MEMO

State of Idaho
Department of Water Resources
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Date: February 9, 2015

To: Gary Spackman, P.E., Director

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

Subject: Staff memorandum for Rangen, Inc. delivery call, water right 36-15501, CM-DC-2014-004

This staff memorandum was prepared to provide technical information in the matter of distribution of water to Rangen, Inc.'s ("Rangen") water right 36-15501. Rangen submitted a petition for delivery call to the Director of the Idaho Department of Water Resources ("IDWR") on June 27, 2014 after the Director issued an order approving portions of IGWA' first mitigation plan[1]. Rangen's petition called for delivery of water pursuant to water rights 36-134B, 36-135A, and 36-15501, but Rangen has withdrawn water rights 36-134B and 36-135A from the call. The pending delivery call is only for water right 36-15501, which has a priority date of July 1, 1957 and authorizes diversion of 1.46 cfs for fish propagation.

<u>The Morris exchange credit agreement and availability of water for water right 36-15501</u>

The Director's order approving portions of IGWA's first mitigation plan included approval of IGWA's proposal to divert water from Curren Tunnel pursuant to water rights held by Howard and Rhonda Morris ("Morris") and deliver the water to Rangen to fulfill a portion of junior groundwater users' mitigation obligation for injury to Rangen's July 13, 1962 water right ("Morris exchange credit agreement"). The Morris exchange credit agreement resulted in the allocation of the entire flow in Curren Tunnel between April 15 and October 15 to water rights with priority dates of 1908 or earlier unless the average flow during this period exceeded 6.23 cfs. The order was appealed by Rangen.[2] On appeal, the Court held that the Morris exchange credit agreement was consistent with the prior appropriation doctrine but reversed the Director on how the credit is calculated. The Court reversed the Director on the use of flow data associated with an average year to determine mitigation credit and the Director's use of an

[1] *Amended Order Approving in Part and Rejecting in Part IGWA's Mitigation Plan; Order Lifting Stay Issued February 21, 2014, Amended Curtailment Order*, May 16, 2014.
[2] *Rangen, Inc., v. IDWR*, Twin Falls County Case No. CV 2014-2446.

annual time period to evaluate the mitigation benefits.[3] The Department has set a status conference on the matter for February 26, 2015.

The method for calculating the Morris exchange credit in future years is expected to be revised, but inspection of 2014 daily discharge records for Curren Tunnel indicates the flow did not exceed 6.23 cfs between April 15, 2014 and October 4, 2014. Thus, if water had been allocated to the Morris water rights on a daily basis, there would have been no water available for diversion pursuant to water right 36-15501 during this time period. A small amount of water (0.02 cfs to 0.72 cfs) would have been available for diversion pursuant to water right 36-15501 between October 5, 2014 and October 14, 2014.

If IGWA had not requested delivery of water pursuant to the Morris water rights in 2014, daily discharge records indicate there were approximately 98 days when the discharge of Curren Tunnel would not have been sufficient to completely fill water right 36-15501. If IGWA does not call for delivery of water pursuant to the Morris water rights in the future, the accuracy of water measurement methods used to determine Curren Tunnel discharge may affect the ability to evaluate shortages to water right 36-15501. IDWR staff opinions regarding measurement methods are provided in Attachment A.

The Morris exchange credit agreement only affects allocation of water between April 15 and October 15, and does not affect availability of water for water right 36-15501 the rest of the year. From January 1, 2014 through April 14, 2014, total Curren Tunnel discharge ranged from 1.7 to 3.2 cfs. From October 16, 2014 through December 31, 2014, discharge ranged from 3.2 to 6.6 cfs.

Simulation of curtailment of groundwater rights junior to July 1, 1957 using ESPAM2.1

Curtailment of groundwater irrigation junior to July 1, 1957 was simulated using the Enhanced Snake Plain Aquifer Model version 2.1 (ESPAM2.1). The Curtailment IAR Tool was used to calculate the area irrigated using junior priority water rights. The 2014 POD file and the 2008 irrigated lands plus CREP file were used as input to the Curtailment IAR Tool.

The curtailment was simulated for three areas, the ESPAM2.1 model domain, the current area of common groundwater supply, and the Great Rift trim line. The ESPAM2.1 predicted increase in discharge at the Rangen model cell was multiplied by 0.63 to calculate the predicted increase in

[3] *Memorandum Decision and Order on Petition for Judicial Review*, December 3, 2014.

discharge from the Curren Tunnel[4]. Modeling results are provided in Attachment B and summarized in Table 1[5].

Comparison with simulations of curtailment of groundwater irrigation junior to July 13, 1962[6] indicate that curtailment of water rights with priority dates between July 1, 1957 and July 13, 1962 increases the predicted steady state response at Curren Tunnel by 2.9 cfs within the Great Rift trim line, 3.2 cfs within the current area of common groundwater supply, and 3.6 cfs within the ESPAM2.1 model domain. These predictions exceed the 1.46 cfs maximum diversion rate for water right 36-15501. If any of these areas is used as the area subject to curtailment, it would not be necessary to curtail all groundwater use with priority dates between July 1, 1957 and July 13, 1982 to result in a predicted steady state increase of 1.46 cfs at Curren Tunnel.

Area of simulated curtailment	Irrigation curtailed (acres)	Consumptive use curtailed (MAF/yr)	Predicted increase in Curren Tunnel discharge (cfs) at steady state	Predicted time to reach 90% of steady state increase in discharge (years)
ESPAM2.1 model domain	721,460	1.58	14.9	14
Current area of common groundwater supply	605,570	1.38	13.9	11
Great Rift trim line	215,190	0.54	12.0	9

Table 1. Predicted increase in discharge at Curren Tunnel resulting from curtailment of groundwater irrigation junior to July 1, 1957.

[4] The relationship between change in discharge from the Curren Tunnel and change in discharge from the Rangen spring complex was established in previous proceedings, *Order Denying Motion for Summary Judgement; Order Regarding Presentation of Evidence*, November 3, 2014, page 9.
[5] Model files are contained on the CD accompanying this memorandum.
[6] Sukow, J., 2013. *Staff memorandum in response to expert reports in submitted for Rangen Delivery Call (In the Matter of Distribution for Water to Water Right Nos. 36-02551 and 36-07694),* dated February 27, 2013, Idaho Department of Water Resources, 67 p.

Predicted response functions (depletion percentages) for spring discharge in the Rangen model cell using ESPAM2.1

Transient response functions for ESPAM2.1 are available for a period of 40 years. Each model cell has a transient response function with respect to each model river reach and spring cell. The transient response function represents the predicted depletion at a river reach or spring cell as a percentage of net groundwater pumping. Figures 1 through 4 show the depletion percentages for each model cell with respect to the Rangen spring cell after 10, 20, 30, and 40 years of pumping[7]. Figure 5 shows the depletion percentage at steady state.

