MEMO

State of Idaho
Department of Water Resources
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Date: April 11, 2017

To: Mathew Weaver, P.E., Deputy Director

Cc: Tim Luke, Water Compliance Bureau Chief

From: Jennifer Sukow, P.E., P.G., Hydrology Section

Subject: Post audit of 2016 aquifer enhancement activities for mitigation, Rangen delivery call (CM-MP-2014-001) and Magic Springs pipeline (36-17028)

This memorandum describes model simulations of aquifer enhancement activities performed by the Idaho Ground Water Appropriators, Inc. (IGWA), Southwest Irrigation District (SWID), and A & B Irrigation District (ABID). The purpose of the model simulations was to evaluate the impacts of aquifer enhancement activities on discharge from Curren Tunnel and flow in the Snake River between Kimberly and King Hill. The Enhanced Snake Plain Aquifer Model Version 2.1 (ESPAM2.1) was used to simulate aquifer enhancement projects and predict impacts to aquifer discharge. Simulations were limited to aquifer enhancement projects located within the Great Rift trim line.

Methods used to simulate the impacts of aquifer enhancement activities are described in this memorandum. Detailed results are presented in Attachment A. Tables 1 and 2 summarize results relevant to mitigation plans for the Rangen water delivery call and the Magic Springs water right transfer. Table 1 summarizes the predicted steady state impact by organization. Table 2 summarizes the total predicted impact of aquifer enhancement activities performed by IGWA and SWID[1] for the past year and upcoming year.

[1] SWID is a participant in IGWA's mitigation plan for the Rangen delivery call. ABID has a separate mitigation plan for the Rangen delivery call.

Entity	Volume of 2016 aquifer enhancement projects	Predicted increase in Curren Tunnel discharge	Predicted contribution to flow in the Snake River between Kimberly and King Hill
IGWA	45,852 AF	1.19 cfs	> 9.9 cfs
SWID	66,762 AF	1.13 cfs	> 13.2 cfs
ABID	3,766 AF	0.06 cfs	not applicable[2]
Total	116,380 AF	2.39 cfs	> 23.2 cfs

Table 1. Predicted steady state impacts[3] by organization.

Time period	Predicted increase in Curren Tunnel discharge	Predicted contribution to flow in the Snake River between Kimberly and King Hill
4/2016 – 3/2017[4]	1.6 cfs	> 15.8 cfs
4/2017 – 3/2018[4]	1.3 cfs	> 14.2 cfs

Table 2. Summary of predicted transient impacts of IGWA and SWID aquifer enhancement project on aquifer discharge at selected locations.

ESPAM2.1 simulations

The impact of aquifer enhancement activities on discharge in the Rangen model cell and other model cells tributary to the Snake River between Kimberly and King Hill was simulated using ESPAM2.1. Impacts to discharge from Curren Tunnel are calculated as 63% of the predicted impact to the Rangen model cell. Impacts to flow in the Snake River between Kimberly and King Hill are predicted to exceed the sum of the impacts to baseflow[5] and impacts to spring discharge in Devil's Washbowl model cell, Devil's Corral model cell, and Box Canyon reach[6].

Aquifer enhancement activities were simulated using both steady state and transient analyses. The steady state analyses simulate the long term effect aquifer enhancement projects performed in 2016

[2] ABID is not a participant in IGWA's mitigation plan and was not an applicant on the water right transfer for the Magic Springs pipeline.
[3] Predicted impact of 2016 aquifer enhancement activities at steady state, assuming 2016 activities continue into future years at the same locations and volumes.
[4] Predicted impact of documented past aquifer enhancement projects from 2005 through 2016, assuming no projects performed in 2017.
[5] Baseflow is subsurface discharge to the Snake River and is unavailable to surface water users. The baseflow between Kimberly and King Hill is represented in ESPAM2.1 using general head boundaries.
[6] The Devil's Washbowl, Devil's Corral, and Box Canyon reaches are located within the Kimberly to King Hill reach and do not contain springs diverted for irrigation use. Spring discharge is represented in ESPAM2.1 using drains.

would have on spring discharge if the projects are continued at the same locations and rates in future years. The transient analyses simulated the effect of documented and approved aquifer enhancement activities that occurred between 2005 and 2016. For each year, the volume of aquifer enhancement activities was input into ESPAM2.1 at a constant rate distributed over a one-year stress period beginning on April 1, with the exception of recharge at Sandy Ponds. Because of the proximity to aquifer discharge boundaries, recharge at Sandy Ponds was simulated over a 214-day stress period representing the irrigation season. Model inputs for 2005 through 2016 were obtained from previous analyses of aquifer enhancement projects within the Great Rift trim line[7]. The transient analyses do not consider potential impacts of aquifer enhancement activities that may occur in 2017 or future years.

Simulation of Conservation Reserve Enhancement Program (CREP)

The CREP reduces withdrawals from the Eastern Snake Plain Aquifer (ESPA) by removing groundwater irrigated land from production. The volume of benefit to the aquifer was calculated using ESPAM2.1 data for the average annual crop irrigation requirement from November 1998 through October 2008 (Figure 1). If a parcel is irrigated to establish a cover crop, 1/3 foot per acre is deducted from the average annual crop irrigation requirement during the year irrigated. For 2016, IGWA CREP lands were obtained from a shapefile, updated January 17, 2017 by Paula Dillon, Idaho Department of Water Resources (IDWR). CREP data are submitted to IDWR by Chuck Pentzer, Idaho Soil and Water Conservation Commission.

For 2016, a shapefile of IGWA CREP lands was created by removing lands outside of the area of common groundwater supply, outside of the Great Rift trim line, lands within SWID or Goose Creek Irrigation District (GCID), and lands enrolled by ABID as identified in Exhibit C to *A&B Irrigation District's Rule 43 Mitigation Plan* dated March 7, 2014. In 2016, there were 4,772 acres of IGWA CREP located within the area of common groundwater supply and Great Rift trim line (Figure 2). The simulated reduction of consumptive use was 11,743 AF/year.

In 2016, there were 572 acres of CREP lands located within both the area of common groundwater supply and SWID or GCID (Figure 2). All of the SWID/GCID CREP lands were located within the Great Rift trim line. The simulated reduction in consumptive use was 1,260 AF/year.

In 2016, there were 98 acres of CREP lands enrolled by ABID (Figure 2) as identified in Exhibit C to *A&B Irrigation District's Rule 43 Mitigation Plan* dated March 7, 2014. The simulated reduction in consumptive use was 242 AF/year.

[7] https://idwr.idaho.gov/legal-actions/mitigation-plan-actions/rangen-delivery-call/IGWA-1st.html/CM-MP-2014-001-20160329-2015-Aq-Enh-Post-Audit.zip

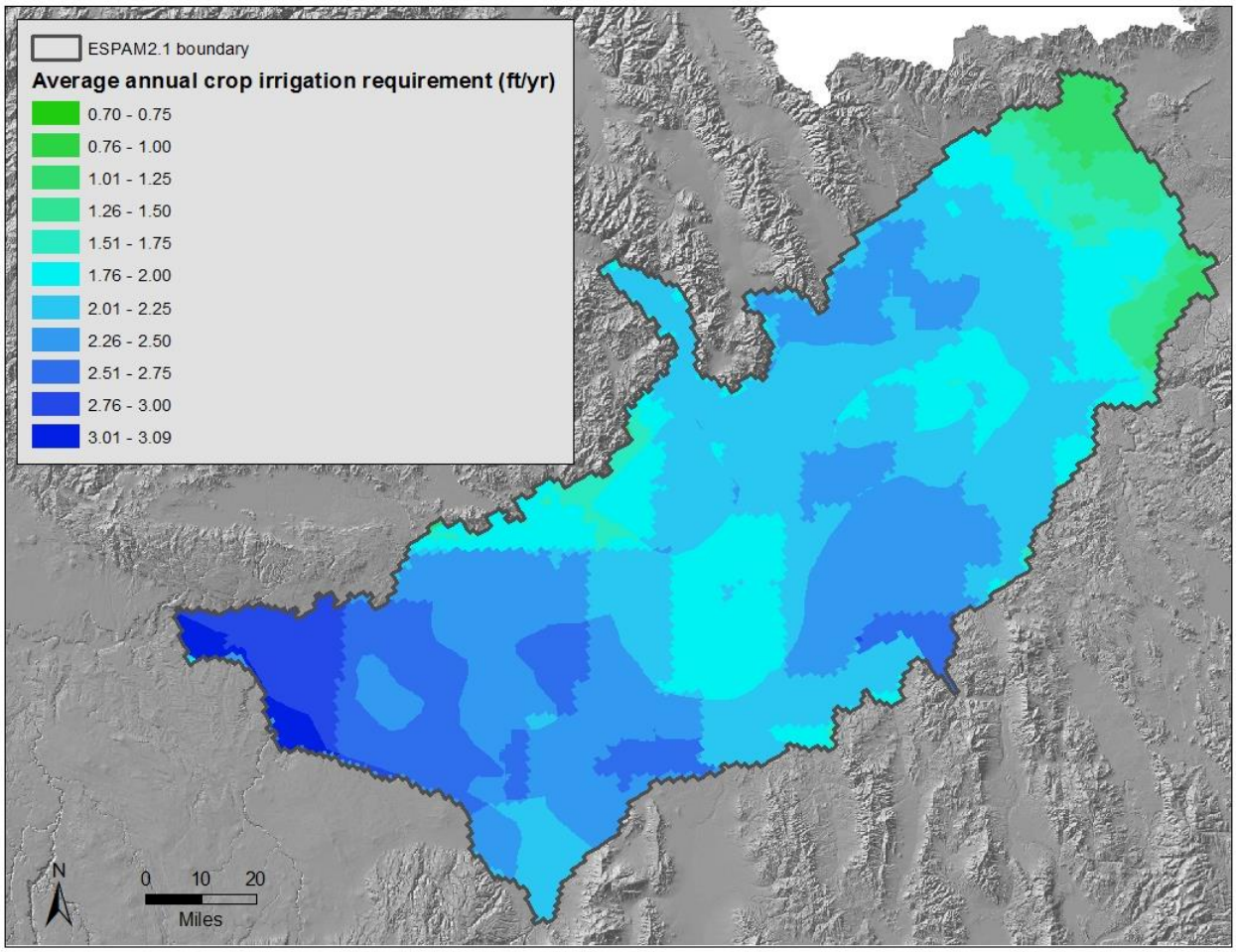


Figure 1. Average annual crop irrigation requirement from November 1998 through October 2008.

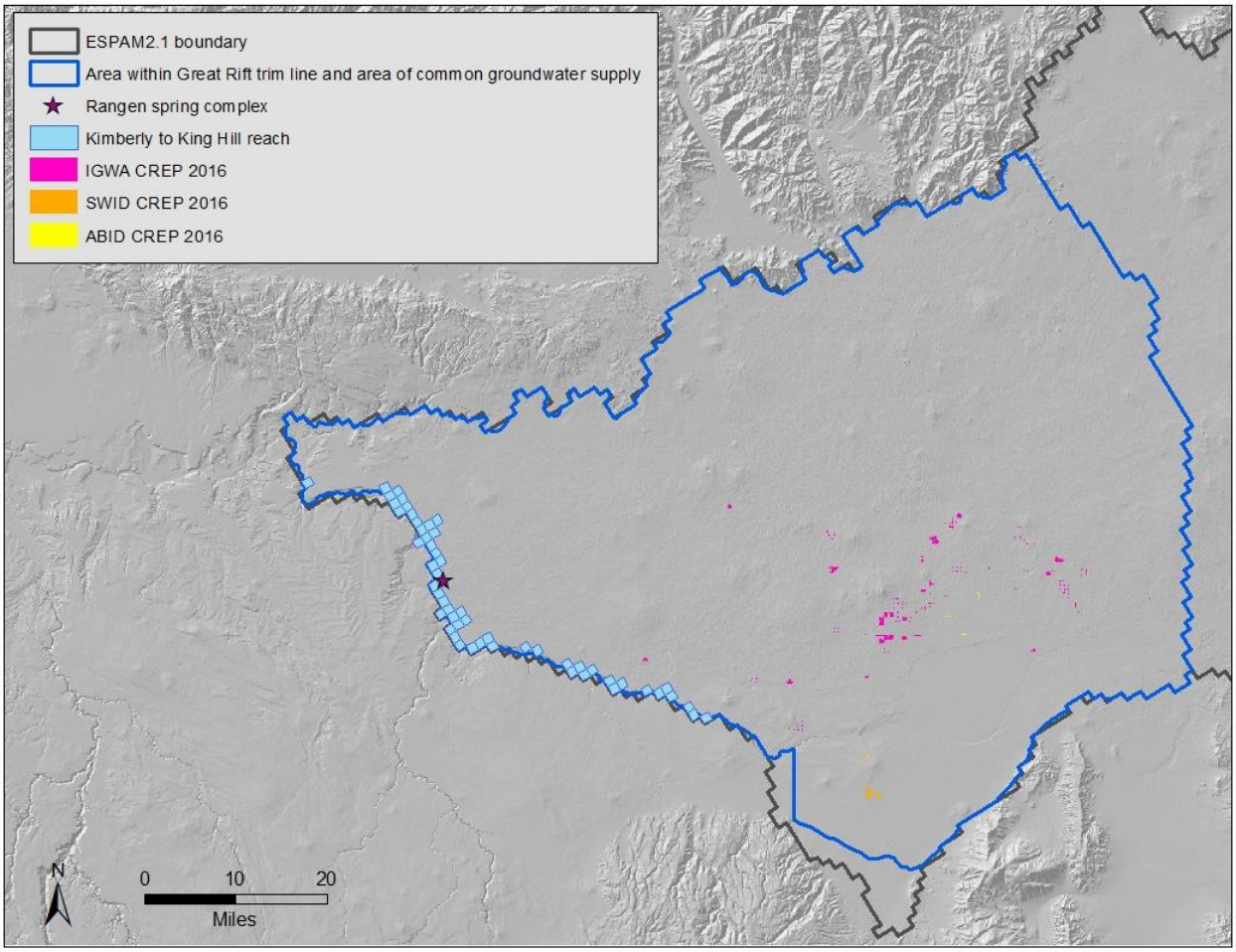


Figure 2. CREP lands in 2016.

Simulation of conversion projects

Conversion projects deliver surface water for irrigation of lands historically irrigated by groundwater. The volume of benefit to the aquifer includes the volume of water delivered to conversion project sites and canal seepage associated with conveyance of the water delivered to conversion project sites.

