

Draft Report:
"Carriage-water" Paradigm
Applied to Groundwater Transfers
Between the South Fork and the Henrys Fork

12 December 2009
B. Contor

Problem Statement

Figure 1 illustrates the area between the Henrys Fork and South Fork of the Snake River, including the communities of Rexburg, Sugar City and Newdale. Groundwater and mixed-source irrigation is also illustrated with a dotted pattern. Experience has shown that applying the existing groundwater rights transfer policies and transfer tool in this area can result in very high mitigation requirements. This is because the tendency of the tool is to suggest that moving the point of diversion even a short distance will significantly shift impacts between the Henrys Fork and South Fork.

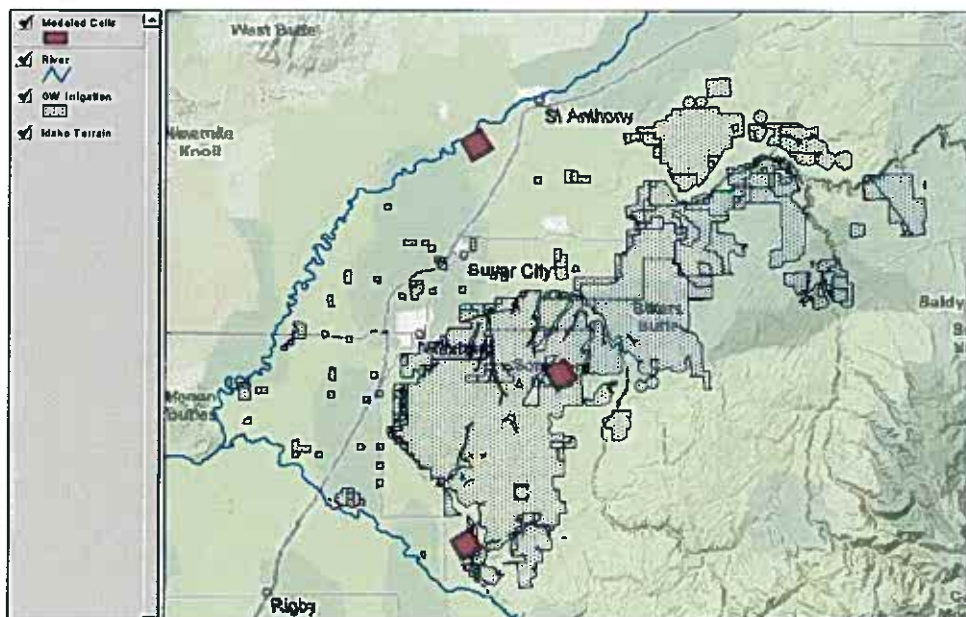


Figure 1. Map of the area between the Henrys Fork and South Fork of the Snake River

There are two reasons that these high mitigation requirements may not be appropriate. The first is the existence of a series of faults that are not represented in ESPAM1.1, and currently do not appear to be contemplated for ESPAM2.

The hydrologic effect of this fault zone is not precisely quantified. However, it will tend to compartmentalize the aquifer in this region, so that any transfer that does

not cross the fault zone will likely have little effect on the partition of impacts between the Henrys Fork and the South Fork. This is not a criticism of the model or of modeling. All models are simplifications of reality; this particular simplification simply results in modeling results that may be inappropriate for analyses that are currently used in transfer administration.

These faults and their hydrologic effects are addressed in a separate report.

The second reason this use of the model may be inappropriate is administrative. While a transfer can be stopped or mitigation required on the likelihood that injury would occur, the possibility of injury must be more than mere speculation, conjecture or administrative policy (Getches Water Law in a Nutshell, 1990). This memo describes characteristics of water delivery in and through the Henrys Fork and South Fork. These indicate that no injury can result to any surface-water diverter from a groundwater transfer in the describe area. Therefore, it is inappropriate to block transfers or require mitigation on the basis of modeled impacts to the Henrys Fork or South Fork. This is true even ignoring the existence of the fault zone.