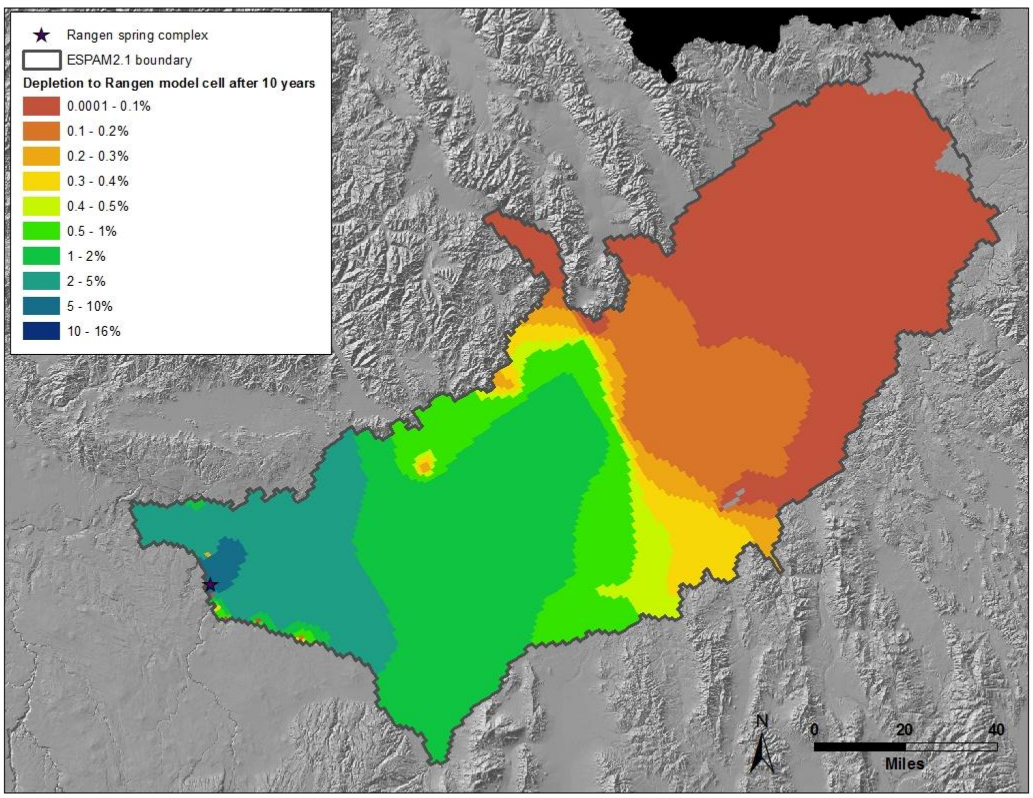

Figure 1. Depletion to Rangen model cell after 10 years of pumping.

[7] Depletion fractions for each model cell are available in the file RangenRF.shp, which is contained on the CD accompanying this memorandum.

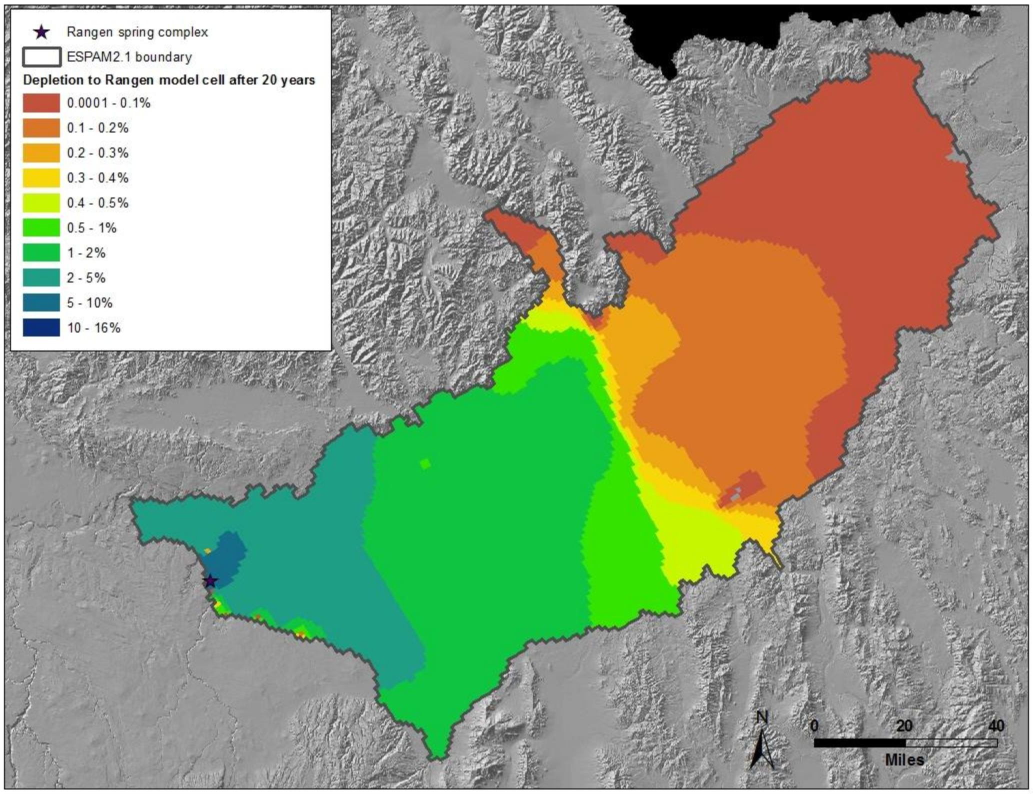

Figure 2. Depletion to Rangen model cell after 20 years of pumping.

