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Memorandum

TO: Bryce Contor

FROM: Spronk Water Engineers, Inc.; Gregory K. Sullivan, P.E.

DATE: January 14, 2009

RE: **Comments to Adjustments to Canal Seepage**

On behalf of the City of Pocatello, I am providing the following comments regarding the adjustments to canal seepage that you describe in the memo to the ESHMC dated December 28, 2009.

Proposed Procedure

Our understanding of the procedure that you used to determine the canal seepage fraction is that you manually adjusted the parameters used in the canal seepage algorithm and the mixed-source fraction to achieve computed annual consumptive use fractions that met your subjective expectations. These subjective expectations are listed in the December 28, 2009 memo.

I agree with your observation that the methodology is troubling. You also stated the following "I have used these subjective estimates and expectations because we don't have and can't reasonably acquire data for objective determination of these parameters." You also noted that the reasoning may be circular, in that the adjusted parameters will be used to generate an input data set for the On-Farm calculation, which will use assumptions about reasonable consumptive-use fractions to generate estimates for return flows. I concur, but the circular procedure can be thought of as a iterative procedure applied to historical data in order to arrive at input parameters that produce results that reasonably match actual or expected water supply adequacy (e.g., consumptive use fraction, percent of years with shortage, etc.). In other words, the process may be thought of to some extent as a calibration procedure.

The following is a proposed procedure to be used in the new water budget tool for computing irrigation losses and irrigation consumptive use.

CU = minimum of [Diversion x (1 - Conveyance Loss %/100)] x [1 - Farm Efficiency%/100], or CIR

There are some additional details in the methodology such has how the on-farm loss and possibly the conveyance loss is split into surface returns and ground water returns, but for purposes of discussion, I will refer to the above simplified form of the equation.

The two unknown parameters in the above generalized equation are the Conveyance Loss % and the Farm Efficiency %. Of these two parameters, I believe that the Conveyance Loss % is the most "knowable." I continue to believe that real data does exist or can be reasonably obtained for many of the canal companies related to the Conveyances Loss %, and the adjustment procedure should be crafted to take advantage of this information. For example, there is significant information available regarding the conveyance losses for the Surface Water Coalition (SWC) entities as a result of the Surface Water Coalition ("SWC") Delivery Call hearing. Canal loss information is also likely available for other companies, especially the larger companies.

Conveyance losses in canal systems can be measured or reasonably estimated. In our experience, irrigation district managers and personnel generally tend to have a good understanding of the conveyance losses in their system because they either measure or estimate farm headgate deliveries to their users. The difference between what they divert and what they deliver is the conveyance loss, and most district managers can either calculate or estimate the fraction of the diversions that are delivered to their users, or conversely, the fraction of the diversions that are lost (to a combination of spill/waste, seepage, evaporation, and non-beneficial consumptive use).

I suggest that information from the canal companies and irrigation districts be obtained regarding conveyance losses, and that information be used to specify a Conveyance Loss % in the above equation for each irrigation user in the model. Alternatively, the specified Conveyance Loss % could be used to derive appropriate parameters in the more detailed canal seepage algorithm that has been previously used.

It will be important to distinguish the portion of the conveyance loss that goes to seepage (and thus recharge of the aquifer) and the portion that returns to the river immediately as surface returns (e.g., spill/waste). I believe there is information available from the canal companies and irrigation districts regarding the portion of their conveyance losses that occur due to spill/waste as opposed to seepage and other miscellaneous (consumptive losses).

<u>Conveyance Losses for Surface Water Coalition Members</u>

As a result of our involvement in the Surface Water Coalition ("SWC") delivery call, we had the opportunity to analyze the historical irrigation operations of each of the SWC members. As a part of that work, we obtained information regarding conveyance losses of each member. We compared the conveyance loss information that were obtained for the SWC members to the canal seepage fractions that are set forth in the December 28, 2009 memorandum. These comparisons revealed some significant differences as described below.

The attached Table 1 includes a comparison of the ESPAM Canal Fraction and the Conveyance Loss percentages that we used in the SWC Delivery Call. The original ESPAM Canal Fractions are listed in column (1) and the modified Canal Fractions described in the December 28, 2009 memorandum are shown in column (2). Note that the Canal Fraction is the average fraction of net irrigation season diversions that becomes canal seepage. Net diversions are the total measured diversions minus the specified return flows (spills/waste).

Columns (3) and (4) show the conveyance loss percentages that were used in the SWC Delivery Call matter by Pocatello's expert (Spronk Water Engineers), and by the SWC experts (HDR and Brockway Engineering). Column (3) shows the conveyance loss percentage that we derived in our analyses on behalf of the City of Pocatello. These data were generally based on records of irrigation deliveries and other information provided by the District managers. These figures represent all conveyance losses including spills/waste, seepage, evaporation, and non-beneficial consumptive use.

