ground water diversions."

Tools for analyzing GW-SW interaction

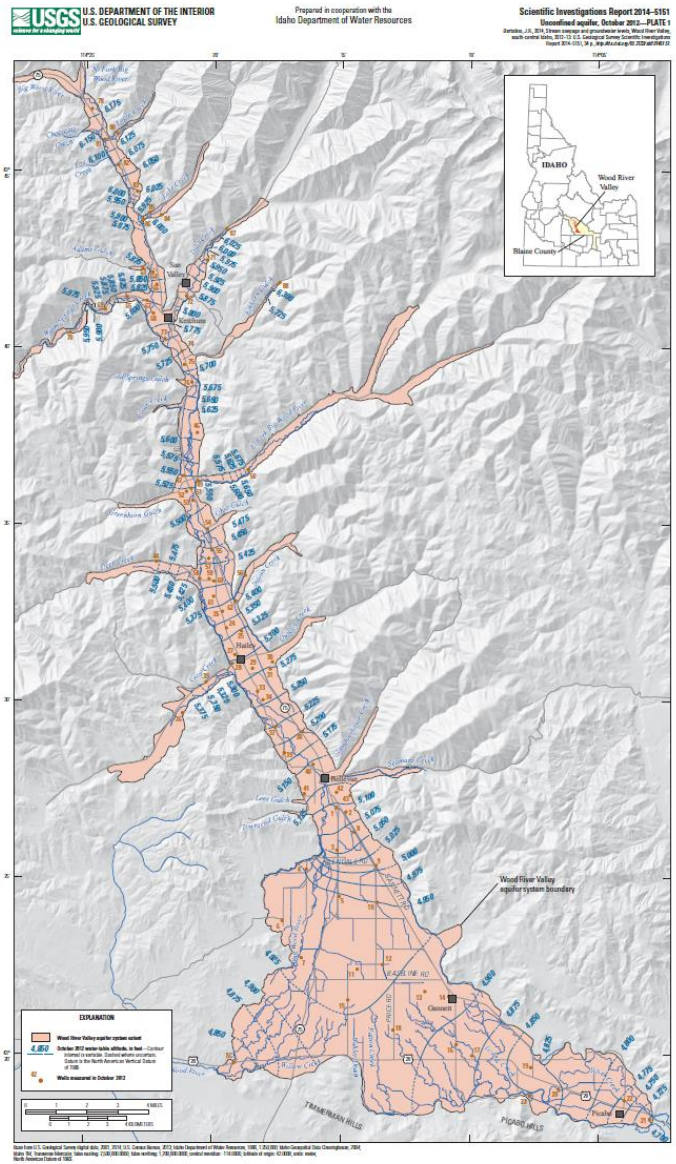
- Predict effects of aquifer stresses on magnitude and timing of aquifer discharge to streams
  - Aquifer stresses can include:
    - Groundwater pumping
    - Incidental recharge (canal seepage, infiltration of applied water)
    - Natural recharge (tributary underflow, infiltration of precipitation)
    - Managed recharge
- Do NOT predict
  - Whether *impacts* to streamflow result in *material injury* to senior water rights
  - Fate of increases in streamflow

Tools for analyzing GW-SW interaction

- Conceptual model (hydrogeologic framework)
  - Wood River aquifer system (Bartolino, 2012; 2014)
  - Camas Prairie aquifer system (Walton, 1962; Wallace, 1972; Young, 1978)
    - Recent water level and seepage survey data (IDWR – Alex Moody)
    - Play Fairway geothermal study (Neupane et al., 2017; Glen et al., 2017; Shervais et al., 2018)

- Quantify consumptive use of groundwater
  - Pumping records
    - assume efficiency to estimate consumptive use
  - Evapotranspiration and precipitation data
    - crop irrigation requirement (CIR = ET – precip)
    - assume duty of surface water irrigation on mixed source land (canal seepage, efficiency)

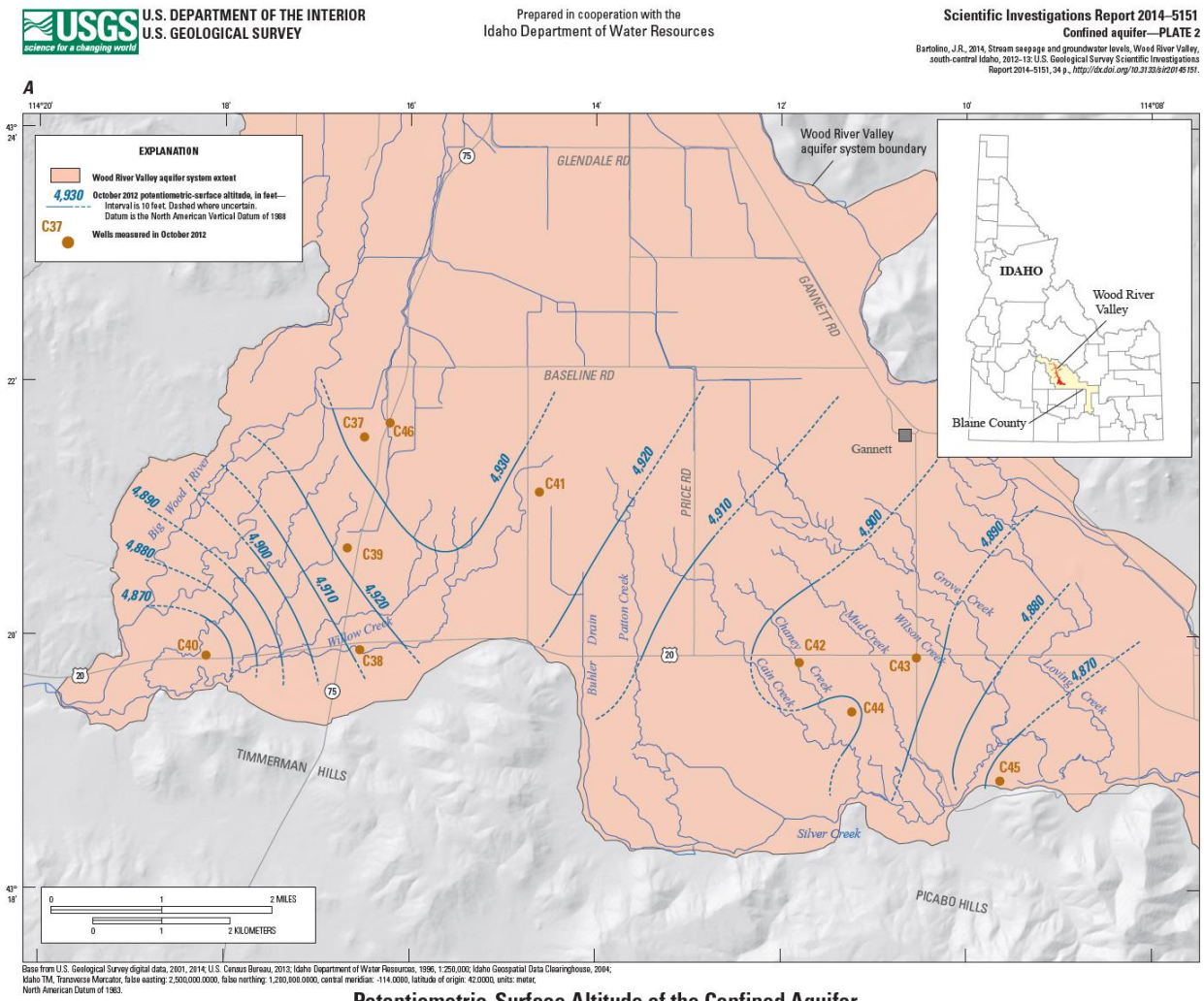
Wood River Valley unconfined aquifer water table



Water-Table Altitude of the Unconfined Aquifer, Wood River Valley Aquifer System, South-Central Idaho, October 2012

From Bartolino (2014)

Wood River Valley confined aquifer head surface



Potentiometric-Surface Altitude of the Confined Aquifer, Wood River Valley Aquifer System, South-Central Idaho, October 2012

From Bartolino (2014)

Representation of Wood River Valley aquifer system

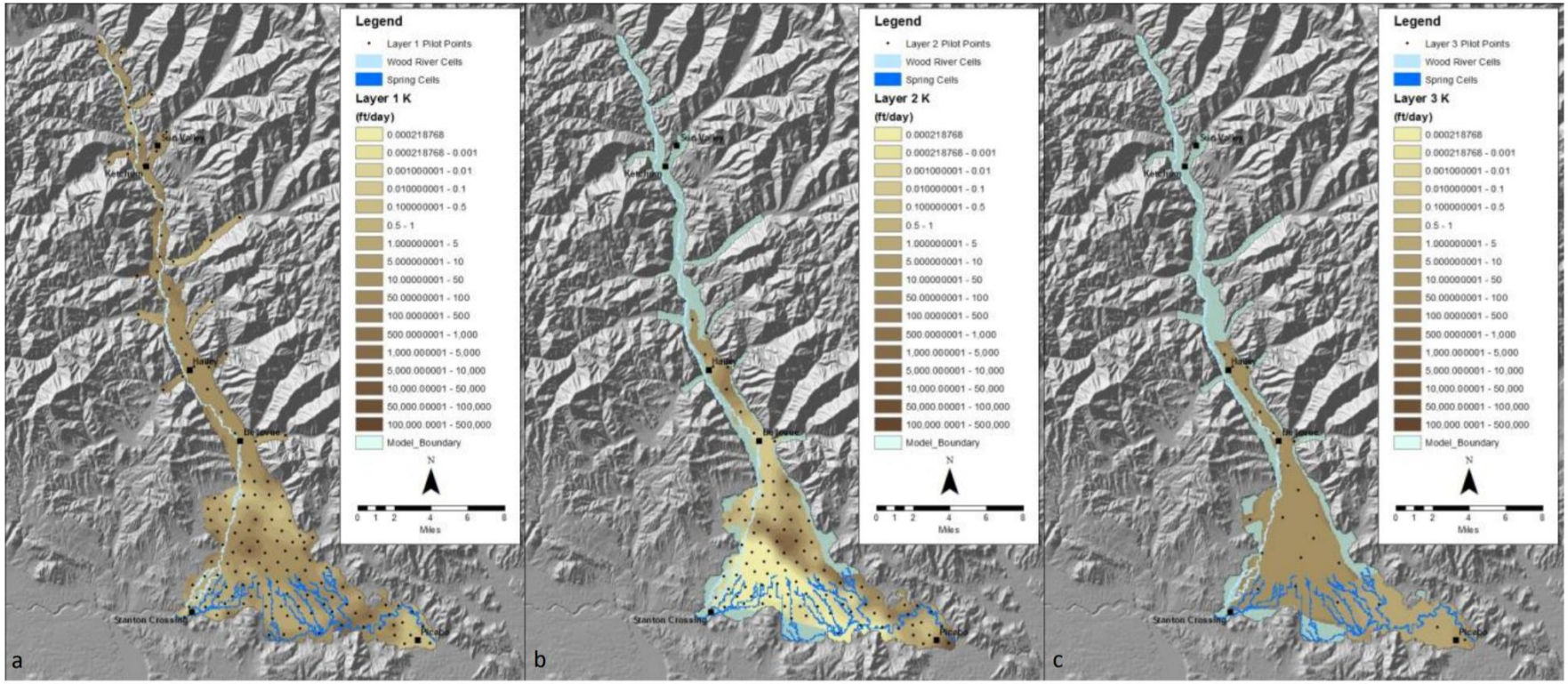
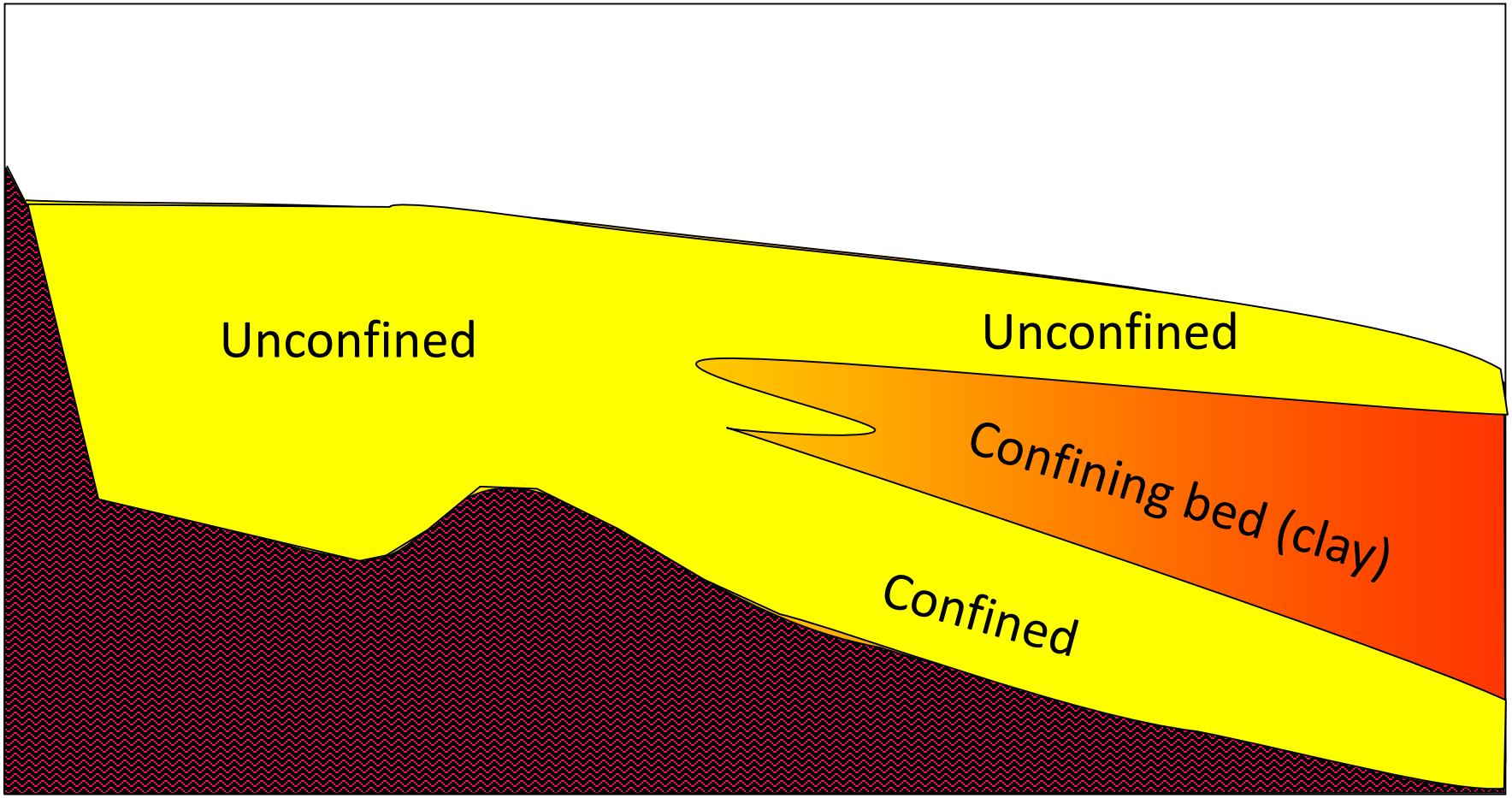


Figure 6. Calibrated hydraulic conductivity for Layers 1, 2, and 3.