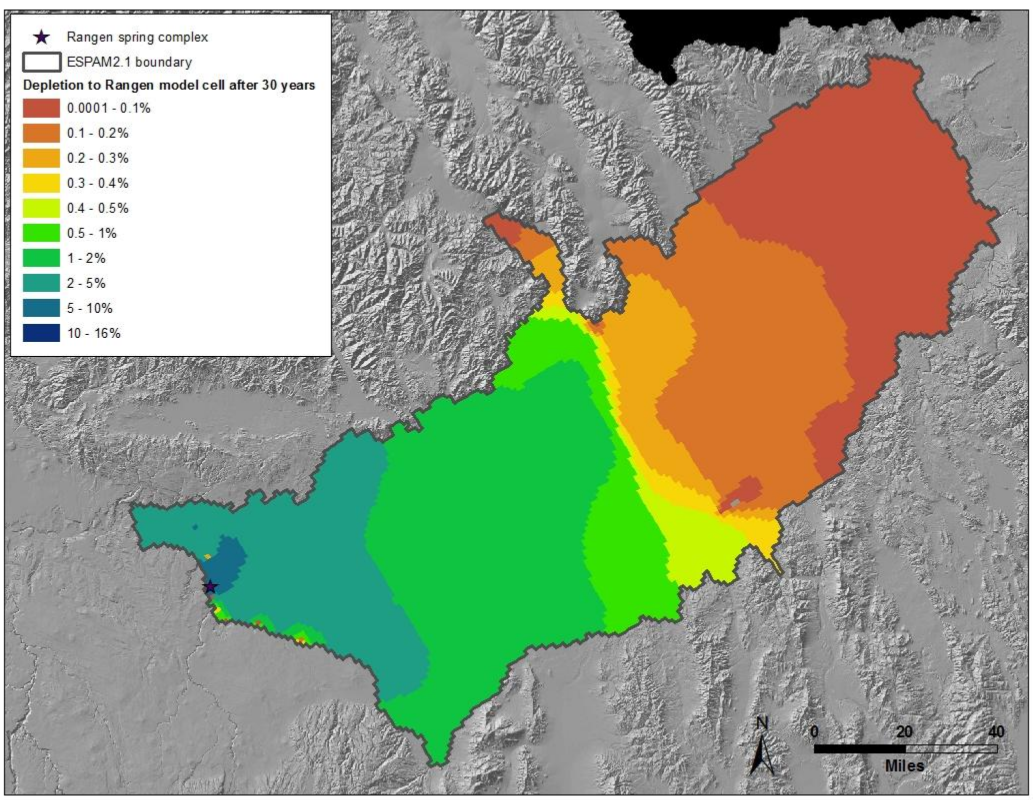

Figure 3. Depletion to Rangen model cell after 30 years of pumping.

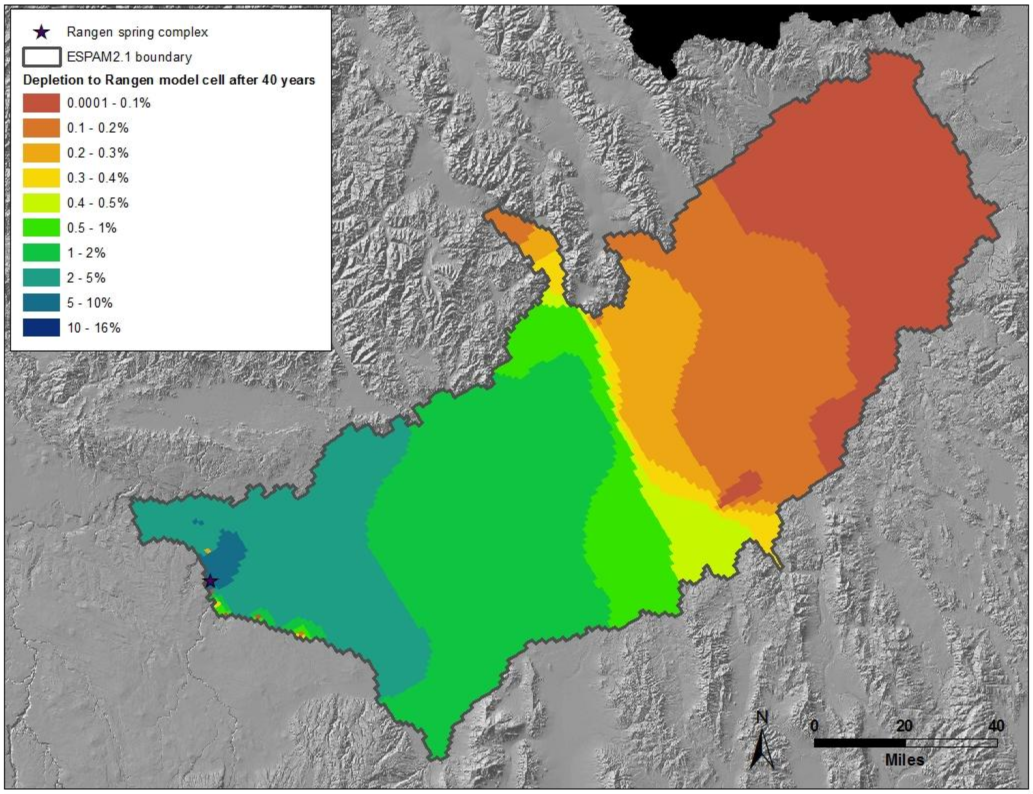

Figure 4. Depletion to Rangen model cell after 40 years of pumping.

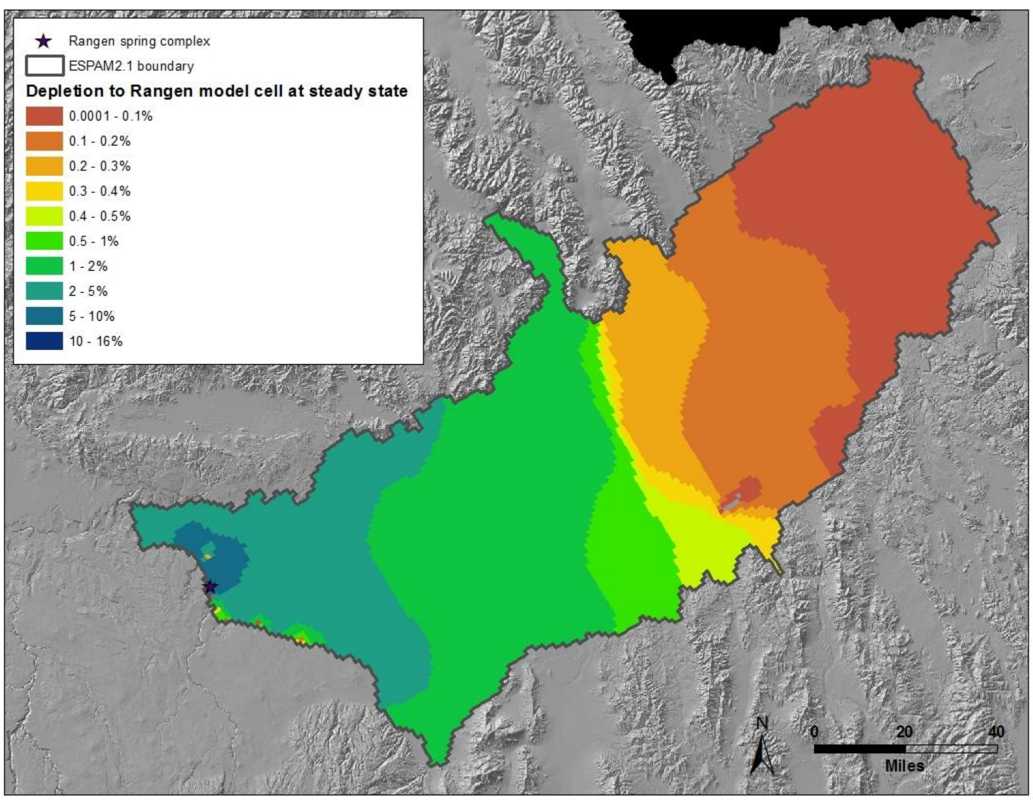

Figure 5. Depletion to Rangen model cell at steady state.