The volume of water delivered to IGWA conversion sites is compiled and reviewed by the Watermaster of Water District 130. Delivery volumes are reported to the Watermaster by canal companies. The volume of water delivered is simulated at the location of the conversion project (Figure 3), unless excess water is delivered. If excess water is delivered, the volume of excess water is distributed evenly across model cells with centroids intersected by irrigated lands within the canal company service area. Canal seepage ratios assessed by North Side Canal Company (NSCC) and American Falls Reservoir District No. 2 (AFRD2) were used to calculate the total

volume of canal seepage associated with conversion projects in each canal system. The volume of canal seepage in each system was distributed evenly across model cells intersected by the delivery system (Figure 3). In 2016, 24,656 AF of surface water was delivered to IGWA conversion projects. Excess delivery of 167 AF was documented at one conversion project within the NSCC service area. Canal seepage associated with conveyance of the surface water was calculated to be 3,820 AF (2,914 AF in NSCC canals and 906 AF in AFRD2 canals).

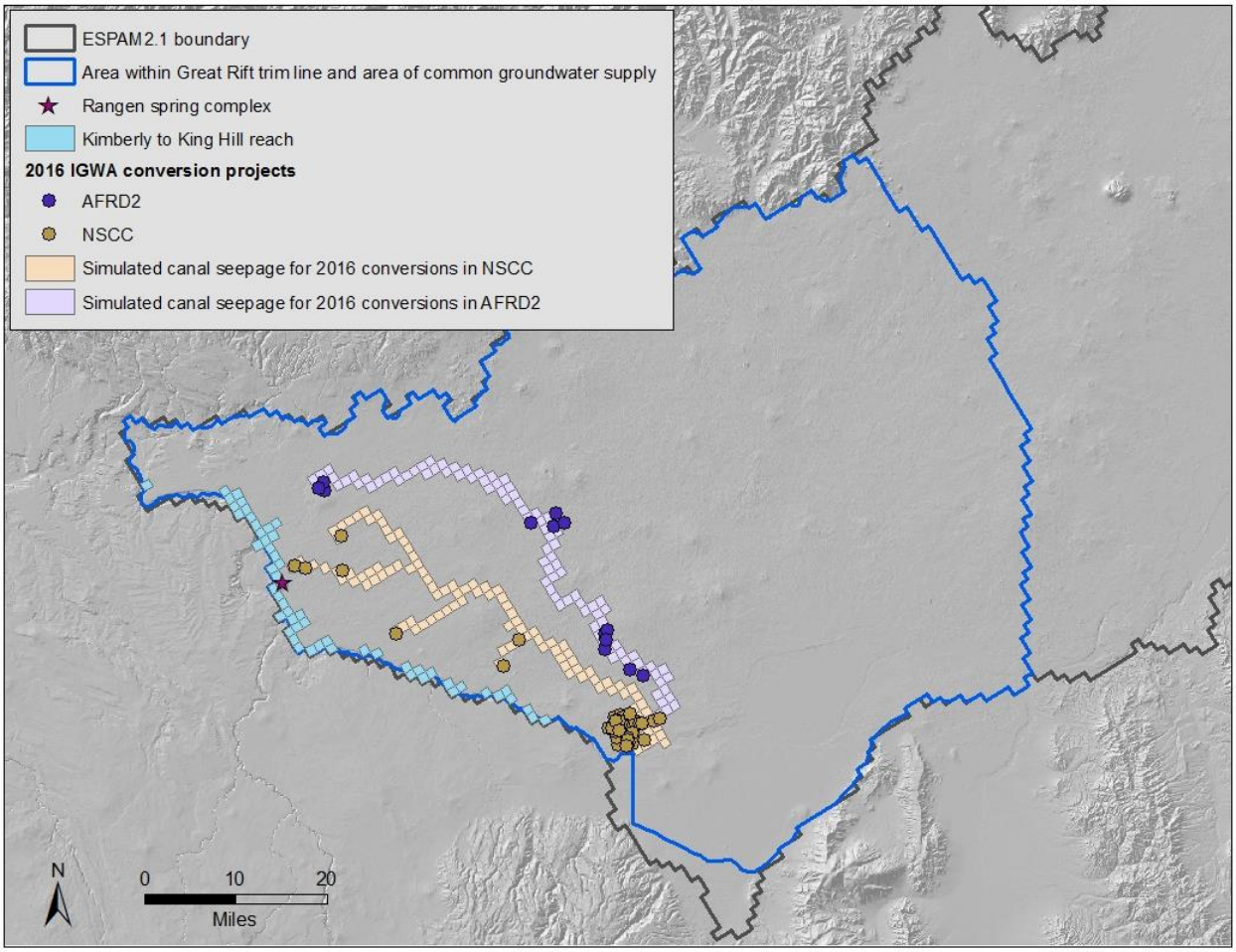


Figure 3. Locations of 2016 IGWA conversion projects and modeled distribution of canal seepage.

The volume of surface water delivered to SWID conversion projects was compiled by the Watermaster of Water District 140 and reviewed by Tim Luke, IDWR. The volume of water delivered is simulated at the location of the conversion project (Figure 4). For SWID conversion projects delivered via the J Canal, canal seepage was calculated at a rate of 38% of diversions. For SWID conversion projects delivered via the Milner Canal, canal seepage was calculated at a rate of 40% of diversions. For SWID conversions delivered via the West Cassia Pipeline, conveyance loss is assumed to be negligible. The volume of canal seepage was distributed evenly across model cells intersected by the delivery system (Figure 4). In 2016, 10,119 AF of water was delivered to West Cassia Pipeline conversion projects, 28,851 AF of water was delivered to J Canal conversion projects, and 2,907 AF of water was delivered to Milner Canal projects. Canal seepage in the J Canal was calculated to be 17,683 AF. Canal seepage in the Milner Canal was calculated to be 1,938 AF.

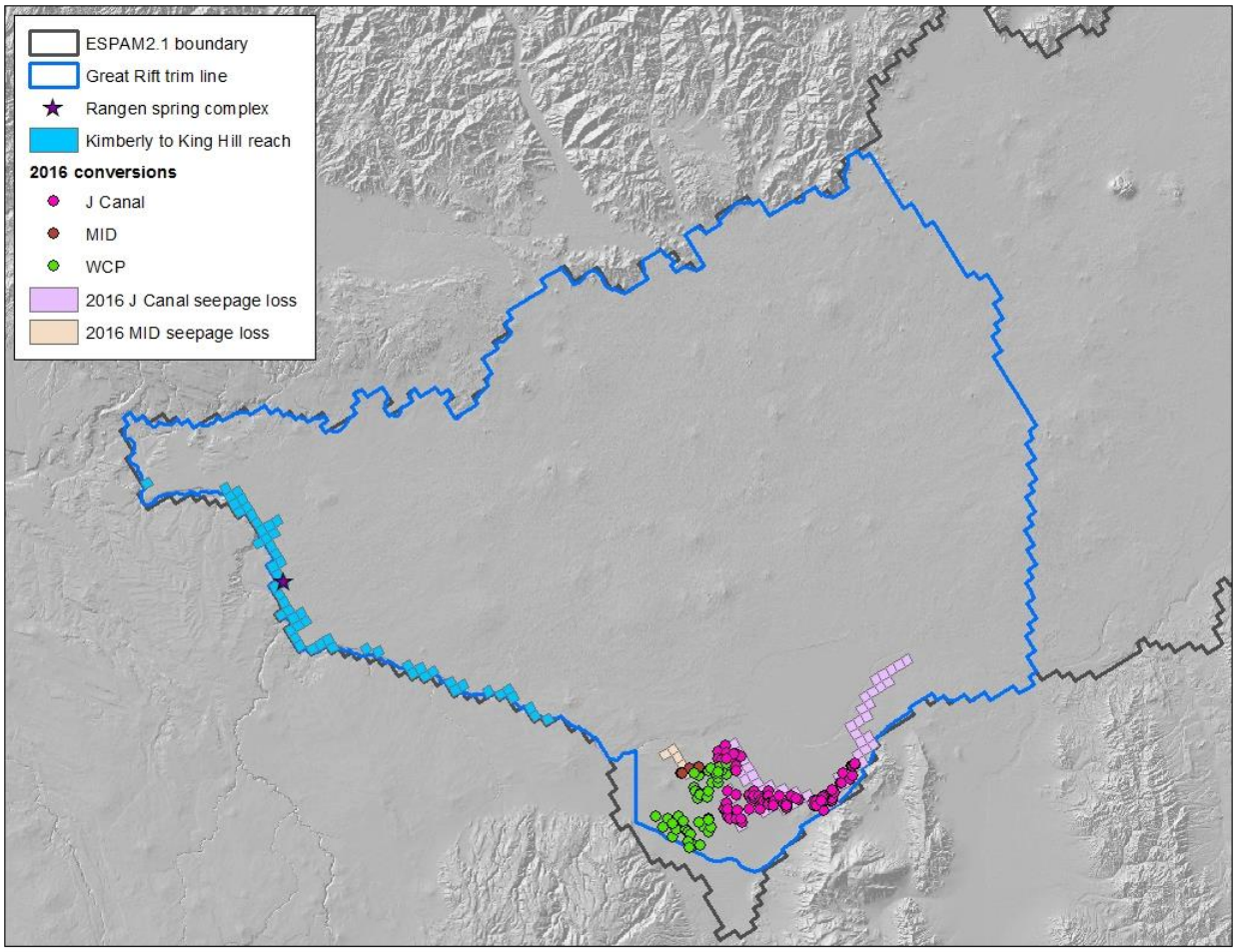


Figure 4. SWID conversion projects in 2016.

The volume of water delivered to ABID conversion projects was compiled by ABID and reviewed by Nathan Erickson, IDWR. The volume of water delivered is simulated at the location of the conversion project (Figure 5). For ABID conversion projects, canal seepage was calculated at a rate of 15% of diversions. The volume of canal seepage was distributed evenly across model cells intersected by the delivery system (Figure 5). In 2016, 2,995 AF of water was delivered to ABID conversion projects. Canal seepage was calculated to be 529 AF.

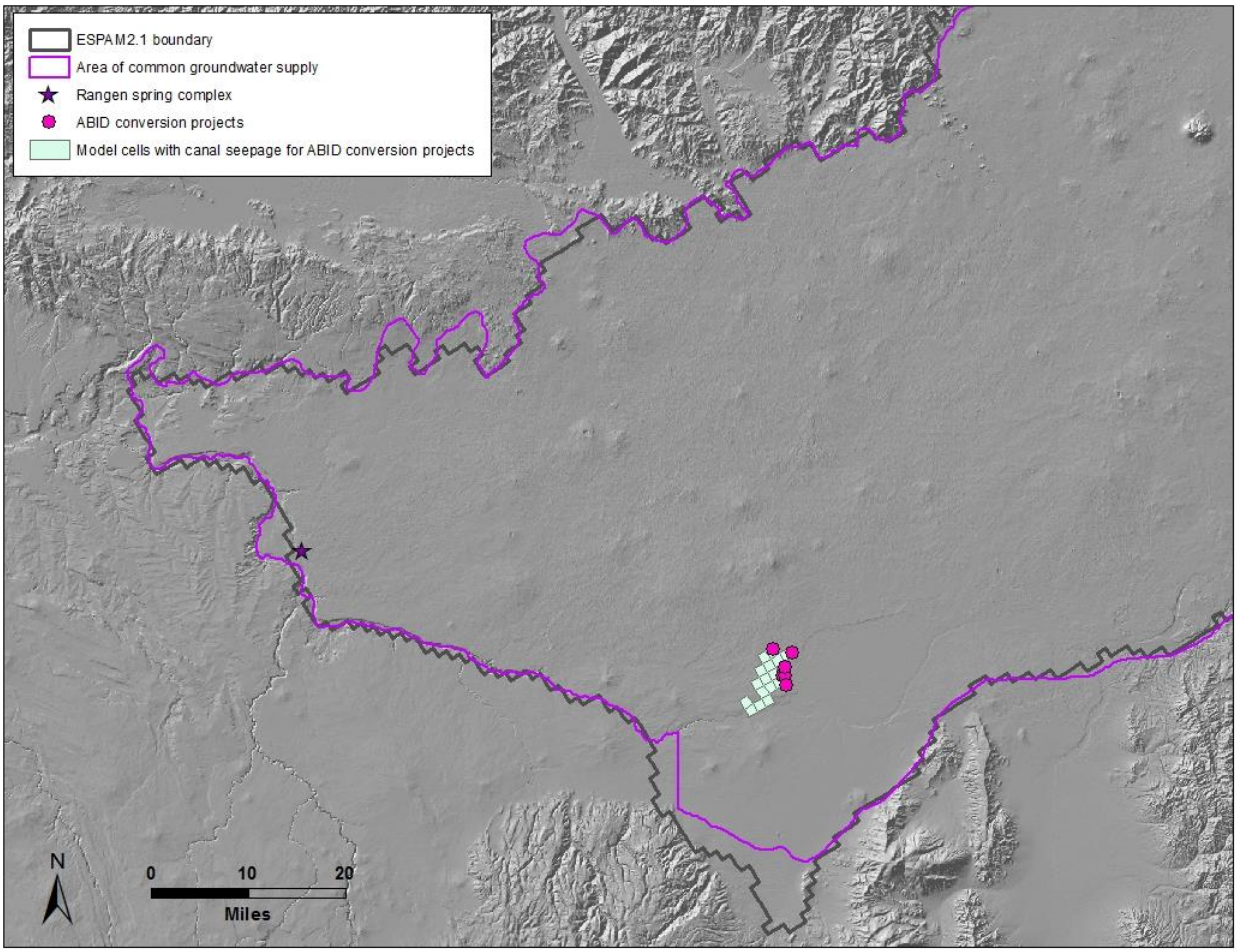


Figure 5. ABID conversion projects in 2016.

Simulation of voluntary curtailment

Voluntary curtailment projects reduce withdrawals from the ESPA by removing groundwater irrigated land from production. SWID is the only entity with voluntary curtailment projects. The locations of SWID voluntary curtailment projects were compiled by Brian Higgs, Watermaster, Water District 140 and reviewed by Margie Wilkins and Tim Luke, IDWR (Figure 6). The volume of benefit to the aquifer was calculated using ESPAM2.1 data for the average annual crop irrigation requirement from November 1998 through October 2008 (Figure 1). If a parcel was historically irrigated by groundwater supplemental to surface water, the area and volume of benefit are multiplied by 0.88[8]. In 2016, SWID voluntary curtailment projects included 1,674 acres. After adjusting for projects with supplemental groundwater, the volume of benefit was calculated for 1,644 acres. The simulated reduction in consumptive use was 3,698 AF.