Carriage-water Concept

Idaho law allows delivery of replacement water into natural streams, to offset surface-water diversions that otherwise would have been out of priority. Clearly, if the injection occurs upstream of the out-of-priority diversion, there is no possibility of injury to other surface-water diverters. At all locations and at all times the stream will contain as much or more water than it would without the diversion and replacement.

However, in the Henrys Fork and South Fork reaches of the Snake River, exchange wells are authorized which are downstream of the out-of-priority diversion, in some cases many miles. Similarly, releases from Palisades Reservoir on the South Fork are sometimes used to mitigate out-of-priority diversions on the Henrys Fork or its tributaries, miles above the confluence of the Henrys Fork and South Fork. Clearly, by the absolute protection of replacement water injected above the out-of-priority diversion is not present in these cases. However, as shown in Figure 2 and Figure 3, the existence of downstream deliveries protects all diverters in the intervening distance between the out-of-priority withdrawal and the replacement injection.

Figure 2 illustrates the without-exchange condition. Fifty cubic feet per second must be delivered to senior diverters or users of storage, to locations below the reach of interest. The aggregate use of intervening diverters in the reach is thirty cubic feet per second.

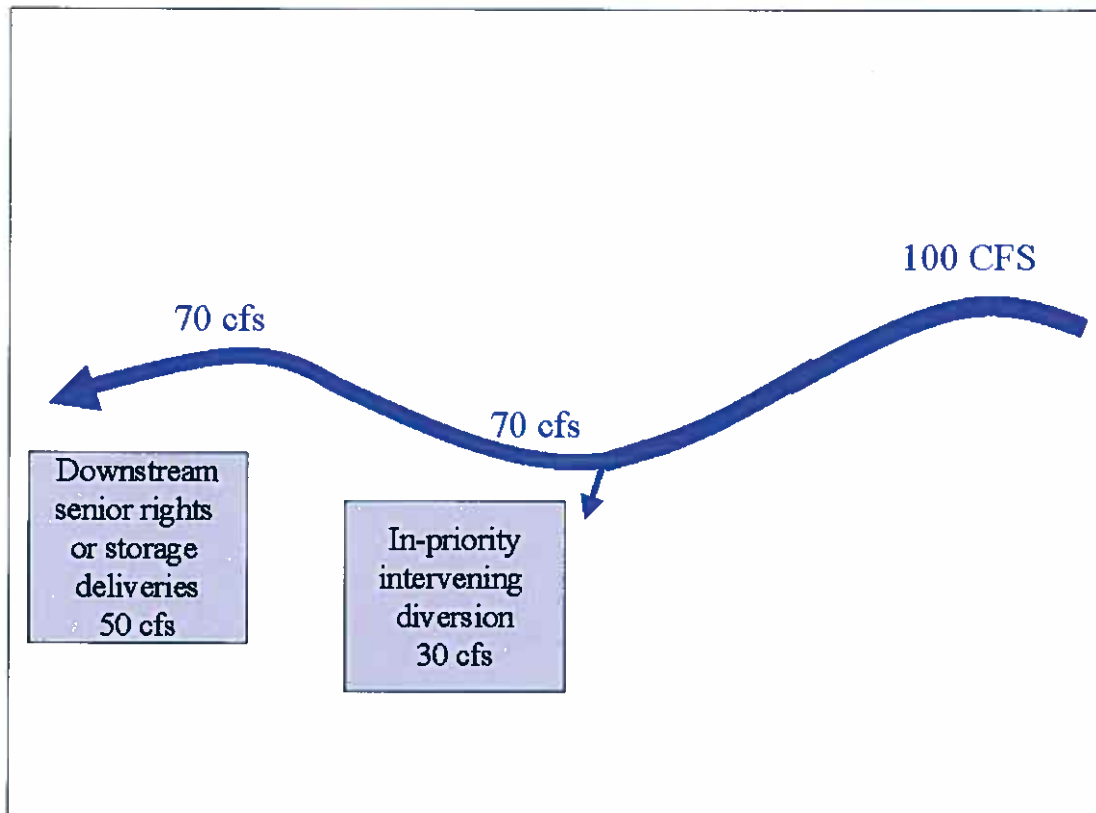


Figure 2. Hypothetical deliveries in sample river reach, without out-of-priority deliveries.