Summary of Expert Reports

Expert reports were submitted by the following authors on January 26, 2015.

- Charles E. Brockway, Ph.D., P.E. and David C. Colvin, P.G., prepared for Rangen, Inc.
- Charles M. Brendecke, Ph.D., P.E. and Sophia Sigstedt, prepared for Idaho Groundwater Appropriators, Inc.
- Gregory K. Sullivan, P.E., prepared for the City of Pocatello
- Bryce A. Contor, prepared for Upper Valley Pumpers

Expert reports submitted on behalf of Rangen

Brockway and Colvin compiled 2014 flow data for Curren Tunnel from IDWR's measurements at the mouth of Curren Tunnel and Rangen's measurement of the PVC pipe. The total flow of Curren Tunnel is presented in Appendix A, however the flow plotted in Figure 1 does not appear to include the flow in the PVC pipe and is lower than the total flow. Brockway and Colvin comment that, "*Curren Tunnel rights with irrigation season seniority over Water Right No. 36-15501 total at least 6 cfs. The 2014 flow measurements indicate that there were no days in the irrigation season when senior rights and the 36-15501 right could be filled*." IDWR staff disagrees with this statement in part. As previously discussed in this memorandum, because of the Morris exchange credit agreement, water was not available for diversion pursuant to water right 36-15501 between April 15, 2014 and October 15, 2014. Water was available for water right 36-15501 during the very early and very late portions of the 2014 irrigation season.

Brockway and Colvin state the opinion that use of a trim line is inappropriate. Brockway and Colvin present results of ESPAM2.1 simulations of curtailment of groundwater irrigation junior to July 1, 1957 with the Great Rift trim line and within the model domain. They state the predicted steady state benefit to Curren Tunnel is 12.20 cfs for the Great Rift trim line and 15.03 cfs for the model domain. These results are slightly higher than the results of ESPAM2.1 simulations of curtailment by IDWR staff presented previously in this memorandum (12.0 cfs for the Great Rift trim line and 14.9 cfs for the model domain).

Expert reports submitted on behalf of junior groundwater users

Brendecke and Sigstedt criticize methods used to measure discharge from the mouth of Curren Tunnel and the PVC pipe. They argue the flow measurements do not provide a sufficiently accurate basis for administration of water right 36-15501. IDWR staff comments on measurement methods were prepared by Tim Luke and Michelle Richman, and are provided as Attachment A.

Brendecke and Sigstedt rely on Sullivan's evaluation of water availability and argue the 2014 data indicate water right 36-15501 was only partially short of water in May, June, and July of

2014. IDWR staff disagrees with this analysis, because it ignores that IGWA's Morris exchange credit agreement resulted in allocation of all available tunnel flow to water rights senior to 36-15501 between April 15 and October 15, and IGWA used the Morris exchange credit to mitigate for injury to water right 36-2551.

Brendecke and Sigstedt present results of ESPAM2.1 model simulations of curtailment of groundwater irrigation junior to July 1, 1957 using four different areas of curtailment. The areas used include the current area of common groundwater supply and three trim line areas. The trim line areas were delineated using ESPAM2.1 steady state depletion percentages with respect to the Rangen model cell. Brendecke and Sigstedt selected depletion percentages of 2.4%, 5%, and 10% to delineate their trim lines. Brendecke and Sigstedt focus on the disparity between the predicted flow increase at Curren Tunnel and the volume of curtailed irrigation use. Brendecke and Sigstedt conclude, "*It is our opinion that curtailment of junior groundwater rights junior to July 1, 1957, will not produce benefits at Rangen in a timely way and that the amount of benefit ultimately received by Rangen will be such a small part of the foregone beneficial use as to constitute a waste of the water resource*."

IDWR staff agrees with Brendecke and Sigstedt that analyses based on ESPAM2.1 simulations and the adopted relationship between Curren Tunnel and total spring complex flow indicate that approximately 0.7% of curtailed consumptive use within the area of common groundwater supply is predicted to accrue to Curren Tunnel at steady state, and that it is predicted to take approximately 11 years for 90% of the steady state impact to be realized. These values are a weighted average for the impact of all junior groundwater irrigation within the area of common groundwater supply. The impact of individual junior groundwater users varies with location, as shown previously in Figures 1 though 5.

IDWR staff performed the transient analysis of curtailment within the area of common groundwater supply using the "SuperTransient10yr_monthly" model files, but was unable to reproduce the results presented by Brendecke and Sigstedt in Table 4. IDWR staff found the predicted Year 1, Year 2, Year 5, and Year 10 benefit to Curren Tunnel to be 3,701 AF, 5,107 AF, 7,316 AF, and 8,803 AF, respectively. IDWR staff did not perform analyses for the 2.4%, 5%, and 10% trim lines selected by Brendecke and Sigstedt, but agree that curtailment within a smaller area that excludes junior use more distant from Rangen will increase the percentage of the curtailed use predicted to accrue to Curren Tunnel, and will decrease the time required to reach 90% of the steady state benefit. This concept is consistent with analyses previously presented to the Director in Rangen's delivery call for water right 36-2551.

Sullivan discusses water measurement methods and provides an analysis of water available to Rangen's 1957 water right. IDWR staff comments on measurement methods were prepared by

Tim Luke and Michelle Richman, and are provided as Attachment A. Mr. Sullivan's analysis allocates water from Curren Tunnel on a monthly basis as follows, "*The monthly average Curren Tunnel flows are first allocated to the senior water rights that currently divert from the Curren Tunnel as described in Section 4.1. Next, water is allocated to the Morris Exchange Credit, which is subsequently applied to mitigate Rangen's 1957 water right. Any remaining Morris Exchange Credit after application to the 1957 water right is allocated to Rangen's 1962 priority right*."

Mr. Sullivan presents the results of his analysis in Table 4-1. IDWR staff disagrees with this analysis, because it ignores that IGWA used the entire volume of the Morris exchange credit to mitigate for injury to Rangen's 1962 priority right in 2014. Mr. Sullivan's analysis also ignores that the mitigation obligation from the January 29, 2014 order[8] did not include mitigation for any potential injury to Rangen's 1957 water right. If the Director determines there has been injury to Rangen's 1957 water right, it is anticipated that IGWA's mitigation obligation will increase. Mr. Sullivan's analysis also allocates water to the Morris exchange credit from February 15 through November 30, which is longer than the April 15 through October 15 time period applied by the Director based on evidence presented regarding Morris' historic season of use[9].