Column (4) shows the conveyance loss percentages that were proposed by the SWC experts for the SWC members. Their figures were derived from an analysis of canal seepage using the Worstell method. The Worstell method is used to estimate canal and lateral seepage based on the wetted area of the canal, and the soil types through which the delivery system is constructed. The Worstell method was previously rejected by the ESHMC for the purposes of determining canal seepage (Contor, 2009, Representation of Recharge from Canal Leakage for Calibration of ESPAM Version 2, As Built, p 8). This method was also determined by the Hearing Officer to be unreliable (see Section XIV.5. of the April 29, 2008 Ruling in the SWC Delivery Call). Nevertheless, this information can still be helpful for comparison purposes if it is evaluated in conjunction with other available data. Note that the conveyance loss figures in Columns (3) and (4) represent total conveyance loss as a percentage of total diversions. This is different than the ESPAM Canal Loss Fractions, which as described above, represent canal seepage loss as a percentage of net diversions (total diversions minus surface return flows).

While there are some definitional differences between the ESPAM Canal Fraction and the Conveyance Loss Percentages in the attached table, it is clear that there are significant differences between the seepage losses proposed to be used in the model and the conveyance loss information developed in the SWC Delivery Call litigation. The following is a summary of the results for each SWC member (except for TFCC[1]).

1. A&B - The Canal Seepage Fraction for the A&B Irrigation District (A-Unit) of 35% is substantially greater than the 17% Conveyance Loss % determined from A&B delivery records.

2. AFRD#2 - In the ESPAM, it appears that AFRD#2 is split into two users, although the basis for this split is unknown. Entity IESW058 has been assigned a proposed Canal Seepage Fraction of 69%. Entity IESW059 has been assigned a Canal Seepage Fraction of 35%.

[1]The majority of the TFCC service area is not located within the ESPAM study area.

These figures compare to the to the 48% conveyance loss percentage determined by both sides in the SWC Delivery Call litigation. The figure from the SWC delivery call represents the percentage loss of water diverted from the Snake River. Depending on the relative portions of diversions assigned to Entity IESW058 and IESW059, the proposed Canal Seepage Fractions may not be unreasonable.

3. BID - The Canal Seepage Fraction for the Burley Irrigation District of 35% matches the Conveyance Loss % that SWE determined in the SWC litigation. However, definitional differences should be considered.

4. Milner - The Canal Seepage Fraction for the Milner Irrigation District was adjusted upward from 36% to 51%. However, delivery data from the District indicates that the conveyance losses are typically in the range of 18% to 20%.

5. MID - The Canal Seepage Fraction for the Minidoka Irrigation District of 22% is much less than the 35% Conveyance Loss % that SWE determined in the SWC litigation.

6. NSCC - The Canal Seepage Fraction for the North Side Canal Company was adjusted downward from 35% to 27%. The modified figure appears to be too low compared to typical 33% conveyance loss reported by Ted Diehl, manager of the NSCC.

We would urge that the Conveyance Loss % from the SWC delivery call litigation be used in the computation of conveyance losses in ESPAM 2.0. Depending on how the Canal Loss Fractions are used in ESPAM 2.0 (i.e., applied to total diversions or net diversions), it may be necessary to adjust the figures from the SWC litigation before they are used in the model.

Consumptive Use Fraction

The attached Table 2 shows the original and modified ESPAM Consumptive Use Fraction for the SWC members. These represent irrigation season values for the period from 1980 - 2008. As described in the December 28, 2009 memorandum, the Consumptive Use Fraction was computed from the ESPAM 1.1 information as the irrigation water requirement divided by the net diversions. Net diversions are the total diversions less the return flows, and less the canal seepage when that was explicitly simulated (three users).

For comparison purposes, Table 2 shows the assumed maximum and computed average actual farm irrigation efficiency (consumptive use divided by farm headgate deliveries) from our analysis of historical water use during the period from 1990 - 2005. The maximum farm irrigation efficiency is the assumed upper limit of consumptive use as a percentage of farm headgate deliveries that could occur under water short conditions. As farm headgate deliveries increase beyond the full supply condition, the computed actual efficiency declines.

The input parameter for the proposed ESPAM 2.0 water budget procedure is the maximum farm irrigation efficiency. We would propose that this figure be determined by trial and error using the equation on page 2 of these comments. The following procedure is proposed.

1. Determine or estimate the Conveyance Loss % from available data, interviews of District officials, comparison to similar canal systems with data available, etc.

2. Specify the portion of the Conveyance Loss % that becomes canal seepage and the portion that occurs as surface return flows (spill/waste). Assign the canal seepage portion to the cells containing the primary canal and laterals.