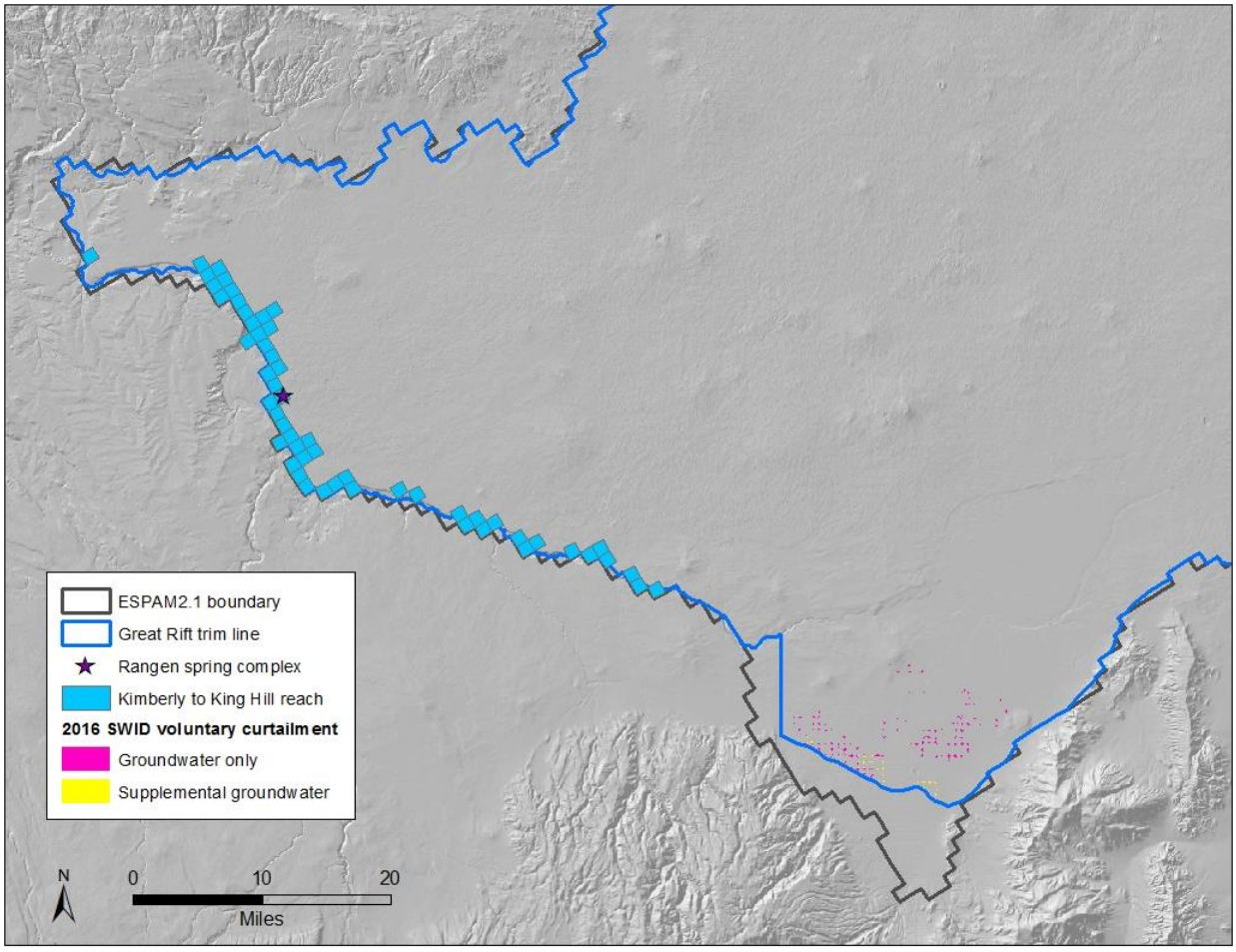


Figure 6. SWID voluntary curtailment projects in 2016.

[8] The average groundwater source fraction for SWID/GCID in ESPAM2.1 is 0.88.

Simulation of managed recharge

Managed recharge not sponsored by the Idaho Water Resource Board (IWRB) is included in IGWA and SWID mitigation plans. IGWA provided documentation[9] of recharge performed in the Sandy Ponds pursuant to water permit 36-17011. During the 2016 irrigation season, 5,466 AF were recharged in the Sandy Ponds. Recharge was distributed evenly between the two model cells containing the Sandy Ponds (Figure 7).

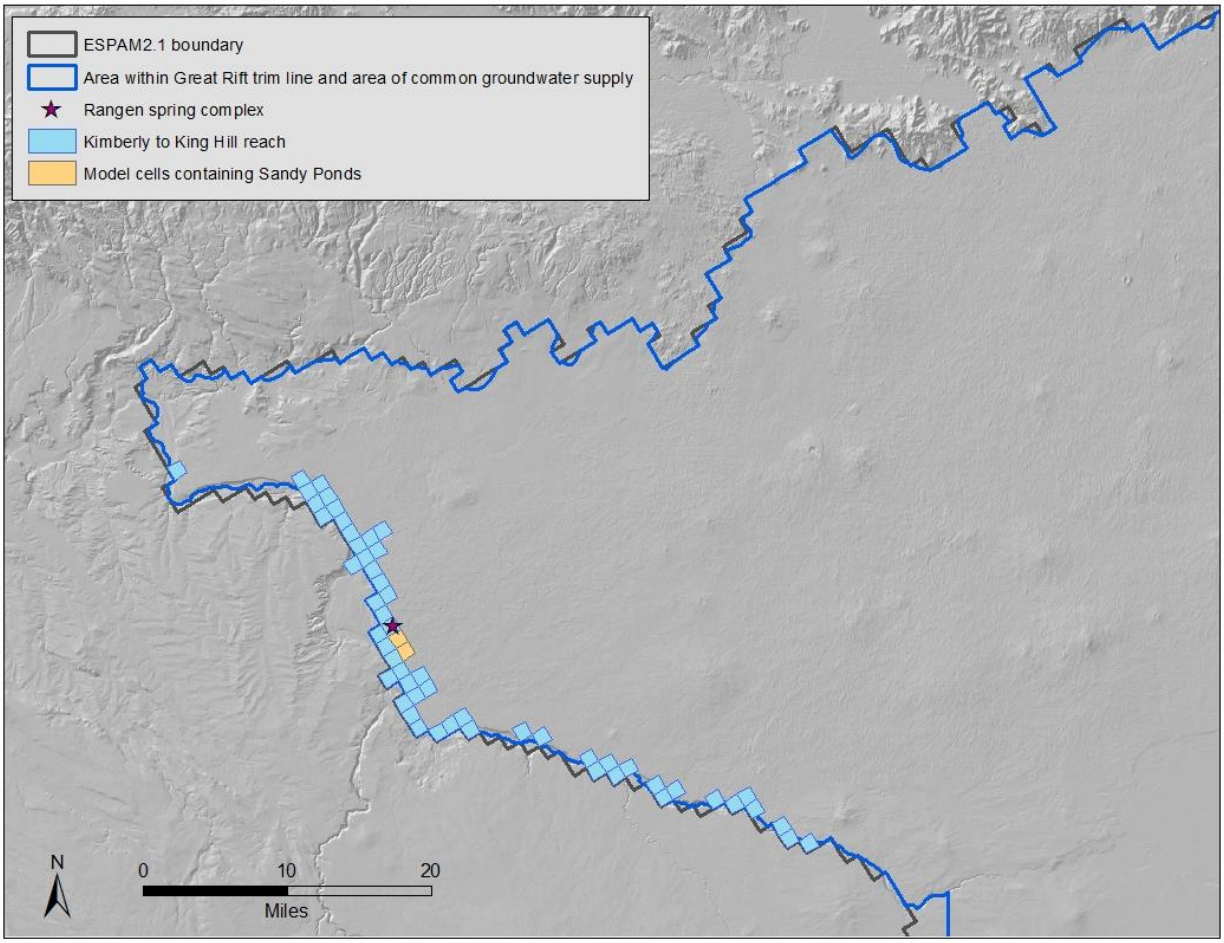


Figure 7. Location of IGWA recharge at Sandy Ponds

[9] King. S., 2017, *Sandy Pond Recharge 2016 Annual Report*, SPF Water Engineering letter to Tim Luke, IDWR, dated January 31, 2017.

In 2016, SWID documented recharge of 305 AF of recharge within the ESPA area of common groundwater supply and not sponsored by the IWRB. Recharge was simulated in the model cell containing the recharge injection well (Figure 8).

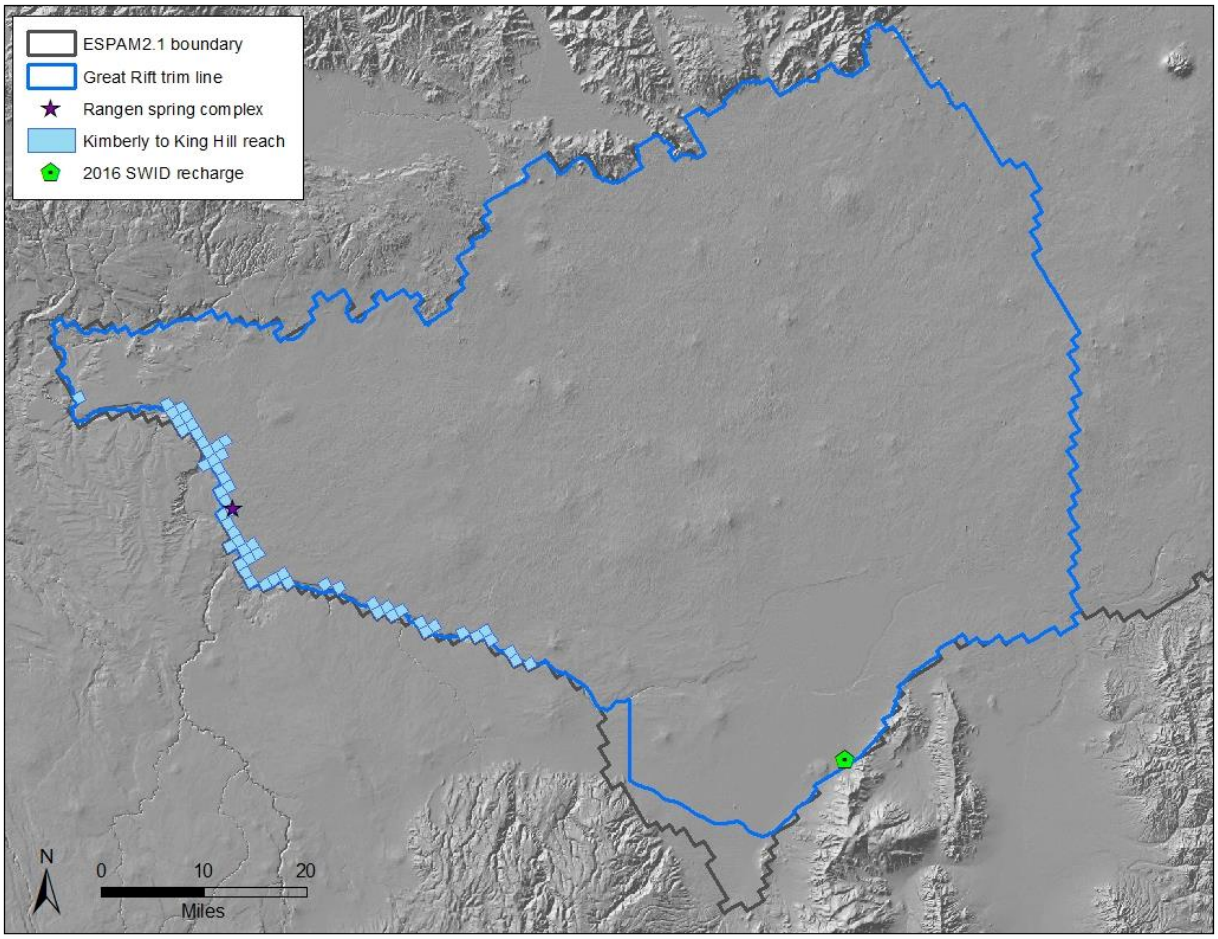


Figure 8. Location of SWID recharge injection well used in 2016

Modeling results

ESPAM2.1 simulation results are provided in Attachment A. Model files are available in the zip folder, 2016AqEnhPostAudit.zip.

ATTACHMENT A.
ESPAM2.1 SIMULATION RESULTS

A-1. Predicted impact of 2005 through 2016 aquifer enhancement projects on discharge from Curren Tunnel.

Mitigation project	Volume (AF/yr) [8]													Predicted average benefit to Curren Tunnel (cfs) [10]					
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Future years [9]	Year 1 (4/2014-3/2015)	Year 2 (4/2015-3/2016)	Year 3 (4/2016-3/2017)	Year 4 (4/2017-3/2018)	Year 5 (4/2018-3/2019)	Impact of 2016 projects at steady state
IGWA Conversions [1]	29,161	35,250	36,915	35,967	13,562	17,210	23,307	30,144	24,335	30,480	10,417	28,643	0	0.54	0.46	0.46	0.36	0.22	0.68
SWID Conversions [2]	0	0	0	0	0	47,138	47,189	58,909	47,350	45,622	57,746	61,498	0	0.44	0.51	0.58	0.65	0.61	1.04
ABID Conversions [3]	4,553	4,553	4,553	4,553	3,884	3,240	3,271	4,772	3,930	3,715	4,082	3,524	0	0.06	0.06	0.06	0.06	0.05	0.06
SWID Voluntary Curtailment [4]	0	0	0	0	0	4,211	4,015	4,015	3,946	3,946	3,211	3,698	0	0.04	0.04	0.05	0.05	0.04	0.06
IGWA CREP [5]	0	0	11,624	16,443	19,787	14,258	14,258	12,266	12,376	11,853	11,696	11,743	0	0.17	0.17	0.16	0.15	0.12	0.18
SWID CREP [5]	0	0	0	0	0	1,588	1,588	1,588	1,588	1,588	1,260	1,260	0	0.01	0.02	0.02	0.02	0.02	0.02
ABID CREP [5]	0	0	0	0	0	0	0	0	0	242	242	242	0	0.0002	0.0009	0.0014	0.0016	0.0012	0.003
IGWA Recharge [6]	0	0	27,360	0	13,687	0	0	0	0	0	0	5,466	0	0.02	0.02	0.34	0.02	0.01	0.34
SWID Recharge [7]	0	0	0	0	0	0	0	1,195	1,169	453	0	305	0	0.005	0.007	0.006	0.006	0.005	0.005
IGWA	29,161	35,250	75,899	52,410	47,036	31,468	37,565	42,410	36,711	42,334	22,113	45,852	0	0.73	0.64	0.96	0.54	0.35	1.19
SWID/GCID	0	0	0	0	0	52,936	52,792	65,706	54,053	51,609	62,218	66,762	0	0.49	0.57	0.65	0.72	0.67	1.13
ABID	4,553	4,553	4,553	4,553	3,884	3,240	3,271	4,772	3,930	3,956	4,324	3,766	0	0.06	0.06	0.06	0.06	0.05	0.06
Total IGWA/SWID	29,161	35,250	75,899	52,410	47,036	84,405	90,357	108,116	90,764	93,943	84,331	112,614	0	1.22	1.22	1.61	1.26	1.02	2.33
Total	33,714	39,803	80,452	56,963	50,920	87,644	93,628	112,888	94,694	97,899	88,655	116,380	0	1.28	1.28	1.67	1.32	1.07	2.39

Notes:

1. IGWA conversion volume includes water delivered to conversion projects, excess water delivered to conversion projects, canal seepage within NSCC and AFRD2 delivery systems, and voluntary idle projects. For 2005-2013, canal seepage was assumed to be 30% of diversions for NSCC and 42% of diversions for AFRD2. Beginning in 2014, canal loss ratios reported to the watermaster by the canal companies were used to calculate canal seepage within the NSCC and AFRD2 delivery systems.