In Table 4-2, Mr. Sullivan summarizes water supplies available to Rangen, including water provided by the Morris exchange credit and the Magic Springs pipeline project, and argues that shortages to the 1957 water right are not expected to occur in 2015 because mitigation water is expected to be available. While IGWA may have sufficient resources to provide mitigation for any potential injury to Rangen's 1957 water right, it is still necessary to determine if there is injury to the 1957 water right based on Curren Tunnel flow available for diversion pursuant to water right 36-15501, excluding mitigation water provided pursuant to Morris' water rights or other mitigation sources. If there is determined to be injury to the 1957 water right, a mitigation obligation will need to be determined for the 1957 water right and added to the mitigation obligation for the 1962 water right.

Mr. Sullivan presents the transient response to Rangen from pumping of City of Pocatello wells located within the area of common groundwater supply as predicted by ESPAM2.1, and the predicted increase in discharge at Curren Tunnel resulting from curtailment of Pocatello's junior irrigation with the area of common groundwater supply. Mr. Sullivan concludes the benefit to Curren Tunnel from curtailment of Pocatello's junior priority rights within the area of common groundwater supply would be minimal. IDWR staff agrees that the increase in discharge at

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[8] *Final Order Regarding Rangen, Inc.'s Petition for Delivery Call; Curtailing Ground Water Rights Junior to July 13, 1962*, January 29, 2014.
[9] *Amended Order Approving in Part and Rejecting in Part IGWA's Mitigation Plan; Order Lifting Stay Issued February 21, 2014, Amended Curtailment Order,* May 16, 2014.

Curren Tunnel resulting from curtailment of only the City of Pocatello's junior groundwater use would be minimal, however, this will be also be true of any analysis of curtailment of only a single water user.

Contor presents three proposals for areas subject to curtailment that preclude the Upper Valley Pumpers. The first proposal is an "Area of Common Supply" that includes the portions of Administrative Basin 36 west of the Great Rift and above the canyon rim and all of Administrative Basins 37, 43, and 45. This proposal includes areas outside of the current area of common groundwater supply and outside of the ESPAM2.1 model domain. Mr. Contor provides suggestions for how to evaluate the hydrologic effects of curtailment of areas outside of the ESPAM2.1 model boundary.

Mr. Contor's second proposal is a "Line of Futility" based on a "combined standard of reasonable timing of relief and waste of the water resource". Mr. Contor's suggested standard is a depletion percentage of 1% with respect to the Curren Tunnel within a period of 10 years. This is equivalent to a standard of 1.59% (1%/63%) with respect to the Rangen model cell. Figure 6 shows the extent of this area within the ESPAM2.1 model boundary based on IDWR's analyses of transient response functions. Mr. Contor's proposed "Line of Futility" appears to be consistent with IDWR's results for transient response functions within the ESPAM2.1 model boundary, but also includes areas outside of the model boundary.

With respect to the timing of impacts, Mr. Contor concludes, "*A clear empirical record establishes at least a 50-year response time of the springs to irrigation within 80 to 90 miles of Curren Tunnel*." IDWR staff disagrees with this statement, as it is contrary to the historic relationship between the Eastern Snake Plain Aquifer water budget and spring discharge documented by prior research.[10] IDWR staff does agree with Mr. Contor that there is uncertainty in the representation of timing in ESPAM2.1. However, as noted in the staff memorandum for the previous Rangen delivery call, numerical models are recognized as the most robust approach for predicting the effects of groundwater pumping on surface-water discharge, and ESPAM2.1 is calibrated to more data than can be incorporated into alternative analytical or empirical analyses[11]. It is the opinion of IDWR staff that ESPAM2.1 is currently the best available scientific prediction of the timing of impacts, and that model uncertainty may result in predictions of timing that are either shorter or longer than actual conditions.

[10] Kjelstrom, L.C., 1995. *Streamflow Gains and Losses in the Snake River and Ground-Water Budgets for the Snake River Plain, Idaho and Eastern Oregon*, U.S. Geological Survey Professional Paper 1408-C, 47 p.

[11] Sukow, J., 2013. *Staff memorandum in response to expert reports in submitted for Rangen Delivery Call (In the Matter of Distribution for Water to Water Right Nos. 36-02551 and 36-07694)*, dated February 27, 2013, Idaho Department of Water Resources, 67 p.

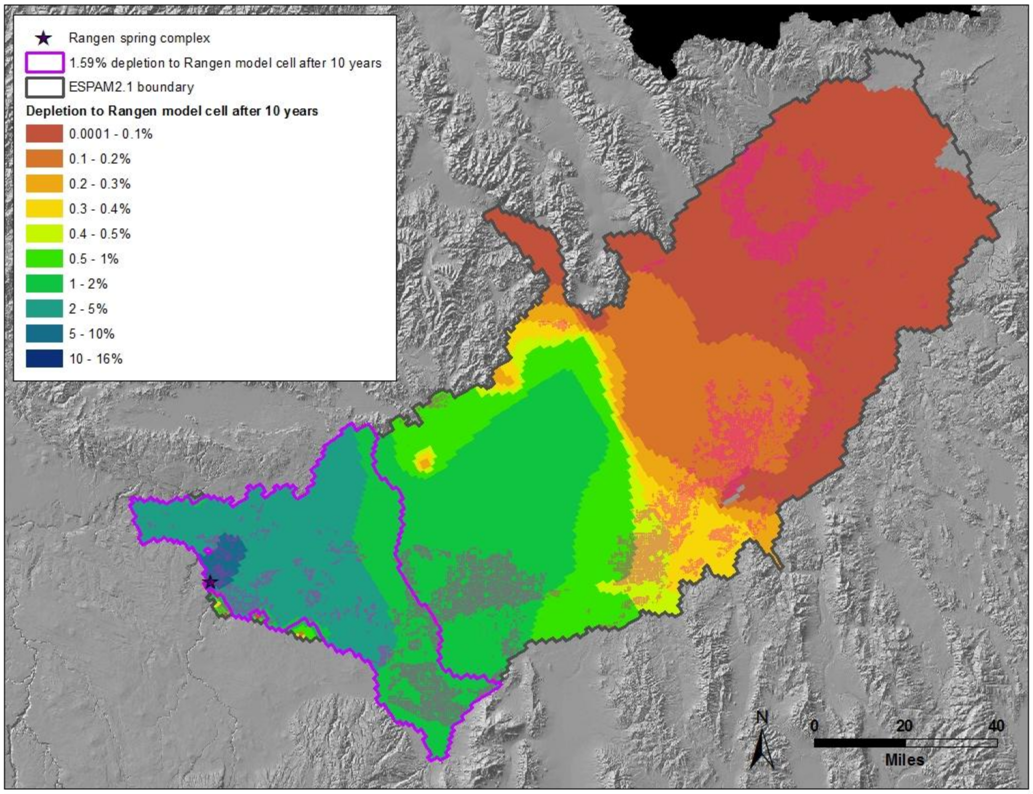


Figure 6. Depletion percentage of 1.59% with respect to Rangen model cell after 10 years within ESPAM2.1 model domain.