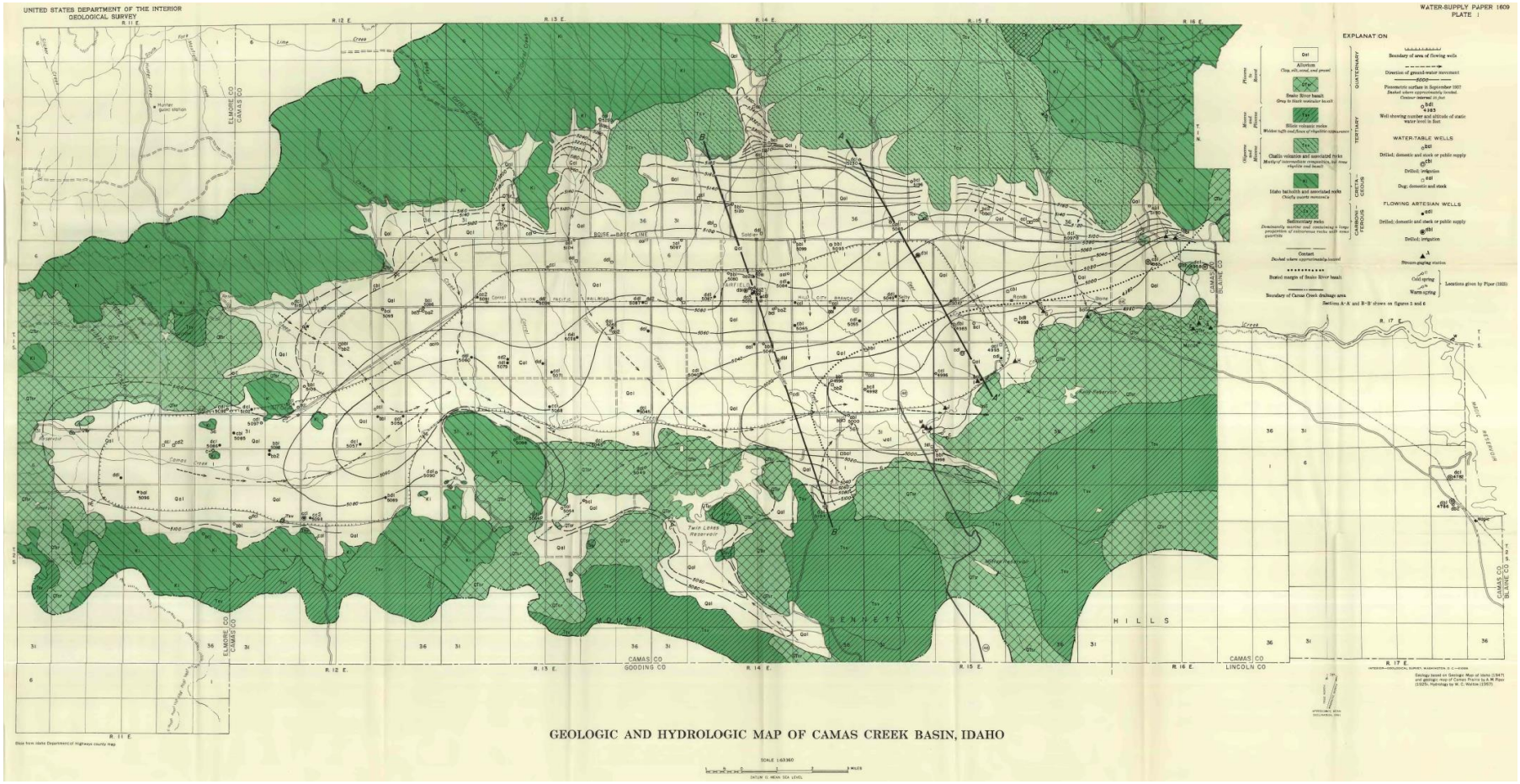
From Wylie, 2019, Version 1.1 groundwater flow model report

Confined and unconfined aquifers



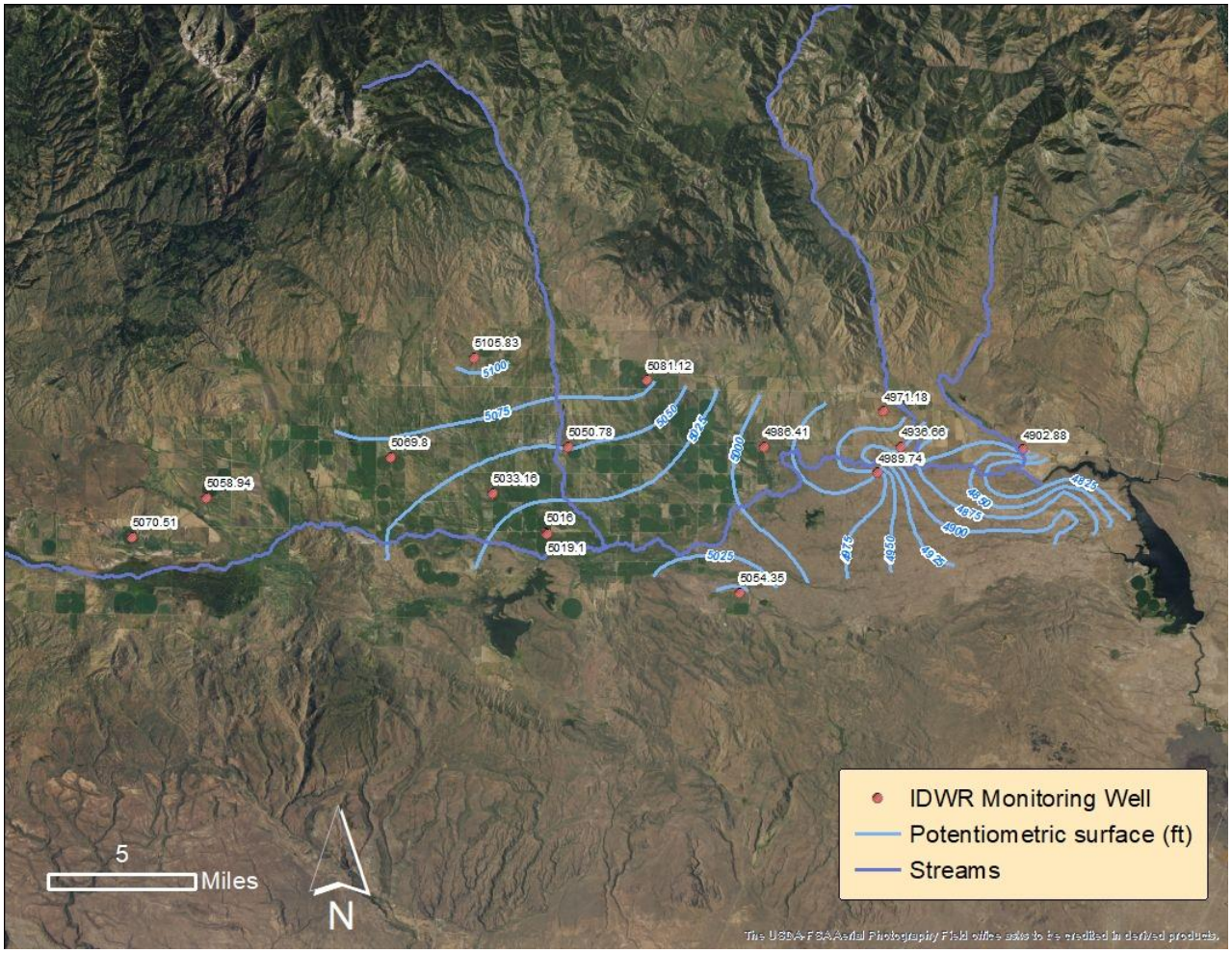
From Jim Bartolino, USGS, presentation to BWRGWMA Advisory Committee, 12/2/2020

Camas Prairie confined aquifer head surface (September 1957)



From Walton (1962)

Camas Prairie confined aquifer head surface (April 2019)



Provisional potentiometric surface contours from Alex Moody

Camas Prairie seepage surveys

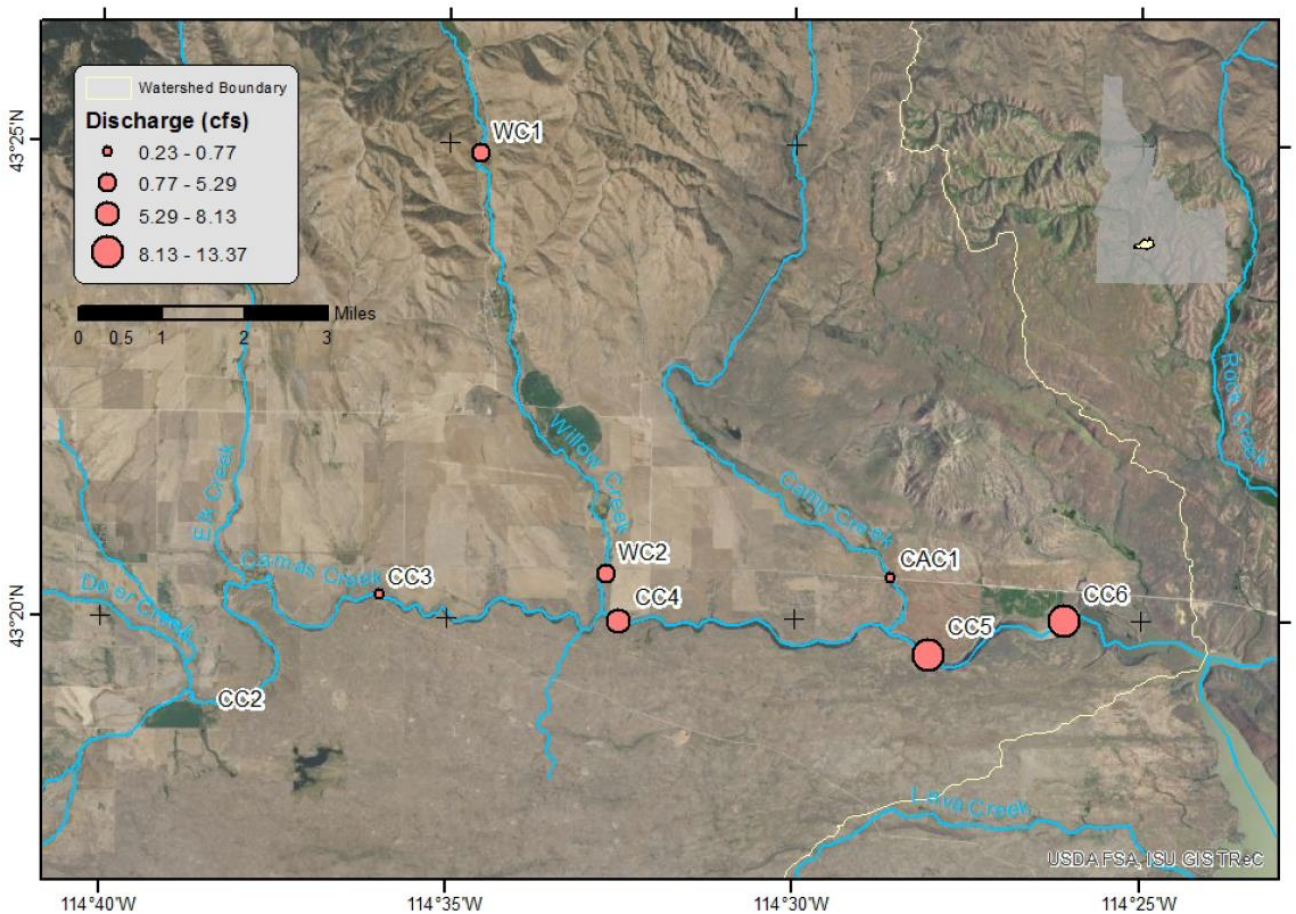


Figure 1: The Camas Prairie Watershed (HUC8 17040220) and location of measured sites in the November 2018 seepage survey.

From Moody (2019)

Play Fairway analysis of Camas Prairie geothermal system

- Do recent studies of the Camas Prairie geothermal system change the conceptual model of the Camas Prairie cold-water aquifer system?
- Play Fairway analysis cites previous work with respect to groundwater flow in the cold-water aquifer system (Neupane, et al. 2017)
  - "*In general, both surface and subsurface waters of the Camas Prairie area flow from west to east towards the Big Wood River, and ultimately, to the Magic Hot Springs Reservoir (Wallace, 1972).*"
- "*An overlying seal is critical to retain heat and fluids, in order to preserve a viable hydrothermal power source.*" (Shervais, et al. 2018)
  - Magnetotelluric surveys suggest a hydrothermally altered clay seal separates the geothermal system from overlying aquifers.
  - Fine-grained basin sediments may also provide an additional seal between the geothermal and cold-water aquifer systems.

Western Camas basin cross-section (Glen, et al. 2017)

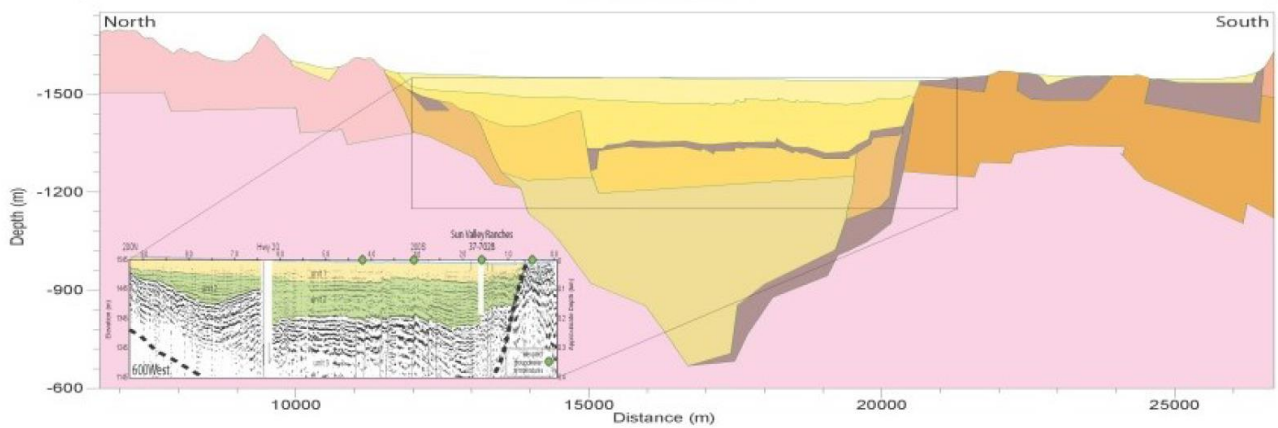


Figure 8) Two-dimensional geophysical model of the Camas Prairie along road 600W.

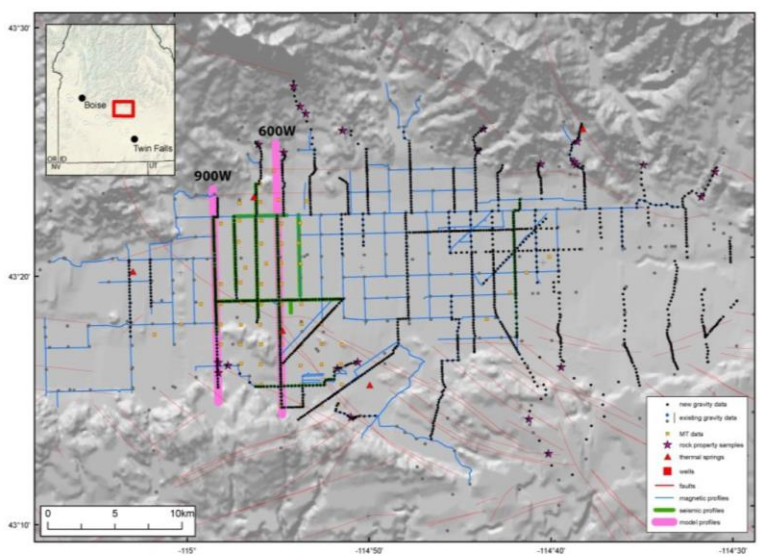


Figure 2) Shaded topographic index maps of the Camas Prairie study area showing newly collected seismic reflection profiles, MT stations, gravity stations, magnetic traverses, and rock property sample locations. Also shown are existing gravity data, modeled profiles, faults, and thermal springs.

Camas geothermal system (Glen, et al. 2017)

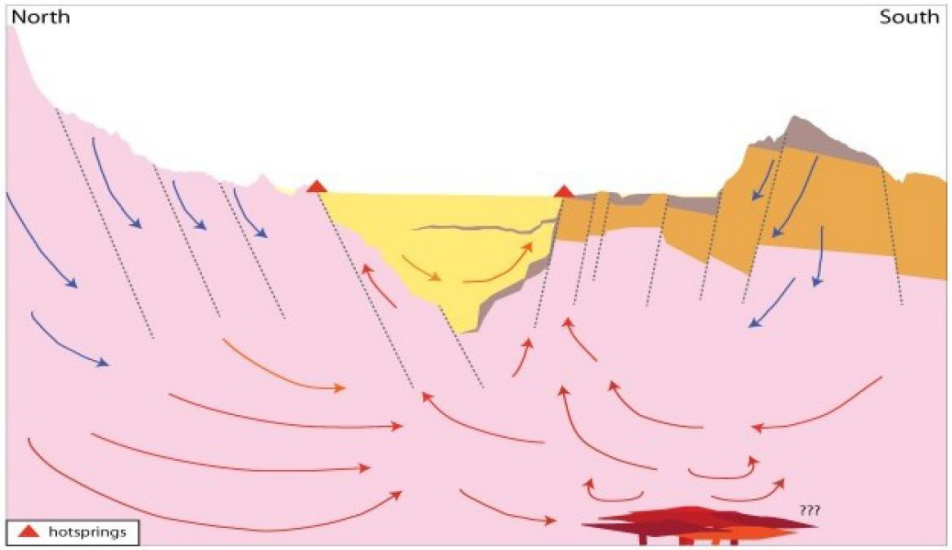


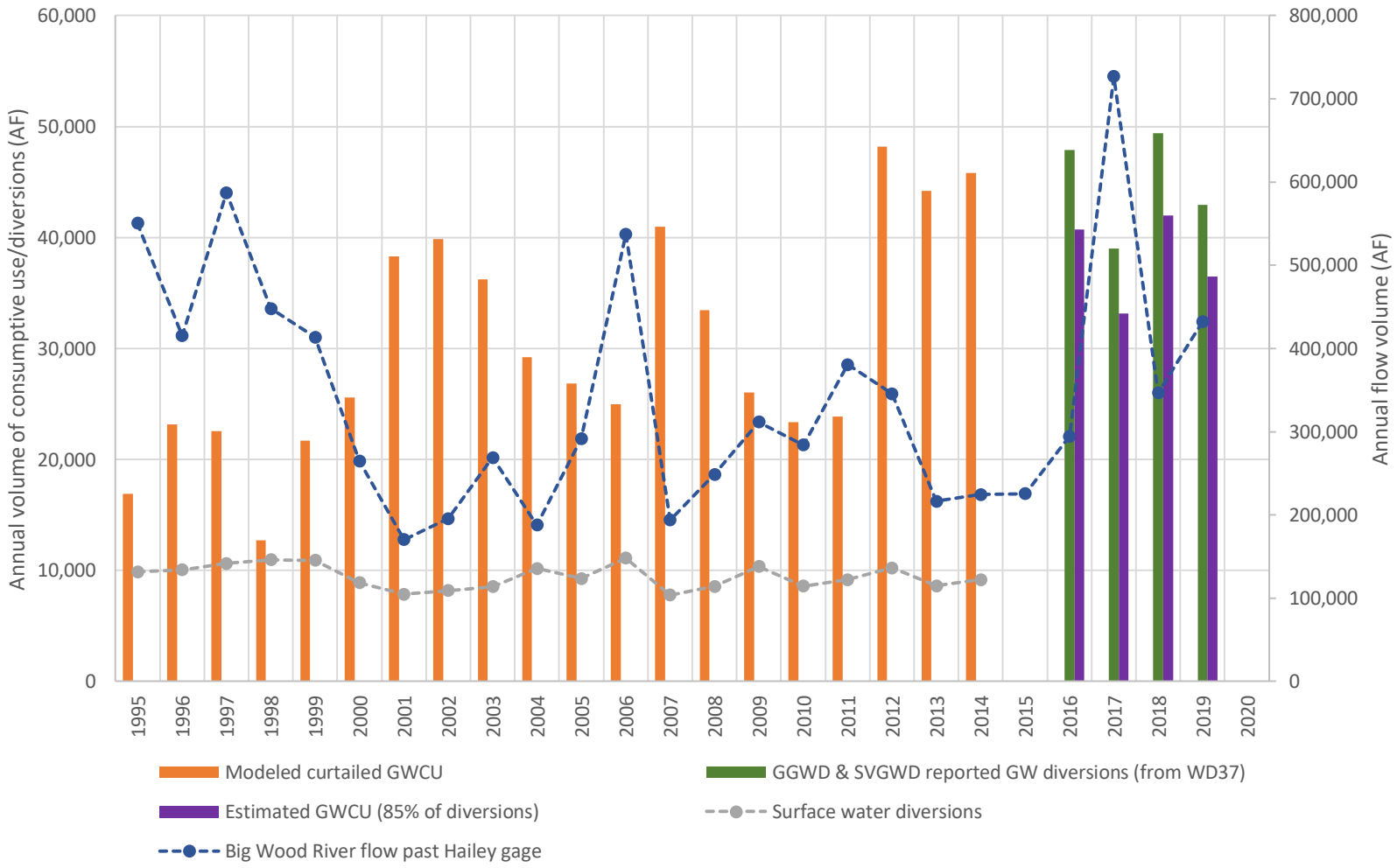
Figure 11) Cartoon illustrating our conceptual model of the structure and geothermal system