2. SWID conversion volume includes water delivered to conversion projects and canal seepage of 38% within the J Canal delivery system.
3. ABID conversion volume includes water delivered to conversion projects and canal seepage of 15% within the delivery system.
4. SWID voluntary curtailments on mixed source lands where groundwater irrigation is supplemental to surface water irrigation were assigned a groundwater fraction of 0.88 for calculation of idled acres and volume of benefit to the aquifer.
5. 2007-2009 IGWA CREP may include land located within SWID/GCID. Beginning in 2010, CREP land located within SWID/GCID is simulated separately. 2007-2013 IGWA CREP may include lands enrolled by ABID. Beginning in 2014, CREP lands enrolled by A&B Irrigation Distict are simulated separately. IGWA CREP lands outside of the Great Rift trim line were excluded from this analysis.
6. IGWA recharge does not include recharge sponsored by IWRB or recharge outside of the Great Rift trim line.
7. SWID recharge is not intended to include recharge sponsored by IWRB. Unable to verify whether or not SWID recharge claimed for 2012 and 2013 was sponsored by IWRB. It may not be appropriate to provide mitigation credit for recharge modeled in 2012 or 2013. Non-IWRB recharge in 2015 may have been performed, but was not documented by SWID in compliance with UIC permit conditions. UIC permits for the Wrigley and Searle sites expired on 10/1/2015 and had not been renewed as of 3/10/2016.
8. Mitigation volumes were modeled at an average constant rate distributed over a one-year period beginning April 1, except for 2016 IGWA recharge at Sandy Ponds, which was averaged over a 214-day period beginning April 1.
9. Predicted average benefit does not consider potential benefits of aquifer enhancement activities that may occur in future years.
10. Predicted benefits to the Rangen spring model cell were calculated using transient and steady state, superposition versions of ESPAM2.1. Predicted benefits to Curren tunnel were calculated as 63% of the benefits to the Rangen spring model cell using a linear regression model adopted by the Director in the Rangen proceeding.

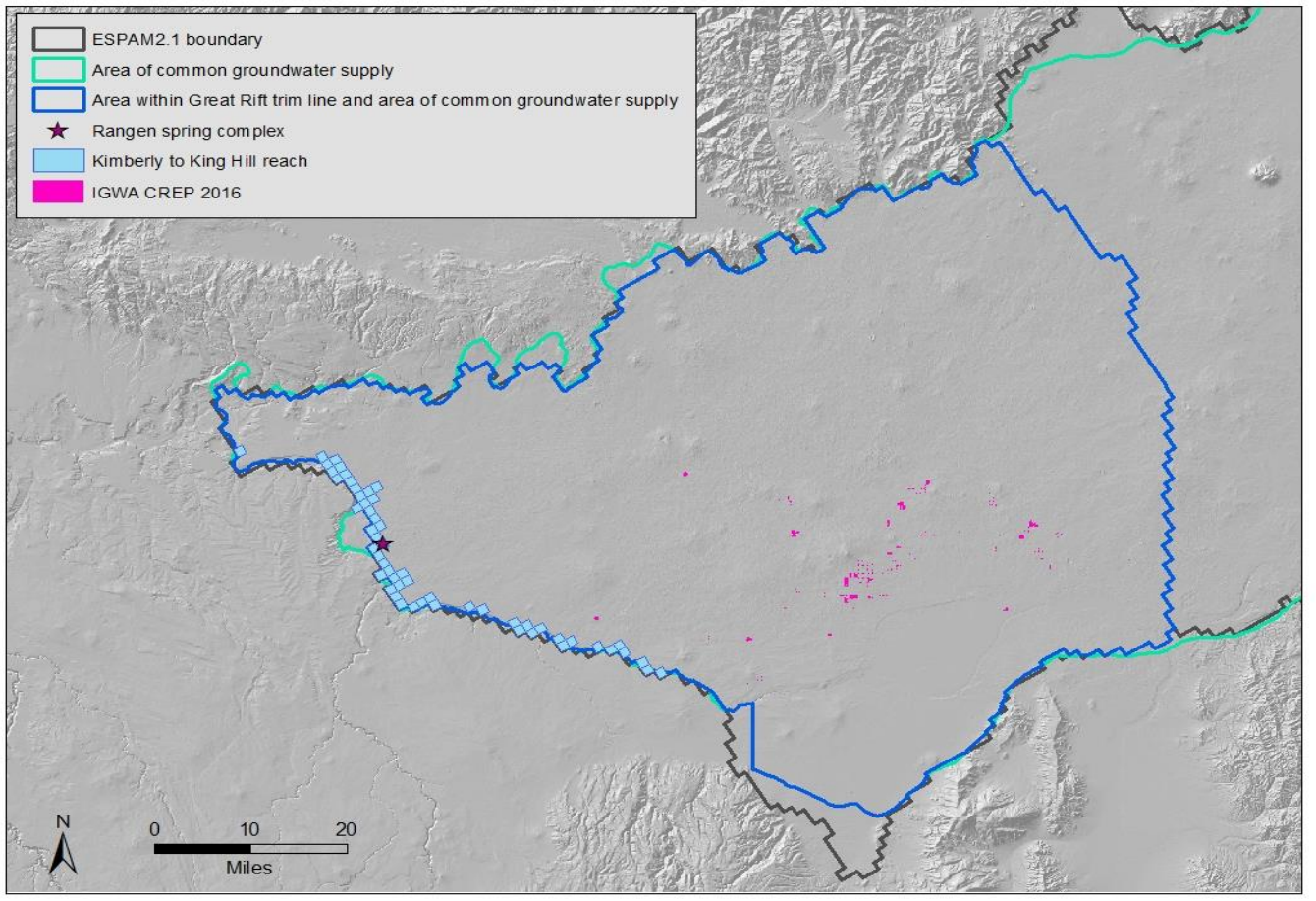
A-2. Predicted impact of 2005 through 2016 aquifer enhancement projects on baseflow and spring discharge tributary to the Snake River between Kimberly and King Hill.

Mitigation project	Volume (AF/yr)[8]													Predicted average benefit to baseflow & spring cells with no irrigation use (cfs)[10]						Predicted average benefit to Kimberly to King Hill reach[11]					
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Future years[9]	Year 1 (4/2014-3/2015)	Year 2 (4/2015-3/2016)	Year 3 (4/2016-3/2017)	Year 4 (4/2017-3/2018)	Year 5 (4/2018-3/2019)	Impact of 2016 projects at steady state	Year 1 (4/2014-3/2015)	Year 2 (4/2015-3/2016)	Year 3 (4/2016-3/2017)	Year 4 (4/2017-3/2018)	Year 5 (4/2018-3/2019)	Impact of 2016 projects at steady state
IGWA Conversions [1]	29,161	35,250	36,915	35,967	13,562	17,210	23,307	30,144	24,335	30,480	10,417	28,643	0	5.39	4.63	4.79	3.79	2.20	7.10	19.98	17.39	17.53	14.35	8.46	26.30
SWID Conversions [2]	0	0	0	0	0	47,138	47,189	58,909	47,350	45,622	57,746	61,498	0	5.67	6.43	7.36	7.88	6.86	12.22	19.20	22.05	25.20	27.61	24.98	43.61
SWID Voluntary Curtailment [4]	0	0	0	0	0	4,211	4,015	4,015	3,946	3,946	3,211	3,698	0	0.48	0.54	0.57	0.57	0.49	0.75	1.62	1.85	1.97	2.02	1.78	2.67
IGWA CREP [5]	0	0	11,624	16,443	19,787	14,258	14,258	12,266	12,376	11,853	11,696	11,743	0	1.71	1.69	1.69	1.54	1.16	1.81	6.66	6.58	6.55	6.00	4.54	7.02
SWID CREP [5]	0	0	0	0	0	1,588	1,588	1,588	1,588	1,588	1,260	1,260	0	0.19	0.22	0.23	0.22	0.19	0.26	0.65	0.74	0.79	0.79	0.68	0.92
IGWA Recharge [6]	0	0	27,360	0	13,687	0	0	0	0	0	0	5,466	0	0.24	0.19	1.08	0.16	0.11	1.03	0.94	0.73	7.50	0.69	0.42	7.37
SWID Recharge [7]	0	0	0	0	0	0	0	1,195	1,169	453	0	305	0	0.08	0.08	0.07	0.07	0.05	0.06	0.26	0.29	0.27	0.24	0.20	0.22
IGWA	29,161	35,250	75,899	52,410	47,036	31,468	37,565	42,410	36,711	42,334	22,113	45,852	0	7.35	6.51	7.56	5.49	3.46	9.93	27.59	24.70	31.58	21.04	13.43	40.69
SWID/GCID	0	0	0	0	0	52,936	52,792	65,706	54,053	51,609	62,218	66,762	0	6.43	7.28	8.23	8.75	7.58	13.30	21.73	24.93	28.23	30.65	27.64	47.42
Total	29,161	35,250	75,899	52,410	47,036	84,405	90,357	108,116	90,764	93,943	84,331	112,614	0	**13.78**	**13.79**	**15.79**	**14.24**	**11.05**	**23.23**	**49.32**	**49.63**	**59.81**	**51.70**	**41.07**	**88.11**

Notes:

1. IGWA conversion volume includes water delivered to conversion projects, excess water delivered to conversion projects, canal seepage within NSCC and AFRD2 delivery systems, and voluntary idle projects. For 2005-2013, canal seepage was assumed to be 30% of diversions for NSCC and 42% of diversions for AFRD2. Beginning in 2014, canal loss ratios reported to the watermaster by the canal companies were used to calculate canal seepage within the NSCC and AFRD2 delivery systems.
2. SWID conversion volume includes water delivered to conversion projects and canal seepage of 38% within the J Canal delivery system.
3. ABID conversion volume includes water delivered to conversion projects and canal seepage of 15% within the delivery system.
4. SWID voluntary curtailments on mixed source lands where groundwater irrigation is supplemental to surface water irrigation were assigned a groundwater fraction of 0.88 for calculation of idled acres and volume of benefit to the aquifer.
5. 2007-2009 IGWA CREP may include land located within SWID/GCID. Beginning in 2010, CREP land located within SWID/GCID is simulated separately. 2007-2013 IGWA CREP may include lands enrolled by ABID. Beginning in 2014, CREP lands enrolled by A&B Irrigation Distict are simulated separately. IGWA CREP lands outside of the Great Rift trim line were excluded from this analysis.
6. IGWA recharge does not include recharge sponsored by IWRB or recharge outside of the Great Rift trim line.
7. SWID recharge is not intended to include recharge sponsored by IWRB. Unable to verify whether or not SWID recharge claimed for 2012 and 2013 was sponsored by IWRB. It may not be appropriate to provide mitigation credit for recharge modeled in 2012 or 2013. Non-IWRB recharge in 2015 may have been performed, but was not documented by SWID in compliance with UIC permit conditions. UIC permits for the Wrigley and Searle sites expired on 10/1/2015 and had not been renewed as of 3/10/2016.
8. Mitigation volumes were modeled at an average constant rate distributed over a one-year period beginning April 1, except for 2016 IGWA recharge at Sandy Ponds, which was averaged over a 214-day period beginning April 1.
9. Predicted average benefit does not consider potential benefits of aquifer enhancement activities that may occur in future years.
10. Predicted benefit to baseflow between Kimberly and King Hill and spring discharge in the Devil's Washbowl cell, Devil's Corral cell, and Box Canyon reach.
11. Predicted benefit to baseflow and springs tributary to the Snake River between Kimberly and King Hill. Some of the predicted increases in spring discharge may be diverted for consumptive use, therefore the increase in flow in the Snake River between Kimberly and King Hill is expected to be less than the increase in aquifer discharge.

A-3. Simulated steady state impact of 2016 CREP for lands enrolled by IGWA within the Great Rift trim line and area of common groundwater supply



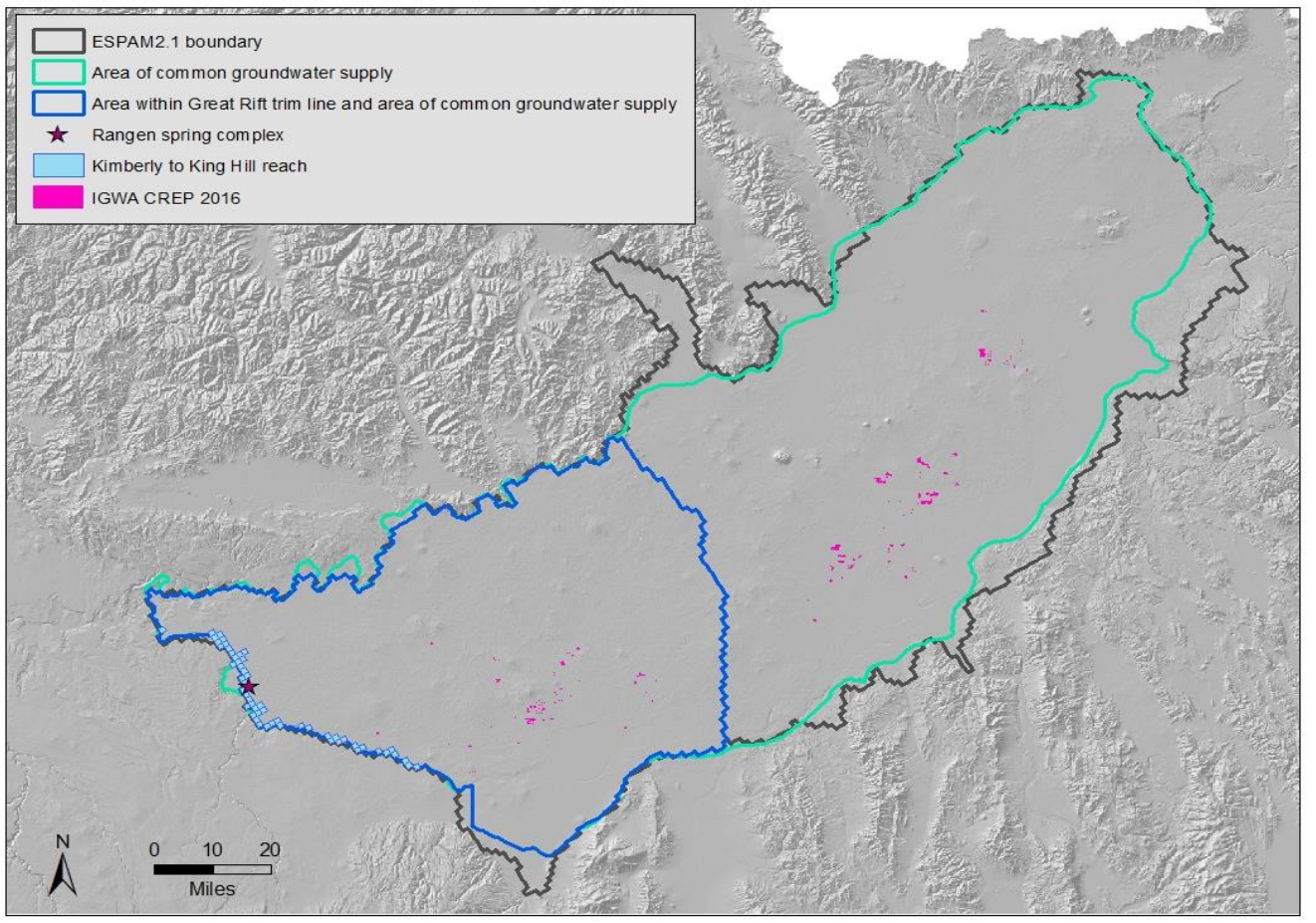
Simulated volume:

4,772	acres
11,743	AF/yr
16.21	cfs
2.46	AF/ac

Predicted response:

Reach	**Response (cfs)**	**Response (AF/yr)**
Ashton to Rexburg	0.22	158
Heise to Shelley	0.64	464
Shelley to Near Blackfoot	1.92	1,388
Near Blackfoot to Minidoka	6.41	4,644
Kimberly to Buhl	2.39	1,730
Buhl to Lower Salmon Falls	3.98	2,883
Lower Salmon Falls to King Hill	0.66	476
Total	16.21	11,743
Group A&B Spring Reaches		
Devil's Washbowl	0.13	92
Devil's Corral	0.17	121
Blue Lakes	0.49	358
Crystal	0.81	588
Niagara	0.55	396
Clear Lake	0.71	511
Briggs	0.02	14
Box Canyon	1.16	842
Sand	0.31	224
Thousand	0.80	581
National Fish Hatchery	0.18	130
Rangen	0.28	204
Three	0.20	148
Malad	0.58	417
Curren Tunnel	0.18	128
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.13	
Devil's Corral	0.17	
Box Canyon	1.16	
Baseflow , Kimberly to King Hill	0.35	
Total	1.81	
Kimberly to King Hill total	7.02	

A-4. Simulated steady state impact of 2016 CREP for lands enrolled by IGWA within ESPA area of common groundwater supply

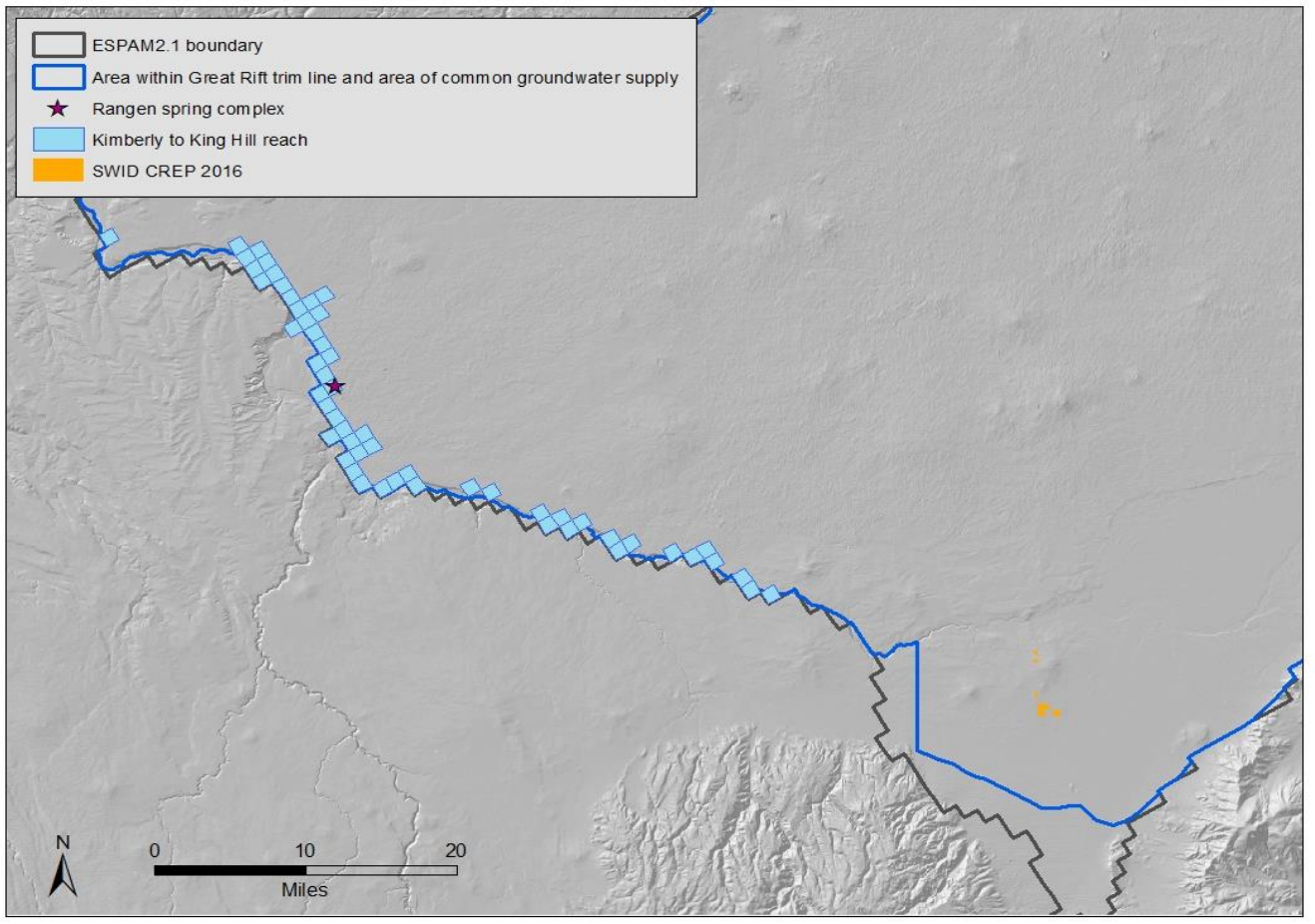


Simulated volume:	13,878	acres
	32,165	AF/yr
	44.40	cfs
	2.32	AF/ac

Predicted response:

Reach	**Response (cfs)**	**Response (AF/yr)**
Ashton to Rexburg	1.14	823
Heise to Shelley	3.06	2,218
Shelley to Near Blackfoot	7.72	5,590
Near Blackfoot to Minidoka	24.09	17,455
Kimberly to Buhl	2.82	2,043
Buhl to Lower Salmon Falls	4.78	3,463
Lower Salmon Falls to King Hill	0.79	573
Total	44.40	32,165
Group A&B Spring Reaches		
Devil's Washbowl	0.15	106
Devil's Corral	0.19	140
Blue Lakes	0.57	413
Crystal	0.97	705
Niagara	0.66	476
Clear Lake	0.85	614
Briggs	0.02	17
Box Canyon	1.40	1,011
Sand	0.37	269
Thousand	0.96	698
National Fish Hatchery	0.22	156
Rangen	0.34	245
Three	0.24	177
Malad	0.69	501
Curren Tunnel	0.21	154
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.15	
Devil's Corral	0.19	
Box Canyon	1.40	
Baseflow , Kimberly to King Hill	0.41	
Total	2.15	
Kimberly to King Hill total	8.39	

A-5. Simulated steady state impact of 2016 CREP for lands enrolled by Southwest Irrigation District



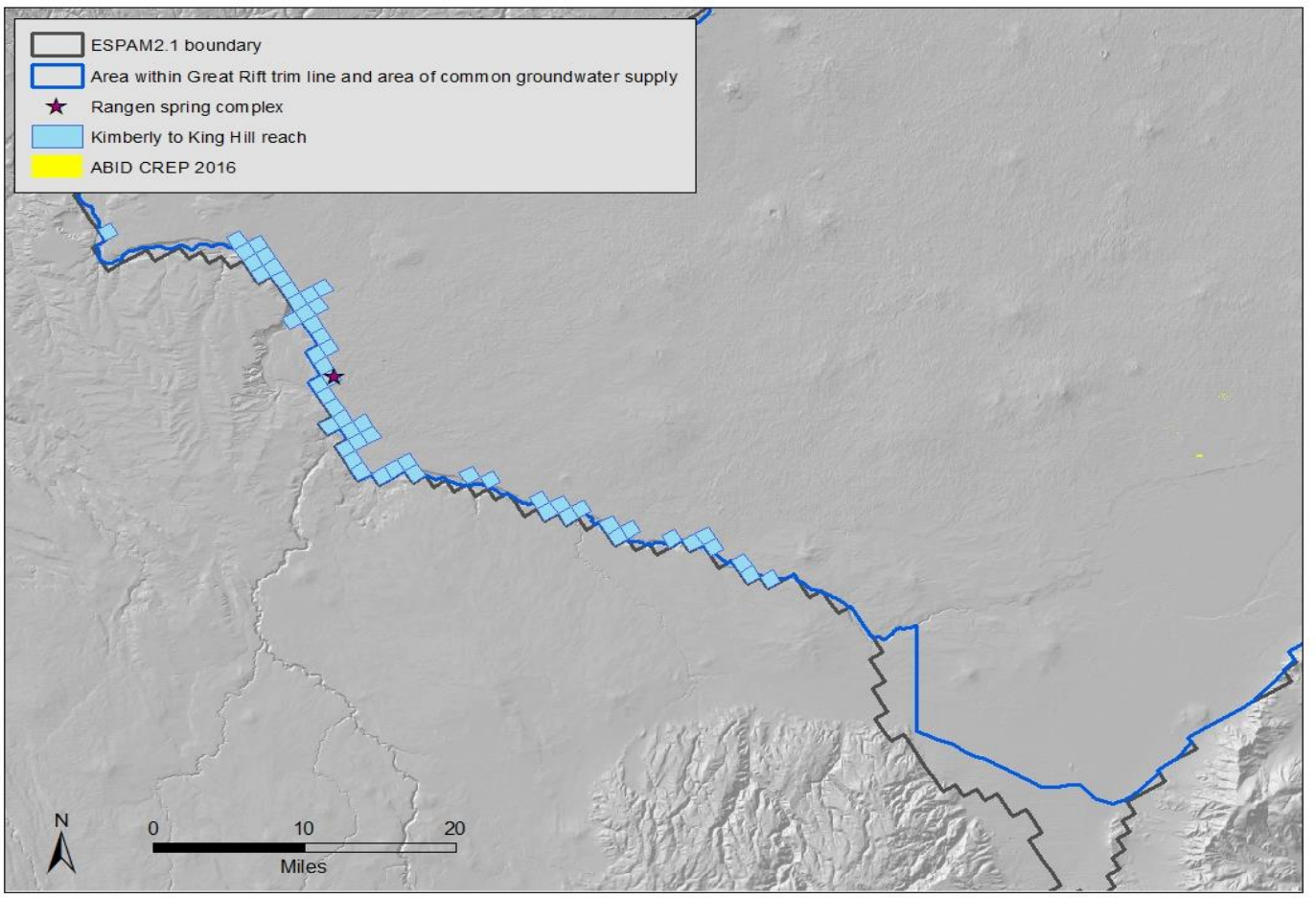
Simulated volume:

572	acres
1,260	AF/yr
1.74	cfs
2.20	AF/ac

Predicted response:

Reach	**Response (cfs)**	**Response (AF/yr)**
Ashton to Rexburg	0.02	14
Heise to Shelley	0.06	41
Shelley to Near Blackfoot	0.17	124
Near Blackfoot to Minidoka	0.57	415
Kimberly to Buhl	0.35	252
Buhl to Lower Salmon Falls	0.49	357
Lower Salmon Falls to King Hill	0.08	59
Total	1.74	1,260
Group A&B Spring Reaches		
Devil's Washbowl	0.03	19
Devil's Corral	0.03	24
Blue Lakes	0.07	53
Crystal	0.10	74
Niagara	0.07	49
Clear Lake	0.09	63
Briggs	0.00	2
Box Canyon	0.14	104
Sand	0.04	28
Thousand	0.10	72
National Fish Hatchery	0.02	16
Rangen	0.03	25
Three	0.03	18
Malad	0.07	51
Curren Tunnel	0.02	16
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.03	
Devil's Corral	0.03	
Box Canyon	0.14	
Baseflow , Kimberly to King Hill	0.06	
Total	0.26	
Kimberly to King Hill total	0.92	

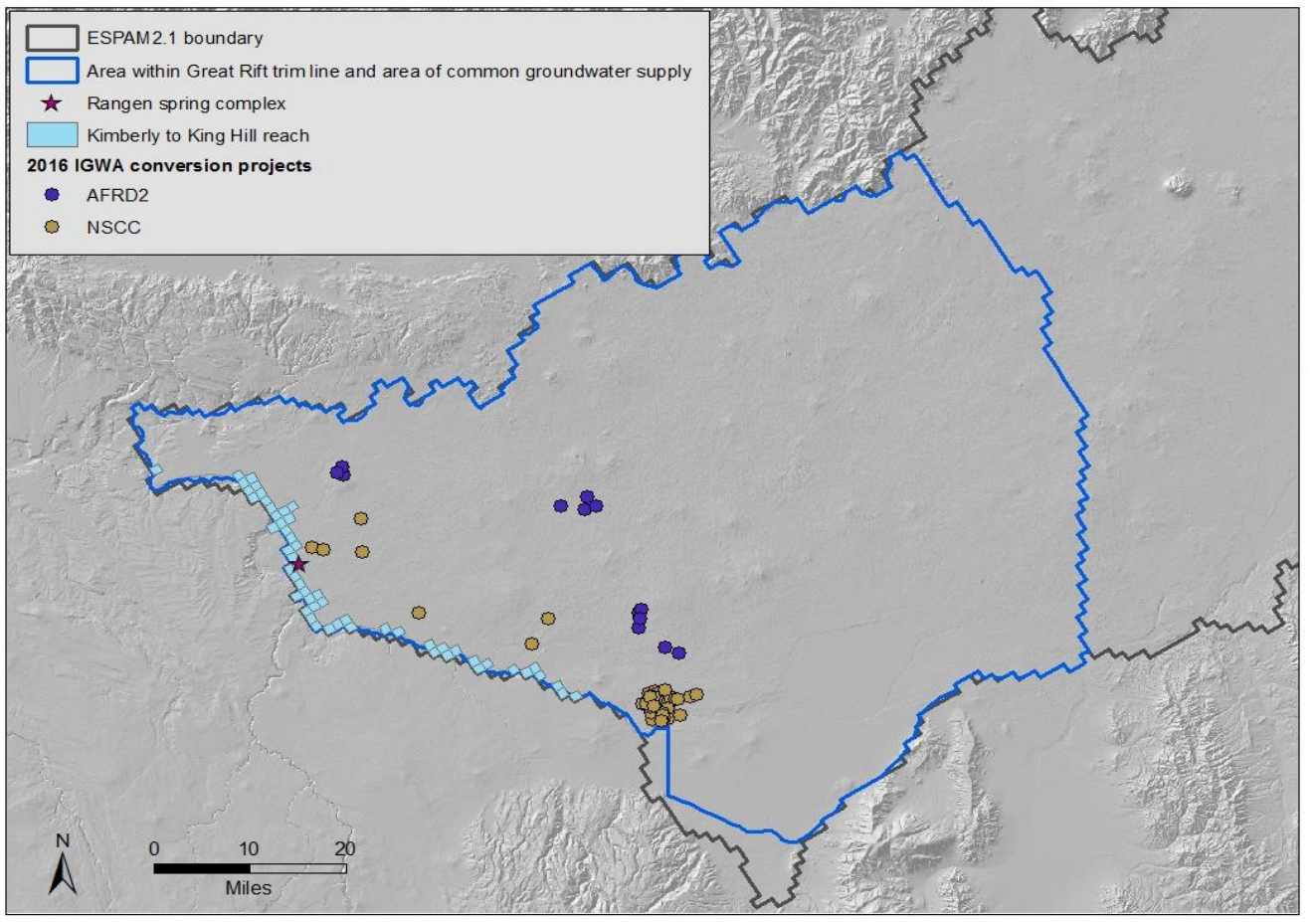
A-6. Simulated steady state impact of 2016 CREP for lands enrolled by A & B Irrigation District