Mr. Contor's third proposal is a 10% "uncertainty-based" trim line with respect to the Thousand Springs to Malad reach. Because the Thousand Springs to Malad reach was not used as a calibration target in ESPAM2.1, Mr. Contor summed model results from eight model cells to obtain values for this reach. IDWR staff note that Mr. Contor's list of cells does not include the Three Springs cell, which is also located within the area previously covered by the Thousand Springs to Malad reach in the superseded model version, ESPAM1.1.

ATTACHMENT A.

IDWR staff comments on water measurement issues

IDWR Staff Comments on Expert Reports - 2014 Rangen Delivery Call, Water Right 36-15501
Comments of Tim Luke and Michelle Richman, IDWR ("Staff"), February 3, 2015, based on review of expert reports prepared on January 26, 2015 by the following authors:

- Gregory K. Sullivan, P.E., prepared for the City of Pocatello ("Pocatello Report")
- Charles M. Brendecke, Ph.D., P.E. and Sophia Sigstedt, prepared for Idaho Groundwater Appropriators, Inc. ("IGWA Report")
- Charles E. Brockway, Ph.D., P.E. and David C. Colvin, P.G., prepared for Rangen, Inc.

Curren Tunnel Measurements

1. IDWR Measurement of Curren Tunnel
    a. Information in the Pocatello and IGWA Reports summarizing the interview with IDWR staff on November 5, 2014 appear to be factual and accurate. During the interview, staff described problems with accurate measurement of flows in the Curren Tunnel. Specifically, the 6-inch White Pipe in the tunnel interferes with the cross-sectional discharge measurement. The existence of the pipe does not create an ideal cross section for discharge measurements and hampers the ability to install a standard measuring device.
    b. The IGWA Report (p. 2-2) states that the USGS (2004) recommends methods for shielding transducers to mitigate against potential error when transducers are placed in an active flow field (an open channel as opposed to a stilling well). IDWR does shield the Curren Tunnel pressure transducer in a galvanized metal pipe with perforated holes to minimize the type of error described in the IGWA Report. The type of error described by IGWA should be adequately mitigated. Although stilling wells are preferred, installation of a stilling well in this location is not practical for IDWR.
    c. A comparison of physical hand-held staff gage readings in the Curren Tunnel taken by IDWR staff from 2010 through 2014 with 15-minute logged water level depths from the installed pressure transducer nearest the time of the IDWR hand held gage reading shows very little variation between the two measurements. As shown in Table A-1, the differences between the two measurements range from -0.05 ft to +0.08 ft, with an average difference of 0.004 ft (absolute average of 0.02 ft). A linear regression fit between the two variables results in an R-squared value of 0.99 (Figure A-1). The strong correlation of the data and small variation between the measurements suggests that error from the installed transducer is negligible.
    d. IDWR acknowledges that there have been several periods where the pressure transducer failed and had to be replaced. Pressure transducers have a limited life and are expected to fail and be replaced periodically. Regarding concerns by Pocatello about IDWR's estimates of Curren Tunnel flows during periods of time when the transducer failed or was moved, IDWR staff recommends removing those estimates from the historical record although removal of those estimates will not likely have a significant effect on average annual flows.

e. The water level or stage recording device in the corrugated metal pipe (CMP) or "steel pipe" within the tunnel has been maintained by IDWR over the years for the purpose of monitoring depth and flow trends. Periodic flow measurements of the tunnel by IDWR staff using a portable current meter allow staff to develop a stage-discharge relationship. This relationship, used with the pressure transducer or continuous water level recorder, provides a continuous flow record for the tunnel. Prior to 2014, IDWR staff did not anticipate that the monitoring equipment in the tunnel would be used to represent the flow diverted or available to Rangen under all of its water rights. Given the current understanding that the source of water and point of diversion under Rangen's water rights is limited only to the Curren Tunnel, then staff concurs with the recommendations from Pocatello and IGWA that a standard measuring device should be installed to measure the discharge of the Curren Tunnel.

f. For practical reasons, staff does not agree with the suggestion in the Pocatello Report that a standard measuring device be installed in the tunnel upstream of the 6-inch White Pipe or somewhere "around the 6-inch White Pipe." Staff recommends that a measuring device be installed in the Farmer's Box, or the area where water discharges from the CMP before discharging to the PVC pipes that convey the CMP discharge to the Rangen collection box ("Rangen Box") located on the talus slope below the Curren Tunnel (refer to map in IGWA Report, p F-2, for locations of Farmers Box and Rangen Box). Any installed measuring device should be a standard device in accordance with *IDWR's Minimum Acceptable Standards for Open Channel and Closed Conduit Measuring Devices*. The Department should consider issuing an order requiring installation of one or more standard measuring and recording devices to measure all of the water diverted by Rangen from its authorized points of diversion.

2. Measurement of 6-inch White Pipe

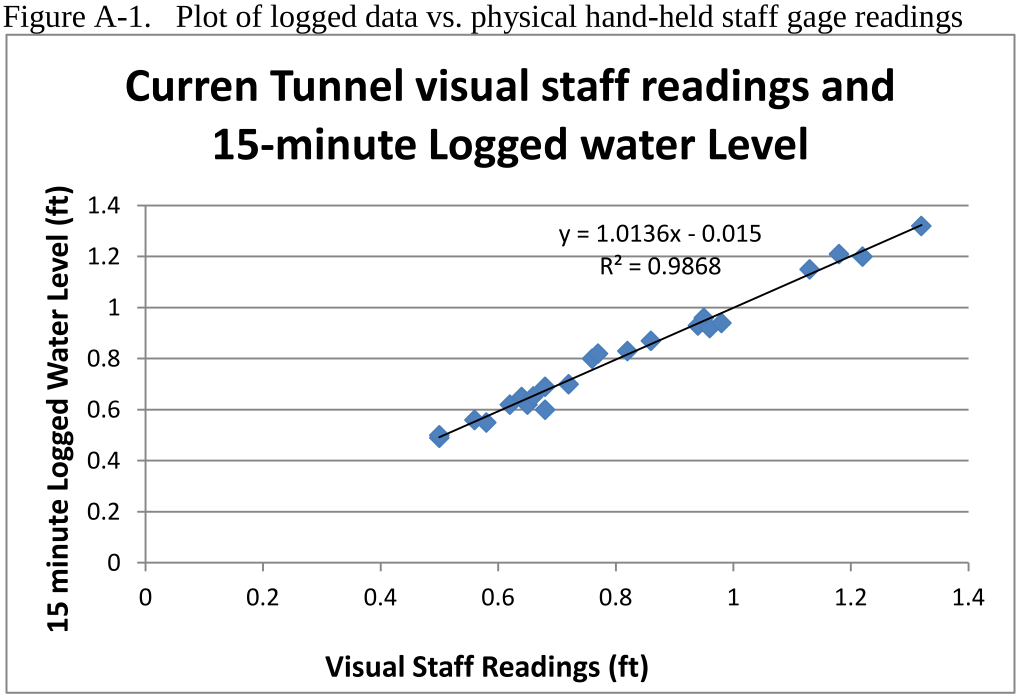
a. The Pocatello Report refers to a December 15, 2006 memorandum from Cindy Yenter, IDWR Watermaster for Water District 130, describing the procedures used by Rangen to estimate flow from the 6-inch White Pipe (Pocatello, p. 11). The actual or correct date of the memorandum by Cindy Yenter is December 15, 2003.