Figure 3 illustrates the same hypothetical condition with an out-of-priority diversion above the intervening diverters, replaced by an exchange well or storage delivery below the intervening users. The existence of storage deliveries or senior natural-flow deliveries below the reach guarantees there will be adequate water in the reach for the juniors. One can conceptually change the flow values to represent priority allocation as inflow to the reach drops, and verify that the juniors are never injured by the presence of the out-of-priority diversion and the exchange wells. This result will hold as long as the sum of (intervening diversions) and (out-of-priority diversions) does not exceed the required downstream deliveries of storage and senior natural-flow water.

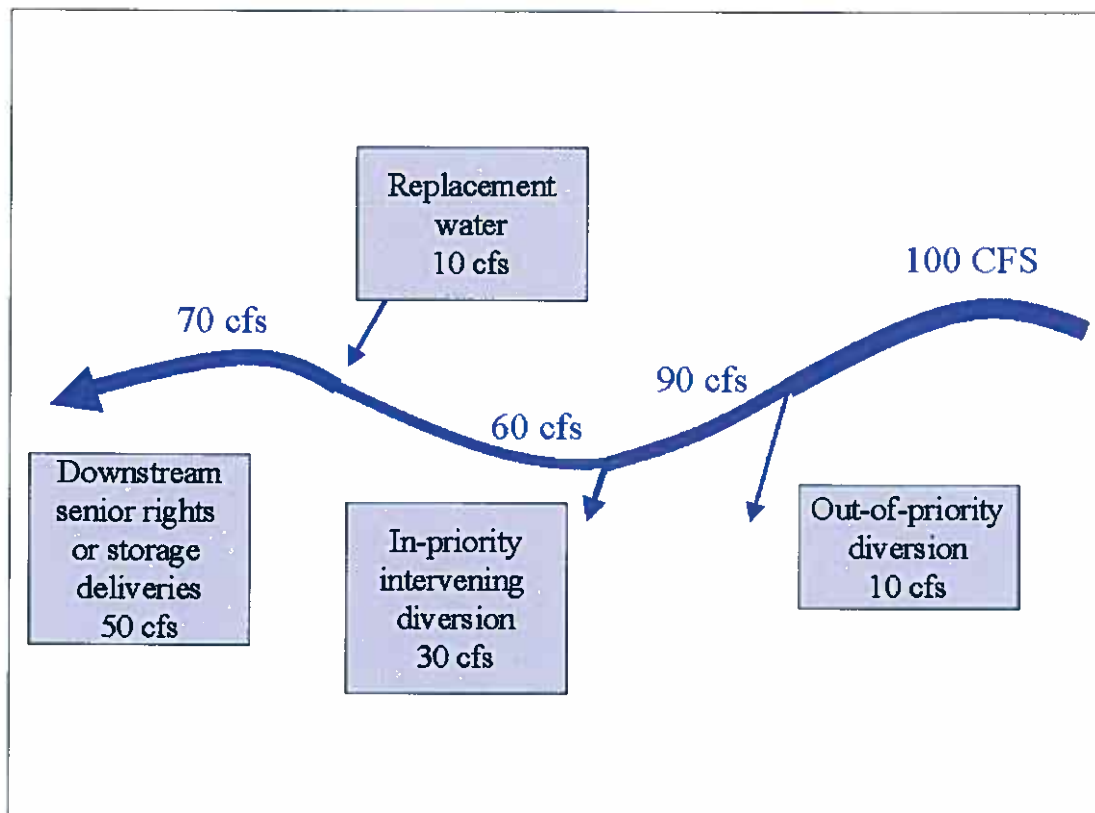


Figure 3. Hypothetical deliveries with out-of-priority diversion and downstream replacement.