Tools for analyzing GW-SW interaction

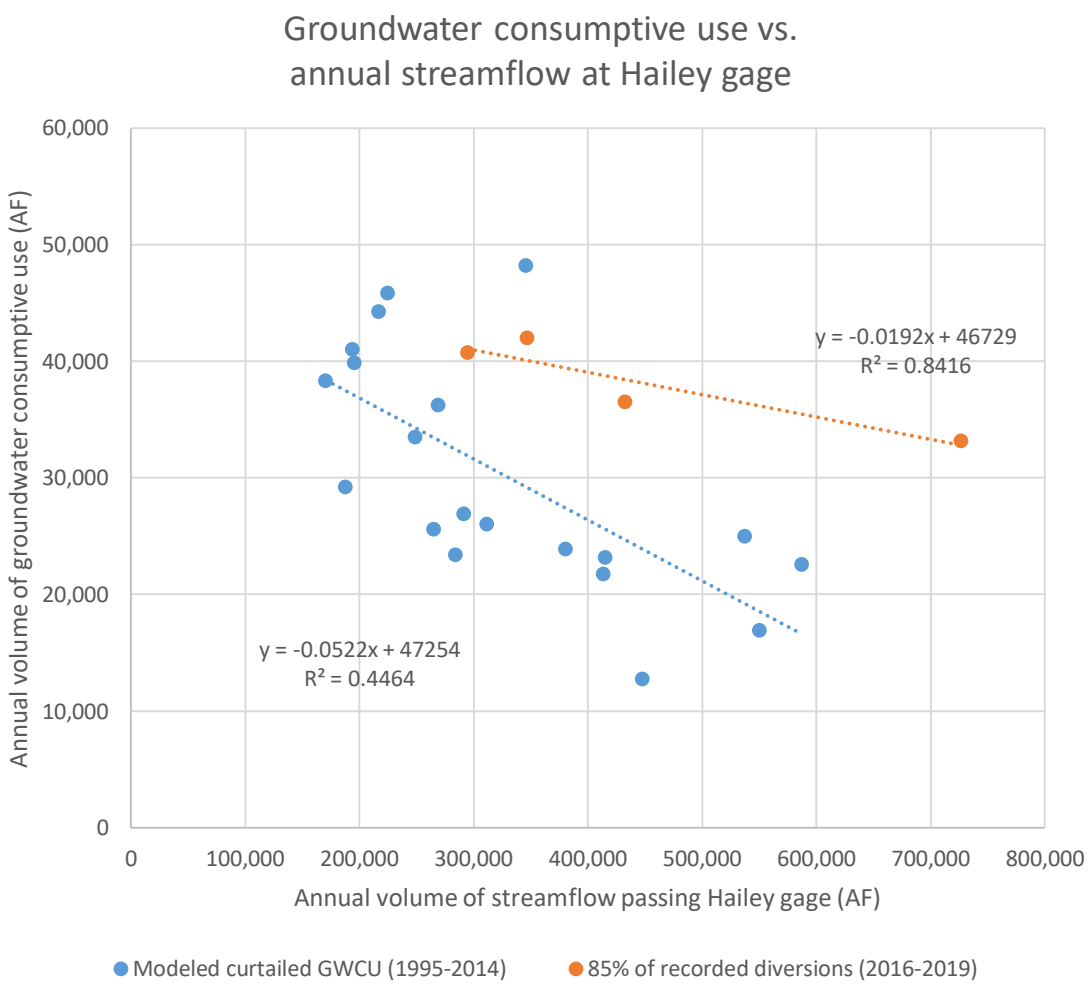
- Hydrogeologic framework (conceptual model)
  - Wood River aquifer system (Bartolino, 2012)
  - Camas Prairie aquifer system (Walton, 1962; Wallace, 1972; Young, 1978; Neupane et al., 2017; Shervais et al., 2018)

- Quantify consumptive use of groundwater
  - Pumping records
    - assume efficiency to estimate consumptive use
  - Evapotranspiration and precipitation data
    - crop irrigation requirement (CIR = ET – precip)
    - assume duty of surface water irrigation on mixed source land (canal seepage, efficiency)

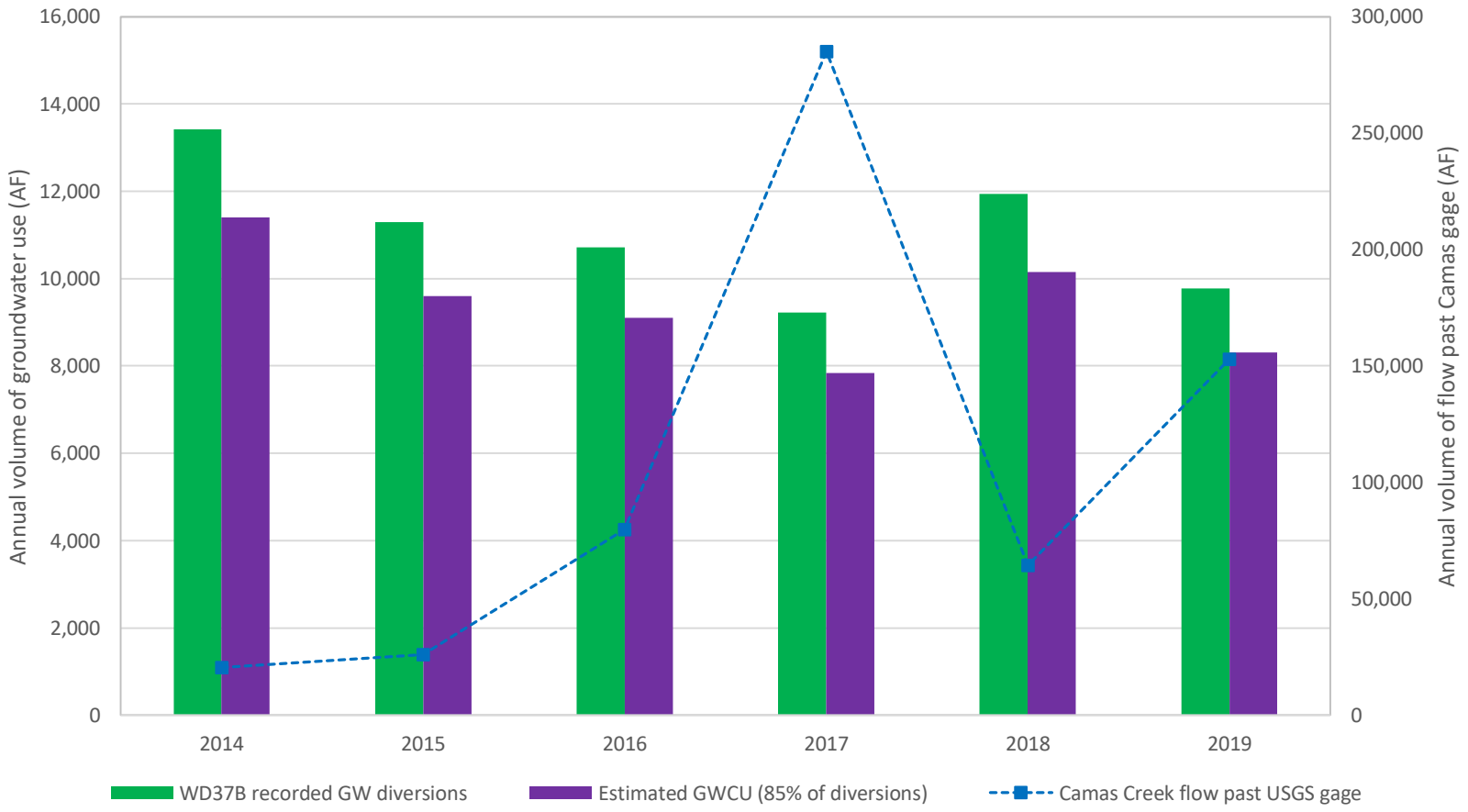
Groundwater use, Wood River aquifer system



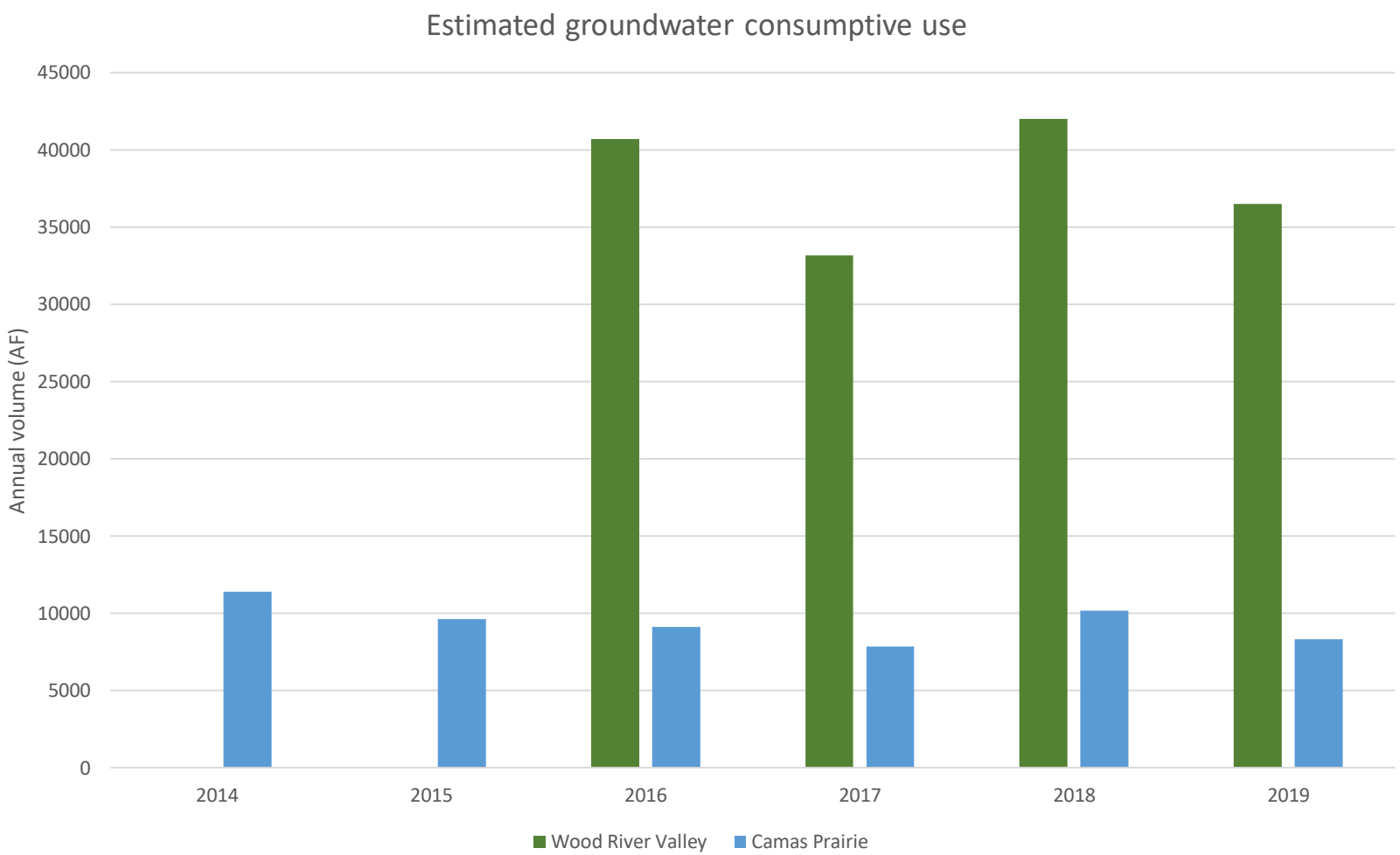
Groundwater use, Wood River aquifer system



Groundwater use, Camas Prairie aquifer system



Recent groundwater use, BWRGWMA

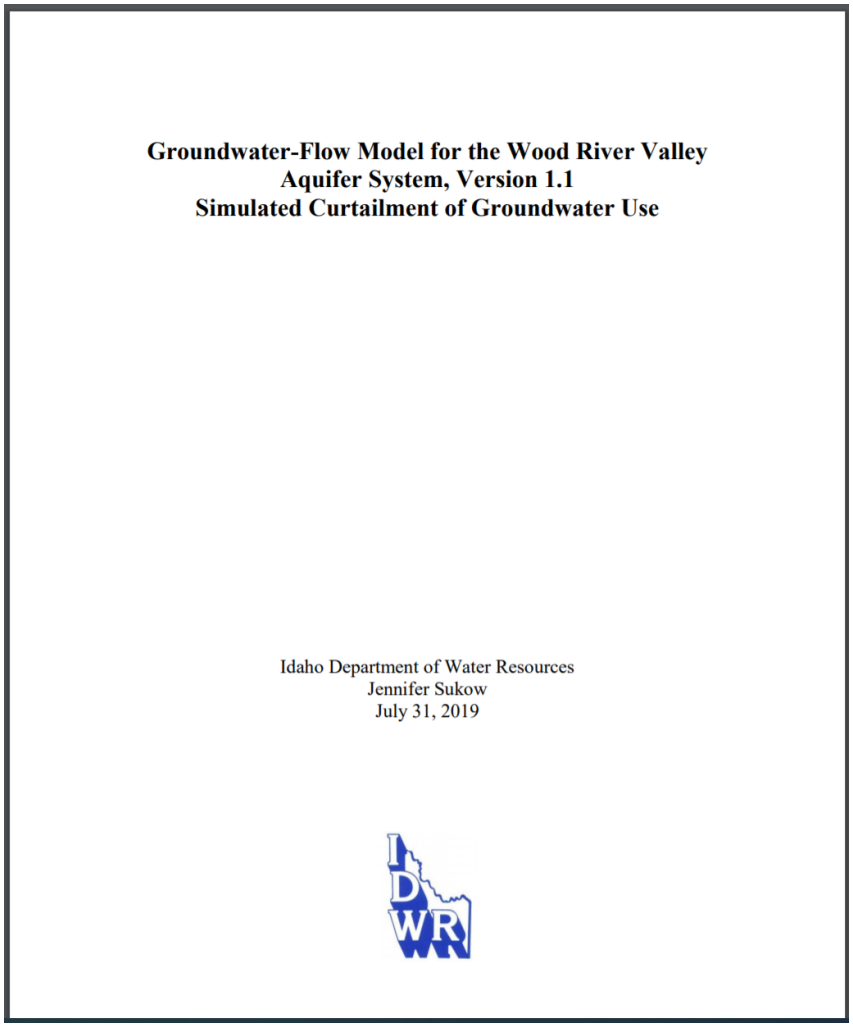


Tools for analyzing GW-SW interaction

- Quantify impacts on aquifer discharge
  - Wood River aquifer system
    - Groundwater Flow Model for the Wood River Valley Aquifer System, Version 1.1 (Wylie, et al., 2019)
    - Net impact is equal to consumptive use of groundwater
    - From conceptual model, impacts are to Big Wood River, Silver Creek and underflow to Eastern Snake Plain Aquifer
    - Model partitions impact between Big Wood River, Silver Creek, and underflow to Eastern Snake Plain Aquifer
    - Model predicts timing of impacts
    - Spatial and temporal predictions are constrained by model calibration to observed historical data
    - Model uncertainty (Wylie, 2019)