b. Staff concurs with recommendations from Pocatello and IGWA Reports that a standard measuring device or flow meter should be installed on the 6-inch White Pipe. Moreover, the weekly frequency of the pipe flow measurements by Rangen and interpolation between measurements is not adequate for providing an accurate and reliable record of water use from the pipe. Staff concurs with the recommendation found in the IGWA Report (p. 3-4) that "a flow meter should be installed in the white pipe upstream of the bifurcation between the hatch house and domestic/irrigation service line." The suggested location will assure that all of the water diverted and used is measured. Staff recommends that IDWR issue an order to Rangen requiring installation of a standard flow meter pursuant to *IDWR's Minimum Acceptable Standards for Open Channel and Closed Conduit Measuring Devices*. The order should also include requirements for installation of a data logger or similar recording device suitable for deriving average daily flows.

Table A-1 Comparison of IDWR Staff Gage Readings with Logged Pressure Transducer Readings

Date/Time	Visual Staff Readings (ft)	15-min Logged Wtr Level (ft)	Difference (Vis - Log)
2/23/2010 13:45	0.86	0.87	-0.01
7/29/2010 11:15	0.64	0.65	-0.01
12/13/2010 12:15	0.94	0.93	0.01
1/31/2012 13:30	0.95	0.96	-0.01
4/12/2012 11:00	0.76	0.8	-0.04
7/25/2012 10:15	0.82	0.83	-0.01
10/24/2012 11:45	1.32	1.32	0.00
12/13/2012 11:00	1.22	1.2	0.02
2/21/2013 14:15	0.96	0.92	0.04
5/3/2013 13:15	0.65	0.62	0.03
6/28/2013 11:30	0.68	0.6	0.08
8/16/2013 9:45	0.56	0.56	0.00
10/17/2013 10:15	1.18	1.21	-0.03
3/5/2014 10:30	0.77	0.82	-0.05
3/14/2014 10:00	0.72	0.7	0.02
4/10/2014 10:00	0.56	0.56	0.00
5/9/2014 11:45	0.5	0.49	0.01
5/13/2014 13:45	0.5	0.5	0.00
6/3/2014 11:45	0.62	0.62	0.00
7/1/2014 9:00	0.66	0.6525	0.01
8/1/2014 12:30	0.58	0.55	0.03
8/22/2014 9:45	0.68	0.69	-0.01
9/25/2014 10:00	0.98	0.94	0.04
10/24/2014 10:15	1.13	1.15	-0.02
		Avg. Difference	0.004

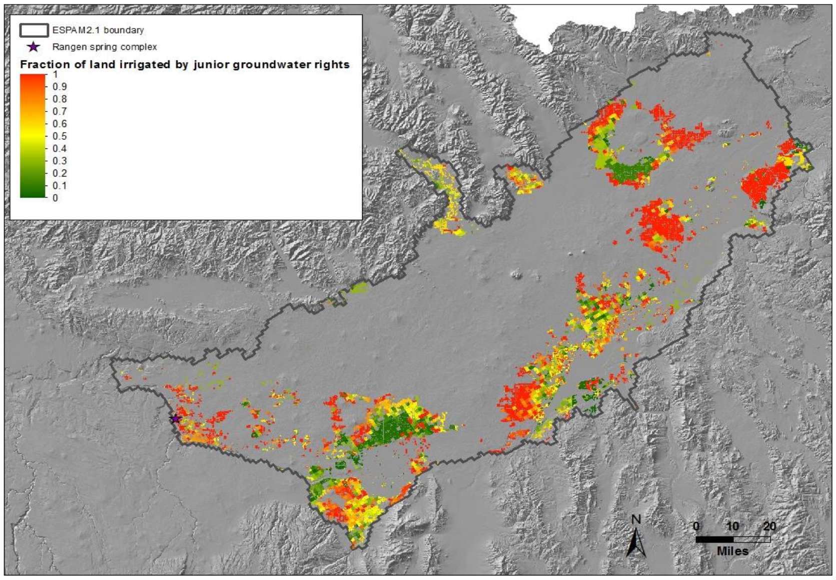
Figure A-1. Plot of logged data vs. physical hand-held staff gage readings



ATTACHMENT B.

ESPAM2.1 model simulations of curtailment junior to July 1, 1957

Simulated curtailment junior to July 1, 1957 within ESPAM2.1 model boundary



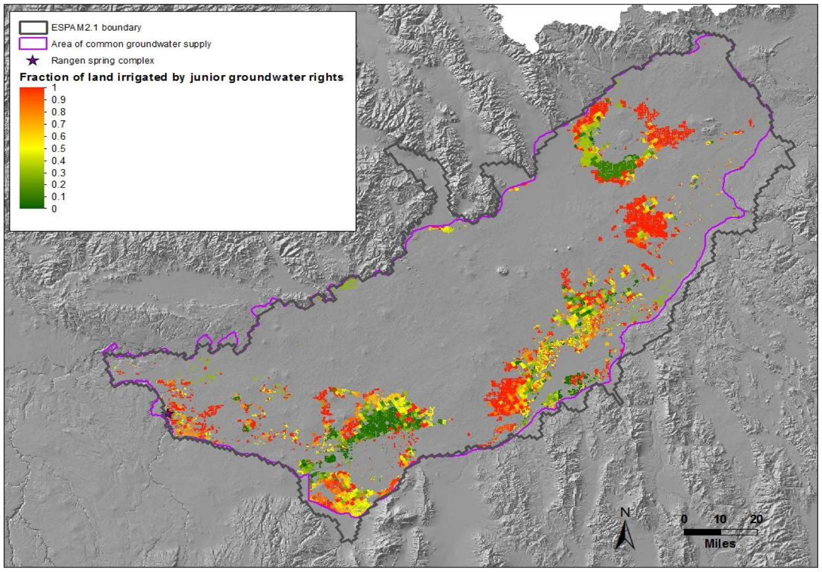
Simulated curtailment:	721,460	acres	
	1,578,335	AF/yr	crop irrigation requirement
	2,178.63	cfs	crop irrigation requirement
	2.19	AF/ac/yr	crop irrigation requirement