These figures explain why the current practice of replacing out-of-priority diversions with downstream exchange well or storage water is appropriate. Because of deliveries of storage or senior natural flow to users below the reach, there will always be adequate flow in the reach for users whose points of diversion are intervening between the out-of-priority diversion and the downstream injection of replacement water. As long as downstream deliveries exceed the in-reach deliveries (including the out-of-priority delivery), injury to surface-water users will not result. This routinely used concept is labeled the "carriage-water" concept for this report.

Application of Concept to Groundwater Transfers

Transfer-tool analyses tend to indicate very small changes to all the model reaches except the Henrys Fork and South Fork. Impacts to these other reaches are generally well below the percentage and/or volume limits of current transfer requirements. Between the Henrys Fork and South Fork, a proposed transfer typically reduces impact to one fork, and increase impact to another fork by a corresponding amount. The amounts often exceed the limits set under current policy.

However, one could apply the "carriage-water" concept to this pair of offsetting impacts. Conceptually, one could consider a transfer as an out-of-priority diversion from one fork, replaced by a replacement injection (due to reduced pumping impacts) to the other.

Intuitively, relative to the hundreds or thousands of cubic feet per second of downstream deliveries in either reach, the very small volume of this conceptual exchange-well transaction is trivial. Not only would it be below the threshold that could cause injury, it is below the technical ability to measure flow in either fork. However, current rationale of transfer policy seems to be to deny any transfer that might, in conjunction with many similar transfers, result in injury. The following analysis explores the possibility of injury from multiple similar transfers, if the "carriage water" paradigm were used to allow transfers without mitigation to Henrys Fork/South Fork changes.

Analysis of Cumulative Effect

Overview. The impact of groundwater pumping for irrigation was estimated by using the input data from the IWRRI Curtailment Scenario (Contor and others, 2006. http://www.if.uidaho.edu/%7ejohnson/Curtail_v1_1.pdf). Municipal pumping was represented by a quick informal estimate. The resulting stress was rounded up to an applied stress of 470 cubic feet per second in the summer trimester, and 20 cubic feet per second in the other two trimesters of each year. This estimate of stress was entered into the water-rights transfer tool at three different locations, in three different analyses. The "Approximate Center" location is model cell Row 64 Column 187, shown as the brown square east of Rexburg in Figure 1. The "Henrys Fork" location is model cell Row 54 Column 189, shown as the brown square west of St. Anthony in Figure 1. The remaining location, model cell Row 68 Column 180, is the southern-most square in Figure 1 and is used as the "South Fork" location.

For each location, the final twenty years¹ of simulated impacts to the Henrys Fork and South Fork were used to assess the potential for injuring intervening water rights above the confluence of the forks. The Henrys Fork analysis moves all groundwater pumping from the "Approximate Center" location to the "Henrys Fork" location. The South Fork analysis moves all pumping from the "Approximate Center" to the "South Fork" location.

Assumptions. The following assumptions are implicit in this analysis. These generally have the effect of exaggerating the indicated potential for injury:

1. All impact from irrigation pumping occurs in a single four-month period.
2. The Approximate Center location is a reasonable proxy for the effect of spatially-distributed groundwater pumping.

¹ Using the final years allows the maximum representation of impact to be considered; the greatest amount of time is allowed for aquifer storage processes to equilibrate.

3. The effects of the fault zone are ignored.
4. It is assumed that *all* pumping would be moved to the extreme north or extreme south locations; that there would be no offsetting transfers in the opposite direction.
5. It would be physically possible to concentrate all post-transfer pumping as close to the reaches as represented in the analysis.
6. Flows at the Lorenzo and Rexburg gages during the dry years 2000 through 2005 are a reasonable proxy of the downstream delivery of senior and/or storage deliveries that must be satisfied before intervening users receive delivery.
7. The algorithm for assessing injury is as follows:

$$EF = G + M_{\text{center}} \quad (1)$$

EF = Equivalent flow, if groundwater pumping were not present

G = Recorded flow at gage

M_{center} = Modeled impact from transfer tool, "Approximate Center" location

$$AT = EF - M_{\text{nearby}} \quad (2)$$

AT = After-transfer flow at gage

M_{nearby} = Modeled impact from transfer tool, assuming all pumping is moved to the location nearest the reach of interest.