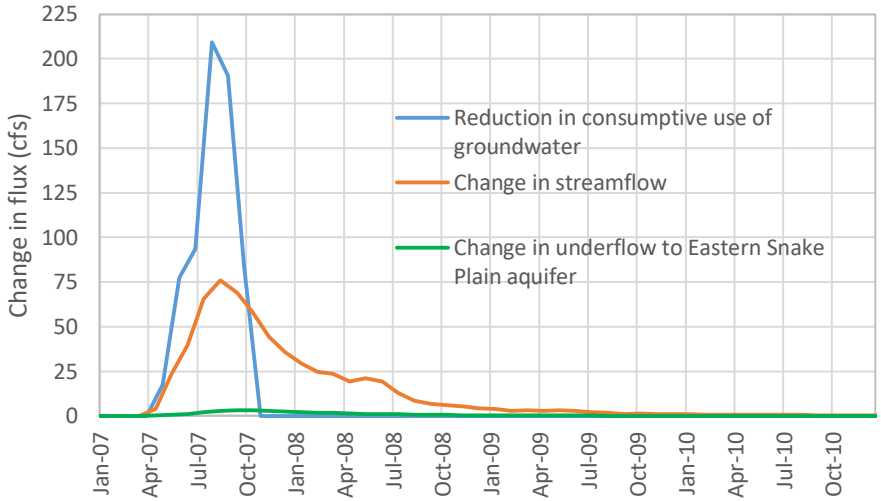
  - Camas Prairie aquifer system
    - Net impact is equal to consumptive use of groundwater
    - From conceptual model, impacts are to Magic Reservoir inflow
    - Analytical or numerical model has not been developed to predict timing of impacts

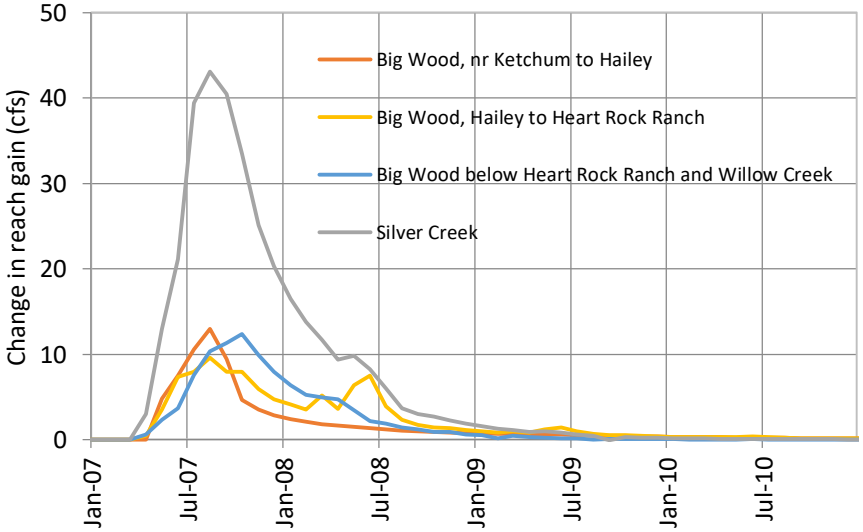
Quantifying impacts, WRV groundwater flow model



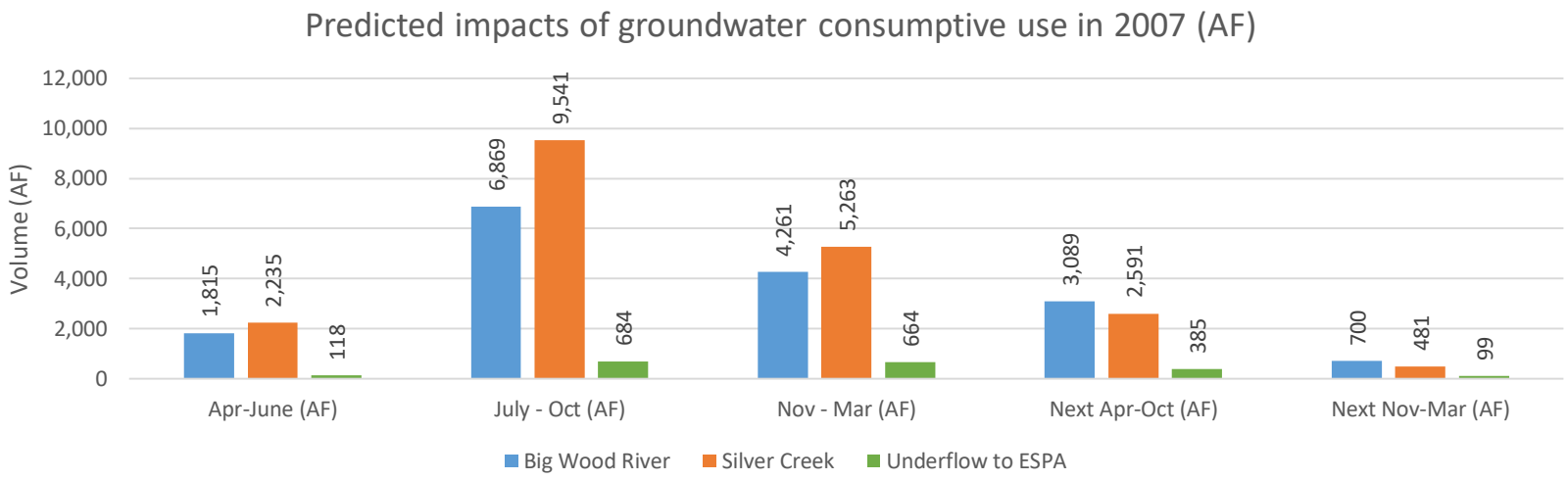
Groundwater-Flow Model for the Wood River Valley Aquifer System, Version 1.1
Simulated Curtailment of Groundwater Use

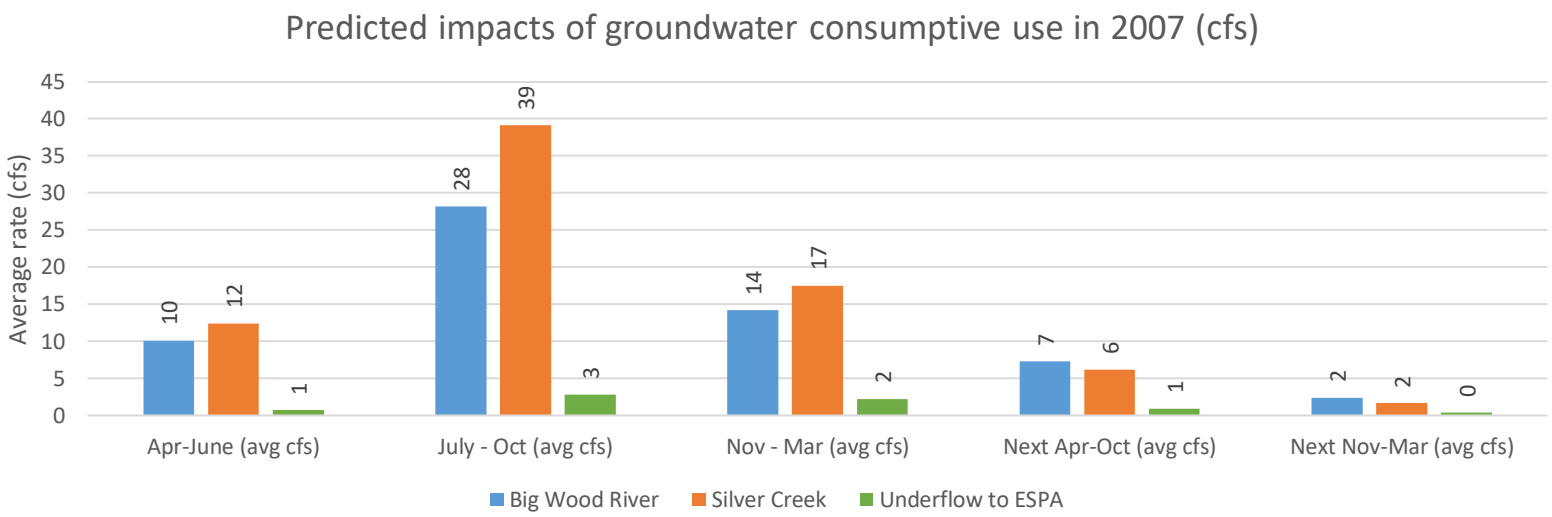
Idaho Department of Water Resources
Jennifer Sukow
July 31, 2019



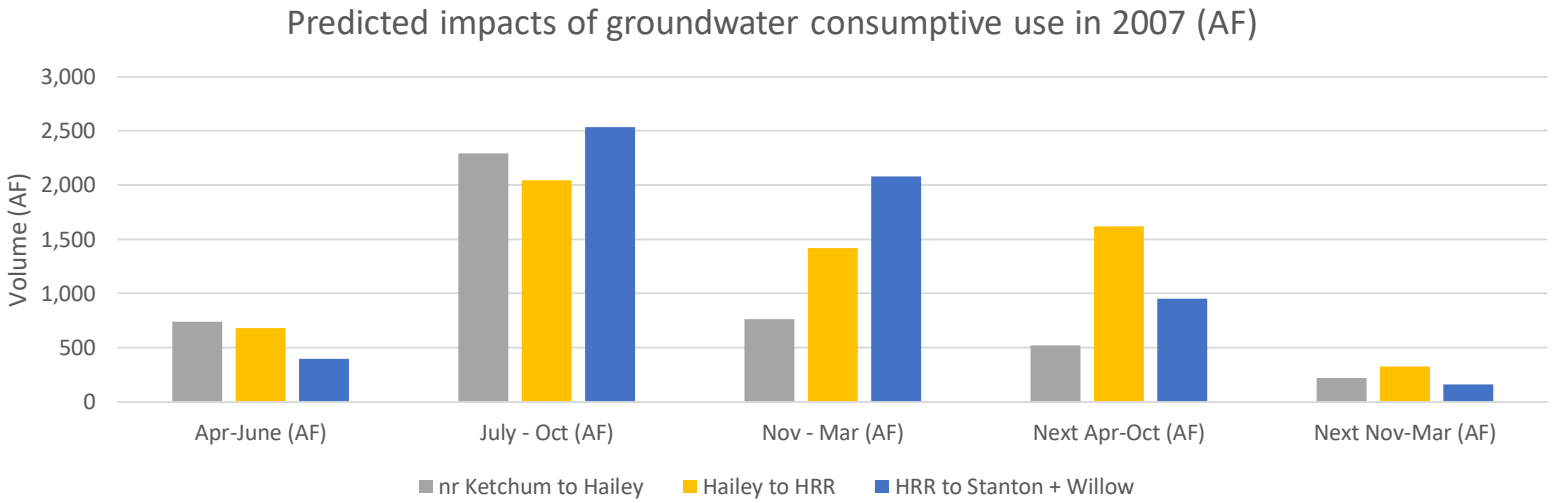


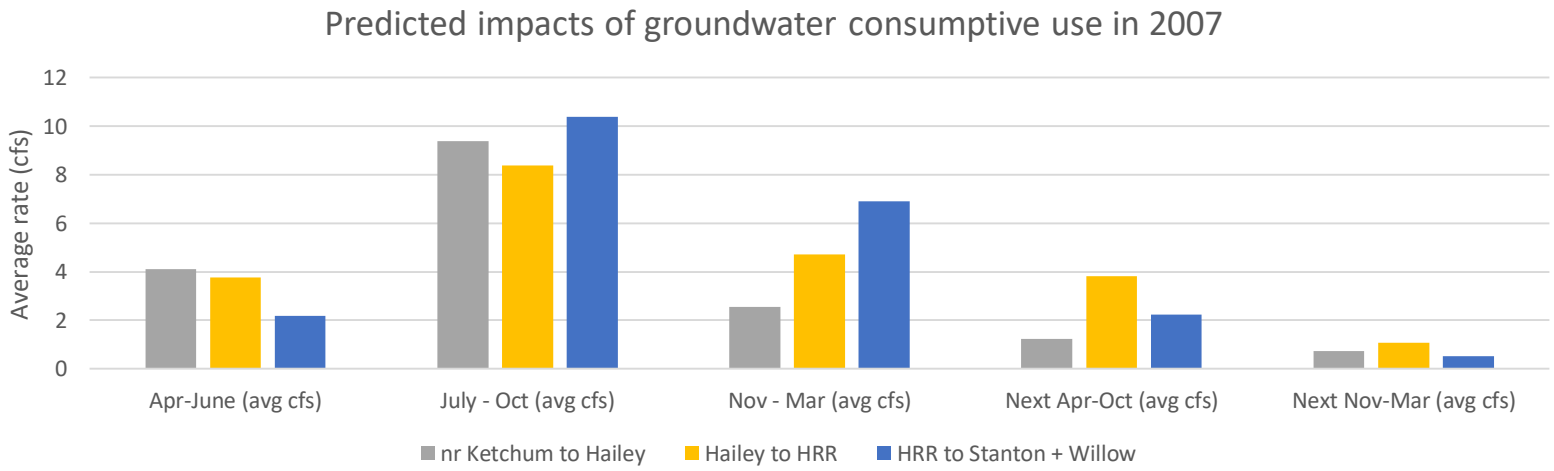
Quantifying impacts, WRV groundwater flow model





Quantifying impacts, WRV groundwater flow model





Other potential applications of WRV groundwater flow model

- Simulate a user-specified change in aquifer stress, such as…
  - Partial reduction in consumptive use
    - Percentage reduction by all users
    - Reduction during specific month(s)
    - Reduction in specific areas
      - by GWD
      - Fallow acres in specific areas
      - Raise crops with lower consumptive use in specific areas
  - Managed recharge
  - Changes in natural recharge (precipitation, tributary underflow)
  - Changes in surface water infiltration
    - Changes in canal seepage
    - Changes in surface water irrigation efficiency
- Model predicts spatial distribution and timing of impacts on river reaches and underflow to ESPA
- Additional analyses may be needed to evaluate effect of changes in streamflow on downstream water users

DISCUSSION

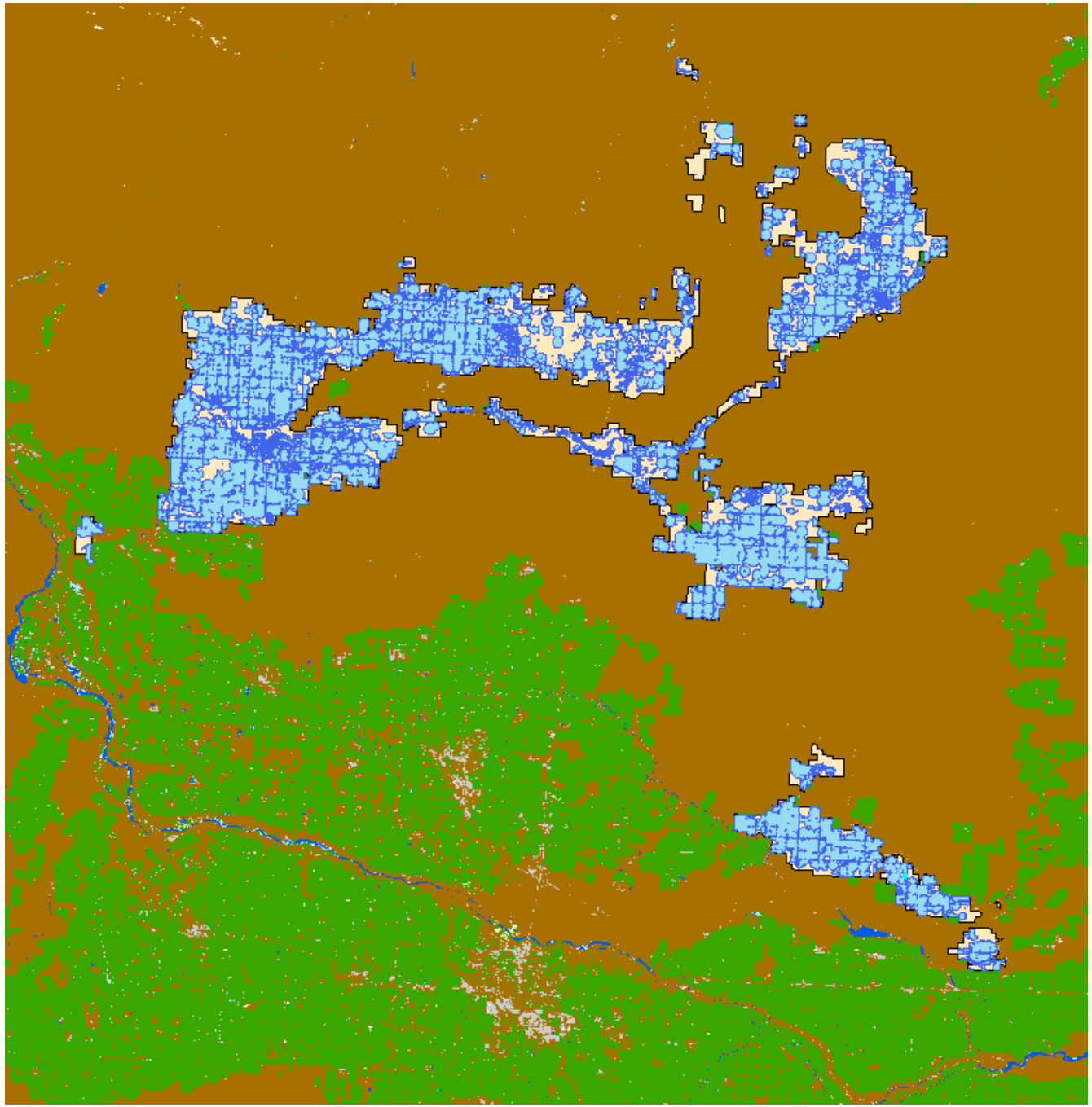
Big Wood River Ground Water Management Area