3. Apply the equation on page 1 using the Conveyance Loss % and vary the Farm Efficiency % until the computed annual or monthly consumptive use values match expected values. The expected values could be anecdotal information regarding water supply adequacy in dry, average, and wet years. Alternatively, the actual values could be determined from analysis of actual consumptive use data from METRIC.

4. Split the on-farm loss between deep percolation and surface runoff using the DPIN and DPEX parameters that have been discussed previously. The deep percolation portion would be distributed across the cells in the canal service area.

5. Compute the total surface return flows as sum of (a) the surface runoff portion of conveyance losses (spill/waste) and (b) the surface runoff portion of on-farm losses.

Table 1
Comparison of ESPAM Canal Fraction and Conveyance Loss Estimates
Surface Water Coalition Members

		(1)	(2)	(3)	(4)
		ESPAM Canal Fraction		Conveyance Loss from SWC Delivery Call	
		Original	Modified	SWE	SWC
	A&B	35%	35%	17%	34%
(5)	AFRD#2 (IESW058)	39%	69%	48%	48%
(6)	AFRD#2 (IESW059)	35%	35%	48%	48%
	BID	35%	35%	35%	42%
	Milner	36%	51%	20%	18%
	MID	35%	22%	35%	24%
	NSCC	34%	27%	33%	53%

Notes:

(1) ESPAM Canal Fraction is the average fraction of net summertime diversions that becomes canal seepage for the period 1980 - 2008 reported in spreadsheets provided by Bryce Contor on 1/5/2009 that contain the manual adjustments to the canal seepage algorithm and the mixed source fraction described in the 12/28/2009 memo to the ESHMC (IESW0*xx* _Analysis_20091223_*entity* .ods.). The Original ESPAM Canal Fractions are described in the 12/28/2009 memo to the ESHMC, expressed as a percent of net diversions (gross diversions minus return flows as computed in ESPAM1.1).

(2) The Modified ESPAM Canal Fractions after Contor adjustments as described in the 12/28/2009 memo to the ESHMC.

(3) Estimates of conveyance loss by Spronk Water Engineers (SWE) and the Surface Water Coalition (SWC) experts presented at the SWC Delivery Call Hearing, expressed as percent of total diversions. The SWE conveyance loss figures were determined based on deposition testimony from managers of the irrigation district or canal company or from district records (SWE, Updated Expert Report dated September 26, 2007 Prepared for the City of Pocatello, p 17).

(4) The SWC conveyance loss figures were computed using the Worstell method (SWC Expert Report, dated September 26, 2007, Appendix AU and associated spreadsheets "*xxx* Water Requirements-Res-Ops.xls".

(5) Entity IESW058 - Lands irrigated from the Milner-Gooding Canal, upstream of the Wood Rivers and Dietrich areas.

(6) Entity IESW059 - Lands irrigated in the Wood Rivers, Dietrich and Richfield area.

Table 2

Comparison of ESPAM Consumptive Use Fraction and Farm Efficiency Estimates

Surface Water Coalition Members

		(1)	(2)	(3)	(4)
		ESPAM CU Fraction		Maximum	Actual
		Original	Modified	Farm Efficiency	Farm Efficiency
	A&B	133%	133%	73%	68%
(5)	AFRD#2 (IESW058)	25%	49%	74%	65%
(6)	AFRD#2 (IESW059)	52%	52%	74%	65%
	BID	63%	63%	71%	67%
	Milner	46%	59%	75%	58%
	MID	86%	72%	74%	70%
	NSCC	73%	66%	78%	49%

Notes:

(1) Average consumptive use fraction for the period 1980 - 2008 reported in the spreadsheets provided by Bryce Contor on 1/5/2009, and referenced in Table 1, Note (1). The Original ESPAM CU Fractions are described in the 12/28/2009 memo to the ESHMC.

(2) The Modified ESPAM CU Fraction after Contor adjustments as described in 12/28/2009 memo to the ESHMC.

(3) The Maximum Farm Efficiency is the upper limit of consumptive use as a percentage of farm headgate deliveries, based on a weighted average of efficiencies for gravity irrigated lands and sprinkler irrigated lands.

(4) The Actual Farm Efficiency is the computed average annual farm efficiency during 1990 - 2007 from the water budget analysis presented by the Pocatello expert at the SWC Delivery Call Hearing. Farm Efficiency = (Crop CU + change in soil moisture)/farm headgate diversions.

(5) Entity IESW058 - lands irrigated from the Milner Gooding Canal, upstream of the Wood Rivers and Dietrich areas.

(6) Entity IESW059 - lands irrigated in the Wood Rivers, Dietrich and Richfield area.