8. Two criteria are applied.

The first criterion is that hypothetical transfer of all groundwater pumping to the near-reach location cannot injure intervening surface-water diverters as long as value AT is above zero.

The second criterion is a measure of the hazard or sensitivity of the analysis. It is the ratio of the minimum value of AT to the peak simulated groundwater pumping rate. It is an indication of the sensitivity of the analysis. Higher numbers indicate the analysis is more robust to imprecision in the modeling or input data.

These assumptions are highly conservative; they are likely to indicate a level of hazard that is many times the true potential.

Results. Figure 4 and Figure 5 show the results for the Henrys Fork and South Fork, respectively. In both cases the pale blue trace shows the irrigation season, when potential injury is a concern. Projected flows are nearly on top of one another, indicating that changes from wholesale transfer of all groundwater rights would be trivial compared to the typical flows that occurred during this drought period. Obviously, the potential for impact would be even less in wetter periods.

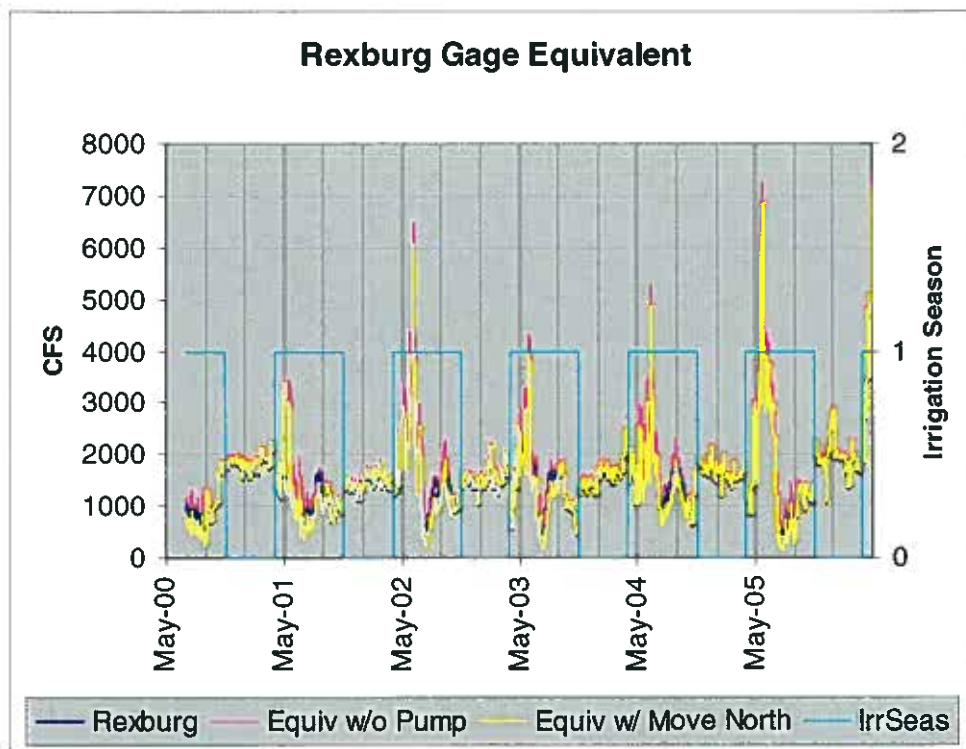


Figure 4. Modeling results for Henrys Fork.