Advisory Committee Meeting

IDWR Presentation – Excess Irrigated Acres

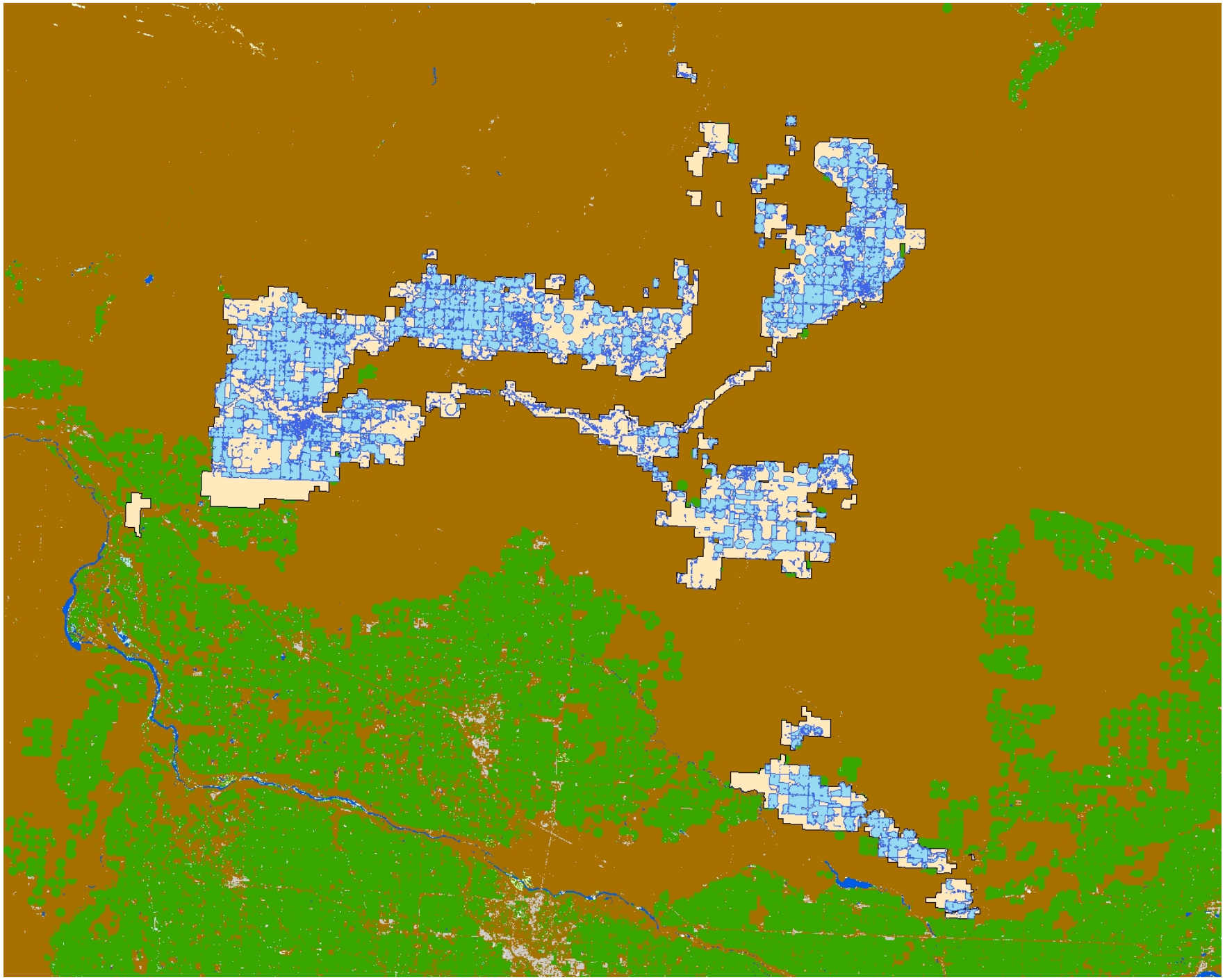
12/15/2020

Total irrigated acres (2020) within BWCC/AFRD2 service area: 109,715 acres



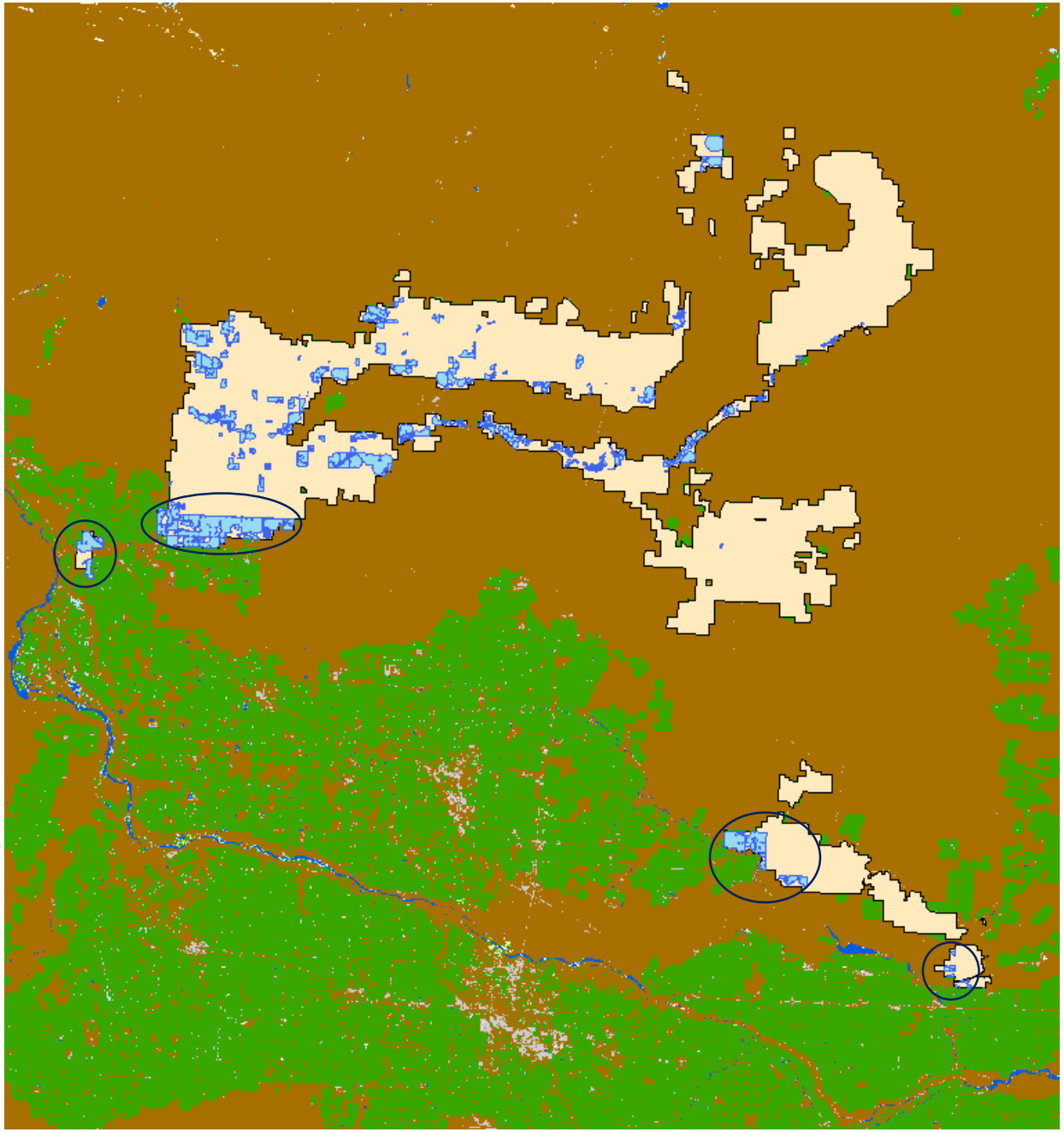
Total irrigated acres (2020) within BWCC/AFRD2 service area with BWCC/ARFD2 water rights only: 75,164 acres (no other overlapping place of use water rights)

(75,164 acres out of 109,715 acres; does not include NSCC overlap)

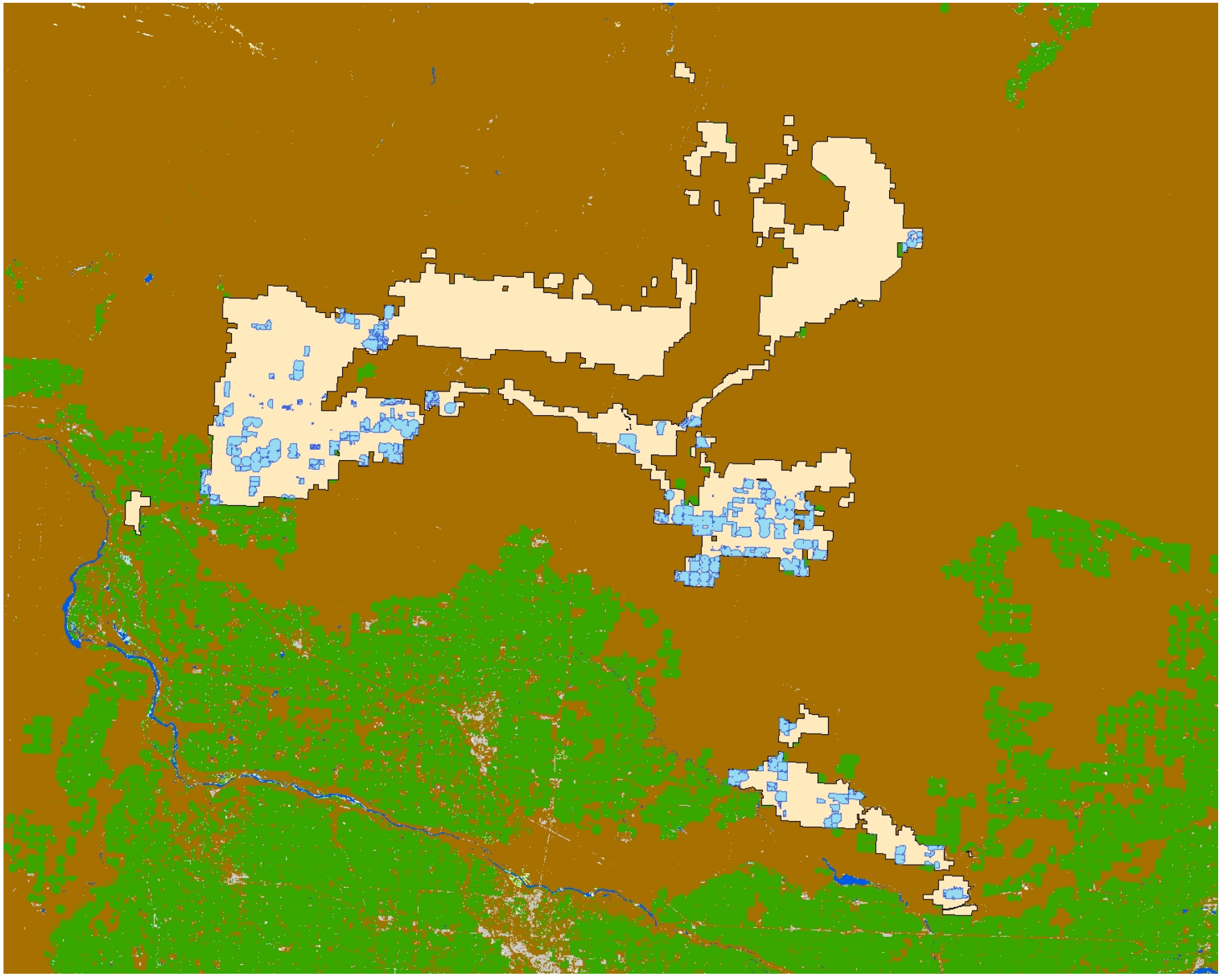


Total irrigated acres (2020) within BWCC/AFRD2 service area with overlapping place of use surface water rights: 16,146 acres

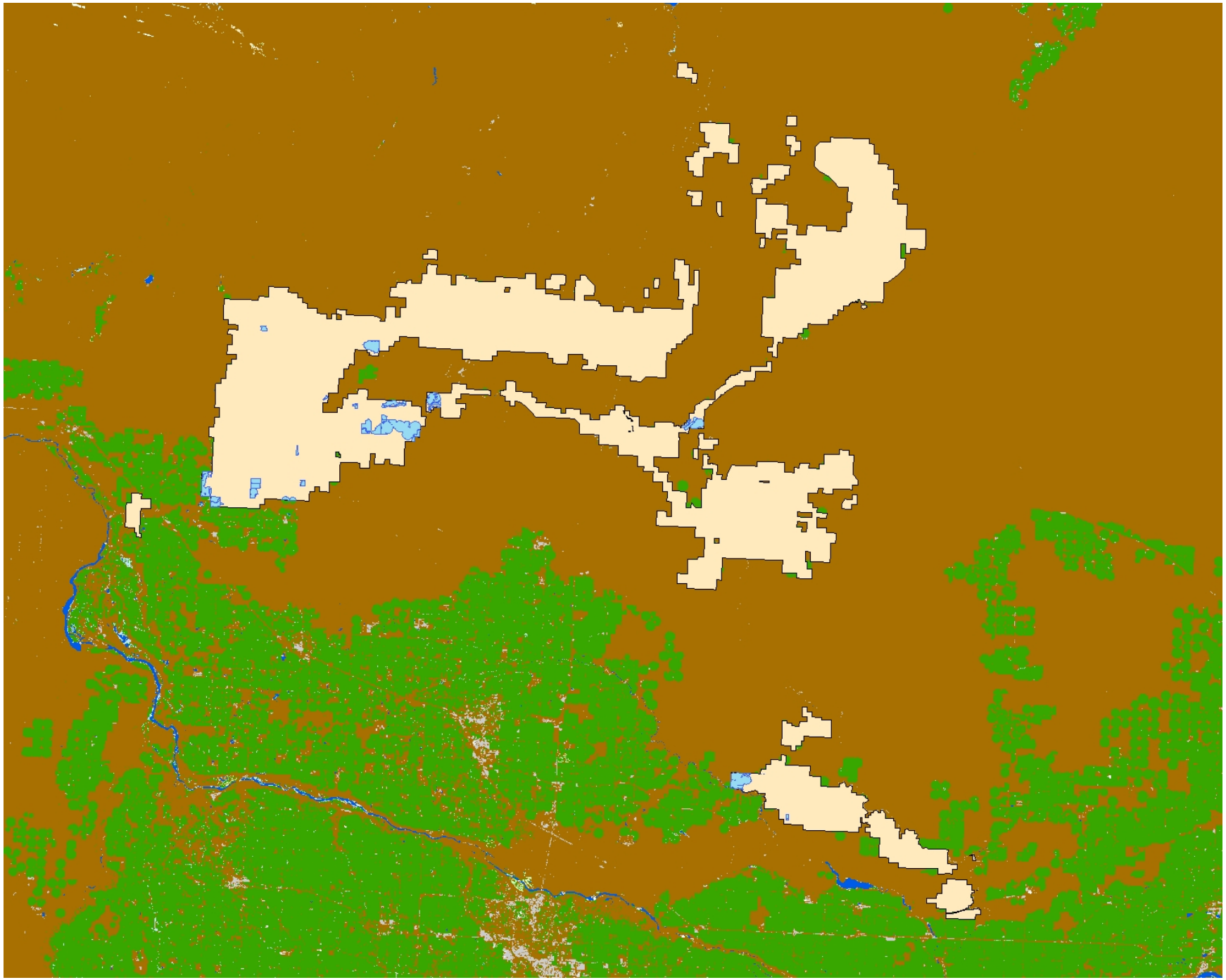
(16,146 acres out of 109,715 acres, includes about 5,200 acres of NSCC overlap, see circles)



Total irrigated acres (2020) within BWCC/AFRD2 service area with overlapping place of use ground water rights: 21,738 acres