Predicted response:	**Reach**	**Response (cfs)**	**Response (AF/yr)**	
	Ashton to Rexburg	185.68	134,516	
	Heise to Shelley	255.81	185,323	
	Shelley to Near Blackfoot	292.96	212,236	
	Near Blackfoot to Minidoka	888.15	643,434	
	Kimberly to Buhl	166.54	120,654	
	Buhl to Lower Salmon Falls	323.97	234,707	
	Lower Salmon Falls to King Hill	65.52	47,466	
	Total	2,178.63	1,578,336	
	Group A&B Spring Reaches			
	Devil's Washbowl	8.00	5,797	
	Devil's Corral	10.42	7,551	
	Blue Lakes	27.94	20,239	
	Crystal	61.99	44,912	
	Niagara	42.88	31,062	
	Clear Lake	56.50	40,936	
	Briggs	1.53	1,106	
	Box Canyon	92.49	67,004	
	Sand	24.65	17,855	
	Thousand	66.67	48,301	
	National Fish Hatchery	15.03	10,891	
	Rangen	23.59	17,087	
	Three	17.11	12,396	
	Malad	55.85	40,459	
Reach of interest:	Curren Tunnel (63% of Rangen)	14.86	10,765	48,554 ac/cfs
	Response/simulated stress	0.7%		
	Time to reach 90% steady state	14 years		
Response at other reaches:		2,163.77	1,567,571	
	Response/simulated stress	99.3%		

Transient analysis:

Year	Average impact at Rangen spring cell (cfs)	Average impact at Curren Tunnel (cfs)
1	6.7	4.2
2	10.7	6.8
3	13.1	8.3
4	14.9	9.4
5	16.3	10.2

Simulated curtailment junior to July 1, 1957 within current area of common groundwater supply



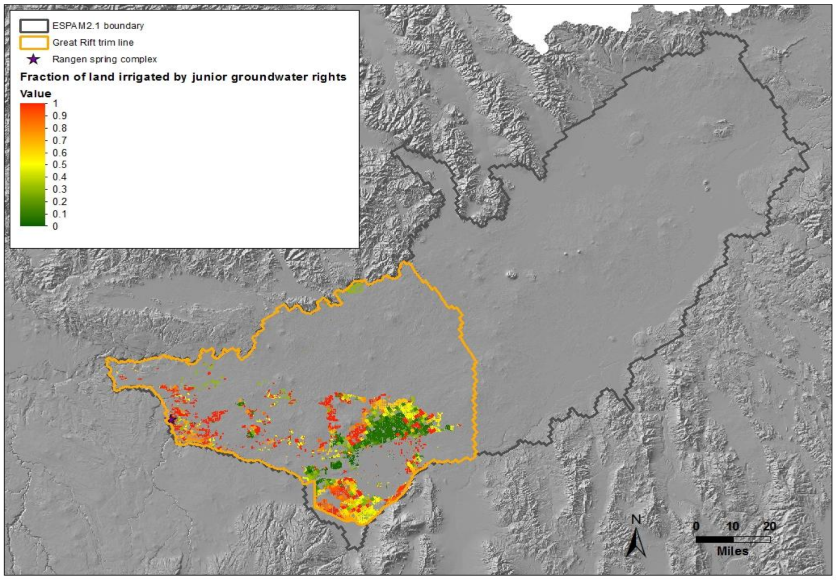
Simulated curtailment:	605,570	acres	
	1,381,929	AF/yr	crop irrigation requirement
	1,907.52	cfs	crop irrigation requirement
	2.28	AF/ac/yr	crop irrigation requirement

Predicted response:	**Reach**	**Response (cfs)**	**Response (AF/yr)**	
	Ashton to Rexburg	127.04	92,032	
	Heise to Shelley	196.40	142,286	
	Shelley to Near Blackfoot	264.64	191,723	
	Near Blackfoot to Minidoka	803.39	582,029	
	Kimberly to Buhl	152.60	110,555	
	Buhl to Lower Salmon Falls	301.62	218,511	
	Lower Salmon Falls to King Hill	61.83	44,792	
	Total	1,907.52	1,381,930	
	Group A&B Spring Reaches			
	Devil's Washbowl	7.13	5,164	
	Devil's Corral	9.29	6,733	
	Blue Lakes	25.22	18,268	
	Crystal	57.43	41,603	
	Niagara	39.81	28,841	
	Clear Lake	52.54	38,060	
	Briggs	1.42	1,029	
	Box Canyon	85.94	62,264	
	Sand	22.91	16,599	
	Thousand	62.18	45,044	
	National Fish Hatchery	14.03	10,164	
	Rangen	22.01	15,945	
	Three	15.97	11,569	
	Malad	52.62	38,123	
Reach of interest:	Curren Tunnel (63% of Rangen)	13.87	10,046	43,672 ac/cfs
	Response/simulated stress	0.7%		
	Time to reach 90% steady state	11 years		
Response at other reaches:		1,893.66	1,371,884	
	Response/simulated stress	99.3%		

Transient analysis:

Year	Average impact at Rangen spring cell (cfs)	Average impact at Curren Tunnel (cfs)
1	6.7	4.2
2	10.6	6.7
3	12.8	8.1
4	14.5	9.1
5	15.8	9.9

Simulated curtailment junior to July 1, 1957 within Great Rift trim line



Simulated curtailment:		215,190	acres		
		538,339	AF/yr	crop irrigation requirement	
		743.09	cfs	crop irrigation requirement	
		2.50	AF/ac/yr	crop irrigation requirement	

Predicted response:	**Reach**	**Response (cfs)**	**Response (AF/yr)**	
	Ashton to Rexburg	7.09	5,134	
	Heise to Shelley	20.76	15,041	
	Shelley to Near Blackfoot	62.18	45,050	
	Near Blackfoot to Minidoka	209.27	151,609	
	Kimberly to Buhl	129.73	93,981	
	Buhl to Lower Salmon Falls	259.28	187,838	
	Lower Salmon Falls to King Hill	54.78	39,686	
	Total	743.09	538,340	
	Group A&B Spring Reaches			
	Devil's Washbowl	6.08	4,402	
	Devil's Corral	7.91	5,732	
	Blue Lakes	21.22	15,373	
	Crystal	48.88	35,409	
	Niagara	34.00	24,633	
	Clear Lake	45.04	32,627	
	Briggs	1.22	882	
	Box Canyon	73.59	53,312	
	Sand	19.62	14,217	
	Thousand	53.64	38,859	
	National Fish Hatchery	12.12	8,782	
	Rangen	19.01	13,775	
	Three	13.80	9,996	
	Malad	46.47	33,664	
Reach of interest:	Curren Tunnel (63% of Rangen)	11.98	8,678	17,964 ac/cfs
	Response/simulated stress	1.6%		
	Time to reach 90% steady state	9	years	
Response at other reaches:		731.11	529,661	
	Response/simulated stress	98.4%		

Transient analysis:

Year	Average impact at Rangen spring cell (cfs)	Average impact at Curren Tunnel (cfs)
1	6.7	4.2
2	10.3	6.5
3	12.2	7.7
4	13.6	8.6
5	14.6	9.2