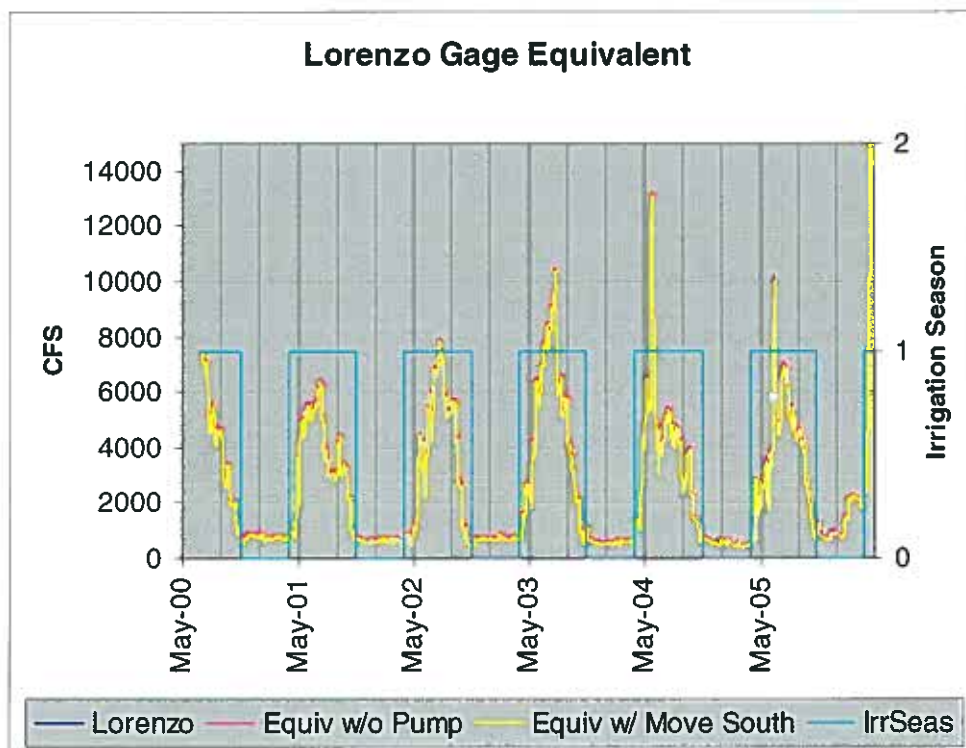


Figure 5. Modeling results for South Fork

In the Henrys Fork simulation, the lowest single irrigation-season observation with the hypothetical transfer of all groundwater pumping to near the river is a projected downstream flow of 80 cfs. Therefore, Criterion 1 is satisfied. Criterion 2, the ratio of minimum downstream flow to summertime pumping, is 17%. In the South Fork, the lowest single irrigation-season observation is 422 cfs. Criterion 1 is satisfied and Criterion 2 is 90%.

Conclusion

The carriage-water paradigm is currently used for administration of exchange-well and storage mitigation in the Snake River system. Conceptually, it is adequate to prevent injury to other surface-water users, as long as downstream deliveries exceed the sum of out-of-priority diversions and intervening diversions in the affected reach. Its use is accepted and appropriate.

This analysis indicates that the carriage-water paradigm could be applied to indications of changes in impact to the Henrys Fork and South Fork, when groundwater transfers are contemplated in the area between these forks. Even under extremely conservative assumptions that exaggerate potential for harm, the aggregate of many transfers in one direction or the other still could not result in injury to surface-water users.

Because increased impact to one fork is offset by decrease impact to the other, the net effect below the confluence is minimal. Because significant volumes of water are delivered through the reaches to uses below the confluence, even in dry years, there is adequate carriage water in either fork to accommodate even the extreme hypothetical wholesale transfers simulated in the analyses.

More sophisticated analysis could be performed by adjusting the assumptions in turn. The result would be that indicated impact would better approach what might be actually expected. These adjustments would tend to reduce the representation of possibility of injury, relative to this analysis.

Recommendation

This analysis points to a policy change that IDWR should consider, and a modeling change that the Eastern Snake Hydrologic Modeling Committee should consider.

1. Transfers should not be denied, nor mitigation required, for modeled changes in impact that move water from the Henrys Fork to the South Fork or vice versa. Since even a wholesale movement of all groundwater pumping could not produce injury, there cannot be any legal justification for pre-supposing injury from any single transfer

application.

2. The calibration of ESPAM2 should include a representation of the fault zone as a lower-transmissivity region of the model. The lack of data suggests that such an adjustment would be imprecise and somewhat arbitrary, but this would still be *less* imprecise and arbitrary than the ESPAM1.1 practice of completely ignoring the geological data that indicate the presence of the zone.