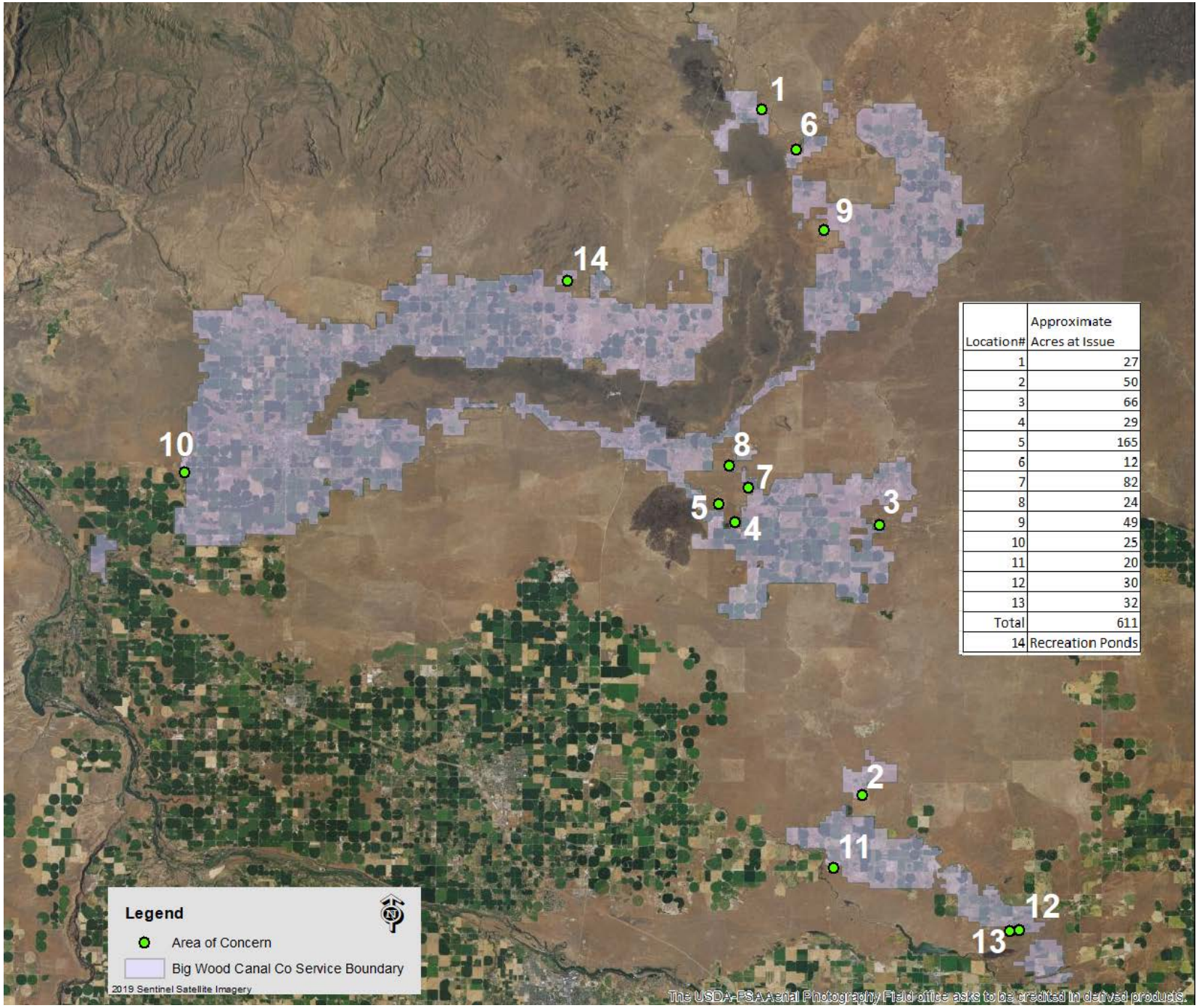


Total irrigated acres (2020) within BWCC/AFRD2 service area with overlapping place of use ground water and surface water rights: 3,333 acres



Irrigated Areas without water rights along BWCC boundary

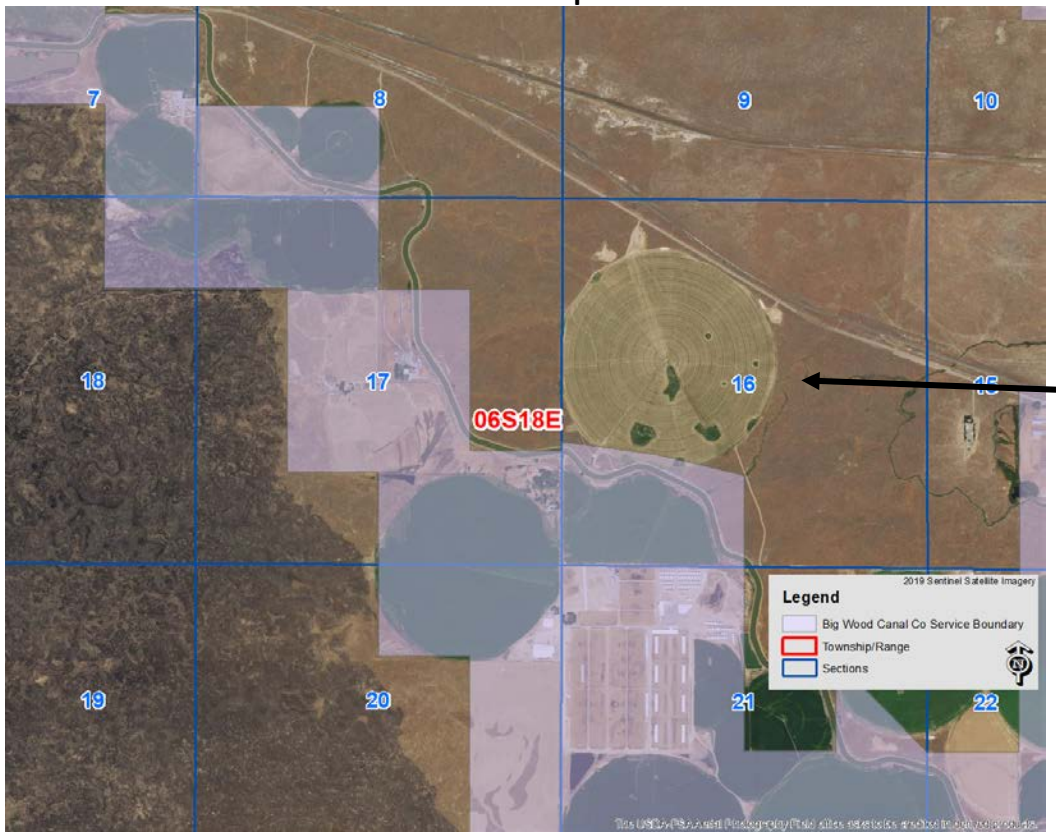
- 13 locations
- 611 acres total
- 12 – 165 acres each
- Letter sent to BWCC in June 2020
- BWCC investigating
- 1 non-irrig use within BWCC

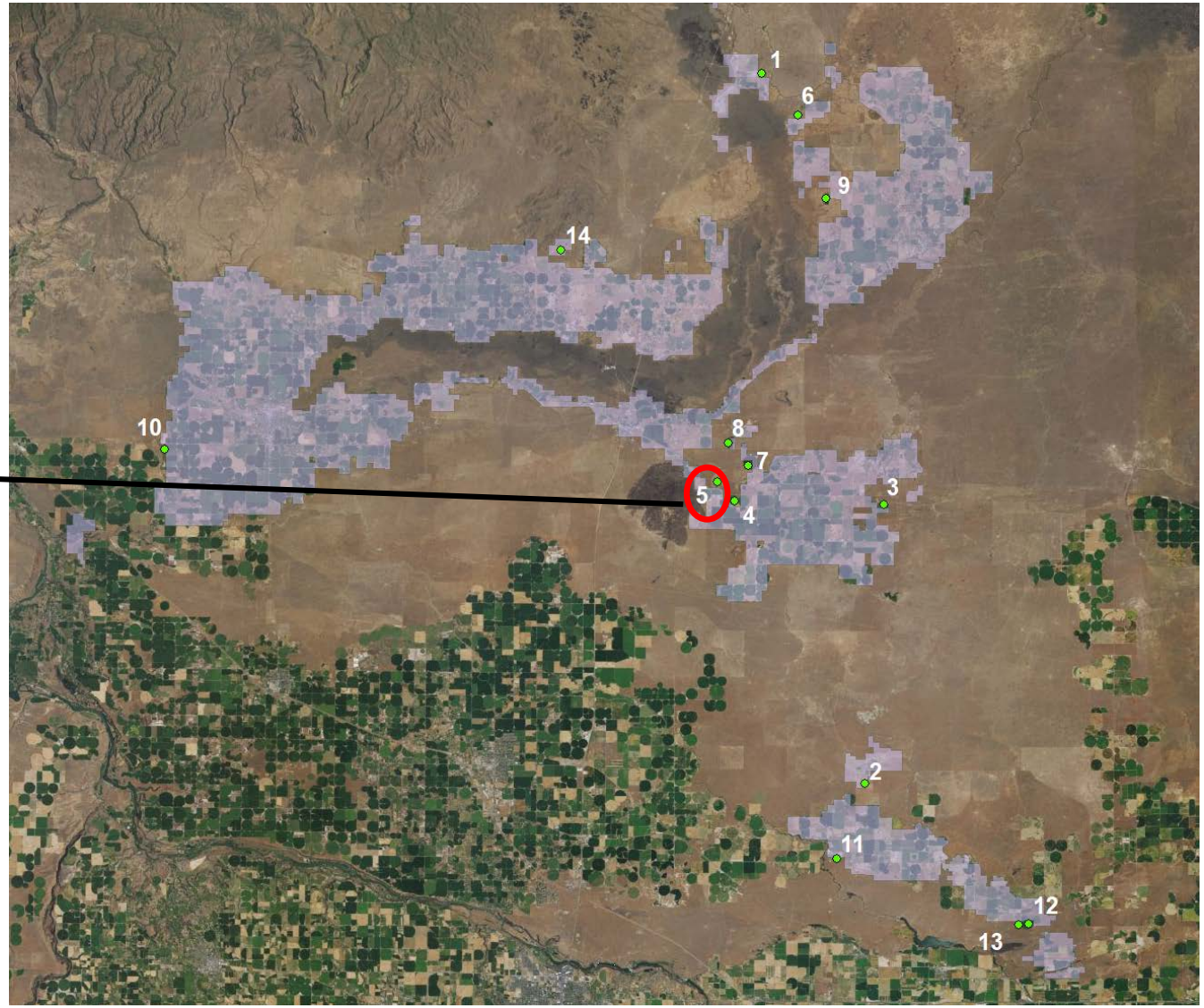


Location#	Approximate Acres at Issue
1	27
2	50
3	66
4	29
5	165
6	12
7	82
8	24
9	49
10	25
11	20
12	30
13	32
Total	611
14	Recreation Ponds

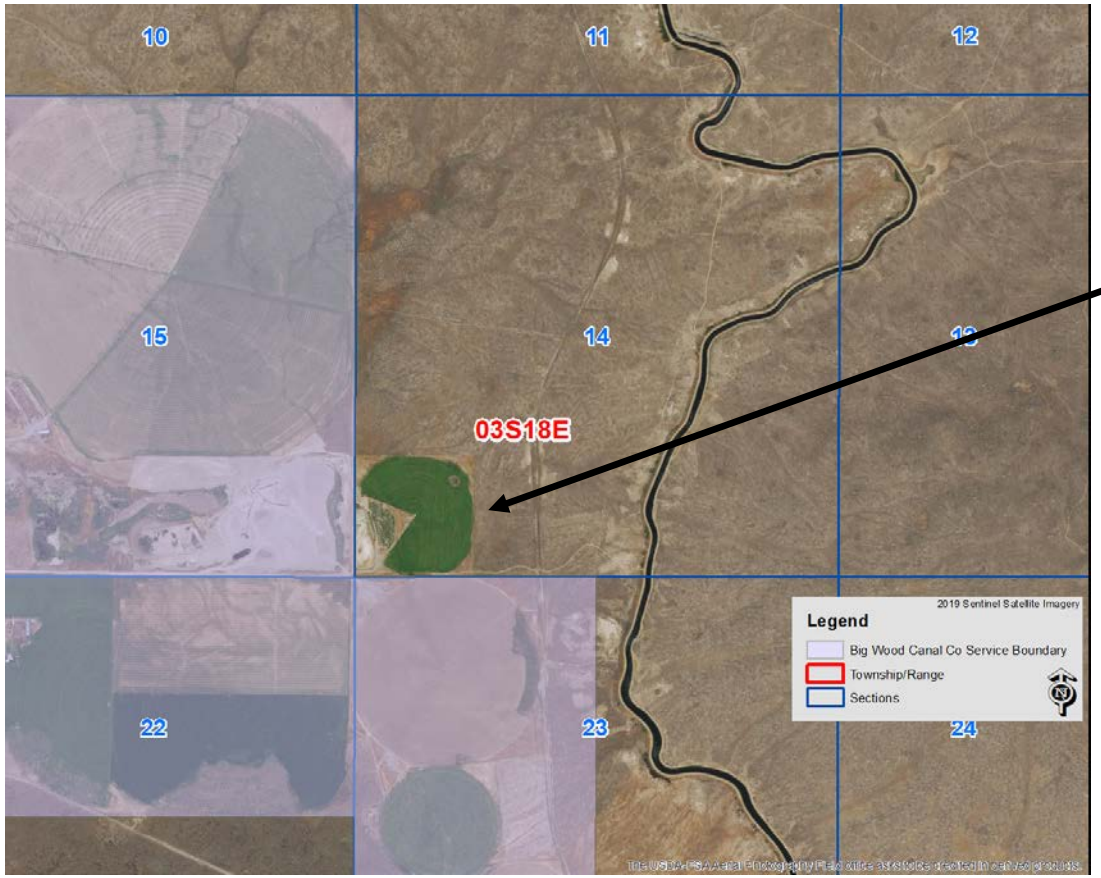
Irrigated Areas without water rights along BWCC Boundary

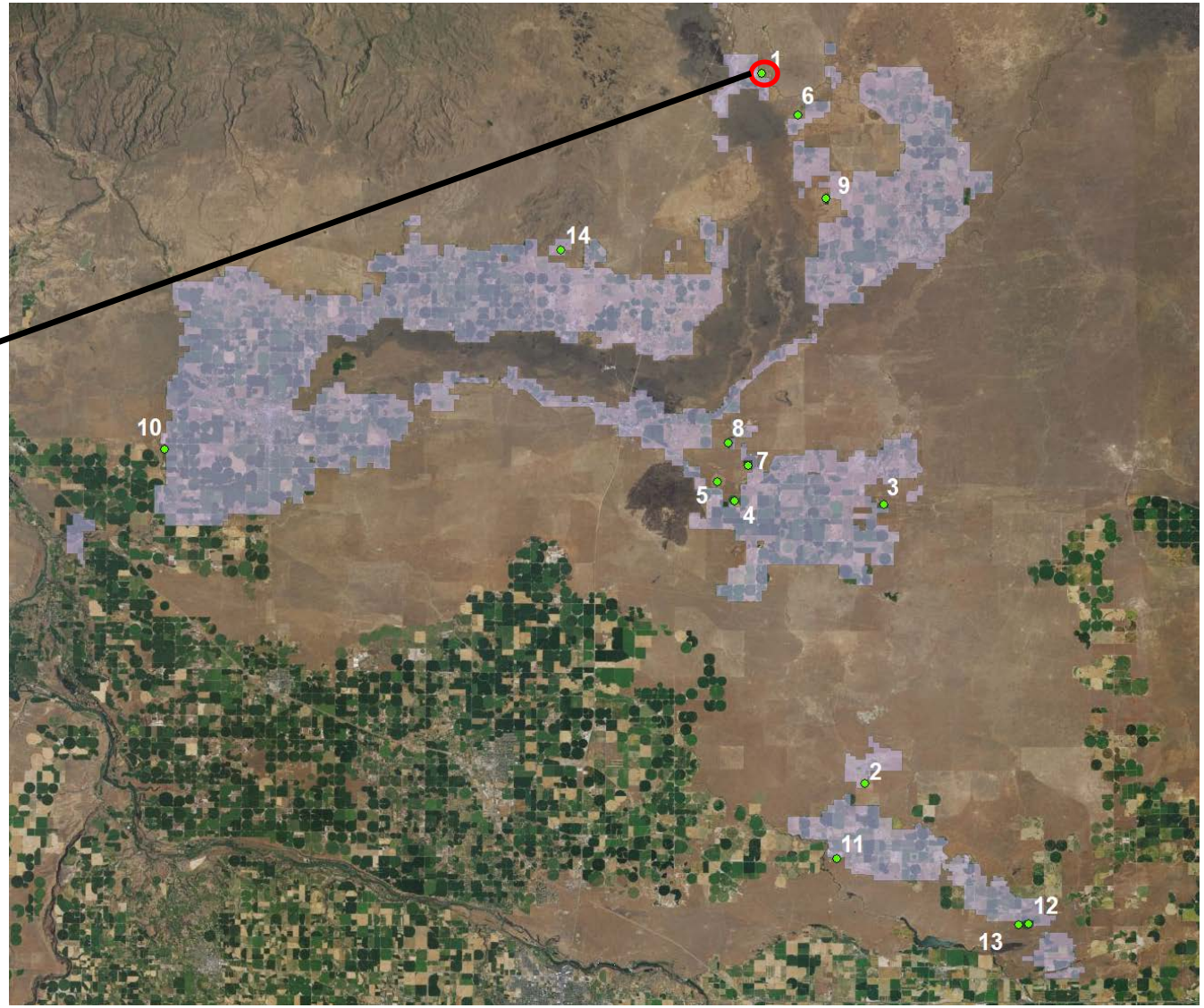
Location Example





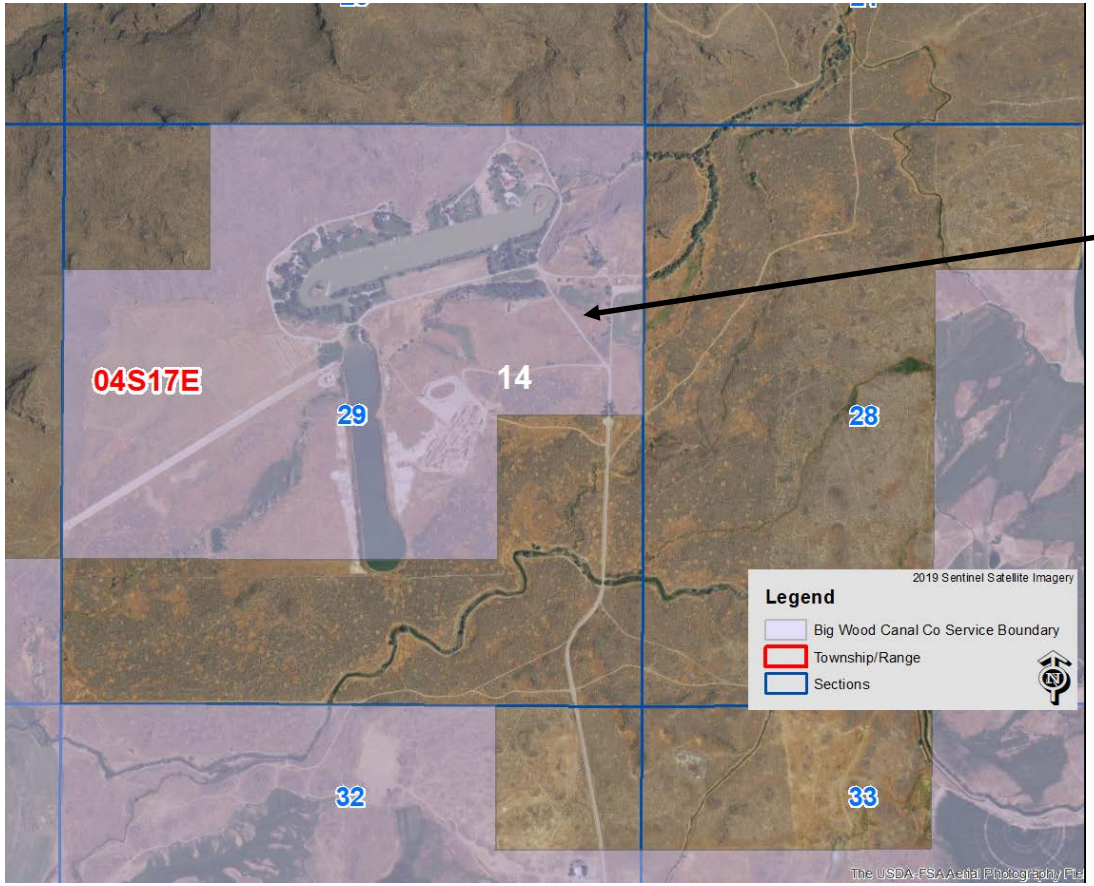
Irrigated Areas without water rights along BWCC Boundary