Simulated volume:	98	acres
	242	AF/yr
	0.333	cfs
	2.46	AF/ac

Predicted response:	**Reach**	**Response (cfs)**	**Response (AF/yr)**
	Ashton to Rexburg	0.005	4
	Heise to Shelley	0.014	10
	Shelley to Near Blackfoot	0.043	31
	Near Blackfoot to Minidoka	0.143	103
	Kimberly to Buhl	0.041	30
	Buhl to Lower Salmon Falls	0.075	55
	Lower Salmon Falls to King Hill	0.013	9
	Total	0.333	242
	Group A&B Spring Reaches		
	Devil's Washbowl	0.002	1
	Devil's Corral	0.002	2
	Blue Lakes	0.007	5
	Crystal	0.015	11
	Niagara	0.010	8
	Clear Lake	0.013	10
	Briggs	0.000	0
	Box Canyon	0.022	16
	Sand	0.006	4
	Thousand	0.015	11
	National Fish Hatchery	0.003	2
	Rangen	0.005	4
	Three	0.004	3
	Malad	0.011	8
	Curren Tunnel	0.003	2

A-7. Simulated steady state impact of water delivered to IGWA soft conversion projects in 2016



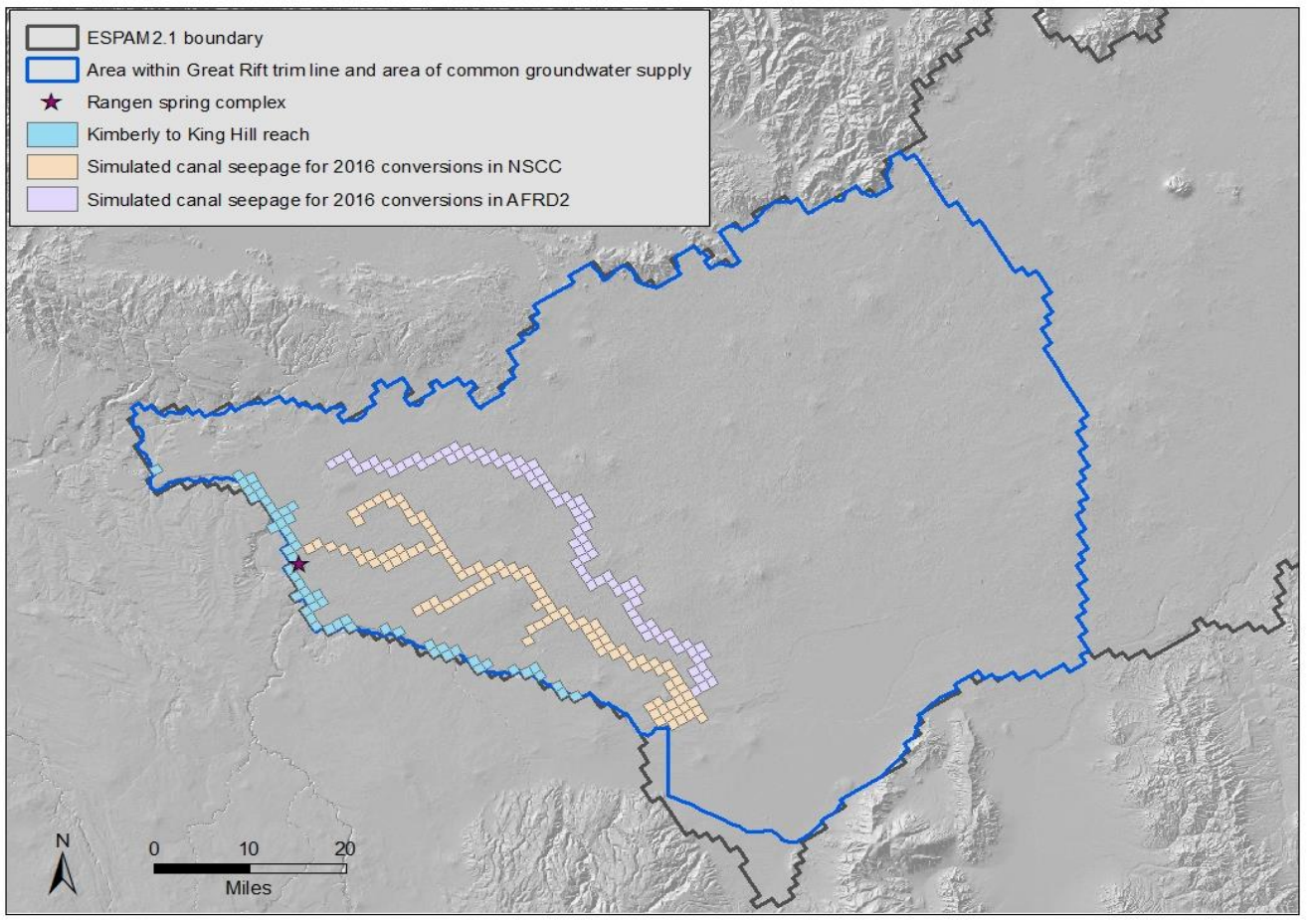
Simulated volume:

24,656	AF/yr
34.03	cfs

Predicted response:

Reach	Response (cfs)	Response (AF/yr)
Ashton to Rexburg	0.28	202
Heise to Shelley	0.82	592
Shelley to Near Blackfoot	2.45	1,774
Near Blackfoot to Minidoka	8.20	5,939
Kimberly to Buhl	8.04	5,825
Buhl to Lower Salmon Falls	12.03	8,715
Lower Salmon Falls to King Hill	2.22	1,609
Total	34.03	24,656
Group A&B Spring Reaches		
Devil's Washbowl	0.59	429
Devil's Corral	0.77	555
Blue Lakes	1.68	1,215
Crystal	2.39	1,730
Niagara	1.59	1,154
Clear Lake	2.06	1,490
Briggs	0.06	40
Box Canyon	3.41	2,468
Sand	0.91	662
Thousand	2.48	1,793
National Fish Hatchery	0.57	412
Rangen	0.90	652
Three	0.66	476
Malad	1.94	1,403
Curren Tunnel	0.57	411
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.59	
Devil's Corral	0.77	
Box Canyon	3.41	
Baseflow , Kimberly to King Hill	1.34	
Total	6.11	
Kimberly to King Hill total	22.29	

A-8. Simulated steady state impact of canal seepage for 2016 IGWA conversion projects



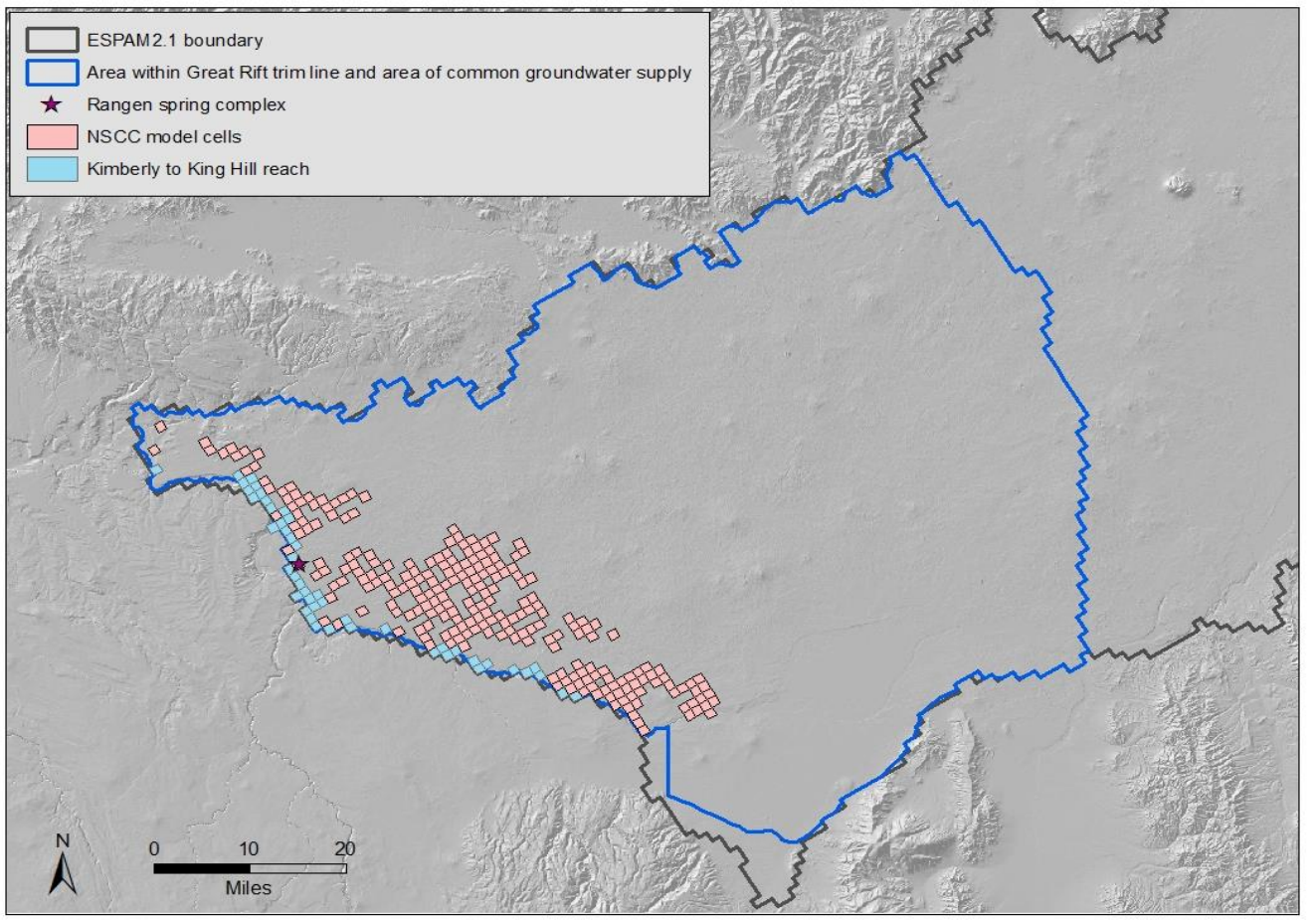
Simulated volume:

3,820 AF/yr
5.27 cfs

Predicted response:

Reach	Response (cfs)	Response (AF/yr)
Ashton to Rexburg	0.03	25
Heise to Shelley	0.10	73
Shelley to Near Blackfoot	0.30	218
Near Blackfoot to Minidoka	1.01	730
Kimberly to Buhl	1.17	844
Buhl to Lower Salmon Falls	2.25	1,633
Lower Salmon Falls to King Hill	0.41	296
Total	5.27	3,820
Group A&B Spring Reaches		
Devil's Washbowl	0.06	42
Devil's Corral	0.07	54
Blue Lakes	0.20	146
Crystal	0.42	307
Niagara	0.30	216
Clear Lake	0.39	280
Briggs	0.01	8
Box Canyon	0.64	464
Sand	0.17	124
Thousand	0.46	336
National Fish Hatchery	0.11	77
Rangen	0.17	122
Three	0.12	89
Malad	0.36	258
Curren Tunnel	0.11	77
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.06	
Devil's Corral	0.07	
Box Canyon	0.64	
Baseflow , Kimberly to King Hill	0.18	
Total	0.95	
Kimberly to King Hill total	3.83	

A-9. Simulated steady state impact of excess delivery for 2016 IGWA conversion projects



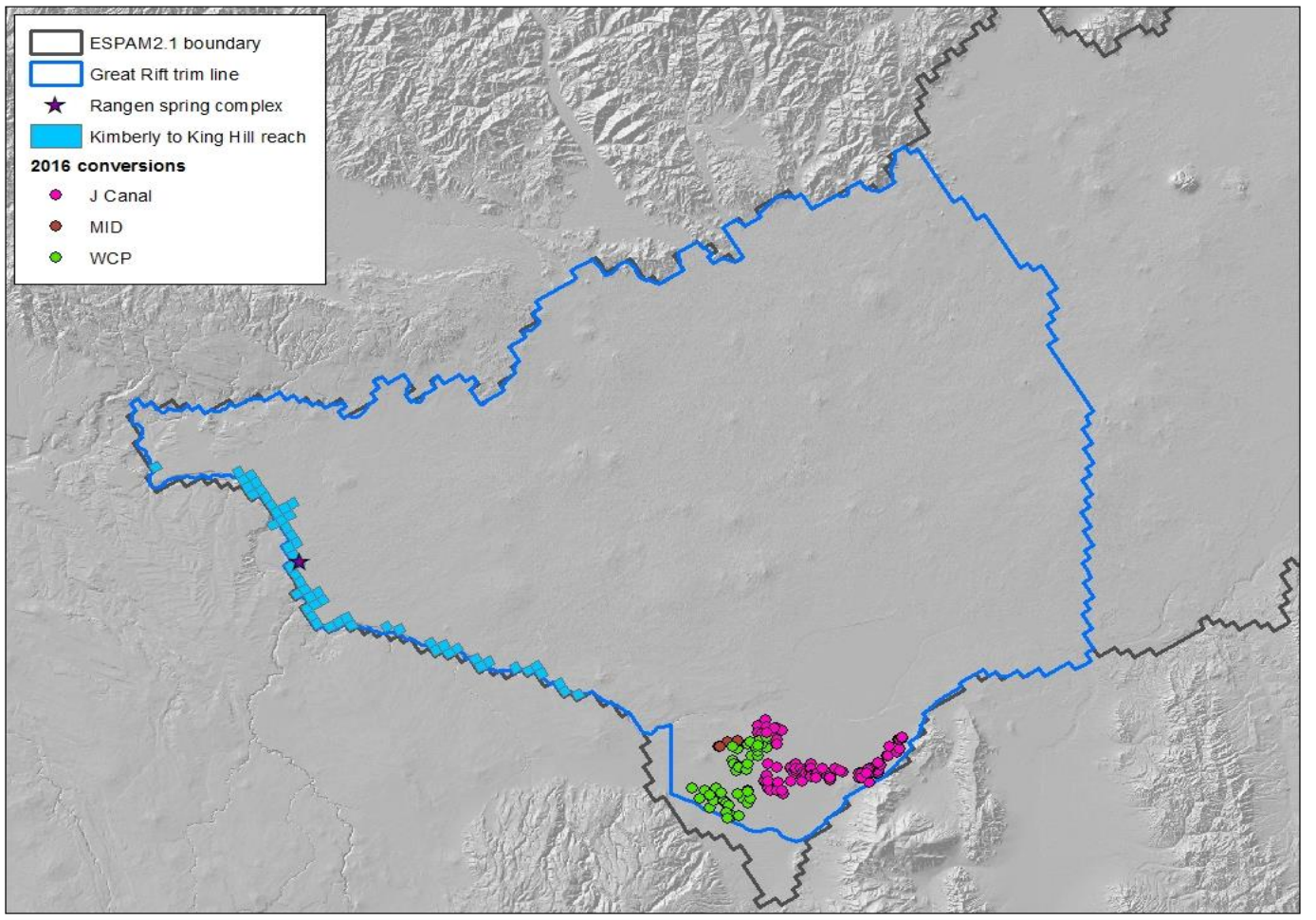
Simulated volume:

167 AF/yr
0.23 cfs

Predicted response:

Reach	Response (cfs)	Response (AF/yr)
Ashton to Rexburg	0.00	1
Heise to Shelley	0.00	2
Shelley to Near Blackfoot	0.01	7
Near Blackfoot to Minidoka	0.03	24
Kimberly to Buhl	0.05	38
Buhl to Lower Salmon Falls	0.10	73
Lower Salmon Falls to King Hill	0.03	21
Total	0.23	167
Group A&B Spring Reaches		
Devil's Washbowl	0.00	1
Devil's Corral	0.00	2
Blue Lakes	0.01	7
Crystal	0.02	15
Niagara	0.01	9
Clear Lake	0.02	13
Briggs	0.00	0
Box Canyon	0.03	20
Sand	0.01	5
Thousand	0.02	15
National Fish Hatchery	0.00	4
Rangen	0.01	6
Three	0.01	4
Malad	0.02	17
Curren Tunnel	0.01	4
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.00	
Devil's Corral	0.00	
Box Canyon	0.03	
Baseflow , Kimberly to King Hill	0.01	
Total	0.04	
Kimberly to King Hill total	0.18	

A-10. Simulated steady state impact of water delivered to SWID conversion field headgates in 2016



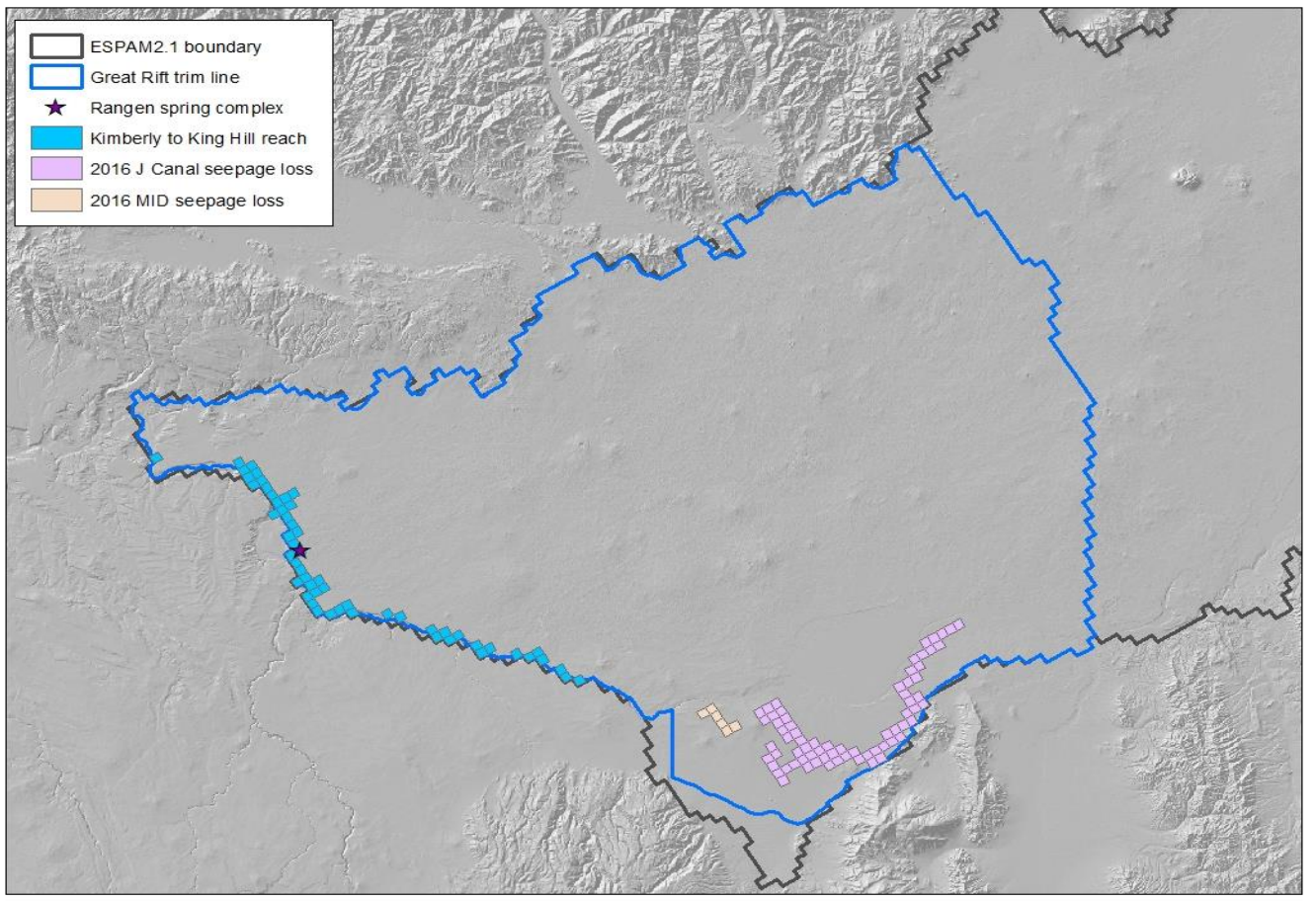
Simulated volume:

41,877 AF/yr
57.80 cfs

Predicted response:

Reach	Response (cfs)	Response (AF/yr)
Ashton to Rexburg	0.65	474
Heise to Shelley	1.92	1,389
Shelley to Near Blackfoot	5.74	4,159
Near Blackfoot to Minidoka	19.28	13,971
Kimberly to Buhl	11.34	8,216
Buhl to Lower Salmon Falls	16.21	11,742
Lower Salmon Falls to King Hill	2.66	1,927
Total	57.80	41,877
Group A&B Spring Reaches		
Devil's Washbowl	0.85	613
Devil's Corral	1.09	787
Blue Lakes	2.37	1,714
Crystal	3.35	2,429
Niagara	2.23	1,618
Clear Lake	2.88	2,084
Briggs	0.08	56
Box Canyon	4.74	3,433
Sand	1.26	913
Thousand	3.26	2,365
National Fish Hatchery	0.73	528
Rangen	1.14	828
Three	0.83	600
Malad	2.33	1,687
Curren Tunnel	0.72	522
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.85	
Devil's Corral	1.09	
Box Canyon	4.74	
Baseflow , Kimberly to King Hill	1.84	
Total	8.51	
Kimberly to King Hill total	30.21	

A-11. Simulated steady state impact of conveyance losses for J Canal and MID conversions in 2016, assuming 38% seepage loss in J Canal and 40% seepage loss in Milner canal



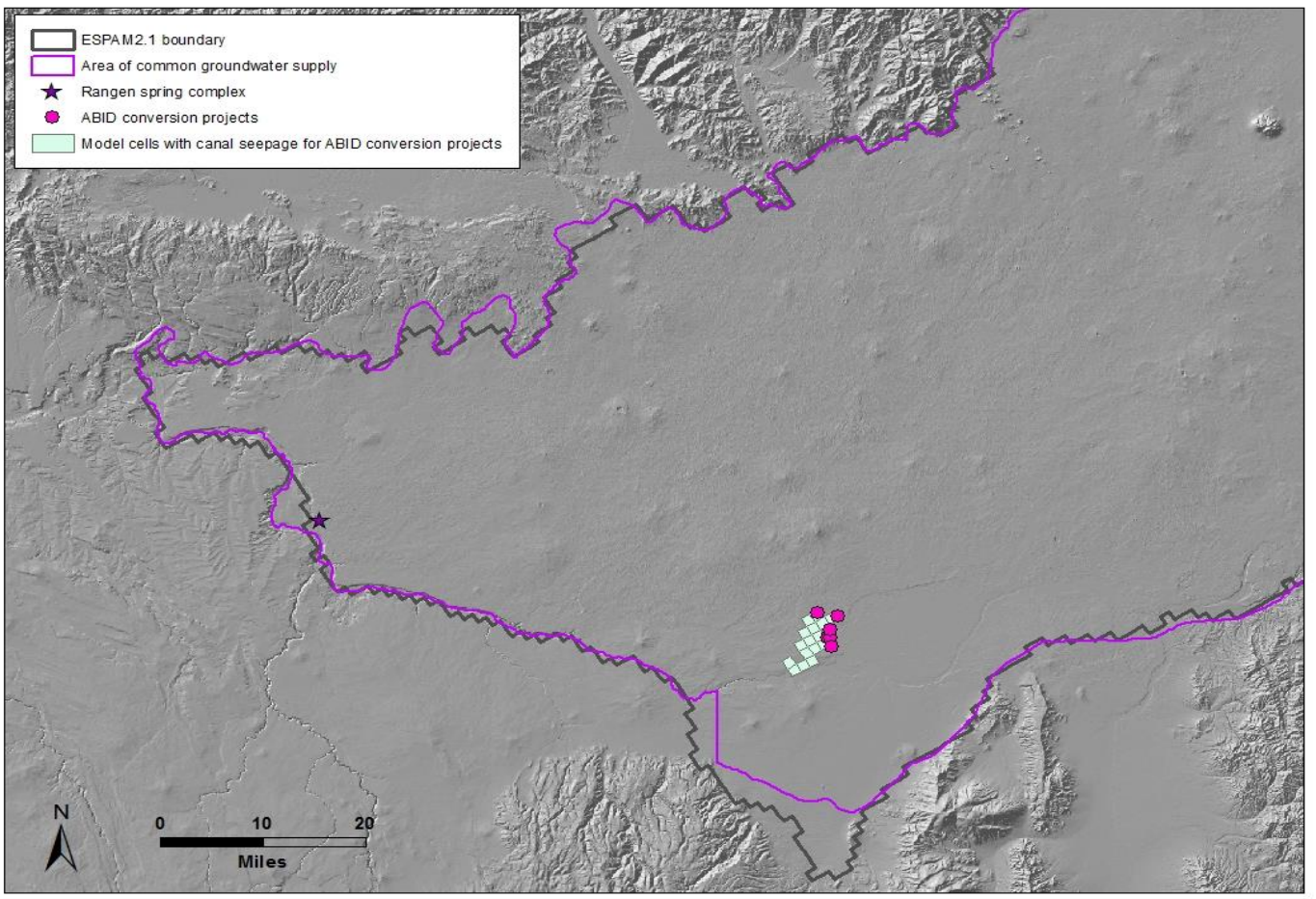
Simulated volume:

19,621 AF/yr
27.08 cfs

Predicted response:

Reach	Response (cfs)	Response (AF/yr)
Ashton to Rexburg	0.32	233
Heise to Shelley	0.94	683
Shelley to Near Blackfoot	2.83	2,047
Near Blackfoot to Minidoka	9.59	6,950
Kimberly to Buhl	4.92	3,566
Buhl to Lower Salmon Falls	7.28	5,275
Lower Salmon Falls to King Hill	1.20	867
Total	27.08	19,621
Group A&B Spring Reaches		
Devil's Washbowl	0.35	254
Devil's Corral	0.45	327
Blue Lakes	1.01	729
Crystal	1.50	1,087
Niagara	1.00	726
Clear Lake	1.29	936
Briggs	0.03	25
Box Canyon	2.13	1,542
Sand	0.57	410
Thousand	1.47	1,062
National Fish Hatchery	0.33	237
Rangen	0.51	372
Three	0.37	270
Malad	1.05	759
Curren Tunnel	0.32	234
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.35	
Devil's Corral	0.45	
Box Canyon	2.13	
Baseflow , Kimberly to King Hill	0.79	
Total	3.72	
Kimberly to King Hill total	13.40	

A-12. Simulated steady state impact of 2016 A & B Irrigation District conversion projects, including conveyance loss of 15%



Simulated volume:

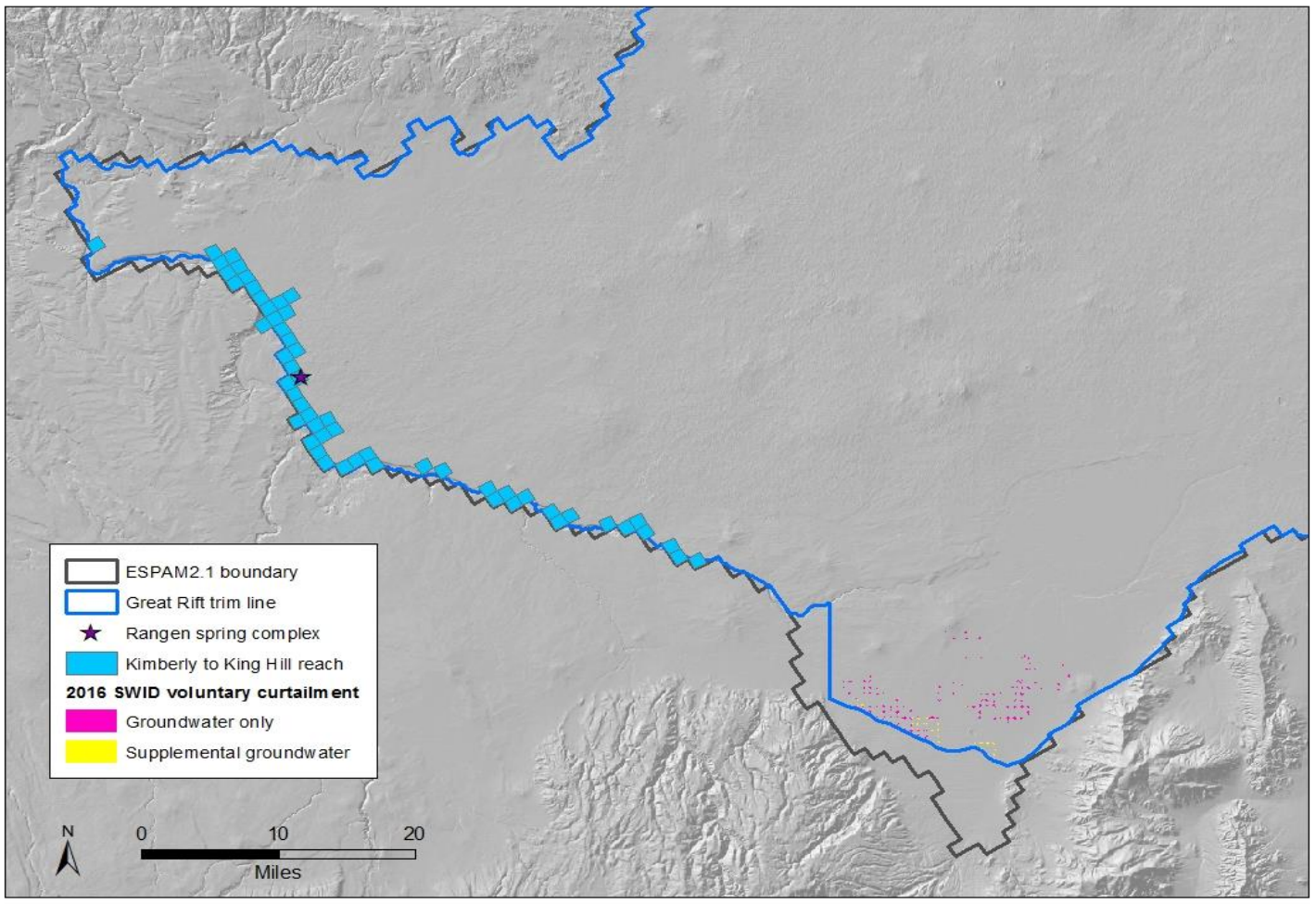
3,524 AF/yr

4.86 cfs

Predicted response:

Reach	Response (cfs)	Response (AF/yr)
Ashton to Rexburg	0.06	41
Heise to Shelley	0.17	121
Shelley to Near Blackfoot	0.50	362
Near Blackfoot to Minidoka	1.67	1,213
Kimberly to Buhl	0.91	659
Buhl to Lower Salmon Falls	1.34	969
Lower Salmon Falls to King Hill	0.22	159
Total	4.86	3,524
Group A&B Spring Reaches		
Devil's Washbowl	0.07	47
Devil's Corral	0.08	61
Blue Lakes	0.19	135
Crystal	0.28	200
Niagara	0.18	133
Clear Lake	0.24	172
Briggs	0.01	5
Box Canyon	0.39	283
Sand	0.10	75
Thousand	0.27	195
National Fish Hatchery	0.06	44
Rangen	0.09	68
Three	0.07	50
Malad	0.19	139
Curren Tunnel	0.06	43

A-13. Simulated steady state impact of SWID voluntary curtailment in 2016

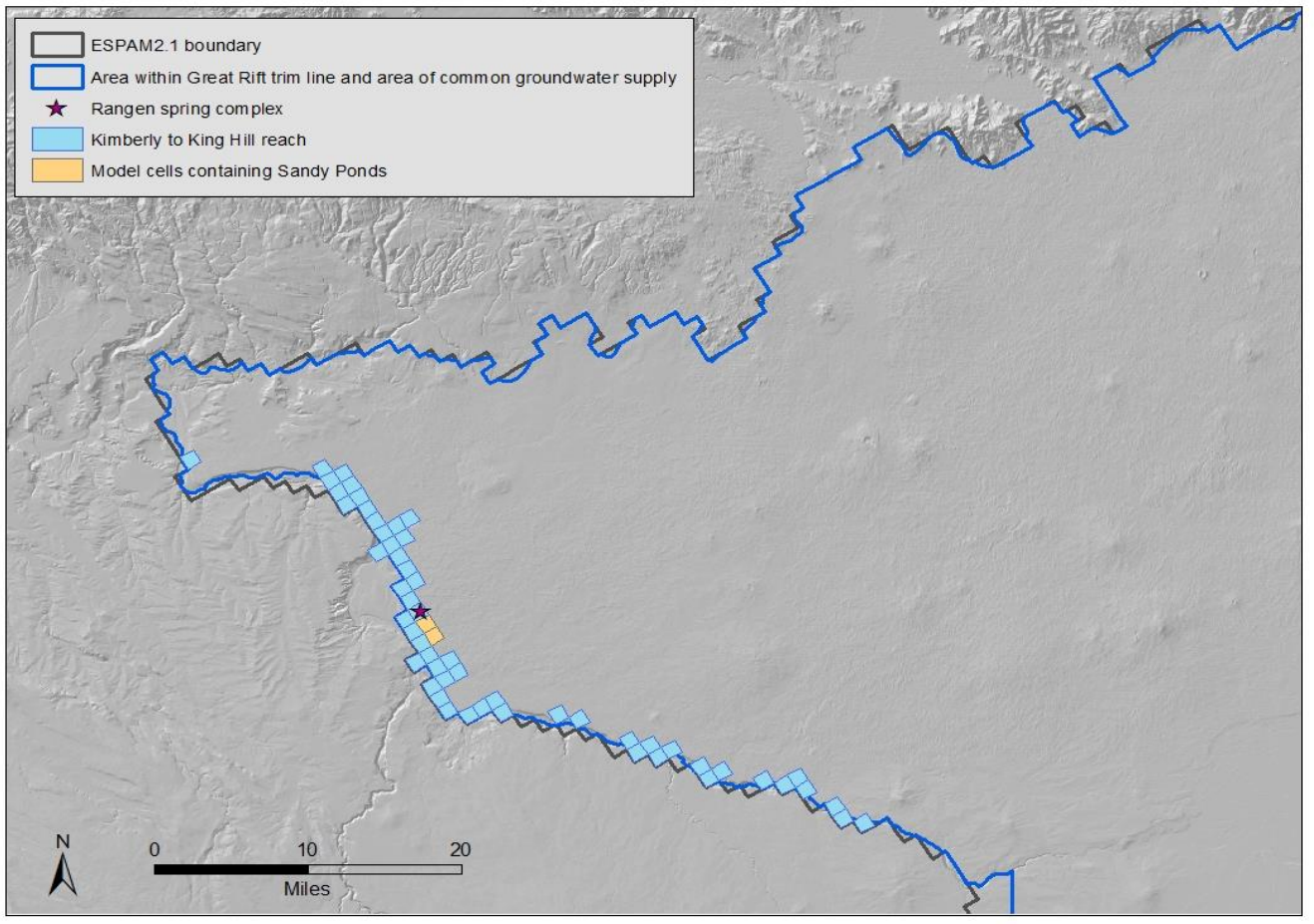


Simulated volume:	1,644	acres	1,674 acres (1,425 acres with primary groundwater rights and 248 acres with supplemental groundwater rights)
	3,698	AF/yr	
	5.10	cfs	
	2.25	AF/ac	

Predicted response:

Reach	**Response (cfs)**	**Response (AF/yr)**
Ashton to Rexburg	0.06	42
Heise to Shelley	0.17	123
Shelley to Near Blackfoot	0.51	367
Near Blackfoot to Minidoka	1.70	1,233
Kimberly to Buhl	1.00	726
Buhl to Lower Salmon Falls	1.43	1,037
Lower Salmon Falls to King Hill	0.23	170
Total	5.10	3,698
Group A&B Spring Reaches		
Devil's Washbowl	0.07	54
Devil's Corral	0.10	70
Blue Lakes	0.21	151
Crystal	0.30	215
Niagara	0.20	143
Clear Lake	0.25	184
Briggs	0.01	5
Box Canyon	0.42	303
Sand	0.11	81
Thousand	0.29	209
National Fish Hatchery	0.06	47
Rangen	0.10	73
Three	0.07	53
Malad	0.21	149
Curren Tunnel	0.06	46
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.07	
Devil's Corral	0.10	
Box Canyon	0.42	
Baseflow , Kimberly to King Hill	0.16	
Total	0.75	
Kimberly to King Hill total	2.67	

A14. Simulated steady state impact of 2016 IGWA recharge at Sandy Ponds



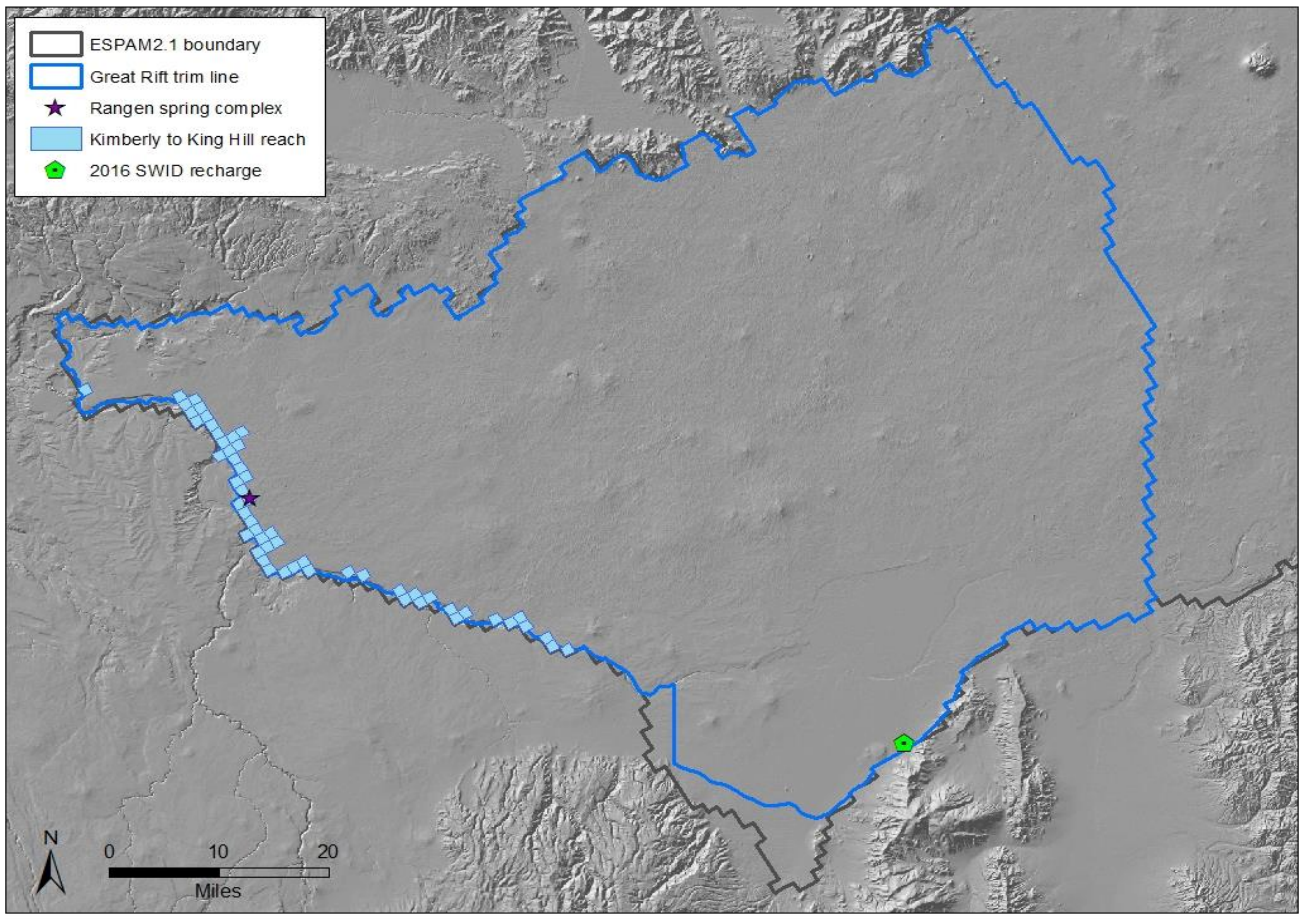
Simulated volume:

5,466 AF/yr
7.55 cfs

Predicted response:

Reach	Response (cfs)	Response (AF/yr)
Ashton to Rexburg	0.00	3
Heise to Shelley	0.01	9
Shelley to Near Blackfoot	0.04	27
Near Blackfoot to Minidoka	0.12	89
Kimberly to Buhl	0.42	301
Buhl to Lower Salmon Falls	6.35	4,598
Lower Salmon Falls to King Hill	0.61	439
Total	7.55	5,466
Group A&B Spring Reaches		
Devil's Washbowl	0.00	3
Devil's Corral	0.01	4
Blue Lakes	0.03	19
Crystal	0.18	133
Niagara	0.19	134
Clear Lake	0.32	229
Briggs	0.01	7
Box Canyon	0.80	580
Sand	0.32	234
Thousand	3.14	2,276
National Fish Hatchery	0.59	427
Rangen	0.53	387
Three	0.25	180
Malad	0.53	385
Curren Tunnel	0.34	244
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.00	
Devil's Corral	0.01	
Box Canyon	0.80	
Baseflow , Kimberly to King Hill	0.22	
Total	1.03	
Kimberly to King Hill total	7.37	

A-15. Simulated steady state impact of 2016 SWID recharge



Simulated volume:

305	AF/yr
0.42	cfs

Predicted response:

Reach	Response (cfs)	Response (AF/yr)
Ashton to Rexburg	0.00	3
Heise to Shelley	0.01	10
Shelley to Near Blackfoot	0.04	31
Near Blackfoot to Minidoka	0.14	103
Kimberly to Buhl	0.08	59
Buhl to Lower Salmon Falls	0.12	85
Lower Salmon Falls to King Hill	0.02	14
Total	0.42	305
Group A&B Spring Reaches		
Devil's Washbowl	0.01	4
Devil's Corral	0.01	6
Blue Lakes	0.02	12
Crystal	0.02	18
Niagara	0.02	12
Clear Lake	0.02	15
Briggs	0.00	0
Box Canyon	0.03	25
Sand	0.01	7
Thousand	0.02	17
National Fish Hatchery	0.01	4
Rangen	0.01	6
Three	0.01	4
Malad	0.02	12
Curren Tunnel	0.01	4
Baseflow and selected spring cells without irrigation use		
Devil's Washbowl	0.01	
Devil's Corral	0.01	
Box Canyon	0.03	
Baseflow , Kimberly to King Hill	0.01	
Total	0.06	
Kimberly to King Hill total	0.22	