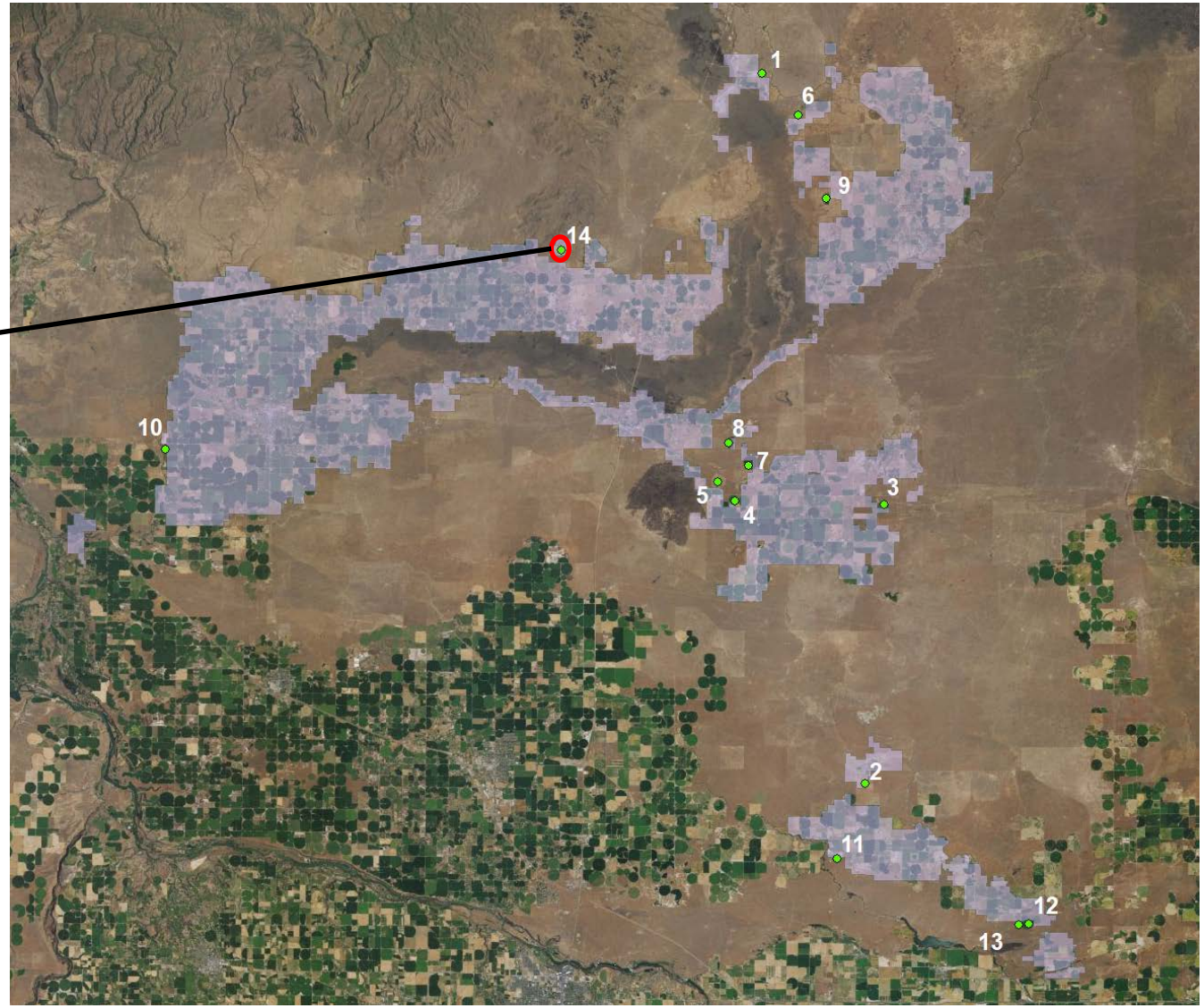




Irrigated Areas without water rights along BWCC Boundary

Non-Irrigation Use





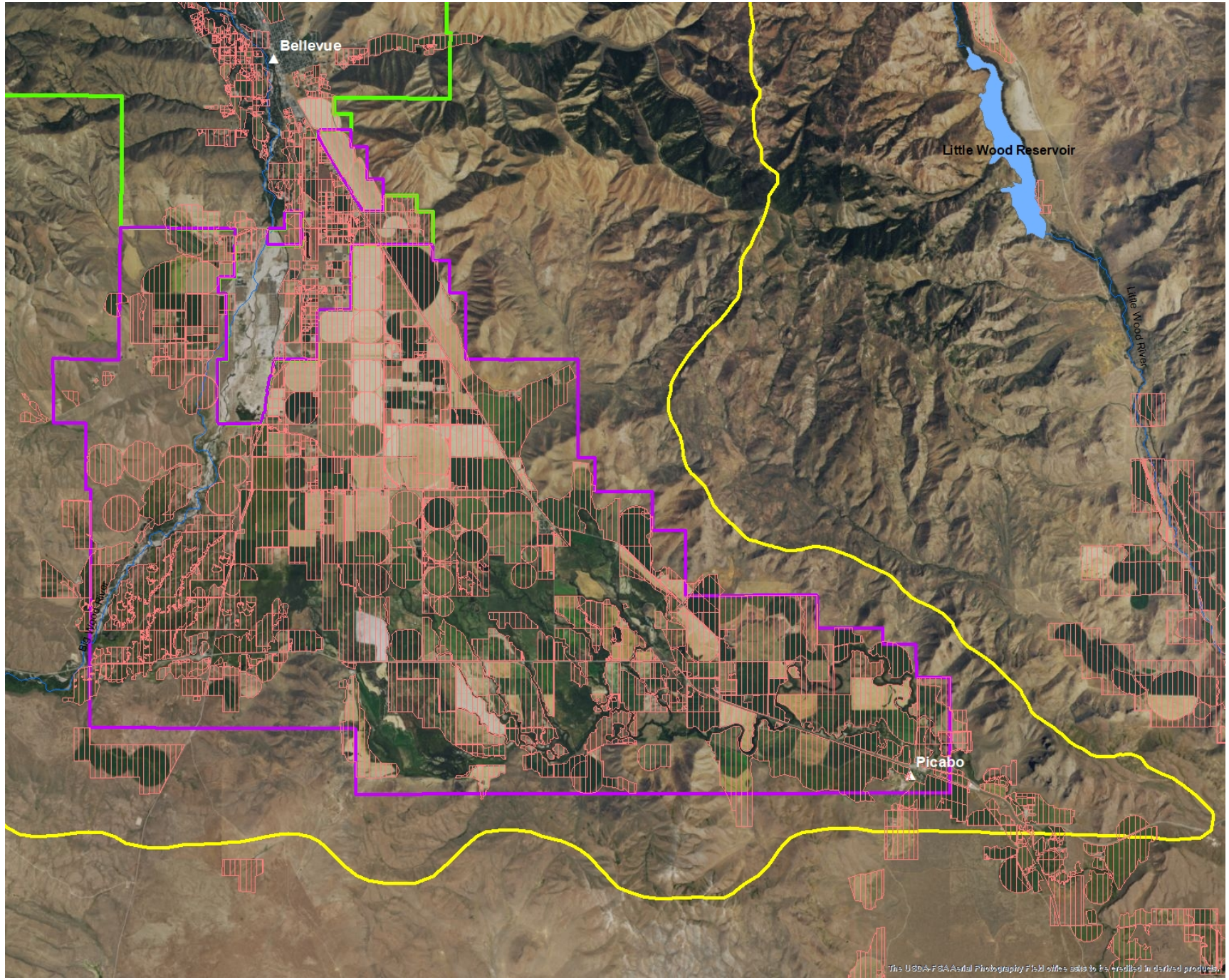
Bellevue Triangle Area

Eyeball Review – November 2020

- Potential Enlargements: 4 tracts
  - 60 acres total
    - 5 to 27 acres each
    - Follow-up needed

- Several additional tracts found
  - Inconclusive (likely sub-irrigated)
    - Follow-up needed

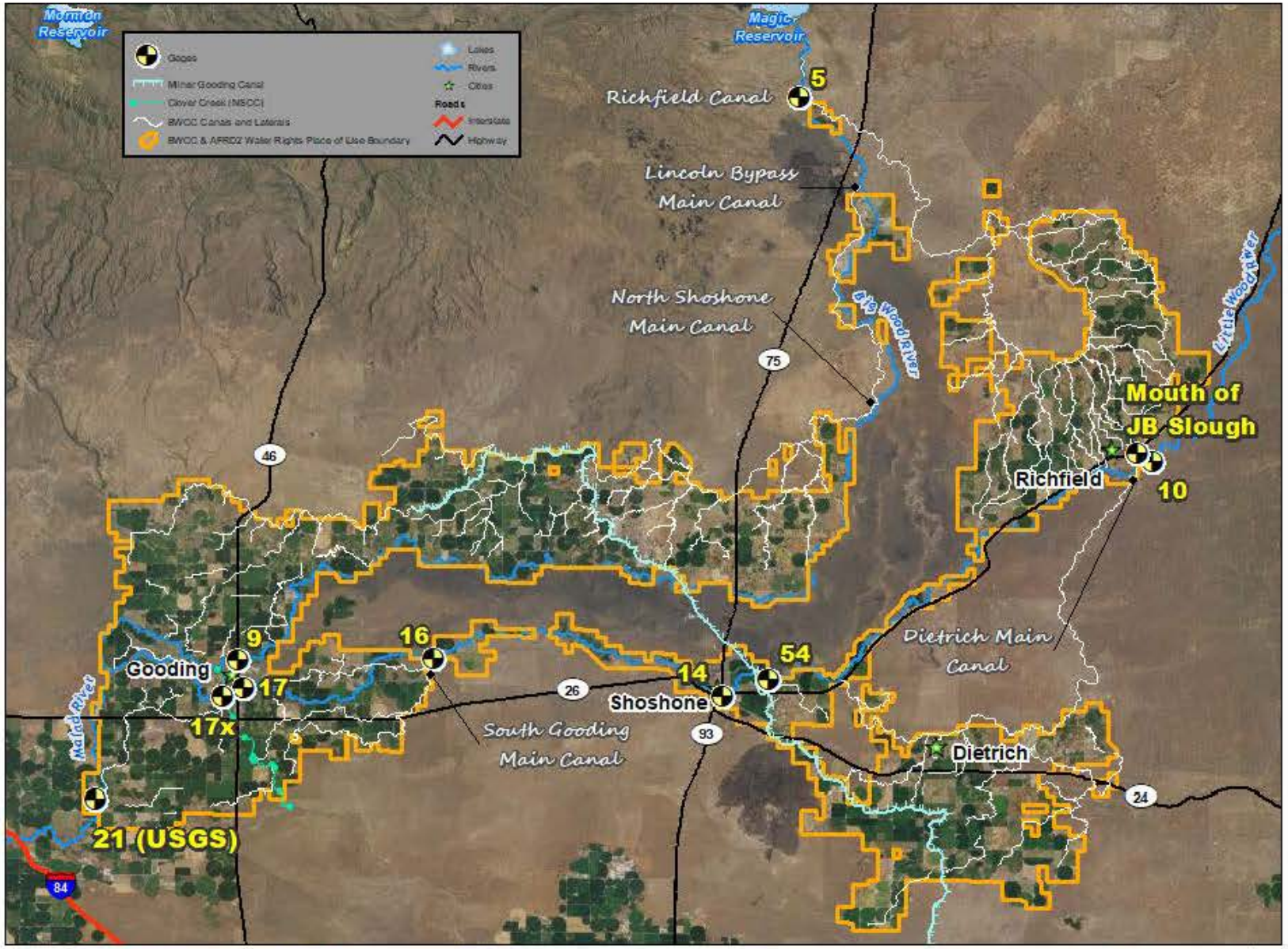
- Several tracts found needing transfers



Prior Reviews – Upper Wood River Area

- 2014
  - 29 NOVs issued
  - 21 resolved with Consent Orders/penalties
  - 4 cases with no violations & 4 resolved through transfers or WSB
  - Small acreage violations
  - Over $18,000 in civil penalties
- 2008
  - 47 sites investigated
  - 23 NOVs issued
  - Mostly small acreage violations

Spills out of WD 37



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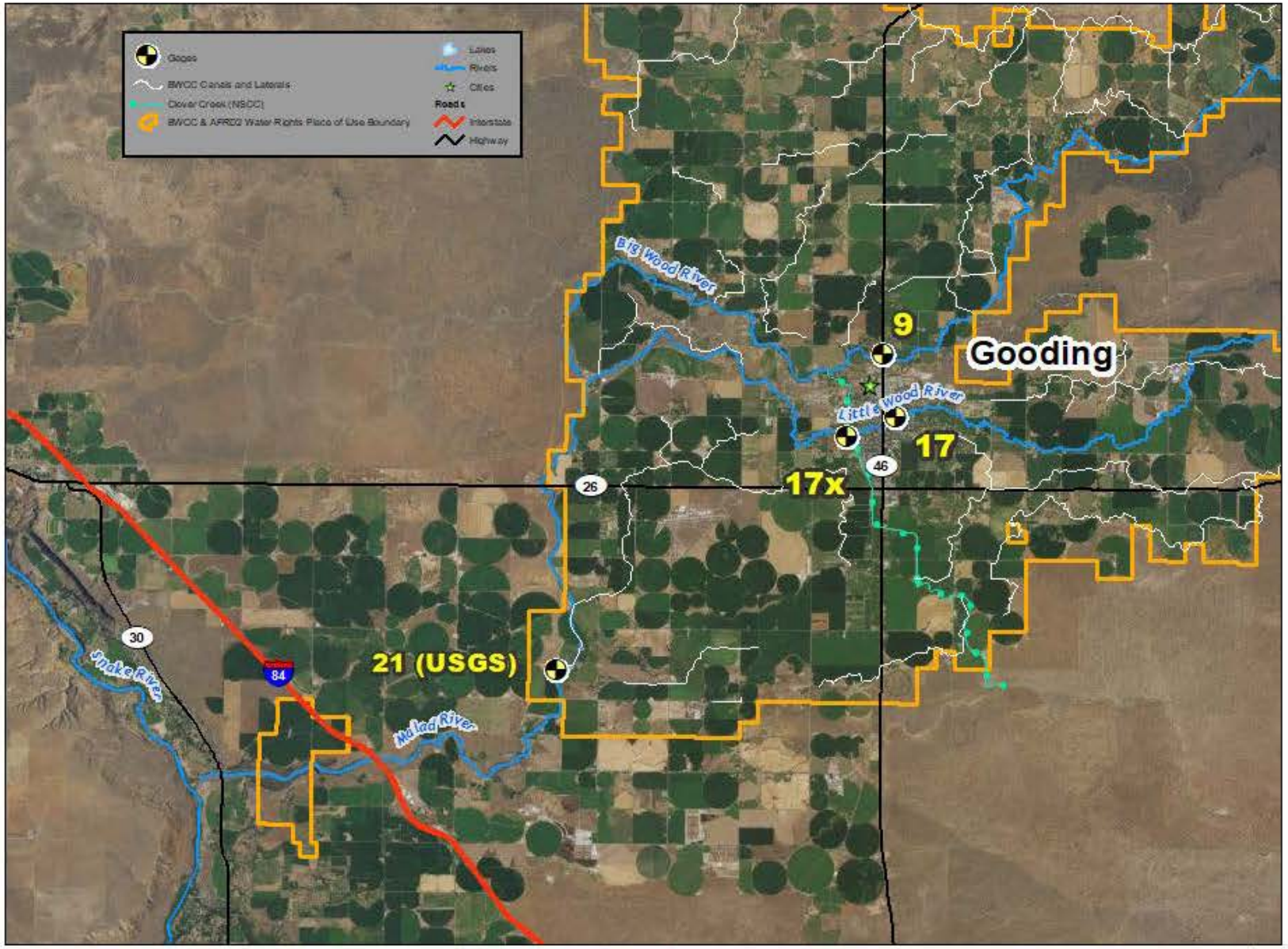
0 1 2 4 6 8 10 Miles

IDWR - pdillon 12/10/2020

Gage Locations



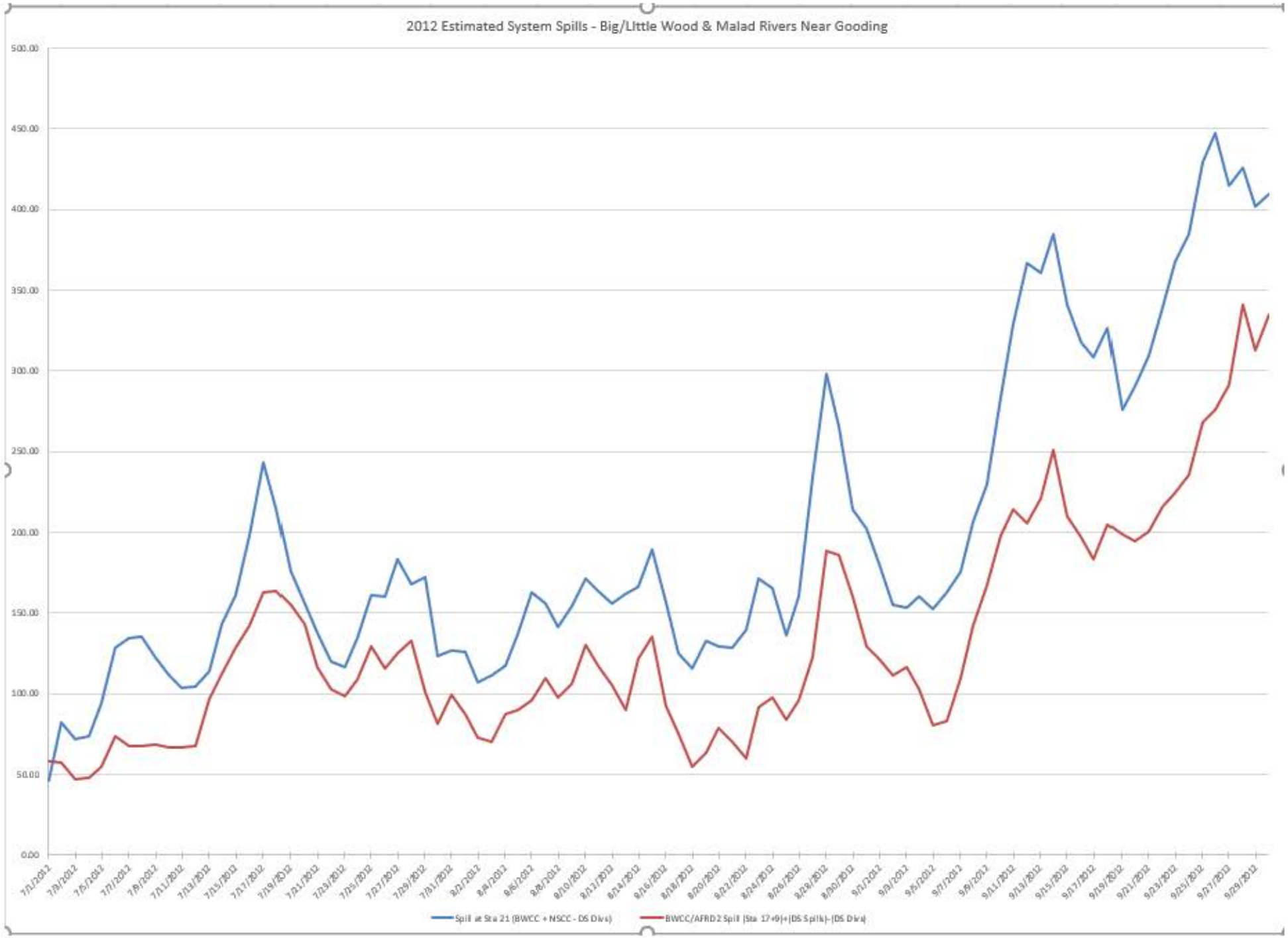
Service Layer Credits: USDA-FSA Aerial Photography Field office: aerial-imagery/ortho_2019_idaho

0 0.5 1 2 3 4 5 Miles

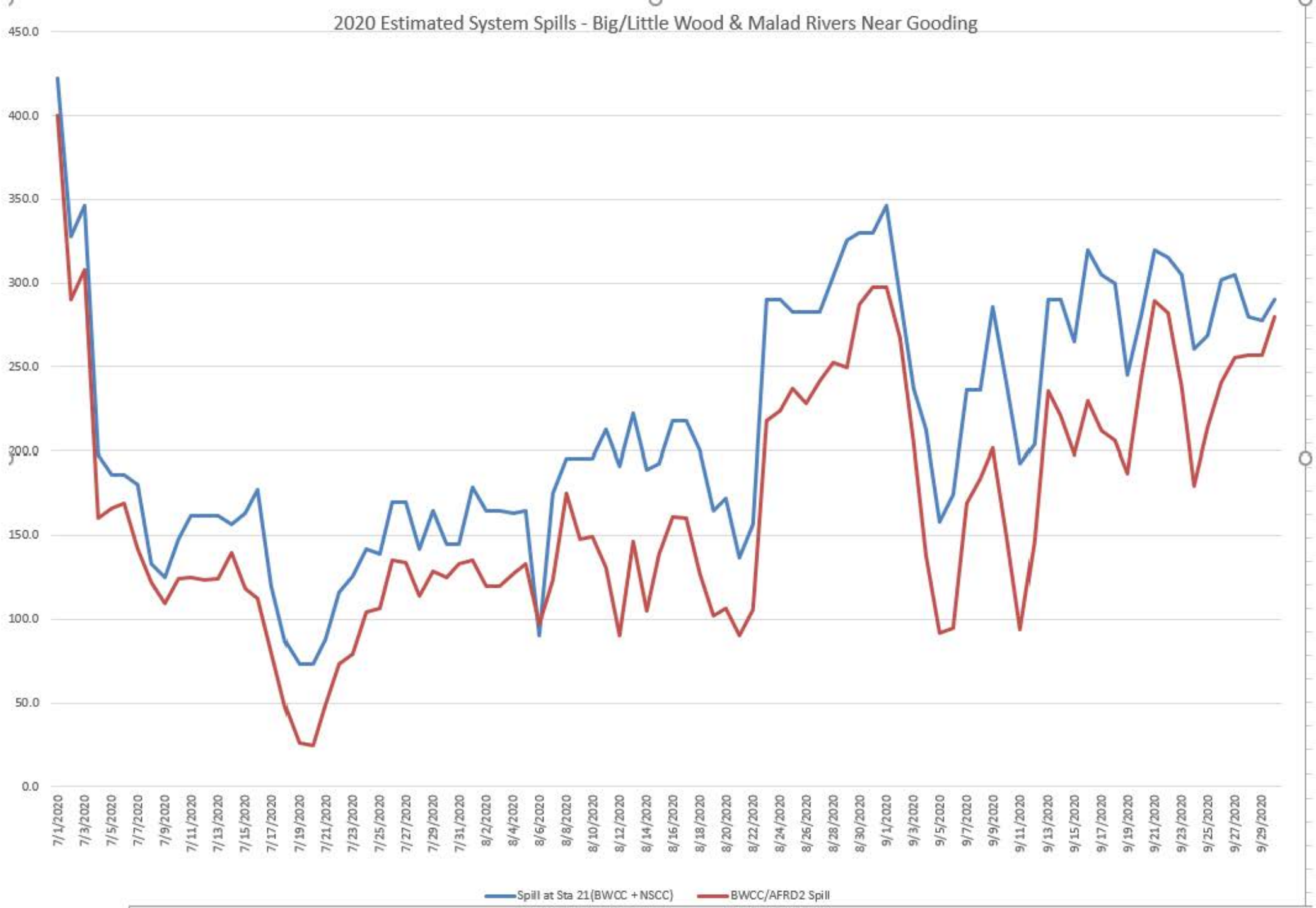
IDWR - pdillon 12/10/2020

Gage Locations

DATE	X Cana NSCC	Station # 17 ttle Wood @ Goodiig	Station #9 Wood @ Goodi	Kra Spill	SOUTH GOODI Spill	LS Spill	River Deliveries	Y canal NSCC	ZCanal NSCC	USGS #21 Malad near Gooding
7/1/2012	381	61	7	7	12	5	20.19	197	102	60.0
7/2/2012	381	61	7	7	12	5	21.11	197	102	96.0
7/3/2012	358	59	8	2	9	4	21.11	197	102	85.0
7/4/2012	355	59	7	5	9	3	20.35	197	100	88.0
7/5/2012	367	62	10	4	9	4	19.35	197	100	109.0
7/6/2012	384	67	21	7	9	5	21.00	200	102	143.0
7/7/2012	393	69	19	3	9	3	21.00	200	102	149.0
7/8/2012	401	70	18	3	9	3	21.00	199	102	150.0
7/9/2012	408	72	17	3	9	5	20.90	197	102	139.0
7/10/2012	402	62	26	4	7	5	20.90	200	98	128.0
7/11/2012	408	65	27	5	5	2	21.01	200	104	120.0
7/12/2012	408	56	31	6	9	3	21.01	200	108	121.0
7/13/2012	402	92	24	4	9	4	22.67	200	108	128.0
7/14/2012	420	94	29	5	12	9	22.67	204	108	157.0
7/15/2012	439	109	30	5	12	9	22.67	204	109	175.0
7/16/2012	457	124	31	5	12	4	19.56	204	110	212.0
7/17/2012	502	141	33	9	9	5	20.56	200	106	257.0
7/18/2012	432	152	31	6	9	3	23.30	200	106	229.0
7/19/2012	408	150	29	4	7	2	23.30	208	104	190.0
7/20/2012	398	143	20	4	9	3	22.27	208	104	170.0
7/21/2012	387	135	10	1	5	2	22.27	208	102	152.0
7/22/2012	390	119	12	1	5	2	22.27	208	101	134.0
7/23/2012	393	104	14	4	9	5	23.96	204	100	130.0
7/24/2012	402	111	16	6	9	5	23.96	204	102	148.0
7/25/2012	405	123	28	3	9	5	25.08	204	102	175.0
7/26/2012	405	113	25	0	12	4	24.44	204	102	174.0
7/27/2012	435	130	18	2	9	4	24.15	204	101	197.0
7/28/2012	402	136	19	4	8	4	24.15	200	102	182.0
7/29/2012	402	104	19	4	8	4	24.15	200	102	186.0
7/30/2012	402	72	19	7	10	6	18.82	200	102	137.0
7/31/2012	405	100	16	6	6	4	18.82	200	100	**141.0**
8/1/2012	414	84	14	7	8	3	16.45	204	102	138.0
8/2/2012	420	74	10	7	8	2	16.45	204	100	119.0
8/3/2012	408	65	13	8	8	3	14.91	204	100	123.0
8/4/2012	390	80	15	8	8	3	14.91	204	100	129.0
8/5/2012	411	79	19	8	8	3	14.91	204	100	149.0
8/6/2012	432	78	24	10	10	5	19.45	204	100	175.0
8/7/2012	411	98	23	7	9	4	19.45	193	100	168.0
8/8/2012	405	84	20	6	15	4	19.19	193	100	153.0
8/9/2012	402	91	24	7	12	3	19.19	193	100	166.0


2012 Estimated System Spills - Big/Little Wood & Malad Rivers Near Gooding
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Spill at Sta 21 (BWCC + NSCC - DS Divs)
BWCC/AFRD2 Spill (Sta 17+9)+(DS Spills)-(DS Divs)

DATE	X Canal NSCC	Station # 17 Little Wood @ Gooding	Station #9 Big Wood @ Gooding	Krall Spill	SOUTH GOODING Spill	LS Spill	River Deliveries	Y canal NSCC	ZCanal NSCC	USGS #21 Malad near Gooding
7/1/2020	344	243	168	13	4	3	15.29	221	107	422.0
7/2/2020	339	175	130	6	6	5	15.29	206	109	328.0
7/3/2020	338	195	130	3	9	3	16.69	204	106	346.0
7/4/2020	352	135	45	4	7	4	18.69	206	108	198.0
7/5/2020	342	141	42	8	5	4	17.69	208	111	186.0
7/6/2020	344	141	42	8	5	4	17.06	208	111	186.0
7/7/2020	348	116	35	15	4	2	17.06	208	112	180.0
7/8/2020	353	109	14	19	5	3	17.54	208	113	133.0
7/9/2020	370	101	12	18	6	1	17.54	208	114	125.0
7/10/2020	370	123	18	6	6	1	20.16	211	113	148.0
7/11/2020	377	131	14	6	3	2	21.16	211	116	162.0
7/12/2020	380	121	13	12	5	3	21.16	213	118	162.0
7/13/2020	364	121	13	12	5	3	20.18	213	118	162.0
7/14/2020	374	138	13	12	3	3	20.18	215	119	157.0
7/15/2020	375	120	13	6	5	4	20.12	215	115	163.0
7/16/2020	392	115	13	5	5	4	20.12	213	118	177.0
7/17/2020	396	85	13	0	6	4	18.73	211	117	120.0
7/18/2020	410	67	0	1	4	4	18.73	211	119	86.4
7/19/2020	409	42	0	4	5	4	18.73	211	119	73.6
7/20/2020	384	42	0	4	5	4	19.66	211	119	73.6
7/21/2020	365	70	0	1	4	4	19.66	213	122	87.8
7/22/2020	372	95	0	2	2	4	19.78	213	118	116.0
7/23/2020	379	95	0	5	4	5	19.78	215	119	126.0
7/24/2020	396	102	17	3	6	4	17.79	217	117	142.0
7/25/2020	385	101	26	4	2	2	17.79	215	119	139.0
7/26/2020	387	113	40	4	4	3	18.79	217	119	170.0
7/27/2020	398	113	40	4	4	3	20.61	217	119	170.0
7/28/2020	401	98	35	4	3	4	20.61	215	119	142.0
7/29/2020	366	100	44	6	6	5	21.87	215	119	165.0
7/30/2020	374	104	38	5	5	5	21.87	213	119	145.0
7/31/2020	402	119	36	2	4	4	21.11	219	118	**145.0**
8/1/2020	387	110	45	1	5	5	21.11	223	117	179.0
8/2/2020	384	102	37	2	5	4	21.11	215	117	165.0
8/3/2020	399	102	37	2	5	4	20.7	215	117	165.0
8/4/2020	421	112	34	2	6	4	19.7	211	118	163.0
8/5/2020	389	109	37	5	8	5	20.58	209	116	165.0
8/6/2020	408	74	39	5	4	5	20.58	209	119	90.4
8/7/2020	399	100	38	4	6	5	19.22	209	118	175.0
8/8/2020	379	136	56	4	4	4	19.22	211	117	196.0
8/9/2020	385	115	47	5	7	4	20.22	208	116	196.0
8/10/2020	389	115	47	5	7	4	19.25	208	116	196.0


2020 Estimated System Spills - Big/Little Wood & Malad Rivers Near Gooding
450.0
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9/15/2020
9/17/2020
9/19/2020
9/21/2020
9/23/2020
9/25/2020
9/27/2020
9/29/2020
Spill at Sta 21(BWCC + NSCC)
BWCC/AFRD2 Spill

Municipal Water Use

System Name	People Served/Connections Approximate	Storage (Gallons)	Average Daily Demand	Max Daily Demand	Reported Sales 2018 (million)*	Reported Salaries 2018 (million)*
BELLEVUE CITY OF	2,287/943	1,000,000	750,000	2,300,000	$80	$41
HAILEY WATER AND SEWER	8,000/3238	3,000,000	2,700,000	7,000,000	$291	$216
KETCHUM CITY OF	3,800/1750	3,000,000	2,380,000	5,100,000	$379	$216
SUN VALLEY WATER AND SEWER DIST	3427/908	3,000,000	1,400,000	6,300,000	$110	$42

* http://sunvalleyeconomy.com/wp-content/uploads/2019/09/Profiles-booklet-19-3.pdf

Acre Feet Use by Year

Municipal	2016	2017	2018	2019
Bellevue	1448.67	1234.29*	1022.98	1231.21
Hailey	2820.43	2442.51	2911.54	2574.11
Ketchum	2830.10	3196.40	3176.86	2718.55
Sun Valley	3098.86	3176.91	3344.74	3241.83

** Meter failed in 2017 this is an average of the reported years*

Blaine County has an estimated 50 Public Water Systems which are systems that serve at least 25 people or have at least 15 connections – HOA, Trailer Parks, Campgrounds, Churches, Summer Camps, Municipalities.

Economic Impact of Blaine County Jobs in Lincoln & Gooding Counties

Water Usage / GDP Comparison				
		Blaine	Lincoln	Gooding
2019 GDP (US BEA)		$1,667,226	$285,060	$1,174,700
	ratio	1	0.17	0.70
Domestic Water Usage		1	1	1
	ratio	1	1.00	1.00

Wage Export / Economic Impact Estimate		
Blaine County Jobs filled by commuters*	1,973	
Ave. Annual Blaine County Wage**		$33,624
Ave. wage spent locally (National Assoc. of Homebuilders)		60%
Direct Economic Impact		$39,804,091
Multiplier Effect***		1.5
Indirect Economic Impact		$59,706,137
Total Economic Impact of Blaine County jobs in Lincoln and Gooding Counties:		**$99,510,228**

*Idaho Dept. of Labor

**Accommodation & Food Service, Retail & Construction Industry weighted average (Idaho Dept of Labor & SVED)

***IMPLAN Labor Income Multiplier Effects range from 1.3 to 2.0 depending on industry